添付資料

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  - ➢ 2017 年（1 月 25 日～1 月 27 日）受入活動時における写真
  - ➢ 2019 年 4 月 22 日　第 2 回現地活動：防災セミナー資料１
  - ➢ 2019 年 4 月 22 日　第 2 回現地活動：防災セミナー資料２

資料 1：本事業で実証実験した製品カタログ(1/2)

JMA-912 RAINWATCHER

JRC

X-Band Polarimetric Radar Rainfall Sensor with Fully Solid State Technology

RAINWATCHER is compact in size and provides high performance based on polarimetric processing and pulse compression technology.

High accuracy rainfall sensor which can be used for various applications in our everyday society.


For River Water Level Control


For Disaster Prevention & Early Warning


For Safety of Airport / Railway Operation


For Road Management

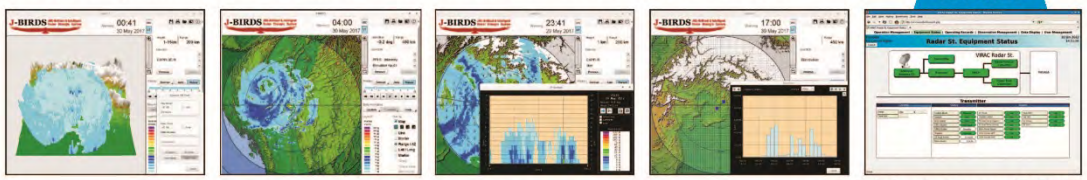
Operation and maintenance cost can be drastically reduced due to low power consumption, no consumables, and long life design.

Easy installation, mobile transportable application.

J-BIRDS Software Package

provides optimized observation data for easier meteorological analysis

Open file format


Included product screens of J-BIRDS™

資料 1：本事業で実証実験した製品カタログ(2/2)

JMA-912 X-Band Polarimetric Radar Rainfall Sensor RAINWATCHER

SYSTEM	
Type	Polarimetric radar with solid state technology
Operating Frequency	9.70 - 9.80 GHz (Option: 9.35 - 9.70 GHz)
Scan Mode	PPI, RHI, CAPPI
Pulse Width	Short (P0N): 1.0 µsec, Long (Q0N): 50 µsec
Pulse Repetition Frequency (PRF)	2000 Hz max.
Maximum Doppler Velocity	12, 24, 36 or 48 m/s (depend on PRF)
Observation Range	80 km @ 23 dBz, 120 km @ 27.8 dBz
T/R Duplexer	Circulator with Diode Limiter (no TR tube)
Output Raw data	Uncorrected Reflectivity (Zu), Corrected Reflectivity (Zc) Doppler Velocity (V), Spectral Width (W) Differential Reflectivity (Z_{DR}), Correlation Coefficient (ρ_{HV}) Differential Phase (Φ_{DP}), Specific Differential Phase (K_{DP}) Liner Depolarization Ratio (LDR)
Operating Temperature	Outdoor: 0 °C to +50 °C (Option: -20 °C to +50 °C) Indoor: +5 °C to +35 °C
Operating Relative Humidity	Outdoor: ≤ 95 % @ < 40 °C, ≤ 75 % @ ≥ 40 °C Indoor: 20 % to 80 % @ 25 °C
Power Consumption	≤ 450 VA @ 100 - 240 VAC, 1φ2W, 50/60 Hz
ANTENNA / PEDESTAL	
Type	Parabolic, prime-focus reflector
Reflector Diameter	≤ 1.2 m (≈ 3.9 feet)
Antenna Gain	≥ 38 dB
Half Power Beam Width (Typical)	≤ 2.0 °
Polarization	Linear Horizontal & Vertical Dual Polarization (Simultaneous H/V& Fixed Horizontal or Vertical Transmission)
Side Lobes (max)	≤ -23 dB
XPD (Cross Polarization Discrimination)	≥ 30 dB
Angle Span	AZ: Full 360 ° EL: -2 to +182 ° (0.1 °step)
Scanning Speed	AZ: 0 - 6 rpm (0.1 rpm step) EL: 0 - 3 rpm (0.1 rpm step)
Positioning Accuracy	+/-0.1 °
Antenna & Pedestal System Weight	≤ 150 kg (include radar equipments inside)

RADOME	
Type	Sandwich, fiberglass with polyurethane foam core
Size	Approx. 1.8 m (≈ 6 feet) diameter
Weight	Approx. 200 kg
Transmission Loss	≤ 0.3 dB (one way, dry surface)
Survival Wind Speed (gust)	≤ 60 m/s (Option: 70 m/s)
TRANSMITTER / RECEIVER	
Transmitter Type	Solid State Power Amplifier (no transmitting tube), Simultaneous H/V& Fixed Horizontal or Vertical Transmission
Peak Power	125 W (H) + 125 W (V)
Occupied Frequency Bandwidth	≤ 4 MHz, V0N (P0N+Q0N)
Receiver Type	Double Superheterodyne with Image reject mixing
Minimum Discernible Signal	≤ -110 dBm @ 1.0 µsec pulse width
Linear Dynamic Range	≥ 90dB with STC
IF DIGITAL RECEIVER/SIGNAL PROCESSOR	
Type	Multi-channel Digital Receiver & Signal Processor
IF Sampling	16 bits, 96 MHz, each per polarization
Pulse Compression Ratio	< 150
Maximum No. of Processed Range Bins	up to 2,500
Minimum Processing Resolution	25 m
Processing Mode	FFT
Clutter Suppression Capability	≥ 40 dB
Various Processing Functions	Range Correction, Velocity De-aliasing, 2nd Trip Echo Suppression, Interference Rejection, Noise Reduction
RADAR WORKSTATION	
Computer System	Commercial Off-the-Shelf PC, Core I5 or higher spec.
Operating System	Linux
Application Software	- Radar control, monitoring and observation schedule - Quick graphical overview of the status of the radar units - Presentation of BITE - Calibration with sun tracking - Radar supervise on remote Web image - Support of single and multi-radar networks*

Center System for Master Station (not included in JMA-912, * =option)			
Computer System	Commercial Off-the-Shelf PC, Core I5 or higher spec.		
Operating System	Linux		
Application Software	J-BIRDS™ Software Package		
Radar Product Server	- Remote radar supervision on Web image - Radar control, monitoring and observation schedule - Alarm monitoring and reset function - Quick graphical overview of the radar unit status - Multi-windows showing different products - Customizable geographic display maps and text annotation - Data zooming, animation & screenshot utility - Radar Volume Corrections:* - Sea Clutter Detection & Correction - Bright Band Correction - Vertical Profile Correction - Occultation Correction - Support Data Type: NetCDF, BUFR, HDF5, XML, ASCII, UF, NEXRAD Level 2, GRIB2 (Selectable) - Automatic Output Data: GIF, PNG, JPG, NetCDF (Selectable)* - Data Transfer Type: FTP - Graphical Indication by Region, Basin or Route *	- Standard Meteorological Products	- PPI, RHI, CAPPI & RTI - Echo Top, Echo Base & Echo Thickness - Vertical Maximum Radar Reflectivity - Arbitrary Vertical Cross Section & Multi Line Cross Section - Height of Maximum Radar Reflectivity, Column Maximum - Layer Average / Maximum Reflectivity - VAD, VVP, Wind Direction and Wind Speed
		- Extended Meteorological Products	- Precipitation Intensity by Z-R or Dual Polarization Parameter - Surface Rainfall Intensity by Z-R or Dual Polarization Parameter - Base Reflectivity, Echo Classification - Wind Shear Detection & Analysis, Layer Turbulence - 3D CAPPI, 3D Cross Section
		- Hydrological Products	- Vertically Integrated Liquid (VIL) - Arbitrary N-hours Rainfall Accumulation by Z-R or Dual Polarization Parameter - Point Rainfall Total and Rainfall Intensity Histogram
		- Forecasting and Warning Products	- Rain Tracking & Centroid Tracking Support for Forecasting - Strong Rainfall and Wind Warning of Specified District with text output - Severe Weather Analysis, Hail Detection
		- Sensor & Data Integration	- Multi-radar Data Composite* - Data Integration with 3rd Party Weather Radars, Rain Gauges / AWS, Satellites and etc.* - Correction with Rain Gauge Data*
		Data Archival and Retrieval Server	- Archive radar data temporarily on a PC hard disk by appropriate method - Transfer to external media such as Optical Disk - Archival data: Raw data, Product Data, System Log and BITE Messages - Open data structure and the file format of archived raw and products data - Archive and retrieve data: HDF5 or BUFR priority over other formats

• Specifications may be subject to change without notice.

For further information, contact:

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Liaison Offices : Hanoi, New York
Overseas Subsidiaries : Rio de Janeiro, Jakarta

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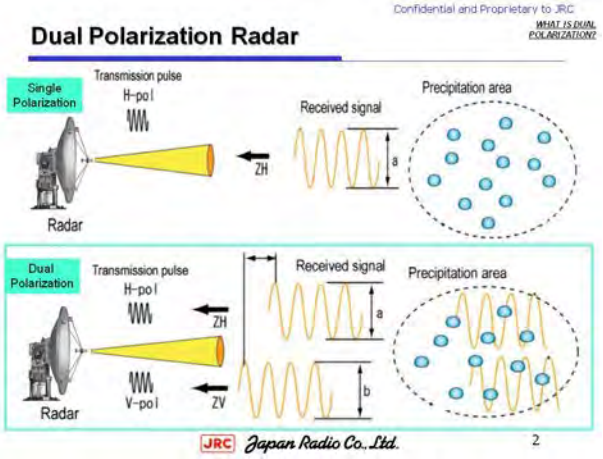
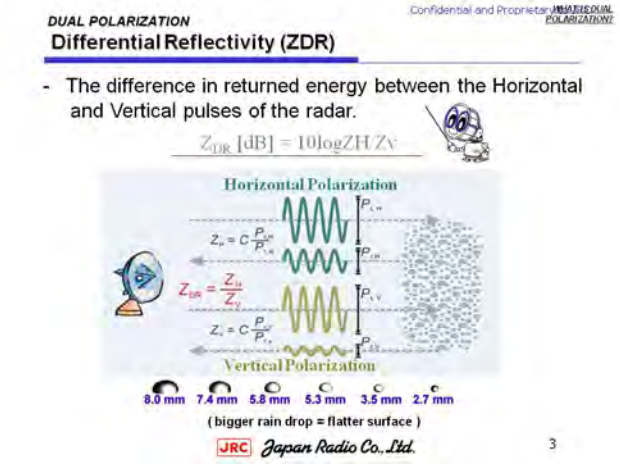
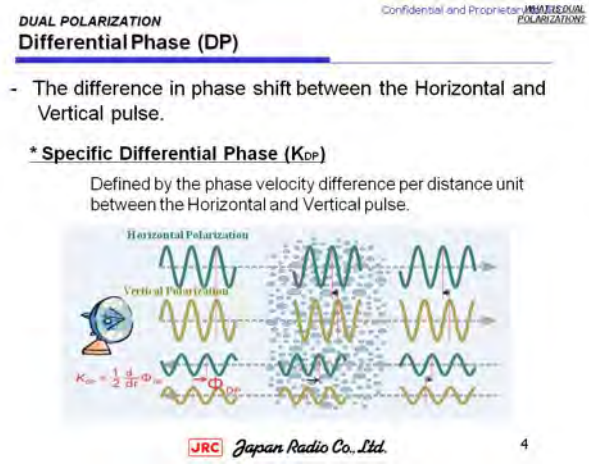
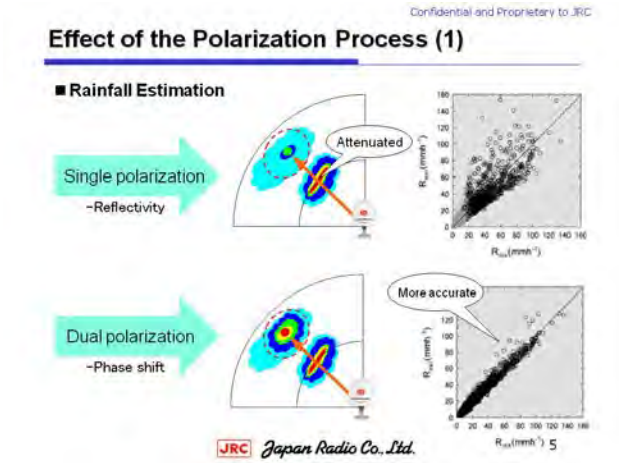
2019.5 Printed in Japan

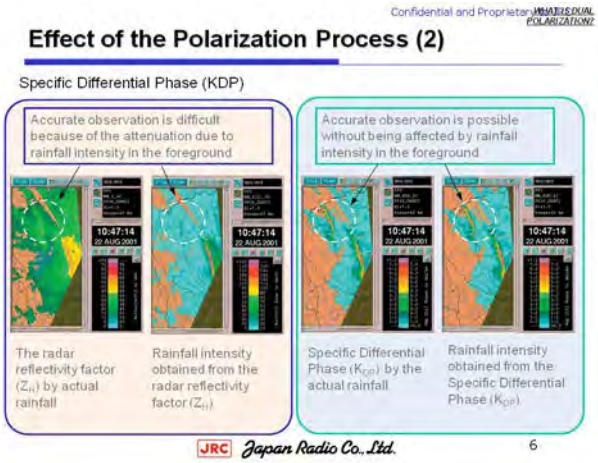
資料 2：2017 年 1 月 25 日　本邦受入活動：日本無線・長野事業所　レーダセミナー資料(1/4)











Compact Weather Radar

Conventional MP Radar

RAINWATCHER

All-in-One
- Smaller (Radome: ϕ1.8m)
- Lighter(≦500kg
- Lower power consumption (≦450VA

Specification

System	
Type	Full Solid State, Dual-Polarization Doppler Radar
Frequency	X-band
Basic output data	Received Power (Pr), Radar Reflectivity (Z/Zh), Doppler velocity (Vr), Velocity Spectrum Width (Wr)
Output data with dual polarization	Differential Reflectivity (ZDR), Differential Phase (ΦDP), Specific Differential Phase (KDP), Correlation Coefficient (ρhv), Linear Depolarization ratio (LDR vh/hv)
Power supply	AC100~230V, 50/60Hz
Power consumption	≦450VA
Total weight	≦500kg
Composition	
Radome, Antenna, TRX unit, DSP unit, Control PC	
Radome (Outdoor equipment)	
Diameter	1.8m
Wind resistance	≦60m/s
Antenna (Included in Radome)	
Antenna	1.2m ϕ Parabolic
Gain	≧39dBi
Beam width	≦2.0°
Polarization	Horizontal and Vertical
Rotation angle	AZ: 360° EL: -2°~+182°
Rotation speed	AZ: Max. 6rpm, EL: Max. 2rpm (changeable)
TRX unit (Included in Radome)	
Transmitter power (peak)	1.25kW (+61 +1.25kW (V))
Minimum detectable power	≦ -110dBm
DSP (Include in Radome)	
Correction	Velocity unwrap, Ground clutter removal, etc.
Monitor/Control PC (Indoor equipment)	
OS	Linux
Software	Radar control software (including Web server function for monitoring)

- Equivalent specification with conventional MP Radar
- Easy observation operation with only one ordinary PC

Kochi University - Immobile

Transportation (Truck x1)

Installing…

All-in-one type makes installation easier, faster, and less costly.

