

# Session 1.4

## Review of the results of the questionnaire on Quality Management of Surface Meteorological Observations in RA II

S. Kigawa, K. Makiyama and T. Hayashi  
Japan Meteorological Agency  
19 March 2018

Thank you  
for joining this workshop

# Communication with you in the last two months

#1  
19 Jan

**JMA/WMO Workshop on Quality Management of Surface Observations**  
RA II WIGOS Project, 19-21 March 2018, Tokyo, Japan

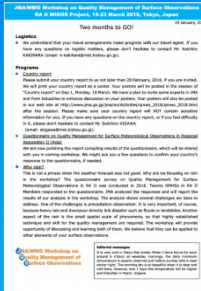
Two months to GO!

**Legends**

- 1. An assessment that your team assessments have prepared with our best effort. If you have any questions or require further assistance, please email feedback to wmo@jma.go.jp.

**Progress**

- 1. **GOALS** - We have your quality reports to do not later than 22 February 2018. If you are not able to do so, please email us as soon as possible. We will be able to provide you with the quality reports for surface observations on 22 February 2018. We will be able to provide you with the quality reports for surface observations on 22 February 2018. We will be able to provide you with the quality reports for surface observations on 22 February 2018.



#2  
25 Jan

**JMA/WMO Workshop on Quality Management of Surface Observations**  
RA II WIGOS Project, 19-21 March 2018, Tokyo, Japan

Heavy snow

**Legends**

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#3  
31 Jan

**JMA/WMO Workshop on Quality Management of Surface Observations**  
RA II WIGOS Project, 19-21 March 2018, Tokyo, Japan

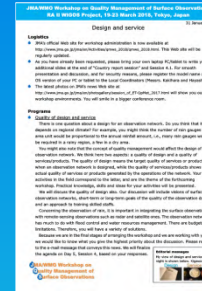
Design and service

**Legends**

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#4  
6 Feb

**JMA/WMO Workshop on Quality Management of Surface Observations**  
RA II WIGOS Project, 19-21 March 2018, Tokyo, Japan

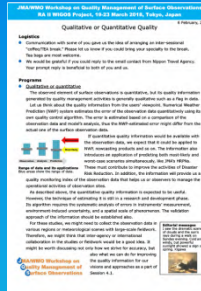
Qualitative or Quantitative Quality

**Legends**

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#5  
14 Feb

**JMA/WMO Workshop on Quality Management of Surface Observations**  
RA II WIGOS Project, 19-21 March 2018, Tokyo, Japan

Timing and reporting tool

**Legends**

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#6  
19 Feb

**JMA/WMO Workshop on Quality Management of Surface Observations**  
RA II WIGOS Project, 19-21 March 2018, Tokyo, Japan


One month to GO!

**Legends**

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**Progress**

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#7  
27 Feb

**JMA/WMO Workshop on Quality Management of Surface Observations**  
RA II WIGOS Project, 19-21 March 2018, Tokyo, Japan

Attendance

**Legends**

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**Progress**

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#8  
6 Mar

**JMA/WMO Workshop on Quality Management of Surface Observations**  
RA II WIGOS Project, 19-21 March 2018, Tokyo, Japan

Emergency assemblies, everything connects

**Message**

- 1. An assessment that your team assessments have prepared with our best effort. If you have any questions or require further assistance, please email feedback to wmo@jma.go.jp.

