Alos4Amazon Advanced Training 2010 No.01

「GIS Tech.」

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Skype&Twitter: mapconcierge

Alos4Amazon
www.alos4amazon.com

- GIS Expert for Alos4Amazon Project
- President of MAPconcierge inc,
- Researcher of CSIS, at the univ. of Tokyo.
- Director of OSGeo.JP foundation
- Evangelist of KML
- **Tree Climber**

Taichi

@mapconcierge

Agenda

Day1: Old/Neo Geographer

Day2: Basic of SQL

Day3: SQL with Geospatial

Day4: Google

I'm a **TreeClimber**

- GIS Expert for Alos4Amazon Project
- President of MAPconcierge inc,
- Researcher of CSIS, at the univ. of Tokyo.
- Director of OSGeo.JP foundation
- Evangelist of KML
- Tree Climber

Taichi

@mapconcierge

Of course, I have

two licenses

TREE CLIMBING JAPAN OFFICIAL WEBSITE

TREE MASTER CLIMBING ACADEMY

6

Because,

It's **related** with the GIS tech.

I (we)

have

a **TreeHouse**

in Japan.

(made by ourself)

It means...

That's my hobby, but...

GIS can use

a lot of GeoSpatial Data

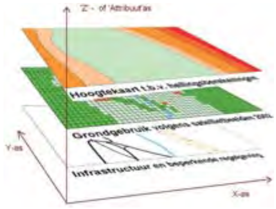
as **MODEL**.

↕

We called **Feature**.

You know,

“MODEL” is not “real”.



From Wikipedia, the free encyclopedia

≒
Similar
but
different

From Wikipedia, the free encyclopedia

In other words…

Every time

we have to **compare**

between

both information

using by **training data.**

“GIS Tech.”

like a “**Bridge**” between

the **IT**world and the **Real**world.

Field work is

very important for GIS tech.

(C) JAXA

(C) Tree Climbing Master Academy

Let’s start!!

Question.1

?

Question.2

?

Do you know

our project name?

Do you know

our web site?

Alos4Amazon

21

Alos4Amazon

www.alos4amazon.com

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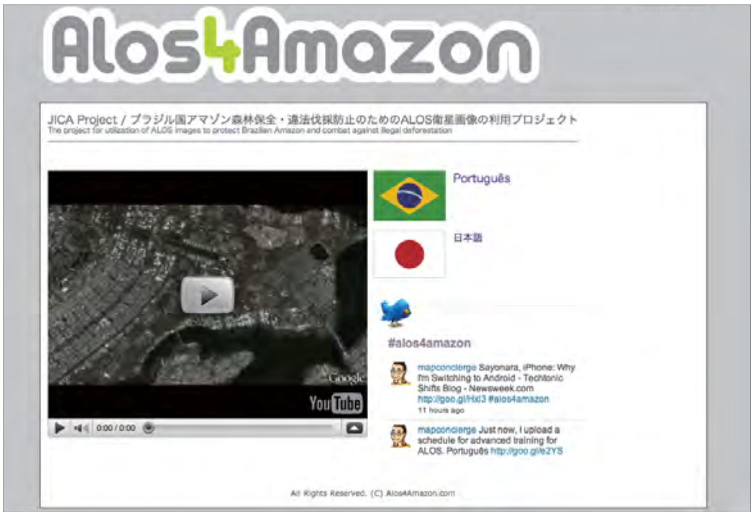
Question.3

?

Have you ever seen

our web site?

in Português



If you want

more information

for our Tech.

Come on!

our site.

by the way,

http://twitter.com

Do you have a

Twitter Account ?

If you not,

ASAP, you have to **create** it!

Hastag is
#alos4amazon

(C) Twitter.

If you

don't

understand

in this training...

http://twitter.com

Please **Tweet!!** to us.

Oh, I found
a new BUG!
#alos4amazon

(C) Twitter.


Please Tweet!! to us.
Oh, EPSG code
is very difficult!!
#alos4amazon
(C) Twitter.
by Taichi FURUHASHI


but,
by Taichi FURUHASHI

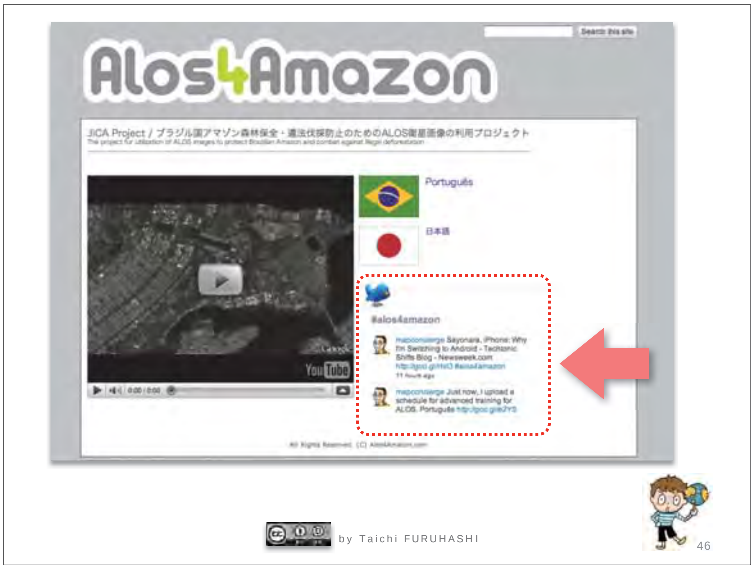

Please Tweet!! to us.
Where is
android SDK?
#alos4amazon
(C) Twitter.
by Taichi FURUHASHI


Don’t tweet
sensitive info.
Oh, I found
a new illegal
deforestation area
in RO!
#alos4amazon
(C) Twitter.
by Taichi FURUHASHI


We can catchup
your tweets!
by Taichi FURUHASHI


Don’t tweet
sensitive info.
Oh, I found
a new illegal
deforestation area
in RO!
#alos4amazon
(C) Twitter.
by Taichi FURUHASHI


but,
Oh, I found new illegal deforestation area in RO! #alos4amazon
(C) Twitter.
by Taichi FURUHASHI


Alos4Amazon
JICA Project / ブラジル国アマゾン森林保全・違法伐採防止のためのALOS衛星画像の利用プロジェクト
Português
日本語
#alos4amazon
by Taichi FURUHASHI
46


without details
That’s OK
Oh, I found new illegal deforestation area!
#alos4amazon
(C) Twitter.
by Taichi FURUHASHI


Mission1:
Let’s tweet!!
using by
#alos4amazon
by Taichi FURUHASHI


Hash tag is
#alos4amazon
by Taichi FURUHASHI


by Taichi FURUHASHI

Let's **back** to

my Presentation

Let's **back** to

my Presentation

Mission2:

Let's follow!!

to

@alos4amazon

@mapconcierge

In this afternoon,

I will explain about

OpenSource

Tools for **Geo**

Because

- GIS Expert for Alos4Amazon Project
- President of MAPconcierge inc,
- Researcher of CSIS, at the univ. of Tokyo.
- Director of OSGeo.JP foundation
- Evangelist of KML
- Tree Climber

Taichi

@mapconcierge

and,

I will explain about…

- GIS Expert for Alos4Amazon Project
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- Researcher of CSIS, at the univ. of Tokyo.
- **Director of OSGeo.JP foundation**
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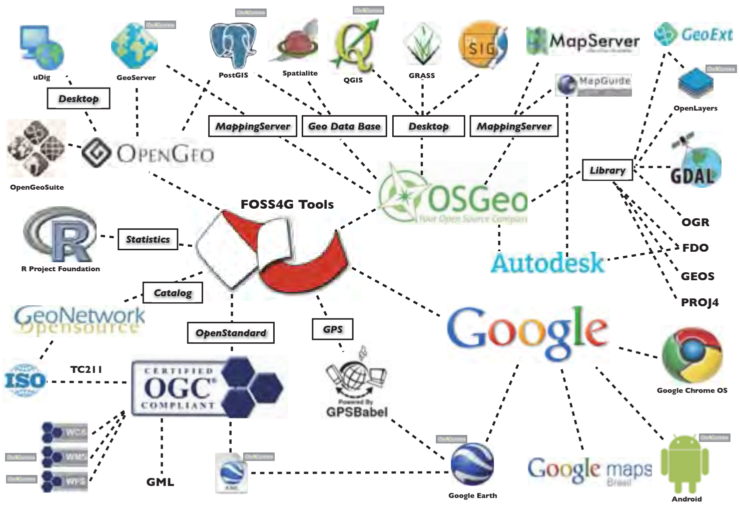
Taichi

@mapconcierge

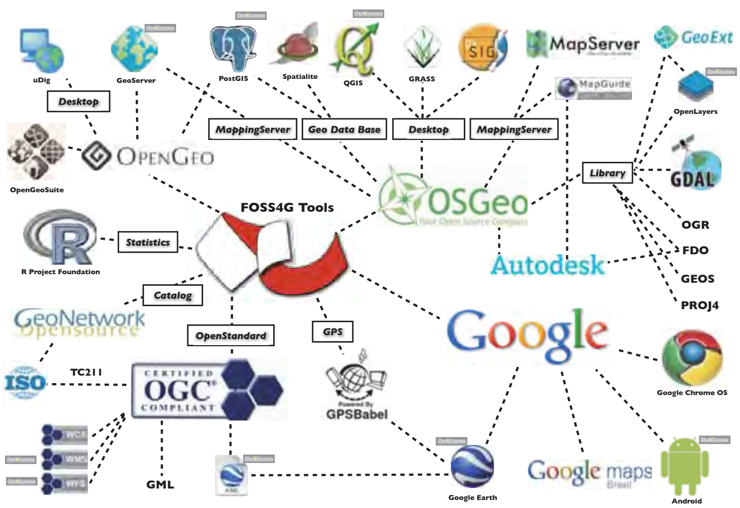


I'm a **director**

with OSGeo.JP

OSGeo Your Open Source Compass

If there is one thing that you don't know…



Mission3:

Let's join

to

http://**goo.gl/TIMk**

(ML of OSGeo.BR)

Why

do you **have to join** the **Twitter** and **ML?**

ML of OSGeo.BR


Brasil — OSGeo Brasil

Sobre Brasil

This list is for local, Brasil, discussions relating to OSGeo. It is primarily in Portuguese.

Para ver a coleção de postagens anteriores a lista, visite os arquivos da Brasil.

Usando Brasil

Para postar uma mensagem a todos os membros da lista, envie um email para brasil@lists.osgeo.org

Você poderá se inscrever na lista ou modificar sua inscrição existente, nas seções abaixo.

Inscrevendo-se na Brasil

Inscreva-se na lista Brasil preenchendo o seguinte formulário. Lhe será enviada um email requisitando confirmação, prevenindo que outros inscrevam você gratuitamente. Esta é uma lista oculta, que significa que a lista de membros está somente disponível para o administrador da lista.

Seu endereço de email:

Seu nome (opcional):

GIS tech. is growing now...

You have to get

newest information

from **internet**

by own operation.

You **can get**

very important

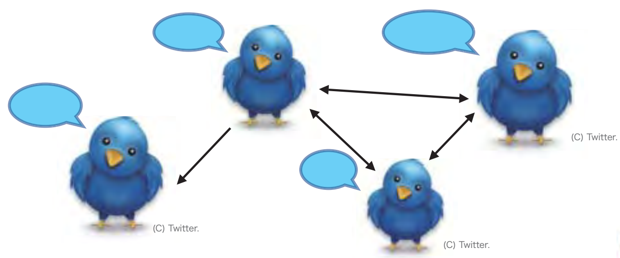
information

in **Português**

Twitter and ML is powerful tool

for **info. gathering**

and **communication.**



via **Human**

We called

“Social Network Service”

You can use my text

in any where, any time

as free.

but, you can

not change

this license.

Attribution-
ShareAlike

I will talk about License.

License

about this text.

CC-by-SA

Commercial use OK / **2nd use** OK

but Attribution-**ShareAlike**

Let’s **start** to

actual training!!

What’s different?

Agenda

Day1: Old/Neo Geographer

Day2: Basic of SQL

Day3: SQL with Geospatial

Day4: Google

I was

OLDGeographer

5 years ago.

NEOGeographer

OLDGeographer

OLD Geographer

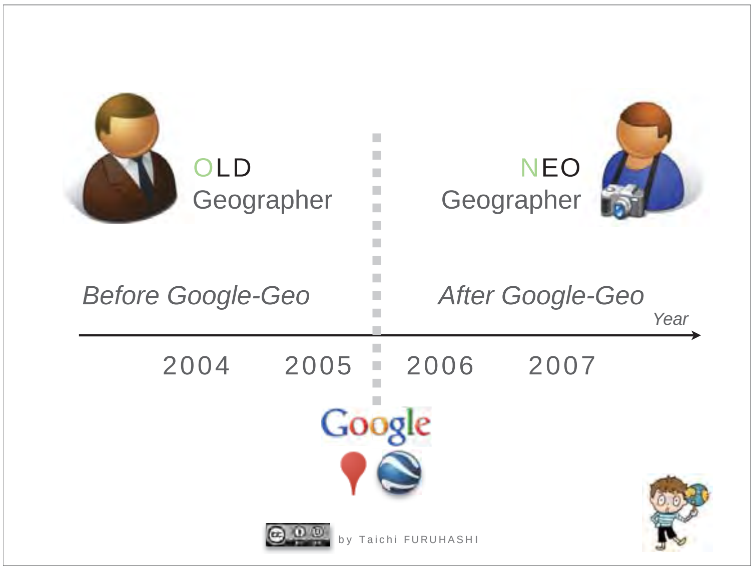
- Cartographer
- Surveyor
- Scientist
- Government
- Forester

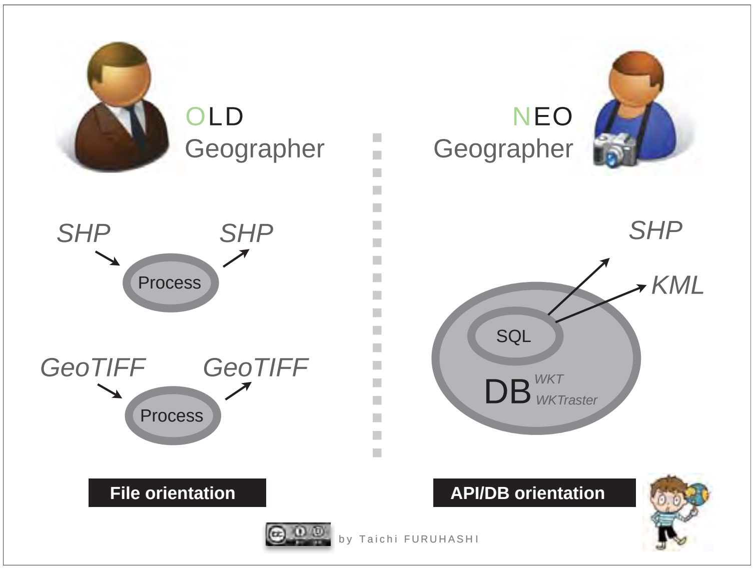
and more...

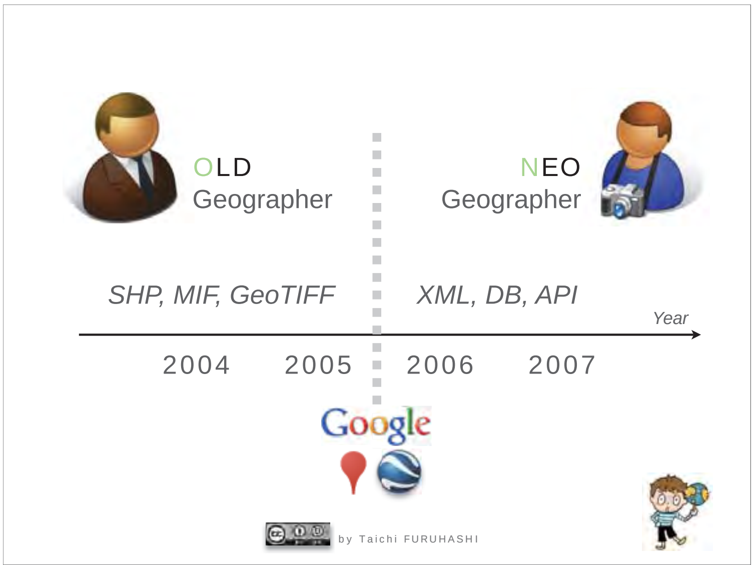
NEO Geographer

- Hobby use
- Google Maps API
- MashUp
- UGC/CGM
- Social Network

and more...







You have to

learn **SQL**

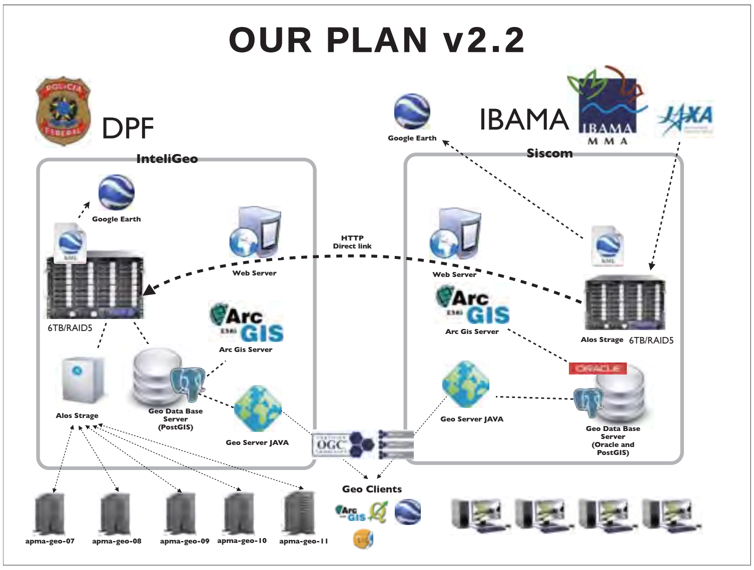
on this traing.

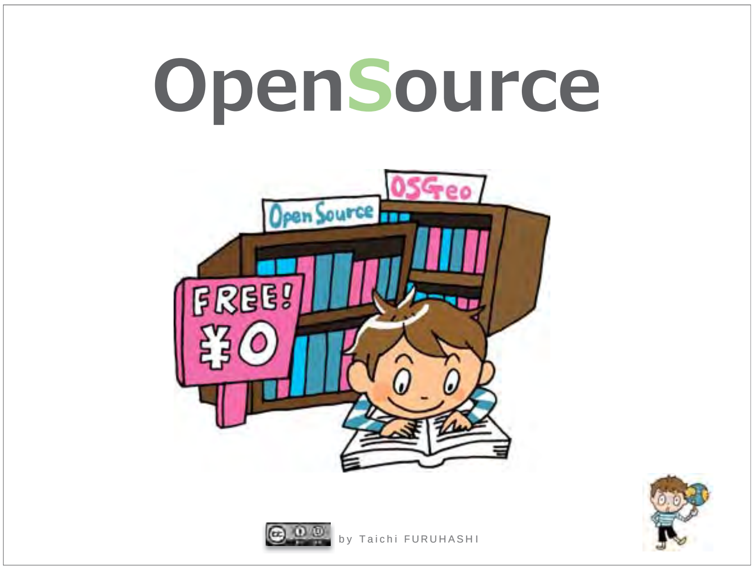
Change to

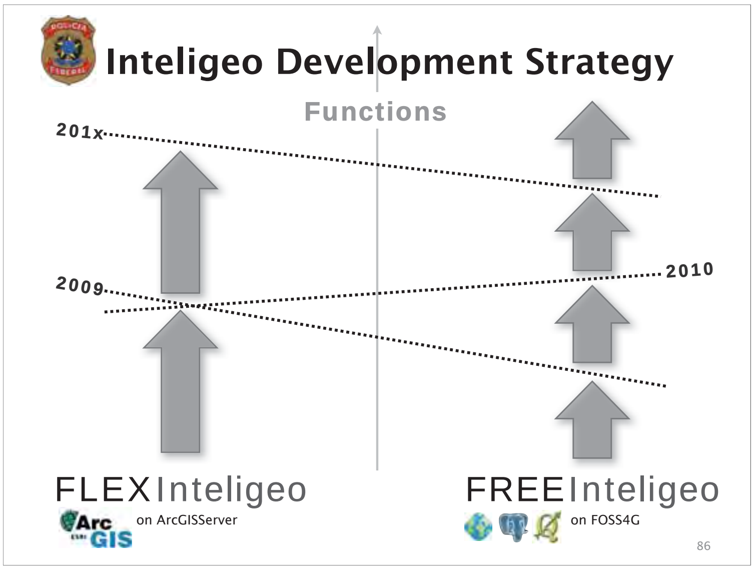
NEOGeographer !

About

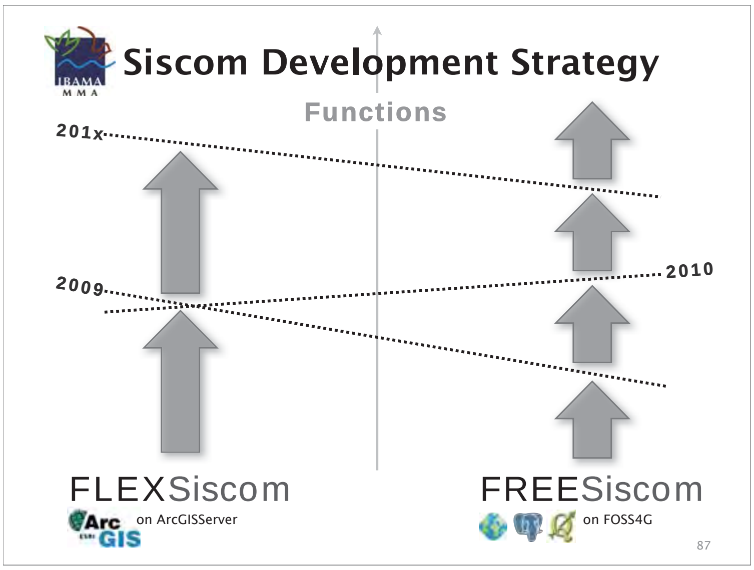
our system

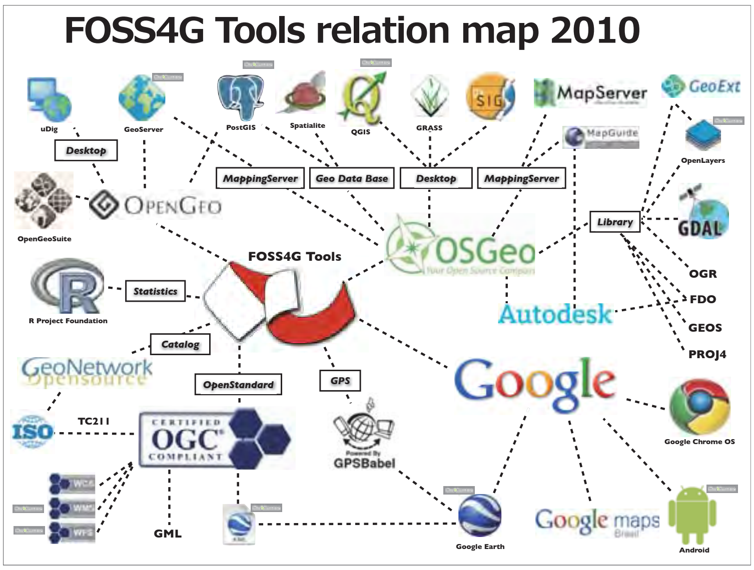

OUR PLAN v2.2
DPF
InteliGeo
Google Earth
Web Server
HTTP
Direct link
Arc GIS
Arc Gis Server
6TB/RAID5
Alos Strage
Geo Data Base Server (PostGIS)
Geo Server JAVA
IBAMA
IBAMA M M A
JAXA
Siscom
Google Earth
Web Server
Arc Gis Server
Alos Strage 6TB/RAID5
ORACLE
Geo Server JAVA
Geo Data Base Server (Oracle and PostGIS)
OGC
Geo Clients
apma-geo-07
apma-geo-08
apma-geo-09
apma-geo-10
apma-geo-11


OpenSource
Open Source
OSGeo
FREE!
¥0
by Taichi FURUHASHI


Inteligeo Development Strategy
Functions
201x
2009
2010
FLEXInteligeo
on ArcGISServer
FREEInteligeo
on FOSS4G
86


OSGeo
Your Open Source Compass
by Taichi FURUHASHI


Siscom Development Strategy
Functions
201x
2009
2010
FLEXSiscom
on ArcGISServer
FREESiscom
on FOSS4G
87


FOSS4G Tools relation map 2010
uDig
GeoServer
PostGIS
Spatialite
QGIS
GRASS
MapServer
GeoExt
MapGuide
OpenLayers
Desktop
MappingServer
Geo Data Base
Desktop
MappingServer
OpenGeoSuite
OPENGEO
Library
GDAL
FOSS4G Tools
OSGeo
OGR
FDO
GEOS
PROJ4
R Project Foundation
Statistics
Autodesk
Catalog
GeoNetwork opensource
OpenStandard
GPS
Google
ISO
TC211
OGC
GPSBabel
Google Chrome OS
GML
Google Earth
Google maps
Android

Licenses

License

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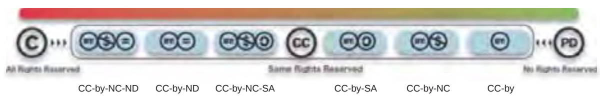

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PD

License

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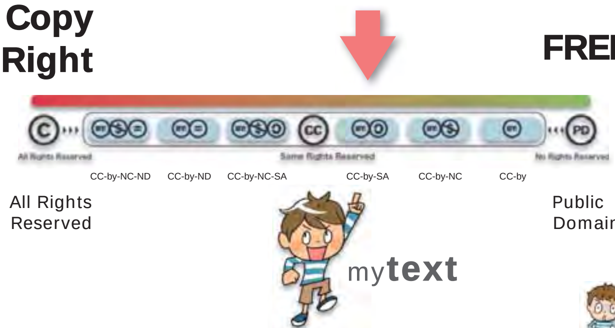

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I will explain about

many type of licenses

in this afternoon.

But, **Geospatial data**

has **weak point of License**

Because,

It is **not** creative.

Just “**fact data**”.

“**GIS Tech.**”

like a “**Bridge**” between

the **IT**world and the **Real**world.

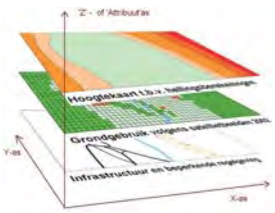
We called

“**CC0**”

Creative Commons Zero

“**GeoSpatial data**”

made by “**real data**”.



From Wikipedia, the free encyclopedia

≒

From Wikipedia, the free encyclopedia


creative commons

CC0 1.0 Universal

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http://**goo.gl/Y8aH**

Alos4Amazon Advanced Training 2010 No.01 afternoon

「GIS Tech.」

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www.alos4amazon.com

OSGeo
Your Open Source Compass

is
supporter
for OpenSource
Geo Community

About OSGeo

OSGeo
Your Open Source Compass

is
supporter
for OpenSource
Geo Community

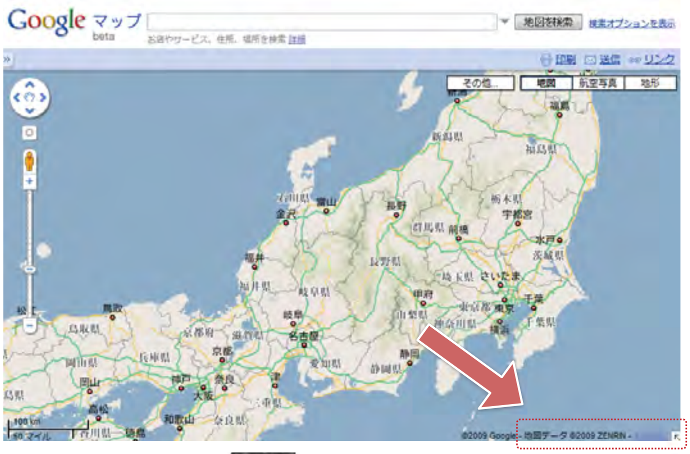
What's
OSGeo

「Geo」
||
GeoSpatial Information

Like the

Google maps Brasil

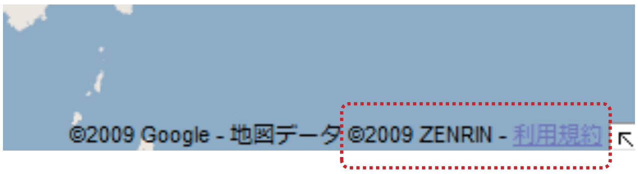
Please click license at lower left.



yes,

but little different.

Let’s read license of Google



GoogleMaps is Free

but **not Open**

Google maps Brasil ≠ Open

Google Maps

can’t

use for print.

We want to make
Mapping Service
like the Google Maps
based on OpenSource.

Example

Is there

JavaScript library

like the Google Maps API?

That's OSGeo!

OSGeo
Your Open Source Compass

OSGeo

Yes we can!

OpenLayers
Google Maps API のような
ユーザーインターフェイスを実現する
JavaScript ライブラリ

OSGeo main streams

①Open**Source**

②Open**Standard**

③Open**Contents**

Example

Is there

Mapping Server product

like the Google Maps?

Yes we can!

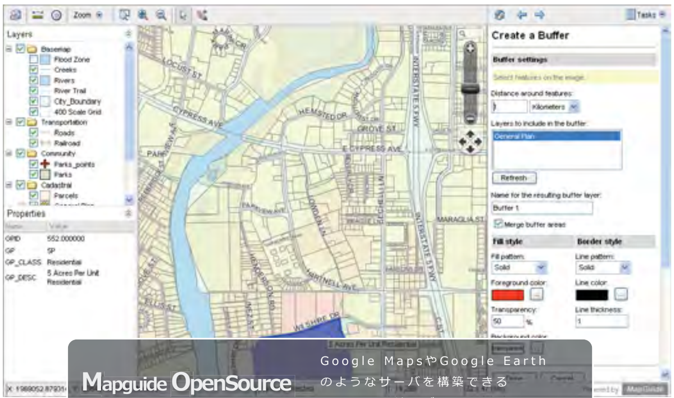
Example

Is there

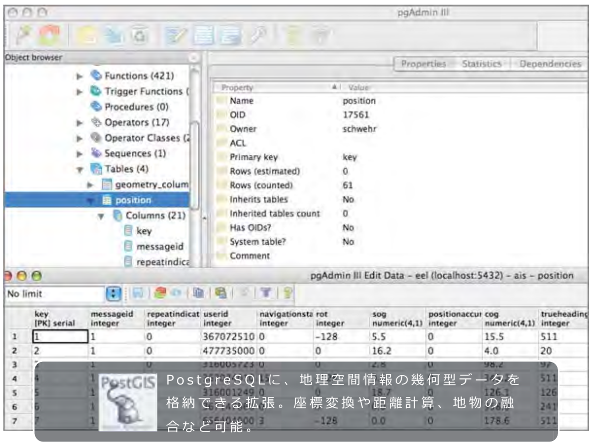
Database for Geospatial

like the Oralce?

Yes we can!



Yes we can!



Yes we can!

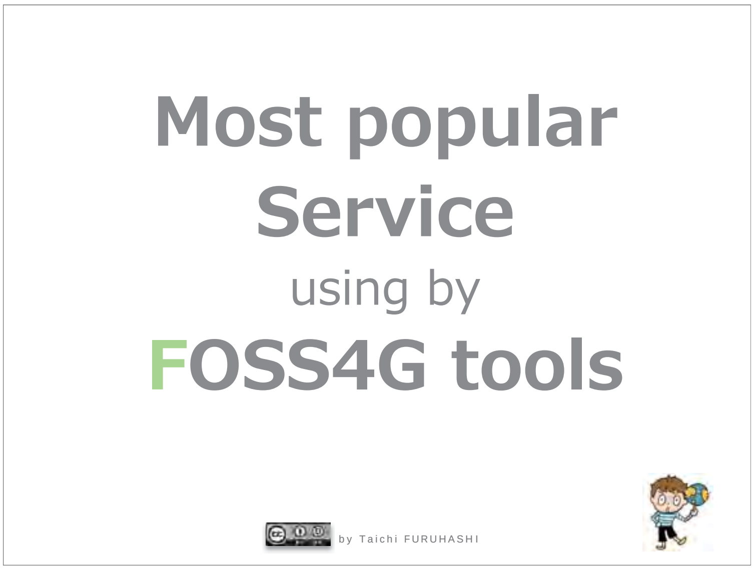
Example

Is there

Desktop GIS

like the ArcGIS?

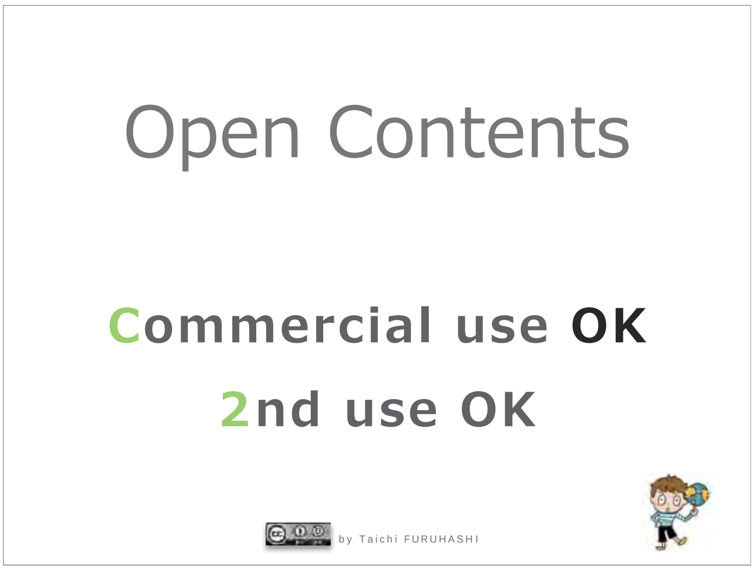

OSGeo
Yes we can!
Q-GIS
スタンドアローンGIS
プラグインを追加することで
自由に拡張可能
by Taichi FURUHASHI

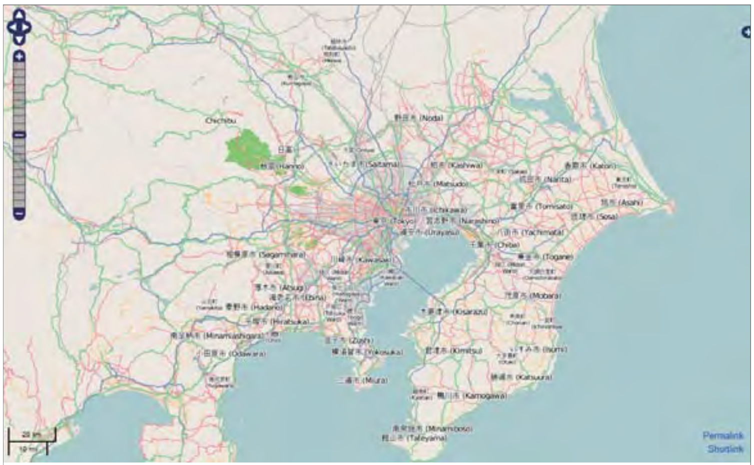

Most popular
Service
using by
FOSS4G tools
by Taichi FURUHASHI


There are
a lot of
Geo Tools
by Taichi FURUHASHI


OpenStreetMap
The Free Wiki World Map
by Taichi FURUHASHI


FOSS4G Tool
Free & Open Source Software for Geospatial
MAPSERVER
PostGIS
GDAL
and more…
by Taichi FURUHASHI


Open Contents
Commercial use OK
2nd use OK
by Taichi FURUHASHI



Tokyo in 2009

OpenSource

Geo Tools

are growing...

Hanno city in 2009

And

We should share

FOSS4G info.

on Conference.

Components

- OpenLayers
- Post-GIS
- PostgreSQL
- PHP5
- Drupal6

That's

FOSS4G

Conference

FOSS4G 2010 Barcelona
Free and Open Source Software for Geospatial CONFERENCE
SEP 6th - 9th
OSGeo

FOSS4G 2009 Tokyo/Osaka
OSGeo.JP

Sponsor of OSGeo

NEOGeographer

Activity

Sponsor of OSGeo

Alos4Amazon Advanced Training 2010 No.01

「Power of NeoGeographer」

Project Haiti with OpenStreetMap

OpenStreetMap Japan

If you want more details...

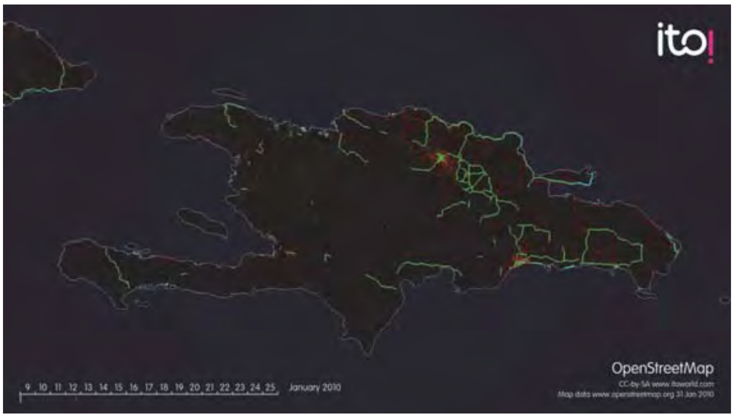
OSGeo Search

Devote condolences to people in Haiti.

12 Jan 2010

How?

by Taichi FURUHASHI



by Taichi FURUHASHI

OpenStreetMap

The Free Wiki World Map

by Taichi FURUHASHI

We made
high quality map
in Haiti for **a few days**.

by Taichi FURUHASHI

Like the
wikipedia method!

by Taichi FURUHASHI

① GPS logging by handyGPS

"The OpenStreetMap community **can help** the response

by tracing Yahoo imagery and other data sources,....."

(13Jan2010)

② Draw map by paper. And scan.

OSM v.s. GoogleMaps v.s. YahooMap v.s. bing Map

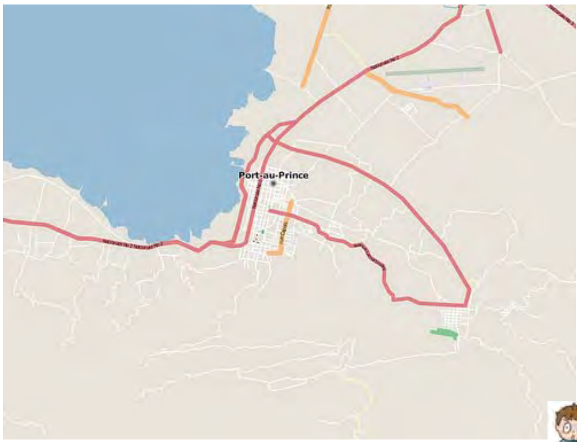
There is **no** good map in Haiti.

③ Digitizing on Satellite images

Start to making map!

on OSM community.

Before



How about
Google Maps ?

After

Google Maps

We plotted many **camp sites**.

Low Quality.

And also,
we compare to

Google map maker

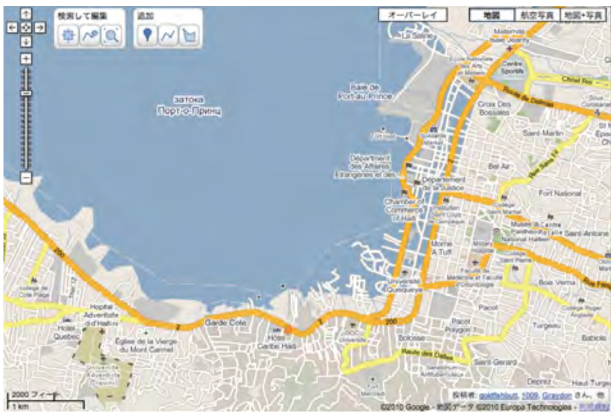
ZOOM in!!

Google MapMaker

Google Maps

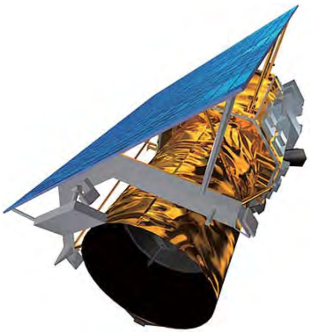
OpenStreetMap

Google MapMaker



OpenStreetMap

GeoEye (Resolution 40cm)

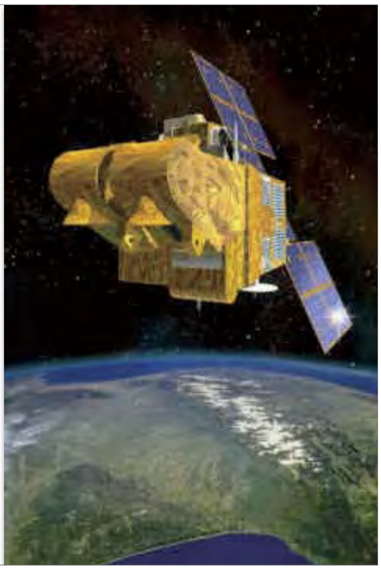


Why,
we could?

QucikBird (Resolution 60cm)

Some satellite image company provide to us, very quickly.

SPOT
(Resolution 2m)



Of course,

Collaborated with

JAXA and **NIED**

ALOS (Resolution 2.5m)

Data protocol is

WMS

Those images

are provided

with Georeference

meta data

We could

mashup to

many services

Especially,

OSM can access to

Road lines as vector.

Quick release as iPhone application

As a Result…

Good point is,

OpenStreetMap

has **many experts**

for editing map

Support portal site used OSM data.

Over 100 people

includes japanese guys…

Mikel
Harry Wood
Tim Waters
Simone Gadenz
Mattia Giovannini
Nicolas Chavent
PB
Andrew Turner
Sam Larsen
Robert Scott
Esperanza
Adam Schreiber
ikiya
Sergio Sevillano
Jeffrey Johnson
Jaakko Helleranta
Andrzej Zaborowski
FredB
harrierco
neuhausr
PaulY
Osbornec
Katie Filbert
Thea Clay
Micha Ruh
SK53
Jonas Krückel (John07)
Colin Marquardt
Floris Looijesteijn
AndyGates
Jean-Marc Liotier

Claudius Henrichs
pascal_n
zvenzzon
Dane Springmeyer
Gianfra
Dave Smith / DruidSmith
Randal Hale
Phil Shipley
Christopher Parker
davespod
Mapconcierge
Imapi
Bikeman2000
Комяра
XBear
acdsig
Divebalu
StellanL
AssetBurned
Ceyockey
Ævar Arnfjörð Bjarmason
Ivansanchez
ALE!
Fabianos
Kevin
Julian
olvagor
Gubaer
UbuntuAcer
RatZillaS
Jean-Guilhem Cailton
clara
steve8
Gert Gremmen (cetest)
Lübeck
sxpert

Axel von Matern
MattD
David Fawcett
torstiko
Phono
Dankarran
tomoki
EdLoach
Seehundeführer
osmapb1
Flacus
Cohan
Morten Jagd Christensen -
Holly Glaser
Temporalista
HB9DTX
Andrew Allison
Justin Houk
Luc Castera
Michael Lane
Mike Hogan
David Runneals -
Jarno Peschier -
helmed,
Boudewijn
Fil
Estela Llorente
Kam
Marc Schneider
Rafa Gutierrez
Samusz
Sean Bennett
Jarrattp
Xapitoun
Pierre Beland

http://wiki.openstreetmap.org/wiki/WikiProject_Haiti/Who_is_helping

Over 100 people

includes japanese guys...

Mikel
Harry Wood
Tim Waters
Simone Gadenz
Mattia Giovannini
Nicolas Chavent
PB
Andrew Turner
Sam Larsen
Robert Scott
Esperanza
Adam Schreiber
ikiya
Sergio Sevillano
Jeffrey Johnson
Jaakko Helleranta
Andrzej Zaborowski
FredB
harrierco
neuhausr
PaulY
Osbornec
Katie Filbert
Thea Clay
Micha Ruh
SK53
Jonas Krückel (John07)
Colin Marquardt
Floris Looijesteijn
AndyGates
Jean-Marc Liotier

Claudius Henrichs
pascal_n
zvenzzon
Dane Springmeyer
Gianfra
Dave Smith / DruidSmith
Randal Hale
Phil Shipley
Christopher Parker
davespod
Mapconcierge
Imapi
Bikeman2000
Комяра
XBear
acdsig
Divebalu
StellanL
AssetBurned
Ceyockey
Ævar Arnfjörð Bjarmason
Ivansanchez
ALE!
Fabianos
Kevin
Julian
olvagor
Gubaer
UbuntuAcer
RatZillaS
Jean-Guilhem Cailton
clara
steve8
Gert Gremmen (cetest)
Lübeck
sxpert

Axel von Matern
MattD
David Fawcett
torstiko
Phono
Dankarran
tomoki
EdLoach
Seehundeführer
osmapb1
Flacus
Cohan
Morten Jagd Christensen -
Holly Glaser
Temporalista
HB9DTX
Andrew Allison
Justin Houk
Luc Castera
Michael Lane
Mike Hogan
David Runneals -
Jarno Peschier -
helmed,
Boudewijn
Fil
Estela Llorente
Kam
Marc Schneider
Rafa Gutierrez
Samusz
Sean Bennett
Jarrattp
Xapitoun
Pierre Beland

http://wiki.openstreetmap.org/wiki/WikiProject_Haiti/Who_is_helping

Time difference

Actually,
over 300 or 400 users
joined.

Maybe...

Usually,

Demerit.

I found

this thing.

But, NeoGeographer
can connect
in the world

It means

24 hours editing.

Tim. J Berners-Lee

talked at

TED Ideas worth spreading

That’s

Strong Point!!

He said...

In addition,

Raw Data Now!

OpenData will change the world

Yes we can!

Bid announcement

in Japan, today.

This is

NeoGeographer's power

OpenStreetMap

The Free Wiki World Map

国土交通省 国土地理院 Geospatial Information Authority of Japan

GSI (**G**eo**S**patial **I**nformation Authority of Japan)

電子国土ポータル 電子国土基本図（地図情報）試験公開中

cyberjapan MappingSystem → 電子国土ポータル FOSS4 cyberjapan MappingSystem

one more thing...

国土交通省 国土地理院 Geospatial Information Authority of Japan

GSI (**G**eo**S**patial **I**nformation Authority of Japan)

電子国土ポータル 電子国土基本図（地図情報）試験公開中

cyberjapan MappingSystem → 電子国土ポータル FOSS4 cyberjapan MappingSystem

OpenGov

OldGeographer use all parameters

Today's

Final Mission

Projection?

Datum?

Zone?

Ellipsoid?

Coordinate System

But,

NeoGeographer use just 4-6 numbers!

EPSG

900913

EPSG

4326

EPSG

900913

Google Projection

EPSG

4326

Lat/Lon WGS84

CRS EPSG code

EPSG Geodetic Parameter Dataset

Let’s go to

http://www.**spatialreference**.org

Last Mission

"Finding code"

If you **can't** find

EPSG code for your work,

Please **Tweet!!** details parameters.

ex. "**SAD69 / UTM zone 20N**"

117

Have a good the Earth!

You have to find

some EPSG codes for your work.

Please **Tweet!!** to us.

Alos4Amazon Advanced Training 2010 No.02

「GIS Tech.」

Taichi FURUHASHI (GIS expert)
taichi@alos4amazon.com
Skype&Twitter: mapconcierge

Alos4Amazon

Thank you for joined by twitter!

Agenda

Day1: Old/Neo Geographer

Day2: Basic of SQL

Day3: SQL with Geospatial

Day4: Google

Morning Mission:

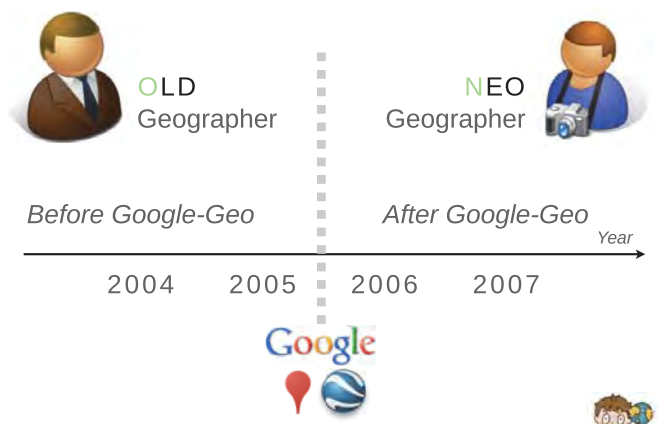
Let's follow!!

to

@mundogeo

@esri

@opengeo



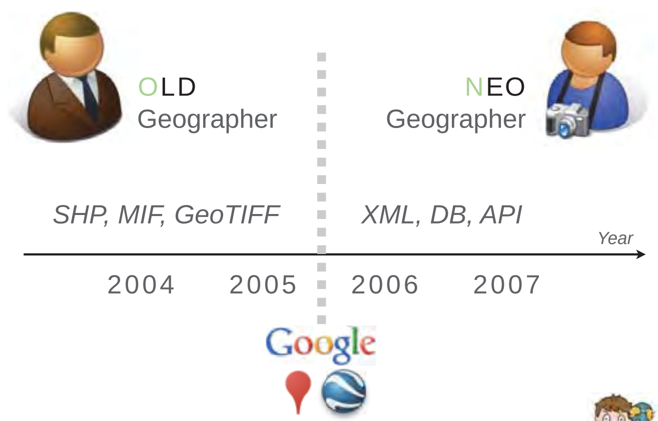
Agenda

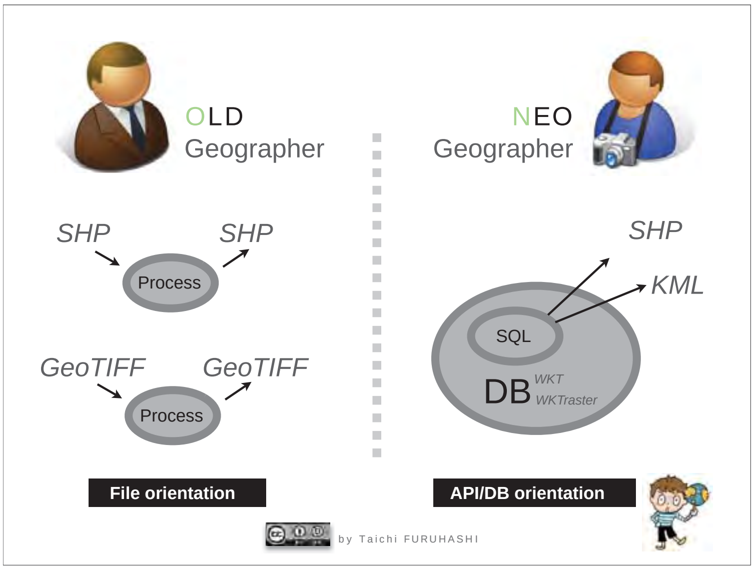
Day1: Old/Neo Geographer

Day2: Basic of SQL

Day3: SQL with Geospatial

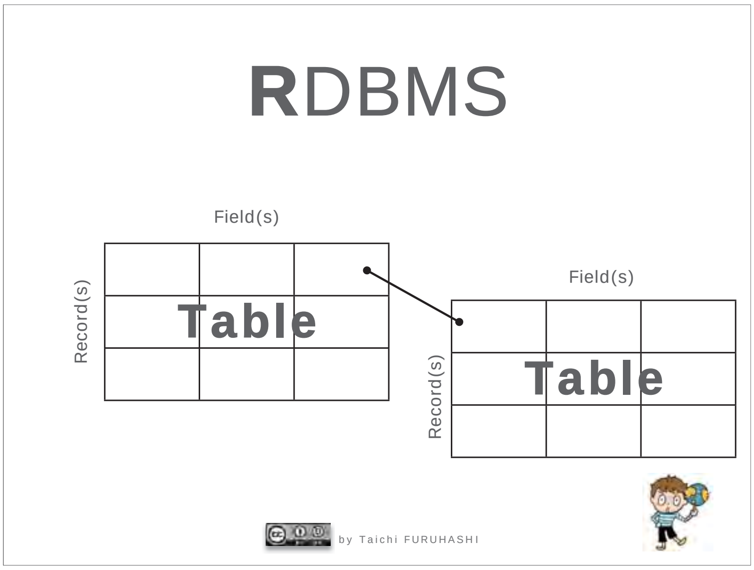
Day4: Google



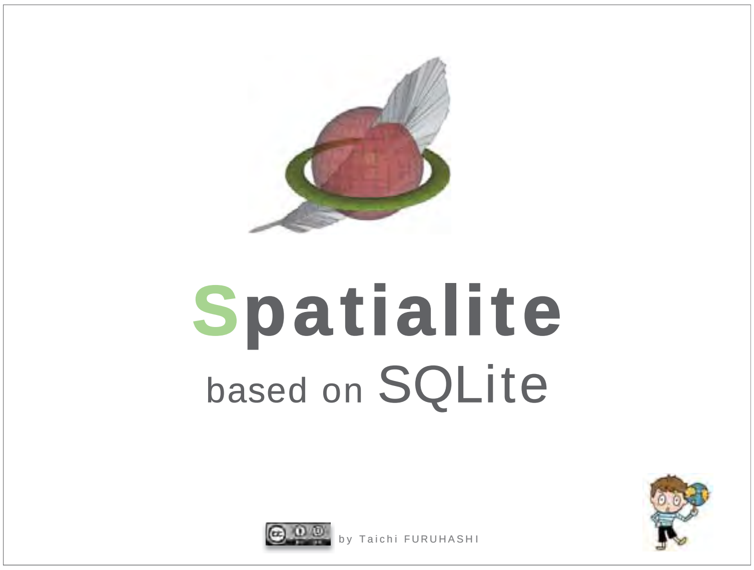

OLD
Geographer
NEO
Geographer
SHP
SHP
Process
GeoTIFF
GeoTIFF
Process
SHP
KML
SQL
DB
WKT
WKTraster
File orientation
API/DB orientation
by Taichi FURUHASHI


for RDBMS
Relational DataBase
Management System
by Taichi FURUHASHI

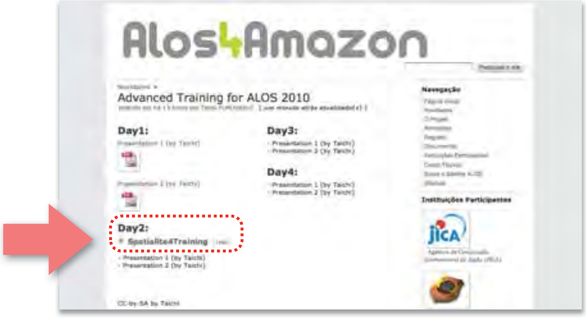

SQL
Structured Query Language
by Taichi FURUHASHI


RDBMS
Field(s)
Record(s)
Table
Field(s)
Record(s)
Table
by Taichi FURUHASHI


SQL was made
by IBM.
But, recently
International Standard.
by Taichi FURUHASHI


Spatialite
based on SQLite
by Taichi FURUHASHI

Let’s Download!