Installed

PAGASA(Philippines) - Mobile

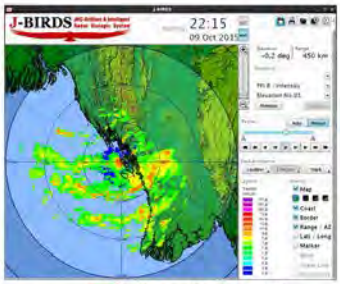
Move around

Observe

Observation can be started instantly at any location.

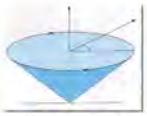
Radar Display Data Products

The radar data display software can generate useful products for weather report, flood forecast, and the meteorological research from the observed data with various algorithms.

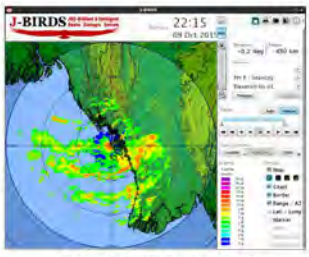


PPI : Plan Position Indicator

The PPI product shows the distribution of selected data parameter on a constant elevation angle rotating on surface horizontal direction. PPI scanning is an essential product for radar observation.



PPI Scan Conceptual Diagram

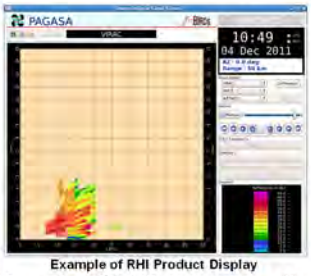


Example of PPI Product Display

RHI : Range Height Indicator

The RHI product is excellent for viewing the detailed vertical structure of a storm. During RHI scanning, the antenna azimuth is fixed and the elevation angle is swept. In the example display below, the horizontal axis is the distance, and the vertical axis is the height from the radar.

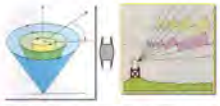
RHI Scan Conceptual Diagram



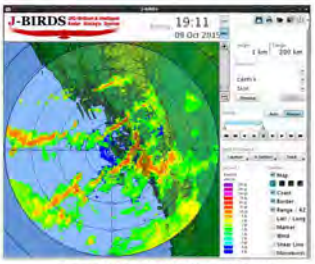
Example of RHI Product Display

CAPPI : Constant Altitude Plan Position Indicator

CAPPI product gathers three-dimensional data by slightly changing the azimuth angle of the antenna per rotation in an upward direction. It displays the equal altitude precipitation distribution.



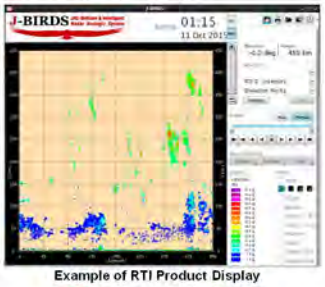
CAPPI Scan Conceptual Diagram



Example of CAPPI Product Display

RTI : Range Time Indicator

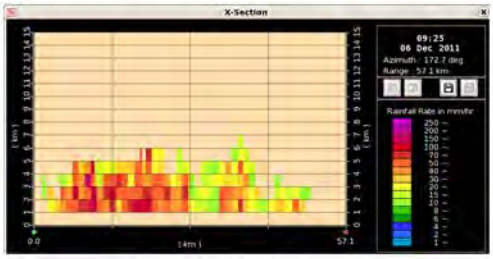
The RTI (also called B-Scope) is most useful for manual scans or "searchlight" scans, which scans at a fixed position. The horizontal axis is the time (seconds after the beginning of the scan), and the vertical axis is the distance from the radar.



Example of RTI Product Display

XSECT : Cross Section

The XSECT product (cross section) is constructed from the CAPPI data. This product lets you make a cross section at any point and along any line — in effect letting you move the radar wherever you want.



Example of XSECT Product Display

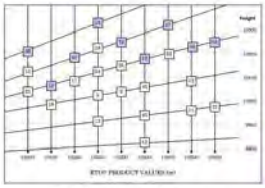
TRACK : Tracking / Prediction

TRACK products show the projected motion for storm features (centroids) based on a series of input products from different time. You define the threshold level and size of the centroids. When new data comes, the TRACK product compares the previous one to the new data to obtain a motion vector of the weather target. Warnings are issued if a centroid hits, or is forecast to pass through, a protected area.

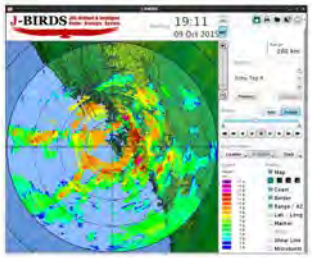
Example of TRACK Product Display

TOPS : Echo Tops

The TOPS product is an excellent indicator of severe weather and hail. It is a display image of the height of the highest occurrence of a selectable threshold of dBZ contour.



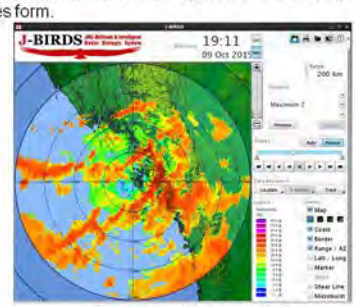
Echo Top Detection Scan Conceptual Diagram



Example of TOPS Product Display

VMAX : Maximum Reflectivity

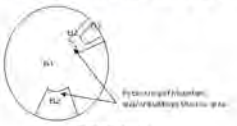
The VMAX product displays the strongest value of the each level in the data generated with the CAPPI product. The display format is XY coordinates form.



Example of VMAX Product Display

S Rain: Surface Rainfall Intensity

The SRI product uses and generates two or more PPI data. Elevation figures can be adopted up to three. The user can edit an elevation table in consideration of the shadow area of mountains.

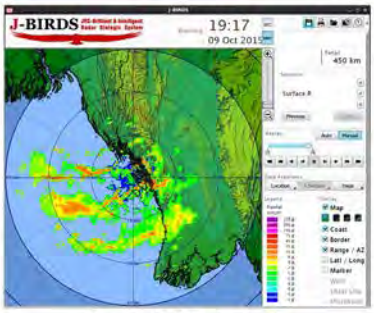


SRI Criteria

Az	Range	El No.	Range	El No.	Range	El No.
10	187.5	1	165	2	247.5	3
160	187.5	1	165	2		
170						

Example of SRI Table Setting

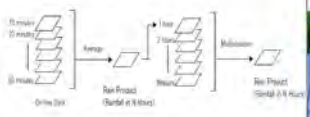
S Rain: Surface Rainfall Intensity



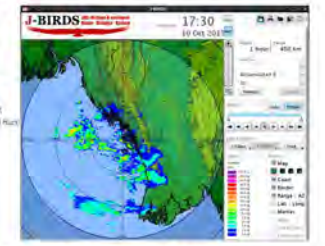
Example of SRI Product Display

RAIN1 and RAINN : Hourly and N-Hour Rain Accumulation

The RAIN1 product uses the previous hour's CAPPI or SRI data to obtain an estimate of the rainfall that fell within that hour. The RAINN is a product of a product: you can sum any number of hours of individual RAIN1 products. The product output shows the last N hours of accumulation.



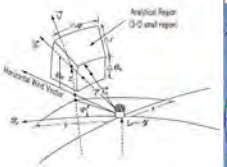
RAIN Product Conceptual Diagram



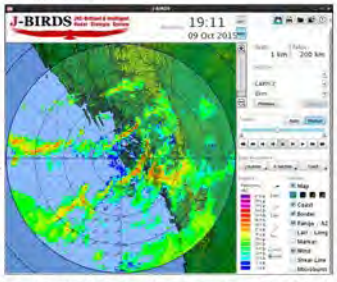
Example of RAIN1 (Hourly Rain) Product Display

WIND: Wind Speed and Direction

The WIND product computes a 2-D array of horizontal wind vectors (the horizontal wind field) using the radial velocity information and the assumption that the wind is uniform over a limited sector.

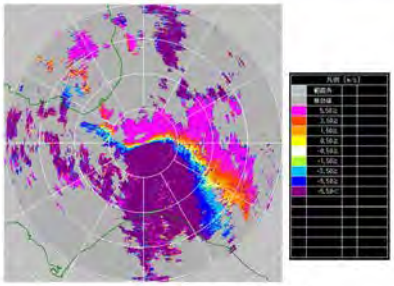


WIND Algorithm Conceptual Diagram



Example of WIND Product (Overlay product with Rainfall) Display

Doppler Velocity



Example of Doppler Velocity Data Display

RADAR Data Analysis System For Landslide Forecasting

25th Jan. 2017

JRC Japan Radio Co., Ltd.

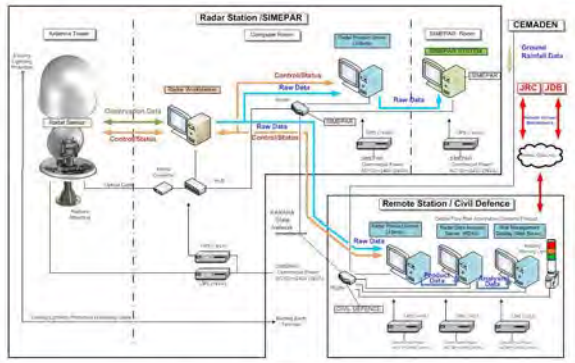
Main Purpose of This Project

JRC

1. Apply JRC RADAR not only weather field, but also hydrological field
   - ✓ Feasible evaluation of dual polarization RADAR
2. Be applicable to forecast landslide occurrence from the data of JRC RADAR
   - ✓ Feasible evaluation of landslide forecasting using RADAR data

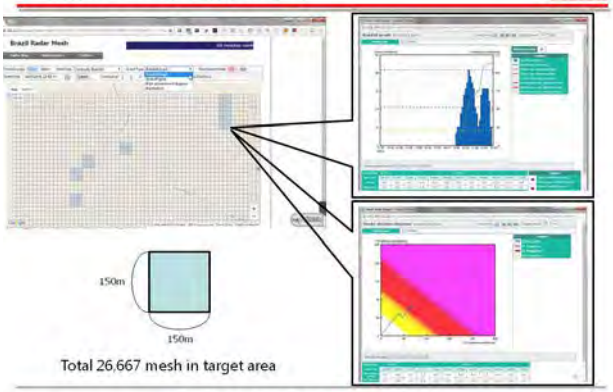
System Configuration Diagram

JRC



Calculation in each mesh

JRC



Total 26,667 mesh in target area

What is the Snake Curve ?

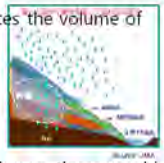
JRC

Snake Curve is contributed to judgment of landslide risk index
This is useful for you as decision making aid

Definitions of Terms

JRC

- **72-hr Half-life Working Rainfall:**
  - The value means accumulated rainfall value which stored under the ground.
  - If the values gets bigger, it means rainfall value under the ground is more large.
  - Long-period rainfall index (index that indicates the volume of water infiltrated into the ground)
  - Horizontal axis in the graph.



- **1.5-hr Half-life Working Rainfall:**
  - The value means accumulated rainfall value which stored on the ground.
  - If the values gets bigger, it means rainfall value on the ground is more heavy.
  - Short-period rainfall index (index that indicates the volume of water around the ground surface)
  - Vertical axis in the graph.

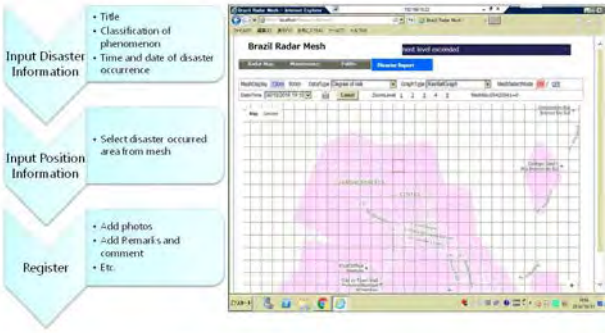
What is the Critical Line ?

JRC

It's defined by data obtained from past record of disaster.
Disaster report input is most important in this function

Disaster Report Function

JRC



Operation of Paraná State Civil Defense

JRC

1. Landslide Occurance
   - How? By whom? From what kind of phenomena?
2. Report to Civil Defense, JRC
   - How? By whom?
3. Input and Save Disaster Report
   - By Civil Defense Operator
4. Change Alarm Level if Necessary
   - By Civil Defense Operator

JRC's Supply Record for Landslide/Debris Flow Monitoring System in Indonesia

JRC

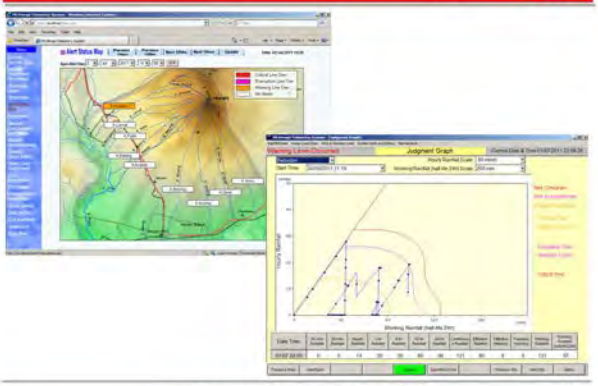
Source: yec

Mt. Merapi
Debris Flow Monitoring System
- Since 1983
- 14 Gauging Station
  (Rainfall, Water Level, Mudflow, Wire Sensor)
- Debris Flow Forecasting

Bili-Bili Dam
Debris Flow Monitoring System
- Since 1998
- 18 Gauging Station
  (Rainfall, Water Level, Vibration Sensor)
- Debris Flow Forecasting

Sample Screen of Mt. Merapi Debris Flow Monitoring System

JRC



Summary

JRC

System provides benefit for you...

- To give notice to operator by visually and aurally before landslide may occur
- To instantly establish the initial posture of administration by real-time data acquisition and judgment
- To improve landslide forecasting by stored data and updating critical line

資料 2：2017 年 1 月 25 日　本邦受入活動：日本無線・長野事業所　防災セミナー資料(3/3)

JMA Forecast Services

Forecast Division
Forecast Department, JMA

1. Multi-Hazard Risk in Japan

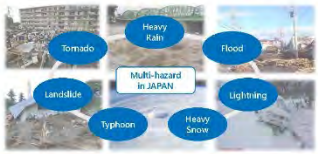
Contents

1. Multi-hazard Risk in Japan
2. The Framework of Japan's Disaster Management
3. More precise, user-friendly information
   - Observation
   - Warnings / Forecasts
   - Communication with DRR authorities
4. JMA Products

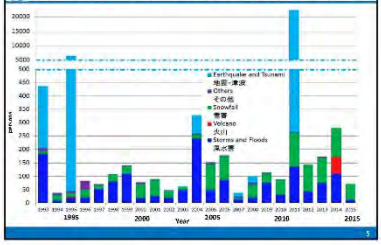
Met/Hydro-related Disasters in Japan

Diversity of Meteorological Disasters in Japan

- Japan is exposed to the risk of various disasters, due to its geographical features.
- There still remain disasters that cause serious damages.
- Some of them are predicted to be more frequent and intense because of climate change.