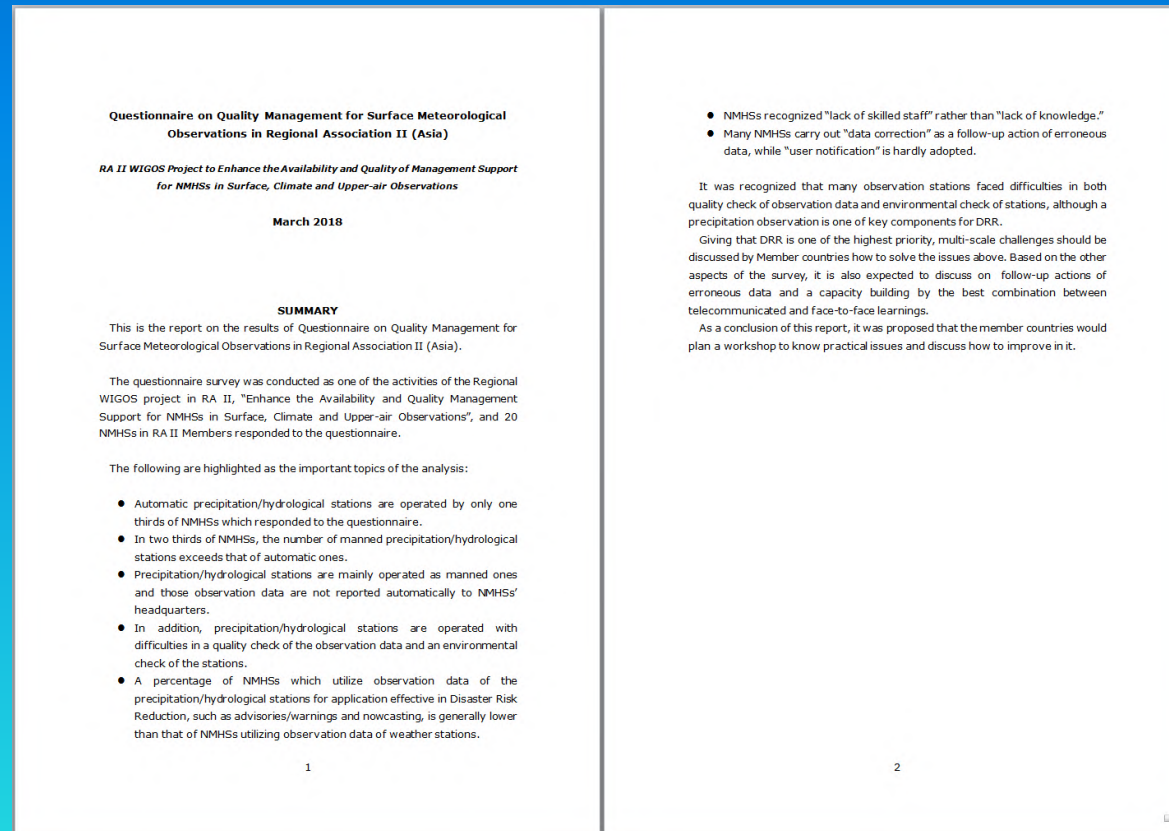
**Legends**

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# And many e-mail messages

# Draft report



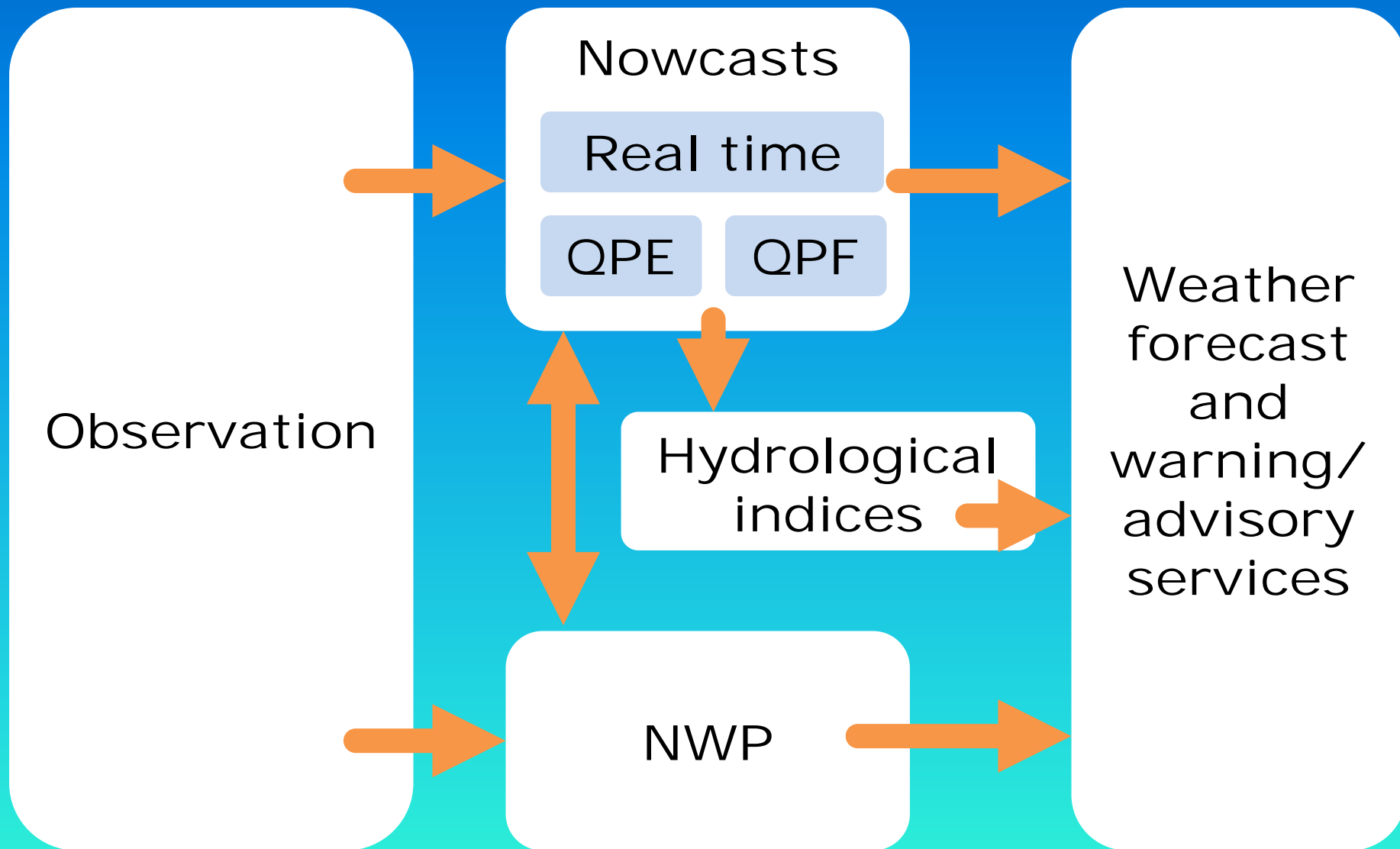
2 tables and 32 graphs

# Why?

## Why do we assemble here?



# JMA's approach



# JMA's posters on Day 4

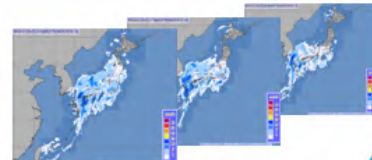
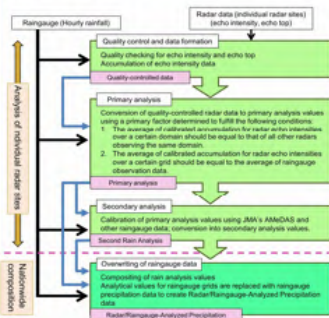
## RADAR/RAINGAUGE-ANALYZED PRECIPITATION

### Outline

The Radar/Rain Gauge-Analyzed Precipitation product (referred to here as "RA") provides estimation data on precipitation in areas lacking rain gauges based on radar observation of rainfall intensity. Radar rainfall calibration using precipitation data from rain gauges increases the quantitative accuracy of RA information, giving it clear superiority over radar and rain gauge data alone.

RA data generation is based on observation results from JMA and MLIT and on information from rain gauges operated by JMA, MLIT and local governments. The process involves the following:

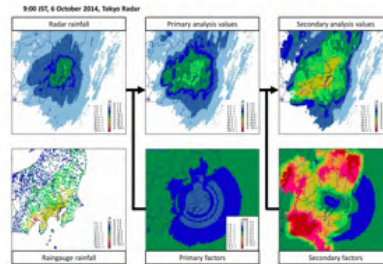
- Quality control
- Data conversion
- Primary analysis of rainfall
- Secondary analysis of rainfall
- Nationwide composition generation
- Rain gauge data overwriting



### Rain gauge data overwriting

Pre-secondary factor interpolation for secondary factor estimation may cause underestimation at rain gauge grid points. To prevent non-detection of heavy rain, hourly rain gauge rainfall data are overwritten for such grid points. Data in the surrounding eight grid points are also overwritten with interpolated values if their original values are lower than hourly rain gauge rainfall.

Light rain from stratus clouds sometimes evades radar detection even if it is caught by rain gauges. When hourly rain gauge rainfall ranges from 0.5 to 4 mm and secondary analysis values around the gauge are lower than this, the hourly rain gauge rainfall for the grid point and its surrounding points is also overwritten.



### Secondary analysis

The objective of secondary analysis is to examine small-scale precipitation distribution using rain gauge data provided by JMA, MLIT and local governments. a) b)



Unbalanced distribution of rain gauges  
The red cubes indicate target grid points, and the blue cylinders are rain gauges.  
a) Each area has one rain gauge.  
b) One of the four areas has more rain gauges.

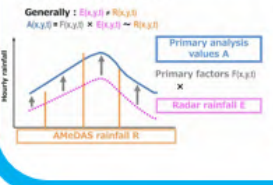
Secondary factor calculation  
The pre-secondary factor for a rain gauge grid point is determined by calculating the ratio of hourly rain gauge rainfall to the primary factor value of its maximum in an 11 x 11 km area. Quality is controlled by comparison with the surrounding areas and values from the past three hours. Secondary factors for target grid points (shown here by the red square in the center) are determined by pre-secondary factor interpolation in a 101 x 101 km area.

### Rain gauge quality control

Rain gauge data provided from outside JMA are quality-controlled upon arrival. Data from rain gauges with quality flags and those for which reported positional conversion and values in the constant table differ are not used. Data from gauges showing excessive cumulative hourly precipitation are also eliminated.

### Primary analysis

Primary analysis is conducted to adjust spatial distributions of hourly radar rainfall data to AMeDAS-based hourly rainfall observation data. AMeDAS is an acronym of Automated Meteorological Data Acquisition System – the name given to JMA's AWS (Automatic Weather Station) network in Japan. The network has approximately 1,300 rain gauges at intervals of around 17 km. Adjustment is conducted by multiplying radar-observed rainfall values with a primary factor for each radar.

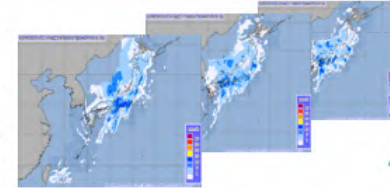


## VERY-SHORT-RANGE FORECASTS OF PRECIPITATION

### Outline

Very-short-range forecasts of precipitation (referred to here as "VSRF") are issued at 10 minute intervals to predict one-hour precipitation amounts for the next six hours.

Extrapolation from an initial value is the most accurate method for precipitation prediction with a head time of up to a few hours. This approach involves prediction of precipitation distribution based on initial intensity and velocity. As the fundamental characteristic of extrapolation is linear, the accuracy of extrapolation-based prediction decreases with head time and deteriorates markedly beyond the lifecycle of a precipitation phenomenon. The accuracy of numerical weather prediction (NWP) also decreases with time, but the deterioration is gradual and lower than that of the extrapolation method in the first few hours. Based on these characteristics, appropriate combination of extrapolation and NWP provides optimal performance in precipitation prediction with a head time of up to several hours.

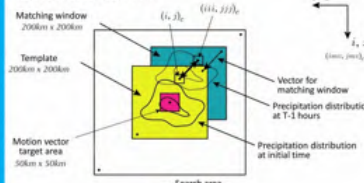


### Initial values

The initial values of precipitation distribution prediction are calculated from the nationwide composition of radar echo intensity and the primary and secondary factors obtained in RA generation.

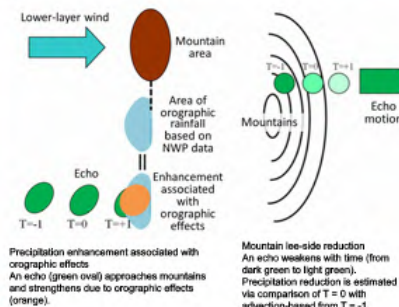
### Motion vectors

Large-scale motion vectors of precipitation distribution are estimated as universal motion vectors based on RA series data from the past three hours. Heavy rain motion vector determination is based on tracking of only heavy rain areas if rainfall of 10 ~ 30 mm/h or more is shown in the initial data.



### Orographic effects

Calculation of landform-induced effects in VSRF involves enhancement in consideration of orographic rainfall, dissipation and mountain overtopping. Orographic rainfall information contained in initial data is estimated using NWP data.