Let’s **start**!!

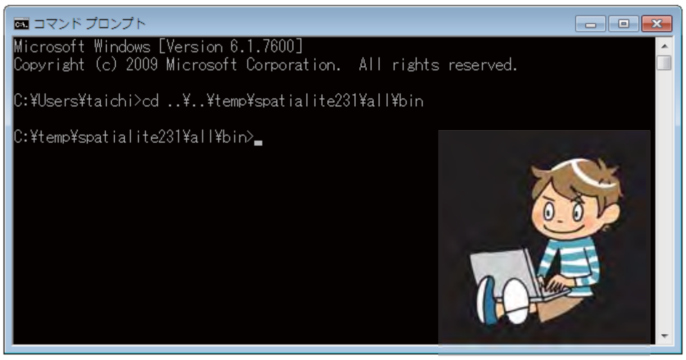
1. Uncompress
2. Move folder to C:＼temp

   as **spatialite231**.
3. [Start] > [Program]

   > [Accessory] > [Command Prompt]

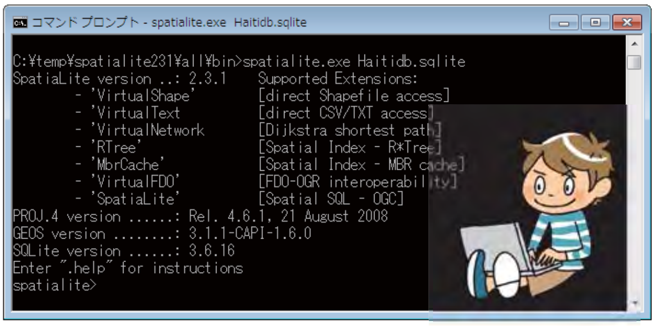
Sample Data

> cd c:\temp\spatialite231\bin



OpenStreetMap

> spatialite.exe Haitidb.sqlite



spatialite> **.databases**

Confirmation for path of db(.sqlite) file

spatialite> **.quit**

Finish

spatialite> **.help**

Confirmation for functions

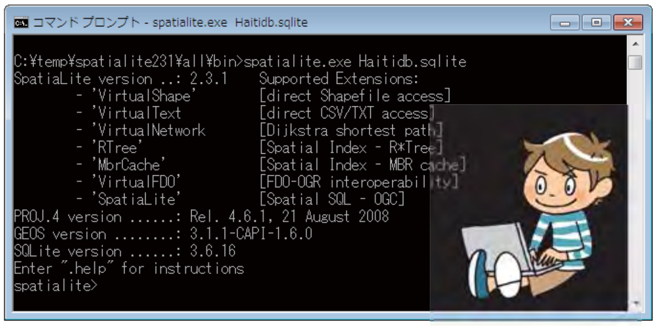
spatialite> **.show**

Setting information

spatialite> **.exit**

Finish

> spatialite.exe Haitidb.sqlite



> spatialite.exe Haitidb.sqlite

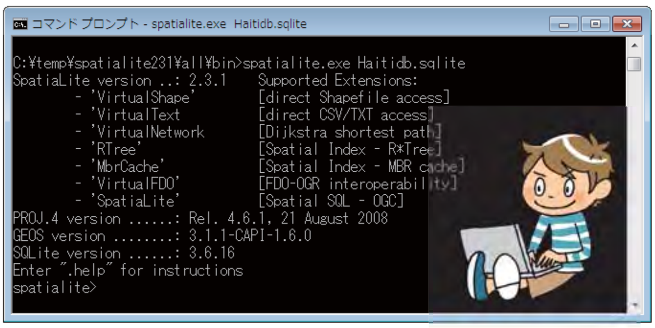


Table list

Basic SQL

spatialite> **.tables**

Advanced SQL

spatialite> **SELECT name**
spatialite> **FROM sqlite_master**
spatialite> **WHERE type='table' UNION ALL**
spatialite> **SELECT name**
spatialite> **FROM sqlite_temp_master**
spatialite> **WHERE type='table' ORDER BY name;**

Basic SQL

spatialite> **SELECT name**
spatialite> **FROM sqlite_master**
spatialite> **WHERE type='table' ;**

Field list

"**;**" means

end of SQL command

Basic SQL

spatialite> **PRAGMA**
spatialite> **table_info('roads');**

Alos4Amazon Advanced Training 2010 No.02 afternoon

「GIS Tech.」

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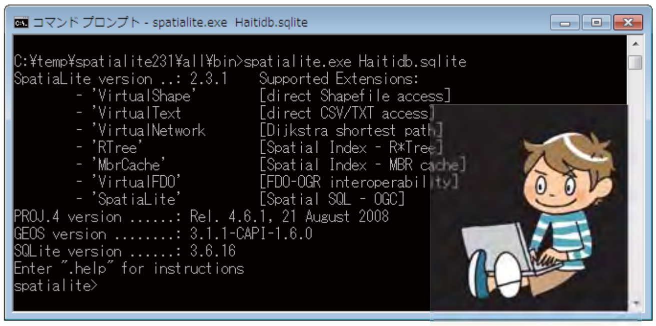
Skype&Twitter: mapconcierge

Alos4Amazon
www.alos4amazon.com

OpenStreetMap

Let's start!!

> spatialite.exe Haitidb.sqlite



```
コマンド プロンプト - spatialite.exe  Haitidb.sqlite
C:¥temp¥spatialite231¥all¥bin>spatialite.exe Haitidb.sqlite
SpatiaLite version ..: 2.3.1    Supported Extensions:
        - 'VirtualShape'        [direct Shapefile access]
        - 'VirtualText'         [direct CSV/TXT access]
        - 'VirtualNetwork       [Dijkstra shortest path]
        - 'RTree'               [Spatial Index - R*Tree]
        - 'MbrCache'            [Spatial Index - MBR cache]
        - 'VirtualFDO'          [FDO-OGR interoperability]
        - 'SpatiaLite'          [Spatial SQL - OGC]
PROJ.4 version ......: Rel. 4.6.1, 21 August 2008
GEOS version ........: 3.1.1-CAPI-1.6.0
SQLite version ......: 3.6.16
Enter ".help" for instructions
spatialite>
```


Sample Data

spatialite> .help
Confirmation for functions

spatialite> .show
Setting information

spatialite> .exit
Finish

> spatialite.exe Haitidb.sqlite

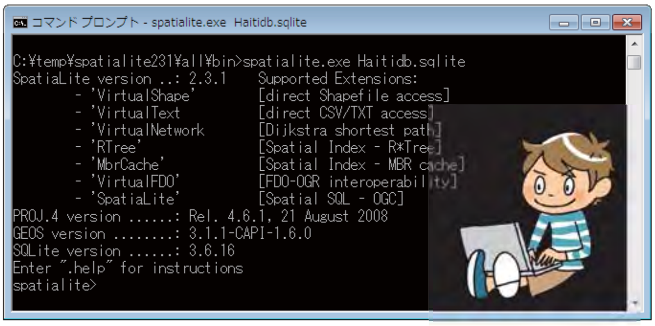


Table list

spatialite> .databases

Confirmation for path of db(.sqlite) file

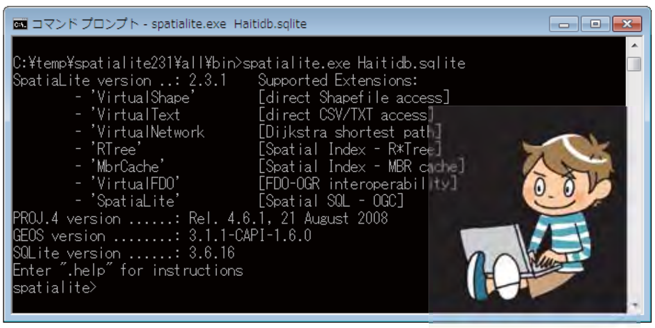
spatialite> .quit

Finish

Basic SQL

spatialite> **.tables**

> spatialite.exe Haitidb.sqlite



Basic SQL

spatialite> **SELECT name**

spatialite> **FROM sqlite_master**

spatialite> **WHERE type='table' ;**

"**;**" means

end of SQL command

Basic SQL

spatialite> **PRAGMA**

spatialite> **table_info('roads');**

Advanced SQL

spatialite> **SELECT name**

spatialite> **FROM sqlite_master**

spatialite> **WHERE type='table' UNION ALL**

spatialite> **SELECT name**

spatialite> **FROM sqlite_temp_master**

spatialite> **WHERE type='table' ORDER BY name;**

View as table

(SELECT FROM)

Field list

Basic SQL

spatialite> **SELECT ***

spatialite> **FROM roads;**

Basic SQL

```
spatialite> SELECT *
spatialite> FROM roads LIMIT 100;
```


Import CSV file (with DELETE)

Output Mode


```
spatialite> create table members(name,value,type);

spatialite> .import AT2010members.csv members

spatialite> SELECT * FROM members ;

spatialite> SELECT * FROM members
spatialite> WHERE  name LIKE ‘name’ ;

spatialite> DELETE FROM members
spatialite> WHERE  name LIKE ‘name’ ;
```



```
spatialite> .mode html
```

HTML <table> format

```
spatialite> .mode csv
```

Comma Separated values

```
spatialite> .separator |
```

Default


```
spatialite> create table url(type,url,twitter);

spatialite> .import AT2010url.csv url

spatialite> SELECT * FROM url ;

spatialite> SELECT * FROM url
spatialite> WHERE  type LIKE ‘type’ ;

spatialite> DELETE FROM url
spatialite> WHERE  type LIKE ‘type’ ;
```

Let's go to

SQLite

http://www.sqlite.org/lang_corefunc.html

Thank you for joining by twitter!

Have a good the Earth!

Morning Mission:

Let's follow!!

to

Dev. of PostGIS
@pwramsey

Dev. of Mapserver
@mapserving

Official FOSS4G account
@foss4g

Alos4Amazon Advanced Training 2010 No.03 morning

「GIS Tech.」

Taichi FURUHASHI (GIS expert)
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Skype&Twitter: mapconcierge

Alos4Amazon
www.alos4amazon.com

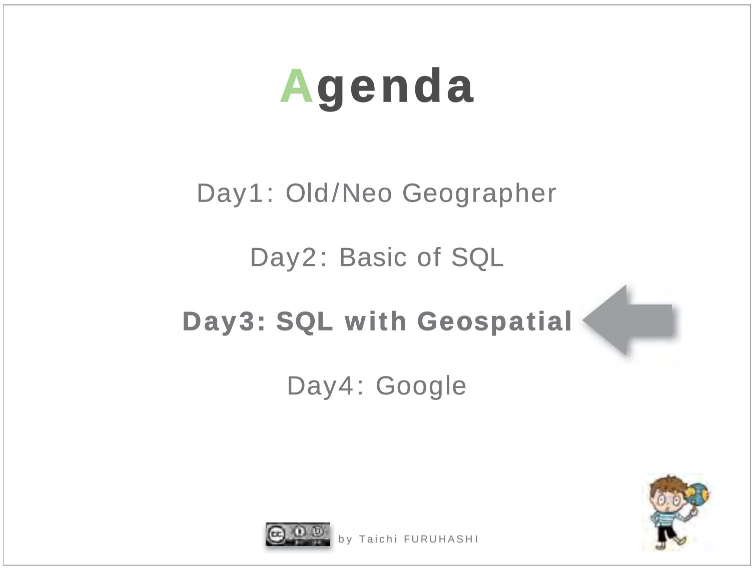
Agenda

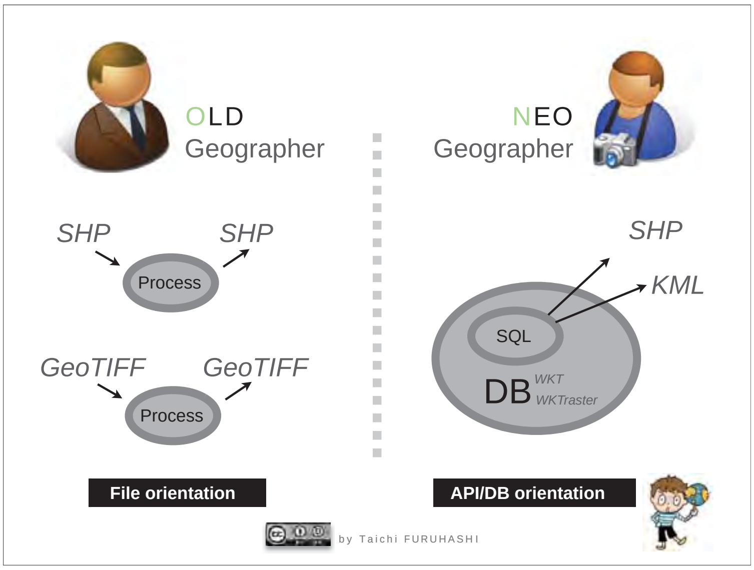
Day1: Old/Neo Geographer

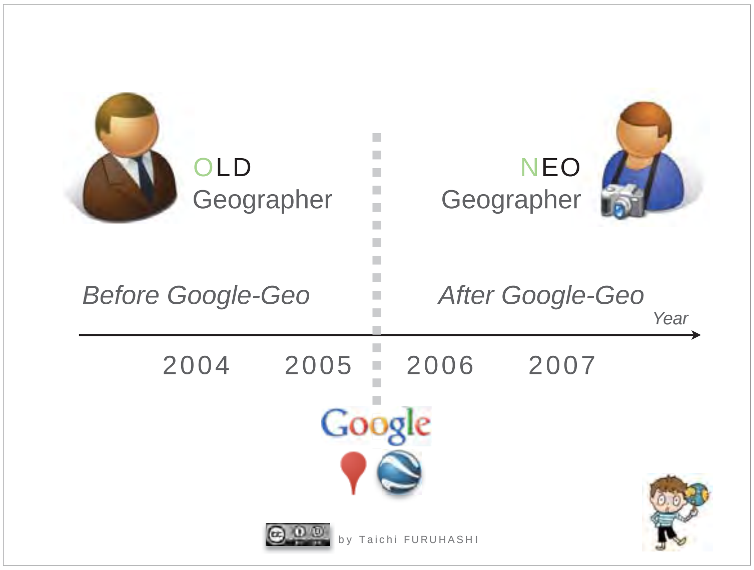
Day2: Basic of SQL

Day3: SQL with Geospatial

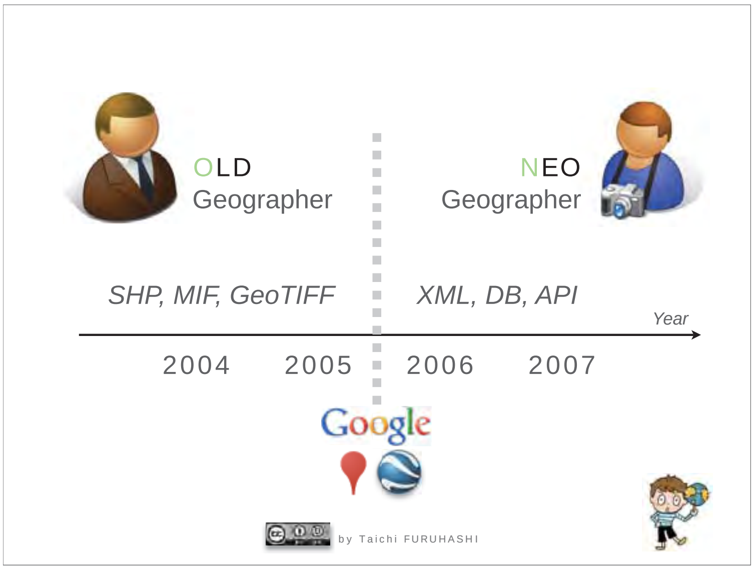
Day4: Google

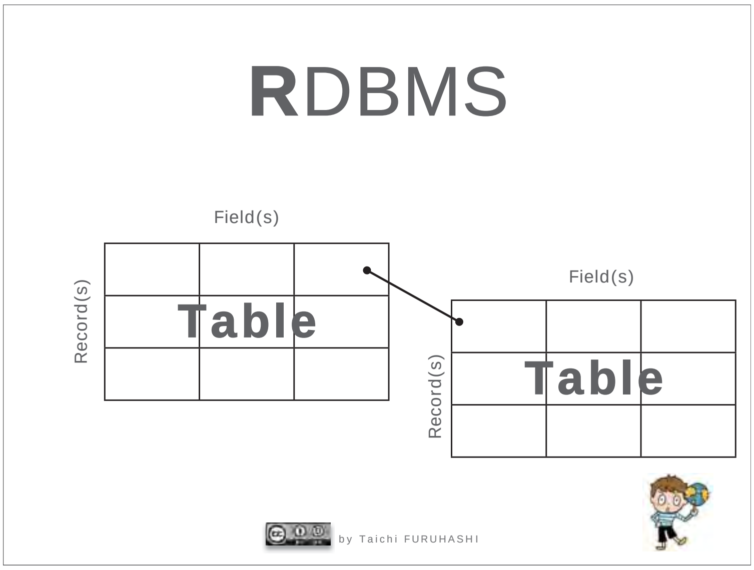

Agenda
Day1: Old/Neo Geographer
Day2: Basic of SQL
Day3: SQL with Geospatial
Day4: Google
by Taichi FURUHASHI


OLD
Geographer
NEO
Geographer
SHP
Process
SHP
GeoTIFF
Process
GeoTIFF
SHP
KML
SQL
DB
WKT
WKTraster
File orientation
API/DB orientation
by Taichi FURUHASHI


OLD
Geographer
NEO
Geographer
Before Google-Geo
After Google-Geo
Year
2004
2005
2006
2007
Google
by Taichi FURUHASHI


SQL
Structured Query Language
by Taichi FURUHASHI


OLD
Geographer
NEO
Geographer
SHP, MIF, GeoTIFF
XML, DB, API
Year
2004
2005
2006
2007
Google
by Taichi FURUHASHI


RDBMS
Field(s)
Record(s)
Table
Field(s)
Record(s)
Table
by Taichi FURUHASHI

Sample Data

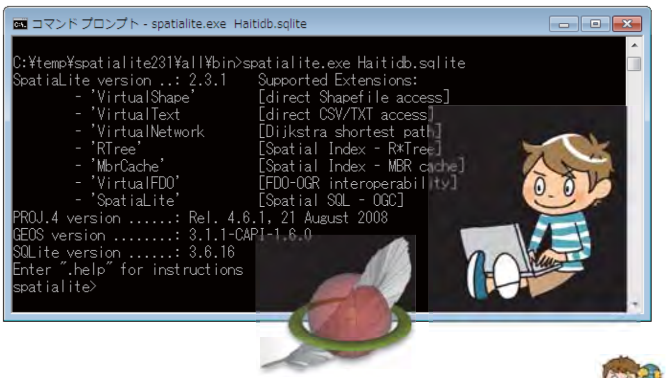
Let's start!!

Let's Download!

AT2010csv.sqlite

Do you remember **yesterday's functions?**

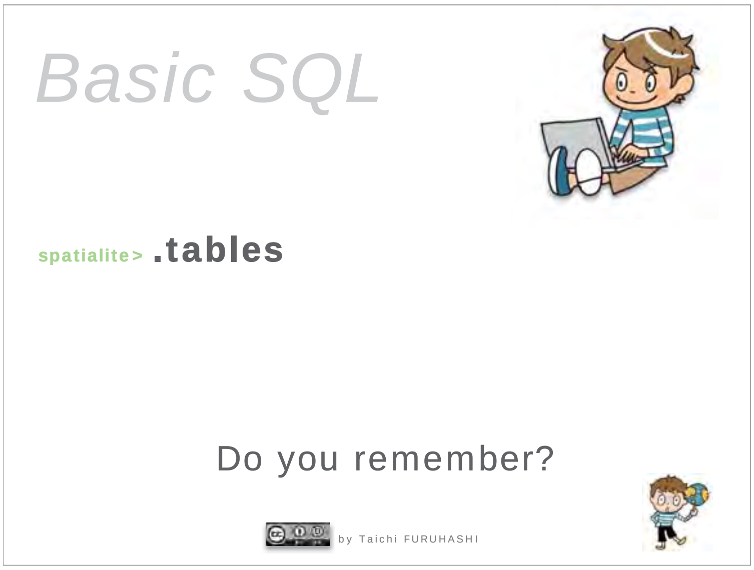
> spatialite.exe **AT2010csv**.sqlite



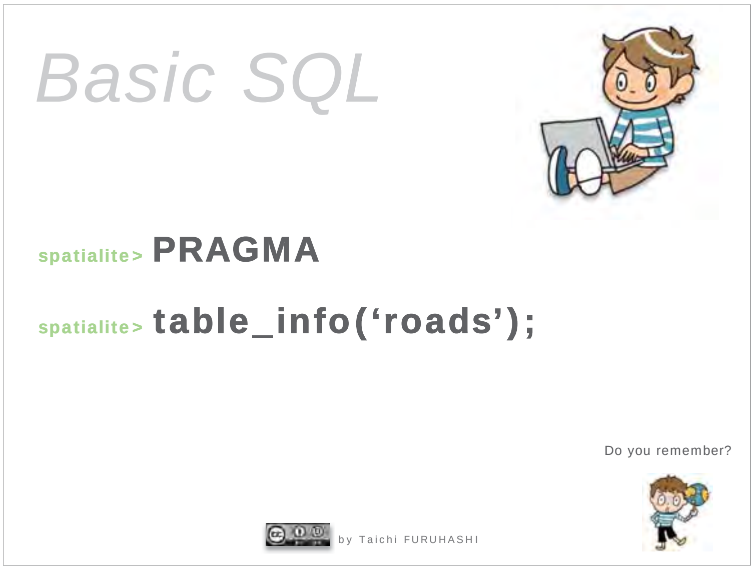
Let's review and practice!!

If you can't remember,

Please confirm by my documents on our website.

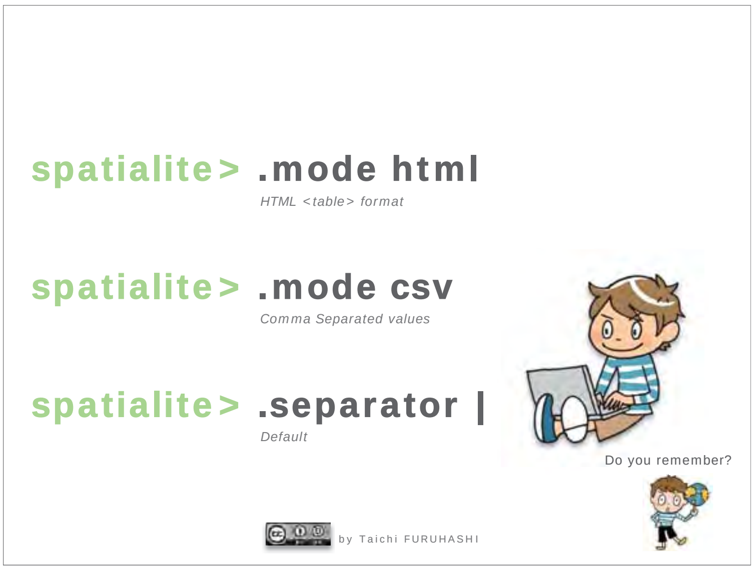

Basic SQL
spatialite> .tables
Do you remember?
by Taichi FURUHASHI


Basic SQL
spatialite> SELECT *
spatialite> FROM members LIMIT 5;
Do you remember?
by Taichi FURUHASHI


Basic SQL
spatialite> PRAGMA
spatialite> table_info('roads');
Do you remember?
by Taichi FURUHASHI


Basic SQL
spatialite> SELECT *
spatialite> FROM members
spatialite> ORDER BY name LIMIT 5;
Do you remember?
by Taichi FURUHASHI


Basic SQL
spatialite> SELECT *
spatialite> FROM members;
Do you remember?
by Taichi FURUHASHI


spatialite> .mode html
HTML <table> format
spatialite> .mode csv
Comma Separated values
spatialite> .separator |
Default
Do you remember?
by Taichi FURUHASHI

```
spatialite> create table members(name,value,type);

spatialite> .import AT2010members.csv members

spatialite> SELECT * FROM members ;

spatialite> SELECT * FROM members
spatialite> WHERE  name LIKE ‘name’ ;

spatialite> DELETE FROM members
spatialite> WHERE  name LIKE ‘name’ ;
```

Do you remember?

```
spatialite> SELECT * FROM url
spatialite> WHERE  type = ‘restec’ ;

spatialite> UPDATE url
spatialite> SET twitter = ‘restec’
spatialite> WHERE type = ‘@restec’ ;
```



```
spatialite> create table url(type,url,twitter);

spatialite> .import AT2010url.csv url

spatialite> SELECT * FROM url ;

spatialite> SELECT * FROM url
spatialite> WHERE  type LIKE ‘type’ ;

spatialite> DELETE FROM url
spatialite> WHERE  type LIKE ‘type’ ;
```

Do you remember?

Aggregate Func.
(count, sum, avg)

Edit Value
(UPDATE)

```
spatialite> SELECT count(*)
spatialite> FROM url;

spatialite> SELECT sum(value)
spatialite> FROM members;

spatialite> SELECT avg(value)
spatialite> FROM members;
```

DELETE TABLE

(create, drop, vacuum)

spatialite> **SELECT ***

spatialite> **FROM members**

spatialite> **INNER JOIN url**

spatialite> **ON members.type = url.type;**

spatialite> **CREATE TABLE foo(field1,field2);**

spatialite> **DROP TABLE foo;**

spatialite> **VACUUM;**

Let's go to

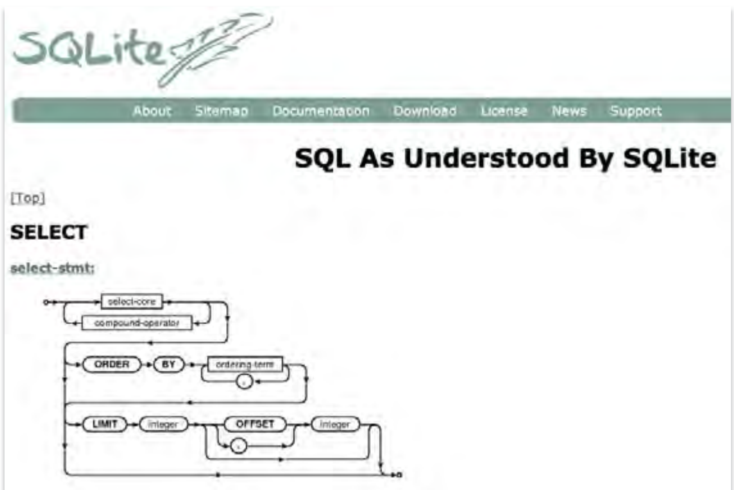
SQLite

http://www.sqlite.org/lang_corefunc.html

http://www.sqlite.org/lang.html

RELATE TABLE

(inner JOIN)

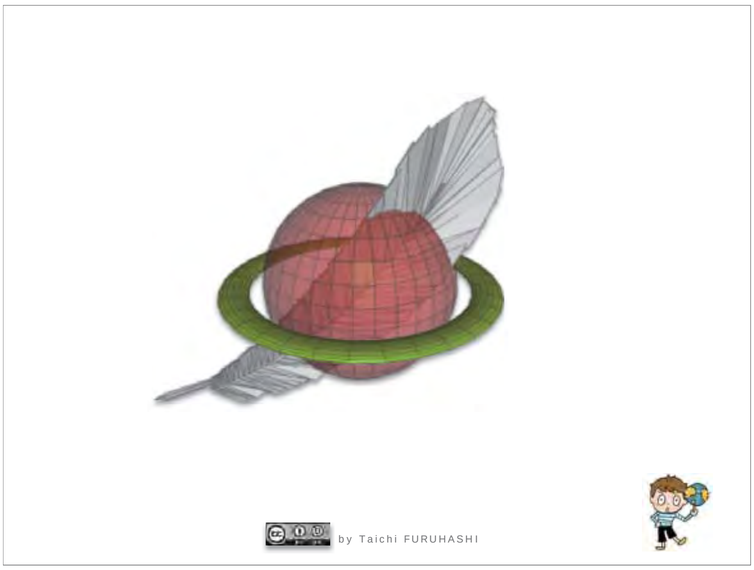



Today's Mission
"Finding newSQL"
SQLite
by Taichi FURUHASHI


Let's start
new SQL with
GeoSpatial tech.
by Taichi FURUHASHI


Please Tweet!!
your SQL to me.
(over 5 tweets)
I learned a SQL func.
SELECT min(value)
FROM members;
#alos4amazon
(C) Twitter.
by Taichi FURUHASHI


> spatialite.exe Haitidb.sqlite
コマンド プロンプト - spatialite.exe Haitidb.sqlite
C:¥temp¥spatialite231¥all¥bin>spatialite.exe Haitidb.sqlite
SpatiaLite version ..: 2.3.1 Supported Extensions:
- 'VirtualShape' [direct Shapefile access]
- 'VirtualText' [direct CSV/TXT access]
- 'VirtualNetwork' [Dijkstra shortest path]
- 'RTree' [Spatial Index - R*Tree]
- 'MbrCache' [Spatial Index - MBR cache]
- 'VirtualFDO' [FDO-OGR interoperability]
- 'SpatiaLite' [Spatial SQL - OGC]
PROJ.4 version ......: Rel. 4.6.1, 21 August 2008
GEOS version ....: 3.1.1-CAPI-1.6.0
SQLite version ......: 3.6.16
Enter ".help" for instructions
spatialite>
by Taichi FURUHASHI


by Taichi FURUHASHI

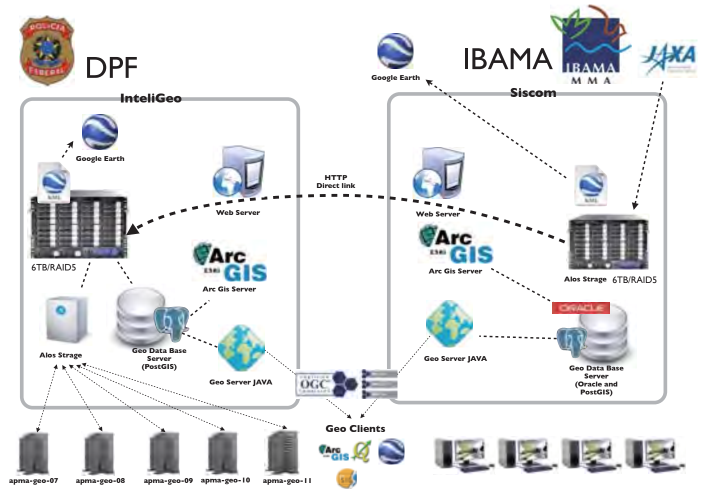

LENGTH
http://goo.gl/1lec
by Taichi FURUHASHI

Buffer

Buffer	Buffer(geom Geometry, dist Double precision) : Geometry	X			X	return a geometric object defined by buffering a distance d around geom, where dist is in the distance units for the Spatial Reference of geom

http://goo.gl/1lec

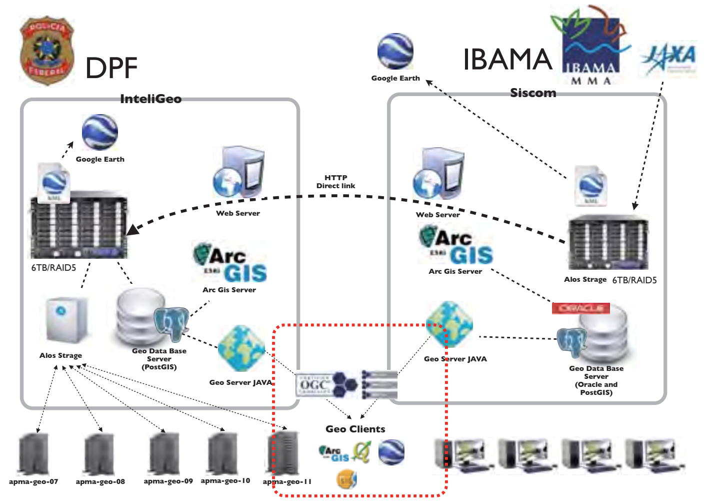
OUR PLAN v2.2



Today's Mission

"Finding newGeoSQL"

OUR PLAN v2.2



Please Tweet!!

your GeoSQL to me.

(over 5 tweets)

I learned a GeoSQL func.

SELECT Length(geom)

FROM roads;

#alos4amazon

(C) Twitter.

OGC Projects

The Open Geospatial Consortium, Inc.® (OGC) is a non-profit, international, voluntary consensus standards organization that is leading the development of standards for geospatial and location based services.

http://www.opengeospatial.org

Protocols

WMS
WFS/WFS-T
WPS

Representation

WKT geometric objects
WKT raster
WKT spatial reference systems

Data Formats

GML
KML

Style

SLD

WMS

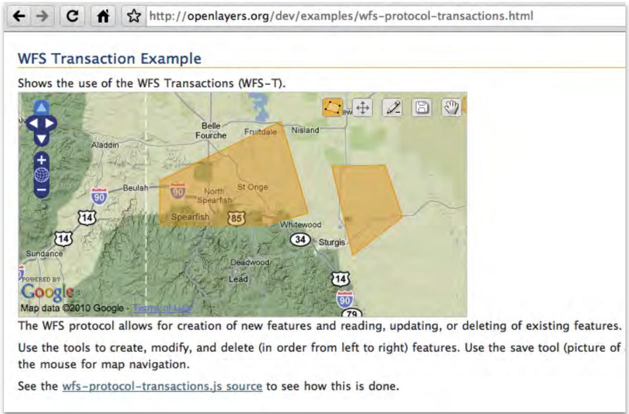
WFS-T

http://

siscom.ibama.gov.br/

geoserver/wms

Let's go to



WFS

WPS

http://www.zoo-project.org

SLD

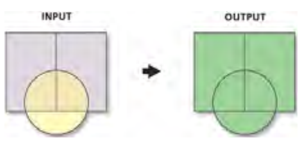
GML

Have a good the Earth!

KML

Union Tool

• Creation script SQL for make Union procedure using OGC standard
• Union:
http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/Union/00080000000s000000/



* Individualizes each geographic area with the attributes of the layers

Logic sequence of script

- Query table: *querypoly*
- "sequence object" create unique ID (use by insert data in querypoly): *seq_queryid*
- View of intersection
- Insert data in querypoly by view previuos
- View of grouping intersection
- Insert exterior data from first Layer ('a')
- Insert exterior data from secondLayer ('b')
- Register the views of output(polygon e multipolygon) in table "geometry_columns"
- View of Polygon query
- View of Multipolygon query

Table *querypoly*

```
CREATE TABLE gis.querypoly
(
   id integer NOT NULL,
   CONSTRAINT q_pkey PRIMARY KEY (id),
   ida integer,
   idb integer,
   the_geom geometry
);
```

seq_queryid

```
CREATE SEQUENCE gis.seq_queryid START 101;
```

View of intersection

```
CREATE OR REPLACE VIEW
gis.vwquery_intersection AS
SELECT nextval('gis.seq_queryid') id, a.id ida,
b.id idb, ST_Intersection(a.the_geom,
b.the_geom) the_geom
FROM gis.vwlayer_a a, gis.vwlayer_b b
WHERE a.the_geom && b.the_geom AND
substring(ST_Relate(a.the_geom, b.the_geom)
from 1 for 1) = '2';
```

Insert data(intersection) in querypoly

```
INSERT INTO gis.querypoly
SELECT id, ida, idb, the_geom
FROM gis.vwquery_intersection;
```

View of grouping by intersection

```
CREATE OR REPLACE VIEW
gis.vwquery_intersection_union AS
SELECT ST_Union(q.the_geom) the_geom
FROM gis.vwquery_intersection q;
```

Insert exterior data from 1o Layer

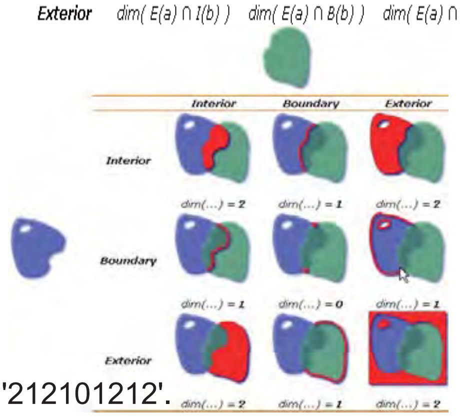
```
INSERT INTO gis.querypoly
SELECT nextval('gis.seq_queryid'), a.id, -1,
ST_Difference(a.the_geom, iu.the_geom)
FROM gis.vwlayer_a a,
gis.vwquery_intersection_union iu
WHERE substring(ST_Relate(a.the_geom,
iu.the_geom) from 3 for 1) = '2';
```

Insert exterior data from 2o Layer

```
INSERT INTO gis.querypoly
SELECT nextval('gis.seq_queryid'), -1, b.id,
ST_Difference(b.the_geom, iu.the_geom)
FROM gis.vwlayer_b b,
gis.vwquery_intersection_union iu
WHERE substring(ST_Relate(b.the_geom,
iu.the_geom) from 3 for 1) = '2';
```

http://postgis.org/documentation/manual-svn/ch04.html#DE-9IM

	Interior	Boundary	Exterior
Interior	dim(I(a) ∩ I(b))	dim(I(a) ∩ B(b))	dim(I(a) ∩ E(b))
Boundary	dim(B(a) ∩ I(b))	dim(B(a) ∩ B(b))	dim(B(a) ∩ E(b))
Exterior	dim(E(a) ∩ I(b))	dim(E(a) ∩ B(b))	dim(E(a) ∩ E(b))



'212101212'.

Where dim(a) is the dimension of a as specified by ST_Dimension but has the domain of {0,1,2,T,F,*}
0 => point
1 => line
2 => area
T => {0,1,2}
F => empty set
* => don't care

PostGIS WKT Raster

Seamless operations between vector and raster layers

Pierre Racine
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BAM project, University Laval, July 2008

These slides:

- **present an argument for the integration of raster data or of references to raster data into PostGIS**
- **suggest specifications of overlay operation between a vector layer and a raster layer**
- **further discuss the specifications of raster integration**
  - **–RASTER as a new type of WKT/WKB geometry**
  - **–stored inside or outside of the database**

Register the views of output

```
INSERT INTO geometry_columns ("f_table_catalog",
f_table_schema,"f_table_name",
"f_geometry_column", "coord_dimension", "srid",
"type")
VALUES ('', 'gis', 'vwresultpolygon','the_geom', 2,
4326, 'POLYGON');

INSERT INTO geometry_columns ("f_table_catalog",
f_table_schema,"f_table_name",
"f_geometry_column", "coord_dimension", "srid",
"type")
VALUES ('', 'gis', 'vwresultpolygonm','the_geom', 2,
4326, 'MULTIPOLYGON');
```

Why integrate raster in PostGIS? & Why are seamless analysis operators important?

View of Polygon query

```
CREATE OR REPLACE VIEW
gis.vwresultpolygon AS
SELECT q.id, q.ida, q.idb, q.ida::text || 'x' ||
q.idb::text idaxidb, q.the_geom
FROM gis.querypoly q
WHERE GeometryType(q.the_geom) =
'POLYGON';

...
WHERE GeometryType(q.the_geom) =
'MULTIPOLYGON';
```

The Case for Raster Integration in PostGIS

Why:

- **For better or worse, there is great demand for it. Ask yourself:**
  - **– How many people do not use (even try) PostGIS because it does not handle raster?**
  - **– How many people reinvented their own "raster in the database" wheel?**
- **This is an opportunity to redefine raster (beyond a mere collection of tiles in a filesystem) as a:**
  - **– coherent continuous coverage of measures, indexed into mutually exclusive tiles (for storage efficiency) or objects (for expressiveness) comparable to features in a vector layer**
  - **– layer in which both tile extents and pixels have significance**
  - **– dataset fully integrated with other layers in a GIS context**
- **This is also an opportunity to implement the foundation of a seamless vector-raster analysis toolkit (overlay operations, map algebra, interpolation, summaries, etc…), given that spatial analysis is one of the next big trend in the geospatial industry.**
- **PostGIS SHOULD provide a standard solution for every kind of geospatial data if we want it to be the BEST foundation for GIS applications, both desktop and web-based.**

The Case for Seamless Operation Between Vector and Raster

Why:

- **Most GIS packages offer two different sets of analytical tools: one for raster, one for vector data. This makes GIS methods harder to learn for novices and time consuming for experts.**
- **It is time to integrate, at the lower level, these tools, allowing us to do analysis independently of the data representation.**
- **This would ease the development of applications (desktop or web), simplify their GUIs and enhance the user experience.**

Example 1

What should be the result of a typical operation (e.g. intersection) between a vector and a raster layer?

3 examples…

The following slides try to design a solution whereby results are stored as raster or vector.

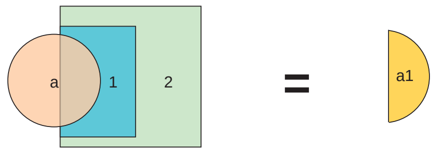
Three cases will be examined in each example:

-a vector/vector operation with results as a vector layer
-a vector/raster operation with results as a raster layer
-a vector/raster operation with results as a vector layer
-a raster/raster operation with results as a raster layer

But first a typical SQL postgis vector/vector request…

Example 1 – Simplest Case
Intersection(vector, vector) → vector

A vector buffer (circle a) is intersected with a vegetation cover - type 1 (blue) and 2 (green)



Tabular form

buffer	
geometry	name
polygon(…)	a

∩

cover	
geometry	type
polygon(…)	1
polygon(…)	2

=

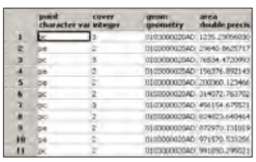
intersection		
geometry	bufferName	coverType
polygon(…)	a	1

Here, PostGIS implementation is trivial.

A simplified but typical SQL vector-only overlay operation in PostGIS…

```
SELECT point, cover, geom, ST_Area(geom) as area
FROM (SELECT ST_Intersection(ST_Buffer(point.geom, 1000),cover.geom) as
geom, point, cover
FROM point, cover
WHERE ST_Intersects(ST_Buffer(point.geom, 1000), cover.geom)) cover
ORDER BY area
```

Result:

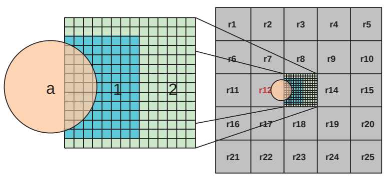


In brief:
- **ST_Buffer on a vector layer**
- **ST_Intersection on a vector layer**
- **ST_Area on the result of the previous operation**
- **ST_Intersects in the 'where' clause (we ignore the &&)**

What if the cover layer was a raster coverage instead?

Example 1 – Simplest Case
What do we usually do now?

- **Intersection is generally used to select which raster files (tiles) have to be loaded in order to construct a display raster (ex. in ArcGIS or MapServer).**
- **A rectangle (here a circle), representing viewport extent, is intersected with polygons representing raster (tiles) extents. Every intersecting polygon is part of the result.**



This is the existing paradigm where raster-vector intersection is used merely to "display" raster.
The raster extent is part of the operation, but not the raster data.
True intersection would take pixel values into account…

Tabular form

buffer	
geometry	name
polygon(…)	a

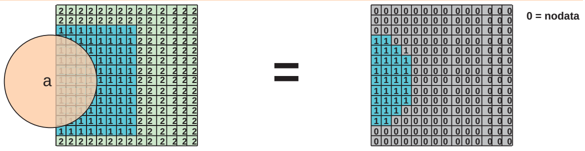
∩

cover	
geometry	tile
polygon(…)	…
polygon(…)	r8
polygon(…)	r9
polygon(…)	r10
polygon(…)	…

=

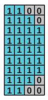
intersection		
geometry	bufferName	coverTile
polygon(…)	a	r12
polygon(…)	a	r13

Example 1 – Simplest Case
Intersection(vector,raster) → raster



Here the result is ALWAYS in raster form

or only



Q1 – What should be the extent of the result? Identical to the source raster, or to the minimal significant area?

Tabular form

buffer	
geometry	name
polygon(...)	a

∩

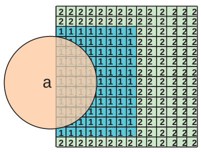
cover
geometry
raster(2,2,2…1,1…2,2,2)

=

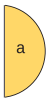
intersection	
geometry	bufferName
raster(0,0,0,1,1…0)	a

Example 2

Example 1 – Simplest Case
Intersection(vector,raster) → vector



=



Here the result is ALWAYS in vector form

Tabular form

buffer	
geometry	name
polygon(...)	a

∩

cover
geometry
raster(2,2,2…1,1…2,2,2)

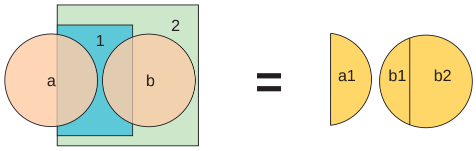
=

intersection	
geometry	bufferName
polygon(...)	a

Here, it is not possible to know the value of intersecting raster pixels (the cover type) since there could be many different values. If we want expressive results in vector form, we must convert rasters to vectors BEFORE intersecting.

Q2-Should the result of overlay operations be vectorial or matricial? Or should we allow both kind of result?

Example 2 – Mutually Exclusive Polygons
Intersection(vector,vector) → vector



Tabular form

buffer	
geometry	name
polygon(...)	a
polygon(...)	b

∩

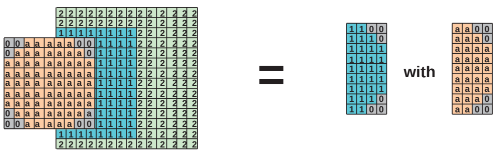
cover	
geometry	type
polygon(...)	1
polygon(...)	2

=

intersection		
geometry	bufferName	coverType
polygon(...)	a	1
polygon(...)	b	1
polygon(...)	b	2

Here also, PostGIS implementation is trivial.

Example 1 – Simplest Case
Intersection(raster,raster) → raster



Tabular form

buffer
geometry
raster(2,2,2…1,1…2,2,2)

∩

cover
geometry
raster(2,2,2…1,1…2,2,2)

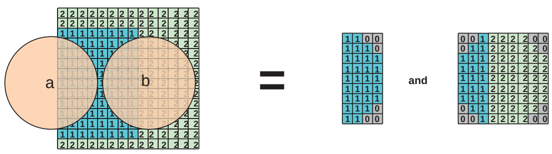
=

intersection	
name	geometry
a	raster(band(1,1,0…0),band(a,a,0…0))

Here, the result must be stored in a multi-band raster.

To obtain a result similar to the
vector/vector → vector operation
we must vectorize the resulting rasters AFTER the intersection and, morevover, this vectorization must take into account both band.

Example 2 – Mutually Exclusive Polygons
Intersection(vector,raster) → raster



Tabular form

buffer	
geometry	name
polygon(...)	a
polygon(...)	b

∩

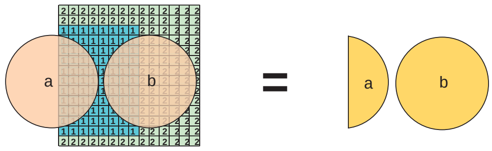
cover
geometry
raster(2,2…1,1…2,2,2)

=

intersection	
geometry	bufferName
raster(1,1,0…0)	a
raster(0,0,1…2,2,2…0)	b

Here, to obtain a result similar to the
vector/vector → vector operation
we must vectorize the resulting rasters AFTER the intersection.

Example 2 – Mutually Exclusive Polygons Intersection(vector,raster) → vector



Tabular form

buffer	
geometry	name
polygon(...)	a
polygon(...)	b

∩

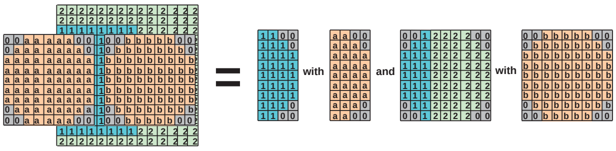
cover
geometry
raster(2,2,2…1,1…2,2,2)

=

intersection	
geometry	bufferName
polygon(...)	a
polygon(...)	b

Here also, it is not possible to know the value of intersecting raster pixels (the cover type) without polygonizing the raster according to pixels values. If we want expressive results in vector form, we must then convert rasters to vectors BEFORE intersecting.

Example 2 – Mutually Exclusive Polygons Intersection(raster,raster) → raster



Tabular form

buffer
geometry
raster(0,0,a…0,0…b,0,0)

∩

cover
geometry
raster(2,2…1,1…2,2,2)

=

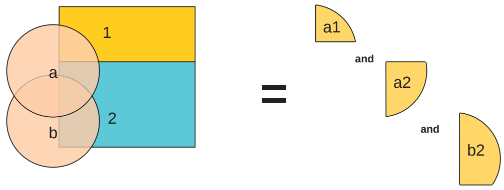
intersection
geometry
raster(band(1,1,0…1,0,0), band(a,a,0…a,0,0))
raster(band(0,0,1,2…2,0,0), band(0,0,b…b,0,0))

Here also, the result must be stored in a multi-band raster.

To obtain a result similar to the
vector/vector → vector operation
we must vectorize the resulting rasters AFTER the intersection and, morevover, this
vectorization must take into account both band.

Example 3

Example 3 – Non-Mutually Exclusive Polygons Intersection(vector,vector) → vector



Tabular form

buffer	
geometry	name
polygon(...)	a
polygon(...)	b

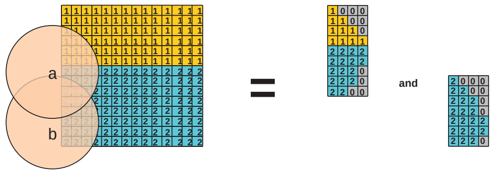
∩

cover	
geometry	type
polygon(...)	1
polygon(...)	2

=

intersection		
geometry	bufferName	coverType
polygon(...)	a	1
polygon(...)	a	2
polygon(...)	b	2

Example 3 – Non-Mutually Exclusive Polygons Intersection(vector,raster) → raster



Tabular form

buffer	
geometry	name
polygon(...)	a
polygon(...)	b

∩

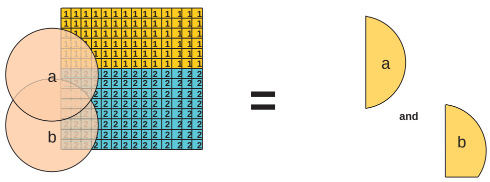
cover
geometry
raster(1,1…2,2,2)

=

intersection	
geometry	bufferName
raster(1,1,0…2,2…0)	a
raster(2,0…2,0)	b

Here also, to obtain a result similar to the
vector/vector → vector operation
we must vectorize the resulting rasters AFTER the intersection.