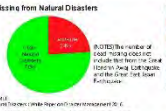
The dead/missing person according to cause of disaster in Japan (1993~2015)



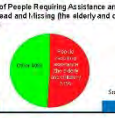
2. The Framework of Japan's Disaster Management

- Of deaths and missing persons from natural disasters, a high proportion are from sediment disasters.
- Of deaths and missing persons from sediment disasters, about 50% are persons that require assistance in the event of a disaster.

■Dead and Missing from Natural Disasters 1993-2015



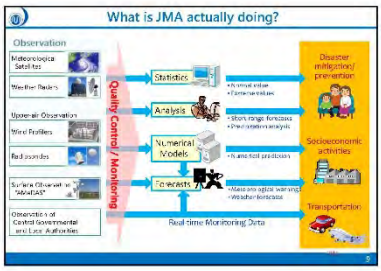
■Percentage of People Requiring Assistance among Landslide Dead and Missing (the elderly and children) (2011-2015)

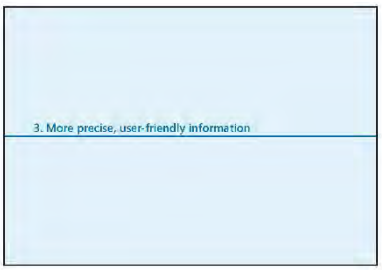


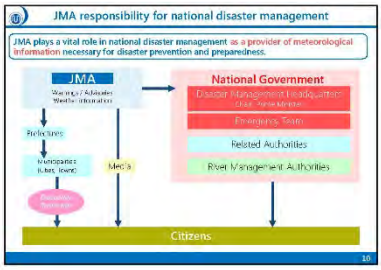
Objectives of Japan Meteorological Agency

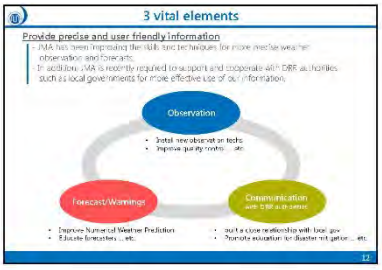
In compliance with "the Act for Establishment of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT)" and "the Meteorological Service Act", JMA ultimate goals are;

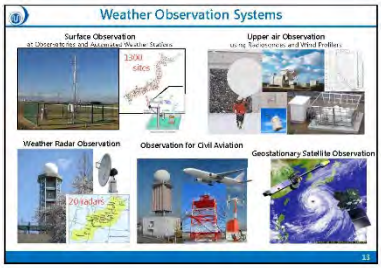
- **Prevention and mitigation of natural disasters**
  - Provide its high-quality forecasts and warnings/advisories for
  - Preparation for disaster evacuation
  - Risk management
- **Safety of transportation**
  - Provide meteorological information to
  - Road administrators
- **Development and prosperity of industry**
  - Provide weather forecasts and meteorological data to
  - Energy companies
  - Agriculture
  - Other industries
- **International cooperation**
  - Technical support
  - Sharing disaster information
  - Exchanges of researchers and

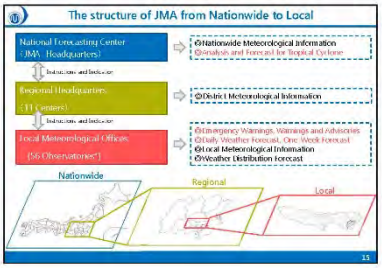

What is JMA actually doing?
Observation
Meteorological Satellites
Weather Radars
Upper-air Observation
Wind Profilers
Rad iosondes
Surface Observation "AMeDAS"
Observation of Central Governmental and Local Authorities
Quality Control / Monitoring
Statistics
Analysis
Numerical Models
Forecasts
Real-time Monitoring Data
Disaster mitigation/ prevention
Socioeconomic activities
Transportation

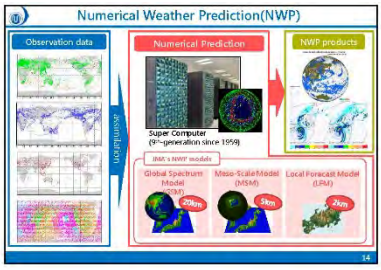

3. More precise, user-friendly information

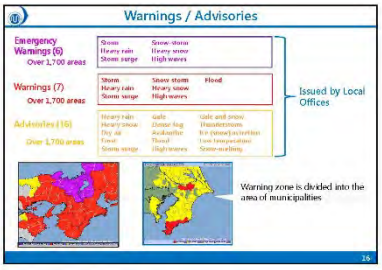

JMA responsibility for national disaster management
JMA plays a vital role in national disaster management as a provider of meteorological information necessary for disaster prevention and preparedness.
JMA
National Government
Disaster Management Headquarters
Emergency Team
Related Authorities
River Management Authorities
Relectines
Municipalities
MeCs
Citizens

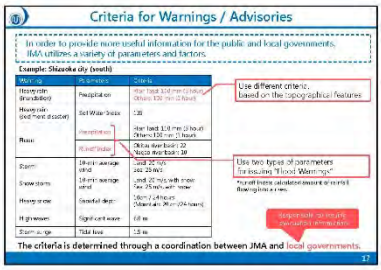

3 vital elements
Provide precise and user friendly information
Observation
Forecast/Warnings
Communication

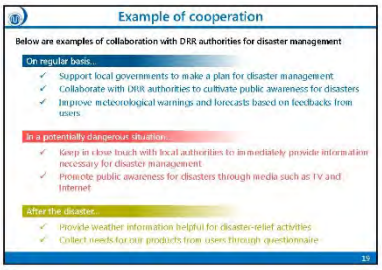

Weather Observation Systems
Surface Observation
1300 sites
Upper air Observation
Weather Radar Observation
20 radars
Observation for Civil Aviation
Geostationary Satellite Observation

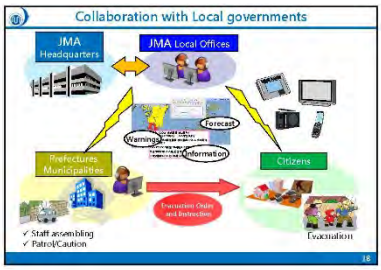

The structure of JMA from Nationwide to Local
National Forecasting Center
(JMA Headquarters)
Regional Headquarters
(11 centers)
Local Meteorological Offices
(56 Observatories*)
Nationwide
Regional
Local

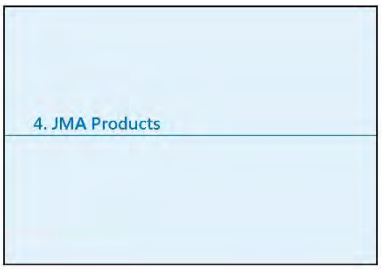

Numerical Weather Prediction(NWP)
Observation data
Numerical Prediction
NWP products
assimilation
Super Computer
(9th-generation since 1959)
JMA's NWP models
Global Spectrum Model (GSM)
Meso-Scale Model (MSM)
Local Forecast Model (LFM)
20km
5km
2km

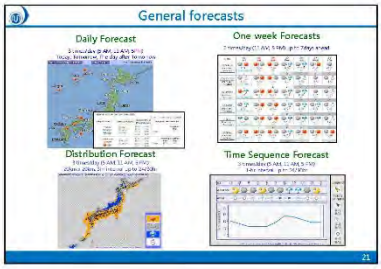

Warnings / Advisories
Emergency Warnings (6)
Over 1,700 areas
Warnings (7)
Over 1,700 areas
Advisories (16)
Over 1,700 areas
Issued by Local Offices
Warning zone is divided into the area of municipalities

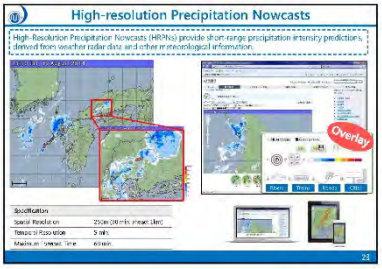

Criteria for Warnings / Advisories
In order to provide more useful information for the public and local governments,
JMA utilizes a variety of parameters and factors.
Use different criteria,
based on the topographical features
Use two types of parameters
The criteria is determined through a coordination between JMA and local governments.

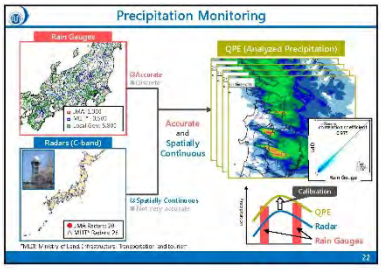

Example of cooperation
Below are examples of collaboration with DRR authorities for disaster management
On regular basis...
Support local governments to make a plan for disaster management
Collaborate with DRR authorities to cultivate public awareness for disasters
Improve meteorological warnings and forecasts based on feedbacks from users
In a potentially dangerous situation...
Keep in close touch with local authorities to immediately provide information necessary for disaster management
Promote public awareness for disasters through media such as TV and Internet
After the disaster...
Provide weather information helpful for disaster-relief activities
Collect needs for our products from users through questionnaire

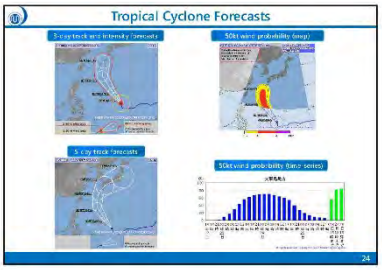

Collaboration with Local governments
JMA Headquarters
JMA Local Offices
Forecast
Warning
Information
Prefectures Municipalities
Citizens
Evacuation Order and Instruction
Evacuation
✓ Staff assembling
✓ Patrol/Caution


4. JMA Products


General forecasts
Daily Forecast
One week Forecasts
Distribution Forecast
Time Sequence Forecast


High-resolution Precipitation Nowcasts
Overlay


Precipitation Monitoring
Rain Gauges
QPE (Analyzed Precipitation)
Radars (C-band)
Accurate
and
Spatially
Continuous
Calibration
QPE
Radar
Rain Gauges

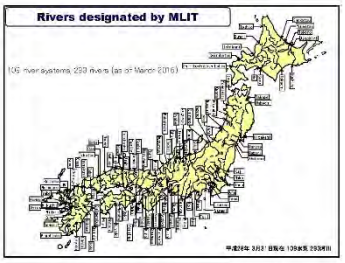

Tropical Cyclone Forecasts


Thank you for your kind attention
JMA official mascot
Harerun (halley-loon)

資料 2：2017 年 1 月 26 日　本邦受入活動：気象庁　洪水予報業務セミナー資料(1/3)

Flood Forecasts

Rivers designated by MLIT



Legal Framework of Flood Forecasts

All rivers in Japan

JMA Flood Warning and Advisory (Both for general and flood control purposes)

[General] Clause 1 in Article 13 of Meteorological Service Act
[Flood control] Clause 1 in Article 14-2 of Meteorological Service Act, Clause 1 in Article 10 of Flood Control Act

Designated rivers

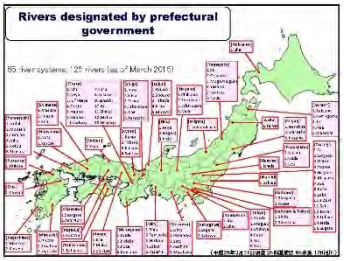
Rivers managed by the Minister of Land, Infrastructure, Transport and Tourism (MLIT)

Flood forecasts in collaboration with MLIT
Clause 2 in Article 14-2 of Meteorological Service Act
Clause 2 in Article 10 of Flood Control Act

Rivers managed by prefectural governors

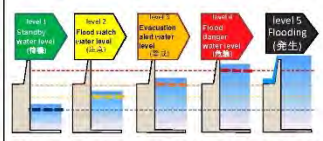
Flood forecasts in collaboration with prefectural government
Meteorological Service Act - Clause 3 of Article 14-2
Flood Control Act - Clause 1 of Article 11

Rivers designated by prefectural government



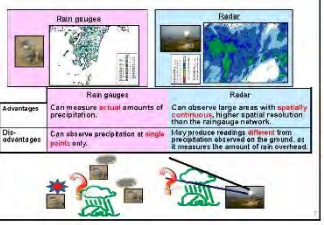
Alert Levels of Flood Forecast

The flood Forecast contains alert levels in accordance with the risk of flooding determined by water level.



Water levels are employed as criteria.

Precipitation observation equipment



Data for Use

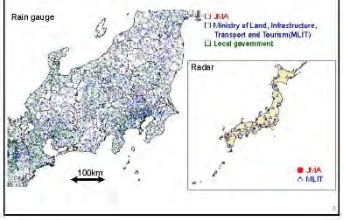
☆Analyzed Precipitation (解析雨量)

☆Very Short-Range Forecasts of Precipitation (降水短時間予報)

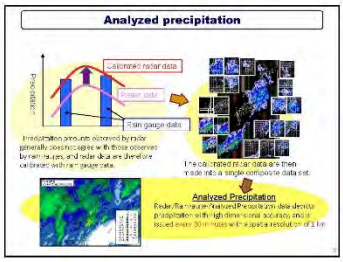
☆Precipitation Nowcast (降水ナウキャスト)

☆Runoff Index (流域雨量指数)

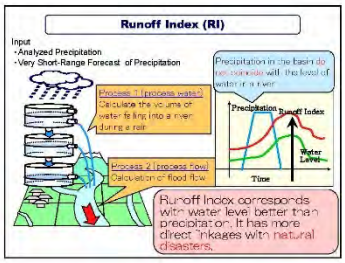
Precipitation observation equipment



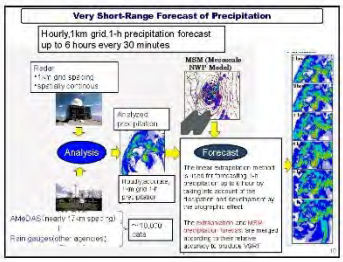
Analyzed precipitation



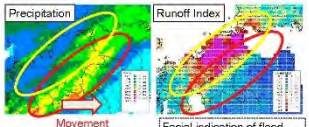
Runoff Index (RI)



Very Short-Range Forecast of Precipitation



Indication of Disaster Risks

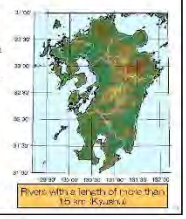


Flood risks are high even after the rain clouds pass.

Runoff Index (RI)

Properties of RI

- RI is calculated on the basis of precipitation from Analyzed Precipitation and Very Short-Range Forecast of Precipitation
- 3,000 rivers in Japan (more than 15km) are divided to 5km meshes
- Calculation of prediction is produced every 30 minutes to 6 hours
- These data are presented on the website in the form of maps (for monitoring)



Information Transmission

Runoff Index (RI) - Reference -

Nagata, K., 2011:
Quantitative Precipitation Estimation and Quantitative Precipitation Forecasting by the Japan Meteorological Agency. RSMC Tokyo Technical Review, No.13, 37-50

http://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/techrev/text13.pdf

RI is shown in Chapter 4.2 of this review.