### Overall Prediction

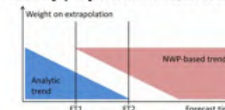
Prediction of precipitation intensity distribution is based on extrapolation of the nationwide composition of precipitation intensity at the initial time with related trend prediction.

Heavy-rain-area motion vectors are merged with universal motion vectors. Multi-time-interval motion vectors are used for prediction at the corresponding forecast time. Thus, while prediction at earlier forecast times is generated using motion vectors determined at shorter time intervals, prediction at later forecast times is based on motion vectors with longer time intervals.

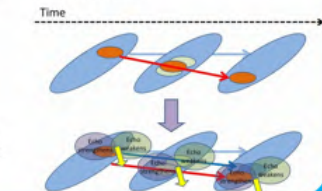
### Trend prediction

Precipitation intensity trends are estimated and predicted using the latest data on echo motion and NWP rainfall forecasts. In the extrapolation method, the drift of precipitation intensity is predicted without intensity change except for orographic effects. This approach provides accurate prediction up to a few hours for large-scale (i.e., long-lasting) meteorological disturbances. However, for small-scale disturbances, trend prediction is needed to improve prediction accuracy.

For VSRF, a method of trend prediction (i.e., variations in precipitation intensity with time) is adopted. This approach is based on trend estimation at the initial time and the trend calculated from NWP data. As illustrated below, the relative weights for this estimation are changes with forecast time. The analytic trend is highly weighed in the first hour, and its weight decreases with time.



The analytic trend is also useful when complex echo motions are observed. Top: A precipitation system (blue) moves eastward and a heavy-rain area (red) in the system moves southward. The extrapolation method involves the use of motion vectors created by combining universal motion vectors with heavy-rain-area motion vectors. If there is a difference in motion between the precipitation system and the heavy rain core, prediction may be insufficient due to the mismatching of motion vectors against this system and core. Trend extrapolation solves this problem. Bottom: Analytic trend information improves prediction accuracy for complex echo motion.





# JMA's posters on Day 4

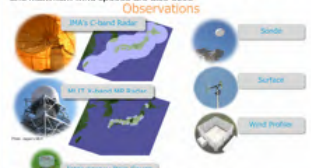
## HIGH-RESOLUTION PRECIPITATION NOWCASTS

### Outline

Since summer 2004, the Japan Meteorological Agency (JMA) has issued Precipitation Nowcasts (referred to here as conventional Precipitation Nowcasts, or CPNs) providing information on horizontal precipitation distribution up to an hour ahead with a spatial resolution of 1 km. To mark the 10th anniversary of the launch of CPNs, High-Resolution Precipitation Nowcasts (HPRNs) were introduced in August 2014 with the primary objective of enhancing capacity for observation and prediction of torrential localized heavy rain and mitigation of related damage. This section describes the analysis/prediction techniques used in HPRN generation.

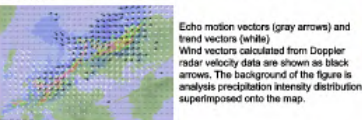
### Data used in HPRNs

HPRN analysis algorithm inputs are observation data including two distinct radar networks, surface, inter-agency rain gauge, radiosonde, wind profiler, GPS (Global Positioning System)-based precipitable water and Lightning Detection Network System (LIDEN) information. Data on typhoon locations and maximum wind speeds are also used.



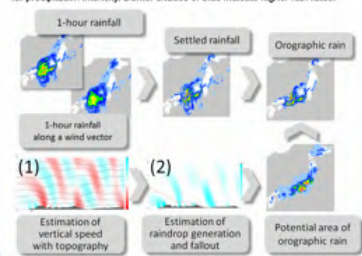
### Motion detection

A multi-scale motion detection technique is adopted for HPRNs, as with CPNs, to determine motion on various temporal and spatial scales for the establishment of echo motion vectors. Scales range in time from 5 minutes to 1 hour, and on a horizontal scale from cumulonimbus cloud size to nearly 100 km.



### Orographic rain estimation

Settled rain is calculated by subtracting the along-track 1-hour rainfall from stationary rainfall. Figure (1) shows the vertical section of vertical velocity with wind from left to right. Ascending and descending areas are indicated in blue and red, respectively. Figure (2) shows the same region as (1), but for precipitation intensity. Darker shades of blue indicate higher rain rates.



### Quick and easy access

HPRNs are intended to support self-protection against sudden heavy rain. JMA's related web pages are designed to give users an overview of the situation with the minimum number of clicks to enable prompt evacuation for safety. These resources are optimized for mobile device and PC viewing.

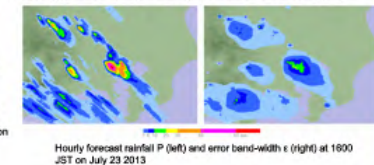


JMA's HPRN web resources Mobile (left) and PC (right) resources are provided to support self-protection. Several options are given for superimposition of information on areas where heavy rain, lightning and hazardous winds are expected. Rainfall amounts from rain gauge observation can also be displayed.

### Error band-width estimation

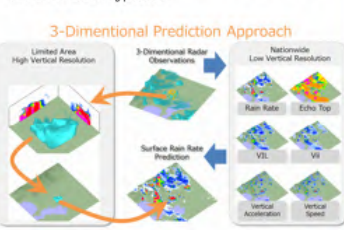
Nowcasting prediction improvement has brought new challenges in the provision of information on prediction quality to users. The quality of prediction between a well-observed echo already present at the initial time and a cumulonimbus developing during the forecast time may differ significantly.

From another viewpoint, prediction quality is affected by the integrity of initial values (i.e., analysis data). Incoherent data caused by radio wave interference can make rain appear heavier than it actually is, and persistent non-precipitation echoes caused by structures such as windmills may be erroneously interpreted as orographic rain. Accordingly, prediction quality is indirectly linked to radar observation quality.



### 3D Prediction

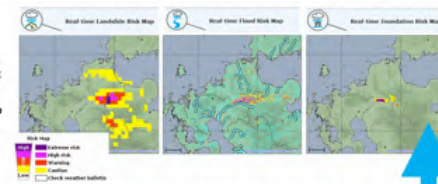
HPRNs adopt an approach using a high-resolution prediction by spatial three dimensions regarding notable heavy rain regions selected. Predictions outside the selected regions are generated by a longer time step and reduced vertical calculations using several two-dimensional information converted from the three-dimensional distribution of rain. This enables to distribute a high-resolution and high-quality prediction with securing its timeliness as nowcasting products.



## SOIL WATER INDEX, RUNOFF INDEX, AND SURFACE WATER INDEX

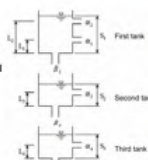
### Outline

When hazardous weather conditions are expected, JMA issues a variety of information including Emergency Warnings, Warnings, Advisories and Bulletins so that appropriate measures can be taken to mitigate possible incidents. Such information is utilized for disaster risk reduction (DRR) activities such as the issuance of evacuation order/instructions by municipal authorities and advice on voluntary evacuation. Emergency Warnings, Warnings, Advisories and Landslide Alert Information are issued in consideration of Soil Water Index and Runoff Index values. Surface Water Index information can be used for Emergency Warnings, Warnings, and Advisories for heavy rain. These three indices are calculated using a tank model.



### Tank model

The relevant tank model was developed more than 50 years ago by the National Research Center for Disaster Prevention (NRCDP) to predict river water levels based on rainfall observation. The original version of the model calculates rainfall amounts flowing into rivers with a temporal delay (Okada, 2000).

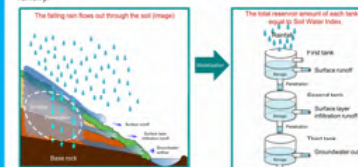


Three-tank cascade model The tank model used by JMA is the one proposed by Itohara and Kobelake (1979). The right figure shows a three-tank cascade model. The first, second and third tanks correspond to surface runoff, surface layer infiltration runoff and groundwater outflow, respectively.

### Soil Water Index

The Soil Water Index provides estimations on average amounts of water stored in soil of certain areas, helping to clarify the risk of landslide-related incidents caused by heavy rain. JMA uses index values as criteria for the issuance of Emergency Warnings, Warnings Advisories for heavy rain and Landslide Alert Information.