Example 3 – Non-Mutually Exclusive Polygons Intersection(vector,raster) → vector



Tabular form

buffer	
geometry	name
polygon(...)	a
polygon(...)	b

∩

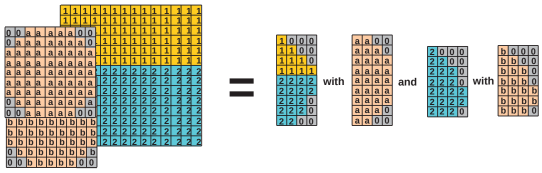
cover
geometry
raster(1,1…2,2,2)

=

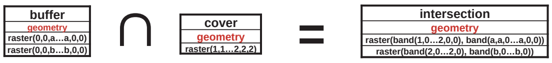
intersection	
geometry	bufferName
polygon(...)	a
polygon(...)	b

Here also, it is not possible to know the value of intersecting raster pixels (the cover type) without polygonizing the raster according to pixels values. If we want expressive results in vector form, we must convert rasters to vectors BEFORE intersecting.

Example 3 – Non-Mutually Exclusive Polygons Intersection(raster,raster) → raster



Tabular form



Here also, to obtain a result similar to the vector/vector → vector operation we must vectorize the resulting rasters AFTER the intersection and the vectorization must take into account both band.

PostGIS WKT raster Specifications

- We want multi-band and multi-resolution (pyramids) support…
- We want nodata values, variable pixel types and sizes…
- Each raster within a coverage is stored as a row in a table.
- We don't want to store a specific format (like tiff or jpeg) since we will generally store tiles, not images… Images should be constructed as aggregates of tiles (rows) using GROUP BY.

We see RASTER as a new variant of WKT/WKB geometry
("RASTER" like "POLYGON" or "LINESTRING").

We must store:

- **For each raster** (tile or row)
  - the width and the height of the raster
  - the pixel size (in the same units as the coordinate system)
  - the number of bands for each raster
  - the number of pyramid
  - a polygon representing the bounding box of the raster
  - the georeference (6 floats) (We can probably deduce this from the bbox polygon, the width and the height.)
- **For each band**
  - the pixel type
  - the nodata value
  - the data for each band and for each pyramid for each band

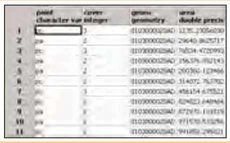
Possible pixel types
- 1-bit boolean (1BB)
- 2-bit unsigned integer (2BUI)
- 4-bit unsigned integer (4BUI)
- 8-bit signed integer (8BSI)
- 8-bit unsigned integer (8BUI)
- 16-bit signed integer (16BSI)
- 16-bit unsigned integer (16BUI)
- 32-bit signed integer (32BSI)
- 32-bit unsigned integer (32BUI)
- 16-bit float (16BF)
- 32-bit float (32BF)
- 64-bit float (64BF)

Example…

Back to our original SQL query…

Our SQL query is very similar to example 3:
- we intersect buffers with a forest cover;
- buffers are in vector form and might overlap;

We want a result equivalent to: no matter in which form is the cover (raster or vector)… →



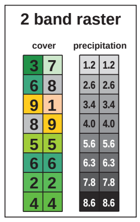
We must be able to compute all the cover areas with the result. We choose to return the result of the intersection in raster form. This way, the resulting rasters are smaller and more simple to vectorize (ST_AsPolygon) AFTER intersecting than if we would have chosen to return the result as vector. In this latter case, we would have had to vectorize whole and complex rasters BEFORE intersecting. The seamless query looks like:

```
SELECT point, cover, geom, ST_Area(geom) as area
FROM (SELECT ST_AsPolygon(ST_Intersection(ST_Buffer(point.geom, 1000),cover.geom), 'RASTER')
as geom, point, cover
FROM point, cover
WHERE ST_Intersects(ST_Buffer(point.geom, 1000), cover.geom)) cover
```

Only two things are different from the original query:
- the result of ST_Intersection() is explicitely returned as a 'RASTER' when the two inputs are in different forms. (Not when they are in the same form…)
- the resulting raster layer is vectorized with ST_AsPolygon() to isolate each cover feature. (ST_AsPolygon simply return the original geometry when it is in vector form)

Example of WKT raster

Creation of a 2x8 raster with 2 bands (8-bit signed integer and 16-bit float) **similar to ST_GeomFromText(text,[<srid>])**



width, height — number of pyramid — number of band — bounding box (a square) — pixel size

```
ST_RasterFromText('RASTER(2,8,30.0,2,2,POLYGON((0.3453 0.7534,4.4634 0.3563,4.4735 4.3626,0.7363 4.8464,0.3453 0.7534)),BAND(8BUI,0,(3,7,6,8,9,1,8,9,5,5,6,6,2,2,4,4),(6,7,5,3)),BAND(16BF,0.0,(1.2,1.2,2.6,2.6,3.4,3.4,4.0,4.0,5.6,5.6,6.3,6.3,7.8,7.8,8.6,8.6),(1.9,3.7,5.95,8.2)))',[<srid>])
```

pixel type for 1st band and 2nd band — 1st pyramid of 1st and 2nd band

nodata value for 1st band and 2nd band — 2nd pyramid of 1st and 2nd band

- Pyramids are automatically created and updated
- WKB form carry data compressed as deflate

Specifications, Open Questions, and Some Query Examples

Raster data inside or outside the database?

- There has been a lot of discussion on this subject. We think it is better to let application developers decide what is best for them given a pro & cons list.
  - Pro inside
    - A single data storage solution (raster are never lost; for small volume, backup is more simple).
    - Faster for analysis (tiled and indexed, no need to extract data from JPEG file).
    - Edition locks provided by DB.
  - Pro outside
    - Reusable files with faster access (TIFF or JPEG) for thin client (WWW) display. No need to convert to JPEG.
    - One time backup (if raster is never edited).
    - No importation (involving copy of huge dataset) needed, just registration.
- We can solve this by allowing raster data (only the band and pyramid arrays in the previous WKT form) to be stored on disk (in TIFF or JPEG) and only reference them ~~with a path in the WKT/WKB.~~

```
ST_RasterFromText('RASTER(2,8,30.0,2,2,POLYGON((0.3453 0.7534,4.4634 0.3563, 4.4735 4.3626,0.7363 4.8464,0.3453 0.7534)),BAND(8BUI,0,c:/datastore/landsat/01b1.tif),BAND(16BF,0.0,c:/datastore/landsat/01b2.tif))',[<srid>])
```

- Every function listed below work seamlessly wherever the raster is stored. Pyramids do not work with JPEG.
- Add *ST_GetPath(raster, band)* to know the name of the raster file.
- Add –R option to the importer so no data are copied to the DB, only reference to the files.

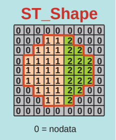
Some Questions

- Georeference: Is it better to…
  - Store only the bbox and derive the 6-floats-georeference from it?
  - Store only the georeference and derive the bbox from it?
- Indexing
  - Is it possible to build a GiST index from bboxes embedded in the raster geometry? If not, how else? Is it a good idea to store it in a different column?
- New WKT/WKB geometry type or set of new composite types?
  - Is it better to embed all the raster information in a new WKT/WKB geometry type (like the one described earlier) or to create a set of new composite type like:
    - raster('width', 'height', 'pixelSize', 'nbBand', 'nbPyramid', 'bbox', 'SRID', 'band[]')
    - band('pixelType', 'noDataValue', 'pyramid[]')
    - pyramid('pixelValue[]')
- Pyramids
  - Should pyramids be stored with each raster tile? Doesn't this lead to an edge effect at lower resolutions? Should them not be stored as a separate raster layer instead, as vector applications do? It would be up to the application to update pyramids when rasters are edited. Maybe both options are useful…
- Lossless data exchange
  - It is important that a physical data format supports export and re-import of raster rows without loss of information. Is TIFF a suitable/preferred format for all our needs?

Logical Operators to Adapt

Existing for vector geometry, adapted for raster geometries, return a boolean.

- Operate on two vector, a vector and a raster or on two rasters.
- In rasters, only pixels with values are taken into account (not the «nodata» values).
- Implies vectorization of the shape of the raster (ST_Shape) before processing in order to isolate pixels with a value from nodata pixels. Should be faster than a true vectorization (ST_AsPolygon) since it does not imply creating different polygons for different values.
- BBox operators (<, >, <<, >>, <|, |>&, <<|, |>>, ~=, @, ~, &&) work with ST_GetBBox(raster|raster) *(1)*
- **ST_Equals**(raster|vector, raster|vector) *(3)*
- **ST_Disjoint**(raster|vector, raster|vector) *(3)*
- **ST_Intersects**(raster|vector, raster|vector) *(1)*
- **ST_Touches**(raster|vector, raster|vector) *(3)*
- **ST_Crosses**(raster|vector, raster|vector) *(3)*
- **ST_Within**(raster|vector A, raster|vector B) *(2)*
- **ST_Overlaps**(raster|vector, raster|vector) *(2)*
- **ST_Contains**(raster|vector A, raster|vector B) *(2)*
- **ST_Covers**(raster|vector A, raster|vector B) *(3)*
- **ST_IsCoveredBy**(raster|vector A, raster|vector B) *(3)*
- **ST_Relate**(raster|vector, raster|vector, intersectionPatternMatrix) *(3)*



Existing Geometry Constructors to Adapt

Existing for vector geometry, adapted for raster geometries. (With implementation priority in parenthesis - 1,2 or 3)

- **ST_Centroid**(raster|vector) → *point geometry (3)*
- **ST_PointOnSurface**(raster|vector) → *point geometry (3)*
- **ST_Buffer**(raster|vector, double) → *same type as first argument (3)*
- **ST_ConvexHull**(raster|vector) → *same type as input (3)*
- **ST_Intersection**(raster|vector, raster|vector, 'raster'|'vector') → *geometry (1)*
- **ST_Difference**(raster|vector A, raster|vector B) → *same geometry type as first argument (3)*
- **ST_SymDifference**(raster|vector, raster|vector, 'raster'|'vector') → *geometry (3)*
- **ST_Union**(raster|vector, raster|vector, 'raster'|'vector') → *geometry (2)*
- **ST_Accum**(raster set|vector set, 'raster'|'vector') → *geometry (2)*
- **ST_Envelope**(raster|vector) → *polygon geometry (1)*
- **ST_Transform**(raster|vector, SRID) → *same type as input (1)*
- **ST_Affine**(raster|vector,…) → *same type as input (3)*
- **ST_Translate**(raster|vector,…) → *same type as input (3)*
- **ST_Scale**(raster|vector,…) → *same type as input (3)*
- **ST_TransScale**(raster|vector,…) → *same type as input (3)*
- **ST_RotateZ,Y,Z**(raster|vector, float8) → *same type as input (3)*
- **ST_Area**(raster|vector) → *double (2)*

The argument 'raster|vector' is always a form of geometry and the return type 'geometry' can be a vector geometry or a raster geometry…

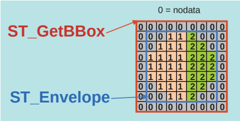
Functions with the 'raster'|'vector' string option return:
- vectors when both input are vectors geometries
- rasters when both input are rasters geometries
- the specified type otherwise

Default is to return a vector geometry

Existing and New Accessors

Existing for vector geometry, adapted for raster geometries

- **ST_AsText**(raster|vector) *(1)*
- **ST_AsBinary**(raster, compression) *(2)*
- **ST_AsKML**(raster|vector) → *KML (3)*
- **ST_AsSVG**(raster|vector) → *SVG (3)*
- **ST_SRID**(raster|vector) → *integer (1)*
- **ST_SetSRID**(raster|vector, integer) *(1)*
- **ST_IsEmpty**(raster|vector) → *boolean (2)*
- **ST_mem_size**(raster|vector) → *integer (2)*
- **ST_isvalid**(raster|vector) → *boolean (2)*



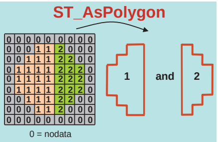
New for raster

- **ST_AsJPEG**(raster, quality) → *jpeg (2)*
- **ST_AsTIFF**(raster, compression) → *TIFF (2)*
- **ST_GetWidth**(raster) → *integer (1)*
- **ST_GetHeight**(raster) → *integer (1)*
- **ST_GetPixelType**(raster, band) → *string (1)*
- **ST_SetPixelType**(raster, band, string) → *string (1?)*
- **ST_GetPixelSize**(raster) → *integer (1)*
- **ST_SetPixelSize**(raster) → *integer (1?)*
- **ST_GetBBox**(raster) → *polygon geometry (1)*
- **ST_GetNbBand**(raster) → *integer (1)*
- **ST_GetNoDataValue**(raster, band) → *string (1)*
- **ST_SetNoDataValue**(raster, band, value) *(1)*
- **ST_Count**(raster, value) → *integer (2)*
- **ST_GetGeoReference**(raster) → *string (1)*
- **ST_SetGeoReference**(raster, string) *(1)*
- **ST_SetValue**(raster, band, x, y, value) *(3)*
- **ST_GetPyramidMaxLevel**(raster) → *integer (1)*
- **ST_GetPyramid**(raster, level) → *raster (1)*

New Geometry Constructors

New for raster geometries

- **ST_RasterFromText**(string, compression, [<srid>]) *(1)*
- **ST_RasterFromWKB**(raster, [<srid>]) *(3)*
- **ST_AsPolygon**(raster) → *polygon geometry set (1)*
- **ST_Shape**(raster) → *polygon geometry (1)*
- **ST_Band**(raster, band) → *raster geometry (1)*
- **ST_Resample**(raster, pixelsize, method) → *raster geometry (2)*

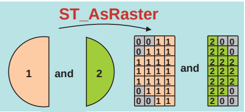


New for raster and vector geometry

- **ST_Clip**(raster|vector,geometry) → *same type as first argument (3)*
- **ST_SelectByValue**(raster|vector, 'expression') → *same type as first argument (2)*
- **ST_Flip**(raster|vector, 'vertical'|'horizontal') → *same type as first argument (3)*
- **ST_Reclass**(raster,string) → *same type as first argument (2)*
- **ST_MapAlgebra**(raster|vector, [raster|vector,…], 'mathematical expression', 'raster'|'vector') → *geometry (3)*

New for vector geometry only

- **ST_AsRaster**(vector, pixelsize) → *raster geometry (2)*
- **ST_Interpolate**(points, pixelsize, method) → *raster geometry (3)*



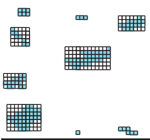
Three ways to use a WKT raster table…

A continuous tiled coverage

landcover	
tileId	geometry
3	raster(…)
4	raster(…)
…	…

- the traditional way of seeing a coverage
- images may overlap

A vector-like discrete coverage



lakes			
lakeId	code	area	geometry
464	03	32.63	raster(…)
375	02	12.53	raster(…)
…	…	6.25	…

- practically identical to a vector layer
  - all the pixels of each raster have the same value
- generally the result of an analysis operation implying rasterization of vectors features
  - *ST_AsPolygon(),*
  - *ST_Intersection(…,…,'RASTER')*

An image warehouse

carPictures		
Id	category	geometry
15436	Sport	raster(…)
35665	SUV	raster(…)
…	…	…

- intended for non-geospatial users
  - for web sites or any other usage (for better or worse!)
- georeference is not used
- open the door to other raster processing functions or packages

raster Importer

USAGE:

raster2pgsql [<options>] rasterfile [rasterfile…] [<schema>.]<table>

- **Create an SQL commands file to create a table of raster. If rasterfile is multiband and –b is not specified, every band are inserted. Multiple band can also be specified using multiple filenames (rasterfile1 is the first band, rasterfile2 the second, etc…). Can process multiple file from a folder.**
- **georeference (and pixel size) must exist directly in the files or in a companion World File.**

OPTIONS:

- **-s <srid> Set the SRID field. Default is -1.**
- **-b <nbband> Specify the number of band. The number of rasterfile must correspond to this number.**
- **-P <pixeltypes> Specify the pixels types in which to store each band. Ex. '8-bit unsigned integer,16-bit float'. conversion may happens.**
- **-n <nodata values> Specify the nodata value for each bands. Ex. '0,0.0'. Default to 'none' for each band.**
- **-t <pixels> Divide rasters into <pixels>x<pixels> tiles, one tile per row. Default is to store whole rasters as one row.**
- **(-d|a|b|c|p) Mutually exclusive options:**
  - –d Drops the table, then recreates it and populates it with current raster file data.
  - –a Appends raster file into current table, must be exactly the same pixel size, number of band, nodata value and pixel type.
  - –B Appends raster files as a new bands. When tiled with the –t option, the new band is inserted tiled in the same way as the original band.
  - –c Creates a new table and populates it, this is the default if you do not specify any options.
  - –p Prepare mode, only creates the table.
- **-r <raster_column> Specify the name of the raster column (mostly useful in append mode).**
- **-D Use postgresql dump format (defaults to sql insert statements).**
- **-I Create a GiST index on the bbox of the raster column.**
- **-? Display this help screen**

Should rast2pgsql produce a SQL file like shp2pgsql or insert rasters directly in PostGIS?

Example 1 – Import/Export

Importing existing rasters as raster into PostGIS

```
>raster2pgsql -s 32198 -t 128 -i forestcover.tif temperature.tif
public.coverandtemp > c:/temp/coverandtemp.sql
```

File by file version where each file is splited into tiles

or

```
>raster2pgsql -s 32198 -t 128,tid -i c:/forestcoverfolder/ c:/temperaturefolder/
public.coverandtemp > c:/temp/coverandtemp.sql
```

Folder version where each file in each folder is imported and tiled. tid is a target column storing a unique identifier for every source file (1,2,3,4,5,6,…) Could also come from part of the filename.

Exporting existing rasters as raster files

```
>pgsql2raster -f c:/temp/image#.tif -h localhost -p pwd -u user -r raster
public.coverandtemp
```

Produce many small files or tiles named image1.tif, image2.tif,…

or

```
>pgsql2raster -f c:/temp/image.tif -h localhost -p pwd -u user public 'SELECT
ST_Accum(ST_Band(raster,1)) FROM coverandtemp WHERE prov='BC' GROUP
BY prov'
```

Produce one big multiresolution raster by aggregation of many tiles.

Example 2
Retrieving tiles intersecting an extent

```
SELECT ST_AsJPEG(ST_GetPyramid(ST_Band(raster,2),3),60)
FROM coverandtemp
WHERE ST_BBox(coverandtemp.raster) &&
ST_GeomFromText('POLYGON(-350926 351220,-350926
199833,-196958 199833,-196958 351220,-350926 351220)',
32198) and
ST_Intersects(coverandtemp.raster,ST_GeomFromText('POLYG
ON(-350926 351220,-350926 199833,-196958 199833,-196958
351220,-350926 351220',32198))
```

Returns a table of jpeg tiles, from the temperature band, intersecting with the specified extent. The intersection takes into account the nodata values (they are not part of the geometry). Only the specified resolution (pyramid) is returned.

Example 3
What is the total length of roads (polylines) crossing different types of forest cover (raster) ?

```
SELECT max(covertype) as covertype,
sum(ST_Length(ST_Intersection(cover.raster,roads.geometry)))
as totallength
FROM cover, roads
WHERE cover.raster && roads.geometry and
ST_Intersects(cover.raster,roads.geometry)
GROUP BY covertype
ORDER BY totallength
```

Example of a totally seamless operation involving a raster layer and a polyline layer.

Example 4
Raster-Only MapAlgebra Operation
(possible also between raster/vector)

```
SELECT
ST_SelectByValue(
  ST_MapAlgebra(
    ST_Reclass(
      ST_Resample(
        ST_Transform(rast1,32198),
        30,'CUBIC'),
      '0-99=0,100-199=1,200-255=2'),
    rast2, 'int(0.434*A+0.743*B)'),
  2)
FROM cover1, cover2
WHERE ST_Transform(rast1,32198) ~= rast2
```

One of the coverage has to be reprojected, resampled and reclassed before doing a map algebra operation with the other coverage. There is as many rows in the result as there is tiles having equivalent extent in the two coverages. Only pixels with value '2' are retained in the final result. Coverages are assumed to have only one band.

Only raster having equivalent extent are part of the calculus

Example 5
Rebuilding a regional raster from a global coverage

```
SELECT
ST_AsJPEG(ST_Accum(A.raster), 60)
FROM
(SELECT ST_Pyramid(ST_Band(raster, 2), 3)) as raster
FROM USACoverage WHERE state='NY') A
```

Use the same ST_Accum aggregate function as the one used with geometry.

PostGIS WKT raster VS Oracle GeoRaster*

Oracle GeoRaster*…

- is stored as a relation between two types in different tables:
  - images (SDO_GEORASTER) and
  - tiles (SDO_RASTER)
- is very complicated. Supports:
  - bitmap mask
  - two compression schemes
  - three interleaving types
  - multiple dimensions
  - embedded metadata (color table, statisitcs, etc…)
  - lots of unimplemented features
- do not allow seamless analysis operations with vector geometries

PostGIS WKT Raster…

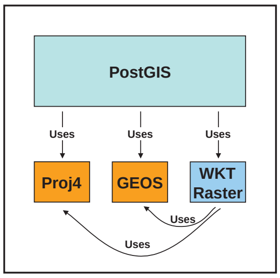
- is stored as a single type in a table, much like the geometry type.
  - It does not distinguish the tile concept from the image concept. Both concepts are interchangeable.
- is more simple. Supports:
  - masks through band
  - only the deflate compression
  - only one interleaving type
  - only two dimensions
  - leave metadata, color table and statistics to the application level
- allows seamless analysis operations with vector geometries

Xing Lin's PGRaster is almost identical to Oracle GeoRaster…

Summary

- rasters are multiband and multiresolution, georeferenced, and support variable extents (per row), nodata values and multiple pixel types.
- raster is implemented as a new WKT/WKB form
  - WKT as ST_RasterFromText('RASTER(…)')
  - WKB as raw raster data, compressed with deflate
- Functions involving only rasters generally return raster.
- Functions involving only vectors generally return vector.
- Functions involving rasters and geometries have an option to specify the type of the output in case of ambiguity.
- Some raster-specific functions must be added but most functions become seamlessly usable with vector geometries or raster geometries.
- WKT Raster is much more simple to use than Oracle GeoRaster
- WKT raster is not an attempt to implement ISO 19123

Implementation



Priorities and Planning

1. **For the BAM project** (marked with 1) *June 2009?*
   a. raster2pgsql
   b. ST_RasterFromText
   c. ST_GetBBox, ST_Envelope, ST_Shape, ST_AsPolygon
   d. &&, ST_Intersection, ST_Intersects
   e. ST_Band, ST_GetPyramid, ST_AsText, ST_Transform
   f. ST_SRID, ST_SetSRID, ST_GetWidth, ST_GetHeight, ST_GetPixelType, ST_SetPixelType, ST_GetPixelSize, ST_SetPixelSize, ST_GetNbBand, ST_GetNoDataValue, ST_SetNoDataValue, ST_GetPyramidMaxLevel
2. **For a first release** (marked with 2) *December 2009?*
   a. pgsql2raster
   b. ST_AsRaster, ST_AsBinary, ST_AsJPEG, ST_AsTIFF
   c. ST_IsEmpty, ST_mem_size, ST_isvalid, ST_Count
   d. ST_Accum, ST_Union, ST_SelectByValue
   e. ST_Within, ST_Overlaps, ST_Contains
   f. ST_Reclass, ST_Resample, ST_Area
3. **All remaining functions** (marked with 3) *June 2010?*

WKT Raster VS ISO 19123

- ISO 19123 is the "Abstract Specification Schema for Coverage Geometry and Functions"
- No "implementation" standard have been produced yet
- Even though the "raster" type is more easily associated with the notion of "coverage", a raster layer is NOT MORE a coverage than a vector layer. In the standard:
  - some types of coverage can be vectorial. e.g.
    - CV_DiscreteSurfaceCoverage (a vector layer of surfaces)
    - CV_DiscretePointCoverage (a vector layer of points)
  - some types of coverage can be matricial. e.g.
    - CV_DiscreteGridPointCoverage (a raster layer representing a grid of discrete points)
    - CV_ContinousQuadrilateralGridCoverage (a raster layer representing a continuous field)
- We think ISO 19123 should be implemented as a layer OVER a vectorial or a raster layer.
  - every ISO 19123 function should have the name of a vector or a raster table as argument. e.g. *evaluate(temp, point)* where temp is the name of a table containing a geometry column (vector or raster)

Acknowledgements

- Steve Cumming (Steve.Cumming@sbf.ulaval.ca), Canada Research Chair in Boreal Ecosystems Modelling, for having initiated this project and financing it through a Canada Foundation for Innovation grant.
- Thierry Badard (http://geosoa.scg.ulaval.ca), Professor/full time researcher at Centre for Research in Geomatics, Université Laval, Quebec, Canada for his valuable comments, revisions, expertise and discussions.

Funding and Future Opportunities

- **Actual Funding -** The Boreal Avian Modeling (BAM) project and the Canadian Foundation for Innovation (CFI) are financing development of a web-based GIS tool to automate buffer operations on large spatial datasets. The objective is to support ecological analysis by reducing the overhead of GIS expertise and data assembly. A half-time position is supported to develop a system prototype including raster integration in PostGIS.
- **Extended Funding -** Steve Cumming and Thierry Badard aim at initiating a new project to complement the funding of the project (and hence enable the financial support of another developer) and explore new avenues for geospatial data analysis provided by such a raster support (e.g. raster based Spatial OLAP applications).
- **Interested? -** If you are interested in such an implementation of the raster support in/with PostGIS and/or in participating to the new project, do not hesitate to contact Pierre Racine (Pierre.Racine@sbf.ulaval.ca), Steve Cumming (Steve.Cumming@sbf.ulaval.ca) and Thierry Badard (Thierry.Badard@scg.ulaval.ca).

MINUTES OF MEETINGS
BETWEEN
THE JAPANESE TERMINAL EVALUATION TEAM
AND
AUTHORITIES CONCERNED OF
THE GOVERNMENT OF THE FEDERATIVE REPUBLIC OF BRAZIL
ON
JAPANESE TECHNICAL COOPERATION PROJECT
FOR
UTILIZATION OF ALOS IMAGES TO SUPPORT THE PROTECTION OF THE BRAZILIAN AMAZON FOREST AND COMBAT AGAINST ILLEGAL DEFORESTATION

Brasilia, Brazil, December 2nd, 2011

Mr. ENDO Hiroaki
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The Japan International Cooperation Agency (hereinafter referred to as "JICA") and the Government of the Federative Republic of Brazil organized a Joint Terminal Evaluation Team (hereinafter referred to as "the Team") composed of the Japanese Evaluation team headed by Mr. ENDO Hiroaki, Director, Forest and Nature Conservation Division II, Global Environment Department, JICA, and the Brazilian Evaluation team headed by Mr. Eron Carlos da COSTA, Projects Analyst from Brazilian Cooperation Agency (ABC), Ministry of External Relations, for the purpose of conducting the terminal evaluation of the Japanese technical cooperation project titled "Utilization of ALOS Images to Support the Protection of the Brazilian Amazon Forest and Combat against Illegal Deforestation" (hereinafter referred to as "the Project").

The Team has carried out intensive study and analysis of the activities and achievement of the Project, and prepared Report of the Joint Terminal Evaluation attached hereto (hereinafter referred to as "the Report") (ANNEX1), which was presented to the Joint Coordinating Committee (hereinafter referred to as "JCC") held on December 2nd, 2011. After discussions on the major issues pointed out in the Report, the JCC accepted it and took note on the recommendations made therein.

Further, the Japanese Evaluation team had a series of meetings with the Brazilian authorities concerned, on the matters related to the Project including the results of the Joint Terminal Evaluation, and agreed on the following matters.

1. Result of Joint Terminal Evaluation

The Team agreed upon the contents of the Report, which was presented at the JCC on December 2nd, 2011.

The Team concluded that, the Project Activities have been implemented without serious problems, producing the Outputs almost as planned, in spite of unexpected termination of ALOS operation in April 2011. The Project Purpose is expected to be practically achieved by the Project end: therefore, the Project will be successfully terminated in June 2012 as planned.

The major recommendations from the Team were as follows.

(1) Preparation for utilization of ALOS-2/PALSAR images

Since ALOS-2 will be launched in near future, it is recommended to prepare for utilization of ALOS-2/PALSAR images in terms of collecting information on analysis/interpretation techniques. For this objective, DPF and IBAMA should identify the necessary activities to enable prompt utilization of ALOS-2/PALSAR data.

(2) Preparation of Post-project strategies

Post-project strategies for each Output should be developed by the end of the Project in order to sustain the effect of the Project.

(3) Agreement between DPF and IBAMA

Currently DPF and IBAMA are coordinating an agreement for ensuring the collaboration between the two organizations after the termination of the Project. It is recommended that DPF and IBAMA make efforts to conclude the agreement by the end of the Project.

(4) Modification of the Project Design Matrix

The Project Design Matrix (hereinafter referred as "PDM") should be modified in regards of the Objectively Verifiable Indicator for the Overall Goal and Important Assumption for the Overall Goal in order to clarify definition and target of enhancement of law enforcement. The draft of modified PDM (draft PDM5), prepared through a series of discussions with the Project Personnel and the Japanese Experts, is attached as Annex 6 of the Report. The modified PDM should be submitted to the meeting of JCC on 2 December 2011 for its review and approval. It is noted that the Indicator for the Overall Goal may be modified by the Project end depending on the contents of the Lower House's Bill No 1, 2010, regarding cooperation between Federal, State, Federal District and Municipal Governments on protection of natural environment, which is being finalized.

(5) Dissemination of the Results of the Project

Considering the good results of the Project, DPF and IBAMA should explore the possibilities of spreading the technology and results of the Project to other countries, for example through the Third Country Training Programme of JICA.

(6) Continuous use of ALOS data

Regarding high-resolution SAR images for Forensic Reports, which is provided by JICA during the Project period, it is recommended that the DPF makes efforts to ensure that images of ALOS and ALOS-2/PALSAR will be continuously obtained after the end of the Project. On the other hand, IBAMA should also make efforts to guarantee that ScanSAR images of ALOS-2, which are necessary for the detection of illegal deforestation, will be provided based on the agreement between IBAMA and JAXA.

2. Implementation of the Project based on the modified PDM approved by the JCC

Both Brazilian and Japanese sides agreed to ensure the implementation of the Project based on the modified PDM approved by the JCC on December 2nd, 2011 (PDM version 5), as attached hereto (ANNEX 2), in the remaining period.

Attached Documents:

ANNEX 1 Report of the Joint Terminal Evaluation

ANNEX 2 PDM version 5

ANNEX 2 PDM 5

1. Project Name : The Project for utilization of ALOS images to support the protection of the Brazilian Amazon Forest and combat against illegal deforestation   PDM 5 approved on 2 Dec, 2011
2. Project site: Brasilia
3. Duration: From June 2009 to June 2012 (three years)
4. Target Beneficiaries: Forensic Experts of Federal Police Department (DPF) and Environmental Analysts of Brazilian Institute for the Environment and Renewable Nature Resources (IBAMA)
5. Target Area: Brazilian Amazon (i.e. 9 Legal Amazon States: Acre, Amapa, Amazonas, Maranhao, Mato Grosso, Para, Rondonia, Roraima, Tocantins)

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal Law enforcement is enhanced ground on technical information based on satellite images on illegal deforestation	a: Deforestation of Brazilian Amazon is monitored with use of SAR images, including ScanSAR (*3) images of ALOS-2 at every Cycle, using/applying the methodologies developed through the Project b: The techniques acquired through the Project are adapted and used for monitoring of deforestation in at least 2 sites in at least one biome different from Amazon. c: SAR images and high-resolution images are utilized /referred to in 100 Environmental Forensic Reports (*4)on illegal deforestation produced by DPF per year. (Note: The Indicator may be modified by the Project end depending on the contents of the Lower House's Bill No 1, 2010, regarding cooperation between Federal, State, Federal District and Municipal Governments on protection of natural environment, which is being finalized)	a-c:Reports by IBAMA and DPF	A: There is no particular change in government policies on protection of Brazilian forest
Project Purpose Technical information based on ALOS(*1)/PALSAR(*2) images on illegal deforestation in the Brazilian Amazon is provided for law enforcement	a: By the Project end, deforestation areas are detected within 3 working days after receiving the ScanSAR images of ALOS/PALSAR by IBAMA. b: By the Project end, the location and size of the detected deforestation areas (i.e. Deforestation Polygons) are provided to the relevant IBAMA regional offices within 2 working days after their detection c: By the Project end, ALOS/PALSAR images (mainly high-resolution ones) are utilized/referred to in 60 Forensic Reports produced by DPF per year	a&b:Comparison of the record of concerned dates kept by IBAMA c: Review of Forensic Reports	A: Budgets and staffs for law enforcement do not decrease drastically B: Responsibilities of DPF and IBAMA in law enforcement in the Brazilian Amazon do not change drastically. C: ALOS-2 launch and provision of its images does not fall behind schedule significantly(*8) D: Provision of ALOS-2 images is not discontinued.

ANNEX 2 *PDM 5*

Output 1: Deforestation areas including suspicious areas are detected using ALOS/PALSAR data	1a: Useless multi-temporal combination of ScanSAR images of ALOS/PALSAR becomes zero by the end of 2009. 1b: Methodologies to extract deforestation information from ScanSAR images of ALOS/PALSAR developed by the Project, including Interpretation guide, forest classification tool, and change detection tool by the end of 2009; and updated by March 2012 1c: Initial version of the technical manuals for IBAMA and DPF for utilization of ALOS/PALSAR images in detection of deforestation areas and preparation of Forensic Reports respectively are developed/approved by September 2011 (in English and Portuguese) 1d: The initial version of the technical manual for IBAMA is uploaded to SISCOM (*5) for the use of Environmental Analysts and the one for DPF is uploaded to InteliGEO(*6) for the use of Forensic Experts by October 2011. 1e: The initial version of the technical manuals for IBAMA and DPF are updated by March 2012 1f: The updated manuals are uploaded to SISCOM and InteliGEO respectively by April 2012	1a: Review of error report produced by IBAMA 1b: Review of the developed tools &progress reports 1c&e: Review of technical manuals & date of approval of each manual by the Project Manager of DPF and IBAMA respectively 1d&f: Review of the uploaded dates recorded in SISCOM and InteliGEO	A: There is no significant organizational change in DPF and /or IBAMA affecting implementation of the Project B: Budgets for satellite monitoring of DPF and/or IBAMA do not decrease drastically
Output 2: The information flow of satellite monitoring system throughout DPF and IBAMA is improved	2a: Information sharing mechanism of DPF developed by the Project (i.e. InteliGEO) is made available to all the Forensic Experts in Brazil by December 2009 2b: By the Project end, 100% of Forensic Reports produced by DPF Forensic Experts, utilizing/referring to ALOS/PALSAR images (mainly high-resolution ones), are made available in InteliGEO for other Experts within one week after the completion 2c: By the Project end, at least one access to INDICAR(*7)/SISCOM of IBAMA are made from each of the 9 Legal Amazon States per cycle of ALOS operation (i.e. 46 days) 2d: Semi-annual access to InteliGEO of DPF is increased by 5 % in relation to the previous semester. 2e: By the Project end, 90 % of the results of visits of the deforestation areas detected by INDICAR/SISCOM & ALOS/PALSAR (i.e. Deforestation Polygons) are fed back to IBAMA HQ	2a:Record of the release date 2b:Check that all Forensic Reports in Criminalistica uploaded in InteliGEO, and the ones that are not more than a week old 2c: Record of access to INDICAR 2d: Record of access to InteliGEO 2e:Record of feedbacks registered in the google.doc.	
Output 3: Human resources in DPF and IBAMA are upskilled to detect and characterize illegal deforestation	3a: Basic and advanced courses for IBAMA and DPF for the general use of ALOS/PALSAR images, including curriculum and textbooks, are developed by September 2009 3b: Basic course specifically for the use of DPF Forensic Experts to produce Forensic Reports are developed by April 2012. 3c: By the Project end, 70 staff members (30 Forensic Experts of DPF and 40 Environmental Analysts of IBAMA) receive official training certificates for the use of ALOS/PALSAR images from IBAMA or DPF 3d: On average, 80% of the trainees give the highest or medium rate on three-level rating about “degree of understanding” and “degree of applicability” of the concerned trainings 3e: The training courses are updated based on the feedbacks from the trainees, including the results of monitoring and evaluation of the trainings, and other Project Activities	3a: Project report &curriculum and textbooks developed 3b: ditto 3c: List of trainees 3d: Results of the questionnaires to the trainees 3e:Analytical report of training	

Activities	Inputs	
Activities 1.1 Convert ALOS/PALSAR data format to fit into INDICAR/SISCOM 1.2 Develop methodologies to extract deforestation information from ALOS/PALSAR images. 1.3 Identify potential deforestation areas using ALOS/PALSAR images and other available geographic information 1.4 Develop technical manuals for DPF and IBAMA for utilization of ALOS images based on the results of the Activities 1.1-1.3 2.1 Document existing monitoring mechanism 2.2 Identify possible upgrading opportunities in the DPF/IBAMA deforestation monitoring mechanism 2.3 Improve the existing satellite information sharing mechanism of IBAMA HQ (i.e. INDICAR/SISCOM) 2.4 Develop an information sharing mechanism at DPF HQ (i.e. InteliGEO) 2.5 Establish an information flow between IBAMA and DPF HQs 2.6 Develop an intra-information flow mechanism between IBAMA HQ and its regional offices 2.7 Develop an intra-information flow mechanism between DPF HQ and its regional offices 3.1 Assess training needs to monitor and characterize illegal deforestation in DPF/IBAMA 3.2 Determine the training plan 3.3 Execute the training plan 3.4 Monitor/evaluate/upgrade the trainings	**Inputs** **<Brazilian Side>** (1) Project & Administrative personnel ● Project Director ● Project Manager(s) ● Other project and administrative personnel (2) Office Spaces and Facilities ● Office space in IBAMA ● Other facilities necessary for the implementation of the Project (3) Administration and operational costs **<Japanese Side>** (1) Experts ● Remote Sensing/Administrative Coordination ● Information and Communication Technology ● Web-programming, GIS ● Other Experts necessary for the Project (2) Training of Brazilian personnel in Japan (3) Machinery and Equipment ● ALOS images, software, servers, storages ● Other materials necessary for the implementation of the Project	A:Main project personnel are not transferred to other departments and/or agencies **Pre-Conditions** A: ALOS/PALSAR images (i.e. ScanSAR images) are provided by Japan Aerospace Exploration Agency (JAXA) based on the Agreement on Cooperation between JAXA and IBAMA B: DPF and IBAMA conclude an agreement on the joint implementation of the project

(*1) ALOS: Advanced Land Observing Satellite launched by JAXA
(*2) PALSAR: Phased Array Type L-Band Synthetic Aperture Radar
(*3) ScanSAR: Scan Synthetic Aperture Radar
(*4) Forensic Report: Technical document produced by DPF Forensic Experts that aims to establish whether a crime has happened, how it happened, and who committed it. This document is used in criminal prosecutions.
(*5) SISCOM: Environmental information sharing mechanism of IBAMA
(*6) InteliGEO: Information sharing mechanism of DPF being developed by the Project under Output 2
(*7) INDICAR: Indicator of Deforestation for Radar Images.
(*8) As of November 2011, ALOS-2 is scheduled to be launched in August 2013. Its operation schedule, including the timing of commencement of provision of images, is expected to be released in advance of the launch. For reference, provision of ALOS images started within 3 months after its launch.

REPORT OF THE JOINT TERMINAL EVALUATION
ON
THE PROJECT FOR UTILIZATION OF ALOS IMAGES TO SUPPORT THE PROTECTION OF THE BRAZILIAN AMAZON FOREST AND COMBAT AGAINST ILLEGAL DEFORESTATION

December 1, 2011

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<Annex>
Annex 1 PDM for Evaluation (Latest PDM with simple editorial errors corrected)
Annex 2 Latest Plan of Operation with progress of activities
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Annex 4 Implementation Process of the Project
Annex 5 Evaluation based on Five Evaluation Criteria
Annex 6 Draft Modified PDM (Draft PDM 5)

<Reference Material (RM)>
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RM B Record of Japanese Inputs
RM C Data for Some Indicators
RM D List of Project Deliverables

1. Introduction

1.1 Objectives of the Joint Evaluation

The evaluation activities were performed with the following objectives:

(1) To verify the accomplishments of the Project compared to those planned;

(2) To identify obstacles and/or facilitating factors that have affected the implementation process;

(3) To analyze the Project in terms of the five evaluation criteria (i.e. Relevance, Effectiveness, Efficiency, Impact, and Sustainability); and

(4) To make recommendations on the Project regarding the measures to be taken for the remaining period as well as the post-project period.

1.2 Members of the Joint Evaluation Team

(1) The Japanese Team

Title	Name	Position
Team Leader	Mr. ENDO Hiroaki	Director, Forest and Nature Conservation Division II, Global Environment Department, Japan International Cooperation Agency
Forest Conservation /Satellite Image Analysis	Dr. HIRATA Yasumasa	Head of Climate Change Office, Forestry and Forest Products Research Institute
Technical Dissemination	Ms. Patricia Shizuka TAKEDA	Staff, JICA Brazil
Cooperation Planning	Mr. SEKIGUCHI Takuya	Officer, Forest and Nature Conservation Division II, Global Environment Department, JICA
Evaluation/Analysis	Ms. HIROUCHI Yasuyo	Permanent Expert, International Development Associates Ltd.

(2) The Brazilian Team

Title	Name	Position
Team Leader	Mr. Eron Carlos da COSTA	Project Analyst, Brazilian Cooperation Agency Ministry of External Relations
Member	Ms. Camila Aparecida LIMA	Analyst on Natural Resources and Environmental Analysis, Operational and Management Division, Centre of Amazon Protection System (CENSIPAM)
Member	Mr. Raphael de Oliveira BORGES	Support Analyst on Natural Resources and Environmental Analysis, CENSIPAM

1.3 Schedule of the Evaluation Study

The evaluation of the Project was conducted from November 16th to December 2nd, 2011. The Joint Review Team (hereinafter referred to as "the Team") collected the information through questionnaires and a series of interviews with Brazilian Project Personnel and Japanese experts. Based on the results of the review, the Team prepared a draft report and finalized it through a series of discussions on November 28th and 30th

2. Outline of the Project

2.1 Background of the Project

Amazon rainforest is the largest rainforest in the world and its conservation is very important for the whole earth. Despite the great efforts of the government of Brazil to conserve it, the forest is decreasing because of several causes such as environmental crimes.

Satellite images are useful tools to monitor the situation of vast Amazon rainforest. The Brazilian government has used them to protect Amazon rainforest from 1970s and developed satellite monitoring systems by using optical sensors. Brazilian monitoring systems are one of the world's advanced systems, and have produced good results on forest conservation.

Satellite monitoring systems play an important role in the Plan of Action for the Prevention and Combat against the Deforestation in Amazonia (PPCDAM). The plan has been operated through a partnership of 13 ministries, and as a result, 20 million hectares of conservation units were created, the System of Real Time Detection of Deforestation (DETER) and the Project on the Monitoring of Deforestation in Legal Amazon (PRODES) were established, the Document of Forest Origin (DOF) which proves legal tree felling was introduced, number of imprisoned persons involved in environmental crimes increased, dozens of irregular companies were discovered, and the deforestation was remarkably reduced.

Although satellite monitoring systems are useful tools to monitor Amazon, there is a serious problem. Amazon is covered by thick clouds about half a year and during that time, monitoring by optical sensors is difficult.

The Japanese satellite Advanced Land Observing Satellite DAICHI (hereinafter referred to as "ALOS") loads a Phased Array Type L-band Synthetic Aperture Radar (hereinafter referred to as "PALSAR"), which can obtain images regardless of the weather. By using ALOS, it becomes possible to monitor the Amazon rainforest throughout the year so that a deterrent effect to environmental crimes can be strengthened.

Beside that, other ALOS images of high resolution (PRISM-Panchromatic Remote Sensing Instrument for Stereo Mapping and AVNIR2-Advanced Visible and Near Infrared Radiometer type 2) can be useful in law enforcement improving the forensic reports that are essential documents to describe the proofs of crimes and to avoid the impunity of environmental criminals.

Therefore, the Japanese technical cooperation project "the Project for Utilization of ALOS Images to support the protection of the Brazilian Amazon Forest and Combat Against Illegal Deforestation" started in June 2009, and Japan International Cooperation Agency (hereinafter referred to as "JICA") will cooperate with the Department of Federal Police (hereinafter referred to as "DPF") and the Brazilian Institute for the Environment and Renewable Natural Resources (hereinafter referred to as "IBAMA") until June 2012.

In April 2011, ALOS has happened to complete its operation due to technical matter. So, new ALOS/PALSAR images have not been provided since this. However, the Project is continuing technical transfer to drive for ALOS-2 which will be launched in the near future, especially focusing on technics concerning analysis/change detection of satellite images and preparation of forensic reports.

Now, as the remaining period of the Project is only half a year, the Team was formed for this terminal evaluation survey.

2.2 Summary of the Project

(1) The Project Purpose: Technical information based on ALOS/PALSAR images on illegal deforestation in the Brazilian Amazon is provided for law enforcement

(2) The Overall Goal: Law enforcement is enhanced ground on technical information based on satellite images on illegal deforestation

(3) The Outputs:

1) Output 1: Deforestation areas including suspicious areas are detected using ALOS/PALSAR data

2) Output2: The information flow of satellite monitoring system throughout DPF and IBAMA is improved

3) Output3: Human resources in DPF and IBAMA are upskilled to detect and characterize illegal deforestation

3. Review of the latest Project Design Matrix (PDM)

For evaluation of a technical cooperation of JICA, Project Design Matrix (hereinafter referred to as "PDM") and Plan of Operations (hereinafter referred to as "PO") are used as essential documents. Prior to the start of the evaluation, the Team reviewed the latest PDM (PDM4) approved by JCC in July 2011, and prepare a PDM for Evaluation (PDME) as a basis of the evaluation, in which some simple editorial errors are corrected (Annex 1). The PDME was prepared by the Team through consultation with Brazilian project personnel and Japanese experts. The latest PO (or detailed PO) with progress of its activities is also attached (Annex 2).

4. Methodology of the Evaluation

4.1 Data Collection Method

The Team made interviews with the Brazilian Project Personnel and the Japanese experts engaged in the Project. The Team also collected information through questionnaires from the concerned personnel.

4.2 Items of Analysis

(1) Accomplishment of the Project

The accomplishment of the Project was measured in terms of the Inputs, the Outputs and the Project Purpose in comparison with the Objectively Verifiable Indicators of PDM as well as the plan delineated in the R/D.

(2) Implementation Process

The implementation process of the Project was reviewed to see if the Activities have been implemented according to the schedule delineated in the latest PO, and to see if the Project has been managed properly as well as to identify obstacles and/or facilitating factors that have affected the implementation process.

(3) Evaluation based on the Five Evaluation Criteria

(a) Relevance: Relevance of the Project was reviewed to see the validity of the Project Purpose and the Overall Goal in connection with the needs of the beneficiaries and policies of Brazil and Japan.

(b) Effectiveness: Effectiveness was analyzed by evaluating the extent to which the Project has achieved and contributed to the beneficiaries.

(c) Efficiency: Efficiency of the Project implementation was analyzed focusing on the relationship between the Outputs and Inputs in terms of timing, quality, and quantity.

(d) Impacts: Impacts of the Project were forecasted by referring to positive and negative impacts caused by the Project.

(e) Sustainability: Sustainability of the Project was analyzed in institutional, financial and technical aspects by examining the extent to which the achievement of the Project would be sustained and/or expanded after the Project is completed.

5. Summary of Accomplishment and Implementation Process of the Project

5.1 Accomplishment of the Project (Details are described in Annex 3)

(1) Inputs (Details are described in section I of Annex 3)

Summary of Inputs is shown in the tables below.

Table 1: Summary of Brazilian Inputs

Allocation of Project Personnel (P/P)	DPF:7persons IBAMA: 8 persons	Allocation of local cost:	US$ 1,298,000 (as of November 2011)

Table 2: Summary of Japanese Inputs

Dispatch of Experts:	4 persons	Provision of Equipment:	¥ 73.2 million
P/P trained in Japan:	16 persons (8 each from DPF and IBAMA)	Disbursement of local cost:	¥ 29.3million (as of October 2011)

(2) Outputs (Details are described in section II of Annex 3)

(a) Output 1: Methodologies for deforestation detection, including interpretation guide, forest classification tool, and change detection tool, developed by the Project, are expected to be updated by March 2012. Initial version of the technical manuals for IBAMA and DPF have been developed and uploaded to SISCOM for the use of Environmental Analysts and to InteliGEO for the use of Forensic Experts of DPF respectively. The manuals are expected to be updated by March 2012 and uploaded to SISCOM and InteliGEO by April 2012.

Output 1 has been mostly achieved and is expected to be fully achieved by the Project end.

(b) Output 2 : Information sharing mechanism of DPF (i.e. InteliGEO) was officially released in November 2010. All of the Forensic Reports produced by DPF Forensic Experts, utilizing/referring to ALOS/PALSAR images, have been made available in InteliGEO for other Experts within one week after their completion (i.e. within an average of 2 days). Semi-annual access to InteliGEO has been increased by more than 5% (i.e. 163%) in relation to the previous semester. Regional Offices in Legal Amazon States have been linked with INDICAR/SISCOM of IBAMA Headquarters since December 2009. According to IBAMA, all of the 9 Legal Amazon States utilized the Deforestation Polygons uploaded in INDICAR/SISCOM in the last 3 cycles of ALOS operation. Less than 10% of the results of the visits of the detected deforestation areas (i.e. Deforestation Polygons) used to be reported back from the Regional Offices, however. In order to ensure the feedbacks from the Regional Offices, IBAMA has developed a feedback system, but it has not been put into use due to unexpected termination of operation of ALOS in April 2011.

Output 2 has been mostly achieved. It is expected that, in effect, the Output would be achieved by the Project end.

(c) Output 3: Basic and Advanced Courses for IBAMA and DPF for the general use of ALOS/PALSAR images have been developed. So far, four trainings (i.e. three Basic and one Advanced Courses) have been conducted and a total of 60 training participants (i.e. 28 DPF Forensic Experts and 32 IBAMA Environmental Analysts) have been awarded the certificates by IBAMA. Since the second Advanced Course for general use was canceled due to unexpected termination of ALOS operation, the number of staff members, in particular those from IBAMA, trained through the Project would be less than planned. Meanwhile, DPF plans to develop a web-based Basic Course training, expecting that the Course would be included in the online training program offered by the National Police Academy. Evaluation of the training is yet to be conducted though informal feedbacks from the trainees have been reflected in planning of the subsequent trainings. It is noted that the Project plans to conduct evaluation by the Project end.

Output 3 has been mostly achieved but would not be fully achieved due to an external condition beyond the control of the Project (i.e. unexpected termination of ALOS).

(3) Project Purpose (Details are described in section III of Annex 3)

Time for the deforestation detection after IBAMA received the Scan Synthetic Aperture Radar (ScanSAR) images of ALOS/PALSAR decreased from more than one month in the beginning of the Project to average of 9.5 days, including rest days, at the last Cycle of

ALOS operation. With a semi-automatic change detection tool under development in place, it is technically possible to further reduce the time for the deforestation detection to 2 working days.

With regard to provision of the location and size of the detected deforestation (i.e. Deforestation Polygons) to the Regional Offices of IBAMA, the gap in time decreased from 69 days in the beginning of the Project to average of 5.78 days at the last Cycle of ALOS operation. At present, it is technically possible for IBAMA to provide the Deforestation Polygons soon after the Polygons are produced on INDICAR/SISCOM by putting them in the database of SISCOM called "Geo DB", which regional staff can access through internet and use the information in GPS and mobile devices in the field.

Total of 90 Forensic Reports on illegal deforestation cases, which utilize/refer to ALOS/PALSAR images, were produced by DPF Forensic Experts from December 2010 to November 2011.