Meteorological Information Transmission Routes for Warning, Advisory, and Other

資料 2：2017 年 1 月 26 日　本邦受入活動：気象庁　洪水予報業務セミナー資料(3/3)

2017/1/26

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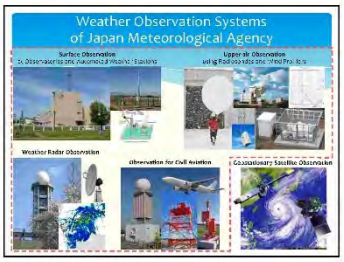
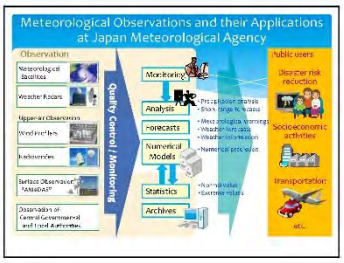
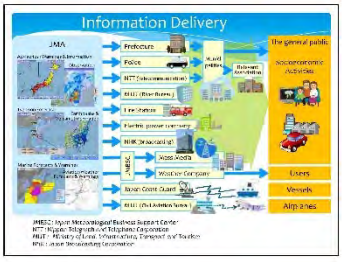
資料 2：2017 年 1 月 26 日　本邦受入活動：気象庁　観測現業セミナー資料(1/4)

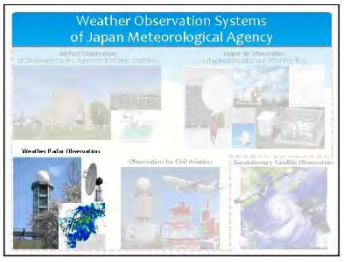
Overview of the JMA's Weather Observation

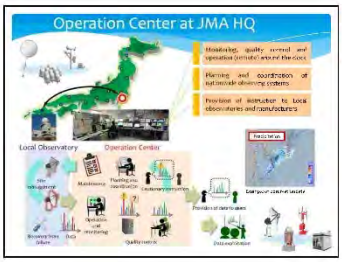
Observation Department
Japan Meteorological Agency
26 Jan. 2017



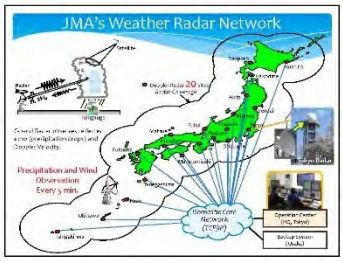








2017/1/26



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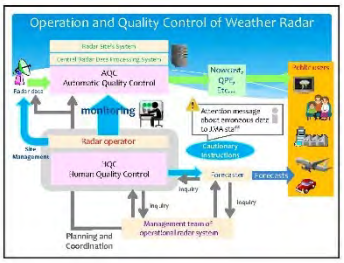
2017/1/26



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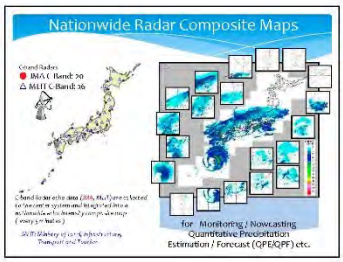
2017/1/26



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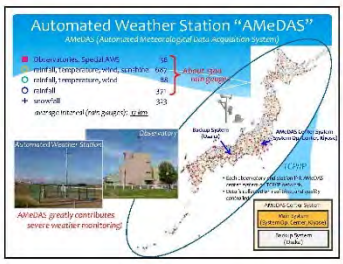
2017/1/26

8

2017/1/26



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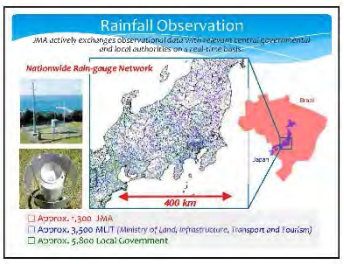
2017/1/26



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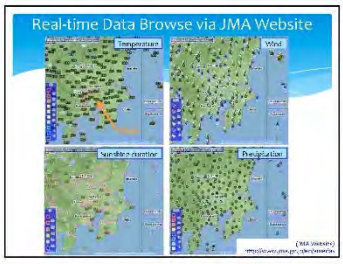
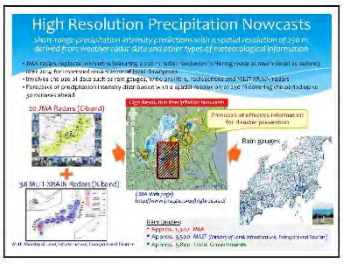
2017/1/26



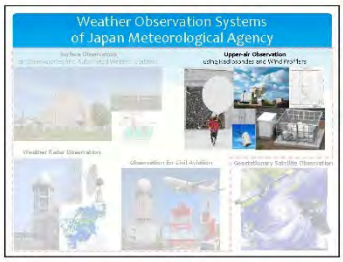
11

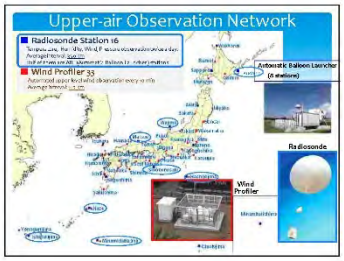
2017/1/26

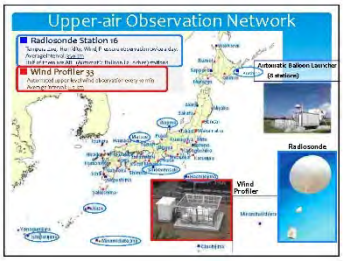


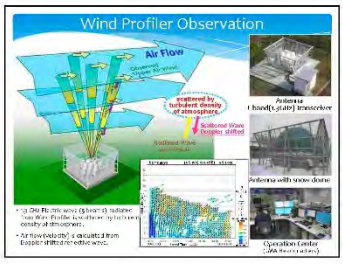
12

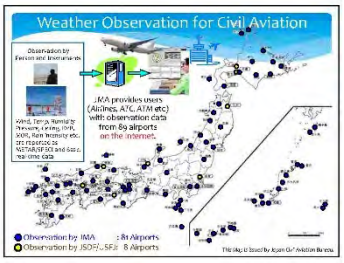
資料 2：2017 年 1 月 26 日　本邦受入活動：気象庁　観測現業セミナー資料(3/4)



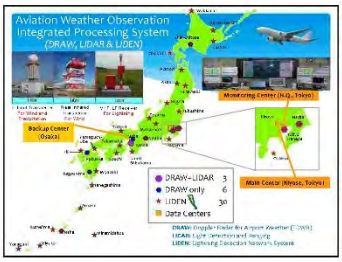








資料 2：2017 年 1 月 26 日　本邦受入活動：気象庁　観測現業セミナー資料(4/4)

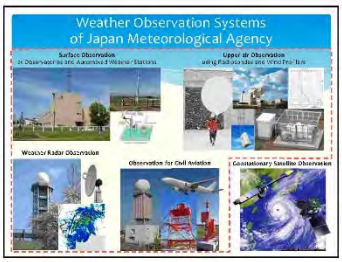


Thank you for your attention.

Curitiba 1408mm
Tokyo 1466mm

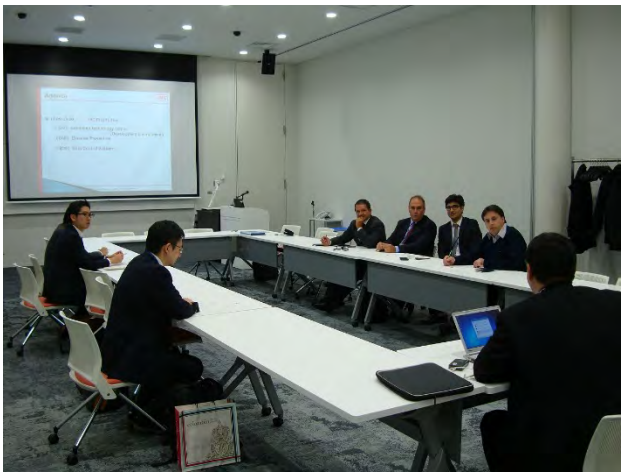
PARANÁ

*We would like to show respect for your efforts to introduce an advanced system for **disaster risk reduction**.*
*We hope our **cooperation** will make great contribution to disaster risk reduction in Paraná state.*



資料 2：2017 年（1 月 25 日～1 月 27 日）受入活動時における写真(1/6)

2017 年 1 月 25 日　長野事業所：技術センター到着



2017 年 1 月 25 日　長野事業所：大会議室

2017 年 1 月 25 日　長野事業所：工場内見学

資料 2：2017 年（1 月 25 日～1 月 27 日）受入活動時における写真(2/6)

2017 年 1 月 25 日　長野事業所：ブラジル向け実機見学及びレーダ研修

2017 年 1 月 25 日　長野事業所：防災研修

2017 年 1 月 25 日　長野事業所：クローズミーティング

資料 2：2017 年（1 月 25 日～1 月 27 日）受入活動時における写真(3/6)

2017 年 1 月 26 日　気象庁：予報業務全般セミナー

2017 年 1 月 26 日　気象庁：洪水予報業務セミナー

2017 年 1 月 26 日　気象庁：予報現業視察

資料 2：2017 年（1 月 25 日～1 月 27 日）受入活動時における写真(4/6)

2017 年 1 月 26 日　気象庁：予報現業視察

2017 年 1 月 26 日　気象庁：観測現業視察

2017 年 1 月 26 日　気象庁：クローズミーティング

資料 2：2017 年（1 月 25 日～1 月 27 日）受入活動時における写真(5/6)

2017 年 1 月 27 日　中野本社：役員と意見交換

2017 年 1 月 27 日　中野本社：役員と意見交換

2017 年 1 月 27 日　中野本社：クローズミーティング

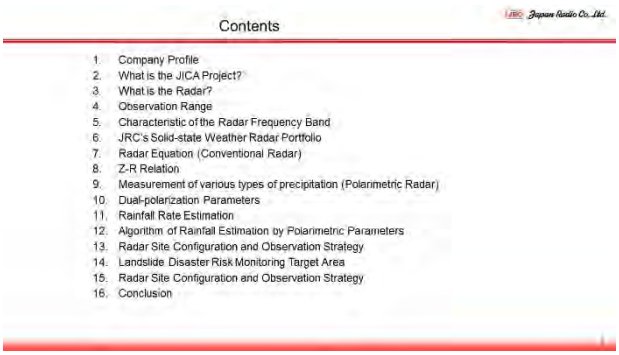
資料 2：2017 年（1 月 25 日～1 月 27 日）受入活動時における写真(6/6)

2017 年 1 月 27 日　在京ブラジル大使館訪問

2017 年 1 月 27 日　在京ブラジル大使館：ブラジル大使と会合

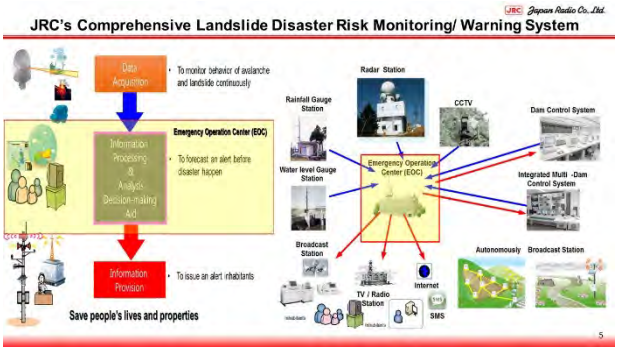
2017 年 1 月 27 日　在京ブラジル大使館：首席公使との意見交換

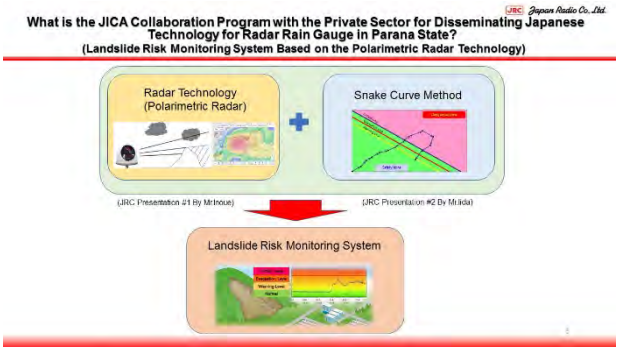

JICA Collaboration Program with the Private Sector for Disseminating Japanese Technology for Radar Rain Gauge in Parana State, Brazil
Landslide Disaster Risk Monitoring System Applying the Latest Radar Technology (X-band Polarimetric Radar)
RAINWATCHER
DEFESA CIVIL
PARANÁ
JRC
Japan Radio Co., Ltd.

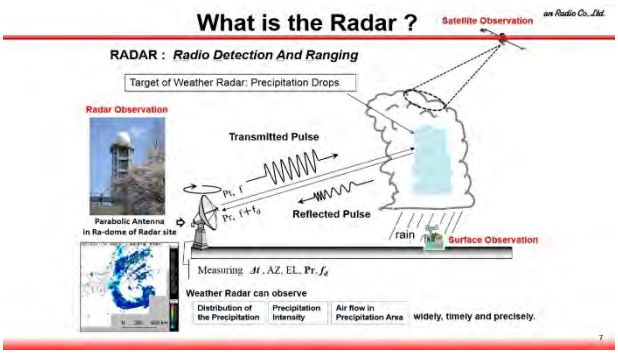

Contents
1. Company Profile
2. What is the JICA Project?
3. What is the Radar?
4. Observation Range
5. Characteristic of the Radar Frequency Band
6. JRC's Solid-state Weather Radar Portfolio
7. Radar Equation (Conventional Radar)
8. Z-R Relation
9. Measurement of various types of precipitation (Polarimetric Radar)
10. Dual-polarization Parameters
11. Rainfall Rate Estimation
12. Algorithm of Rainfall Estimation by Polarimetric Parameters
13. Radar Site Configuration and Observation Strategy
14. Landslide Disaster Risk Monitoring Target Area
15. Radar Site Configuration and Observation Strategy
16. Conclusion

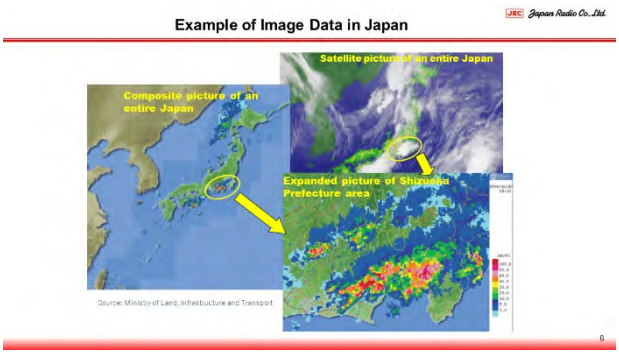

Organization
Nisshinbo Holdings Inc. (NISH)
Japan Radio Co., Ltd. (JRC)
Alphatron Marine Beheer (AMB)
Nagano Japan Radio Co., Ltd. (NJRC)
Ueda Japan Radio Co., Ltd. (UJRC)
Global Network
History


JRC's Business Fields of Solution Business Division
Communication
Disaster Prevention
Management
Aviation /Vessel/ Water Management
Applied Radio Technology
Aviation
Broadcasting
Security
Network
Others
Simulator


JRC's Comprehensive Landslide Disaster Risk Monitoring/ Warning System
Data Acquisition
Information Processing & Analysis, Decision-making Aid
Information Provision
Emergency Operation Center (EOC)
Save people's lives and properties


What is the JICA Collaboration Program with the Private Sector for Disseminating Japanese Technology for Radar Rain Gauge in Parana State?
(Landslide Risk Monitoring System Based on the Polarimetric Radar Technology)
Radar Technology (Polarimetric Radar)
Snake Curve Method
Landslide Risk Monitoring System


What is the Radar ?
RADAR : Radio Detection And Ranging
Target of Weather Radar: Precipitation Drops
Radar Observation
Transmitted Pulse
Reflected Pulse
Parabolic Antenna in Ra-dome of Radar site
Satellite Observation
Surface Observation
Weather Radar can observe
Distribution of the Precipitation
Precipitation Intensity
Air flow in Precipitation Area
widely, timely and precisely.