Rainwater penetrates the ground surface and flows into rivers or into the ground. As the amount of water stored in soil increases, the risk of land slope collapse rises. Figure below shows a tank model simulating how rainwater flows out through soil. Each tank has a side outlet representing outflow to the surrounding soil and a bottom outlet representing outflow to deeper ground. Output from the side outlet of the first tank corresponds to surface runoff, that of the second tank corresponds to infiltration runoff at the surface layer, and that of the third tank corresponds to runoff as groundwater. Input to the first tank corresponds to rainfall, and input to the second and third tanks is output from the bottom outlet of the upper tank (infiltration runoff).



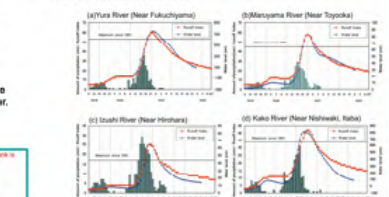
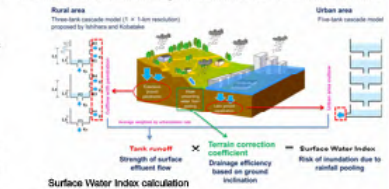
Modeling of rainfall accumulation in soil and runoff

### Runoff Index

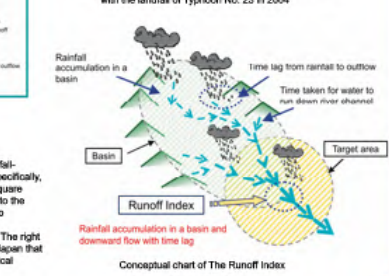
The Runoff Index represents the probability and potential magnitude of rainfall-related flooding. It indicates the amount of rain water contained in rivers. Specifically, values express the amount of water at a certain point in a river with 5-km square resolution. Calculation is based on simulation in which precipitation flows into the river (runoff process) and flows downstream (flow process) with reference to information on the river channel, basin and land use. JMA uses the Runoff Index for issuance of Flood Warnings and Advisories. The right figure outlines the concept of the index, which is calculated for all rivers in Japan that have a length of 15 km or more and are registered in National Land Numerical Information.

### Surface Water Index outline

Surface Water Index values indicate the risk of inland inundation caused by rainfall. Such inundation occurs when rainfall exceeds the capacity of sewers, roadside ditches and other drainage facilities, and is often seen in low-lying areas regardless of proximity to rivers. Accordingly, surface effluent flow is considered to play a pivotal role in inland inundation. Topographical gradients are also important factors; in areas with steep landform gradients, rainwater flows rapidly downstream and is less likely to accumulate. Based on this concept, the Surface Water Index was designed for estimation of runoff amounts using a tank model with landform-induced correction.



River water levels and Runoff Index values associated with the landfall of Typhoon No. 23 in 2004



# Questionnaire survey

The questionnaire survey on Quality Management for Surface Meteorological Observations in RA II was conducted in 2016.

Twenty NMHSs in RA II Members responded to the questionnaire.

JMA analyzed the responses and prepared the draft report of the survey results.

# Survey analysis

Four groups: **manned weather** stations,  
**manned precipitation/hydrological** stations,  
**automatic weather** stations and  
**automatic precipitation/hydrological** stations  
are used

Four icons are used



**Manned**

Manned



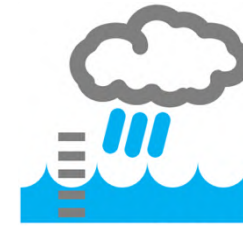
**Auto**

Automatic



**Weather**

Weather

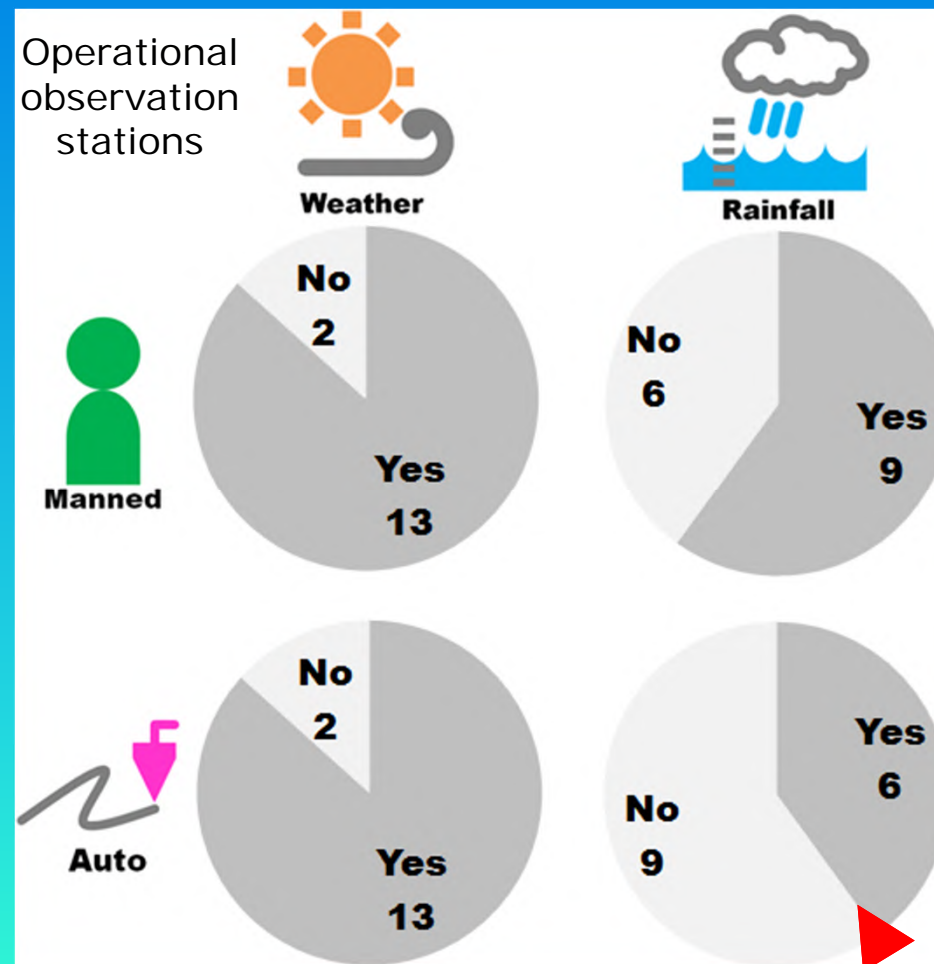


**Rainfall**

precipitation/  
hydrological

# Major findings (1/4)

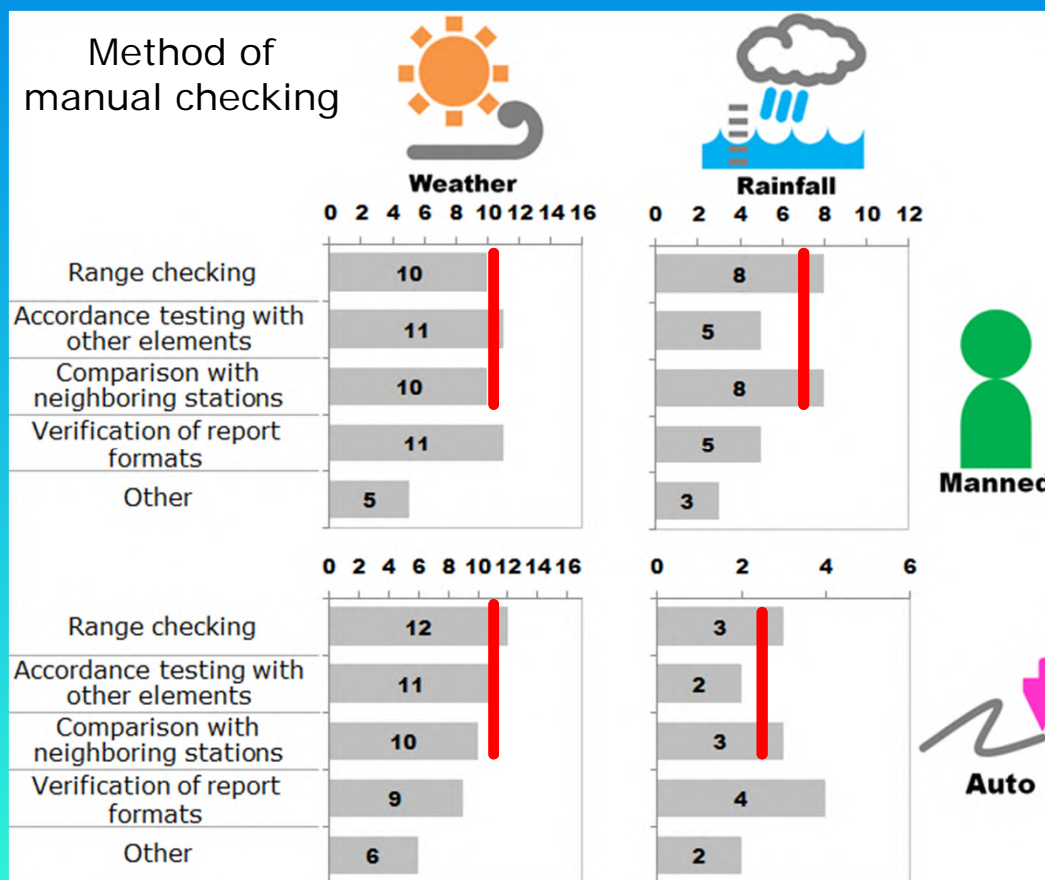
Automatic precipitation/hydrological stations are operated by only one third of NMHSs.