5-2 Implementation Process of the Project (Details are described in Annex 4)

Overall, the Project has been proceeding well though some of the Activities could not be implemented as planned mainly due to external factors beyond control of the Project.

The Project has been implemented jointly by DPF and IBAMA. Though the agreement for joint implementation has not been concluded as initially planned, both organizations have worked in close partnership. Communication within the Project is sufficient for smooth implementation. Cooperative relations between Brazilian and Japanese sides have been built up. The Project has coordinated/collaborated with various organizations, including INPE and CENSIPAM. Initiative and commitment of the Director of Technical Scientific Directorate (DITEC) of DPF (as Project Director) and Director of Environmental Protection Directorate (DIPRO) of IBAMA as the chairman of the Joint Coordinating Committee (JCC) as well as motivation and diligence of the Project Personnel have been identified as the factors that have facilitated the implementation process. Through a series of discussions with the Project Personnel and the Japanese Expert Team at Mid-term Review, the PDM as well as the PO became detailed enough as a management tool for the Project.

6. Summary of Evaluation based on Five Evaluation Criteria

6.1 Relevance (Details are described in Section I of Annex 5)

The Overall Goal and the Project Purpose are still relevant with the needs of Brazil and Target Groups (i.e. Forensic Experts of DPF and Environmental Analysts of IBAMA).

They are still consistent with the national development plan of Brazil as well as the Official Development Assistance (ODA) policies of Japan. Japanese technical advantage has been confirmed. The comparative advantage of ALOS/ALOS-2 images in forest monitoring has been also confirmed.

Overall, the Project is still relevant.

6.2 Effectiveness (Details are described in Section II of Annex 5)

Although objectively verifiable data was not available because production of Deforestation Polygons has been discontinued due to ALOS shutdown, judging from the achievement level of the Indicators, the Project Purpose is expected to be practically achieved by the end of the Project with continuous effort of the Brazilian and Japanese sides.

Logical relation between the Project Purpose and the Outputs is confirmed. All of the Outputs (i.e. development of methodologies for deforestation detection, improvement of satellite information flow throughout DPF and IBAMA, and development of human resources in DPF and IBAMA for detection and characterization of deforestation) are relevant with the Project Purpose. They have contributed to the achievement of the Project Purpose.

Taken together, the Project is considered to be practically effective.

6.3 Efficiency (Details are described in Section III of Annex 5)

Progress has been made mostly as expected in producing Outputs, judging from the achievement level of its Indicators as well as the progress of the Activities. Output 1 and Output 2 would be produced by the end of the Project. Output 3 has been mostly produced but would not be fully produced by the Project end mainly because of unexpected termination of ALOS operation.

Inputs from the Brazilian and Japanese sides have been mostly appropriate in producing the Outputs in terms of timing, quality and quantity, except for (i) the delay of the initial delivery of the equipment and high-resolution images of ALOS/PALSAR, which are necessary for operationalization of information sharing mechanism of DPF (i.e. InteliGEO) and production of Forensic Reports with ALOS images and (ii) absence of IT specialist(s) solely engaged in INDICAR/SISCOM of IBAMA. As for the former, the adverse effect on production of the Output was minimized because IBAMA, as an emergency measures, had rented their server computer for free of charge to DPF until the basic equipment was delivered and DPF made the existing equipment temporarily available for the Project. Absence of IT specialist(s) solely engaged in INDICAR/SISCOM is a lingering concern for CSR/IBAMA. The Evaluation Team notes that through the hard work of the IT specialists, who worked with INDICAR/SISCOM on part-time basis, as well as support and collaboration from their colleagues and Japanese Expert team, the Output is being produced.

The Inputs are considered to have contributed to production of the Outputs mostly. Overall, the Project is considered to have been mostly efficient.

6.4 Impacts (Details are described in Section IV of Annex 5)

Impacts at the Overall Goal level: The Overall Goal is likely to be achieved in three years after the Project end. The Evaluation Team notes that (i) "responsibilities of DPF and IBAMA in law enforcement in the Brazilian Amazon do not change drastically" and (ii) "ALOS-2 launch and provision of its images does not fall behind schedule significantly" and (iii) "provision of ALOS-2 images is not discontinued" are additional important assumptions for the Overall Goal.

Other impacts: Various positive impacts have been observed already and more are foreseen. For example, satellite monitoring of Brazilian Amazon has become possible in all seasons of the year. More than 2,000 deforestation areas have been detected by IBAMA. According to IBAMA, the deforested area in Brazilian Amazon has decreased by 40% in the last two years, part of which is attributable to the efforts made by its staff members utilizing the ScanSAR images of ALOS/PALSAR and INDICAR/SISCOM for law enforcement. Through establishment of InteliGEO, useful information for production of Forensic Reports, including high-resolution images of ALOS/PALSAR, has become available to all DPF Forensic Experts in Brazil. Utilizing the ALOS/PALSAR images and InteliGEO, DPF has become able to produce Forensic Reports in better quality, with more reliable and updated information from multiple sources to convince judges. Moreover, InteliGEO is expanding its border to other forensic issues. Negative impacts have not been observed. They are not foreseen, either.

6.5 Sustainability (Forecast) (Details are described in Section V of Annex 5)

Institutional and organizational aspects: Policy support for law enforcement using technical information based on satellite monitoring in Brazilian Amazon is likely to continue. Almost all of the Brazilian project personnel are permanent staff of the Government of Brazil, whose employment is ensured. They are expected to be assigned to the relevant posts in the post project period so that they could utilize the techniques/experiences obtained through the Project continuously. The collaborative relationship between DPF and IBAMA has been enhanced through joint implementation of the Project. For reference, DPF and IBAMA have taken up process of developing an umbrella agreement on collaboration.

Financial aspects: So far, DPF and IBAMA have allocated necessary budget for the implementation of the Project activities. Budgets for Environmental Forensic Section (APMA) of INC/DPF and Remote Sensing Center (CSR) of IBAMA have been increasing, reflecting the commitment of the both organizations on the combat for illegal deforestation in Brazilian Amazon as well as the organizational interests in utilizing satellite images for law enforcement. In addition, DPF has already started mobilizing financial (as well as technical) resources in expanding InteliGEO from those who are interested in using it. In the meantime, it is uncertain whether or not budget for high-resolution images of ALOS/PALSAR, which are procured by JICA during the Project, would be secured by DPF after the end of the Project, especially in light of recent restriction on purchasable number of the ALOS images for research purpose that are available at discounted price.

Technical aspects: Project staff of DPF and IBAMA have been playing main role in planning, implementation, and monitoring of the Activities with minimal advisory support from the Japanese Experts. They are expected to be equipped with sufficient skills and knowledge to continue the relevant Activities by the Project end: however, it is uncertain whether or not they are fully ready for ALOS-2 images without further technical support. The transferred methods and techniques as well as the project deliverables are relevant with the local level and needs. Judging from specifications of sensor of ALOS-2, they would be applicable to ALOS-2 though some modification may require. They are expected to be continuously utilized and/or disseminated, considering appreciation shown by the DPF and IBAMA and their demonstrated commitment in their respective field of responsibility. The equipment provided by the Project is expected to be fully utilized after the end of the Project.

From a comprehensive viewpoint, sustainability of the Project is likely to be ensured on condition that (i) ALOS-2 launch do not fall behind schedule (i.e. August 2013) seriously: (ii) responsibilities of DPF and IBAMA in law enforcement in the Brazilian Amazon do not change drastically: and (iii) DPF can manage to secure budget for procurement of necessary ALOS/ALOS-2 images.

7. Conclusion

With active involvement of the committed Brazilian Project Personnel and support of the dedicated Japanese Experts, the Project Activities have been implemented without serious problems, producing the Outputs (i.e. development of methodologies for detection of deforestation area using ALOS/PALSAR images, improvement of information flow throughout DPF and IBAMA, and development of human resource in detection of deforestation area and production of Forensic Report on illegal deforestation, using ALOS/PALSAR images) almost as planned, in spite of unexpected termination of ALOS operation in April 2011. The Project Purpose is expected to be practically achieved by the Project end: therefore, the Project will be successfully terminated in June 2012 as planned.

Regarding the evaluation criteria, the Project is considered to be relevant because the Overall Goal as well as the Project Purpose still agree with the needs of Brazil. In addition, comparative advantage of ALOS/ALOS-2 in forest monitoring is confirmed. The Project is considered to be practically effective because (i) the Project Purpose is expected to be practically achieved in spite of unexpected termination of operation of ALOS through effort of Brazilian Project Personnel and support from Japanese Experts; and (ii) all of the Outputs have contributed to achievement of the Project Purpose. The Project has been conducted mostly efficiently because both Brazilian and Japanese side have overcome constraints of some of the Inputs through mutual collaboration. The Overall Goal is likely to be achieved in three years after the Project end. Various positive impacts have been observed already and more are foreseen. Sustainability of the Project is likely to be ensured on condition that (i) ALOS-2 launch do not fall behind schedule (i.e. August 2013) seriously: (ii) responsibilities of DPF and IBAMA in law enforcement in the Brazilian Amazon do not change drastically: and (iii) DPF and IBAMA can manage to secure obtain the ALOS/ALOS-2 images.

In sum, the Project has made valuable contribution to combat against illegal deforestation in Brazilian Amazon. With continuous effort of Brazilian side, it is expected that the acquired skills and knowledge as well as the project deliverables will contribute to law enhancement on illegal deforestation and to protection of the Brazilian Amazon further.

8. Recommendations and Lessons Learned

8.1 Recommendations

8.1.1 Recommendations within the project period

(1) Preparation for utilization of ALOS-2/PALSAR images (Output 1)

Since ALOS-2 will be launched in near future, it is recommended to prepare for utilization of ALOS-2/PALSAR images in terms of collecting information on analysis/interpretation techniques. For this objective, DPF and IBAMA should identify the necessary activities to enable prompt utilization of ALOS-2/PALSAR data.

(2) Preparation of Post-project strategies

Post-project strategies for each Output should be developed by the end of the Project in order to sustain the effect of the Project.

(3) Agreement between DPF and IBAMA

Currently DPF and IBAMA are coordinating an agreement for ensuring the collaboration between the two organizations after the termination of the Project. It is recommended that DPF and IBAMA make efforts to conclude the agreement by the end of the Project.

(4) Modification of the PDM

The PDM should be modified in regards of the Objectively Verifiable Indicator for the Overall Goal and Important Assumption for the Overall Goal in order to clarify definition and target of enhancement of law enforcement. The draft of modified PDM (draft PDM5), prepared through a series of discussions with the Project Personnel and the Japanese Experts, is attached as Annex 6. The modified PDM should be submitted to the meeting of JCC on 2 December 2011 for its review and approval. It is noted that the Indicator for the Overall Goal may be modified by the Project end depending on the contents of the Lower House's Bill No 1, 2010, regarding cooperation between Federal, State, Federal District and Municipal Governments on protection of natural environment, which is being finalized.

(5) Allocation of IT Specialist(s) at CSR/IBAMA

IBAMA should solve the absence of IT specialists by allocation of IT specialists and collaboration with related sections to improve INDICAR/SISCOM operation.

(6) Technique of semi-automatic change detection from ALOS/PALSAR image (Output 1)

Technique of change detection from ALOS/PALSAR image plays a key role to reduce the time of illegal deforestation detection with ALOS/PALSAR image. Therefore the technique for semi-automatic change detection, being developed, should be included in the technical manual for IBAMA by the end of the Project.

(7) Evaluation of training courses (Output 3)

The results of questionnaires for the past training courses should be analyzed to improve future courses.

(8) Preparation of Terminal Report

The Terminal Report should be prepared and submitted to the final JCC as per the Detailed Plan of Operation (DPO). Contents of the Report include progress of DPO and Indicators, issues, post-project strategies, progress in implementation of the recommendations of the Terminal Evaluation.

(9) Organization of Periodical Meetings

DPF and IBAMA should continue periodical meeting at least once a month to further improve the coordination and monitoring of the Project, with the participation of Japanese Experts in Brazil and, if necessary, JICA Brazil. After the end of the Project, DPF and IBAMA are recommended to hold the meeting regularly to continue the activities.

8.1.2 Recommendations after the end of the Project

(1) Dissemination of the Results of the Project

Considering the good results of the Project, DPF and IBAMA should explore the possibilities of spreading the technology and results of the Project to other countries, for example through the Third Country Training Programme of JICA.

(2) Continuous use of ALOS data

Regarding high-resolution SAR images for Forensic Reports, which is provided by JICA during the Project period, it is recommended that the DPF makes efforts to ensure that images of ALOS and ALOS-2/PALSAR will be continuously obtained after the end of the Project.

On the other hand, IBAMA should also make efforts to guarantee that ScanSAR images of ALOS-2, which are necessary for the detection of illegal deforestation, will be provided based on the agreement between IBAMA and JAXA.

(3) Preparation for utilization of ALOS-2/PALSAR images

The necessary activities identified to prepare for prompt utilization of ALOS-2/PALSAR data should be implemented accordingly.

(4) Continuation of end-user assessment

DPF and IBAMA should implement the end-user assessment at least once a year to improve the usage of InteliGEO and INDICAR/SISCOM.

(5) Continuation of Remote Sensing Trainings

Basic courses for general remote sensing techniques should be continued by IBAMA after the end of the Project.

8.2 Lessons Learned

The Team identified the lessons described below, learned from the experience and knowledge acquired from the implementation of the Project

(1) In case of project that utilize satellite images, detailed planning concerning response when satellite complete the operation will enable rapid, smooth decision to take necessary actions for the project.

(2) It is important to fit the project activities to common interests in order to guarantee the sustainability of Project results; for example, the system established by the Project was expanded and improved by inputs from other projects to make possible the multi-utilization.

End of Document

Annex 1 ***PDM for Evaluation (i.e. Latest PDM with simple editorial errors corrected)***

PDM~~3~~4 approved on ~~Nov.19, 2010~~ July 20, 2011

1. **Project Name** : The Project for utilization of ALOS images to support the protection of the Brazilian Amazon Forest and combat against illegal deforestation
2. **Project site**: Brasilia
3. **Duration**: From June 2009 to June 2012 (three years)
4. **Target Beneficiaries**: Forensic Experts of Federal Police Department (DPF) and Environmental Analysts of Brazilian Institute for the Environment and Renewable Nature Resources (IBAMA)
5. **Target Area:** Brazilian Amazon (i.e. 9 Legal Amazon States: Acre, Amapa, Amazonas, Maranhao, Mato Grosso, Para, Rondonia, Roraima, Tocantins)

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal Law enforcement is enhanced ground on technical information based on satellite images on illegal deforestation	a:Number of law enforcement actions using monitoring documents produced in the month of cloud cover is increased (Note: The Indicator for the Overall Goal would be discussed and clarified by the Project in the first semester of 2011)	a.Reports by IBAMA and DPF	A: There is no particular change in government policies on protection of Brazilian forest
Project Purpose Technical information based on ALOS(*1)/PALSAR(*2) images on illegal deforestation in the Brazilian Amazon is provided for law enforcement	a: By the Project end, deforestation areas are detected within 3 working days after receiving the ScanSAR (*3)images of ALOS/PALSAR by IBAMA. b: By the Project end, the location and size of the detected deforestation areas (i.e. Deforestation Polygons) are provided to the relevant IBAMA regional offices within 2 working days after their detection c: By the Project end, ALOS/PALSAR images (mainly high-resolution ones), are utilized/referred to in 60 Forensic Reports(*4) produced by DPF per year	a&b:Comparison of the record of concerned dates kept by IBAMA c: Review of Forensic Reports	A: Budgets and staffs for law enforcement do not decrease drastically
Output 1: Deforestation areas including suspicious areas are detected using ALOS/PALSAR data	1a: Useless multi-temporal combination of ScanSAR images of ALOS/PALSAR becomes zero by the end of 2009. 1b: Methodologies to extract deforestation information from ScanSAR images of ALOS/PALSAR developed by the Project, including Interpretation guide, forest classification tool, and change detection tool by the end of 2009; and updated by March ~~2011~~2012. 1c: Initial version of the technical manuals for IBAMA and DPF for utilization of ALOS/PALSAR images in detection of deforestation areas and preparation of Forensic Reports respectively are developed/approved by September 2011 (in English and Portuguese) 1d: The initial version of the technical manual for IBAMA is uploaded to SISCOM (*5) for the use of Environmental Analysts and the one for DPF is uploaded to InteliGEO(*6) for the use of Forensic Experts by ~~April~~ October 2011. 1e: The initial version of the technical manuals for IBAMA and DPF are updated by March 2012 1f: The updated manuals are uploaded to SISCOM and InteliGEO respectively by April 2012	1a: Review of error report produced by IBAMA 1b: Review of the developed tools &progress reports 1c&e: Review of technical manuals & date of approval of each manual by the Project Manager of DPF and IBAMA respectively 1d&f: Review of the uploaded dates recorded in SISCOM and InteliGEO	A: There is no significant organizational change in DPF and /or IBAMA affecting implementation of the Project B: Budgets for satellite monitoring of DPF and/or IBAMA do not decrease drastically
Output 2: The information flow of satellite monitoring system throughout DPF and IBAMA is improved	2a: Information sharing mechanism of DPF developed by the Project (i.e. InteliGEO) is made available to all the Forensic Experts in Brazil by December 2009 2b: By the Project end, 100% of Forensic Reports produced by DPF Forensic Experts, utilizing/referring to ALOS/PALSAR images (mainly high-resolution ones), are made available in InteliGEO for other Experts within one week after the completion 2c: By the Project end, at least one access to INDICAR(*7)/SISCOM of IBAMA are made from each of the 9 Legal Amazon States per cycle of ALOS operation (i.e. 46 days) 2d: Semi-annual access to InteliGEO of DPF is increased by 5 % in relation to the previous semester. 2e: By the Project end, 90 % of the results of visits of the deforestation areas detected by INDICAR/SISCOM & ALOS/PALSAR (i.e. Deforestation Polygons) are fed back to IBAMA HQ	2a:Record of the release date 2b:Check that all Forensic Reports in Criminalistica uploaded in InteliGEO, and the ones that are not more than a week old 2c: Record of access to INDICAR 2d: Record of access to InteliGEO 2e::Record of feedbacks registered in the Google Docs.	

Annex 1 ***PDM for Evaluation (i.e. Latest PDM with simple editorial errors corrected)***

Output 3: Human resources in DPF and IBAMA are upskilled to detect and characterize illegal deforestation	3a: Basic and advanced courses for IBAMA and DPF for the general use of ALOS/PALSAR images, including curriculum and textbooks, are developed by September 2009 3b: Basic course specifically for the use of DPF Forensic Experts to produce Forensic Reports are developed by December 2011. 3c: By the Project end, 70 staff members (30 Forensic Experts of DPF and 40 Environmental Analysts of IBAMA) receive official training certificates for the use of ALOS/PALSAR images from IBAMA or DPF 3d: On average, 80% of the trainees give the highest or medium rate on three-level rating about "degree of understanding" and "degree of applicability" of the concerned trainings 3e: The training courses are updated based on the feedbacks from the trainees, including the results of monitoring and evaluation of the trainings, and other Project Activities	3a: Project report &curriculum and textbooks developed 3b: ditto 3c: List of trainees 3d: Results of the questionnaires to the trainees 3e:Analytical report of training	

Activities 1.1 Convert ALOS/PALSAR data format to fit into INDICAR/SISCOM 1.2 Develop methodologies to extract deforestation information from ALOS/PALSAR images. 1.3 Identify potential deforestation areas using ALOS/PALSAR images and other available geographic information 1.4 Develop technical manuals for DPF and IBAMA for utilization of ALOS images based on the results of the Activities 1.1-1.3 2.1 Document existing monitoring mechanism 2.2 Identify possible upgrading opportunities in the DPF/IBAMA deforestation monitoring mechanism 2.3 Improve the existing satellite information sharing mechanism of IBAMA HQ (i.e. INDICAR/SISCOM) 2.4 Develop an information sharing mechanism at DPF HQ (i.e. InteliGEO) 2.5 Establish an information flow between IBAMA and DPF HQs 2.6 Develop an intra-information flow mechanism between IBAMA HQ and its regional offices 2.7 Develop an intra-information flow mechanism between DPF HQ and its regional offices 3.1 Assess training needs to monitor and characterize illegal deforestation in DPF/IBAMA 3.2 Determine the training plan 3.3 Execute the training plan 3.4 Monitor/evaluate/upgrade the trainings	**Inputs** **<Brazilian Side>** (1) Project & Administrative personnel ● Project Director ● Project Manager(s) ● Other project and administrative personnel (2) Office Spaces and Facilities ● Office space in IBAMA ● Other facilities necessary for the implementation of the Project (3) Administration and operational costs **<Japanese Side>** (1) Experts ●Remote Sensing/Administrative Coordination ●Information and Communication Technology ●Web-programming, GIS ●Other Experts necessary for the Project (2) Training of Brazilian personnel in Japan (3) Machinery and Equipment ●ALOS images, software, servers, storages ●Other materials necessary for the implementation of the Project	A:Main project personnel are not transferred to other departments and/or agencies **Pre-Conditions** A: ALOS/PALSAR images (i.e. ScanSAR images) are provided by Japan Aerospace Exploration Agency (JAXA) based on the Agreement on Cooperation between JAXA and IBAMA B: DPF and IBAMA conclude an agreement on the joint implementation of the project

(*1) ALOS: Advanced Land Observing Satellite launched by JAXA
(*2) PALSAR: Phased Array Type L-Band Synthetic Aperture Radar (*3) ScanSAR: Scan Synthetic Aperture Radar
(*4) Forensic Report: Technical document produced by DPF Forensic Experts that aims to establish whether a crime has happened, how it happened, and who committed it. This document is used in criminal prosecutions.
(*5) SISCOM: Environmental information sharing mechanism of IBAMA
(*6) InteliGEO: Information sharing mechanism of DPF being developed by the Project under Output 2 (*7) INDICAR: Indicator of Deforestation for Radar Images.

Annex 2 Latest Detailed Plan of Operation with progress of Activities

No.	Activities as per the latest DPO	Expected Results as per the latest DPO	Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Org in charge	Person in Charge (as of Nov 2011)	Implementors (as of Nov 2011)	Other major inputs: Japanese	Other major inputs: Brazilian	Progress	
			2009			2010				2011				2012								
			JFY2009				JFY2010				JFY2011			12								
Output 1	Deforestation areas including suspicious areas are detected using ALOS/PALSAR data															DPF/IBAMA	Sano (IBAMA)/Rafael (DPF)		JE(RSI/Adm Ono)			
1.1	Convert ALOS/PALSAR data format to fit to INDICAR/SISCOM															IBAMA	Rodrigo (IBAMA)	Werner, Daniel, Felipe, Silvia (IBAMA)	JE(RSI/Adm-Ono)			Note from DPO:SISCOM is a data server and INDICAR is a function in the SISCOM which enable detection of deforestation using ALOS/PALSAR images
1.1.1	Establish ALOS/PALSAR data upload path for INDICAR/SISCOM	PALSAR data uploaded to SISCOM periodically														IBAMA	ditto	ditto	ditto		A	
1.1.2	Establish preprocess functions to use an individual PALSAR image for SISCOM/INDICAR.	Preprocess conduceted without errors														IBAMA	ditto	ditto	ditto		A	
1.1.3	Create image catalog to access the PALSAR data uploaded in SISCOM	Catalog list exported as a file														IBAMA	ditto	ditto	ditto		A	
1.1.4	Establish preprocess functions to use multi-temporal PALSAR images for INDICAR	Preprocess conduceted without errors														IBAMA	ditto	ditto	ditto		A	
1.1.5	Validation/Evaluation and improvement of the methodologies developed	Methodologies validated and improved														IBAMA	ditto	ditto	ditto		B2	Additional validation/evaluation is necessary to correct th errors in detection which have been reported by the Regional Offices
1.1.6	Develop a plan to adapt INDICAR to ALOS-2 system.	Plan document prepared														IBAMA	ditto	ditto	ditto		C1	Additional activity planned for 2012 in view of termination of operation of ALOS
1.2	Develop methodologies to extract deforestation information from ALOS/PALSAR images.															IBAMA	Rodrigo (IBAMA)	Werner, Daniel, Felipe, Silvia (IBAMA)	JE(RSI/Adm-Ono)			
1.2.1	Develop an interpretation guide for detection of deforestation area using ALOS/PALSAR (w/optical images and ground truthing)	Interpretation guide developed														IBAMA	ditto	ditto	ditto		A	
1.2.2	Develop a forest classification (i.e.discrimination of forest/non-forest)tool, using ALOS/PALSAR images	Forest classification tool developed														IBAMA	ditto	ditto	ditto		A	
1.2.3	Develop a change detection tool for identification of possible deforestation areas through conducting time series analysis using the results of Act.1.2.2	Change detection tool developed														IBAMA	ditto	ditto	ditto		A	
1.2.4	Validation/Evaluation and improvement of the methodologies developed	Methodologies validated and improved														IBAMA	ditto	ditto	ditto		B1	
1.2.5	Develop high resolution PALSAR data and alos data handling tools for detailed analysis using ALOS PALSAR data (for DPF)	Tools developed														DPF	Rafael (DPF)	Rafael, Russo, Miranda (DPF)	ditto		A	This is an acctivity which wshould have been included in the latest DPO

Legend (schedule):
- Plan as per the latest DPO
- Plan as per the latest DPO (Follow up activities)
- Actualt progress & current plan

Legend (progress):
A=completed,
B1=ongoing as planned/ to be completed by Project end,
B2=ongoing with some problems / to be completed,
B3=ongoing with some problems/not to be completed
C1=Not started (as planned)/ to be completed
C2=Not started (delayed)/to be completed,
D=others

Annex 2 Latest Detailed Plan of Operation with progress of Activities

No.		Activities	Expected Output	Jun (JFY2009)	Jul-Sep (JFY2009)	Oct-Dec (JFY2009)	Jan-Mar (JFY2009)	Apr-Jun (JFY2010)	Jul-Sep (JFY2010)	Oct-Dec (JFY2010)	Jan-Mar (JFY2010)	Apr-Jun (JFY2011)	Jul-Sep (JFY2011)	Oct-Dec (JFY2011)	Jan-Mar (JFY2011)	Apr-Jun (12)	Org. in charge	Person in Charge (as of Nov 2011)	Implementors (as of Nov 2011)	Other major inputs: Japanese	Other major inputs: Brazilian	Progress	
1.2.6		Validation/Evaluation and improvement of the above data handling tools for DPF	Tools validated and improved														DPF	ditto	ditto	ditto		B1	ditto
1.2.7		Identify necessary items to fit INDICAR to ALOS-2 data and create scope of necessary activities (for IBAMA) to make quick start of ALOS 2 data utilization possible	List for necessary items & activities developed														IBAMA	Rodrigo (IBAMA)	Werner, Daniel, Felipe, Silvia (IBAMA)	JE(RSI/Adm-Ono)		C1	Additional activity planned for 2012 in view of termination of ALOS
1.2.8		Identify necessary items to fit InteliGEO to ALOS-2 data and create scope of necessary activities (for DPF) to make quick start of ALOS-2 data utilization possible	ditto														DPF	Miranda (DPF)	Rafael, Russo, Miranda (DPF)	ditto		C1	ditto
1.3		Identify possible deforestation areas using ALOS/PALSAR images and other available geographic information															IBAMA	Rodrigo (IBAMA)	Werner, Daniel, Felipe, Silvia (IBAMA)	JE(RSI/Adm-Ono)			
1.3.1		Identify geographic information useful for identification of deforestation area from multipule data sources	Useful info identified														IBAMA	ditto	ditto	ditto		A	Digital Elevation Model (DEM) info &DETER/PRODES info identifed
1.3.2		Develop methodologies to integrate the useful geographic information from multiple data sources into data servers of IBAMA and DPF (INDICAR/SISCOM and InteliGEO)															IBAMA/DPF	George(IBAMA), Rafael (DPF)	Werner, Mariano	ditto			
	a	Integration into the data server of IBAMA (INDICAR/SISCOM)	Useful info integrated into the data server of IBAMA		SRTM DEM			AsterDEM				PrismDEM					IBAMA	George (IBAMA)	Mariano, Werner (IBAMA)	JE(RSI/Adm-Ono)		B2	Integration of Prism DEM has been delayed because dispatch of J/E in 2011 had been held back till July in view of termination of operation of ALOS
	b	Integration intothe data server of DPF developed in Activity 2.4 (i.e. InteliGEO)	Useful info integrated into the data server of DPF						AsterDEM PrismDEM								DPF	Rafael (DPF)	Rafael, Russo, Miranda (DPF)	ditto		B2	ditto
1.3.3		Utilize the information integraed in the data servers in preparation of Deforestation Polygone/A4 Reports of IBAMA and Foresing Report of DPF															IBAMA/DPF	Rodrigo(IBAMA), Rafael (DPF)	Rafael, Daniel, Miranda (DPF) Rodrigo, Werner, Daniel,Silvia, Felipe (IBAMA)	JE(RSI/Adm-Ono)			
	a	In preparation of Deforestation Polygon/A4 Report (IBAMA)	Info in the data server utilized														IBAMA	Rodrigo (IBAMA)	Rodrigo, Werner, Daniel, Felipe, Silvia (BAMA)	ditto		D	The activity has been stopped due to termination of operation of ALOS
	b	In preparation of Forensic Report (DPF)	ditto														DPF	Rafael (DPF)	Rafael, Russo, Miranda (DPF)	ditto		B1	*Interferometry technology learned in the Advanced Course (see Output 3) is utlized in prepareing Forensic Report *Though operation of ALOS has been terminated, the activitiy has been continued utilizing archive data.

Annex 2 ***Latest Detailed Plan of Operation with progress of Activities***

Activities as identified in PDM		Expected output / performance	Schedule													Org. in charge	Person in Charge (as of Nov 2011)	Implementors (as of Nov 2011)	Other major inputs			
			2009			2010				2011				2012								
			JFY2009				JFY2010				JFY2011			12								
			Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun				Japanese	Brazilian		
1.4	Develop technical mannuas for DPF and IBAMA for utilization of ALOS images based on the results of the Activities 1.1-1.3															DPF/IBAMA	Rafael (DPF) Sano(IBAMA)	Rafael, Daniel, Miranda (DPF) Rodrigo, Werner, Daniel, Felipe, Silvia (IBAMA)	JE(RSI/Adm-Ono)			Note:The manuals consists of the common part and individual parts for each organization .
1.4.1	Develop the manual for DPF for the use of Foresnsic Expert to prepare Forensic Report	English and Portugease manuals developed														DPF	Rafael (DPF)	Rafael, Russo, Miranda (DPF)	ditto		A	Developing the initial manual took longer than envisaged because dispatch of J/E in 2011 had been suspended till July in view of termination of ALOS operation
1.4.2	Update the above manual	ditto														DPF	ditto	Rafael, Diogo, Laura, Emiliano, Luciano (DPF)	ditto		B1	
1.4.3	Develop the manual for IBAMA for the use of Environmental Analysts to prepare Deforestation Polygon	ditto														IBAMA	Sano (IBAMA)	Rodrigo, Werner, Daniel, Felipe, Silvia (IBAMA)	ditto		A	Same as 1.4.1
1.4.4	Update the above manual	ditto														IBAMA	ditto	ditto	ditto		B1	
Output 2 [illegible] of satelite monitoring system througout DPF and IBAMA is improved																DPF/IBAMA	Rafael (DPF) Sano(IBAMA)		JE(RSI/Adm-Ono)			
2.1	Document existing monitoring mechanism throughout DPF and IBAMA.															DPF/IBAMA	Rafael (DPF) George(IBAMA)	Rafael, Daniel, Miranda (DPF) Mariano, Werner (IBAMA)	JE(GIS1-Kawaguchi GIS2/Web-Furuhashi)			
2.1.1	Develop a flow chart on information sharing and transmission system, including the existing INDICAR/SISCOM	The flow chart developed														DPF/IBAMA	ditto	ditto	ditto		A	
2.2	Identify possible upgrading opportunities in the DPF/IBAMA crime monitoring mechanism.															DPF/IBAMA	Rafael (DPF) George(IBAMA)	Rafael, Daniel, Mranda (DPF) Rodrigo, Werner (IBAMA)	JE(GIS1-Kawaguchi GIS2/Web-Furuhashi)			
2.2.1	Analyze the flow chart developed in Act.2.1	Analytical report prepared														DPF/IBAMA	ditto	ditto	ditto		A	
2.3	Improve the existing satelite information sharing mechanism of IBAMA at HQ (i.e. INDICAR/SISCOM)															IBAMA	George (IBAMA)	Mariano, Werner (IBAMA)	JE(GIS-Kawaguchi, RS2/ICT-Nishimura, GIS2/Web-Furuhashi)			
2.3.1	Prepare immediate upgrading plan for INDICAR/SISCOM	A report on upgrading plan developed														IBAMA	ditto	ditto	ditto		A	
2.3.2	Implement immediate upgradeing plan	Official version of INDICAR released														IBAMA	ditto	ditto	ditto		A	
2.3.3	Implement integration and performance test on the mechanism developed	*Performance report developed														IBAMA	ditto	ditto	ditto		A	

Annex 2 Latest Detailed Plan of Operation with progress of Activities

	Activities	Expected results as per the latest PO	Schedule 2009 JFY2009 Jun	Jul-Sep	Oct-Dec	Jan-Mar	2010 JFY2010 Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	2011 JFY2011 Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	2012 12 Apr-Jun	Org. in charge	Person in Charge (as of Nov 2011)	Implementors (as of Nov 2011)	Other major inputs: Japaese	Other major inputs: Brazilian	Progress	
2.3.4	Implement the end-user assessment	Assessment conducted once														IBAMA	ditto	ditto	ditto		A	
2.3.5	Excute further upgrading based on the end-user assessment and as appropriate (needed)	Mechanism upgraded														IBAMA	ditto	ditto	ditto		B1	
2.4	Develop a information sharing mechanism at DPF HQ (i.e. InteliGEO)															DPF	Rafael (DPF)	Rafael, Daniel, Miranda (DPF)	JE(GIS-Kawaguchi, RS2/ICT-Nishimura, GIS2/Web-Furuhashi)			Note from DPO: *Information means ALOS/PALSAR images (with high resolution in particular) and Forensic Reports for Act 2.4 *The data server called InteliGEO has been developed
2.4.1	Prepare a plan	A report on plan developed														DPF	ditto	ditto	JE (ditto)		A	
2.42	Develop the mechanism based on the plan (2.4.1)	*A report on design developed *Equipment installed according to the design														DPF	ditto	ditto	JE (ditto) Equipment LC for consultant		A	Protorype of the InteliGEO was developed, utilizing the equipment rented from IBAMA as emergency measure.
2.4.3	Implement integration and performance test on the mechanism developed (i.e. InteliGEO)	Performance report developed														DPF	ditto	ditto	ditto		A	
2.4.4	Oerationalize the InteliGEO officially	The InteliGEO service launched officially														DPF	ditto	ditto	ditto		A	
2.4.5	Implement the end-user assessment	Assessment conducted twice					I		I	II	II					DPF	ditto	ditto	ditto		B1	In addition to the formal assessments, end-users give feedbacks to DPF through Opinion Poll and commnet form on InteliGEO as well as e-mail and telephone calls.
2.4.6	Upgrade the InteliGEO based on the assessment	Mechanism upgraded as appropriate														DPF	ditto	ditto	ditto		A	
2.5	Establish the information flow between DPF and IBAMA HQ (i.e. InteliGEO and INDICAR/SISCOM)															DPF/IBAMA	Rafael (DPF) George(IBAMA)	Rafael, Daniel, Miranda (DPF) Mariano, Werner (IBAMA)	JE(GIS1-Kawaguchi GIS2/Web-Furuhashi)			
2.5.1	Prepare a plan	A report on plan developed														DPF/IBAMA	ditto	ditto	ditto		A	
2.5.2	Develop the mechanism based on the above plan (2.5.1)	*A report on design developed *Equipment installed according to the design														DPF/IBAMA	ditto	ditto	ditto		A	
2.5.3	Implement integration and performance test on the mechanism developed	Performance report developed														DPF/IBAMA	ditto	ditto	ditto		A	

Annex 2 Latest Detailed Plan of Operation with progress of Activities

No.	Activities as per the latest PDO	Expected results as per the latest PDO	Org. in charge	Person in Charge (as of Nov. 2011)	Implementors (as of Nov. 2011)	Other major inputs: Japanese	Other major inputs: Brazilian	Progress	
2.5.4	Operationalize the mechanism officially	Access to INDICAR become possible through InteliGEO	DPF/IBAMA	ditto	ditto	ditto		B1	DPF is able to access Polygons in the INDICAR/SISCOM of IBAMA through InteliGEO. ALOS images in the INDICAR/SISCOM are expected to become accessible from InteliGEO by the end of 2011.
2.5.5	Implement the end-user assessment	Assessment conducted twice	DPF/IBAMA	ditto	ditto	ditto		B1	Principal end-users (i.e. project staff of DPF and IBAMA) have exchanged opinions as needed. In view of the above, the second assessment was cancelled
2.5.6	Upgrade the mechanism based on the assessment	Mechanism upgraded	DPF/IBAMA	ditto	ditto	ditto		B1	
2.6	Develop an intra-information flow mechanism beteen IBAMA HQ and its Regional Offices		IBAMA	George (IBAMA)	Werner, Mariano (IBAMA)	JE(GIS-Kawaguchi, RS2/ICT-Nishimura, GIS2/Web-Furuhashi)			Note from DPO: *Information means Polygons and ALOS/PALSAR images for Act.2.6 *Web interface for GIS has been developed
2.6.1	Prepare a plan	A report on plan developed	IBAMA	ditto	ditto	ditto		A	
2.6.2	Develop the mechanism based on the plan (2.6.1)	A report on design developed	IBAMA	ditto	ditto	ditto		A	
2.6.3	Implement integration and performance test on the mechanism developed	Performance report developed	IBAMA	ditto	ditto	ditto		A	
2.6.4	Operationalize the mechanism in full-scale	Information transmitted between IBAMA and 9 Amazon State Offices	IBAMA	ditto	ditto	ditto		B1	Regional Offices can access Polygons. ALOS/PALSAR images are expected to become accessible by the end of 2011.
2.6.5	Implement the end-user assessment	Assessment conducted twice	IBAMA	ditto	ditto	ditto		B2	The second assessment would be implemented in December 2011
2.6.6	Upgrade the mechanism based on the assessment	Mechanism upgraded	IBAMA	ditto	ditto	ditto		B1	
2.7	Develop an intra-information flow mechanism beteen DPF HQ and its Regional Offices		DPF	Rafael (DPF)	Rafael, Daniel, Miranda (DPF)	JE(GIS-Kawaguchi, RS2/ICT-Nishimura, GIS2/Web-Furuhashi)			Note from DPO: *Informationfor Act.2.7 means ALOS/PALSAR images * Web interface for GIS has been developed
2.7.1	Prepare a plan	A report on plan developed	DPF	ditto	ditto	ditto		A	
2.7.2	Develop the mechanism based on the plan (2.7.1)	A report on design developed Equipment installed based on the design	DPF	ditto	ditto	ditto		A	
2.7.3	Implement integration and performance test on the mechanism developed	Performance report developed	DPF	ditto	ditto	ditto		A	

Annex 2 Latest Detailed Plan of Operation with progress of Activities

No.	Activities [illegible]	Expected results as per the latest PO	Schedule (2009–2012; JFY2009, JFY2010, JFY2011, 12; Jun, Jul-Sep, Oct-Dec, Jan-Mar, Apr-Jun, Jul-Sep, Oct-Dec, Jan-Mar, Apr-Jun, Jul-Sep, Oct-Dec, Jan-Mar, Apr-Jun)	Org. in charge	Person in Charge (as of Nov. 2011)	Implementors (as of Nov. 2011)	Other major inputs: Japanese	Other major inputs: Brazilian	Progress	[illegible]
2.7.4	Operationalize the mechanism in full-scale	Information transmitted between InteliGEO and 9 Amazon State Offices		DPF	ditto	ditto	ditto		B1	Since internet speed is not as fast as desired in Regional Offices for transmission of ALOS/PALSAR images, media transref by DHL is being considered as a practical solution
2.7.5	Implement the end-user assessment	Assessment conducted twice	I, I, II, II	DPF	ditto	ditto	ditto		B1	Same as Act. 2.5.4
2.7.6	Upgrade the mechanism based on assessment	Mechanism upgraded		DPF	ditto	ditto	ditto		B1	
Output 3: [illegible] DPF and IBAMA are upskilled to detect and characterize illegal deforesta[illegible]				IBAMA/DPF	Sano (IBAMA)/Rafael (DPF)		JE(RS/Adm-Ono)			
3.1	Assess training needs to monitor and characterize illegal deforestation in DPF/IBAMA..			IBAMA	Humberto (IBAMA)	Rodrigo, Werner, Rafael, Daniel, Felipe (IBAMA) Rafael, Magliano (DPF)	JE(RS/Adm-Ono, GIS1-Kawaguchi, GIS2/Web-Furuhahsi)		A	
3.2	Determine the training plans			IBAMA/DPF	Werner (IBAMA)/Rafael (DPF)	Rodrigo, Werner, Rafael, Daniel (IBAMA) Rafael, Russo, Diogo, Luciano, Garcia (DPF)	ditto			
3.2.1	Develop training plan Basic Course for those who do not have technical background using ALOS/PALSAR images, including curriculm and materialsl, including curriculm and materials	Three GIS and RS courses planned/updated	I, II, III	IBAMA	Werner (IBAMA)	Rodrigo, Werner, Rafael, Humberto, Sano, Daniel (IBAMA)	ditto		A	
3.2.2	Develop training plan for Advanced Course for those who have technical background using ALOS/PALSAR images, including curriculm and materials	Two GIS and RS courses planned/updated	I, II, TOT	IBAMA	ditto	ditto	ditto		D	*Due to termination of ALOS operation, the second advance course was cancelled via decision of the third JCC in June 2011. As an alternative, a 2-day followup training/TOT, utilizing the existing materials, for the HQ staff with advanced level is planned in 2012
3.2.3	Develop training plan for Basic Course specifically for DPF Forensic Experts to produce Forensic Reports, including curriculm and materials	One GIS and RS courses planned	I, I	DPF	Rafael (DPF)	Rafael, Russo, Diogo, Luciano, Garcia (DPF)	ditto		B2	In light of budget cuts on travel costs for trainees from regional offices, a web-based distance training course (like the one offered at National Police Academy) is being planned.
3.3	Execute the training plans.			IBAMA/DPF	Werner (IBAMA)/Rafael(DPF)	Rodrigo, Werner, Rafael, Daniel (IBAMA) Rafael, Russo, Diogo, Luciano, Garcia (DPF)	ditto			
3.3.1	Execute Basic course for IBAMA and DPF (by IBAMA)	Three courses implemented	I, II, III	IBAMA	ditto	Rodrigo, Werner, Rafael (IBAMA)	ditto	Training cost	A	

Annex 2 Latest Detailed Plan of Operation with progress of Activities

[illegible]		[illegible]	Schedule 2009 JFY2009 Jun	Jul-Sep	Oct-Dec	2010 Jan-Mar	Apr-Jun	JFY2010 Jul-Sep	Oct-Dec	2011 Jan-Mar	Apr-Jun	JFY2011 Jul-Sep	Oct-Dec	2012 Jan-Mar	JFY12 Apr-Jun	Org. in charge	Person in Charge (as of Nov. 2011)	Implementors (as of Nov. 2011)	Other major inputs: Japanese	Brazilian	[illegible]	[illegible]
3.3.2	Execute Advanced course for IBAMA and DPF (by IBAMA)	Two courses implemented				I				II		Follow-up/TOT				IBAMA	ditto	ditto	ditto	ditto	D	See 3.2.2
3.3.3	Execute Basic course for DPF (by DPF)	On course implemented										I		I		DPF	Rafael (DPF)	Rafael, Russo, Diogo, Luciano, Garcia (DPF)	ditto	ditto	B2	See 3.2.3
3.4	Monitor/Evaluate/Upgrade the trainings.															IBAMA/DPF	Werner(IBAMA)/Rafael(DPF)	Rodrigo, Werner, Rafael, Daniel (IBAMA) Rafael, Russo, Diogo, Luciano, Garcia (DPF)	JE(RSI/Adm-Ono)			
3.4.1	Monitor the trainings through questionnnares at the end of each course															IBAMA/DPF	ditto	ditto	ditto			
a	Basic course in Brazil (IBAMA)	Results compiled within (time)		I				II				III				IBAMA	Werner (IBAMA)	Rodrigo, Daniel (IBAMA)	ditto		A	
b	Advanced course in Brazil (IBAMA)	ditto				I				II						IBAMA	ditto	ditto	ditto		D	See 3.2.2
c	Basic course in Brazil (DPF)	ditto										I				DPF	Rafael (DPF)	Rafael, Russo, Diogo, Luciano, Garcia (DPF)			B2	See 3.2.3
3.4.2	Evaluate the trainings															IBAMA/DPF	Rodrigo (IBAMA)/Rafael(DPF)	same as 3.4.1	ditto			
a	Basic course in Brazil (IBAMA)	Evaluationl report with suggestions developed						I	II			III				IBAMA	Rodrigo (IBAMA)	Rodrigo, Werner, Rafael,, Daniel (IBAMA)	ditto		C2	
b	Advanced course in Brazil (IBAMA)	ditto							I				I			IBAMA	ditto	ditto	ditto		C2	
c	Basic course in Brazil (DPF)	ditto										I				DPF	Rafael (DPF)	Rafael, Russo, Diogo, Luciano, Garcia (DPF)	ditto		B2	
3.4.3	Upgrade the trainings based on the results of Monitoring and Evaluation and other Project Activities															IBAMA/DPF	Werner (IBAMA)/Rafael(DPF)	same as 3.4.1	ditto			
a	Basic course in Brazil (IBAMA)	The courses upgrade as needed							■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	IBAMA	Werner (IBAMA)	Rodrigo, Werner, Rafael, Daniel (IBAMA)	ditto		B1	
b	Advanced course in Brazil (IBAMA)	ditto							■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	IBAMA	ditto	ditto	ditto		B1	
0. Activities [illegible] management and public relations																DPF/IBAMA	Magliano(DPF)/George(IBAMA)		JE(RSI/Adm-Ono)			
0.1	Organize a Joint Coordination Committee (JCC)	*JCC organized at least once ayear *M/M signed														DPF/IBAMA	ditto	DPF staff &CSR Satff	JE(RSI/Adm-Ono) Local sraff (August)			Note from DPO: Actions for the raised issues, deadline, responsible person(s) would be included in the M/M
0.2	Prepare Annual PO for approval by JCC	*Draft prepared before JCC														DPF/IBAMA	ditto	ditto	ditto			Note from DPO:Integrated APO for the Project is presented to JCC

Annex 2 Latest Detailed Plan of Operation with progress of Activities

	[illegible]	Expected Results per [illegible] PO	Org. in charge	Person in Charge (as of Nov. 2011)	Implementors (as of Nov. 2011)	Other major inputs: Japanese	Other major inputs: Brazilian	[illegible]
0.3	Prepare Semi-annual Reports for submittion to JICA	*Semi-annual reports submitted to JICA without delay	DPF/IBAMA	ditto	ditto	ditto		Note from DPO:Semi-annual progress of APO/Indicators, issues&actions, plan for the next semester, progress made on the recommendation of the Mid-term Review,,etc. included
0.4	Organize Project Executive Meetings (Project Director, JCC Chairman, Project Managers of IBAMA/DPF and Expert team)		DPF/IBAMA	ditto	ditto	ditto		Note from DPO:Semi-annual report presented & discussed
0.5	Prepare Annual Reports for review by JCC	*Draft prepared before JCC	DPF/IBAMA	ditto	ditto	ditto		Note from DPO: Progress of Indicators&annual PO, issues &actions, progress on the Recommendations of the Mid-term Review, etc. are included
0.6	Prepare a Terminal Reporfor review by the final JCC	*Draft prpared before the final JCC	DPF/IBAMA	ditto	ditto	ditto		Note from DPO: Progress of Indicators&DPO, issues& post-project strategies, progress on the reccomendation of the Final Evaluation etc. are included
0.7	Organize internal Meetings periodically		DPF/IBAMA	ditto	ditto	JE(RSI/Adm-Ono)		
a	Meeting between DPF & IBAMA	Montly meeting held	DPF/IBAMA	Magliano (DPF)/George (IBAMA)	ditto	All experts in Brazil		Note from DPO: Progress &plans, issues & actions discussed.
b	Meeting between DPF & Japanese Experts	Weekly meeting held when J/E are in Brazil	DPF	Magliano(DPF)	ditto	ditto		Note from DPO: Progress of the perevious week, plan for the week, issues&actions discussed
c	Meeting between IBAMA & Japanese Experts	ditto	IBAMA	George (IBAMA)	ditto	ditto		ditto
0.8	Monitor the achievement of the Indicators	Information collected and organized periodically	DPF/IBAMA	Magliano(DPF)/Rodrigo (IBAMA)	ditto	JE(RSI/Adm-Ono)		
0.9	Facilitate conclusion of Termo de Cooperacao Tecnica (DPF/IBAMA)	Conclusion facilitated	DPF/IBAMA	Magliano(DPF)/George (IBAMA)	ditto	JE(RSI/Adm-Ono)		
0.10	Prepare for Joint Evaluation	*Necessry data is made available to the Mission	DPF/IBAMA	ditto	ditto	JE(RSI/Adm-Ono)		
0.11	Follow-up the Recommedations of the Evaluation	All the recommendations implemented	DPF/IBAMA	ditto	ditto	JE(RSI/Adm-Ono)		
0.12	Organize project seminars	4 Seminars held	DPF/IBAMA	ditto	ditto	JE(RSI/Adm-Ono)		
0.13	Develop post-project strategy	Post-project strategy for each Output developed before JCC	DPF/IBAMA	ditto	ditto	JE(RSI/Adm-Ono)		Post-project strategy for utilization of ALOSimages, information sharing, and training would be developed by DPF and IBAMA respectively for review by JCC

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Sept. 9, 2010

User’s Manual of ALOS Viewer
(Ver. 2.2.5)

M. Ono
Remote Sensing Technology Center of Japan

1

Computer

- Since file size of ALOS images are large, at least following power is necessary to handle the images.
- OS:Windows XP/W7
- Memory：at least 1GB MB(2GB-4GB is recommended)
- Clock speed：at least 1GHz

Currently MacOS is not supported.

2

About Version2.2.5

- Bug fix in the previous versions
- Automatic brightness control
- Orthographic conversion
- KML file output for polygons on the image
- Support Geo Polygon export and import. Geo polygon is a polygon of which vertex point is expressed by lat/long values.

3

Opening Dialog

Click the button to start

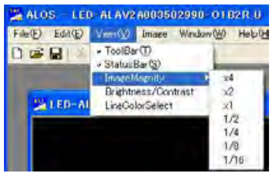
4

File Menu

ALOSImage must be CEOS format
Support following PRISM Level 1B2R, AVNIR2 Level 1B2R
PALSAR Level 1.5, PALSAR Level 1.1

5

View Menu



Currently, Enlarge and shrink is supported.

6

Brightness contrast control

1. Select “Intensity modify”, display image size will be reduced to 1/8 scale. Press keys repeatedly following list below, image appearance is controlled interactively in reduced size image.

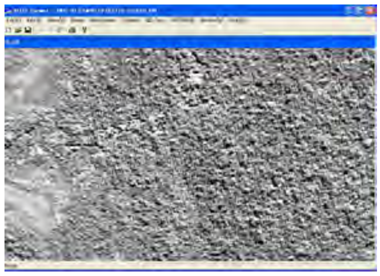
Press key

Brightness			Contrast		
r	t		r	t	Red channel
g	h	SHIFT +	g	h	Green channel
b	n		b	n	Blue channel
j	k		j	k	All channel
High /Low			High /Low		

2. Select “Apply modification”. Image brightness is recalculated for all scales and redisplay in original image scale.

7

Display

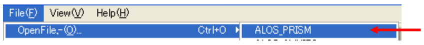


In version 2.0 image brightness and contrast is automatically adjusted to a default setting.

When click mouse button in the image, pixel info(x,y address and Latitude and longitude) will be displayed. If you click mouse button while pressing Shift key, clicked pixel location is moved to top left corner. If you click mouse by pressing Ctrl key, top lect point is moved to clicked position
You can open next image from file menu at this moment.
You can select image after opening, from window menu.