Example of Image Data in Japan
Composite picture of an entire Japan
Satellite picture of an entire Japan
Expanded picture of Shizuoka Prefecture area

Observation Range

The radar transmits the radio wave straightly from the antenna. One part of radio wave is reflected by raindrops and other is go to far away. However the observation range is limited by the earth curvature and meteorological condition as shown Fig.1, Fig.2.
The radar can measure the rainfall only within the range which the radio wave passes under the level of bright band.
In layer of bright band, the falling ice particles turn to raindrops.

Fig.1 Concept of Radar Rain-gauge Observation

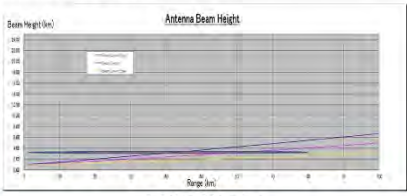
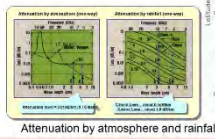


Fig.2 Altitude of Antenna Beam

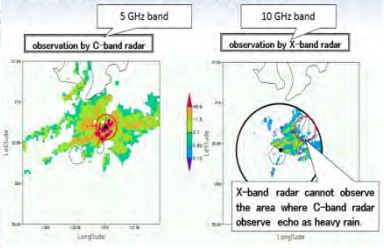
Characteristic of the Radar Frequency Band

Radar Frequency Band

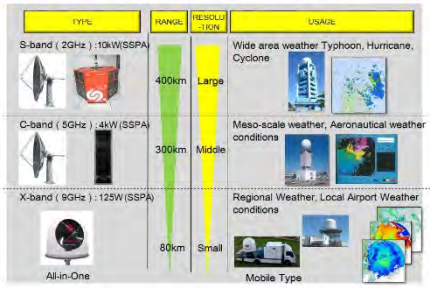


Attenuation by atmosphere and rainfall

Difference of radar observation between C-band and X-band



JRC's Solid-state Weather Radar Portfolio



Radar Equation (Conventional Radar)

When radio-wave impinges on a raindrop in air, it is scattered. By receiving the wave reflected by raindrops, it is possible to determine the precipitation amount. This is relationship is given by the so called radar-equation which is shown below.

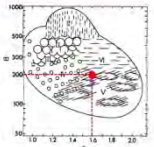
RADAR EQUATION

The relation between Z and rain rate R (mm/h) is expressed statistically as follows.

(rain) β: 80~1000, β: 1.0~2.0

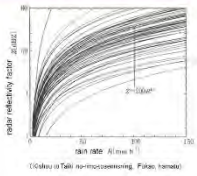
(snow) β: 500~2000, β: 2.0

If value of terms B and β are know, the precipitation can be calculated from reflected echo, etc. The Japan Meteorological Agency has determined B and β value based on past survey and research and is applying them practically.

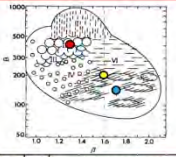


I. Diffusive and a little massive part of thunderstorm echo, or high isolated convective echo in a dry atmosphere (where there is large vaporization of raindrops).
II. The center of strong thunderstorm echo, or a little diffusive strong cumuliform echo.
III. Formation and growing stage of a convective cell.
IV. Small hard convective echo, lined in a scattering or linear state.
V. Evenly spreading layer echo, or weak diffusive echo.
VI. End stage where precipitation spreads completely from a thunderstorm, or spreads apart.

Z-R Relation



$Z = BR^{\beta}$



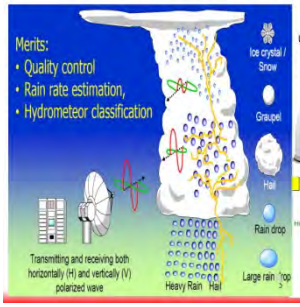
Type of rain	B	β	Weak ← The strength of the rain (mm/h) → Strong					
JMA	200	1.6	0.50	1.0	4	16	64	256
II (Convective)	400	1.3	0.25	0.6	3.2	18	93	540
			50%	59%	81%	111%	152%	211%
V (Stratiform)	130	1.7	0.67	1.3	4.8	18	65	238
			134%	129%	119%	109%	101%	93%

In JMA, B = 200 and β = 1.6 are adopted.
Parameters of Drop size are greatly different with time and space.

So, it is impossible to estimate exactly rain rate from radar reflectivity factor.

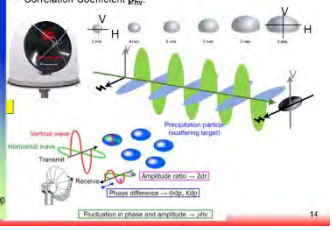
Comparison of rainfall when using B and β of JMA standard, II, V in the figure on the right.
Showing percentages are comparison with JMA standard.

Measurement of the Various Types of Precipitation



Polarimetric Radar Observation

Using the Polarimetric type weather radar, we can observe follows;
- Differential Reflectivity Z_{DR},
- Differential Propagation Phase φDP and KDP.
- Correlation Coefficient ρ_{hv}.

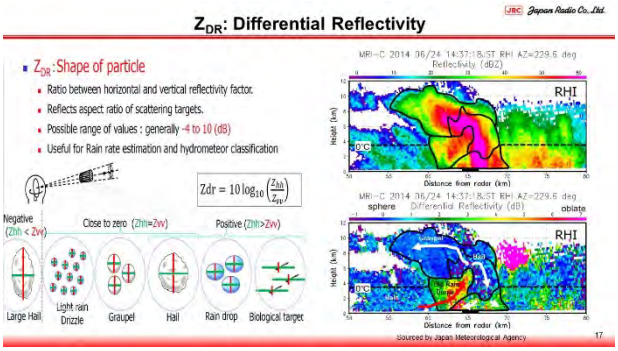


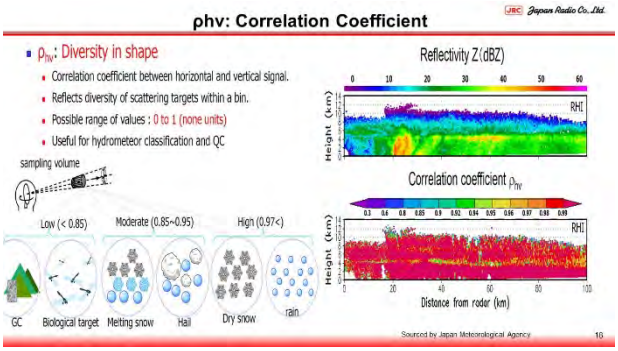
Dual-polarization Parameters

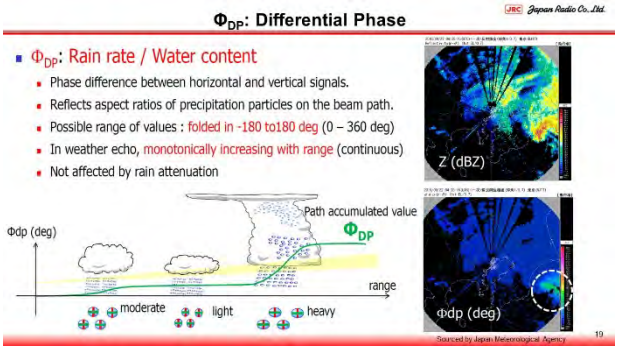
- Z_{DR}: Differential reflectivity : Shape of particle
  - Ratio between horizontal and vertical reflectivity.
  - Information on aspect ratio of scattering targets.
- ρ_{hv}: Correlation coefficient : Diversity of shape
  - Correlation coefficient between horizontal and vertical signal.
  - Information on aspect ratio variation of scattering targets.
- Φ_{DP}: Differential phase : Rain rate / Water content
  K_{DP} : Specific differential phase
  - Phase difference between horizontal and vertical signal.
  - Information on aspect ratios of propagation medium.

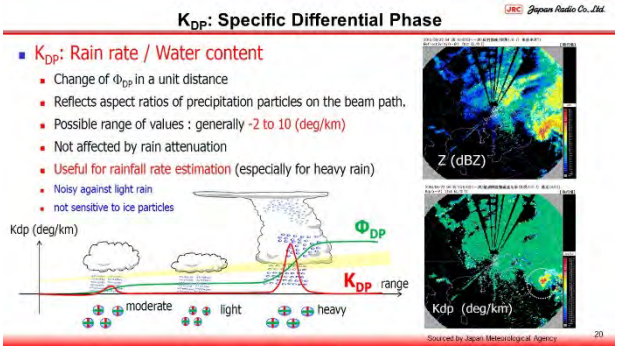
Rainfall Rate Estimation

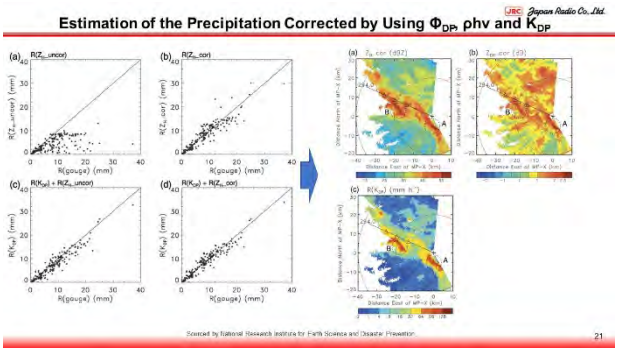
- Estimation using a Z-R relation alone suffers from
  - attenuation by rain
  - sensitiveness to drop size distribution (DSD)
- Using a Kdp-R relation improve estimation accuracy for heavy rain.
  - Kdp is not affected by rain attenuation
  - Kdp-R relation is less sensitive to DSD
- Z-R relation is still needed for light rain (and solid precipitation).
  - Kdp is noisy for light rain

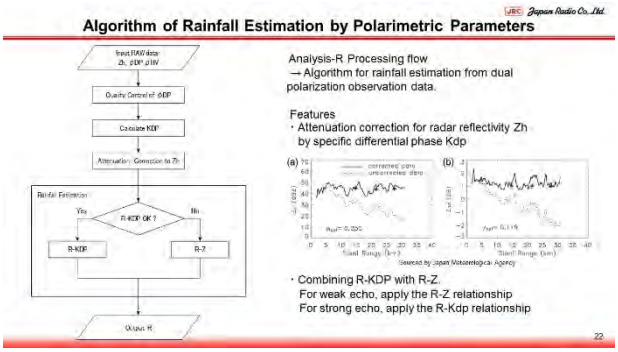

Z_{DR}: Differential Reflectivity
Z_{DR} :Shape of particle
Ratio between horizontal and vertical reflectivity factor.
Reflects aspect ratio of scattering targets.
Possible range of values : generally -4 to 10 (dB)
Useful for Rain rate estimation and hydrometeor classification
$Zdr = 10\log_{10}\left(\frac{Zh}{Zv}\right)$
Negative (Zhh < Zvv)
Close to zero (Zhh=Zvv)
Positive (Zhh>Zvv)
Large Hail
Light rain Drizzle
Graupel
Hail
Rain drop
Biological target
RHI
Distance from radar (km)
Height (km)
Sourced by Japan Meteorological Agency
17

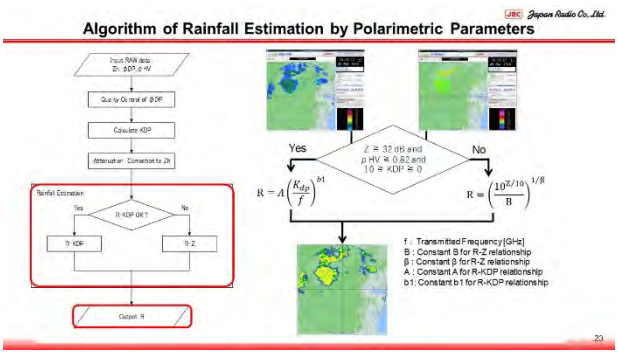

ρhv: Correlation Coefficient
ρ_{hv}: Diversity in shape
Correlation coefficient between horizontal and vertical signal.
Reflects diversity of scattering targets within a bin.
Possible range of values : 0 to 1 (none units)
Useful for hydrometeor classification and QC
sampling volume
Reflectivity Z(dBZ)
Correlation coefficient ρ_{hv}
Low (< 0.85)
Moderate (0.85~0.95)
High (0.97<)
GC
Biological target
Melting snow
Hail
Dry snow
rain
RHI
Height (km)
Distance from radar (km)
Sourced by Japan Meteorological Agency
18

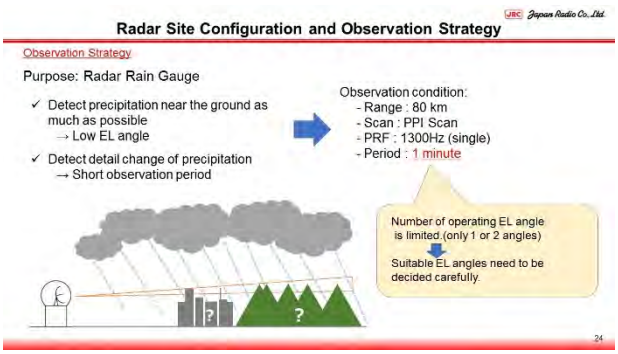

Φ_{DP}: Differential Phase
Φ_{DP}: Rain rate / Water content
Phase difference between horizontal and vertical signals.
Reflects aspect ratios of precipitation particles on the beam path.
Possible range of values : folded in -180 to180 deg (0 – 360 deg)
In weather echo, monotonically increasing with range (continuous)
Not affected by rain attenuation
Z (dBZ)
Φdp (deg)
Path accumulated value
Φ_{DP}
range
moderate
light
heavy
Sourced by Japan Meteorological Agency
19


K_{DP}: Specific Differential Phase
K_{DP}: Rain rate / Water content
Change of Φ_{DP} in a unit distance
Reflects aspect ratios of precipitation particles on the beam path.
Possible range of values : generally -2 to 10 (deg/km)
Not affected by rain attenuation
Useful for rainfall rate estimation (especially for heavy rain)
Noisy against light rain
not sensitive to ice particles
Z (dBZ)
Kdp (deg/km)
Φ_{DP}
K_{DP}
range
moderate
light
heavy
Sourced by Japan Meteorological Agency
20


Estimation of the Precipitation Corrected by Using Φ_{DP}, ρhv and K_{DP}
R(gauge) (mm)
Sourced by National Research Institute for Earth Science and Disaster Prevention
21


Algorithm of Rainfall Estimation by Polarimetric Parameters
Analysis-R Processing flow
→ Algorithm for rainfall estimation from dual polarization observation data.
Features
・Attenuation correction for radar reflectivity Zh by specific differential phase Kdp
・Combining R-KDP with R-Z.
For weak echo, apply the R-Z relationship
For strong echo, apply the R-Kdp relationship
Sourced by Japan Meteorological Agency
22


Algorithm of Rainfall Estimation by Polarimetric Parameters
Yes
No
Z ≥ 32 dB and ρ HV ≥ 0.82 and 10 ≤ KDP ≤ 0
$R = A\left(\frac{K_{dp}}{f}\right)^{b1}$
$R = \left(\frac{10^{Z/10}}{B}\right)^{1/\beta}$
f : Transmitted Frequency [GHz]
B : Constant B for R-Z relationship
β : Constant β for R-Z relationship
A : Constant A for R-KDP relationship
b1: Constant b1 for R-KDP relationship
23


Radar Site Configuration and Observation Strategy
Observation Strategy
Purpose: Radar Rain Gauge
✓ Detect precipitation near the ground as much as possible
→ Low EL angle
✓ Detect detail change of precipitation
→ Short observation period
Observation condition:
- Range : 80 km
- Scan : PPI Scan
- PRF : 1300Hz (single)
- Period : 1 minute
Number of operating EL angle is limited.(only 1 or 2 angles)
Suitable EL angles need to be decided carefully.
24

Landslide Disaster Risk Monitoring Target Area

X-band polarimetric radar is installed on the top roof of SIMEPAR Office. The target area is selected a mountain area but the populated town area and landslide disasters were occurred before many years.