# Major findings (2/4)

Precipitation/hydrological stations are operated with difficulties in a quality check of the observation data and an environmental check of the stations.

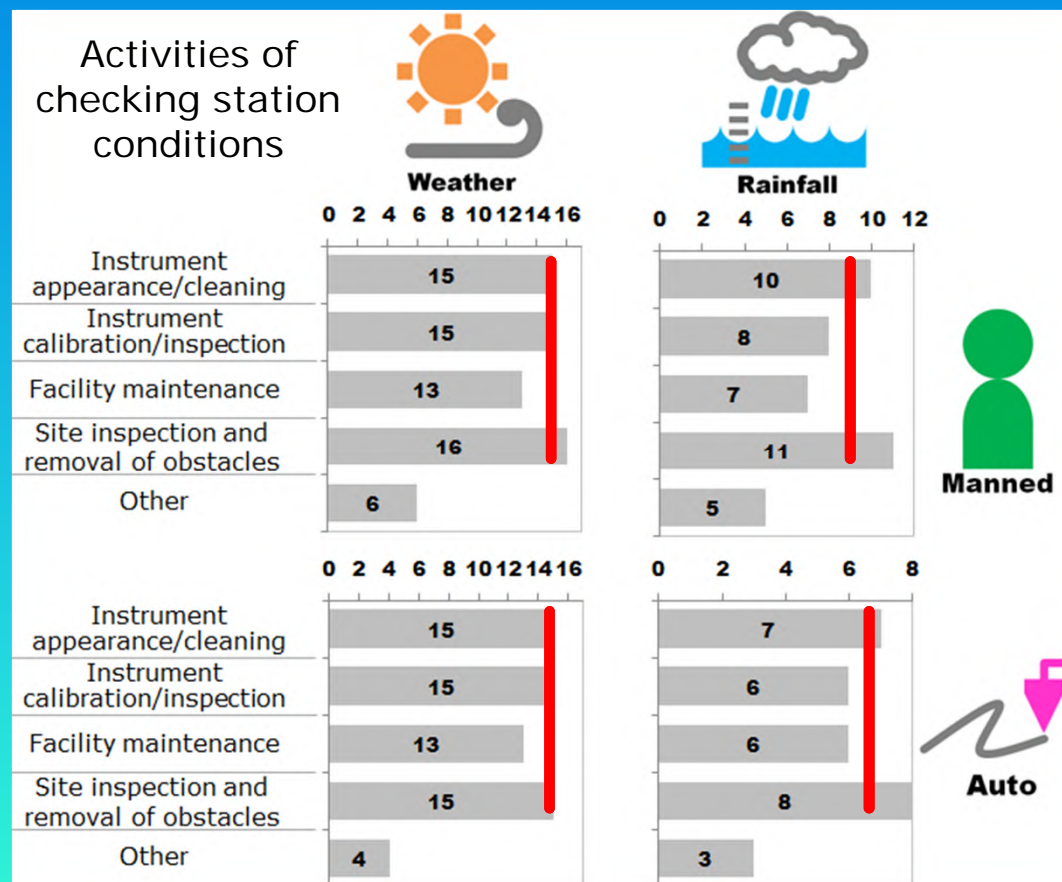
Only one half of NMHSSs manually check observation data.



# Major findings (2/4 cont.)

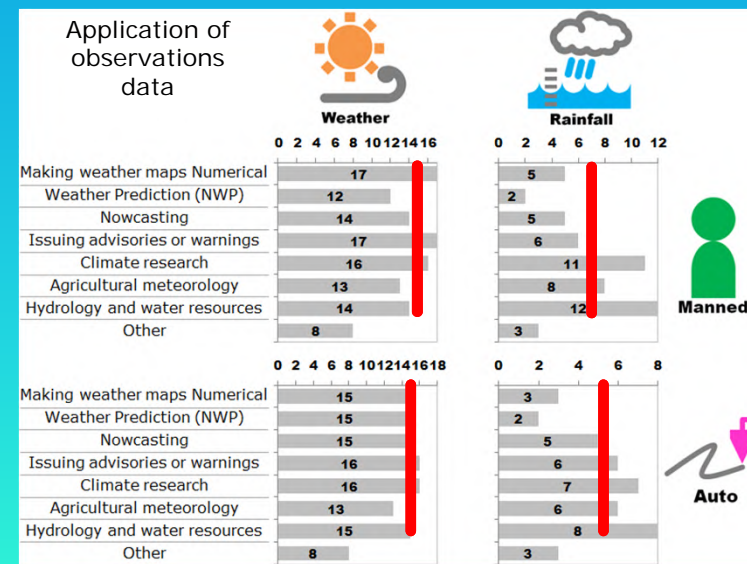
Precipitation/hydrological stations are operated with difficulties in a quality check of the observation data and an environmental check of the stations.

Lower activities are conducted for checking station conditions.



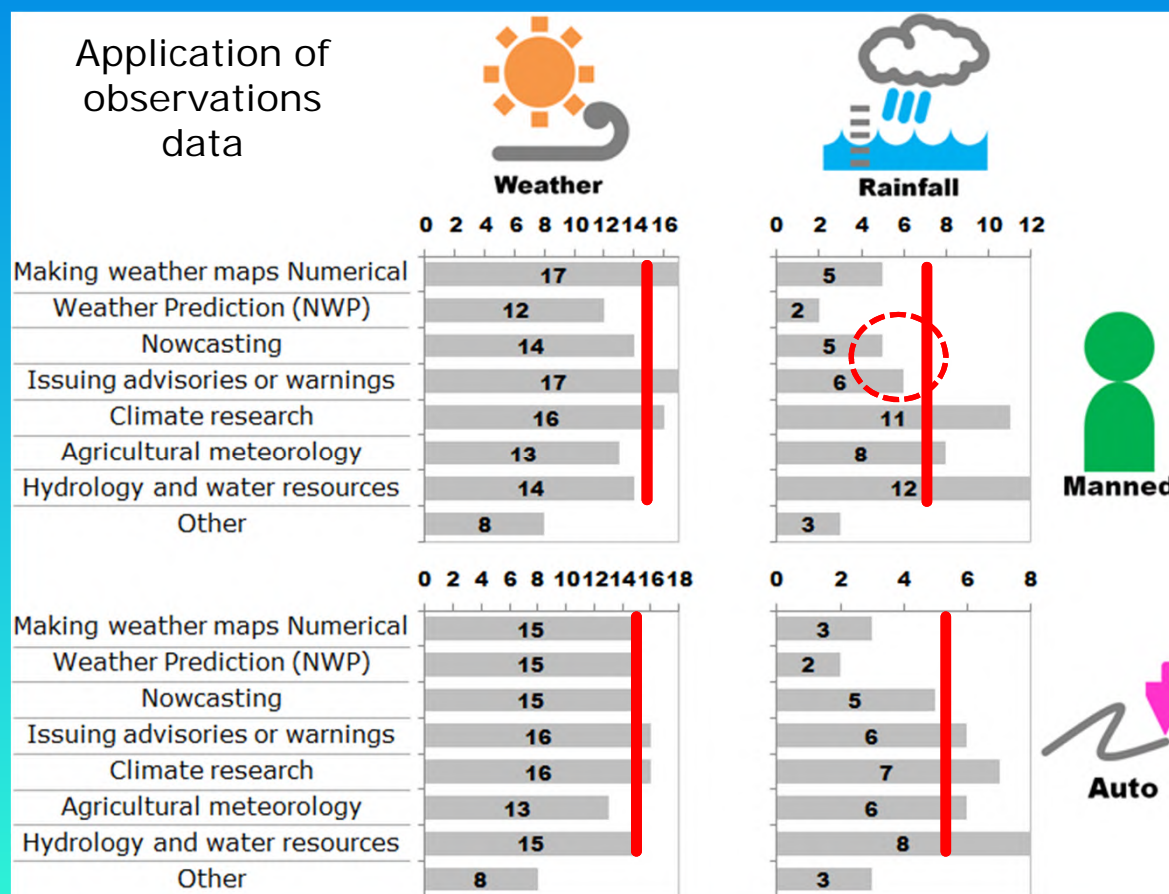
# Major findings (3/4)

A percentage of NMHSs which utilize observation data of the precipitation/hydrological stations for application effective in Disaster Risk Reduction, such as advisories/warnings and nowcasting, is generally lower than that of NMHSs utilizing observation data of weather stations.