10

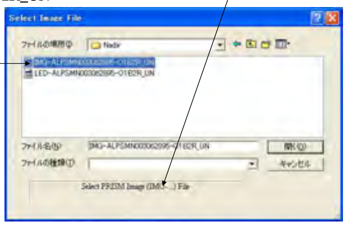
Open PRISM Image



IMG-ALPSM*******-O1B2R_UN**
and
LED-ALPSM*******-O1B2R_UN**
are necessary

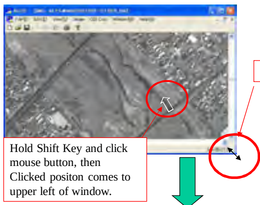
（1）follow the instruction

（2）
Select IMG-***
file



8

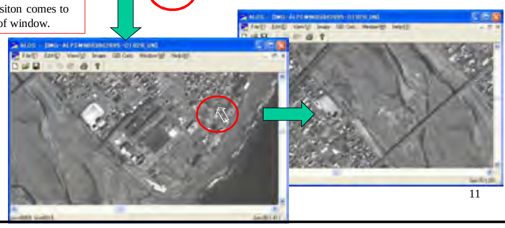
Move Displayed Area



Change wubdow size by mouse drag here.

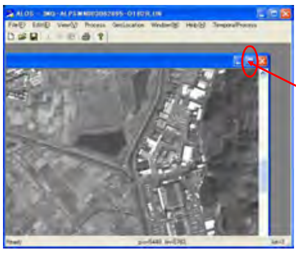
Hold Shift Key and click mouse button, then Clicked positon comes to upper left of window.

Hold CTRL key and click mouse in The image, then top left point of image moves to the clicked position.



11

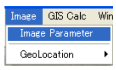
Image is Open



Click the button in advance of other command

9

Display Image Info



Select menu “Image” -> “Image Parameter”,then a Dialog will be displayed as shown left.
Key image parameter is shown.

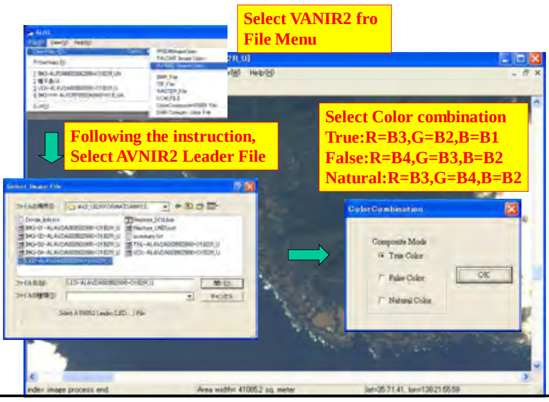
12

Enlarge image

- At initial opening, Prism image is displayed as reduced size index image.
- To display full scale image, hold "z" key and click mouse in the index image frame.
- A square patch area will be enlarged and displayed.
- To switch index image and enlarged image, press "v" key.

13

Open AVNIR2 Image



Open PALSAR Image

Newly PalsarViewer was developed to handle Lev 1.5 data.
Complex data is supported by PalsarFringe generater.

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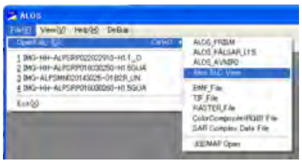
Open PALSAR SLC (complex Image)



Single Look Complex Data(SLC) of SAR which is used by Interferometry or Polarimetry is not a raster image.
It will be visualize after a processing to convert original data to intensity value. From File Menu of SLC, you can look at an intensity image of 1/4 scale of original. Holding "z" key and click a point in image, a 1/1 scaled small patch of the image will be displayed. Pressing "v" key will switch 1/4 scale and 1/1 scale

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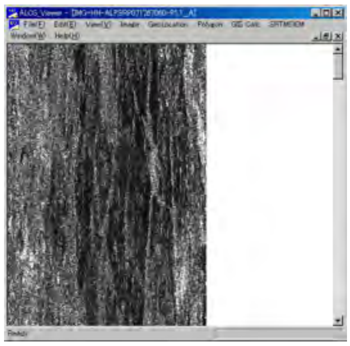
SLC displayed as Intensity image



17

Open ALOS Pan Sharpened Image

Select "ALOS Pan Sharpened GeoTif" from File Menu.
Leader file must exists in the same folder with image.
After a while, image will open.

ALOS Pan Sharpened Image file size is 600MB or 1.2GB, which are beyond Windows image handling limit. In the initial opening, 1 / 4 scale of original image will open. To look full precision image, follow the process in the next page.

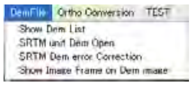
18

Display Full Precision Pan Sharpened image

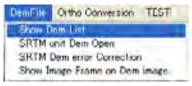
- Clock mouse where you want to see with full precision, by holding “z” (Zoom) key.
- A 1024x1024 pixel area with clicked pixel at center will be open. Enlarge image of the patch is selectable from scale menu items.
- Press “v” key to switch to the reduced size image and full precision image.
- Click another place in reduced size image by holding “z” key will change the full precision scene.

19

Dem file menu (one degree unit)



DemFile menu handles SRTM* dem to correct foreshortening of SAR image.



“Show Dem List” displays a dialog to show necessary SRTM dem file name(s). Prepare the files and geoid file to make orthographic SAR image.

*SRTM: Shuttle Radar Topographic Mission

22

Orthographic conversion

- SAR image is geometerically distorted due to the local elevation feature appears as fore shortening mapping distortion. Optical sensor also have tangential distortion due to cross track parallax.
- In this version, these distortion can be corrected using SRTM dem (1degree mesh) to generate orthographically mapped data.
- Follow the process from the next pages to use SRTM dem.
- After correcting the dem, orthographic conversion is just a one click operation. Select menu below and follow the dialog.

Output is Geotif file which can be imported to general GIS software.

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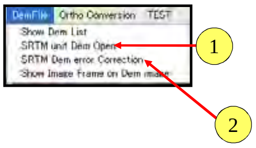
SRTM data Handling



Original SRTM dem have occasional error point (missing data). To use the Dem you must correct the error in advance by following process as;

1) Open element dem file. (menu item 1 shown above)
2) Make polygon to surround error area.
3) Correct Dem by interpolation (menu item 2 shown above).

23

Conversion from 5 deg SRTM to 1 deg SRTM

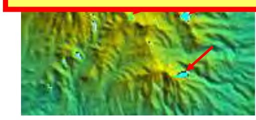
1. Select menu and find new style dem name and prepare the data.
2. Then click OK.
3. five degree dem is cut to one degree dem to fit with old style.
4. 25 one degree dem will be created from a unit five degree dem.

21

Error Correction of SRTM Dem (1/4)

SRTM Dem some times has defect pixels where Dem value is set to be zero intentionally. For fore shortening correction or differential interferogram generation, these defect point must be repaired in advance.
In this program, interpolation using surrounding valid pixel value is applied.
Defect points are displayed as light blue which is the same color of sealevel but

Error correction is not necessary if you convert 5 degree srtm into one degree mesh dem



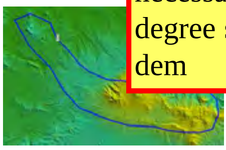
of SRTM Dem.
Shadow or steep fore slope int Space shuttle radar operation causes such unprocessed pixels.

24

Error Correction(2/4)

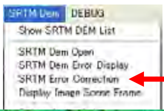
(1)Hold “t” key and click mouse to surround error area by a polygon (yellow line).

Error correction is not necessary if you convert 5 degree srtm into one degree dem

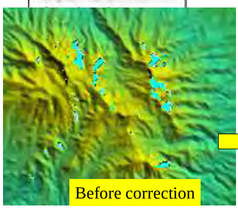


25

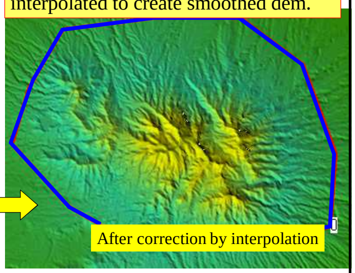
Error Correction(3/4)



(5)Select menu in the left image, then Error inside active polygon will be interpolated to create smoothed dem.



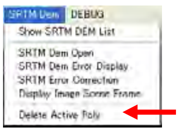
Before correction



After correction by interpolation

26

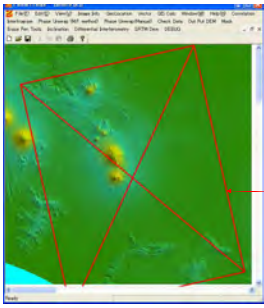
Error Correction(4/4)



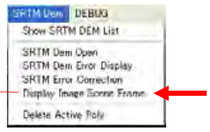
To delete polygon, selet left menu. Activated polygon will be erased and remained polygon is renumbered.

27

Display Shadowed SRTM Dem



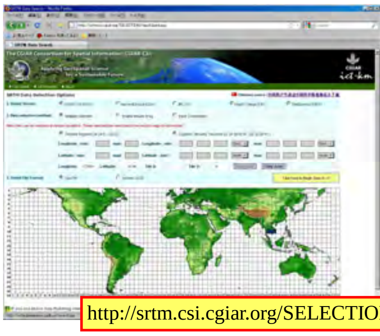
When you select a Dem in file dialog SRTM dem will be displayed as shown left.
SRTM Dem is Color Coded by altitude and shadowed by slope illumination.



When you select above menu item, SAR image frame of current scene will be displayed.
Selet same menu to erase the frame.

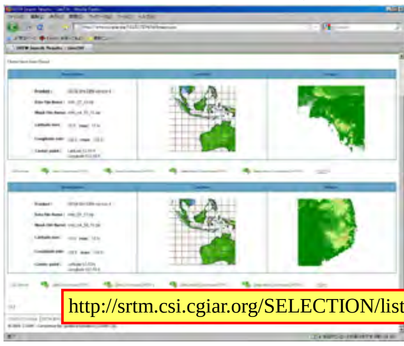
28

NEW SRTM (v4.0)



http://srtm.csi.cgiar.org/SELECTION/inputCoord.asp

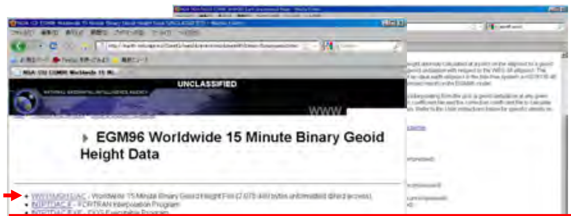
NEW SRTM (v4.0)



http://srtm.csi.cgiar.org/SELECTION/listImages.asp

30

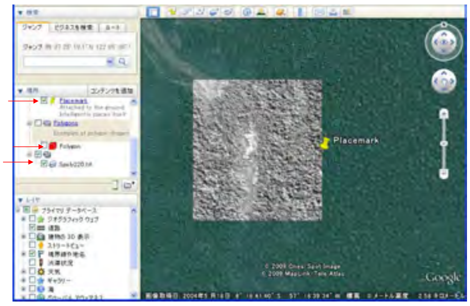
Geoid Data



http://earth-info.nga.mil/GandG/wgs84/gravitymod/egm96/egm96.html

http://earth-info.nga.mil/GandG/wgs84/gravitymod/egm96/binary/binarygeoid.html

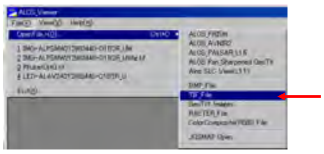
Display on Google Earth



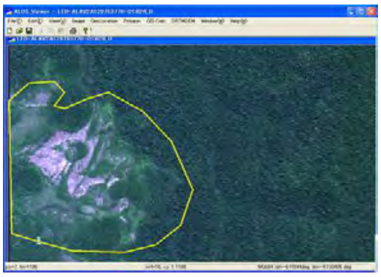
Prism patch is overlay on Google earth image.

Opening Geotif file

•After generating geotif file of an original image, the file can be open from file menu when original image is open.
•After opening operation is almost same with Prism image handling.



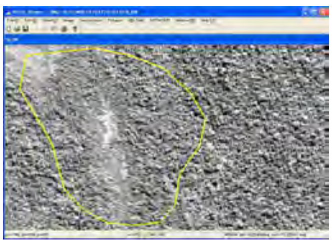
Avnir2 image by AlosViewer



Polygon is generated on enhanced Avnir2 image and registered.

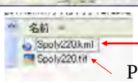
KML file output

KML dictionaryV1.2 is necessary to operate the process.



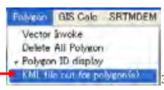
•Create polygons by holding "t" key and click mouse on the image, then press "r" key to register polygons.

•Select menu below then a KML file with multiple polygons will be created along with image patch of the area.

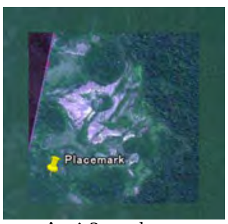


Polygon

Patch image (tif)



Avnir2 image on Google Earth



Avnir2 patch

Original google image

Multiple Geo polygon handling

- Polygon drawn on a ALOS image can be exported as text file and the text file can be imported from other ALOS images.
- For example draw a polygon on AVNIR image and export then import the polygon on a PALSAR image which covers the same area with the AVNIR image.

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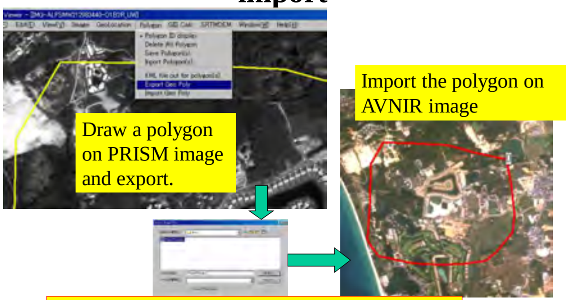
Example of Geo Polygon export and import



The polygon shows the same area on both image.

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June 1st 2010

User's Manual of ALOS PALSAR Fringe

Version 4.0

M. Ono

Remote Sensing Technology Center of Japan

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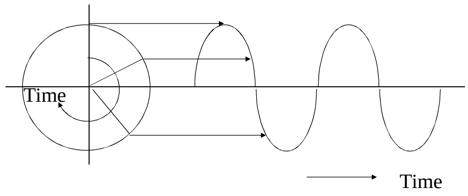
2

(intentionally Blank)

3

1. Radar System

1.1 Wave and Phase



SAR uses Electro Magnetic wave

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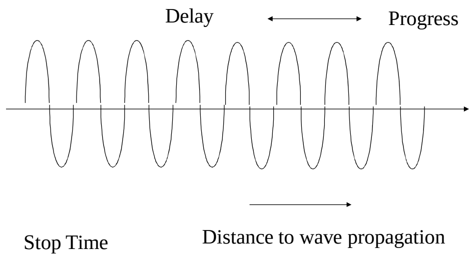
Phase (in Space by Stop Time)



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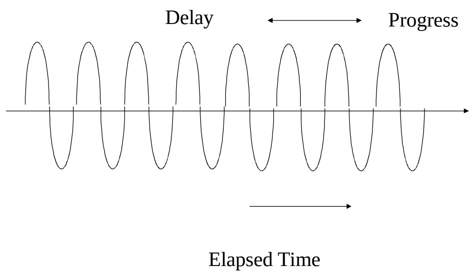
Phase in Time at a Point in Space



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Phase at a Space Position and Time

$f(t, R)=A(t) \exp[j(\omega t-4\pi R/\lambda)]$

Where t:elapsed time
ω:angular frequency (=2πf)
R: distance along wave propagation
λ:wavelength

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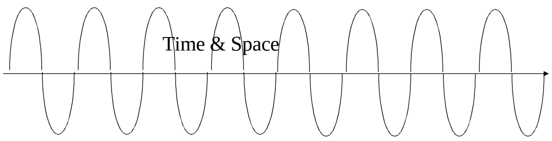
Nature of Phase Function



•if we set time and position in space, we can calculate phase.
•But if we define phase we can not decide time and position.
•Inverse of phase function is ambiguous.

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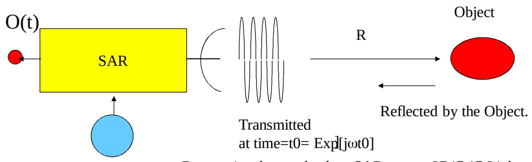
1.2 Detection of Phase Delay

"t" is time



Transmitted
at time=t0= Exp[jωt0]

Stable Oscillator
Signal=exp[jωt]

(Phase progress by time)

Return signal come back to SAR at t_{delay}=2R/C (C:Light Speed)
Stable Oscillator signal at returned time is exp[jω(2R/C)]
In the SAR receiver returned signal is divided by the stable oscillator signal
As
O(t)=Ar exp[jwt0- jw((2R/C)+t0)]
=Ar exp[-jw(2R/C)]=Ar exp[-4π/λR]

Phase delay is preserved in the signal by the receiver function.

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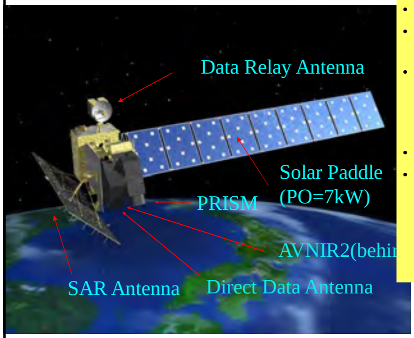
1.3 About ALOS Satellite



- Weight 4 metric tons
- Designed Life:3~5 years (Launch 2006.1.21)
- Orbit Sunsync:H=691.65km, Inc=98.16deg, Recursion=46days, sub cycle=2days
- Total turn/recursion=671
- Sensors:
  PALSAR:Radar
  PRISM :Optical
  AVNIR2:Optical

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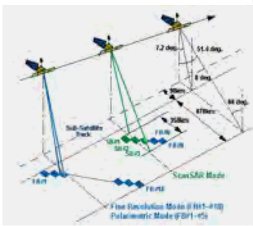
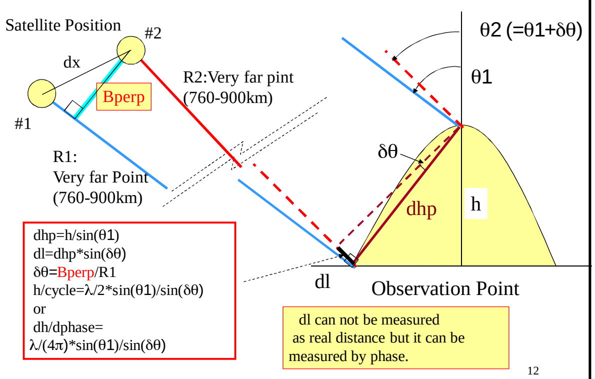
ALOS Sensor PALSAR



PALSAR Characteristic

Mode	Fine		ScanSAR	Polarimetric (Experimental mode)*1
Center Frequency	1270 MHz(L-band)			
Chirp Bandwidth	28MHz	14MHz	14MHz,28MHz	14MHz
Polarization	HH or VV	HH+HV or VV+VH	HH or VV	HH+HV+VH+VV
Incident angle	8 to 60deg	8 to 60deg	18 to 43deg	8 to 30deg
Range Resolution	7 to 44m	14 to 88m	100m (multi look)	24 to 89m
Observation Swath	40 to 70km	40 to 70km	250 to 350km	20 to 65km
Bit Length	5 bits	5 bits	5 bits	3 or 5bits
Data rate	240Mbps	240Mbps	120Mbps,240Mbps	240Mbps
NE sigma zero *2	< -23dB (Swath Width 70km) < -25dB (Swath Width 60km)		< -25dB	< -29dB
S/A *2,*3	> 16dB (Swath Width 70km) > 21dB (Swath Width 60km)		> 21dB	> 19dB
Radiometric accuracy	scene: 1dB / orbit: 1.5 dB			

1.5 Interferogram



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Interferogram Calculation

- O1(P)=Ar exp[-j4πR1/λ]; out put form #1 configuration
- O2(P)=Ar exp[-j4π(R1-dl)/λ]; output from #2 configuration

D(P)=O2(P)/O1(P)

=exp[j4π(dl)/λ]=R+jX ;phase detection (element of inteferogram)

$\phi=\tan^{-1}(X/R)$; Fringe value

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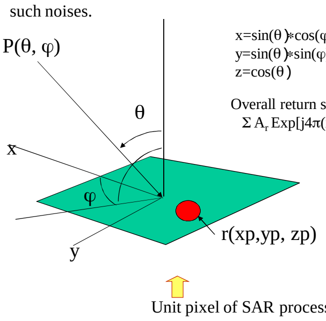
1.7 Phase Noise

(Reflectance in a Pixel of SAR)

As a inherent problem of SAR system, there is speckle noise to disturb accurate phase calculation. The image below shows the mechanism to cause such noises.



x=sin(θ)*cos(φ)
y=sin(θ)*sin(φ)
z=cos(θ)

Overall return signal of a pixel=

$\Sigma A_r \mathrm{Exp}[j4\pi(xp*x+yp*y+zp*z)/\lambda]$

In a unint pixel, there are many objects which reflect radar wave with various strength and phase.

Unit pixel of SAR processed image.

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Phase and Amplitude Stability

(Dependency to Observer Point)

Example shown below was simulated sugnal for a 10m size pixel with 10 sub section (see previous page. "φ" is assumed to be zero).
This table shows an example of ampritude and phase variation depending on the observation incident angle.

Incident angle (degree)	Sin(θ)	cos(θ)	Amp	Phase(degree)
30	0.5	0.866025	1.09556	−26.96440517
30.05	0.501	0.865589	0.924711	4.235031869
30.1	0.502	0.865151	0.862187	1.119699379
30.15	0.502	0.864713	0.796748	−1.994057568
30.2	0.503	0.864275	0.730097	−5.106236602
30.25	0.504	0.863836	18.01189	−8.216835352
30.3	0.505	0.863396	0.59033	−11.32585145
30.35	0.505	0.862955	0.518221	−14.43328253
30.4	0.506	0.862514	0.444981	−17.53912622

Amp and phase changes significantly by a slight incident angle change.

In a distance of satellite from a ground observed point, observation angle difference for 1 km apart points is around 0.07 degrees.
To make a satellite SAR image, more than 10km separated raw data is accumulated along a satellite path which suffers this signal modification and finally appears as speckled image.

Phase stability is important to obtain noise free interferogram

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Source of Phase Error and method to reduce the effect in SAR interferometry

- Cell reflectance variation for observation angle change
- Receiver Noise
- Along track phase instability

Avoid by Averaging after Inteferogram calc.

- Conjugate point evaluation error

Accurate orbit calculation

- Time dependency of the objects
- Environmental dependency of the observation (freeze temperature or not, wet or dry)

Avoid by Scene Selection

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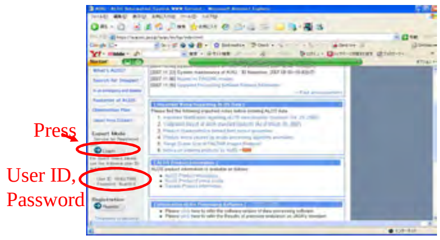
2. SAR Interferometry Process

2.1 How to Check Pair Data

Orbit distance between a pair observation is a key parameter in interferometry process.
To check orbit distance of Palsar data, open Auig at "https://auig.eoc.jaxa.jp/"



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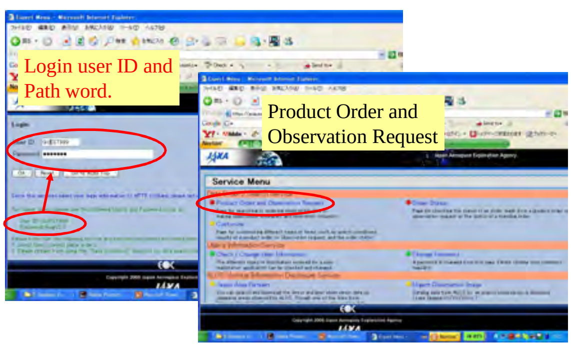
Auig



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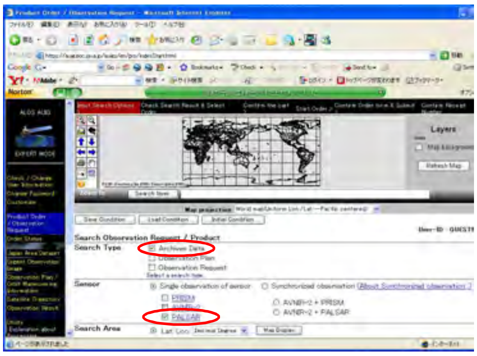
Auig (initial search window)



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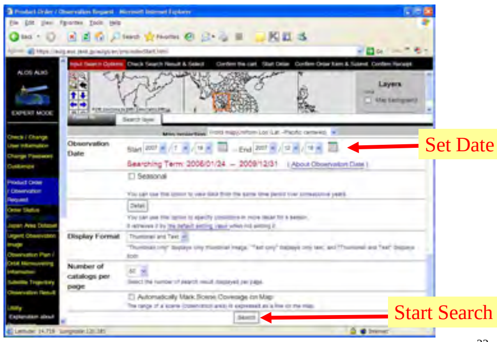
Set Search Date Duration and Start Search



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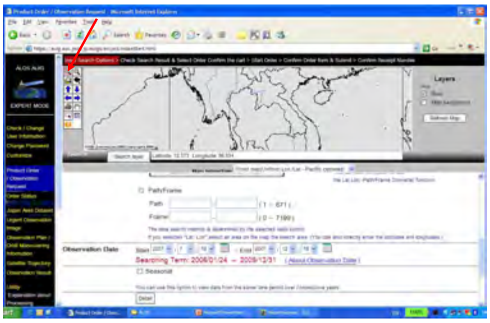
Enlarge Target Area



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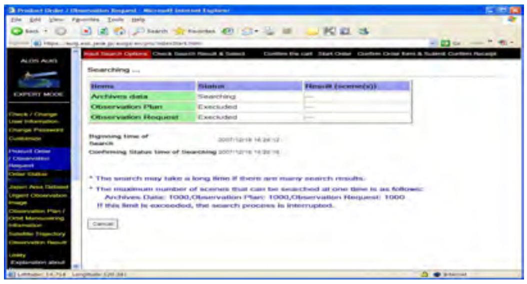
Running Search



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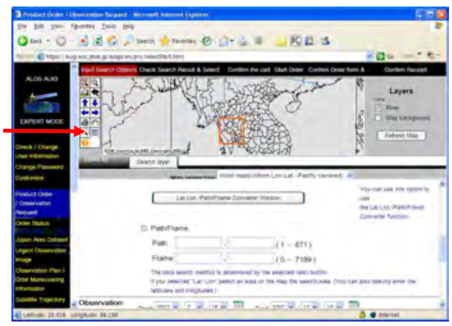
Set Search Region



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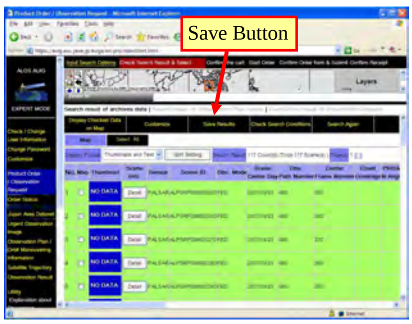
Results Come up and Save to File



Search result output is “CSV” List table.

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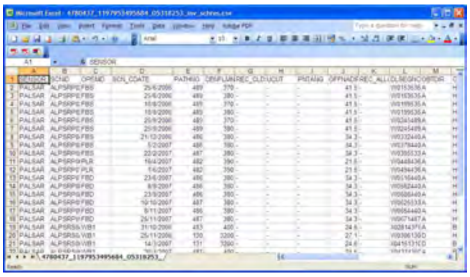
Saved Result as a CSV file



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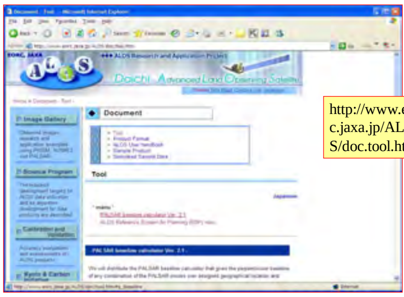
2.2 Orbit Distance Analysis

Down Load an Orbit Distance Analysis Tool



http://www.eorc.jaxa.jp/ALOS/doc.tool.htm

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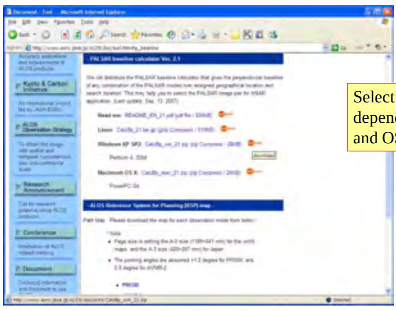
Select Target File



Select an item depending on your PC and OS.

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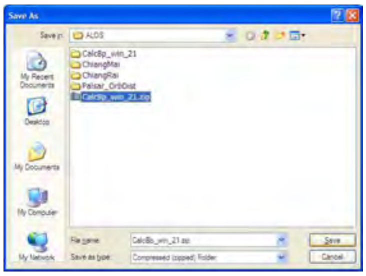
Save Data



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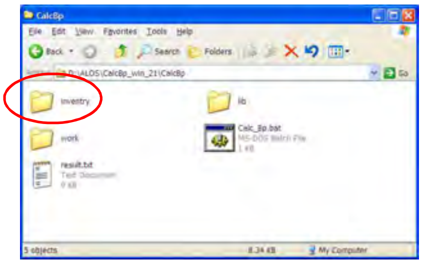
Move Search Result(page 35) to the Inventory Folder then Apply Calc_Bp.bat.



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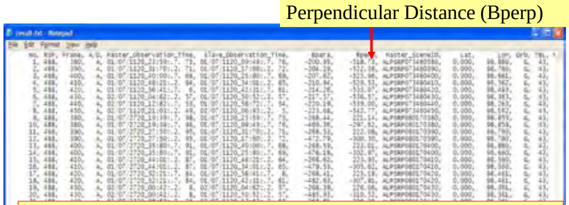
Calculated Results (Bperp is the key parameter)

Perpendicular Distance (Bperp)



Refer Bperp in p. 8 of this document.
In general for PALSAR case, Bperp is preferable to be less than 500m and both observation is preferable to be in dry season and no drastic temperature difference combination*.

*note: drastic temperature difference combination means one observation is conducted at higher than water freeze temperature while other is conducted at lower than water freeze temperature.

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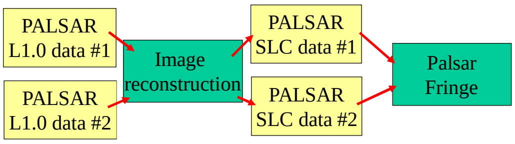
3. SAR Image Generation PalsarProcessor

For detailed manual, refer" PALSAR_ProcessorV2.2".

- Palsar Porcessor is a tool to convert Palsar level 1.0 data into a single look complex data (SLC).
- The process is SAR image reconstruction and after SLC generation for a pair SAR data interfrogram will be generated by the next program "PalsarFringe".



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3.1 Image Reconstruction

- SAR image is almost same with hologram
- Image reconstruction either in Single Look Complex (SLC) form or amplitude form is necessary.
- To process SAR interfrometry, original SAR signal must be processed to Single Look Complex (SLC) data.
- This process exactly trace SAR signal compression in complex number space.
- Amplitude conversion from SLC is usual SAR intensity image. In the usual intensity image, phase information (complex number is discarded.
- SAR image reconstruction is almost linear operation which means reversible operation.
- From raw data to single look complex (SLC) process is exactly a linear operation where a Fast Fourier Transform(FFT) is preferred to accelerate the processing speed drastically.

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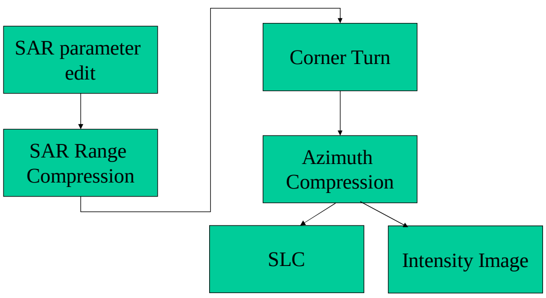
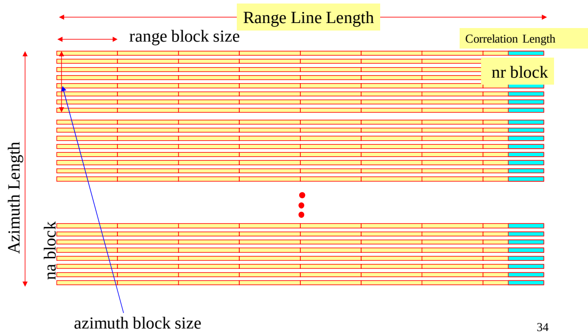
Image Reconstruction process flow

SAR image reconstruction is a linear correlation process using reference function generated from sensor parameter and orbit/attitude information. Since data size is huge, some treatment of a data file is necessary.



Data Structure of SAR Processing

- Range Compression



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SAR image Reconstruction

- This is the process described in the previous page.
- A new program "PALSAR Processor" is prepared to conduct the whole process.

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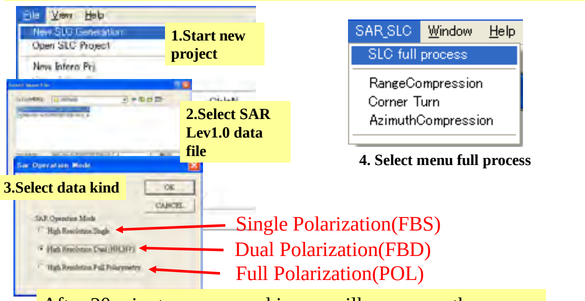
PALSAR Processor Operation

Follow the process below, basic process flow is shown in page 16.

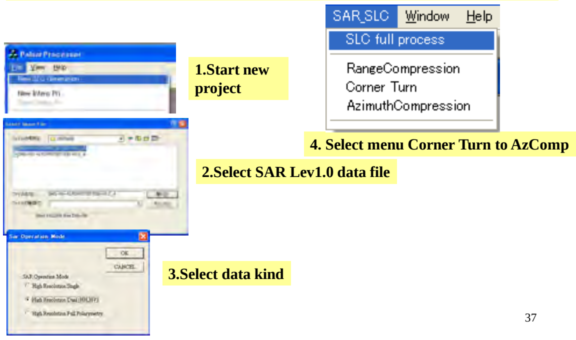
Range Compression (from SAR parameter edit to range Compression)



After 20 minutes, processed image will appear on the screen.

PALSAR Processor Operation

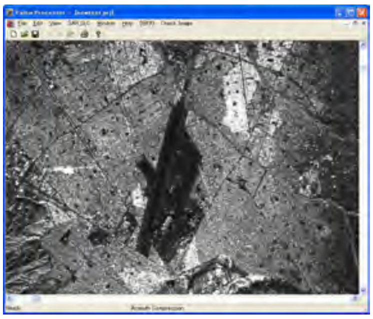
You can process data step by step manner. The first step is range compression then, Corner Turn to Azimuth Compression



In Case Error Happens when running SAR Processor

•In case error happens in the "SLC full process", start program again but this time from open project.
•Start corner turn and wait until "corner turn complete" message appear.
•Start Azimuth compression.

An Result of Palsar Processor

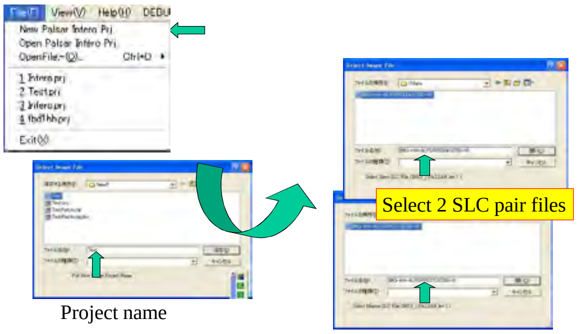


La Paz Air port

4. SAR Interferogram Generation
4.1 Fringe Program

After processing two images a pair of Single Look Complex data(SLC) is ready. Now you can start the program "PalsarFringe.exe"

4.3 Create New Project and Select Associate Files

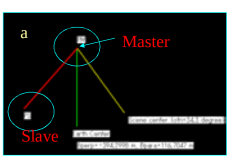


Project name

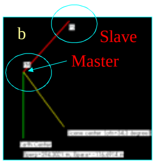
4.4 Index Image after Opening files

•When you create interferogram, always 2 images(SLC) are selected as specified by initial parameter selection.
•After the initial selection or after select open project, an index images are created and displayed.
•Default display is the first SLC image you have specified.
•By pressing "v" key, you can switch image 1(Master SLC) to 2 (Slave SLC) and vice versa.

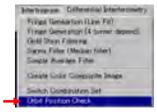
Selection of Master/ Slave images



a)Master image by observation 1, Slave image by observation 2.



b) Master image by observation 2, slave image by observation 1.



To display orbit position, use above menu.

In order to make fringe phase increase coincide with height increase, slave orbit position must be right of master orbit position in above images. So, b) is OK but in a), phase increase in fringe corresponds to height decrease. If orbit combination looks like a), change scene selection order so that orbit position becomes like b).

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Revised Key Stroke

- In the current version new switch function is added.
- "v" key :Switch master and slave images.
- "f" key :Switch master image to fringe.
- "s" key :master image to simulated image
- Shift + "s" key: Fringe to simulated fringe

Last 2 function will work after switching to differential mode.

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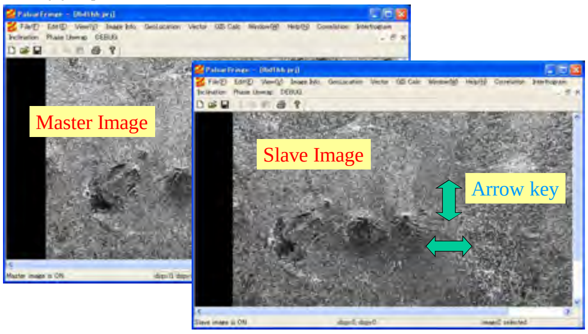
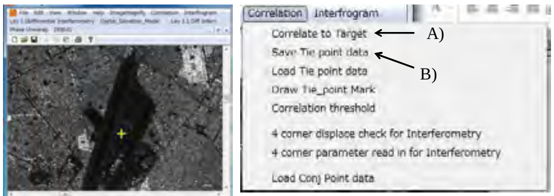
4.5 Switch Master and Slave images

In image display, you can switch master and slave images by pressing "v"key. By click arrow key slave image moves any direction depending on the arrow key you pressed.



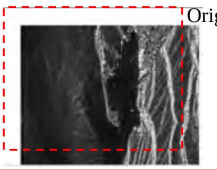
Conjugate Point Calc.



- •Hold "c" key and click mouse in master image once, yellow "+" mark appears.
- •After this operation, "+" mark will move to clicked point.
- •Switch to slave image by pressing "v" key and move image so that master and slave image overlap to a save point within 10 pixel distance.
- •A)Select menu "Correlation->Correlate to target", then both image will be exactly overlap at the "+" mark (check by pressing "v" key).
- •B)Store the conjugate point parameter to save file by Correlation menu->Save Tie Point Data". Only one point in the scene is enough.

4.6 Moving Slave Image

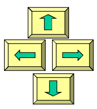
Slave image can move in the display frame while master image is fixed in the frame. This function is used to make conjugate point in two images be close. To move slave image, click arrow key to any direction.
By a click, image is one pixel displaced to arrow direction.



Original position

Current shift values are indicated in the bottom task bar.

By holding Ctrl key and click arrow key , 50 pixel displacement occurs.



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Important Note

After adjustment by Menu "Correlation, you must check stability of the conjugate point (no motion) by pressing "v" key.

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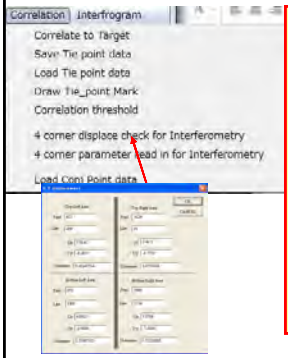
4.8 Check 4 corner Displacement



After saving a tie point parameter, you can call back the data from menu "Correlation ->Load Tie point data". Relative displacement near the 4 corner of the image can be checked by a table shown below. The table is displayed from menu "4 corner displace check for Interferometry". You don't need to change the parameter. Just watch!

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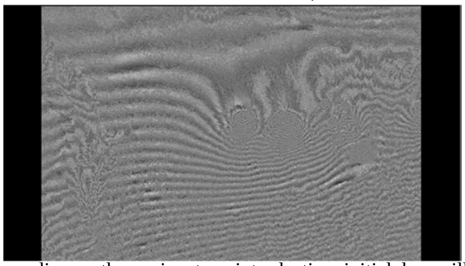
Initial Fringe(without flat earth correction)



Depending on the conjugate point selection, initial dem will have different patterns.
This will be corrected by applying "Flat Earth Correction" in the interferogram menu.

After fringe generation slave image is replaced by fringe.

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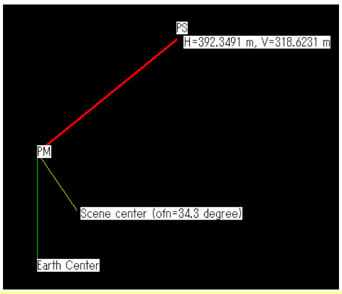
Relative orbit position display



Relative orbit position is displayed at the top left corner of window
From the coordinates, height sensitivity
(altitude change per fringe cycle = a rank) will be calculated

Flat Earth Correction

- Due to the fringe inclination, even a seashore or lake shore looks not flat.
- But using the natural object, we can correct water shoreline inclination.
- Put 3 point along a water land boundary to make a triangle which must be a horizontal plane.
- In the ALOS system orbit information is so accurate that we can correct flat erath relying on the information.
- By the menu selection as shown in the right menu, the image inclination will be corrected using orbit information.
- Exact equation of flat earth correction is shown in the next page.

In the current version "Flat Earth Correction" is done associated with "Fringe generation". You don't need to awared of this process.

4.9 Fringe Generation

- After establishment of 4 corner lock on, fringe generation is an simple process.
- Select menu "Fringe generation".

Fringe generation process and flat earth correction process start successively.

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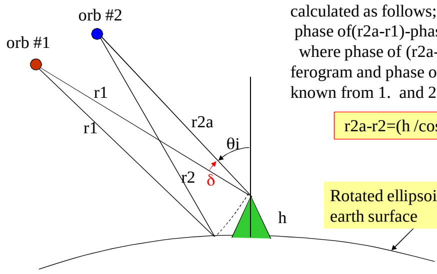
Equation of Flat Earth Correction

Note: phase is the fraction part of a value divided by wavelength.
In SAR fringe, this becomes as ;
phase=(r2a-r2)/λ-[(r2a-r2)/λ],
where l is wavelength and [] is Floor and ceiling function (integer part of value).

1. r1 is calculated from slant range line number and orbit parameter.
2. r2 is calculated conjugate point address (line number) and orbit parameter.
3. r2a is unknown but phase of (r2a-r2) is calculated as follows;
   phase of(r2a-r1)-phase of(r2-r1),
   where phase of (r2a-r1) is original interferogram and phase of (r2-r1) is already known from 1. and 2. (above).

r2a-r2=(h /cos θi) sin δ



Rotated ellipsoidal earth surface

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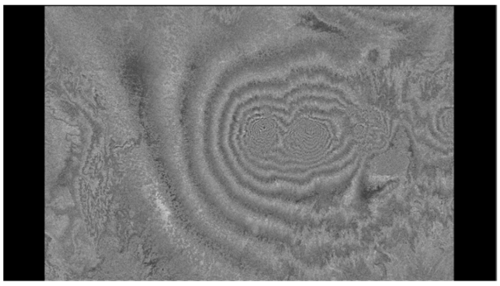
After Flat Earth Correction



This fringe coincide with dem.

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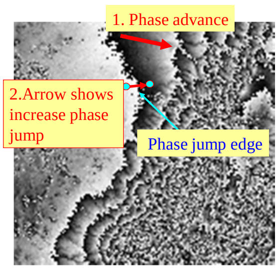
4.10 Understanding Fringe



•Fringe is a gray scaled expression of interferogram.

•Fringe is divided into many sub areas surrounded by phase jump edge as sub area border.

•In a sub area, phase advances in accordance with brightness increase(see 1, in the left image).

•On the contrary, increase phase jump occurs at the bright to dark change at the border(see 2 in the left image).

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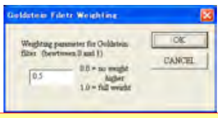
4.11 Filter , Goldstein Fileter

- Goldstein filter is a popular tool to reduce fringe noise.
- To apply the filter select menu "Goldstein filter". Then put weighting factor (0-1). Weighting 0 means no filtering and 1 is highest filtering. Usually 0.2-0.7 is adequate value. Usually it is recommended to use appeared default value.



In most of cases, apply "Goldstein Filter" once. Or "Median Filter" once. No other filter is necessary.

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4.12 Sigma Filter

- Sigma filter is a kind of Median filter but dedicated to preserve phase continuity.
- The filter works any point either before Goldstein filtering, after it. But apply either one once.
- Multiple operation is also possible but may corrupt details of fringe structure.

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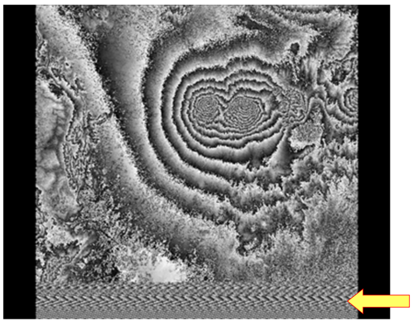
Results of filtering (Goldstein)



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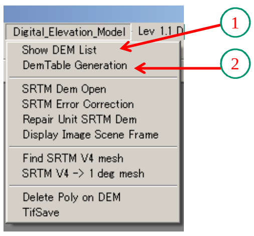
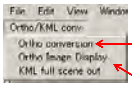
Dem table generation



To avoid multi dem element call frequently, dem table can be created to cover whole scene of master image with sum additional margin to cover fore shortening effect.
Once the table is generated, SAR image simulation for differential interferometry and orthographic rectification can be done using the dem table.
You will feel comfortable to do the processes without accessing original

This process is recommended to access in early step before dem is required. Once the dem table is generated. The data is kept in a file inside project folder. In the next reopen the project, the table is automatically accessed when needed.

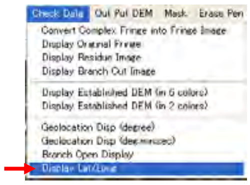
Orthographic rectification



To convert image to orthographic rectified one, select menu shown above and select source file to c be orthographically rectified.

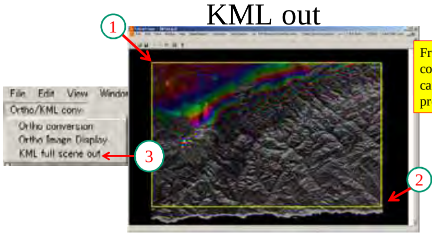
Orthorectifyed image can be displayed from this menu.

Display GeoLocation



When you select left menu item, mouse clicked point geolocation (latitude nd longitude) is displaied in the bottom task bar.

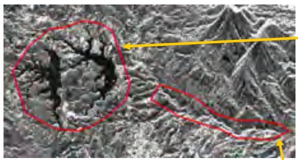
KML out



Fringe and Diffringe and color composite of them can be displayed by the process.

1) Click mouse and press “F1” key,
2) Click mouse at bottom of image corner and press “F2” key, yellow frame line will drawn on the displayed image.
3) Select menu to convert image frame area into KML file.
4) Double click created “kml “ file to display image on Google Earth. (Google Earth must be installed in advance).

Save Polygon parameter as Geolocation data



ID=0, Np=15
x=1206, y=960, lat=-7.02268332, lon=107.68680984
x=1246, y=923, lat=-7.02667972, lon=107.69337123
x=1255, y=885, lat=-7.04581157, lon=107.69887902
x=1236, y=826, lat=-7.05467983, lon=107.69814475
x=1213, y=761, lat=-7.07857276, lon=107.70016483
x=1185, y=744, lat=-7.08475732, lon=107.68369483
x=1144, y=738, lat=-7.08683990, lon=107.67832320
x=1100, y=754, lat=-7.08591981, lon=107.67186048
x=1066, y=757, lat=-7.08948800, lon=107.65388556
x=1015, y=801, lat=-7.07078368, lon=107.64248138
x=979, y=858, lat=-7.06683148, lon=107.62249438
x=1010, y=954, lat=-7.03535951, lon=107.63393869
x=1079, y=992, lat=-7.02792785, lon=107.64213027
x=1134, y=997, lat=-7.02260308, lon=107.66269634
x=1167, y=985, lat=-7.02329359, lon=107.66754261
x=1206, y=960, lat=-7.02268332, lon=107.68680984
ID=1, Np=17
x=1629, y=998, lat=-6.99295364, lon=107.79491604
x=1612, y=983, lat=-6.99557072, lon=107.79310325
x=1565, y=973, lat=-7.00128747, lon=107.77411037
x=1535, y=973, lat=-7.00218645, lon=107.77007842
x=1510, y=972, lat=-7.00307619, lon=107.76674960
x=1458, y=958, lat=-7.00951928, lon=107.74714147
x=1427, y=933, lat=-7.01396478, lon=107.74374454
x=1404, y=916, lat=-7.01704540, lon=107.74117600
x=1348, y=895, lat=-7.03866760, lon=107.72428470
x=1324, y=888, lat=-7.04037392, lon=107.72126315
x=1304, y=923, lat=-7.02199497, lon=107.71436560

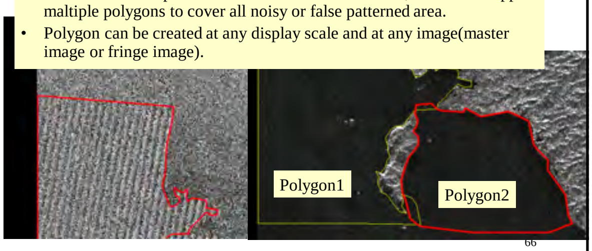
When you select menu “display lat/lon” as shown in previous page and create polygons and save, text file with the polygon file will be saved as text. The text file name is the same with your specified polygon file but the attribute of ”txt”.

4.13 Note on Open Project

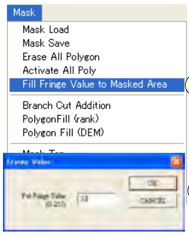
- After conducting new project menu items, you can close the program and restart program with Open Project to go back to the last process before you close the program.
- If you move files to other directory of original point or you import the data (project files and/or SLC files), you must first start with new project menu again and select existing project to overwrite it.
- Then close the project and open the project again.
- All the process parameter is kept as before and move on to next step without conducting interferogram generation again.

4.14 Masking Sea or Lake Area

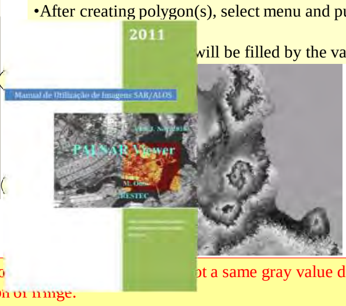
- Some times, sea or lake area shows noisy or periodic false pattern in fringe image.
- The area must be cut out for phase unwrapping.
- To clear the area first make polygons to enclose the area. Since individual vertex point number must be less than 255, create overlapped maltiple polygons to cover all noisy or false patterned area.
- Polygon can be created at any display scale and at any image(master image or fringe image).



Masking polygon with a Fringe value



•After creating polygon(s), select menu and put a



will be filled by the value

In this example which sho ot a same gray value due to mostly plane inclination of image.
To correct the inclination, it is easier to apply differential interferogram and inclination correction (see Chapter 6.6).

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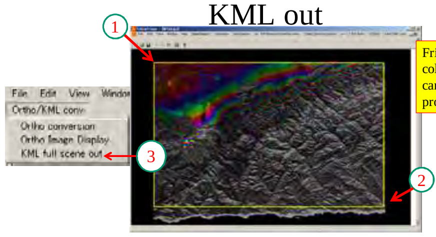
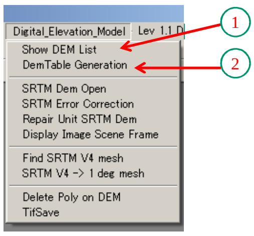
KML out



Fringe and Diffringe and color composite of them can be displayed by the process.

1) Click mouse and press “F1” key,
2) Click mouse at bottom of image corner and press “F2” key, yellow frame line will drawn on the displayed image.
3) Select menu to convert image frame area into KML file.
4) Double click created “kml “ file to display image on Google Earth. (Google Earth must be installed in advance).