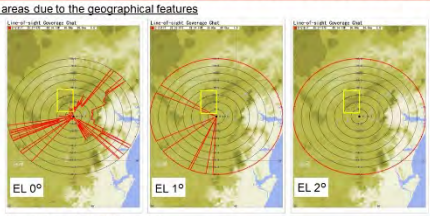
Geographical condition to the north-west direction from the radar site

(There are many high buildings about 1500m away from the radar site in north area where makes a blind area beyond the buildings wall.)

25

Radar Site Configuration and Observation Strategy

Blind areas due to the geographical features



Red line: Blind Area

Blue circle: Target Area

Obstructions in the city (buildings etc.)

Panoramic photo around Radar

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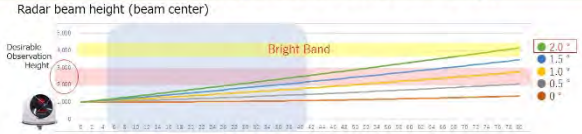
Radar Site Configuration and Observation Strategy

Radar beam height (beam center)



Target Area

Considering geographical features and microwave characteristics,

EL2.0 is the most suitable observation angle.

Let's take a closer look for more precise decision on operation angles with actual observed data.

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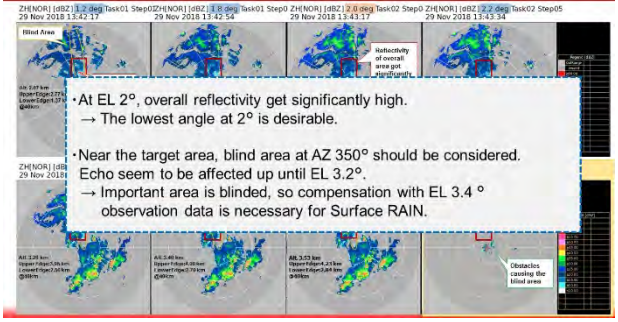
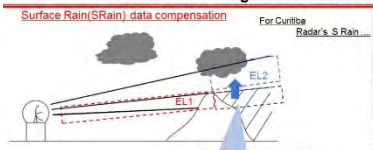
Radar Site Configuration and Observation Strategy

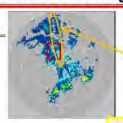


- At EL 2°, overall reflectivity get significantly high.
  → The lowest angle at 2° is desirable.
- Near the target area, blind area at AZ 350° should be considered. Echo seem to be affected up until EL 3.2°.
  → Important area is blinded, so compensation with EL 3.4 ° observation data is necessary for Surface RAIN.

Radar Site Configuration and Observation Strategy

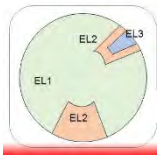
Surface Rain(SRain) data compensation



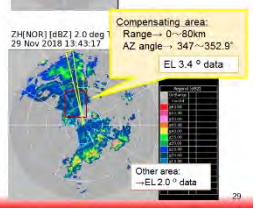


This blind area can be compensated with EL 3.4° data.

Compensate the blind area data with the upper EL angle data.



Register S Rain table with suitable EL angles.



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Radar Site Configuration and Observation Strategy

Sammary of Observation Strategy

- Observation Interval: 1min.
- Scan Mode: PPI scan
- Antenna Rotation Speed: 3.5 rpm for AZ (21 degrees/sec)
- Pulse width: 1 usec (Short Pulse: Observation Range 0 – 10km)
  50 usec (Long Pulse: Observation Range over 10 km)
  Range resolution 150m
- Pulse Repetition Frequency(PRF): 1300 Hz (Single PRF)
- Elevations: 2.0 degrees, 3.4 degrees

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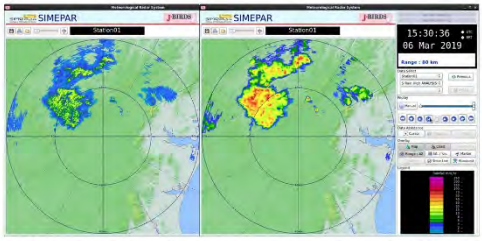
Sample of Rainfall Estimation Results

Sammary of Operation Observation Strategy



SRAIN estimated by R-Z　SRAIN estimated by R-Z+R-Kdp

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Conclusion

1. Well understanding what is a difference of performances between a Conventional Radar and a Polarimetric Radar.
2. Well understanding why we need a Polarimetric Radar for precipitation measurement.
3. Well understanding the location of the Radar Site.
4. Well understanding why we need setting two high beam antenna angles.
5. We confirmed that the X-band Polarimetric Radar installed at the top roof of SIMEPAR was available for using as a rain gauge at Target Area. Therefore, we confirmed that the X-band Polarimetric Radar Data was directly used for as the application of software for the Landslide Risk Monitoring System.

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資料 2：2019 年 4 月 22 日　第 2 回現地活動：防災セミナー資料 1 (5/5)

Interim Report

Collaboration Program with the Private Sector for Disseminating Japanese Technology for Radar Rain Gauge in Parana State

Apr. 2019

JRC Japan Radio Co., Ltd.

Contents

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Purpose of the Project

Period	Jan. 2019 (System operation started)
Target Area	Near Curitiba City (Landslide risk: High)
Main Purpose	Transferring technologies on Disaster Risk Prevention System with X-band Radar to Civil Defense in Parana.

Data Acquisition → Risk Analysis → Warning

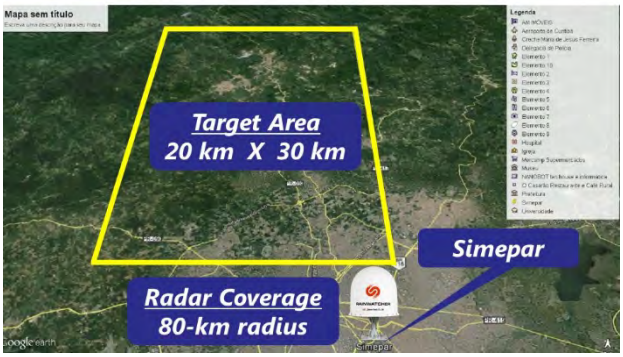
Polarimetric X-band Radar
Real-time Rainfall Data

Radar Data Analysis Server
Landslide Risk Evaluation

Civil Defense
Evacuation Order

Test Field

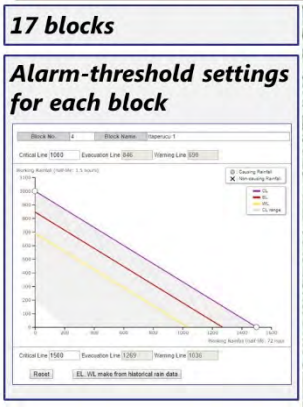
Target Area	Near Curitiba City (Landslide risk: High)

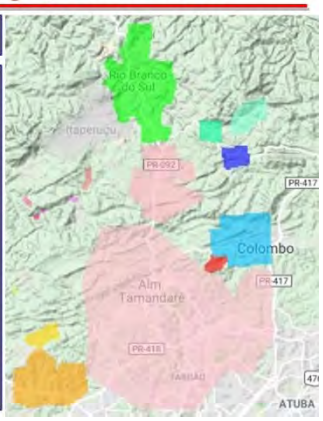


Alarm-threshold Settings for Each Block

17 blocks

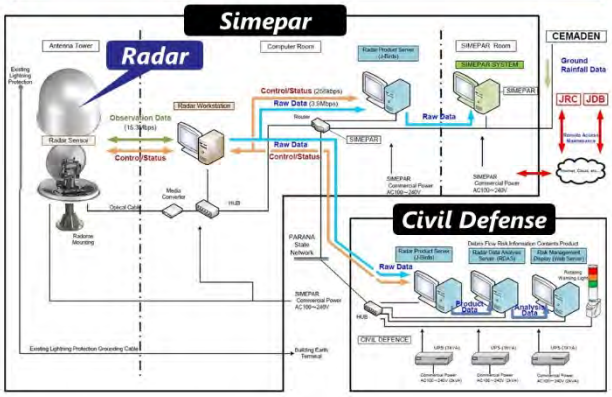
Alarm-threshold settings for each block





1. System Overview

System Configuration



2. System Function

Contents

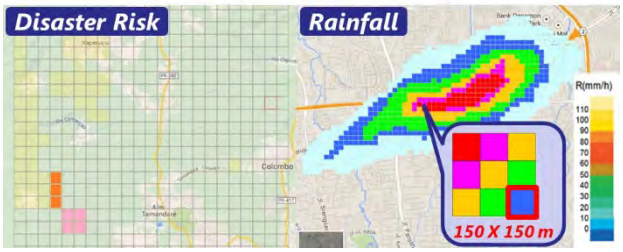
2. System Function

Radar Data Analysis Function

Output Data

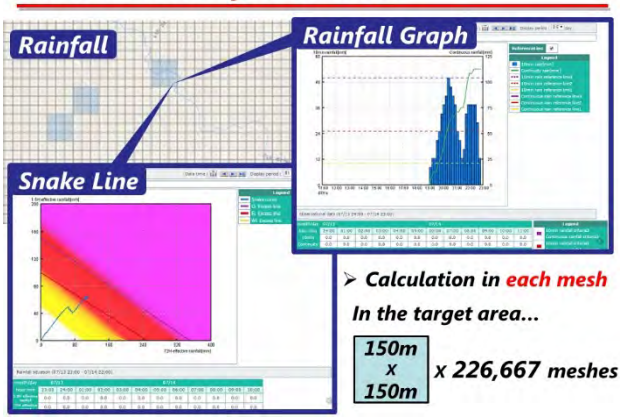
For Flood Forecasting
- 1/10/60-min rainfall
- 24/48-hr rainfall
- Continuous rainfall

For Landslide Forecasting
- 1.5-hr half-life working rainfall
- 72-hr half-life working rainfall



2. System Function

Radar Data Analysis Function



- ***Calculation in each mesh***

In the target area...

150m x 150m **x 226,667 meshes**

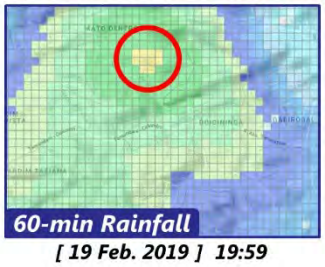
2. System Function

Radar Data Analysis Function

Advantage of 150m-mesh Analysis

- Wide Coverage & High Resolution

→ **The system can detect local heavy rain.**



[19 Feb. 2019] 19:59

2. System Function

Disaster Report Function

Register the disaster information.
- Disaster Type
- Date & Time
- Location (Mesh)
- Photo
- Remarks & Comment

Review the system settings.
- Changing rainfall alarm thresholds
- Changing landslide alarm thresholds

3. Landslide Alarming based on Snake Line

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1. System Overview
2. System Function
3. Landslide Alarming based on Snake Line
4. Case Study 1
5. Case Study 2
6. Threshold Settings
7. Removal of Ground Clutter Effects
8. Future Issues

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3. Landslide Alarming based on Snake Line

What is Snake Line ?

- Snake Line is a graph to analyze landslide risk.
- It's based on 1.5/72-hr Half-life Working Rainfall.

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3. Landslide Alarming based on Snake Line

What is 1.5/72-hr Half-life Working Rainfall ?

1.5-hr Half-life Working Rainfall

- Rainfall accumulated on the ground surface
- Used as a short-period rainfall index

72-hr Half-life Working Rainfall

- Rainfall accumulated under the ground
- Used as a long-period rainfall index

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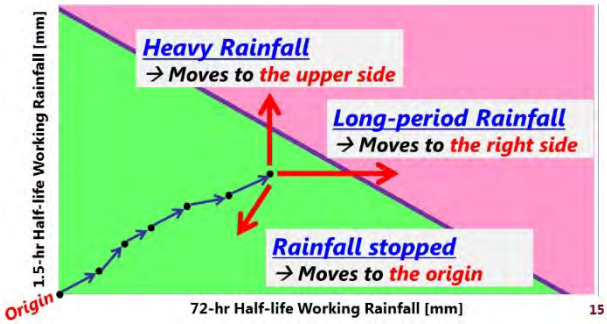
3. Landslide Alarming based on Snake Line

How does Snake Line move ?

- Snake Line moves based on the conditions below.



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4. Case Study 1

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7. Removal of Ground Clutter Effects
8. Future Issues

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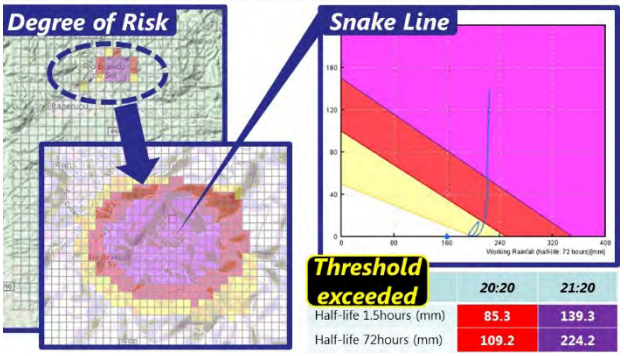
4. Case Study 1

Landslide Warning – 30 Jan. 2019

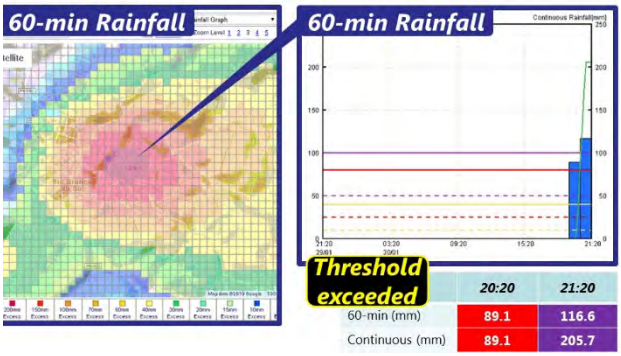
[30 Jan. 2019] 20:08 Landslide Warning was generated with heavy rain.