# Major findings (3/4)

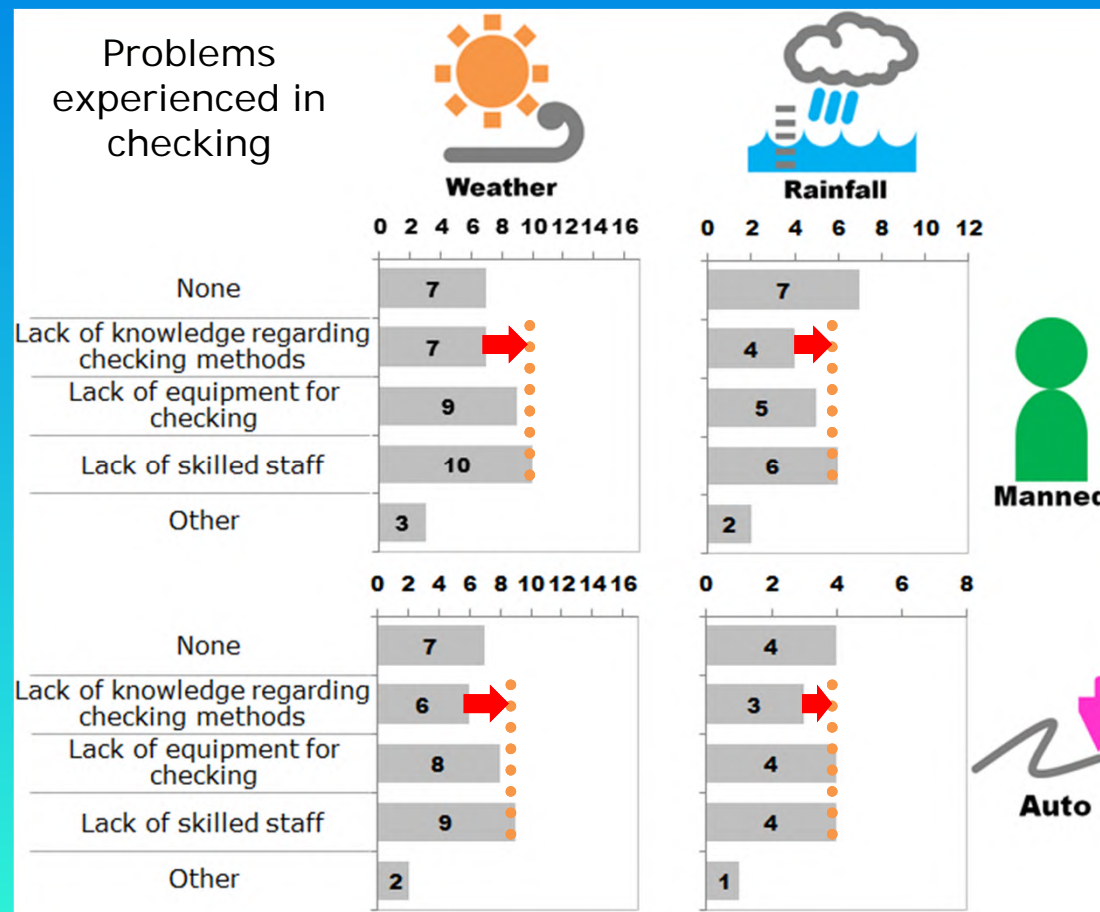
A percentage of NMHSs which utilize observation data of the precipitation/hydrological stations for application effective in Disaster Risk Reduction, such as advisories/warnings and nowcasting, is generally lower than that of NMHSs utilizing observation data of weather stations.





# Major findings (4/4)

NMHSs recognized “lack of skilled staff” rather than “lack of knowledge.”



# Survey results

Many NMHSs which responded to the questionnaire operate services in rainy regions.

Although a precipitation observation is one of key components for DRR, it was recognized that many observation stations faced difficulties in both the quality check of observation data and the environment check of the stations.

It was also found that there was room for improvement in applications of observation data such as nowcasting or issuing advisories/warnings.

# Discussions

Given that DRR is one of the highest priorities, multi-scale challenges should be discussed by Member countries to solve issues.

We are focusing on the precipitation observation in this workshop.

# Although we focus on rain...

**One-week Forecasts:**  
**Tokyo**

Get more information on this area

Prefecture Tokyo  [Notes](#)

[Probability of warnings](#)

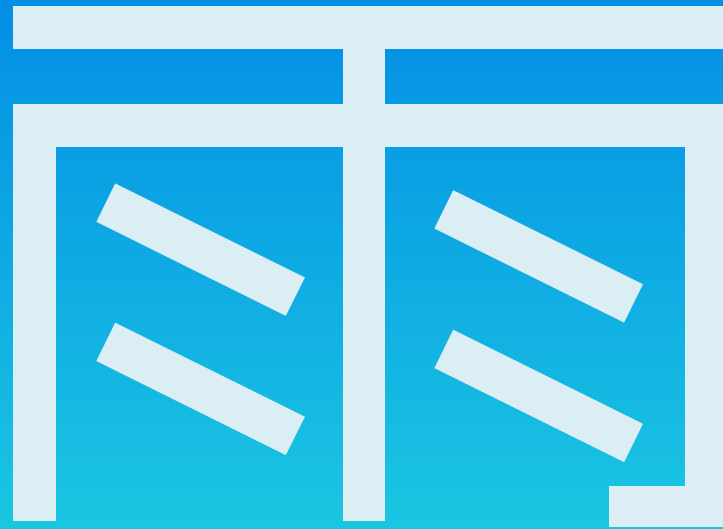
Updated at 11:00 JST, 18 March 2018

Date	19 Mon	20 Tue	21 Wed	22 Thu	23 Fri	24 Sat	25 Sun	
<b>Tokyo</b> Daily Forecast								
Probability of precipitation (%)	10/20/40/60	80	90	60	20	20	20	
Reliability	/	/	A	C	A	A	B	
<b>Tokyo</b>	High (°C)	18	10 (8 - 12)	8 (6 - 10)	18 (14 - 22)	17 (15 - 18)	18 (16 - 19)	20 (18 - 23)
	Low (°C)	9	6 (4 - 7)	3 (2 - 5)	7 (4 - 9)	6 (4 - 8)	5 (4 - 7)	7 (5 - 9)