Dem table generation



To avoid multi dem element call frequently, dem table can be created to cover whole scene of master image with sum additional margin to cover fore shortening effect.
Once the table is generated, SAR image simulation for differential interferometry and orthographic rectification can be done using the dem table.
You will feel comfortable to do the processes without accessing original

This process is recommended to access in early step before dem is required.
Once the dem table is generated. The data is kept in a file inside project folder.
In the next reopen the project, the table is automatically accessed when needed.

6. Differential Interferometry

- Differential interferometry is a good tool to monitor precise displacement or changes happened in between the two observations for inteferogram genaration.
- It can be used to monitor small land deformation in an earthquake, industrial or city area land subsidence due to overwelling in the area, monitoring large scale land slide, or monitoring volcanic activities.
- To achieve differential interferometry, we need a reference Digital elevation model and currently Shuttle Radar Topgraphic Mission (SRTM) provides us a good quality DEM.
- In the current program the DEM is used. Most of the area except USA are covred by 3 arcsec spacing DEM which is almost enough to be used as the reference DEM.

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Orthographic rectification

To convert image to orthographic rectified one, select menu shown above and select source file to c be orthographically rectified.

Orthorectifyed image can be displayed from this menu.

6.1. Dem data handling

- Palsar data have fore shortening distortion which obstruct Palar data on GIS system.
- Correction of the distortion and make orthographically rectified image can be done using dem data.
- In this program, SRTMDEM or ASTERGDEM is used for the correction of fore shortening distortion.

*SRTM:Shuttle Radar Topographic Mission=a radar mission to generate DEM from interferogram.

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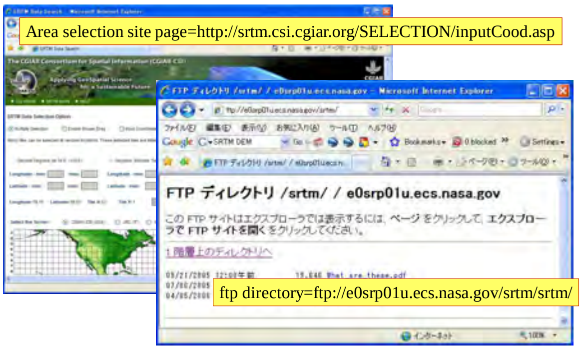
SRTM site

Area selection site page=http://srtm.csi.cgiar.org/SELECTION/inputCood.asp

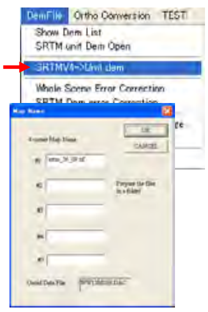


ftp directory=ftp://e0srp01u.ecs.nasa.gov/srtm/srtm/

6.1.1 Old SRTM and New

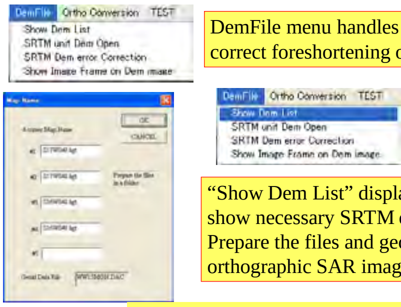
- Old SRTM is cut to cover 1 degree grid both in latitude and longitude, which has often defect point.
- New SRTM is cut to cover 5 degree grid as a unit, which is error corrected to remove defect point.
- In this program, old SRTM is standard and conversion from new to old style is supported.

6.1.2 Conversion from 5 degree SRTM to 1 degre SRTM



1. Select menu and find new style dem name and prepare the data.
2. Then click OK.
3. five degree dem is cut to one degree dem to fit with old style.
4. 25 one degree dem will be created from a unit five degree dem.

6.1.3 Dem file menu (one degree unit)

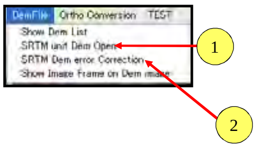


DemFile menu handles SRTM* dem to correct foreshortening of SAR image.

"Show Dem List" displays a dialog to show necessary SRTM dem file name(s). Prepare the files and geoid file to make orthographic SAR image.

*SRTM: Shuttle Radar Topographic Mission

6.1.4 SRTM error correction



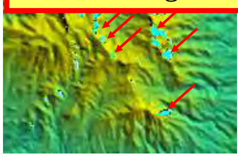
Original SRTM dem have occasional error point (missing data). To use the Dem you must correct the error in advance by following process as;

1) Open element dem file. (menu item 1 shown above)
2) Make polygon to surround error area.
3) Correct Dem by interpolation (menu item 2 shown above).

Error Correction of SRTM Dem (1/4)

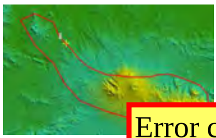
SRTM Dem some times has defect pixels where Dem value is set to be zero intentionally. For fore shortening correction or differential interferogram generation, these defect point must be repaired in advance.
In this program, interpolation using surrounding valid pixel value is applied.
Defect points are displayed as light blue which is the same color of sealevel but y

Error correction is not necessary if you convert 5 degree srtm into one degree dem



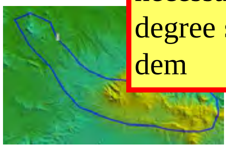
Light Blue speckle in the left image (indicated by red arrow) is defect points of SRTM Dem.
Shadow or steep fore slope int Space shuttle radar operation causes such unprocessed pixels.

Error Correction(2/4)



(1)Hold “t” key and click mouse to surround error area by a polygon (yellow line).

Error correction is not necessary if you convert 5 degree srtm into one degree dem



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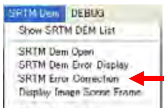
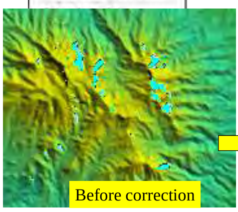
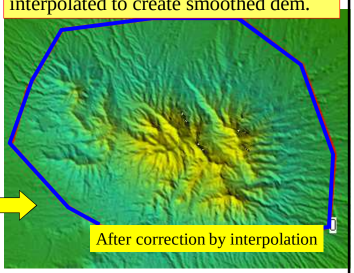
Error Correction(3/4)



(5)Select menu in the left image, then Error inside active polygon will be interpolated to create smoothed dem.



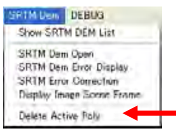
Before correction



After correction by interpolation

80

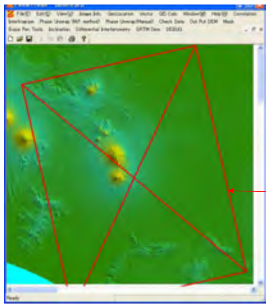
Error Correction(4/4)



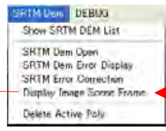
To delete polygon, selet left menu. Activated polygon will be erased and remained polygon is renumbered.

81

6.1.5 Display Shadowed SRTM Dem



When you select a Dem in file dialog SRTM dem will be displayed as shown left.
SRTM Dem is Color Coded by altitude and shadowed by slope illumination.



When you select above menu item, SAR image frame of current scene will be displayed.
Selet same menu to erase the frame.

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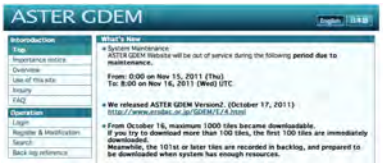
6.2 ASTER GEDEM V2

- ASTERGDEM Version2 is very much improved from previous version.
- Sampling space is 1arcsec (~30m) and blank data is filled by other data sources.
- Palsar viewer support the data use.
- For data acquisition visit the site below.

http://www.gdem.aster.ersdac.or.jp/index.jsp



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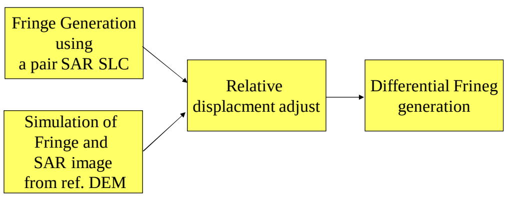
6.3 Process of Differential Interferometry

Process of differential interferometry is shown in the process image.



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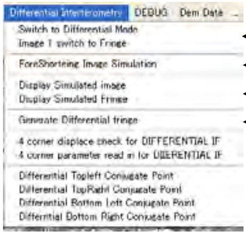
6.4 Differential Interferometry Menu Items



Control Display mode

Simulate SAR image and fringe

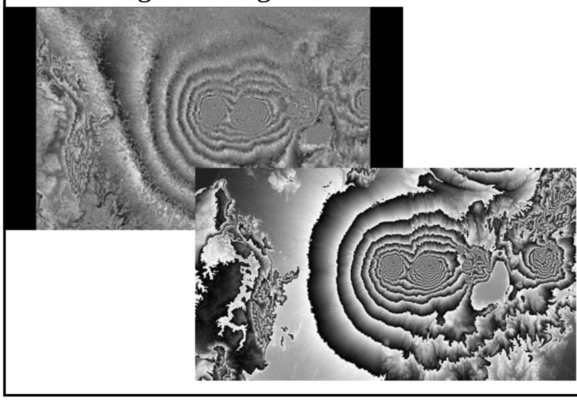
Display simulated images

Final process of differential

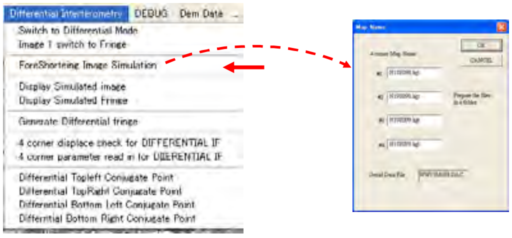
Conjugate point adjustment between Real SAR image and simulated one.

85

Original Fringe and Simulated one



6.5 SAR Image Simulation



When you select simulation menu item, a dialog apperas to show necessary SRTM dem and Geoid files. Take note the file name and cancel dialog at the moment. Prepare the data in a folder and repeat the process again but this time selct OK in the dilalog to go next step.

86

SAR Image Simulation(2/2)

Go to SRTM DEM and Geoid file folder, then open indicated image.
Simulation process starts and after several minutes simlation will be complete.

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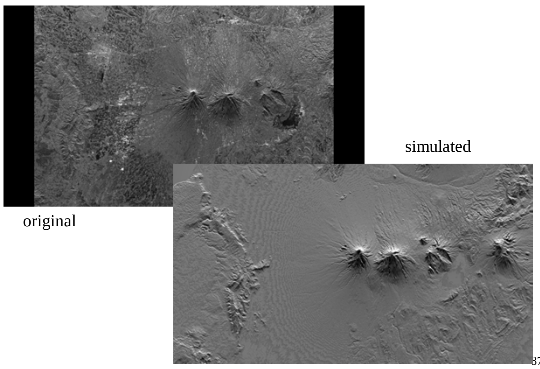
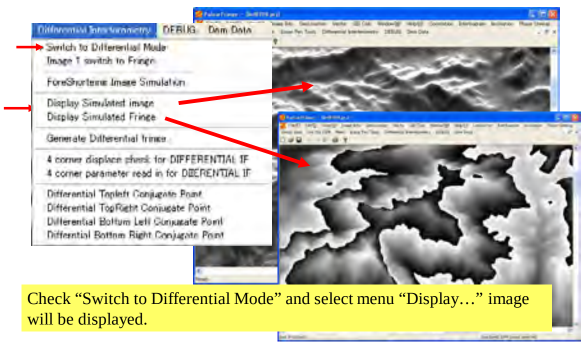
Original Image and Simulated Image



87

Display simlated image



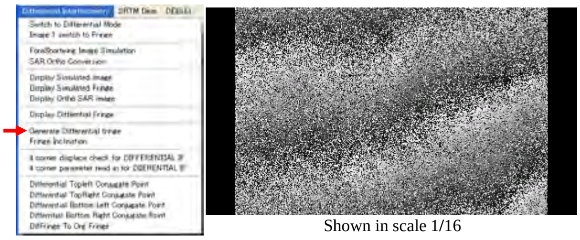
Check “Switch to Differential Mode” and select menu “Display…” image will be displayed.

Key Assignment in Differential mode

s	Switch Master image and simulated image
f	Switch Master image and interferogram
k	Fringe square parameter in vertical cycle increase
SHIFT + k	Fringe vertical cycle decrease
L	Fringe horizontal cycle increase
SHIFT + L	Fringe horizontal cycle decrease
h	Fringe square parameter in vertical cycle increase
SHIFT + h	Fringe vertical cycle decrease
j	Fringe horizontal cycle increase
SHIFT + j	Fringe horizontal cycle decrease

91

6.6 Calculate Differntial Fringe



Shown in scale 1/16

Select "Generate Differential frine", the process will be executed. When the process complete, differential interferogram will be appeared on the display. You can display the differential interferogram from menu.

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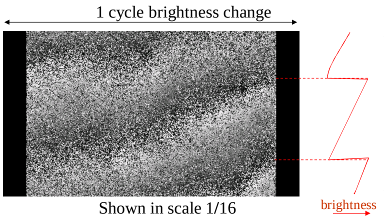
Differential Image Display



Shown in scale 1/16

In the current case differential calculation was conducted on SRTM DEM so the difference shows deviation from SRTM dem.
Looking at the fringe, you recognize 2 cycle almost linear brightness change in the vertical direction and 1 cycle in horizontal direction.

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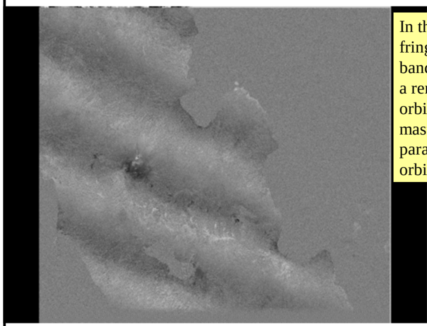
Differential Image Display



In the initial differential fringe, often stripe of bright band appears. This is due to a remaining error of relative orbit position between master image orbit parameter and slave image orbit parameter.

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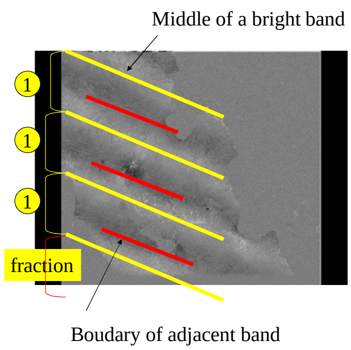
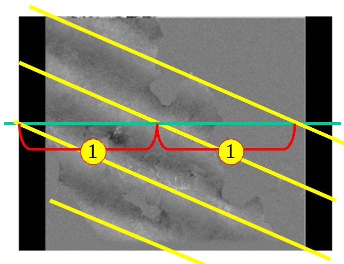
6.7 Inclinaton Correction(1/3)



In this differential fringe case, 3 brightness band plus a fraction part is recognized in vertical direction.
Since the bright band is inclined, horizontal inclination also exist.

95

Inclinaton Correction(2/3)



Also, 2 brightness band plus a fraction part is recognized in horizontal direction.

96

Correction of inclination using GUI

Usually initial differential fringe looks like what is shown left. In a large area average scene must be almost flat. The initial view has apparent inclinations which must be corrected.
In the current program this inclination is corrected by flat plane inclination model.
Interactive operation of this process is shown in the next pages.

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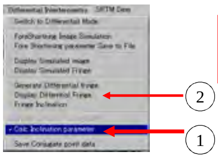
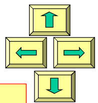
Dif. Fringe Inclination Process



Activate visual inclination function by selecting left menu item.



Press arrow key to modify differential fringe.
"Ctrl key + arrow key" is fine adjustment.

Quadratic parameter can be modified by holding "shift key" and apply above control

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Quadrature component control

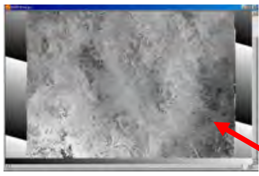
- "q" key increases and "w" key decreases quadrature component in horizontal direction.
- "y" key increases and "u" key decreases quadrature component in vertical direction.
- Holding "shift" key reduces change rate to above key stroke to ½ and holding "ctrl" key reduces to change rate to 1/10 of above key stroke

99

100

Flatten differential fringe

By pressing arrow key, fringe inclination is corrected as shown left.

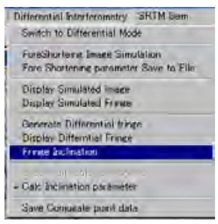


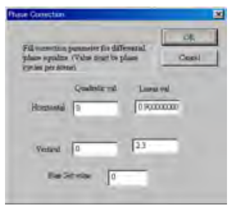
Interactively modified.

Initial

101

Apply the interactive correction parameter





After adjusting parameter, select menu "Fringe Inclination" to show above dialog.
The parameter is already picked up in accordance with the interactive modificcation.
Click OK to start inclination correction.

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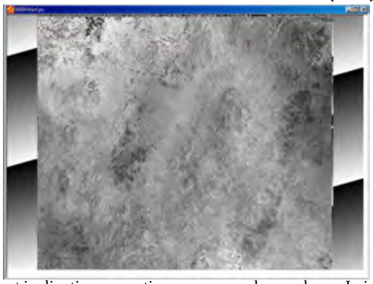
Inclination Correction(3/3)



Resultant inclination correction appears as shown above. In inclination correction process, original interferogram is corrected simultaneously and result become the fringe shown in the next page.

103

Quadrature component correction

- Press q-key and w-key to modify vertical curve correction and y-key and u-key to modify horizontal curve correction.
- Hold shift key to make change half and hold cntrl key to make change 1/10 of un hold key.

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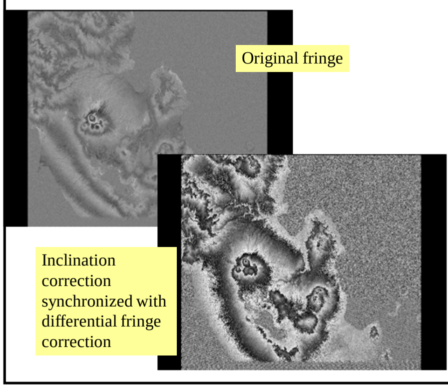
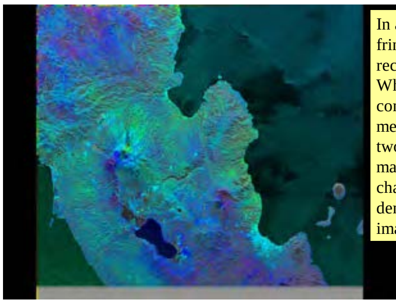
Inclination correction on original Fringe



Inclination correction on differential interferogram is synchronized with the original interferogram correction. When you apply inclination correction on dif. Fringe, original interferogram inclination is corrected accordingly.

Color Composite of Dif. Fringe



In a corrected differential fringe no bright band is recognized.
When you generate a color composite, different color means some changes between two observation date of master and slave image plus a change between reference dem generation and master image generation.

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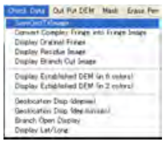
GeoTiff output of color composite



After creating color composite image either differential or original and display interferogram (original or differential), this image can be converted to geotiff file by selecting menu shown left.
In this process unnecessary blank area can be cut out from frame dialog(left bottom).
Output filename is specified by your input in standard file out dialog.
Following 3 geotiff files with the last characters of "G.tif" will be created.

1) Color composite (differential or original).
2) SAR image of the same area.
3) SAR fringe (or differential fringe) of the same area.

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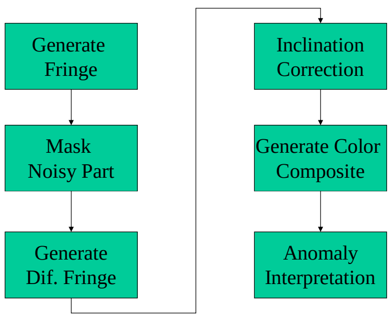
6.8 Change Detection by Differential Interferometry

Process Flow:



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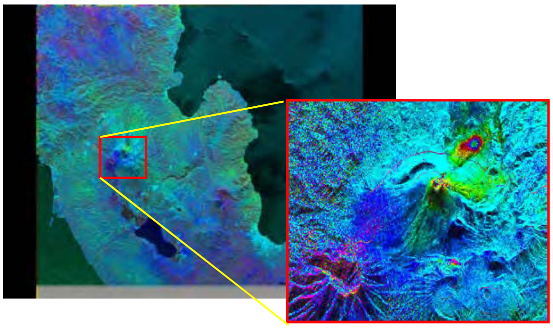
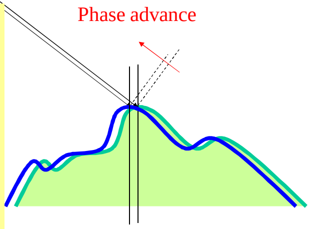
Color Composite



Change Value

Line of sight from master orbit

Phase change happened also by horizontal displace emtn of a target area.
As the result change signal in differential interferogram is the combination of both vertial and horizontal displacement but it can not be separated.
So you must interpret visually what is the cause of this anomaly lookng at the geological or environmental feature of the target area.



112

Change Source

In a corrected differential fringe no bright band is recognized.
When you generate a color composite, different color means some changes between two observation date of master and slave image plus a change between reference dem generation and master image generation.

Change appears in differential fringe

Change between reference image acquisition date to slave image acquisition date.

+

Change between reference dem to master image acquisition date.

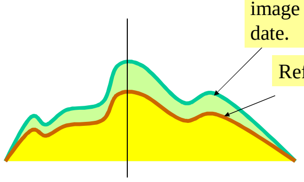
110

Phase Change to Dem Change

Since phase difference in differential interferogram is not so sensitive to the DEM height change, phase pattern in the interferogram can be interpreted as the change between two SAR observation.

DEM at master image acquisition date.

Reference DEM.



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Change Value

Line of sight from master orbit

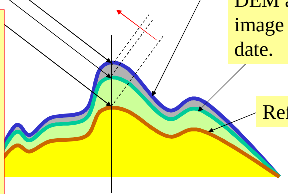
DEM at slave image acquisition date.

Phase advance

DEM at master image acquisition date.

Reference DEM

In the differential fringe image, phase change is interpreted as the distance change from satellite to target which is very sensitive as half wave length of radar for one cycle diferential fringe.



In this analysis we assume hight increase

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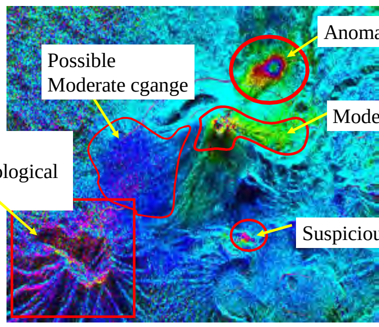
Interpretation of Anomaly



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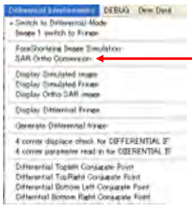
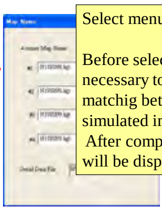
7. Orthographic Conversion of SAR image(1/2)

- After generating differential interferometry, relative postion table between original image and DEM is established.
- Using the table and DEM data, orthographic conversion of SAR is possible.
- The process flow is almost same with SAR image simulation for the part to select SRTM DEM. Remainig process is automatic and not necessary to aware of the individual process.





Select menu “SAR Ortho Conversion.

Before selecting the menu, it is necessary to establish 4 corner position matchig between orginal image and simulated image.
After completion of process ortho image will be displayed.

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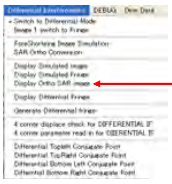
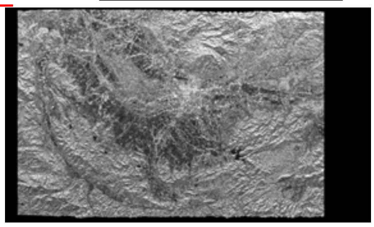
Orthographic Conversion of SAR image(2/2)



You can display orth image any time after ortho conversion by the left menu.



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Ver 1.5 July 2010

PALSAR Phase Unwrap Tool

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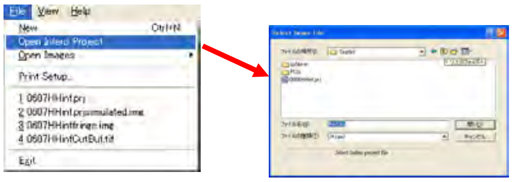
Process conditions

This tool is dedicated to unwrap phase of SAR interferometry for DEM extracton.
Program is designed to work on the results of "PALSARFringeV4.5" or later program.

Process environment:
OS: Windows XP (Vista is not recommended but works with minor GUI incompatibilities.)
Memory: more than 2 GB
HD space: more than 10GB free space
Clock Speed 2GHz or better (works on 1GHz but slow)

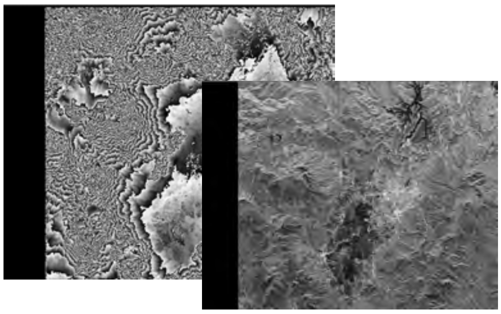
Start Program

Open Project



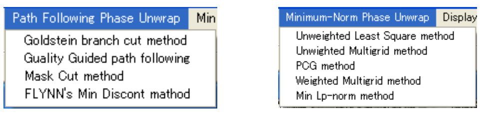
To start process, open inferoproject which was created by "PALSAR_Fringe" program.
In the new system, projectname is "***inf.prj" instead of "***.prj".

Switch Image



By pressing "v" key image and inter ferogram can be switched.

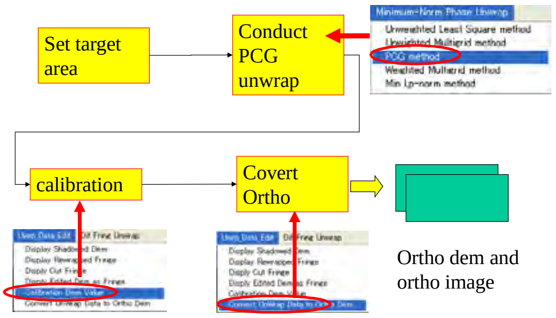
Phase Unwrap Menu Items



There are various method of phase unwrapping, original algorithms are borrowed from an excellent literature (1).
Currently not all process of unwrap menu items work.
PCG method and Min Lp-norm method is recommended tentatively.

(1) Dennis C. Ghiglia and Mark D. Pritt, "Two-Dimensional Phase Unwraping Theory, Algorithms, and Software", John Wiley & Sons Inc., 1998.

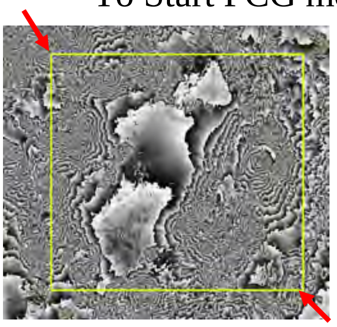
Orthographic Dem Process



Ortho dem and ortho image

C 7

To Start PCG method

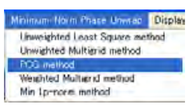


Click mouse at topleft and bottom right of the valid fringe area by holding “c” key. Target area of unwrap is marked by yellow line square.

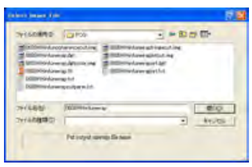
Holding “c” key and click mouse again, frame will disappear.

C 8

PCG dialog



Select menu “PCG method



Output file dialog appears. Create a folder to store unwrapped data with associated several files. In this example, PCG folder is created. For output file name, you can specify a unique name.

C 9

PCG Parameter

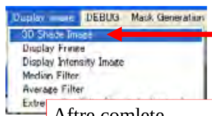
In the PCG method, processing frame size is limitted number, select button to set frame.
Left and Top is a mouse clicked point address.
Only red arrow indicated point may be modified.

C 10

PCG process check

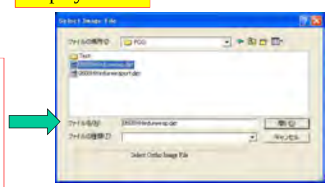
After selecting “OK” in the previous dialog, unwrap process start and after a while process will complete.
Bottom left task bar area, process step will be displayed.

PCG unwrap complete



Display DEM

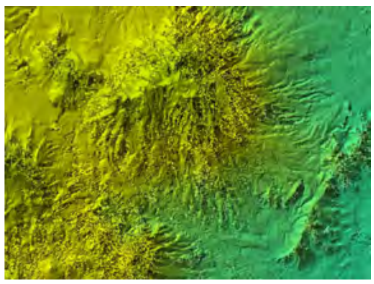
Aftre comlete process, select menu shown left, 3D shaded unwrap data will be displayed.



Select created **.dgt file.

C 11

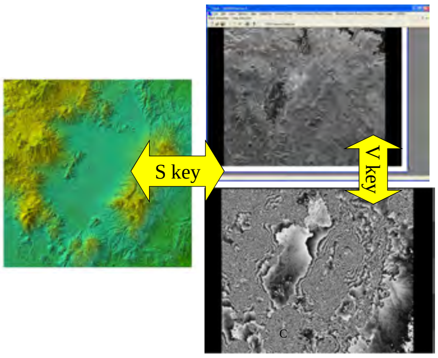
3D shadowed dem



Unwrapped shadow dem is displayed by the selection menu in previous page.
By pressing “s” key, you can switch to original image either intensity image or fringe.

C 12

Switch 3D dem and original Image

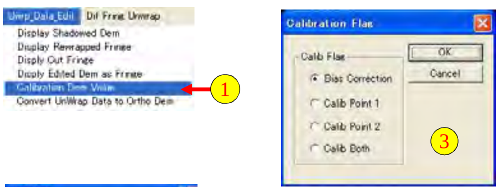


By pressing “s” key, you can switch to original image either intensity image or fringe. Press “s” key again go to 3D dem image

Calibration

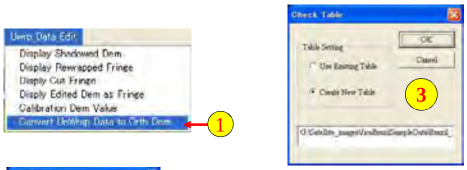
- Dem after unwrap has bias uncertainity because interferogram itself have no data to deduce bias component.
- To calibrate bias component, a low resolution dem like SRTM can be used.
- To utilize the bias component adjustment using SRTM, you must conduct differential interferogram process in PALSAR Fringe program.

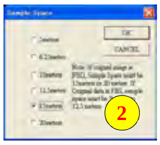
Calibration menu and parameter



In above dialog #3,
Bias correction is adjust dem bias,
Calib 1 is adjust phase cycle jump
Calib Point 2 is re adjust cycle jump after bias correction

Convert to Orthographic Dem

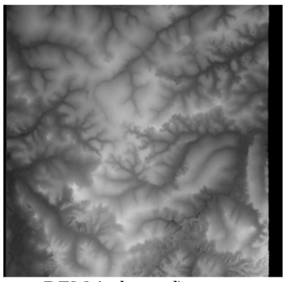




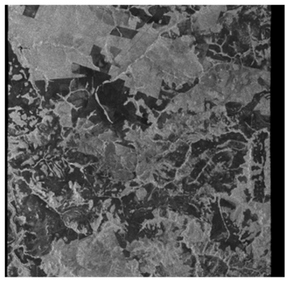
In above dialog, you must select “Create New Table” when you first process a target area. If you reprocess the same area, table remains in the process folder and you can select “Use Existing Table”.

After a while both ortho dem and ortho image will be created in the process folder.

Ortho Dem and Image



DEM (enhanced)



Image

Both data is GeoTiff and north is almost upper.

Process Unit

- The size of frame to unwrap fringe have some limit depending on the process you have chosen.
- In PCG method, 2049x2049 is a recommended size but smaller is faster to process. The size of 4097x4097 will work on phase unwrap process but due to large memory consumption, it can not be converted to ortho dem and ortho image (due to out of memory in window system).
- In Min Lp-norm method smaller size like 1024 by 1024 is recommended to achieve a good result.
- Multi element connection is necessary but currently not supported yet.

June, 2009

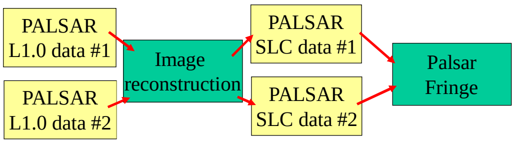
Palsar Processor
V 2.5

M. Ono
Remote Sensing Technology Center of Japan

1

PalsarProcessor

- Palsar Porcessor is a tool to convert Palsar level 1.0 data into a single look complex data (SLC).
- The process is SAR image reconstruction and after SLC generation for a pair SAR data interfrogram will be generated by the next program “PalsarFringe”.



2

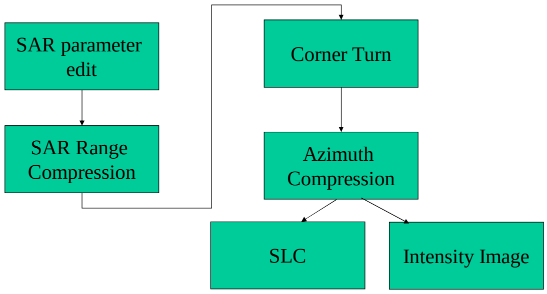
Image Reconstruction

- SAR image is almost same with hologram
- Image reconstruction either in Single Look Complex (SLC) form or amplitude form is necessary.
- To process SAR interfrometry, original SAR signal must be processed to Single Look Complex (SLC) data.
- This process exactly trace SAR signal compression in complex number space.
- Amplitude conversion from SLC is usual SAR intensity image. In the usual intensity image, phase information (complex number is discarded.
- SAR image reconstruction is almost linear operation which means reversible operation.
- From raw data to single look complex (SLC) process is exactly a linear operation where a Fast Fourier Transform(FFT) is preferred to accelerate the processing speed drastically.

3

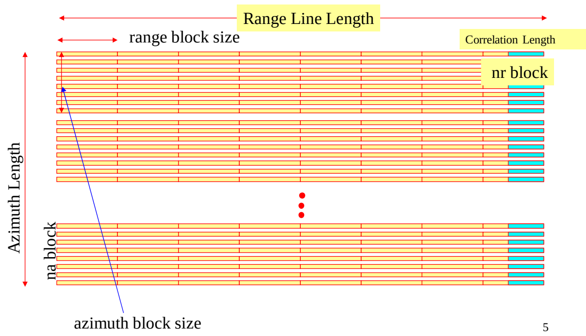
Image Reconstruction process flow

SAR image reconstruction is a linear correlation process using reference function generated from sensor parameter and orbit/attitude information. Since data size is huge, some treatment of a data file is necessary.



Data Structure of SAR Processing

- Range Compression



5

SAR image Reconstruction

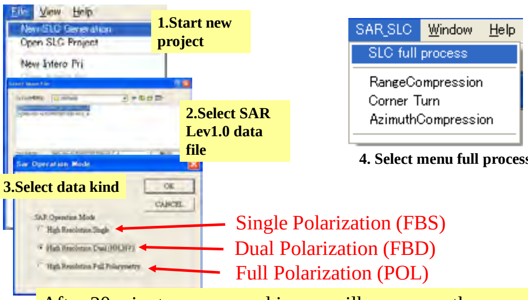
- This is the process described in the previous page.
- A new program “PALSAR Processor” is prepared to conduct the whole process.

6

PALSAR Processor Operation

Follow the process below, basic process flow is shown in page 16.

Range Compression (from SAR parameter edit to range Compression)



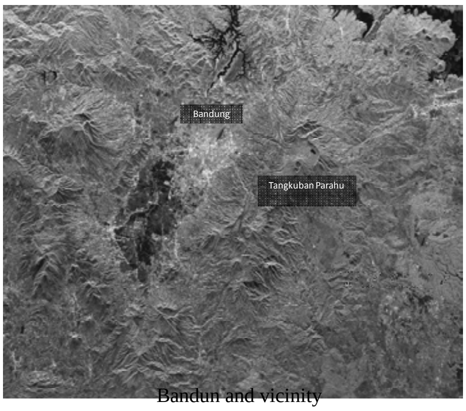
After 20 minutes, processed image will appear on the screen.

In Case Error Happens when running SAR Processor

•In case error happens in the "SLC full process", start program again but this time from open project.
•Start corner turn and wait until "corner turn complete" message appear.
•Start Azimuth compression.

8

An Result of Palsar Processor



Bandun and vicinity

9

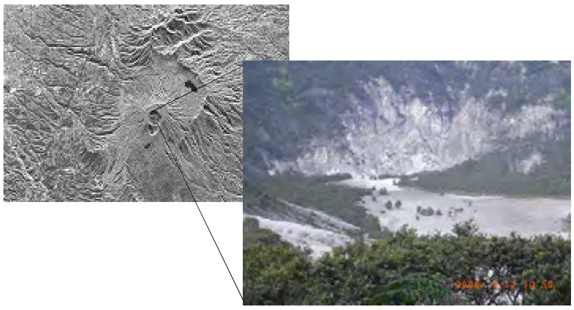
Display Geolocation Parameter

- When you display image, pixel address will be displied in the bottom task bar.
- If you select lat/long display in the menu. Latitude and longitude value of the clicked point will also be displayed.

To dispable the function, select the menu again.

10

Tangkuban Parahu



11

Sampled Range Compression Image

5354 (FBD)

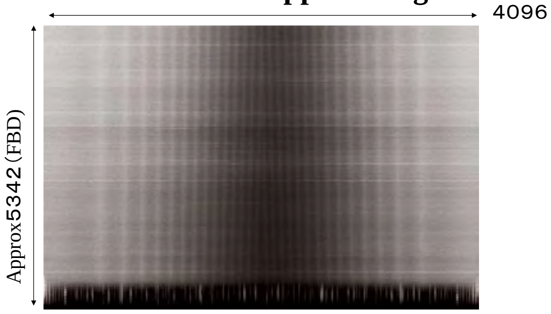
8192

When you process an image Several associated files are created. Range compressed image and azimuth doppler spectrum is shown as samples.

Sampled Range Compression Image(--.ocp.img)

12

Azimuth Doppler Image



Azimuth Doppler Spectrum is saved as sampled raster file(--azdoppler.img)

13

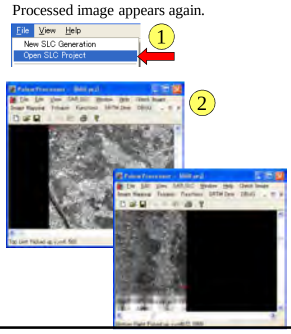
Ground Range Mapping(1/3)

- Original image after reconstruction is slantrange image which has equal space In slant range.
- On mapdislpay, the image must be mapped with equal space on ground, which is not equal space on slant range.
- Slant range equal space to ground range equal space can be converted using orbit parameter, SAR parameter (off nadir angle and slant range), and local earth radius.
- Follow the process in the next pages.

14

Ground Range Mapping(2/3)

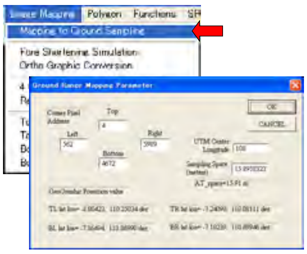
After processing an image, exit the processor. You don't need to save the processed data.
Processed results are saved to a folder whre you put the project file.
Restart the processor again and select open project to specify previous project.
Processed image appears again.



Hold "c" key and click near top left corner of valid image, then press "F1" key to pick up the pixel address.
Do this near the bottom right corner of valid image, then press "F2" key to pick up the pixel address.

15

Ground Range Mapping(3/3)



4 edge parameter and recommended ground sample space appears. Click OK to proceed.
You can modify the value but sampling space is applied only for ground range direction. Along track space is kept as is.

After the process ground range image will be displayed. Processd data is save as a raster file in the location of project file with the attribute "---gr.img".

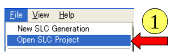
16

Orthographic Conversion

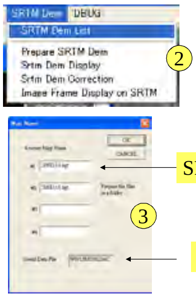
- SAR image is originally mapped using slant image, which causes higher altitude point mapping error called "fore shortening".
- To correct fore shortening a digital elevation model is necessary.
- In this program, SRTM dem which covers almost plus or minus 60 degrees latitude area.

17

Ortho-conversion Process (1/ 6)



Open SLC project



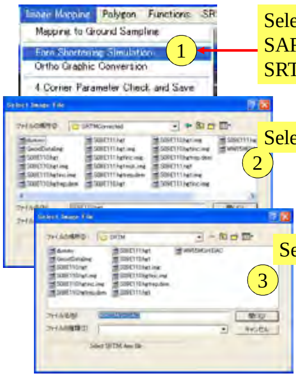
Display SRTM file list to cover the target SAR scene.

SRTM file name(s).

Geoid File

Prepare SRTM files and a Geoid file, unpack them.
If dem errors exist, repair in advance.
(Find in the Web page as shown SRTM section).

Ortho-conversion Process (2/ 6)

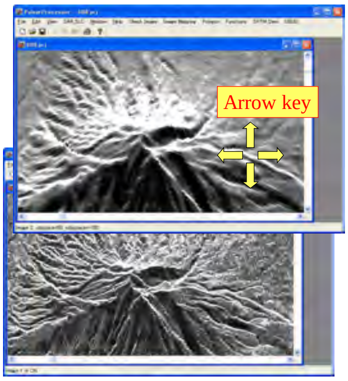


Select this menu to simulate target SAR scene using SRTM dem and Geoid data.

Select SRTM dem file(s).

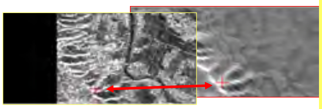
Select Geoid file.

Ortho-conversion Process (3/ 6)

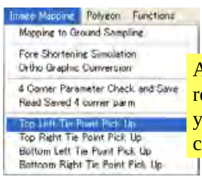


After a while simulation image will appear.
By pressing “v” key, simulated image and original image can be switched.
The simulated image can move relative to original image by pressing arrow key.

Ortho-conversion Process (4/ 6)



Move simulated image near the 4 corner of valid image of original SAR scene.
Be careful that you are selecting nearly real 4 ccorner of valid area rather than apparent 4 corner.



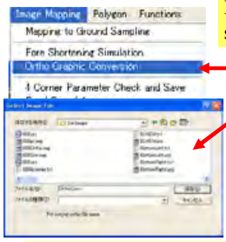
After relative position adjustment so that relative motion can not be recognized when you switch the images, select menu of corrsponding tie point location.

Ortho-conversion Process (5/ 6)

Select the menu to check tie points.

Check dat in appeared dialog.
Check whither pixel and line make sence for valid 4 corner.
And check displacement value is close (no extreme displeacement).
Click “OK” button.

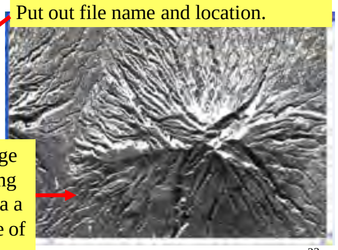
Ortho-conversion Process (6/ 6)



Define TopLeft and Bottom Right as shown in page 14-15 of this manual.

Select menu then process starts.

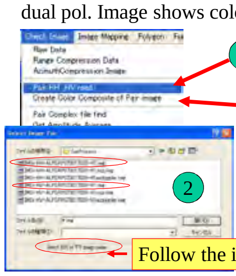
Put out file name and location.



After a while ortho image of ground range sampling will appear. Saved file ia a raster file with attribute of “--ort.img”.

Dual Polarization Composite

•Dual polarization composite is made from FBD data of ALOS Palsar.
•Due to a higher reflectance of volume scattering at forest area, dual pol. Image shows color to depict forest coverd area.



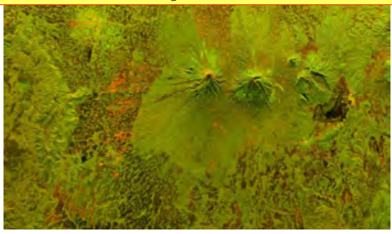
Creation process is simple.
Follow the sequence shown left.

Follow the indication

Example Dual Polarization Composite

Note: GeoTiff File of the color composite will be created automatically when you create a color combination. Output File name is the same with your specified one with the attribute of "g.tif".

HH:Red
HV:Green



Due to that volume scattering is stronger in HV image than that of HH image at forest area, forest areas become green.

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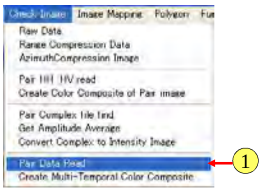
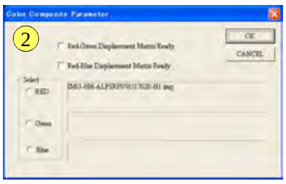
Multi Temporal Composite

Adjut relative position for Time1-Time2, and Time1-Time3, multi-temporal color composite will be created. To create MTC image, follow the process below.





1. Select menu as shown in 1, then a dialog appears. When you select a SAR project, red channel image is assigned by the sar image of the project.
2. Then select green button and click OK (continued to next page).

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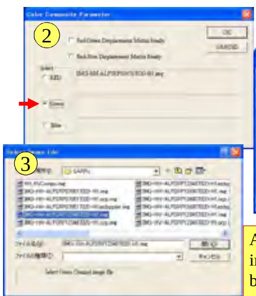
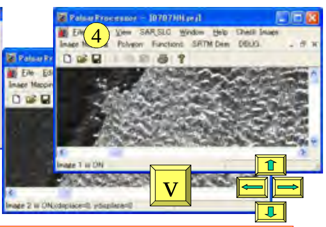
Multi Temporal Composite





After opening the second image, project image and second image can be switched by pressing "v" key. Second image can move relative to first image by clicking arrow key.

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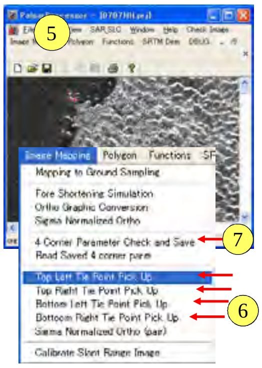
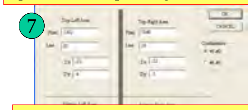
Multi Temporal Composite

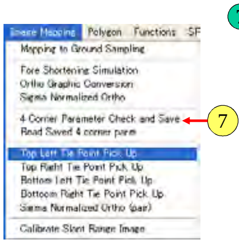


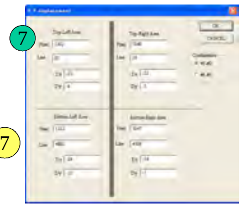
6 Move second image near the 4 corners to match relative position with first image.
Position matiching at the 4 corner is independent with each others.
Pick up the relative displacement value at each corner by selecting tie point pick up menu corresponding to each corner.



Check the 4 corner position and displacement value by appeared dialog.
Click OK.
If the result is not good (4 corner position is wrong), repeat 6 again.

Multi Temporal Composite





Check the 4 corner position and displacement value by appeared dialog.
Click OK.
If the result is not good (4 corner position is wrong), repeat 6 again.

Do process 1 throgh 7 for 3rd image.

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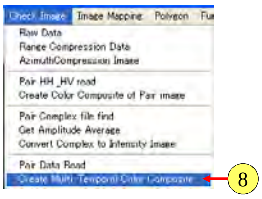
Multi Temporal Composite



Select menu to create MTC image.

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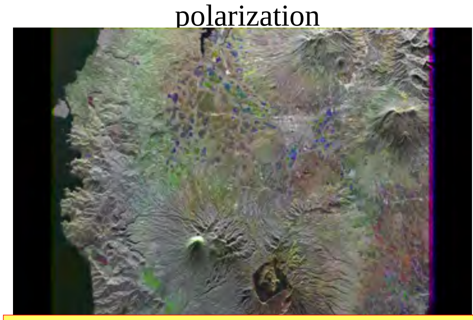
Multi-temporal Composite of HH polarization



Note: GeoTiff File of the color composite will be created automatically when you create a color combination. Output File name is the same with your specified one with the attribute of “g.tif”.

Interpretation of Color in Multi-temporal color composite

Dry — Wet

Bright — Dark

Time1(red)	Dry	Dry	Dry	Dry	Wet	Wet	Wet	Wet
Time2(green)	Dry	Dry	Wet	Wet	Dry	Dry	Wet	Wet
Time3(blue)	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
	(white)	(yellow)	(magenta)	(red)	(cyan)	(green)	(blue)	(black)

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Dem data handling

- Palsar data have fore shortening distortion which obstruct Palar data on GIS system.
- Correction of the distortion and make orthographically rectified image can be done using dem data.
- In this program, SRTM is used for the correction of fore shortening distortion.

*SRTM:Shuttle Radar Topographic Mission=a radar mission to generate DEM from interferogram.

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Old SRTM and New

- Old SRTM is cut to cover 1 degree grid both in latitude and longitude, which has often defect point.
- New SRTM is cut to cover 5 degree grid as a unit, which is error corrected to remove defect point.
- In this program, old SRTM is standard and conversion from new to old style is supported.

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Conversion from 5 deg SRTM to 1 deg SRTM

1. Select menu and find new style dem name and prepare the data.
2. Then click OK.
3. five degree dem is cut to one degree dem to fit with old style.
4. 25 one degree dem will be created from a unit five degree dem.

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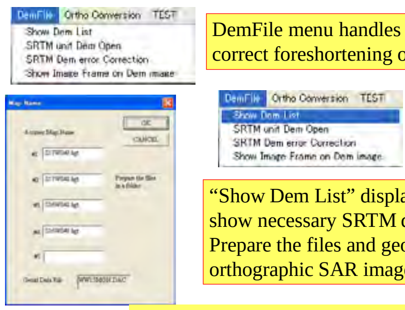
Dem file menu (one degree unit)



DemFile menu handles SRTM* dem to correct foreshortening of SAR image.

“Show Dem List” displays a dialog to show necessary SRTM dem file name(s). Prepare the files and geoid file to make orthographic SAR image.

*SRTM: Shuttle Radar Topographic Mission

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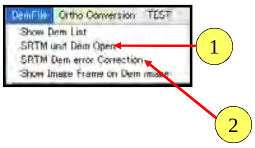
SRTM data Handling



Original SRTM dem have occasional error point (missing data). To use the Dem you must correct the error in advance by following process as;

1) Open element dem file. (menu item 1 shown above)
2) Make polygon to surround error area.
3) Correct Dem by interpolation (menu item 2 shown above).

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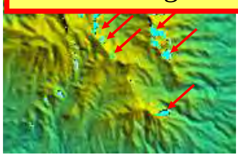
Error Correction of SRTM Dem (1/4)

SRTM Dem some times has defect pixels where Dem value is set to be zero intentionally. For fore shortening correction or differential interferogram generation, these defect point must be repaired in advance.
In this program, interpolation using surrounding valid pixel value is applied.
Defect points are displayed as light blue which is the same color of sealevel but y

Error correction is not necessary if you convert 5 degree srtm into one degree dem



Light Blue speckle in the left image (indicated by red arrow) is defect points of SRTM Dem.
Shadow or steep fore slope int Space shuttle radar operation causes such unprocessed pixels.

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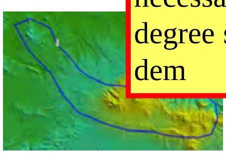
Error Correction(2/4)

(1)Hold "t" key and click mouse to surround error area by a polygon (yellow line).

Error correction is not necessary if you convert 5 degree srtm into one degree dem



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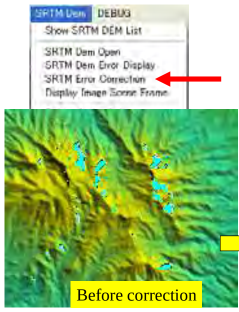
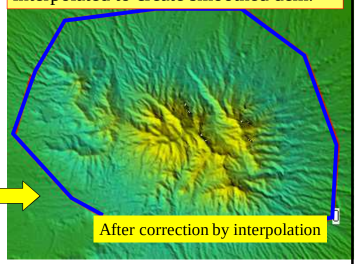
Error Correction(3/4)

(5)Select menu in the left image, then Error inside active polygon will be interpolated to create smoothed dem.





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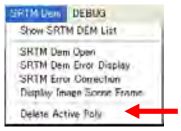
Error Correction(4/4)



To delete polygon, selet left menu. Activated polygon will be erased and remained polygon is renumbered.