4. Case Study 1

Landslide Warning – 30 Jan. 2019

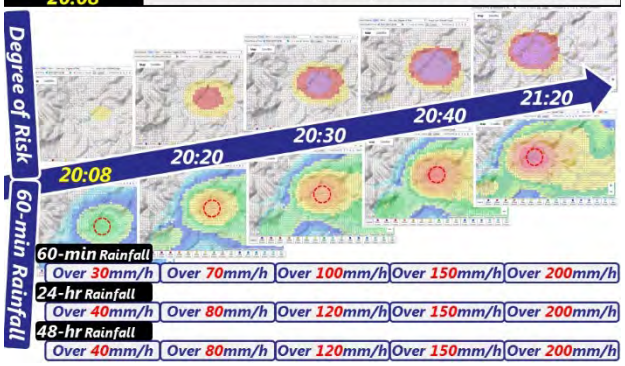
[30 Jan. 2019] 20:08 Landslide Warning was generated with heavy rain.



4. Case Study 1

Landslide Warning – 30 Jan. 2019

[30 Jan. 2019] 20:08 Landslide Warning was generated with heavy rain.



5. Case Study 2

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7. Removal of Ground Clutter Effects
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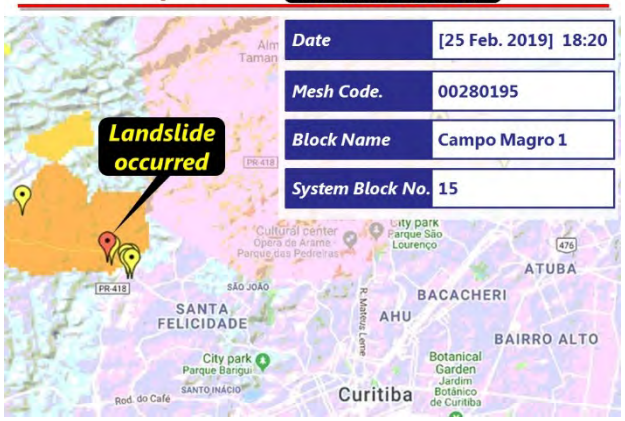
5. Case Study 2

Disaster Report

[25 Feb. 2019] 18:20 Landslide occurred



5. Case Study 2

Rainfall Period

[25 Feb. 2019] 18:20 Landslide occurred

Rainfall period
26/03/2019 16:03:00 ~
24/03/2019 15:16:00 ~ 26/03/2019 14:53:00
22/03/2019 14:51:00 ~ 23/03/2019 08:09:00
21/03/2019 00:05:00 ~ 22/03/2019 03:57:00
19/03/2019 13:40:00 ~ 20/03/2019 17:39:00
04/03/2019 13:45:00 ~ 06/03/2019 00:36:00
28/02/2019 08:11:00 ~ 01/03/2019 18:28:00
23/02/2019 12:18:00 ~ 28/02/2019 06:48:00
18/02/2019 18:40:00 ~ 23/02/2019 11:54:00
15/02/2019 07:11:00 ~ 18/02/2019 06:58:00
11/02/2019 14:23:00 ~ 14/02/2019 01:40:00
08/02/2019 13:53:00 ~ 08/02/2019 23:36:00
30/01/2019 16:16:00 ~ 06/02/2019 13:32:00
16/01/2019 12:55:00 ~ 28/01/2019 19:18:00
05/01/2019 06:48:00 ~ 06/01/2019 15:00:00
30/12/2018 19:31:00 ~ 04/01/2019 13:30:00
20/12/2018 23:00:00 ~ 30/12/2018 18:41:00
18/12/2018 12:08:00 ~ 20/12/2018 22:11:00
06/12/2018 00:18:00 ~ 16/12/2018 19:42:00

[23 Feb. 2019] 12:18
Rainfall started

[25 Feb. 2019] 18:20
Landslide occurred

[28 Feb. 2019] 6:48
Rainfall stopped

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5. Case Study 2

Rainfall Period

[25 Feb. 2019] 18:20 Landslide occurred

25 Feb. 2019 10:00 to 18:30

60min Rainfall

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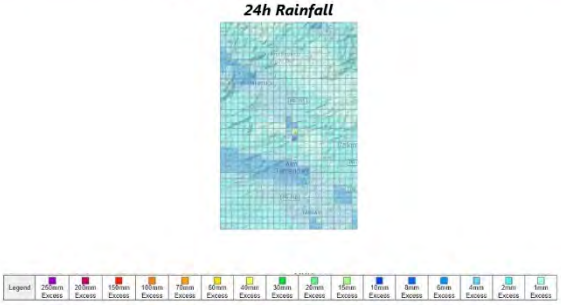
Rainfall Period

[25 Feb. 2019] 18:20 Landslide occurred

5. Case Study 2

25 Feb. 2019 10:00 to 18:30

24h Rainfall



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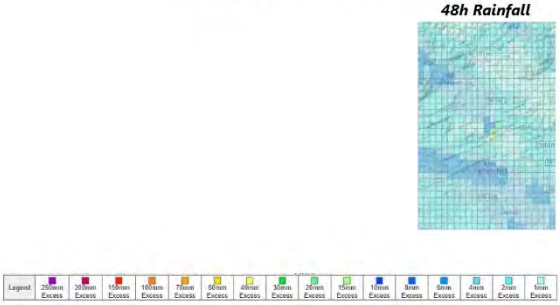
Rainfall Period

[25 Feb. 2019] 18:20 Landslide occurred

5. Case Study 2

25 Feb. 2019 10:00 to 18:30

48h Rainfall



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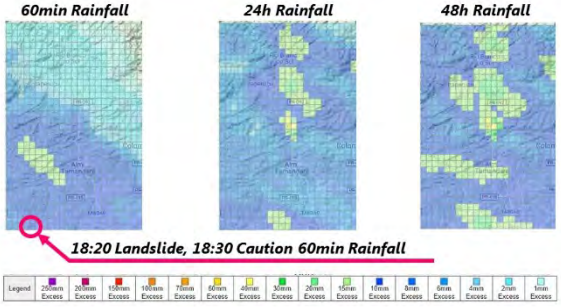
Rainfall Period

[25 Feb. 2019] 18:20 Landslide occurred

5. Case Study 2

25 Feb. 2019 18:30

60min Rainfall　24h Rainfall　48h Rainfall



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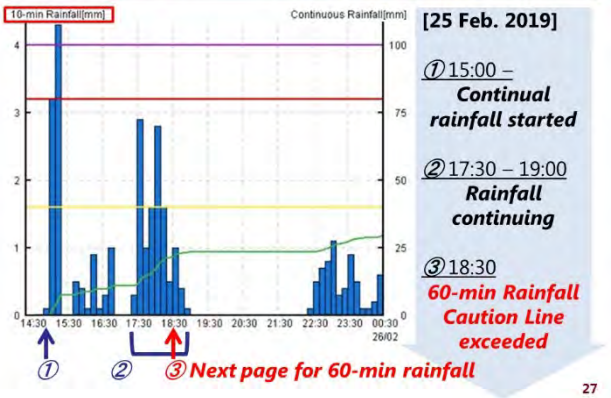
10-min Rainfall

[25 Feb. 2019] 18:20 Landslide occurred

5. Case Study 2



[25 Feb. 2019]

①15:00 – Continual rainfall started

②17:30 – 19:00 Rainfall continuing

③18:30 60-min Rainfall Caution Line exceeded

Next page for 60-min rainfall

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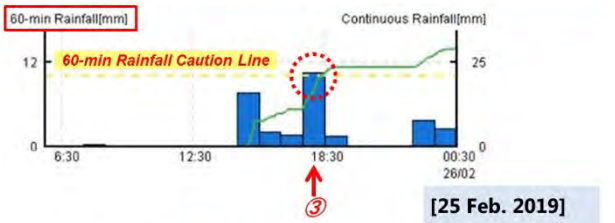
60-min Rainfall

[25 Feb. 2019] 18:20 Landslide occurred

5. Case Study 2



[25 Feb. 2019]

③18:30 60-min Rainfall Caution Line exceeded

- Threshold *for Rainfall* exceeded
- Alarm *for Rainfall* generated

but...

- Alarm *for Landslide* ***NOT*** generated

because...

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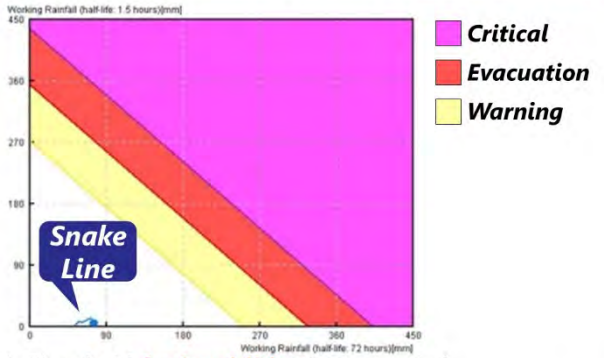
Snake Line

[25 Feb. 2019] 18:20 Landslide occurred

5. Case Study 2



- Threshold *for Landslide* ***NOT*** exceeded

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5. Case Study 2

Issue and Solution

When the landslide occurred...

➢Threshold ***for Rainfall*** exceeded
→ The risk of landslides was ***high***.

but...

➢Threshold ***for Landslide*** ***NOT*** exceeded

How can we solve the issue ?

1. Accumulating more data
2. Setting better thresholds

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5. Case Study 2

Issue and Solution

1. Accumulating more data

➢ ***Accumulating rainfall data improves accuracy.***

Only 3 months have passed since the system started. It's desirable to acquire data for rainy seasons.

➢ ***Accumulating landslide data improves accuracy.***

Don't forget to input landslide occurrences to the disaster report page of the system!!

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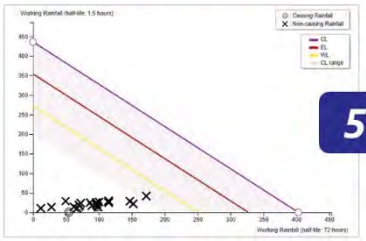
5. Case Study 2

Issue and Solution

2. Setting better thresholds

➢ Updating thresholds regularly improves accuracy.

How can we determine thresholds?



5 patterns

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6. Threshold Settings

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8. Future Issues

5 patterns

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6. Threshold Settings

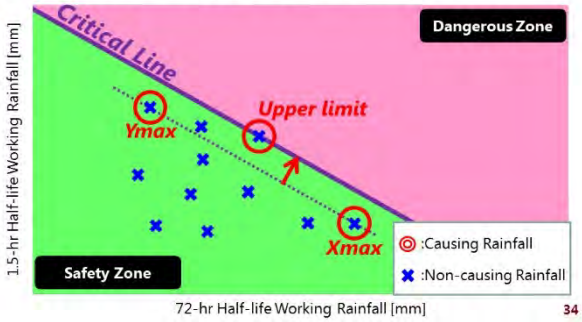
No Landslide Occurrence

Pattern 1

No Causing Rainfall exists.

Use this method only when the Non-causing Rainfall data is reliable.

➢ Connect Xmax and Ymax.
➢ Move the line to the upper limit of Non-causing Rainfalls.



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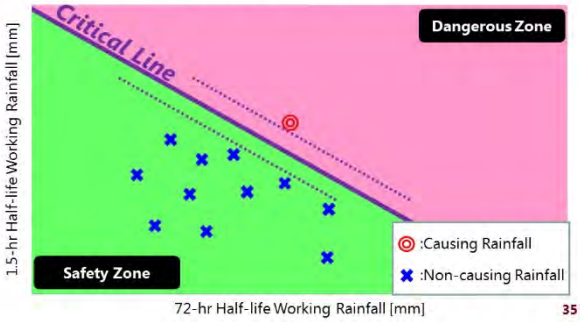
6. Threshold Settings

Single Landslide Occurrence (1)

Pattern 2

A single Causing Rainfall exists separated from Non-causing Rainfalls.

➢ Set a critical line between the upper limit of Non-causing Rainfalls and the lower limit of Causing Rainfall.



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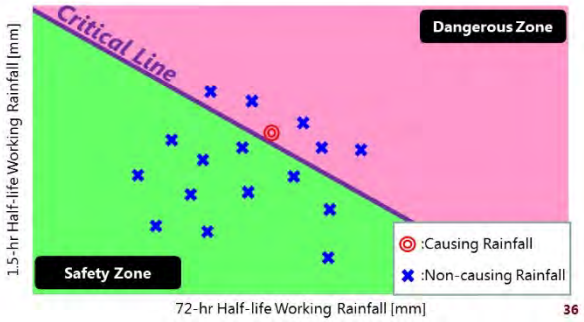
6. Threshold Settings

Single Landslide Occurrence (2)

Pattern 3

A single Causing Rainfall exists mixed with Non-causing Rainfalls.

➢ Set a critical line along the lower limit of Causing Rainfall.



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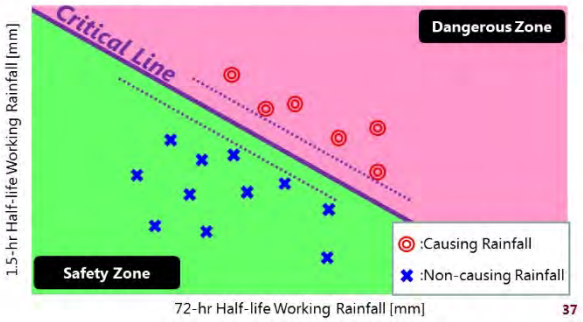
6. Threshold Settings

Multiple Landslide Occurrences (1)

Pattern 4

Multiple Causing Rainfalls exist separated from Non-causing Rainfalls.

➢ Set a critical line between the upper limit of Non-causing Rainfalls and the lower limit of Causing Rainfalls.



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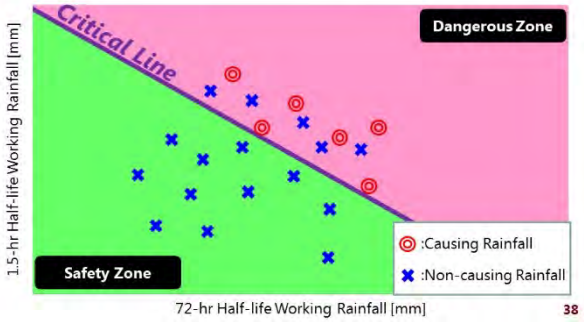
6. Threshold Settings

Multiple Landslide Occurrences (2)

Pattern 5

Multiple Causing Rainfalls exist mixed with Non-causing Rainfalls.

➢ Set a critical line along the lower limit of Causing Rainfalls.



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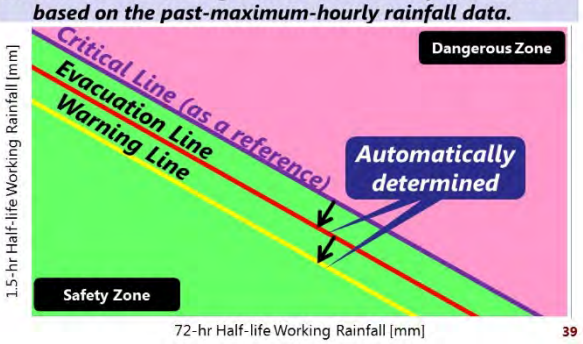
6. Threshold Settings

Setting Evacuation Line & Warning Line

1. ***Critical Line is set as a reference line.***
2. ***Evacuation/Warning Line is automatically determined based on the past-maximum-hourly rainfall data.***



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7. Removal of Ground Clutter Effects

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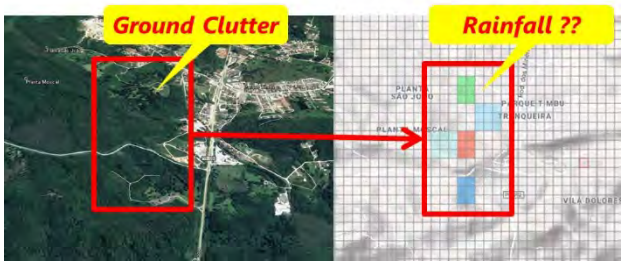
7. Removal of Ground Clutter Effects

Negative Effects by Ground Clutter

What's "Ground Clutter"?