# What?

## What do we learn and discuss?

# Rain



Heavy

Rain

Big



Big raindrop

# Science!

## We need science



# Workshop outline

## Session 1

- WIGOS
- Survey
- Country report

## Session 2

- Calibration/  
traceability

## Session 3

- Operational QM
- *Science*

## Session 4

- Discussions
- Workshop  
outcome

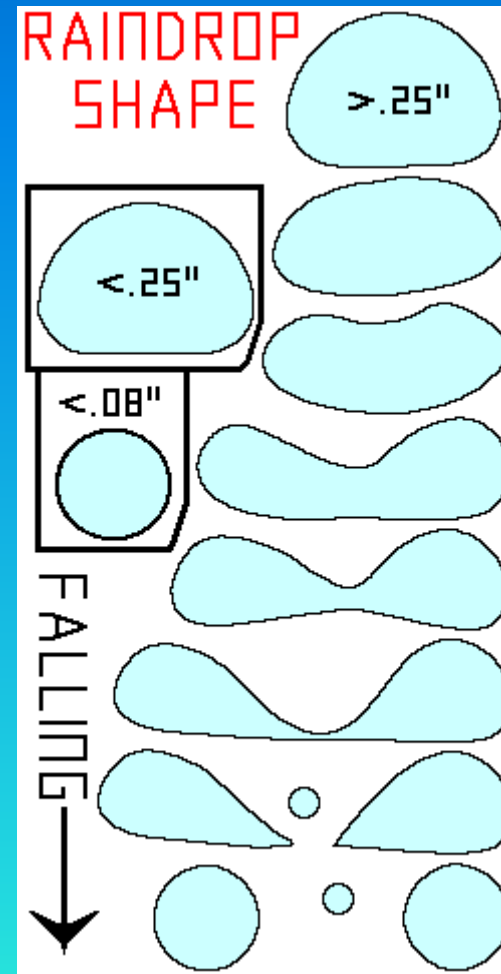
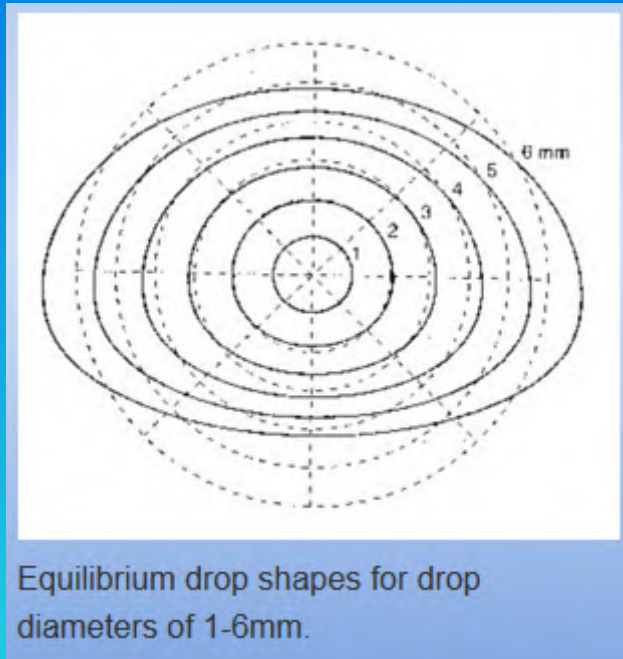
# Huge raindrop



Unnatural?



# Raindrop shape and size

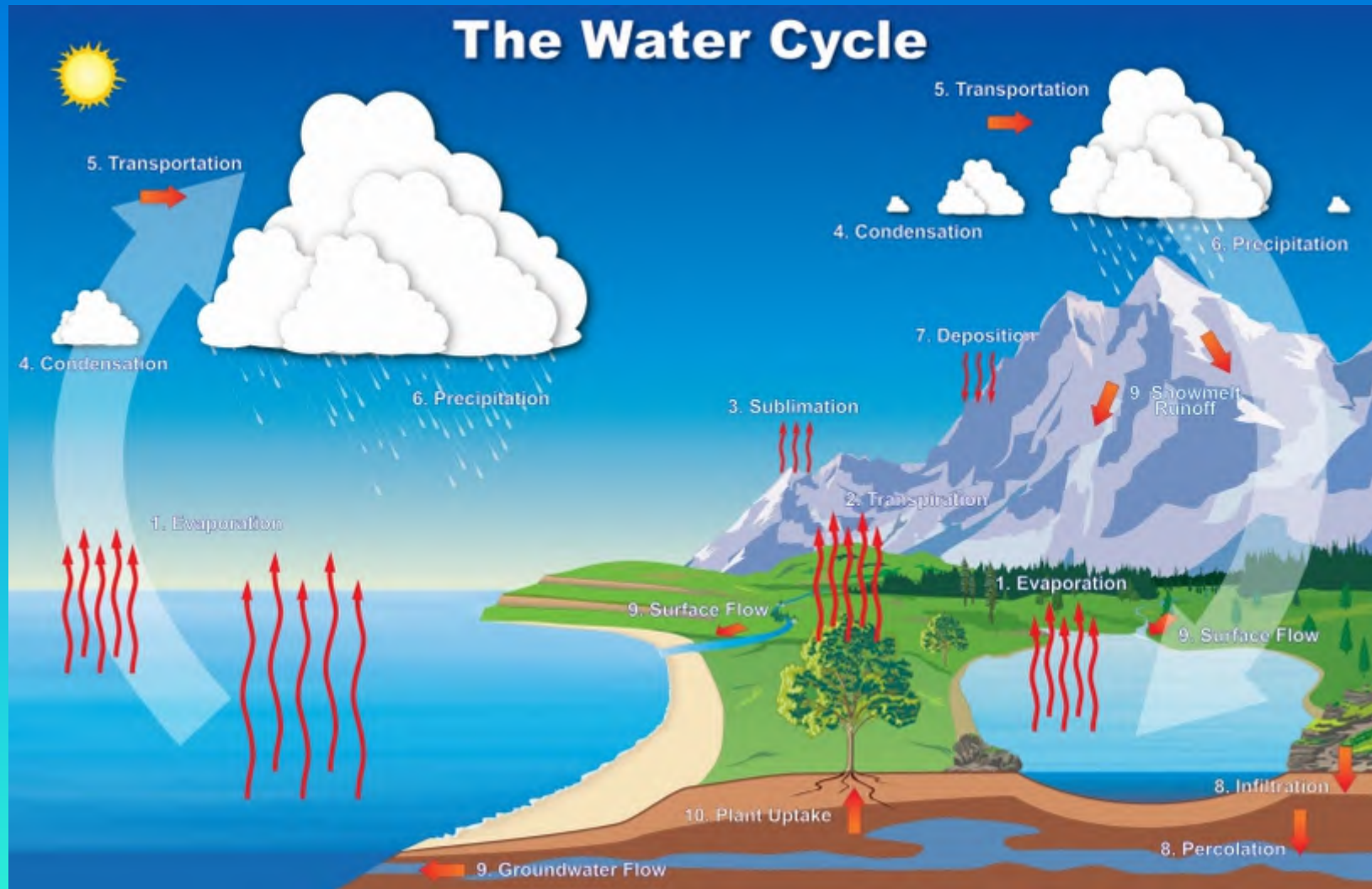


<https://pmm.nasa.gov/education/articles/shape-of-a-raindrop>

# Motivation and inspiration



# Motivation and inspiration



<http://www.noaa.gov/resource-collections/water-cycle>

# Findings and discussions

Automatic precipitation/hydrological stations are operated by only one third of NMHSs.

Precipitation/hydrological stations are operated with difficulties in a quality check of the observation data and an environmental check of the stations.

A percentage of utilization of precipitation/hydrological observation data for Disaster Risk Reduction applications is generally.

NMHSs recognized "lack of skilled staff" rather than "lack of knowledge."

(A) Visions of surface observation networks

(B) Short-term or long-term goals of the quality of observation data

(C) Improvement of on-site quality management

(D) Approach to training skilled staffs

How?

How do we discuss?

# Organization

(A) Visions of surface observation networks

Ms. Al Hameli, Ms. Al Mandoos  
Ms. Do, Mr. Faisal, Mr. Le Xuan

(B) Short-term or long-term goals of the quality of observation data

Dr. Cui, Mr. Douangmala  
Mr. Phapany, Mr. Promsut  
Mr. Sungkhawanna  
Mr. Thala Bandaralage  
Mr. Wimalasuriya

(C) Improvement of on-site quality management

Mr. Abdul Karrem, Dr. Ahmad  
Mr. Hak, Mr. Lwin, Ms. Nan  
Mr. Toe Aung

(D) Approach to training skilled staffs

Ms. Baten, Mr. Chowdhury  
Mr. Gayyoom, Mr. Lyhon

Supported  
by  
speakers



# Key words

(A) Visions of surface observation networks

design, DRR, integrated, international/inter-agency, observation/analysis, regional climate

(B) Short-term or long-term goals of the quality of observation data

DRR, field work, international collaboration, quality information, services/products, study

(C) Improvement of on-site quality management

calibration, environment, instrument, integration, spatiotemporal scale, system

(D) Approach to training skilled staffs

cooperation, face-to-face, post-workshop newsletters, practical demonstration, telecommunicated, training materials

# Related stories

(A) Visions of surface observation networks

Rain and snow (25 Jan)  
Quality of design and service (31 Jan)

(B) Short-term or long-term goals of the quality of observation data

Quality of design and service (31 Jan)  
Qualitative or quantitative (6 Jan)