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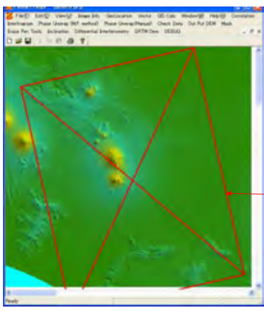
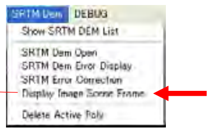
Display Shadowed SRTM Dem



When you select a Dem in file dialog SRTM dem will be displayed as shown left.
SRTM Dem is Color Coded by altitude and shadowed by slope illumination.



When you select above menu item, SAR image frame of current scene will be displayed.
Selet same menu to erase the frame.

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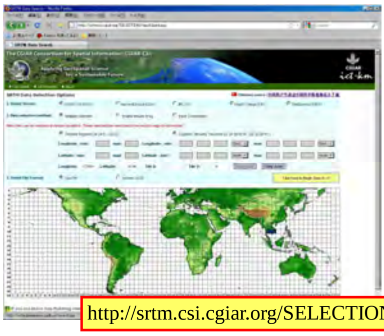
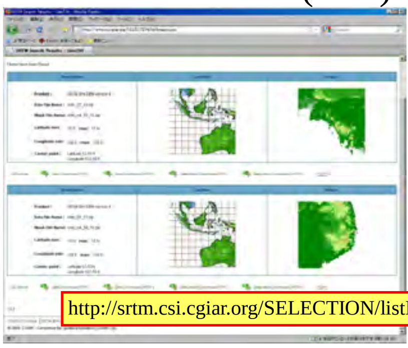
NEW SRTM (v4.0)



http://srtm.csi.cgiar.org/SELECTION/inputCoord.asp

NEW SRTM (v4.0)



http://srtm.csi.cgiar.org/SELECTION/listImages.asp

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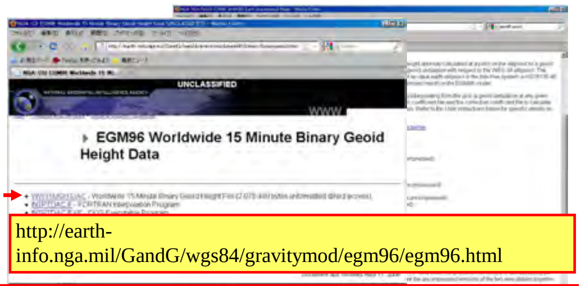
Geoid Data



http://earth-info.nga.mil/GandG/wgs84/gravitymod/egm96/egm96.html

http://earth-info.nga.mil/GandG/wgs84/gravitymod/egm96/binary/binarygeoid.html

Rev. 2.0, 2010.10.18

PALSAR Viewer user's manual

October 2010

M. Ono, Remote Sensing technology Center of Japan

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1. General Information
1.1 Functions of the Program

a) Open Individual ALOS PALSAR images.
b) Create FBD color composite
c) Create L1.5 data multi temporal composite for change detection
d) Create full polarimetry color composite
e) Open PALSAR Scam mode strip data and cut to frames and save as Geotif file
f) Create multi temporal Scan mode data and cut to frames and save as Geotif file
g) Change scale of opened image, display mouse clicked point geo location and pixel value with RDAR reflectance coefficient
h) Change intensity of opened image
i) Create polygon and cut out as KML file
j) Measure statistics for polygon area
k) Convert Image into orthographic projection and Save as Geotif file
l) Convert Image into orthographic projection and Save as Geotif file

1. 2 Opening Dialog

Start PALSAR Viewer, then opening dialog appears as shown Above.
Click "Click me" to proceed.

1.3 Menu items for input image selection

2. Openning PALSAR Level 1.5 Images

2.1 Single PLASAR Image Opening

•From “Palsar 1.5 file Open” menu, you can open Palsar data as gray scaled image.
•Image intensity is converted so that average intensity value of original 2 byte image pixel is converted to digital number of 32 in one byte gray scale image value. This conversion is linear and overflow value is converted to max value of 1 byte image (255).
•When you click a pixel in displayed image frame, original 2 byte integer value of the pixel and calibrated RADAR reflection coefficient is displayed at bottom status bar area.

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2.2 Open FBD as Color Composite

- PALSAR FBD is a dual polarized image obtained from PALSAR FBD observation mode.
- FBD observation is to transmit RADAR pulse with horizontally polarized wave and receive both horizontal (co polarization), and vertical (cross polarization)polarization waves.
- Cross polarization value are affected by vegetation land cover, which often shows green appearance in the color composite image.
- Display amplitude is adjusted so that average of each channel is adjusted to value 32 of byte image pixel value.

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2.3 Open PALSAR multi-temporal Color composite

- From “” menu, you can open 2 or 3 different date PALSAR images as color composite.
- Relative position is automatically adjusted using location table calculated from associated leader file of each image.
- Intensity adjustment is the same manner with single image opening.
- Element image is assigned to R G and B following the opening order.

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2.4 Open Dual temporal FBD color images

- Using Geotiff of FBD color composite, you can open 2 images to cover the same area which must observed in different date (day difference is multiple of 46 days recursion cycle).
- Relative position displacement is automatically adjusted so that each correspomding pixels are overlapped within the accuracy of half pixel width.
- Eah image can be displayed by quick switching respond to a key stroke.
- Change detection by visual monitoring is possible by the operation.

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2.5 Open General Geotif PALASAR images

- PALSAR images provided as Geotiff format can be opened from “general Geotiff image open” menu.
- Image File name assumes to follow original CEOS format naming provided by JAXA but allowed to eliminate initial image key “IMG-xx-” where “xx” is “HH” or “HV” or “VH” or “VV”.
- Geotiff output porduced in the program (PALSARViewer) is also opened by the process.
- If the file name follows the rule, observation date is correctly interpreted in the program.

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2.6 Open Full Polarimetry PALSAR image

- Full polarimetry Level 1.5 image of PALSAR can be opened as color composite.
- Althogh full polarimetry consists of 4 channels (HH,HV,VH,VV) only 3 among the data can be assigned to 3 channel RGB display.
- Since HV and VH is almost same value in principle, it is recommended to assign HH,HV and VV to RGB.

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3. Scan SAR Strip Image Handling

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3.1 Open Single strip and cut to frame scenes

- Scan SAR strip image is provided to specific organizations which exchange agreement on the data provision with JAXA.
- In Brazil, IBAMA is an organization to be assigned as receptor of the image.
- Currently IBAMA CSR is using to detect new deforestation using multi-temporal change detection capability of PALSAR.
- To open the image, select “Scan SAR image open” menu.
- The displayed image is an reduced size index image full scale image can be cutout as equal interval frame image of geotiff format.

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3.2 Color composite of Scan SAR images

- 2 or 3 different date strips covering a same area can be opend from “Multi temporal Scan SAR” menu.
- Relative position is adjusted within 1 pixel accuracy.
- The displayed image is an reduced size index image full scale image can be cutout as equal interval frame image of geotiff format.
- Change detection can be recognized as color difference of the image from no change points.

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4. Working on Opened Image

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4.1 Change image scale and Intensity

- Full scale to reduced scale can be switched from View menu-> image scale.
- Currently magnification is not supported.
- Image intensity can be adjusted from View menu->Brightness->change.
- By the slection, displayed image scale is reduced to 1/8 index image. Press “b” to make image bright, press “n” to dark. This operation is applied just for dieplyed index image.
- To apply the result to original image, selectView menu->Brightness->apply change to original image.

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4.2 Polygon Handling

- You can draw polygon on displayed image to evaluate pixel value statistics, export KML file of polygon area.

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4.2.1 Create polygon

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4.2.2 Save and Read polygon data

20

4.2.3 Export/Import polygon as Geodata table

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4.3 Image Statistics evaluation

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4.4 Export KML files

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4.5 Orthographic conversion and Slope correction

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4.6 DEM data Handling

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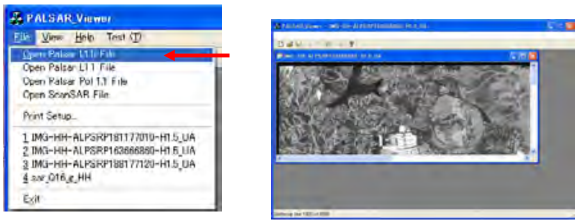
2.1 Select File



Currently, "Open Palsar L1.5 File" and "Open ScanSAR File" is supported. Other selections do not work.
After selecting file, index image appears and follow on process start behind.

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2.2 Full scale image display

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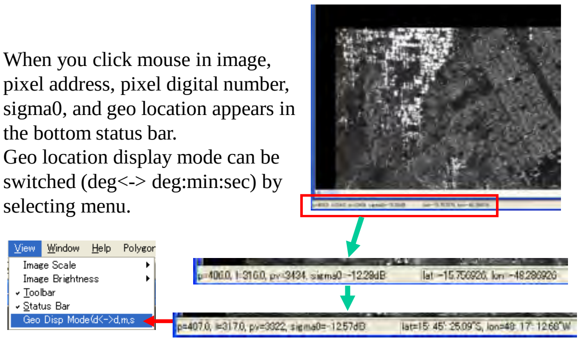
2.3 Reaction on Mouse click

When you click mouse in image, pixel address, pixel digital number, sigma0, and geo location appears in the bottom status bar.
Geo location display mode can be switched (deg<-> deg:min:sec) by selecting menu.



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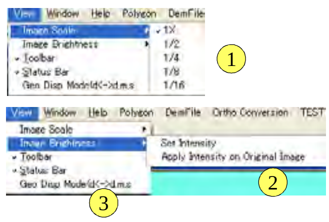
2.4 Menu items



View menu contains;

1) Image scaling
2) Image intensity
3) Geo display option

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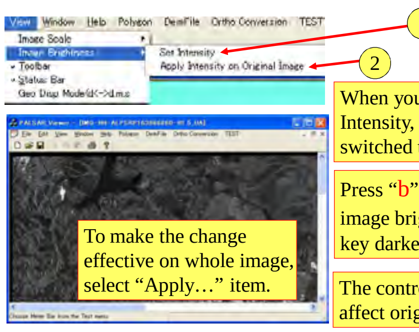
2.5 Brightness control



When you select "Set Intensity, image is switched to index mode.

Press "b" key to make image brighter, and "n" key darker.

The control does'nt affect original data.

2.6 Polygon Menu

Polygon menu handles polygon data on display.
Polygon data can be stored or loaded to or from file.

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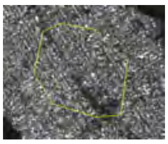
2.7 Drawing polygons on display

Hold “t” key and click mouse in the image, polygon edge will be created. To close a polygon, press “r” key.
After pressing “r” key, you can create next polygon in the same way.

Mouse click at vertex.



Press “r” key.

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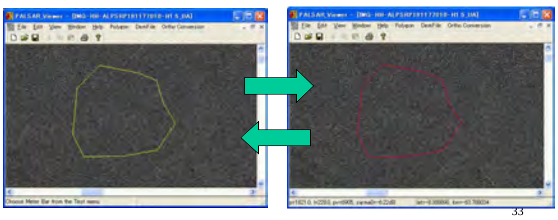
2.8 Polygon activate/inactivate

Hold “a” key and click mouse inside a inactive polygon(marked by yellow polygon), the polygon is activated (marked by red polygon) and vice versa.



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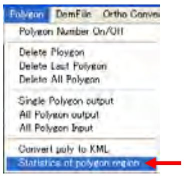
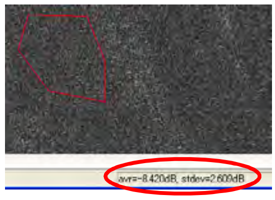
2.9 σ_0 Statistics

- σ_0 statistics in active polygon is calculated from the menu selection. The results appears at the second task bar.





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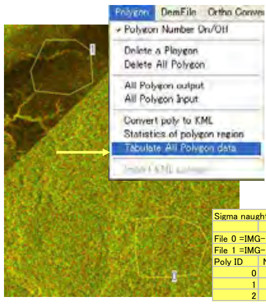
2.10 Tabulate σ_0 Statistics



1. Create multiple polygons.
2. Select menu “Tabulate…”
3. Statistics of σ_0 will be generated as shown below.

Sigma naught statistics of polygons							
File 0 =IMG-HH-ALPSRP078776970-H1.5_UA							
File 1 =IMG-HH-ALPSRP186136970-H1.5_UA							
Poly ID	N smples	latitude	longitude	R-Sigma0(	Stdev(db)	G-Sigma0(	Stdev(db)
0	13104	-10.107	-64.6397	-8.8825	2.9754	-8.9707	2.9476
1	4799	-10.1411	-64.6637	-14.921	4.1655	-14.2375	3.9818
2	8743	-10.0931	-64.4685	-9.4608	3.0286	-9.089	3.0758

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3. Dem data handling

- Palsar data have fore shortening distortion which obstruct Palar data on GIS system.
- Correction of the distortion and make orthographically rectified image can be done using dem data.
- In this program, SRTM is used for the correction of fore shortening distortion.

*SRTM:Shuttle Radar Topographic Mission=a radar mission to generate DEM from interferogram.

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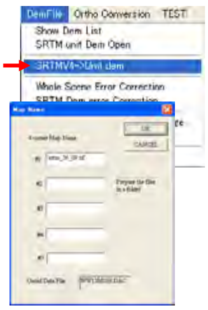
3.1 Old SRTM and New

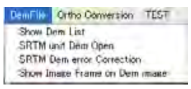
- Old SRTM is cut to cover 1 degree grid both in latitude and longitude, which has often defect point.
- New SRTM is cut to cover 5 degree grid as a unit, which is error corrected to remove defect point.
- In this program, old SRTM is standard and conversion from new to old style is supported.

3.2 Conversion from 5 deg SRTM to 1 deg SRTM

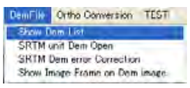


1. Select menu and find new style dem name and prepare the data.
2. Then click OK.
3. five degree dem is cut to one degree dem to fit with old style.
4. 25 one degree dem will be created from a unit five degree dem.

3.3 Dem file menu (one degree unit)



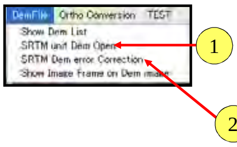
DemFile menu handles SRTM* dem to correct foreshortening of SAR image.



"Show Dem List" displays a dialog to show necessary SRTM dem file name(s). Prepare the files and geoid file to make orthographic SAR image.

*SRTM: Shuttle Radar Topographic Mission

3.4 SRTM data Handling



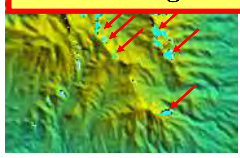
Original SRTM dem have occasional error point (missing data).
To use the Dem you must correct the error in advance by following process as;

1) Open element dem file. (menu item 1 shown above)
2) Make polygon to surround error area.
3) Correct Dem by interpolation (menu item 2 shown above).

3.4.1 Error Correction of SRTM Dem (1/4)

SRTM Dem some times has defect pixels where Dem value is set to be zero intentionally. For fore shortening correction or differential interferogram generation, these defect point must be repaired in advance.
In this program, interpolation using surrounding valid pixel value is applied.
Defect points are displayed as light blue which is the same color of sealevel but y

Error correction is not necessary if you convert 5 degree srtm into one degree dem

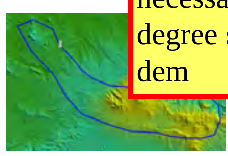


Light Blue speckle in the left image (indicated by red arrow) is defect points of SRTM Dem.
Shadow or steep fore slope int Space shuttle radar operation causes such unprocessed pixels.

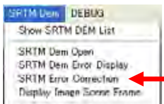
Error Correction(2/4)

(1)Hold "t" key and click mouse to surround error area by a polygon (yellow line).

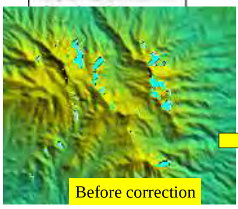
Error correction is not necessary if you convert 5 degree srtm into one degree dem



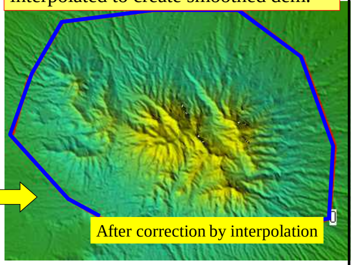
Error Correction(3/4)



(5)Select menu in the left image, then Error inside active polygon will be interpolated to create smoothed dem.

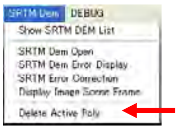


Before correction



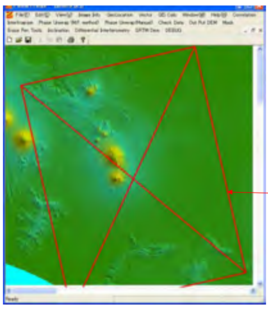
After correction by interpolation

Error Correction(4/4)

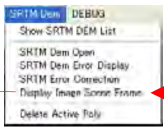


To delete polygon, selet left menu. Activated polygon will be erased and remained polygon is renumbered.

3.5 Display Shadowed SRTM Dem

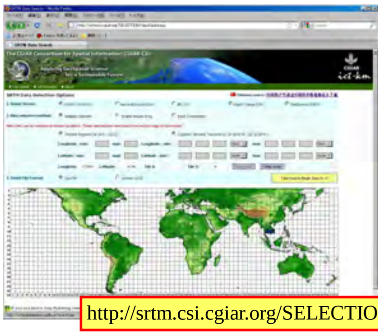


When you select a Dem in file dialog SRTM dem will be displayed as shown left.
SRTM Dem is Color Coded by altitude and shadowed by slope illumination.



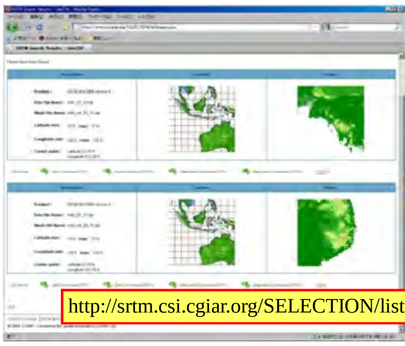
When you select above menu item, SAR image frame of current scene will be displayed.
Selet same menu to erase the frame.

3.6 Download NEW SRTM (v4.0)



http://srtm.csi.cgiar.org/SELECTION/inputCoord.asp

NEW SRTM (v4.0)



http://srtm.csi.cgiar.org/SELECTION/listImages.asp

ASTER GTM

- Aster dem is generated by ASTER Optical Stereo images which covers + or – 80 degree latitude area of globe and sampling space is 1 arcsec. Using the data you can obtain better results for ortho conversion and slope correction than using SRTM 3 arcsec dem.

ERSDAC Home Page and ASTER GDM Page

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GTM page and Log in

ASTER GDM

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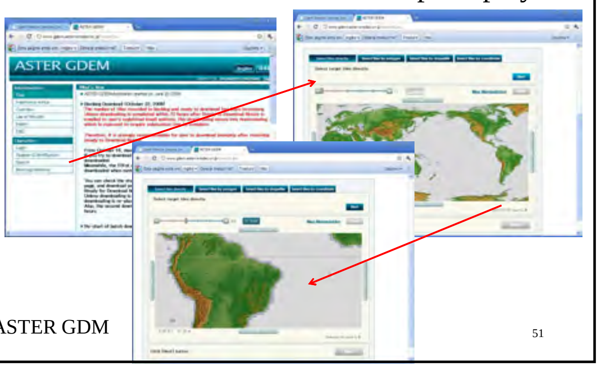
Search Menu and Gridded Map Display



ASTER GDM

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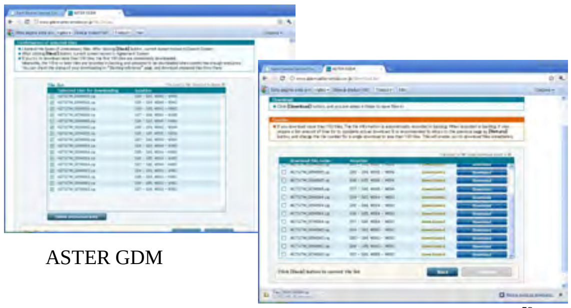
Scene selection and down load



ASTER GDM

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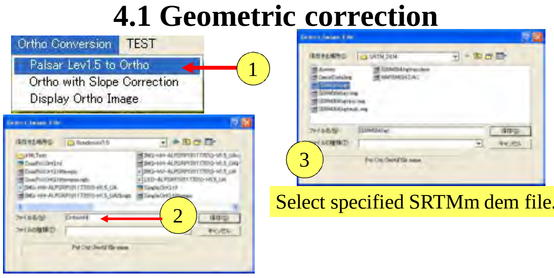
3.7 Geoid Data

http://earth-info.nga.mil/GandG/wgs84/gravitymod/egm96/egm96.html

http://earth-info.nga.mil/GandG/wgs84/gravitymod/egm96/binary/binarygeoid.html

4. Orthographic conversion(1)
4.1 Geometric correction



Select specified SRTMm dem file.

After correcting dem defect, the data can be used to evaluate foreshortening value and correction to orthographic projection point for each pixel. The result will comes up as a GeoTiff file. Currently, this menu item is applicable only to Palsar georeference data (***H1.5_UA, ***H1.5_UD, ***P1.5_UA, ***P1.5_UD).

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4.2 Slope corrected Orthographic conversion(2)

Remaining process flow is the same with the process in the previous pages.

SLOPE correction

In the orthographic conversion process, intensity modificantion has two options as;
1)distortion correction,
2)distortion and intensity correction (Slope Correction).
Due to the dem sampling space is not enough to remove all of slope effect but surface difference depending on the difference of surface condition is easier to recognize in the slope corrected image.

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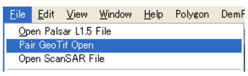
4.3 Ortho image open

•Ortho image can be open to another layer of display image.

•Select file menu “Pair GeoTif Open”, then geo tif ortho image opens.

•To switch original and ortho, press “v” key.



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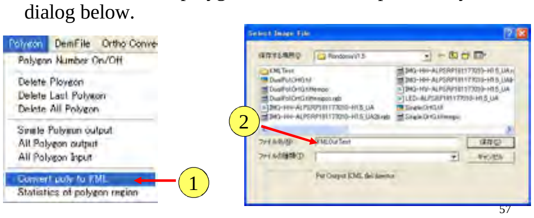
5. Generating KML file

- When you create polygon on SAR image(Ortho image), the polygon can be converted to KML file (polygon) to be displayed on “Google earth or Google map.
- After creating single or multiple polygon on displayed image, select menu “Convert poly to KML”, all polygon will be converted to KML polygon in a KML file specified by dialog below.



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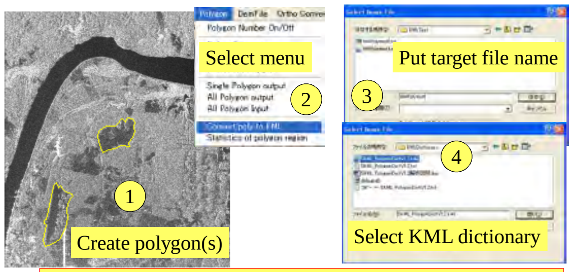
5.1 Generate polygon on SAR image



By following the sequence, a KML file and tif patche(s) will be generated as specified file name

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5.2 Polygon made on Google Earth

By double click the generated KML file, GoogleEarth will start and display created polygon area.

If a Polygon size is too large, tif file may not be created.

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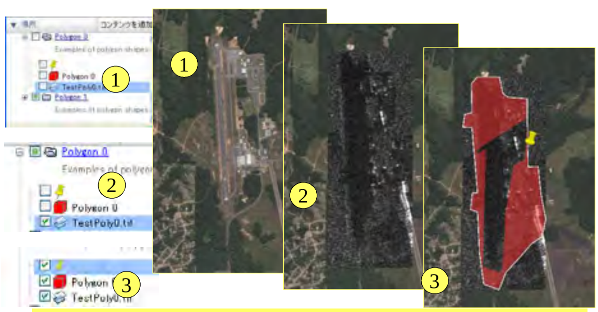
5.3 Google Menu



In the generated kml file, each polygon area is in a polygon folder with polygon number. Clicking the button in the folder items, display will be change

6. Multiple Image Handling

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6.1 Polarization composite

After generating color composite image, orthographic conversion or other menu items work as single image open case.

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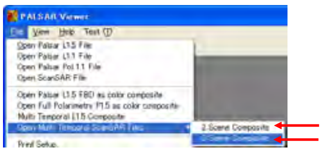
6.2 Multi temporal composite

- Multi temporal composite is supported for PalsarScanmode data only at this moment.



Select menu “2 scene composite” or “3 scene composite”.

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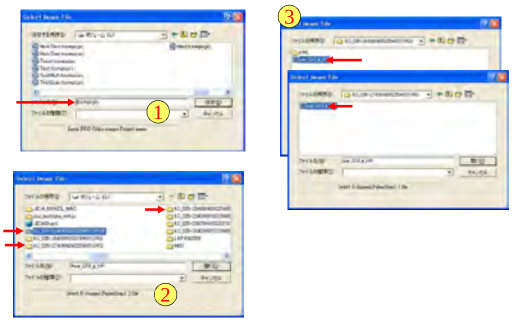
6.3 Process of Multi temporal composite



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7. Basic image interpretation

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7.1 Image interpretation of multi temporal composite image

In a PALSAR image intensity varies from dark to bright depending on the surface condition of target.
In general, flat surface shows dark reflectance. And flat surface is often made by still water or wet surface.
In this context, dark area can be a flat surface or still water covered area and bright area is rough or dry area.

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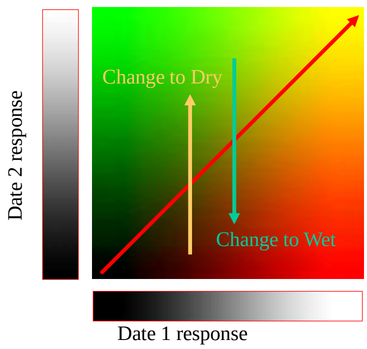
7.2 Two date color composite (Dry Wet interpretation)



Dry and wet interpretation is applicable in marsh land, swamp, rice paddy or flooded area.

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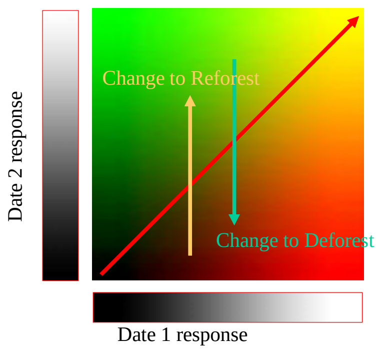
7.3 Two date color composite (Deforest Reforest interpretation)



Flat surface is often caused by tree cut in forest area.
So, dual date composite can be interpreted as deforest or reforest in forest area.

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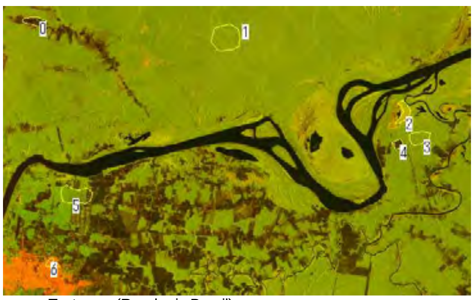
7.4 Image interpretation by dual pol. SAR



Test area (Rondonia Brazil)

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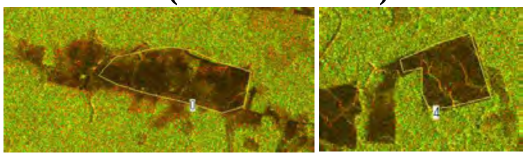
7.5 Statistics of Polygon 0 and 4 (deforested area)



Polygon	HH-s0	HH-stdDev	HV-s0	HV-stdDev	Description
0	−13.124	3.479	−22.101	3.592	deforestation
1	−8.164	2.718	−13.235	2.716	forest
2	−5.579	2.812	−12.307	2.715	grass or low tree
3	−8.427	2.704	−13.52	2.779	forest
4	−13.384	3.342	−21.375	3.165	deforestation
5	−9.726	3.352	−14.767	3.944	forest and load
6	2.778	4.749	−15.692	3.437	city

Sigma naught distribution (in dB)

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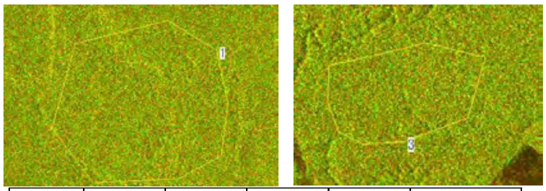
7.6 Polygon 1, 3(forest)



Polygon	HH-s0	HH-stdDev	HV-s0	HV-stdDev	Description
0	−13.124	3.479	−22.101	3.592	deforestation
1	−8.164	2.718	−13.235	2.716	forest
2	−5.579	2.812	−12.307	2.715	grass or low tree
3	−8.427	2.704	−13.52	2.779	forest
4	−13.384	3.342	−21.375	3.165	deforestation
5	−9.726	3.352	−14.767	3.944	forest and load
6	2.778	4.749	−15.692	3.437	city

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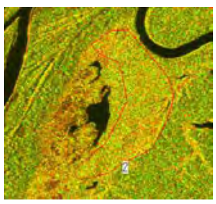
7.7 Polygon 2 (Grass or low tree)



Polygon	HH-s0	HH-stdDev	HV-s0	HV-stdDev	Description
0	−13.124	3.479	−22.101	3.592	deforestation
1	−8.164	2.718	−13.235	2.716	forest
2	−5.579	2.812	−12.307	2.715	grass or low tree
3	−8.427	2.704	−13.52	2.779	forest
4	−13.384	3.342	−21.375	3.165	deforestation
5	−9.726	3.352	−14.767	3.944	forest and load
6	2.778	4.749	−15.692	3.437	city

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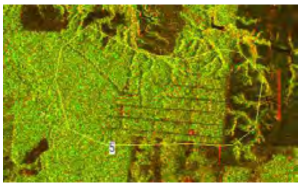
7.8 Polygon 5(forest and access road)



Polygon	HH-s0	HH-stdDev	HV-s0	HV-stdDev	Description
0	-13.124	3.479	-22.101	3.592	deforestation
1	-8.164	2.718	-13.235	2.716	forest
2	-5.579	2.812	-12.307	2.715	grass or low tree
3	-8.427	2.704	-13.52	2.779	forest
4	-13.384	3.342	-21.375	3.165	deforestation
5	-9.726	3.352	-14.767	3.944	forest and load
6	2.778	4.749	-15.692	3.437	city

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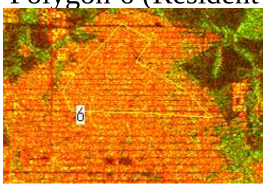
7.9 Polygon 6 (Resident area)



Polygon	HH-s0	HH-stdDev	HV-s0	HV-stdDev	Description
0	-13.124	3.479	-22.101	3.592	deforestation
1	-8.164	2.718	-13.235	2.716	forest
2	-5.579	2.812	-12.307	2.715	grass or low tree
3	-8.427	2.704	-13.52	2.779	forest
4	-13.384	3.342	-21.375	3.165	deforestation
5	-9.726	3.352	-14.767	3.944	forest and load
6	2.778	4.749	-15.692	3.437	city

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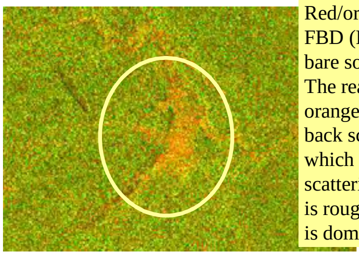
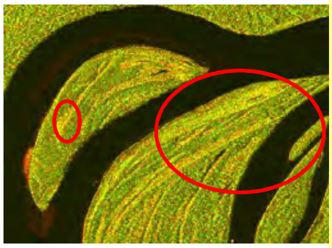
7.10 Red/Orange in a forest



Red/orange area appears in FBD (RG=HH,HV) image, is bare soil or manmade object. The reason is that red to orange means relatively weak back scatter in HV component, which means volume scattering is low. Thus the area is rough but surface reflection is dominant.

75

7.11 Yellow in forest area



Yelllow in FBD(RG=HH,HV) image is low tree or grass land. The reason is that volume scattering exists but the value is low com pared with forest, that means low tree or grass causes weak volume scattering.

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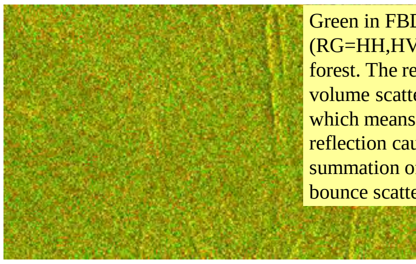
7. 12 Green in FBD image



Green in FBD (RG=HH,HV) image is forest. The reason is that volume scattering is high, which means stronger reflection caused by summation of double bounce scattering by trees.

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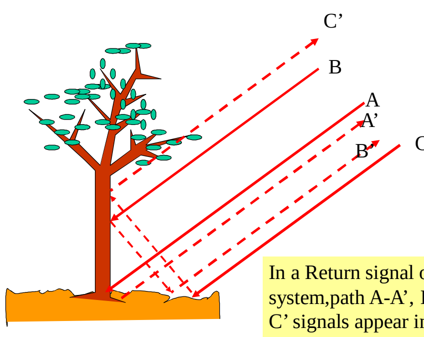
7.13 Reflection by trees

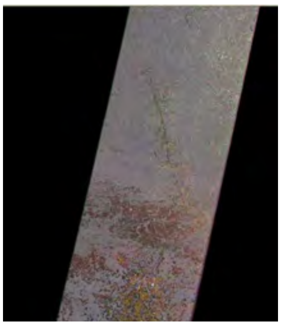


In a Return signal of a SAR system,path A-A’, B-B’, and C-C’ signals appear in the same pixel.

8. Scan SAR data handling

- Currently scansar long strip data is disclosed only for some restricted researchers.
- Other people can not access to the data.

7.1 Index color composite image



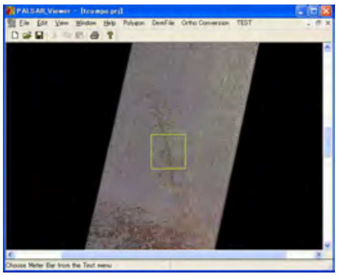
After a while index color composite image appears.

By “holding SHIFT key and click mouse” in the image, a small patch area will be displayed.

7.2 Full scale patch image

This image can be exported as Geotif file (use menu below).

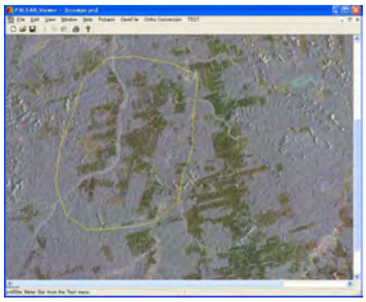
7.3 Frame of full scale image



By pressing “v” key index image and full scale image is switched.
Yellow square in index image is the frame of full scale image. Center of frame is your mouse clicked point.

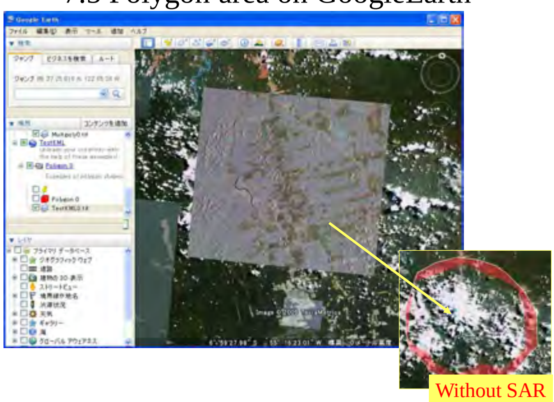
This image can also be exported as the previous page menu.

7.4 Draw polygon

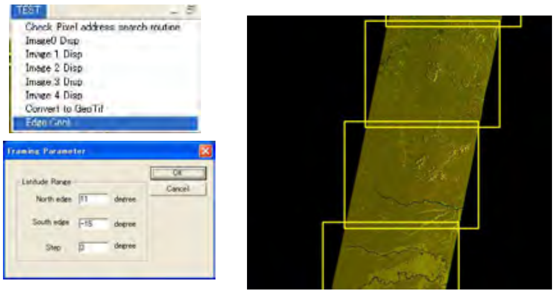


Draw polygons on full scale patch and select menu “Convert poly to KML”.
Then, a KML file with associated tiff file which enclose polygon area will be created.

7.5 Polygon area on GoogleEarth

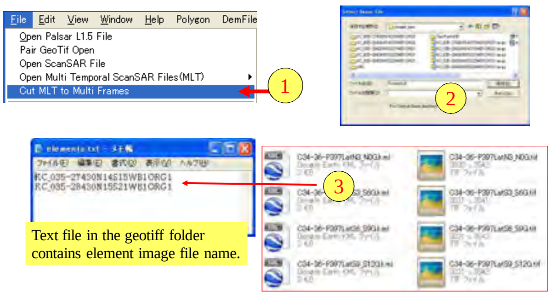


7.6 Framing full path data



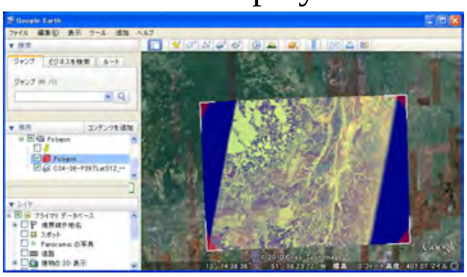
By selecting menu shown above and put parameter in the appeared dialog, frame is generated.

KML and Geotiff out of frames



Framed region is processed to be geotiff files as shown above.

KML display



If you click a kml file icon as shown in the previous page, Google Earth will start and display frame of the tif image and image itself.

May 3rd, 2007

Manual of Pan Sharpen Software

ALOS AVNIR2 and PRISM

M. Ono
Remote Sensing Technology Center of Japan

1

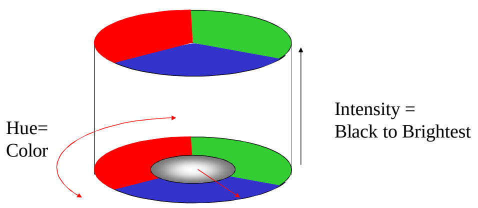
Principle

- This Pan Sharpen Program works on ALOS PRISM and AVNIR2 images taken simultaneously to observe same area on the Earth.
- Principle is HIS conversion technique to sharpen AVNIR2 color image by PRISM panchromatic image
- Basic of the process is shown in the next page.

2

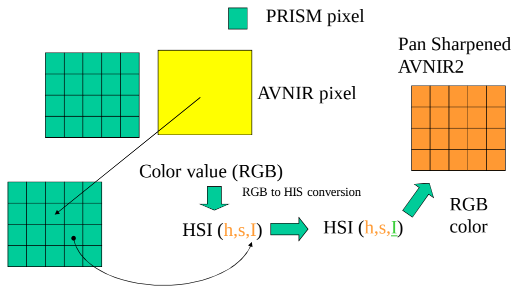
RGB to HIS conversion

Every RGB color value can be converted to a HIS value



3

Pan Sharpen

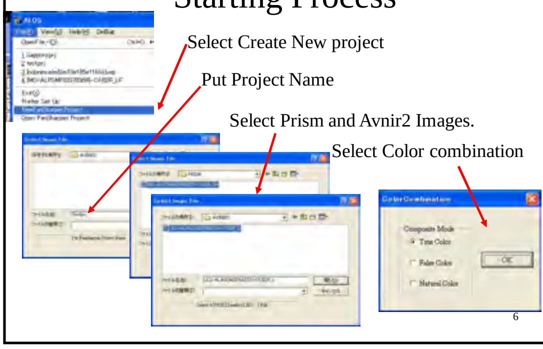


4

Opening Program

5

Starting Process



6

Key Assignment and mouse click

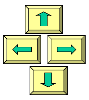
- V key: change displayed image
- Arrow Key: move AVNIR2 image in the frame
- Hold C and click: Cross Mark at clicked point
- A mouse click activates clicked point regardless of holding “c” key or not.

7

Use of Arrow Key

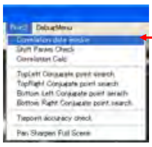
Avnir2 image can move in the display frame while Prism image is fixed in the frame. This function is used to make conjugate point in two images be close.
To move Avnir2 image, click arrow key to any direction.
By a click, image is one pixel displaced to arrow direction.

By holding Ctrl key and arrow key click, 50 pixel displacement occurs.



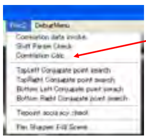
8

Conjugate Point Search



At first select this menu

Find conjugate point from neighbor area.



Before select the menu item, check target point in Avnir2 image is close to reference point IN Prism IMAGE.

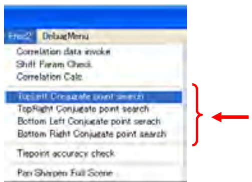
9

Locking to master pixel

10

4 Corner conjugate point search

- Find conjugate point near the Top Left, Top Right, Bottom Left and Bottom Right by selecting menu items shown below.
- Corner location is not so strict. If some corner is cloud or sea, nearest land are may be in place.



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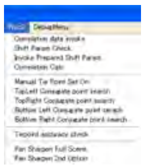
Check Data

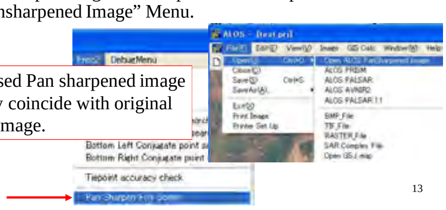
After 4 corner search and lock process preformed, the data
Will be monitored form menu “Shift parm check. Check whether the Dx and Dy is close for 4 corners within the order of several pixels (unit of Dx and Dy is pixel).
In “Manual Tie Point Set On” mode (explained in later pages), Dx and Dy are integer numbers.



12

Final Process

- Select menu "Pan Sharpen Full Scene".
- Out put is RGB file (BIP) to specified name and folder.
- File size to about 700MB, ALOS viewer is not supprting the file but in the next training the viewer will support to see the image.
- The output image can be opened from "Open ALOS Pansharpened Image" Menu.



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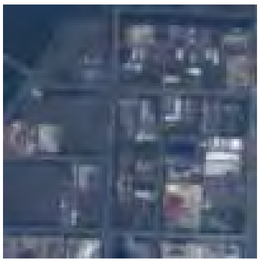
Process Output


AVNIR2


Pan Sharpened

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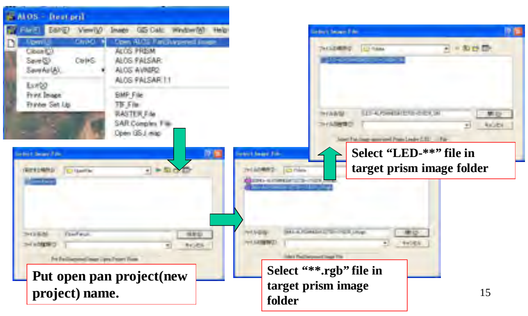
Open Pan Sharpened Image



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Open Pan Sharpened Image

- In the initial display, image is an index image with the size of 1/4 of final Pan Sharpened image due to the too large file size of processed image.
- Click a point in the image by holding "SHIFT" key. Then full scale image of clicked area will be displayed.
- Press "v" key to go back to index image

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In Case of Bad Locking(1)

- If the conjugate point search and lock does not work adequately, you must prepare conjugate point list manually.
- In the case select Menu "Manual Tie Point Set On".
- After the menu selection the item is checked(see below right).
- To escape the check, select the item again.

Go to next page

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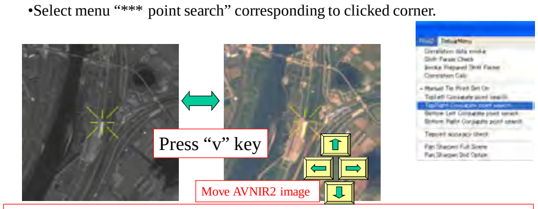
In Case of Bad Locking(2)

•Click one of near 4 corners in the image.
•Move AVNIR2 image by Arrow key so that Prism image and AVNIR2 image coincide at the clicked point (marking by "c" key and click is good way to identify clicked point).
•Select menu "*** point search" corresponding to clicked corner.



When Prism and AVNIR2 image coincide at a marked point, Image motion by pressing "v" key is less than one pixel.
If remaining sub pixel level displacement exist, slight motion remains by pressing "v" key after conjugate matching. Choose smaller motion position for AVNIR2 image position.

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GeometricAccuracy

- In the current “PanSharpenProcessor”, Pixel address of pansharpened image is the same with the original PRISM pixel address which provide Intensity information for the processed color pixel.
- Oweing to the arrangements, geometric accuracy is exactly that of original PRISM.

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PRISM Position Accuracy

1) Absolute Accuracy
The evaluations were carried out about 1,390 GCPs (64 image scenes) for each radiometer.

	Pixel direction (cross track)	Line direction (along track)	Distance
Nadir view (RMS)	6.5 m	7.3 m	9.8 m
Forward view (RMS)	8.0 m	14.7 m	16.7 m
Backward view (RMS)	7.4 m	16.6 m	18.1 m

* Evaluation method: Compared with the GPS measured geolocation of GCPs after projected onto the GRS 80 in correcting the height.

2) Relative Accuracy

	Pixel direction (cross track)	Line direction (along track)	Distance
Std. dev. in a scene(1σ)	1.9 m	2.3 m	3.0 m

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Cross Track Geometrical Distortion

- In the satellite image mapping system using optical camera, instantaneous view point is calculated from,
  a)Satellite Orbit Position,
  b)Satllite (Camera) attitude, and
  c)Earth model.
- Orbit position and satellite attitude are well calibrated to keep necessary earth surface pointing accuracy.
- Earth model is rotated ellipsoidal model (WGS84) and ground surface height is not considered.
- If there are some height object, mapping position will be distorted.

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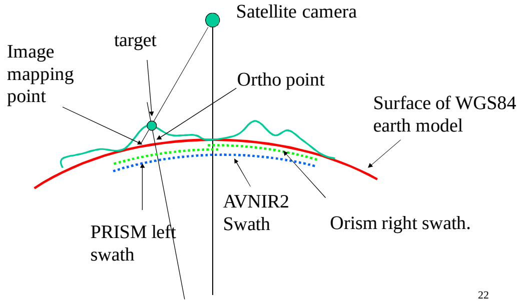
Cross Track Geometrical Distortion



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Cross Track Geometrical Distortion

- The distortion is strong as the pointing angle increases from nadir direction.
- In the case of ALOS, both PRISM and AVNIR2 has same distortion value.
- So, in the Pan Sharpen process image coregistration is exactly kept every where in a image scene even if target area has high mountains.

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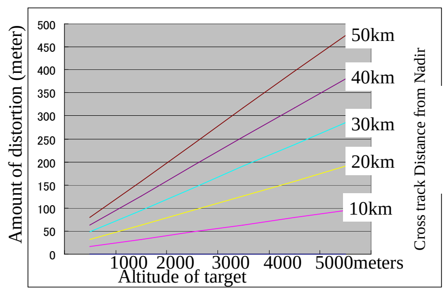
Distortion Value Evaluation for ALOS



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Jan. 5, 2009

Revision 1.0

Manual of Prism DEM

Version 4.0

M. Ono
Remote Sensing Technology Center
Of Japan

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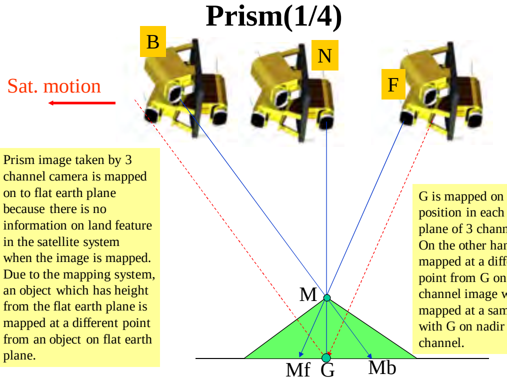
Preface

What is New in the version 3.0

- Version 4.0 is fully revised to enhance accuracy, speed and user friendly operation.
- Output results spans from normal dem to orthographically projected dem and associated orthographic nadir image.
- All data is GEOTIFF to be easily export to general GIS software.

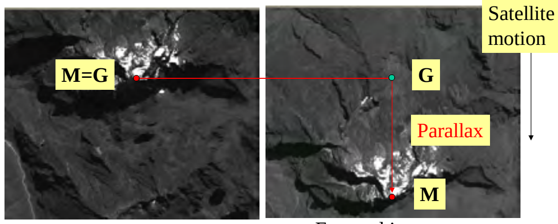
1. Principle of Dem extraction by Prism(1/4)



Prism image taken by 3 channel camera is mapped on to flat earth plane because there is no information on land feature in the satellite system when the image is mapped. Due to the mapping system, an object which has height from the flat earth plane is mapped at a different point from an object on flat earth plane.

G is mapped on the same position in each image plane of 3 channel camera. On the other hands, M is mapped at a different point from G on oblique channel image while it is mapped at a same point with G on nadir looking channel.

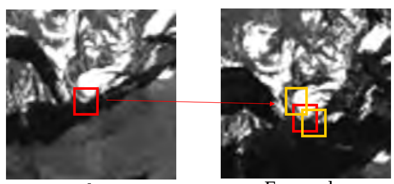
Principle of Dem extraction by Prism(2/4)



Nadir image Forward image

In the nadir image mapping position is not shifted in satellite image motion direction. On the other hands, high position is mapped to shift in satellite motion direction. Position of G (zero height point) is calculated from pixel address to latitude and longitude conversion table and inverse table provided in Leader file of Prism data.(**Paddressnadir->Lat/Long->Paddressoblique**).

Principle of Dem extraction by Prism(3/4)



Nadir Forward

In this Dem evaluation system, conjugate point of a nadir image pixel must be searched and evaluated on Oblique channel image.
Evaluation method of conjugate is to calculate correlation factor of squared area put on oblique image and find maximum correlation point in the search.

Principle of Dem extraction by Prism(4/4)-conjugate point evaluation

A small window N by M pixels in nadir image (center pix address= I,J)

A small window N by M pixels in nadir image (center pix address= K,L)

Position of maximum correlation is recognized as conjugate point.
Sub pixel size accuracy is achieved by the evaluation.

$$\mathrm{Correlation}(dx,dy) = \frac{\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}(A_{ij}-Av)*(B_{kl}-Bv)}{\sqrt{\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}(A_{ij}-Av)*(A_{ij}-Av)}\ \sqrt{\sum_{i=0}^{N-1}\sum_{j=0}^{M-1}(B_{kl}-Bv)*(B_{kl}-Bv)}}$$

(Av, Bv is average of pixel value in the small windows).

(k=i+dx, l=j+dy), dx and dy is center position difference between nadir image and oblique image.

7

Geometric Accuracy of Prism 1B2 (JAXA data)

1) Absolute Accuracy

The evaluations were carried out about 1,390 GCPs (64 image scenes) for each radiometer.

	Pixel direction (cross track)	Line direction (along track)	Distance
Nadir view (RMS)	6.5 m	7.3 m	9.8 m
Forward view (RMS)	8.0 m	14.7 m	16.7 m
Backward view (RMS)	7.4 m	16.6 m	18.1 m

* Evaluation method: Compared with the GPS measured geolocation of GCPs after projected onto the GRS 80 in correcting the height.

2) Relative Accuracy

	Pixel direction (cross track)	Line direction (along track)	Distance
Std. dev. in a scene(1σ)	1.9 m	2.3 m	3.0 m

This means relative dem is very accurate and bias component should be calibrated.

2. Program for DEM extraction
2.1 Overall function of the program

- The version 3 of the program is improved in processing and repair operation as follows;

(1) Support multi- regional mask operation,
(2) Abolition of seed propagation,
(3) Introduction of Median filter.
(4) Check shadow area by nadir-oblique channel comparison.
(5) Check DEM by comparison of pair project (comparison between Nadir-Back and Nadir-Forward pair results).
(6) Error indication using coherence in tie oint search.
(7) Additional pen tool to erase error point.

By the modification processing and repair time is drastically reduced.