➢ Unwanted reflection from mountains, buildings, etc.

→ **The system can determine it as rainfall.**



7. Removal of Ground Clutter Effects

Negative Effects by Ground Clutter

Negative Effects on the System

1. False alarming

Thresholds of...

- 60-min Rainfall
- 24-hr Rainfall
- 48-hr Rainfall
- Continuous Rainfall

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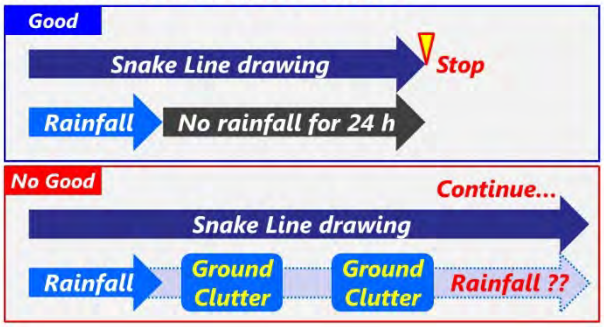
7. Removal of Ground Clutter Effects

Negative Effects by Ground Clutter

Negative Effects on the System

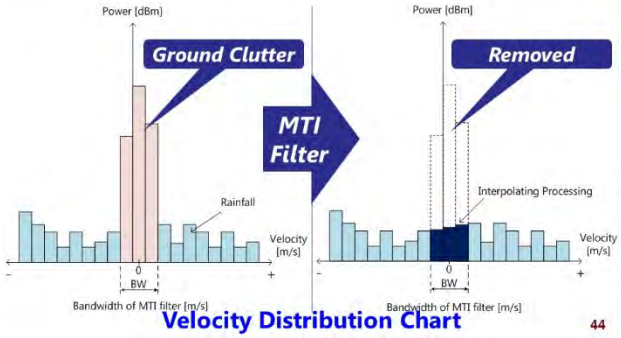
2. Snake Line drawing NOT stopped



7. Removal of Ground Clutter Effects

How to Remove Ground Clutter Effects

1. Moving Target Indication (MTI) Processing



Velocity Distribution Chart

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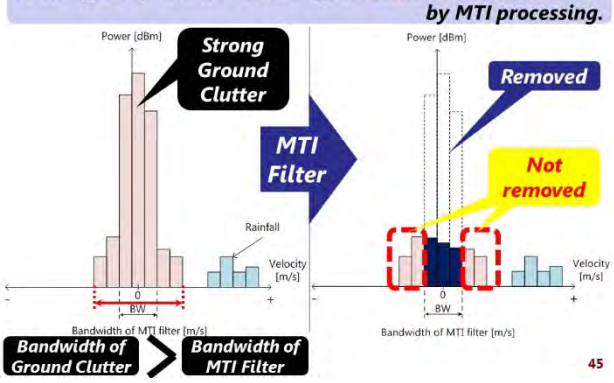
7. Removal of Ground Clutter Effects

How to Remove Ground Clutter Effects

Some types of Ground Clutter effects cannot be removed by MTI processing.



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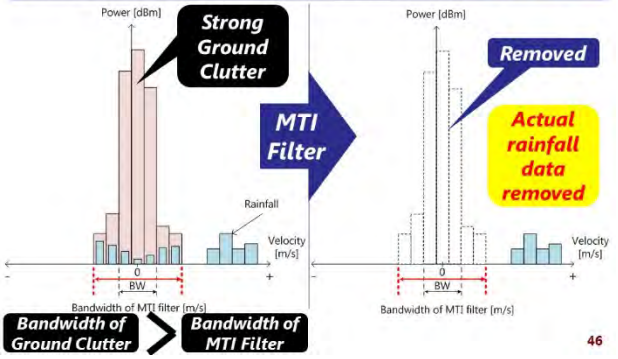
7. Removal of Ground Clutter Effects

How to Remove Ground Clutter Effects

What if the bandwidth of MTI Filter makes wider ?



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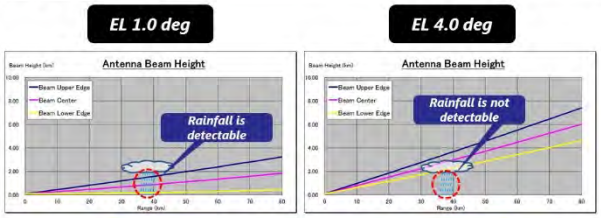
7. Removal of Ground Clutter Effects

How to Remove Ground Clutter Effects

2. Making the elevation angle of Radar higher



If the angle is higher, rainfalls can be measured with no accuracy.

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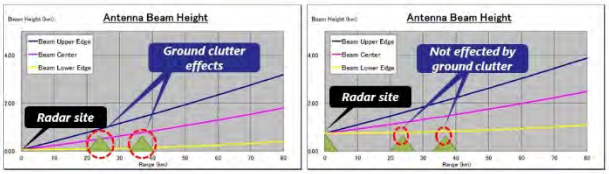
7. Removal of Ground Clutter Effects

How to Remove Ground Clutter Effects

3. Moving the radar site to a higher place



High Cost
- **Power Facilities**
- **Roads to the site**

etc.

7. Removal of Ground Clutter Effects

How to Remove Ground Clutter Effects

It's difficult to remove the Ground Clutter effects completely.

What measures against Ground Clutter effects are taken in the system at present ?

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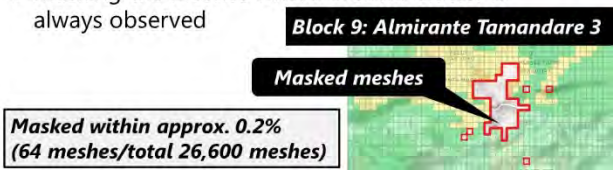
7. Removal of Ground Clutter Effects

Measures against Ground Clutter in System [Now]

Measures against Ground Clutter Effects

- Making the elevation angle of Radar as large as possible
- Making the bandwidth of MTI Filter as wide as possible
- Masking the meshes where Ground Clutter is always observed



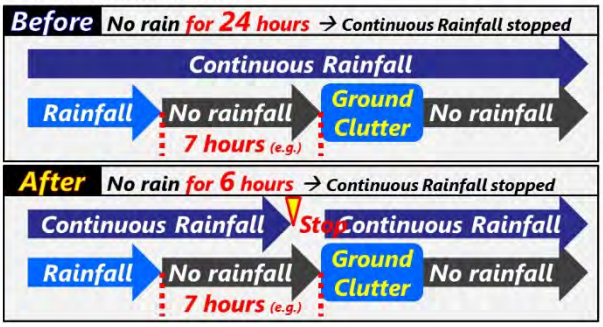
Masked within approx. 0.2% (64 meshes/total 26,600 meshes)

7. Removal of Ground Clutter Effects

Measures against Ground Clutter in System [Now]

Measures against "False Alarming"

- Changing the conditions to determine when to stop "Continuous Rainfall"



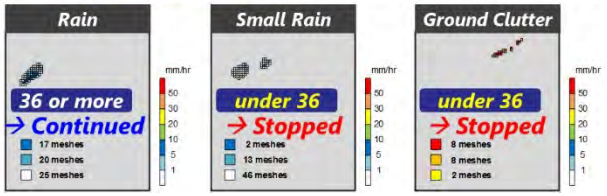
7. Removal of Ground Clutter Effects

Measures against Ground Clutter in System [Now]

Measures against "Snake Line drawing NOT stopped"

- Changing the conditions to determine when to stop Snake Line drawing

Before	**No rain in all the meshes for 24 hours → Drawing stopped**
After	**1mm/hr-or-more rainfall/mesh in under 36 meshes for 24 hours → Drawing stopped**



8. Future Issues

Contents

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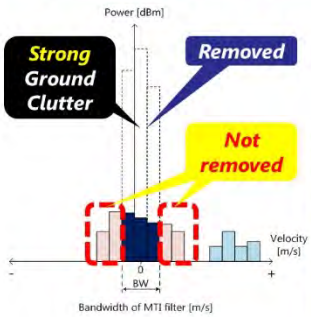
8. Future Issues

Future Issues

1. Removal of Ground Clutter in non-masked meshes



Characteristics of Ground Clutter

- Occurs in very short time.
- Occurs in different places every time.

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8. Future Issues

Future Issues

2. Removal of interference from other radars

Characteristics of Interference

- Occurs in different places every time.

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Conclusion

Conclusion

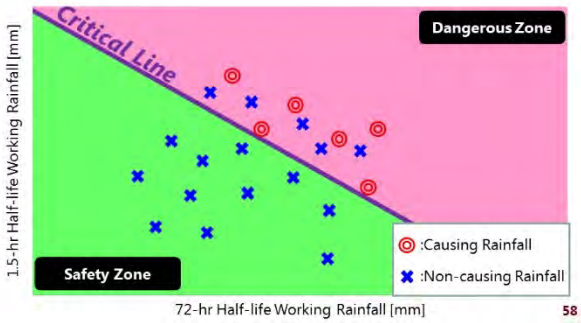
Polarimetric radar as a radar rain gauge is effective for landslide risk management.

Appendix

Appendix 1

[Appendix 1] How to Plot Rainfall Data

- **Appendix 1** describes how rainfall data is plotted.



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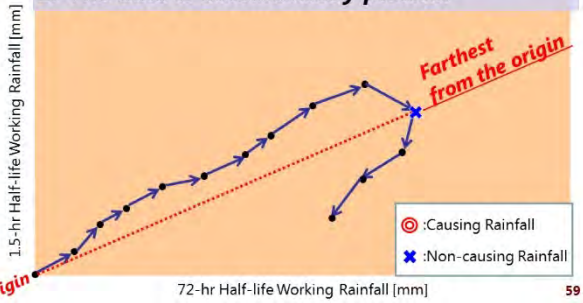
Appendix 1

[Appendix 1] How to Plot Rainfall Data

Plotting Non-causing Rainfall

1. The data farthest from the origin is selected.
2. The data is automatically plotted.



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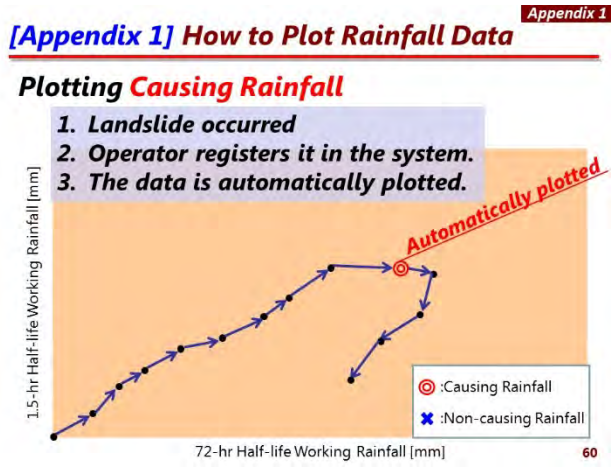
Appendix 1
[Appendix 1] How to Plot Rainfall Data
Plotting Causing Rainfall
1. Landslide occurred
2. Operator registers it in the system.
3. The data is automatically plotted.
Automatically plotted
:Causing Rainfall
:Non-causing Rainfall
1.5-hr Half-life Working Rainfall [mm]
72-hr Half-life Working Rainfall [mm]
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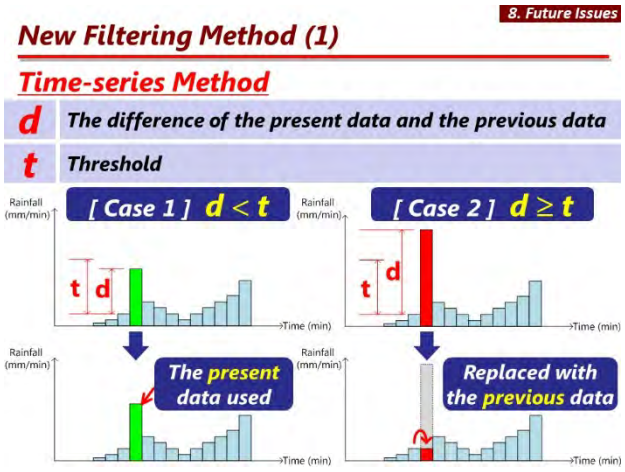
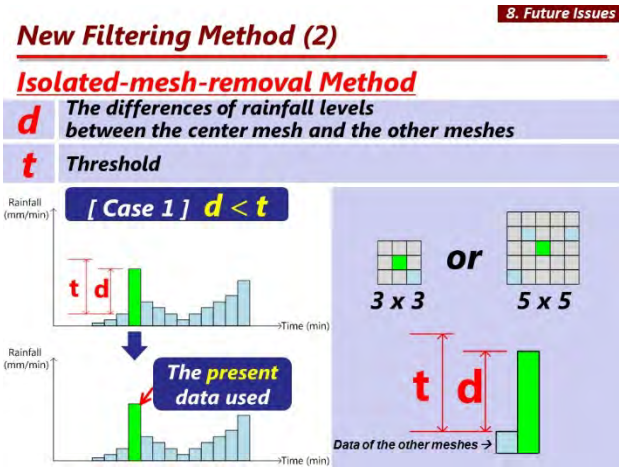
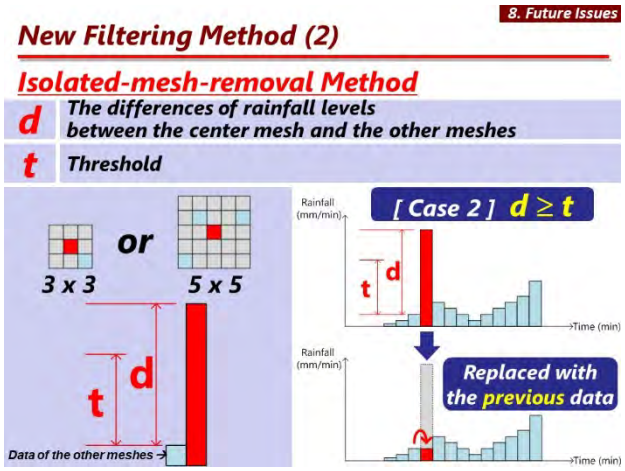

8. Future Issues
New Filtering Method (1)
Time-series Method
d The difference of the present data and the previous data
t Threshold
[Case 1] d < t
[Case 2] d ≥ t
Rainfall (mm/min)
Time (min)
The present data used
Replaced with the previous data


8. Future Issues
New Filtering Method (2)
Isolated-mesh-removal Method
d The differences of rainfall levels between the center mesh and the other meshes
t Threshold
[Case 1] d < t
Rainfall (mm/min)
Time (min)
The present data used
or
3 x 3
5 x 5
Data of the other meshes


8. Future Issues
New Filtering Method (2)
Isolated-mesh-removal Method
d The differences of rainfall levels between the center mesh and the other meshes
t Threshold
or
3 x 3
5 x 5
Data of the other meshes
[Case 2] d ≥ t
Rainfall (mm/min)
Time (min)
Replaced with the previous data