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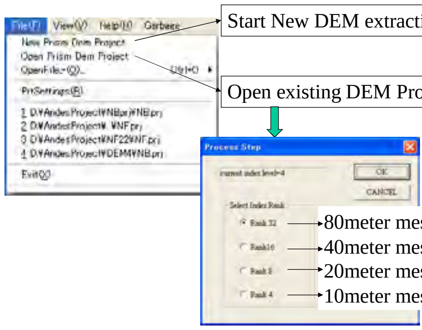
2.2 Program Menu Items (1/7)

File Menu



Start New DEM extraction Project

Open existing DEM Project

80meter mesh DEM
40meter mesh
20meter mesh
10meter mesh

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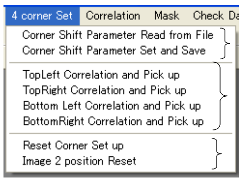
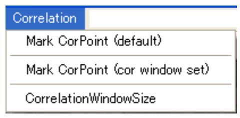
Program Menu Items (2/7)



4corner shift parameter Load / Save

4 corner conjugate point set

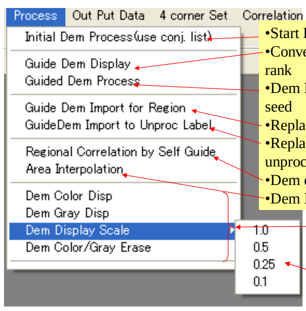
Corner parameter reset/ displacement reset



Single point correlation and correlation window parameter

11

Program Menu Items (3/7)



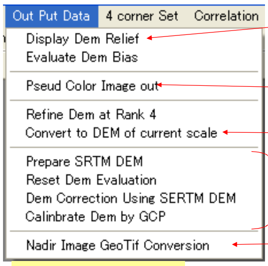
•Start First process in rank 32 image
•Convert lower rank image data into current rank
•Dem Process using lower rank image data as seed
•Replace current data by Guide Dem value
•Replace current data by Guide Dem for unprocessed label area
•Dem extraction in limited Polygon
•Dem Interpolation in limited Polygon

Dem Display

Color scale factor

12

Program Menu Items (4/7)



Currently Dispabled

•Pseudo color image of Prism

•Final DEM out put in current scale(GeoTif)

SRTM data handling

•Nadir Image out as GeoTif

Note:DEM space
Rank 32: 80m
Rank 16: 40m
Rank 8: 20m
Rank 4: 10m

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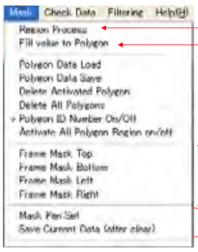
Program Menu Items (5/7)



•Operation in polygon
•Direct draw in polygon

•Polygon definition and activation

•Framing of scene edges

•Erase Dot-Pen radius set

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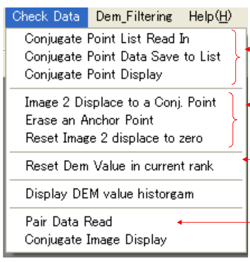
Program Menu Items (6/7)



•Conjugate point save and load/display

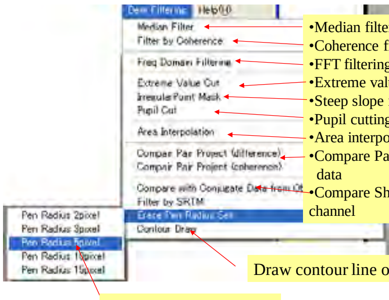
•Conjugate point edit

•Reset current rank data

•Pair Project data Read in

15

Program Menu Items (7/7)



•Median filter
•Coherence filter
•FFT filtering
•Extreme value cut
•Steep slope mark
•Pupil cutting
•Area interpolation
•Compare Pair Project data and erase error data
•Compare Shadow of Nadir and Oblique channel

Draw contour line o Dem Image

Erase pen Radius set

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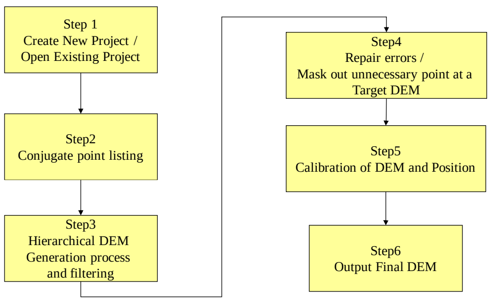
2.3 DEM Extraction Process Flow

The process flow of one pair DEM extraction.



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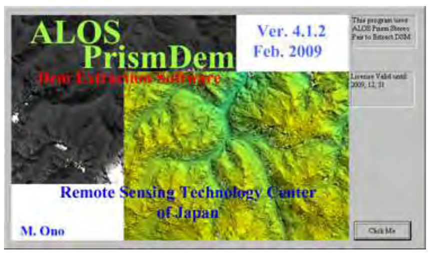
3. Using Dem Program
3.1 Opening Window

When you click "PrismDEMv4.1.2.exe" Icon, opening window appears as below. Click "Click Me" button to proceed.



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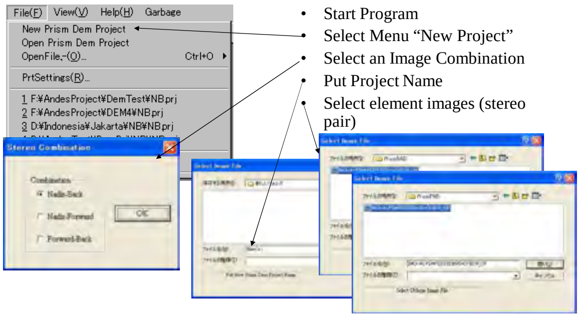
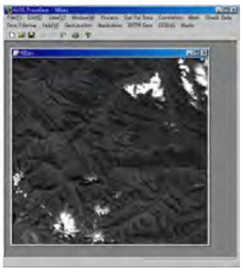
3.2 New Project / Open Project

To start new DEM project, follow the illustrated steps.
To open a project, just select a existing project name.



- Start Program
- Select Menu “New Project”
- Select an Image Combination
- Put Project Name
- Select element images (stereo pair)

Initial Image in a Opened Project



Displayed image is a reduced size image of the 1/32 scale of original image. Pixel size of reduced size image is 80m by 80m.

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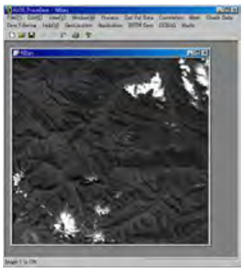
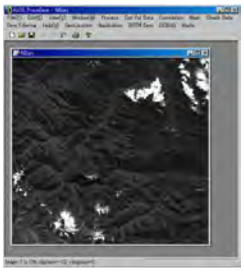
Switching Image and Slave Image

By pressing “v” key, master and slave image is switched.





Oblique channel image(slave image) is rotated so that parallax due to height altitude occurs exactly on vertical line of nadir image (master image).

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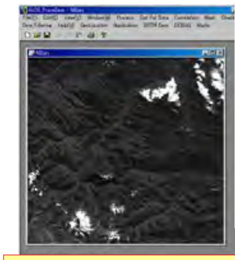
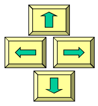
Moving Slave Image(1/2)



Slave image can move in the display frame while master image is fixed in the frame. This function is used to make conjugate point in two images be close.
To move slave image, click arrow key to any direction one pixel displacement.
By a click, image is one pixel displaced to arrow direction.

By holding Ctrl key and clicking arrow key, 50 pixel displacement occurs.
By holding Shift key and and clicking arrow key, 10 pixel displacement occurs.



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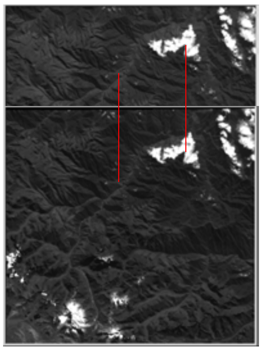
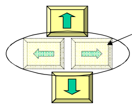
Moving Slave Image(2/2)



In the initial opening stage, Master image and slave image position is adjusted so that horizontal position of slave image is exactly same with master position.
By this adjustment, parallax due to land elevation occurs only towards vertical direction.
You don’t need to move horizontal direction to overlay a slave image point on the conjugate point on master image.
Just move vertically.



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On rank4 image

3.5 Anchoring Conjugate Points

- Anchor many conjugate point in the rank 4 image will speed up following process.
- In the New Project or Opening Project with rank 4, you can set anchors
- Click arbitrary point on land area to show red square frame in image 1 display.
- Switch to image 2 and move the image so that same point in image one come to the red square frame and select Menu “Mark CorPoint”. The image 2 show small motion.
- Confirm no significant motion in the frame when you switch the images by pressing “v” key.

If lock of target point is confirmed, press “**s**” key to save the data.
(see next page)

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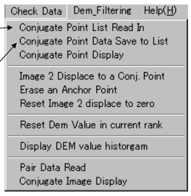
Anchor Points

Call back saved conjugate point list from file.

After setting anchors, save the data to file.

When you select Menu “Conjugate Point Display”, marked points are displayed in red X. Water color X is corner mark



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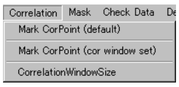
Anchor Points



To obtain good quality dem in the first stage (Rank 32), setting many conjugate point as anchor point of processing is necessary.

(1) To click mouse at a point in master image and move corresponding point in slave image close to the first image and

(2) Select Mark CorPoint. Slave point will automatically pulled to master point.

(3) If conjugate point is correctly stick to the master point, the point must be stable for the image switch by pressing “v” key.

(4) Save the conjugate point data into file by pressing “s” key.

(5) If it is not the case try to enlarge correlation window from Correlation window size menu.

Due to the hierarchical approach of DEM extraction process, initial anchor points number is enough to set around 5-10 points.Upper limit of anchor points number is 255.

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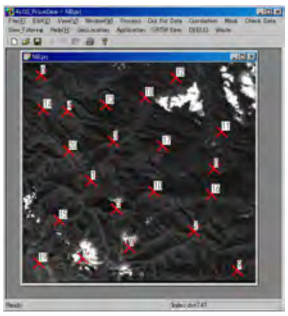
Processed Anchor Points



•When you press “s” key conjugate points data are saved to file automatically.

•You can start initial dem process immediately.

•This conjugate point data can be reload if you stop the program and start again at rank 32.

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Step2
Cloud, Sea Mask & other masks by Polygon, Conjugate point listing

Check Anchor Point

•Checking anchor point location can be done from menu “Image 2 Displace to Conj. Point” and put anchor point ID in appeared dialog.

•Slave image displacement will be adjusted to the anchor information. Check displacement at set anchor ID by pressing “v” key. If the anchoring is adequate, slave image pixel will be still at the anchor point.

•If the point is not still, erase the point (see next page to erase data).

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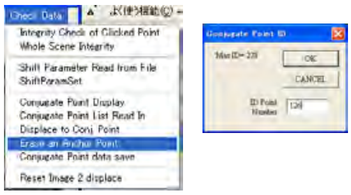
Step2
Cloud, Sea Mask & other masks by Polygon, Conjugate point listing

Erase Bad Anchor Points

- To erase bad anchor point, select menu “Erase an anchor point” and put anchor ID in the appeared dialog.



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4. Dem Extraction Process

Dem extraction consists of two part, that is Dem extraction by window matching and repair/calibration process.
In this program, latter part relies on SRTM dem. But SRTM dem has errors due to the shadow of radar wave.
In this program, SRTM error correction function is implemented.

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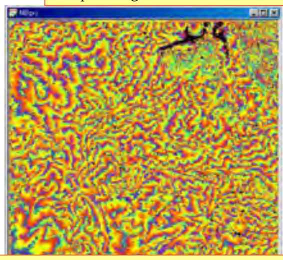
Initial Processing

After selecting the menu item process start providing result as shown below.



After making many conjugate point as seeds of dem extraction, initial process is to start "Initial Dem Process" menu.

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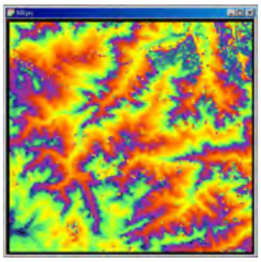
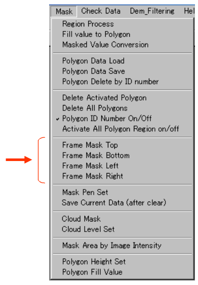
Masking 4 edges





To avoid bad interpolation work in edge area, mask 4 edges several pixels at rank 32 dem.

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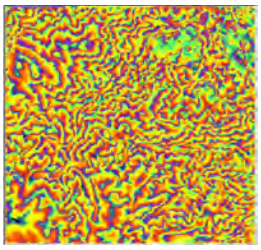
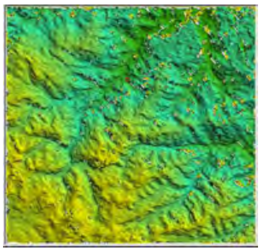
Dem Display Options(1/2)

Repeated color scale/gray scale



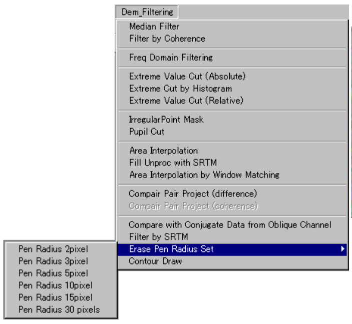
Shadow Dem display

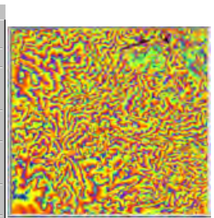


Apply median filter several times so that displayed dem become smooth.
You can check the result by shadow dem style.

32

Filtering Menu





Apply Median filter.

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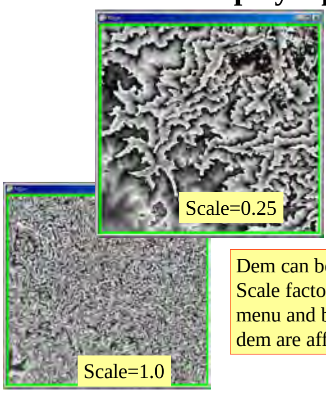
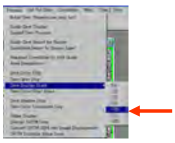
Dem Display Options(2/2)





Dem can be displayed as gray scale. Scale factor can be modified from file menu and both color dem and gray scale dem are affected by the modification.

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Median Filter

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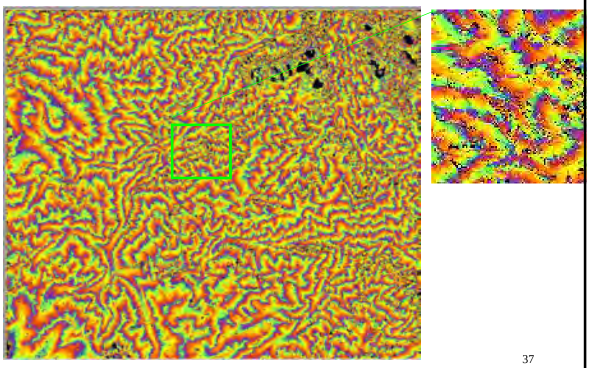
Move to Next Rank



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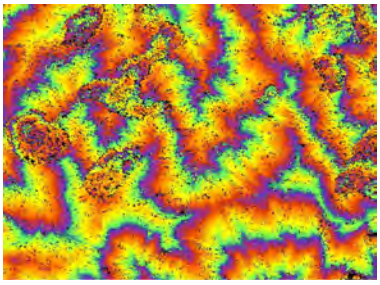
End of Rank 4 Dem process



At the end of rank 4 processing, output becomes as shown above.
Black dot is noise which must be eliminated by median filter.

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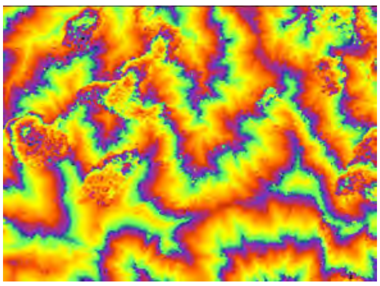
Apply median filter twice



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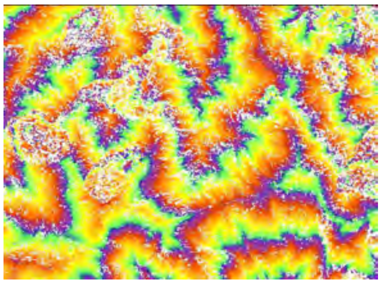
Apply Coherence filter



Coherence=0.65

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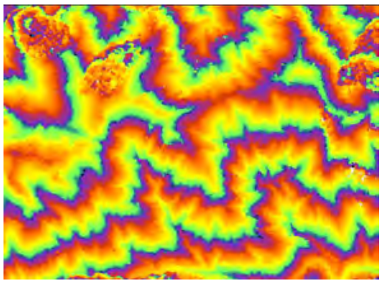
Median filter



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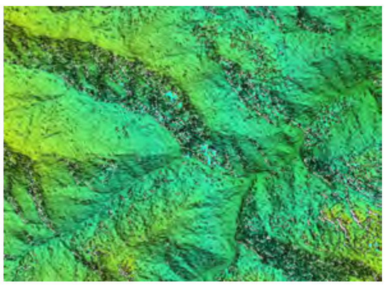
Shadow Display



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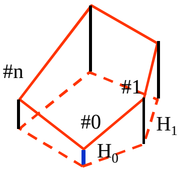
Erase Bad Dem Area and Reprocess



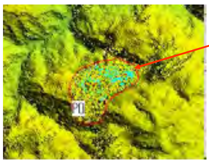
•To repair bad dem area more precisely, a polygon correction tool is prepared.

•Basic idea is to create polygon closely surrounding bad dem area and specify dem value at polygon vertex interactively.

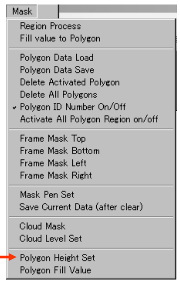
•Then calculate dem value in the polygon by interpolation using vertex dem value.

• Recalculate the dem in the polygon region by window correltion using interpolation dem value as seed.

Define Polygon and Activate



1. Create a polygon to surround bad dem area closely and activate it.



2. Select menu to activate polygon process mode

Level Sliced Masking

- Hold both **"Shift" key and "e" key**, then click mouse at a lake or sea area.
- Connected area with mouse clicked point and level with mouse clicked point with some allowance will be erased.
- Repeat this at lake/sea side close to shore area then lake/sea area will be erased without eroding shore part.
- Convert to arbitral default or interpolate or fill in specific value.

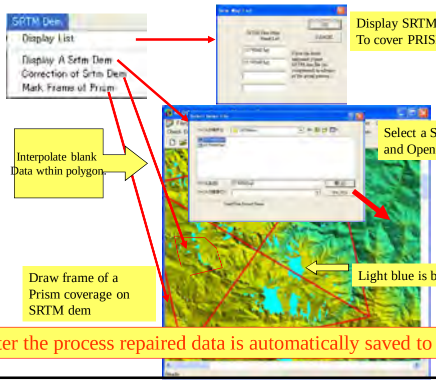
Statistical masking

- In a flat area like watershed or swamp, some extreme value appears due to false conjugate point lock on.
- Such bad data cab be eliminated by eliminating statistical extreme values.
- In advance of the process first apply absolute extreme cut by putting high valute to 10000(meters) and low value -500(meters) to avoid effect by non-numeric error happens in the conjugate point search process.
- Then apply "statistical extreme cut" and area interpolation.

Large Area Masking

- Large Area can be masked either by polygon and fill value or erase pen tool.
- Erased pixels can be converted to various default values.

4.1 Preparation and Repair SRTM Dem (1/2)



After the process repaired data is automatically saved to file.

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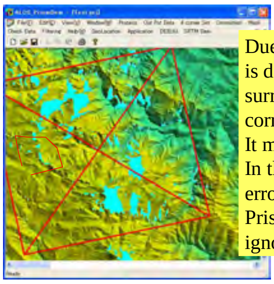
Preparation and Repair SRTM Dem 2/2)



Due to that blank dem correction is done by interpolation using surrounding values, wide area correction is not recommended. It must be remain as is.
In the use of SRTM DEM for error correction of processed Prism dem, blank of SRTM is ignored (not used).

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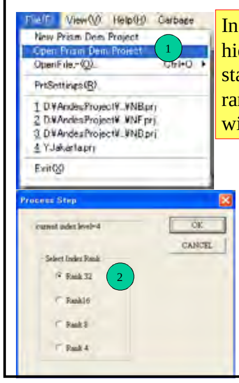
4.2 Hierarchical Dem Extraction Process



In this program, dem extraction process is a hierarchical approach, where intial process starts with rank 32 and step by step increase rank. Final rank is 4 where 10 m space dem will be created

1. Select menu and start project.
2. Select rank 32 at first stage.

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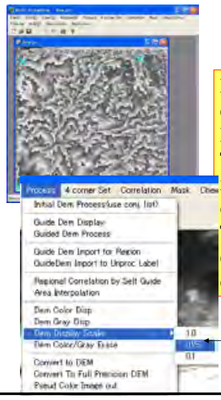
Process end at rank32(Andes)



Left image is a gray scale (module) display of DEM as the result of initial DEM extraction process.
This expression is similar to SAR interferogram and in this case you can change height sensitivity from menu.
This expression is ambiguous in dem expression but is good for detail check of cloud masking.

Gray Dem to height sensitivity

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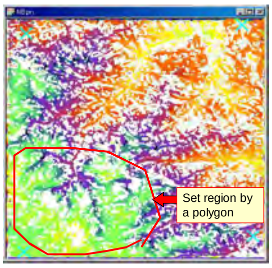
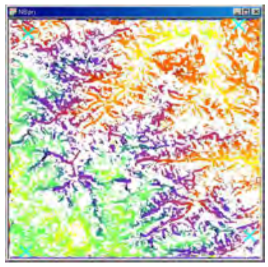


Apply region limitted pupil cut to eliminate irreglar point in cut out area.



Apply more strict coherence value(0.9).

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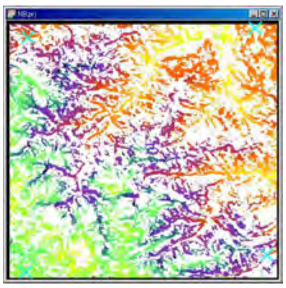
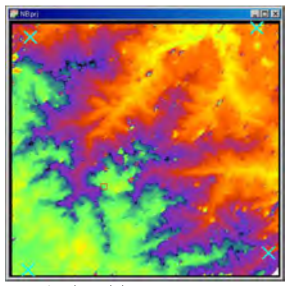


Set frame to eliminate un processed area.



Area interpolation.

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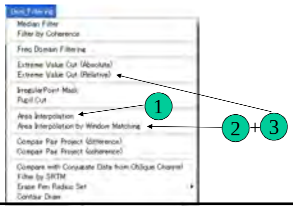
Options for Area Interpolation

- There are two different area interpolation method.
- First one is traditional area interpolation using neighboring values. Usually you can use this interpolation method. 1
- The second one is to conduct small window matching technoque as initial dem process or guided dem porcess but modify correlation window size and scan range. In case area interpolation causes unrealistic dem, use this imterpolation and extreme cut(relative). 2+3



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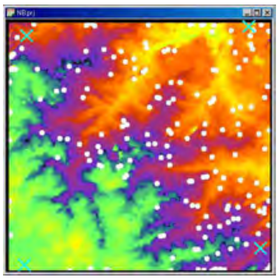
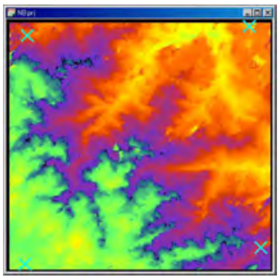


Apply erase pen (r=5pix), erase speckle, and set frame again.



End of 1st process (Rank 32). Close to proceed next Rank.

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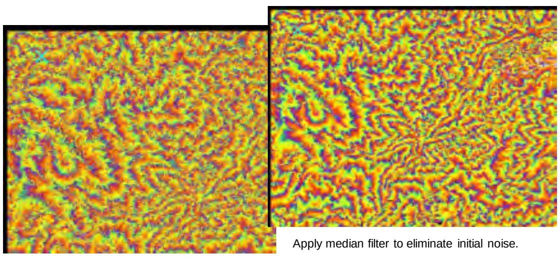

Initial result of Rank 16 (Guided dem process. Part of data.). Noise is dominant.

Apply median filter to eliminate initial noise.

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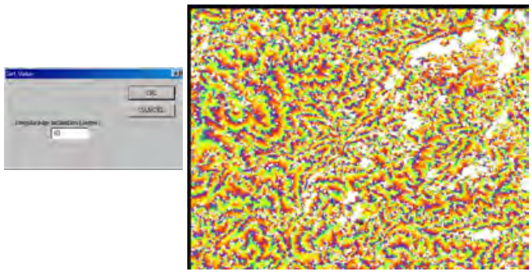

Apply steep slope to eliminate spike noise in dem data and pupil cut.

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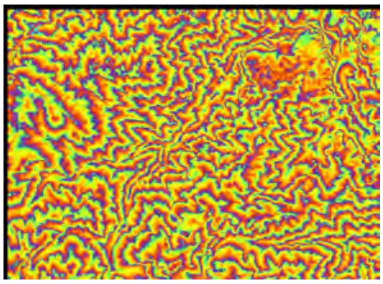
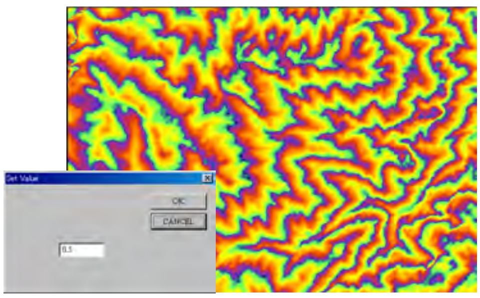


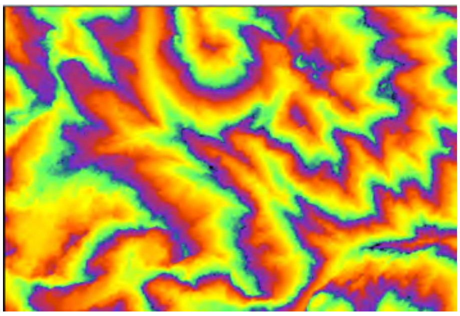
Apply Irregular point mark (inc. limit=75 degree) and frame mask again and area interpolation. End of Rank 16 process.

59



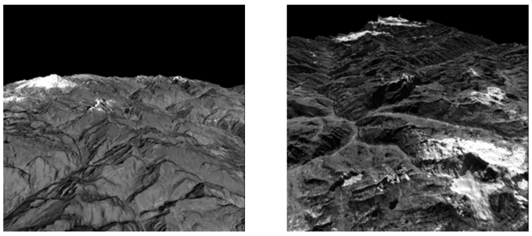
At Rank 8, after running guided dem process, apply Extreme Value Cut (Relative) and set value to 0.5. and area interpolation. After this apply median filter again.

60



At rank 4, after running Guided Dem Process with restricted scan parameter (wx=wy=5,sx=2,sy=5), apply Extreme cut (relative) with parameter 0.5, Coherence filter with 0.75, and median filter once. Above result will appear.

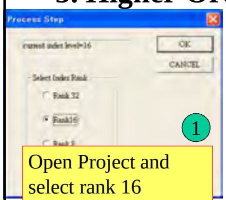
61

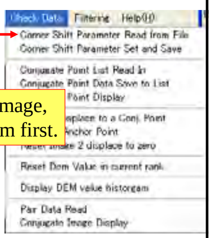


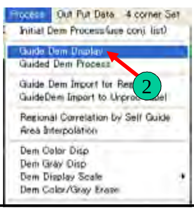
3D display of Prism with extracted Dem. (Dem is from Rank 8 =20m spacing)

62

5. Higher Order Rank Process







1. Open Project and select rank 16

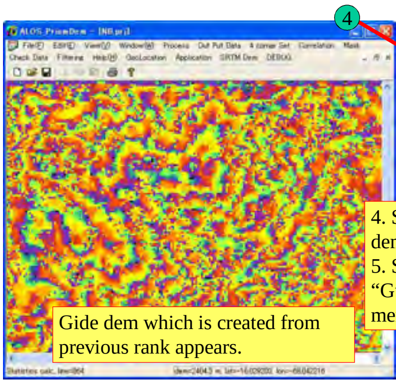
2.

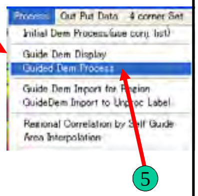
3. After Opening the image, Select this menu item first.

Different from Rank 32, from Rank 16 to rank 4 is processed using guide dem which is made from lower rank.

63

5.1 Process at Rank 16





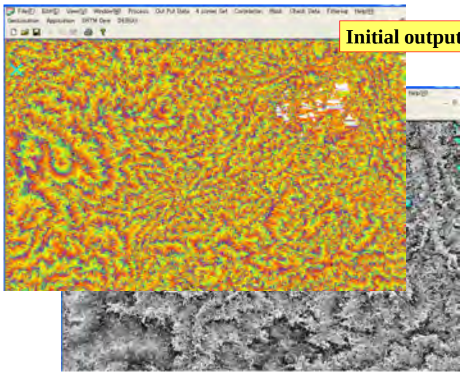
4. Select menu and guide dem will appear.
5. Start dem process by "Guided dem process" menu.

Gide dem which is created from previous rank appears.

64

Result of processing at Rank 16

Initial output is a bit noisy.



65

5.2 Process at rank 8 and rank 4

Process at rank 8 and rank4, which must be conducted successively, is the same with the case of rank 16 except opening rank selection.

Every time when you open the dem image from process menu,

1. apply slope check and
2. erase pupil in the cut image by erase pen tool, then
3. Apply area interpolation.
4. Then apply coherence fileter, then
5. Set 4 corner Frame, then
6. Apply Area Interpolation.

66

5.3 Error Correction Overview

- Initial error correction must be done by filtering by coherence value.
- Following step for error correction is as follows.
- Current approach of DEM processing is hierarchical approach starting from low resolution image and enhance accuracy by higher resolution images. In the process various error occurs which must be corrected in this repair process.
- There are several error sources which damage the extracted DEM accuracy.
- The error source in this process is as follows;
  1) Seed position error (start point error)
  2) low intensity of the source image or saturation of image (low correlation factor)
  3) image pattern ambiguity
- These errors can be eliminated either by recalculating conjugate point starting from more reliable seed data or by a simple interpolation using neighboring DEM values.

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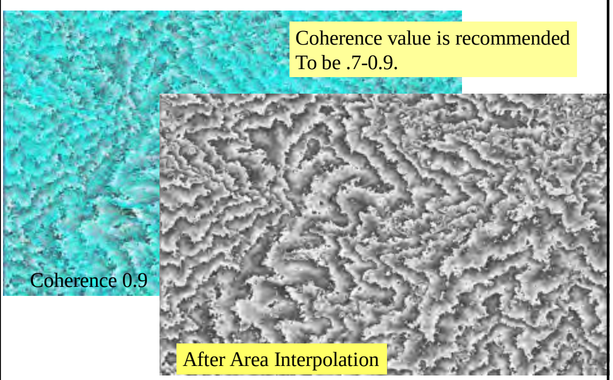
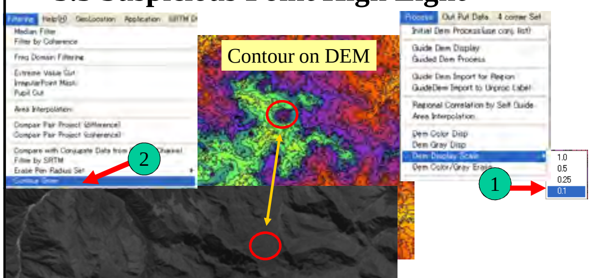
5.4 Filter by coherence



68

5.5 Suspicious Point High Light

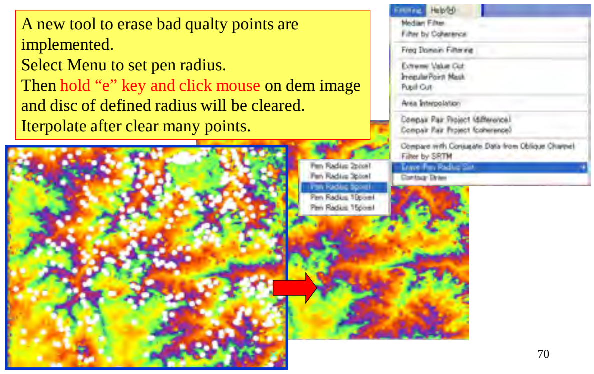


- Display Dem at low scale (0.1 or 0.25) and Select Menu "Contour Draw".
- High dense contour in a moderate slope area is suspicious peak or hollow in the processed Dem.
- Erase the area by erase pen tool (page 53) and interpolate.
- To Erase the countour line, select menu "Dem Color Disp" or "Dem Gray Disp".

69

5.6 Noise Cut Tools
5.6.1 Erase Pen

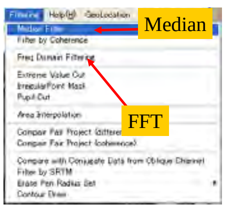
A new tool to erase bad qualty points are implemented.
Select Menu to set pen radius.
Then hold "e" key and click mouse on dem image and disc of defined radius will be cleared.
Iterpolate after clear many points.



70

Step4
Repair errors / Mask out at a Target DEM

5.6.2 Median Filter



You can apply "Median filter" in filter menu either in polygons you create or whole scene.
The results of the filter is smoothing DEM without spike noises.

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5.6.3 Other noise elimination functions

- Eliminate apparent suspicious values
- Suspicious values are;
  1) Extreme values or unrealistic values
  (DEM value less than 0 m or higher than 7000m in Andes mountain area)
  2) Extreme value cut (Relative) This works to cut local spikes effectively by comparing FFT filtered value with original. Parameter is displacement pixel value (0.1-0.5 is almost adequate value).
  3) Steep slope with the inclination exceeding slope inclination in degree.
- These steps must be carried out at every rank process so that error transfer to the higher rank must be reduced as much as possible. But to reduce total processing time where repair process is most significant element some error can be allowed so that in the final process (highest rank process) the error will be corrected.

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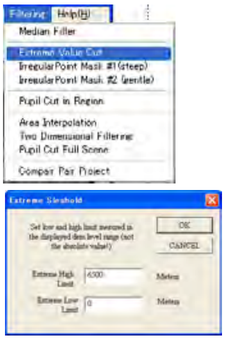
5.6.4 Extreme value cut



This process is used to cut out extreme values either in a polygon Region(s) or full scene.
After select menu a dialog to specify extreme will be appear.
Set extreme high limit inconsideration of scene land feature.
Default high is 9000m and low is -500~0.

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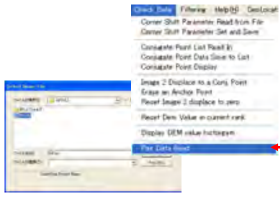
Repair DEM for Triplet Image case(1/3)

In case that you have triplet data (Nadir,Forward, backward) and processed DEM for Nadir-Forward, Nadir-Backward pair at rank32, you can compare data by selecting menu "Pair Data Read" and select pair project file.

Original image



Select Menu and select pair project

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5.7 Calibration and Correction by SRTM DEM(1/2)

- Shuttle Radar Topographic Mission(SRTM) provide us a good reference of DEM covering most of low latitude to middle latitude areas.
- But this DEM is 90m spacing which is not sufficient to replace the PRISM DEM.
- Still SRTM DEM is good for calibrating bias value of DEM extracted by "Prism DEM" program.
- Also extreme dem value which happens in the "Prism DEM" program can be cut out using SRTM DEM.

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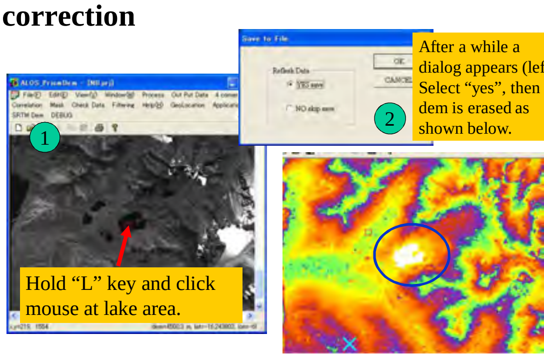
5.8 Lake, Cloud, Shadow Mask and correction



After a while a dialog appears (left). Select "yes", then dem is erased as shown below.

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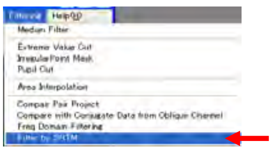
Calibration and Repair by SRTM DEM(2/2)



By applying the menu item indicated left, extreme deviated point will be masked to be "unprocessed".

After this apply "Area Interpolation".

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5.9 Snow Covered Area Correction

- Snow covered area is almost saturated but some bare rocks or other object is recognized where DEM is extracted reasonably.
- The saturated area is processed to evaluate DEM by interpolation using surrounding DEM values. This is only one possible estimation of DEM for saturated area.

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Snow Covered Area Recovery (actual process 1/3)

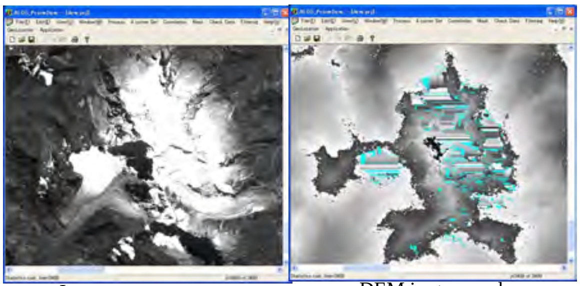

Image DEM in gray scale

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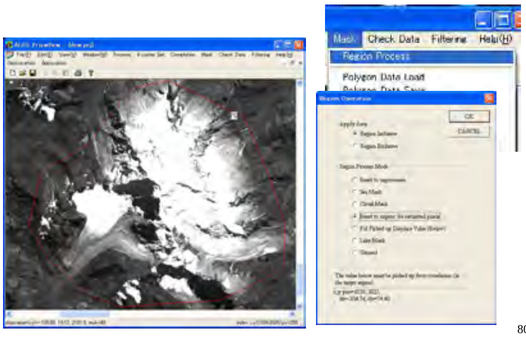
Snow Covered Area Recovery (actual process 2/3)



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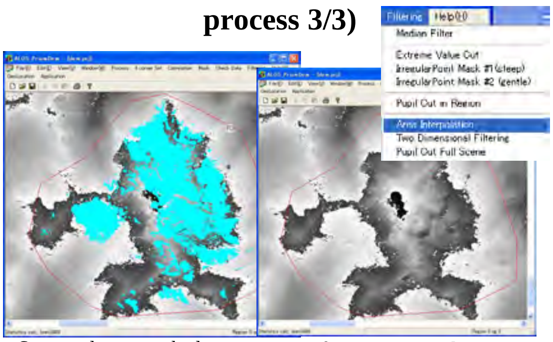
Snow Covered Area Recovery (actual process 3/3)



Saturated area masked After area interpolation

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5.10 Emergency Recovery Process

Step4
Repair errors /
Mask out at a
Target DEM

- Some times, you may damage an area (Polygon region) during repair.
- In such a case there are 2 recovery method.
- The first is select menu “Un Do”. Most of the unrecoverable process is supported by undo. You can select Menu “Undo” to return to previous state. Multi undo is supported.
- Other method is to start processing from the scratch by applying lower Rank data in a defined polygon.

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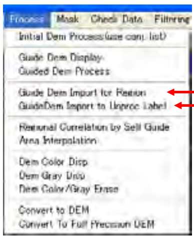
5.11 Ultimate Recovery

Step4
Repair errors /
Mask out at a
Target DEM

Go back to lower Rank data



1) Generate a Polygon to mask damage area and activate.
2) Select Menu “Guide Dem Import for Region”
3) Select Menu “Regional Correlation by Self Guide”.
4) Then you will return to the initial processed state in the region.
5) Apply repair process again.

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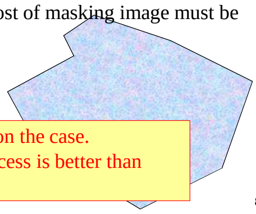
5.12 Polygons for Masking a Process Area

Step2
Cloud, Sea Mask & other masks by Polygon,
Conjugate point listing

- Making mask is an important task.
- Most of masking process can be limited in the defined polygon
- A polygon group can be saved and imported any time without considering rank of current work.
- In the version 2 program, most of masking image must be done by defining **polygons**.



Use of cloud musk is depend on the case.
Some times masking after process is better than masking before processing

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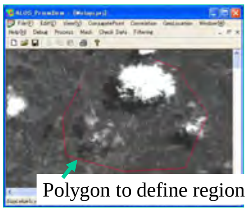
Polygon Set and Registration

Step2
Cloud, Sea Mask & other masks by Polygon, Conjugate point listing



Polygon to define region

•In the following process, user sometimes need to set a region where some operation will be conducted within the region.
•A region for the purpose can be defined by a polygon.
•To set a polygon, first press "p" key for flushing polygon buffer.
•Then hold "t" key and click mouse. Since the last point of polygon will be connected to the first point, user doesn't need to close the polygon.
•Register the Polygon by pressing "r".

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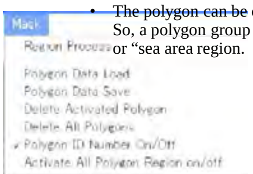
Polygon Data Save and Load

Step2
Cloud, Sea Mask & other masks by Polygon, Conjugate point listing

- One polygon can be defined by the process described in the previous page.
- After pressing "r" key to register the polygon, you can start next polygon by the same process in the previous page.
- You can create polygon up to 512 polygons and each polygon can have 256 vertex at most.
- The polygon data can be saved to a file or load from file. You can generate various polygon groups.
- The polygon can be converted to a mask by the region operation. So, a polygon group may be a specific meaning like "cloud region" or "sea area region.



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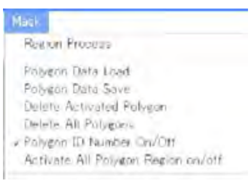
Polygon Activate and Inactivate(1/2)

Step2
Cloud, Sea Mask & other masks by Polygon, Conjugate point listing

- Polygons in a group can be activated or inactivated by a menu selection.
- Region operation like erasing a polygon area can be controlled by the activation.
- Only active polygons can work under the regional operation menu.



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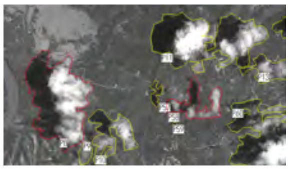
Polygon Activate and Inactivate(2/2)

Step2
Cloud, Sea Mask & other masks by Polygon, Conjugate point listing



1) Hold "a" key and click mouse in a polygon, the polygon will be activated inclusively. Active polygon is drawn by a red line while inactive polygon is drawn by a yellow line.

2) Hold both "SHIFT"+ "a" key and click mouse in a polygon, the polygon will be activated exclusively. All the other polygon will be inactive.

3) By a menu selection, all polygon can be activated or all polygon can be inactivated.

4) Polygon ID number can be on or off by a menu selection.

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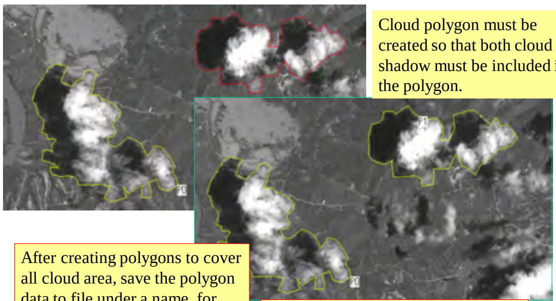
Cloud Polygon (Manual setting)

Step2
Cloud, Sea Mask & other masks by Polygon, Conjugate point listing



Cloud polygon must be created so that both cloud and shadow must be included in the polygon.

After creating polygons to cover all cloud area, save the polygon data to file under a name, for example, "Cloud__Region".

Save current polygons to a file.

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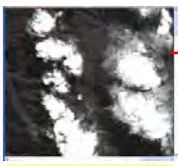
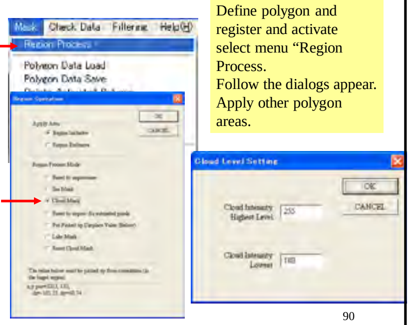
Cloud Masking (Level slicing in region)



After creating polygons Save them under arbitral name for future use.

Results of the masking can be monitored by clicking "d" key.



Define polygon and register and activate select menu "Region Process.
Follow the dialogs appear.
Apply other polygon areas.

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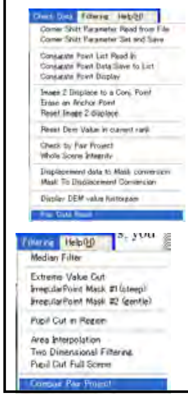
6. Output Process

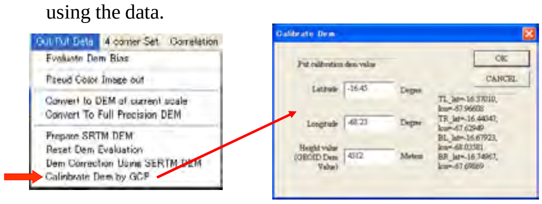
6.2 DEM quality enhance



•If you have 3 scenes of stereo of Prism, you can create DEM at least 2 pairs, you can improve DEM quality.
•Process DEM extraction on both nadir-forward pair and nadir-backward pair.
•Then import data from a file menu.
•Select Menu “Compare Pair Project”.
•After several minutes, error position will be masked.
•Then select area interpolation from filter menu items.

6.3 Calibration by GCP

- If you have one GCP data, you can calibrate output dem using the data.

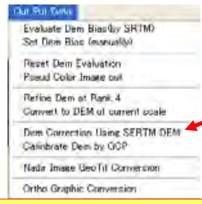


By putting GCP value, out put dem bias will be calibrated when you select “Convert to DEM…” menu.

Step5
Output Final DEM

6.4 Output DEM

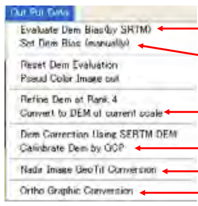
In the new version absolute DEM on rotated ellipsoid earth model of WGS84 is generated. Geoid height is not counted yet.
Output DEM is created under current scale. At rank 4, dem space is 10m. DEM is expressed in 2byte integer in meter. Dem file is GeoTif format.



If you activate DEM correction by SRTM (check the menu item), bias of dem will be calibrated and out put will be converted to geoid dem. Only a clud covered area will be converted to SRTM DEM.

Dem parameter is in a text file with the same name of output dem name.

Output DEM (continued)



Dem level calibration using SRTM dem.
Bias offset by specifying static value
Output dem in cullret rank
One point calibration
Convert nadir image into geotiff
Convert to ortho dem and ortho image.

7. DEM Error Evaluation

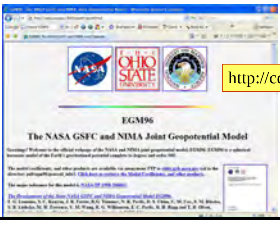
- Error sources
  (1)Conjugate point error (1/4 pixel=1.25m)
  (2)Coordinate error of pixel(lat long value error=6m approx)
  (3)View vector estimation error(counted in(2))
  (4) Bias error from geoid to rotating ellipsoid model(this is not error but have bias component in the processed DEM)
  (5) Error related to DSM and DEM (not applicable in the current process)

Total of ALOS DEM error in the current program is around 20m of absolute error. If you have one GCP, the bias component of the error will be deduced and be eliminated.

As a new function, DEM calibration can be done by using SRTM DEM applying the method bias component of the dem will be calibrated very precisely with the order of several meters.

Appendix II: Import SRTM Dem and Geoid Data

- Currently SRTM dem can be down loaded from various site supporting SRTM project.
- The dem is edted to 1 degree segment and modified to geoid dem using EGM96 geoid.
- For current use, rotated ellipsoidal dem is necessary. So, geoid data is also necessary to convert SRTM dem int rotated ellipsoidal dem.



http://cddis.nasa.gov/926/egm96/egm96.html

Geoid data=WW15MGH.DAC

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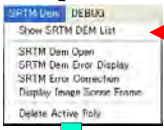
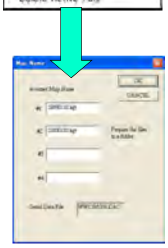
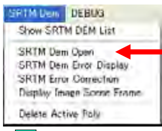
SRTM data Handling
Open SRTM Dem Files



①

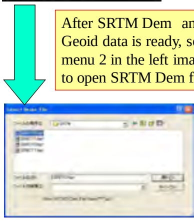


Select the menu, then a dialog appears to show SRTM dem file name(s) which covres opend SAR image scene.
Just click OK to close the dialog.



②

After SRTM Dem and Geoid data is ready, select menu 2 in the left image to open SRTM Dem file.



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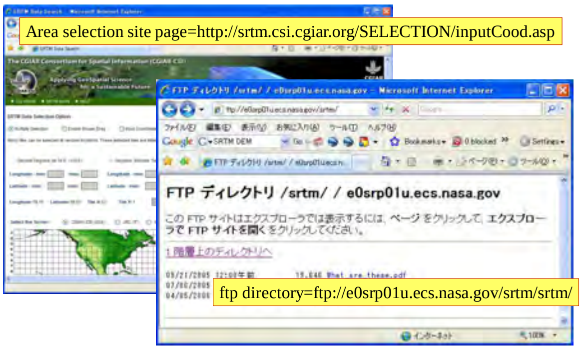
SRTM site



Area selection site page=http://srtm.csi.cgiar.org/SELECTION/inputCood.asp

ftp directory=ftp://e0srp01u.ecs.nasa.gov/srtm/srtm/

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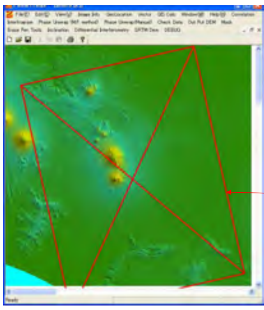
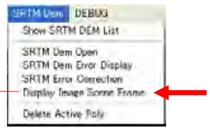
Display Shadowed SRTM Dem



When you select a Dem in file dialog SRTM dem will be displayed as shown left.
SRTM Dem is Color Coded by altitude and shadowed by slope illumination.



When you select above menu item, SAR image frame of current scene will be displayed.
Selet same menu to erase the frame.

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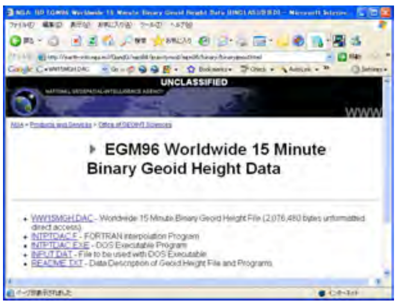
Geoid Data Search



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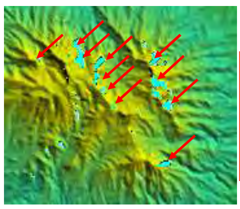
Error Correction of SRTM Dem (1/4)

SRTM Dem some times has defect pixels where Dem value is set to be zero intentionally. For fore shortening correction or differential interferogram generation, these defect point must be repaired in advance.
In this program, interpolation using surrounding valid pixel value is applied.
Defect points are displayed as light blue which is the same color of sealevel but you can recognize defect points as a light blue speckle in high relief area.



Light Blue speckle in the left image (indicated by red arrow) is defect points of SRTM Dem.
Shadow or steep fore slope int Space shuttle radar operation causes such unprocessed pixels.

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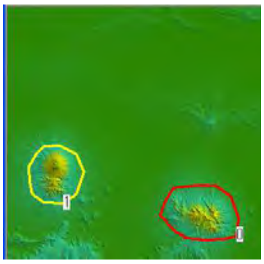
Error Correction(2/4)



(1)Hold “t” key and click mouse to surround error area by a ploygon.
(2)Press “r” key to register polygon.
(3)Hold shift key and click mouse inside the polygon to activate it(red polygon).
(4) Hold control key and click mouse inside polygon to inactivate it (yellow polygon).
In the left image, polygon “0” is activated while polygon 1 is inactivated.

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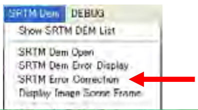
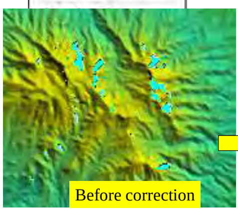
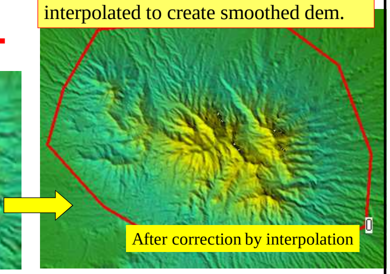
Error Correction(3/4)



(5)Select menu in the left image, then Error inside active polygon will be interpolated to create smoothed dem.





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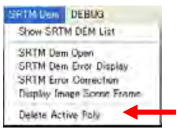
Error Correction(4/4)



To delete polygon, selet left menu. Activated polygon will be erased and remained polygon is renumbered.

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