(C) Improvement of on-site quality management

Qualitative or quantitative (6 Jan)  
Quality management for WIGOS era (19 Feb)




(D) Approach to training skilled staffs

Training for improving skill (14 Feb)  
Workshop (19 Feb)

# Schedule

## Session 4.1

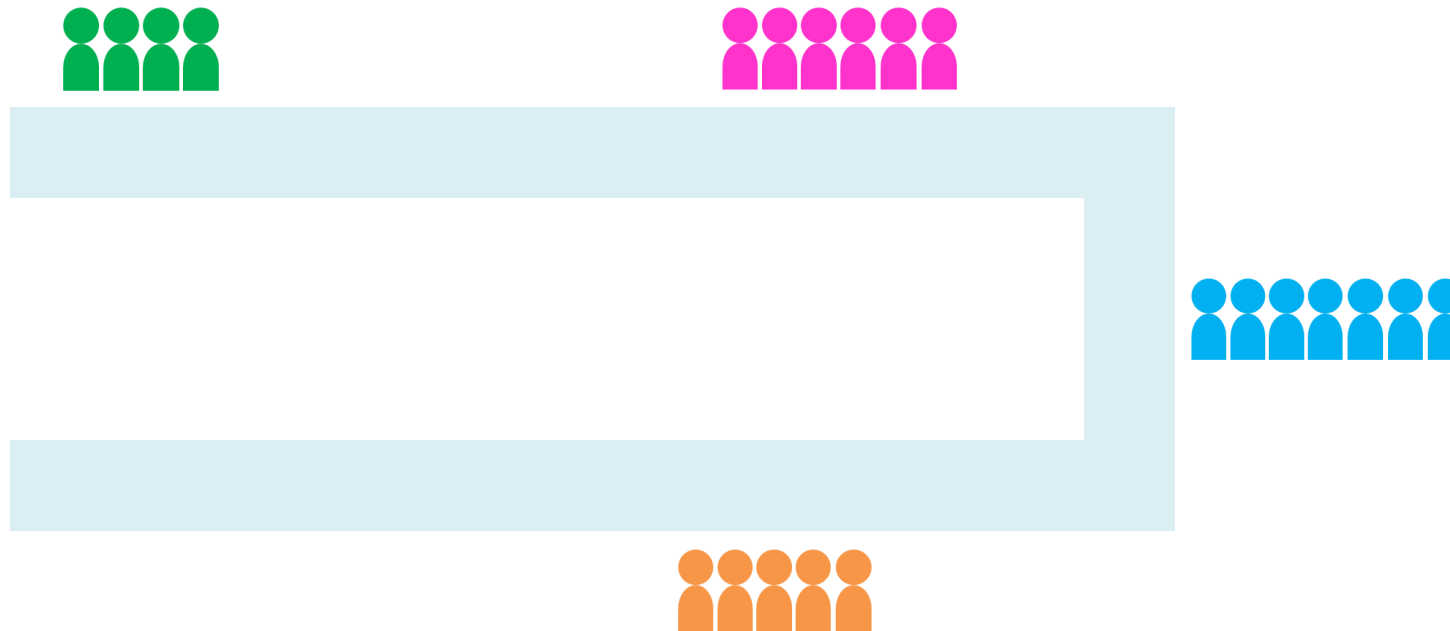
Discussion on future activities/actions for improvement of quality management of observation data in RA II

0900-0910	Discussion guidance
0910-1030	<p>Group discussions</p> <ul style="list-style-type: none"><li>• Discuss a group's topic with referring other sessions' lectures, key words and related stories (newsletter dated 19 Feb.).</li><li>• Write presentation slides on a summary of group discussions using a template below.</li></ul> 
1030-1100	Break
1100-1130	<p>Presentations on group discussion results</p> 
1130-1230	<p>General discussion on proposal for action plan</p> 

# Configuration

## Session 4.1

Discussion on future activities/actions for improvement of  
quality management of observation data in RA II  
0910-1030 Group discussions



# Links

(A) Visions of surface observation networks



(B) Short-term or long-term goals of the quality of observation data



(C) Improvement of on-site quality management



(D) Approach to training skilled staffs

Because ultimately only skilled staffs would realize (A), (B) and (C). Therefore, discussions on (A), (B) and (C) should be linked to (D).

## (D) Approach to training skilled staffs

It is noted that many NMHSs recognized “lack of skilled staff” rather than “lack of knowledge” according to the survey.

Sharing knowledge and information is becoming easy through technological innovations of telecommunication.

We live in our highly-telecommunicated age and the telecommunicated approaches must provide many people opportunity to learn.

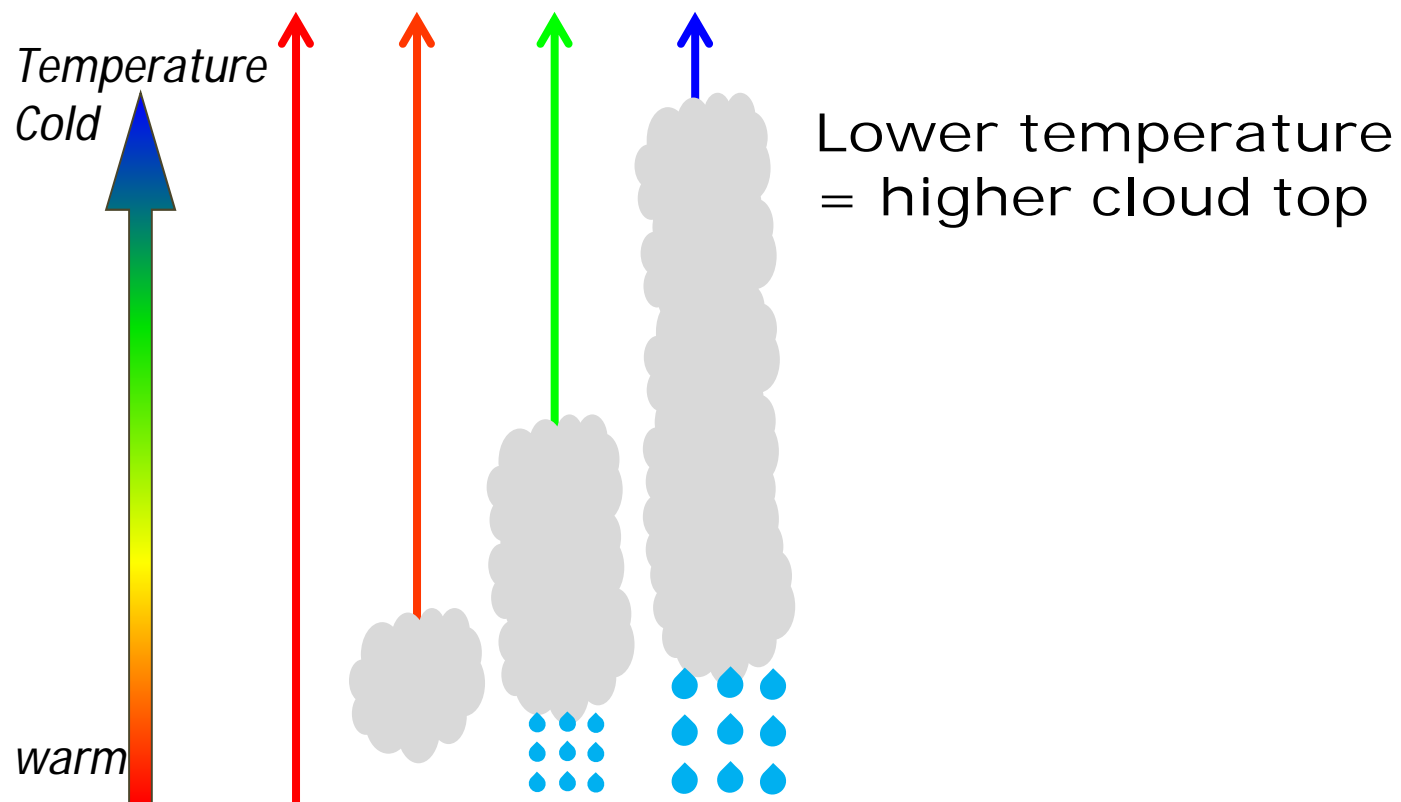
Face-to-face meetings still have a significant role such as learning, training, and finding common goals.

A face-to-face meeting works to unite the people concerned.

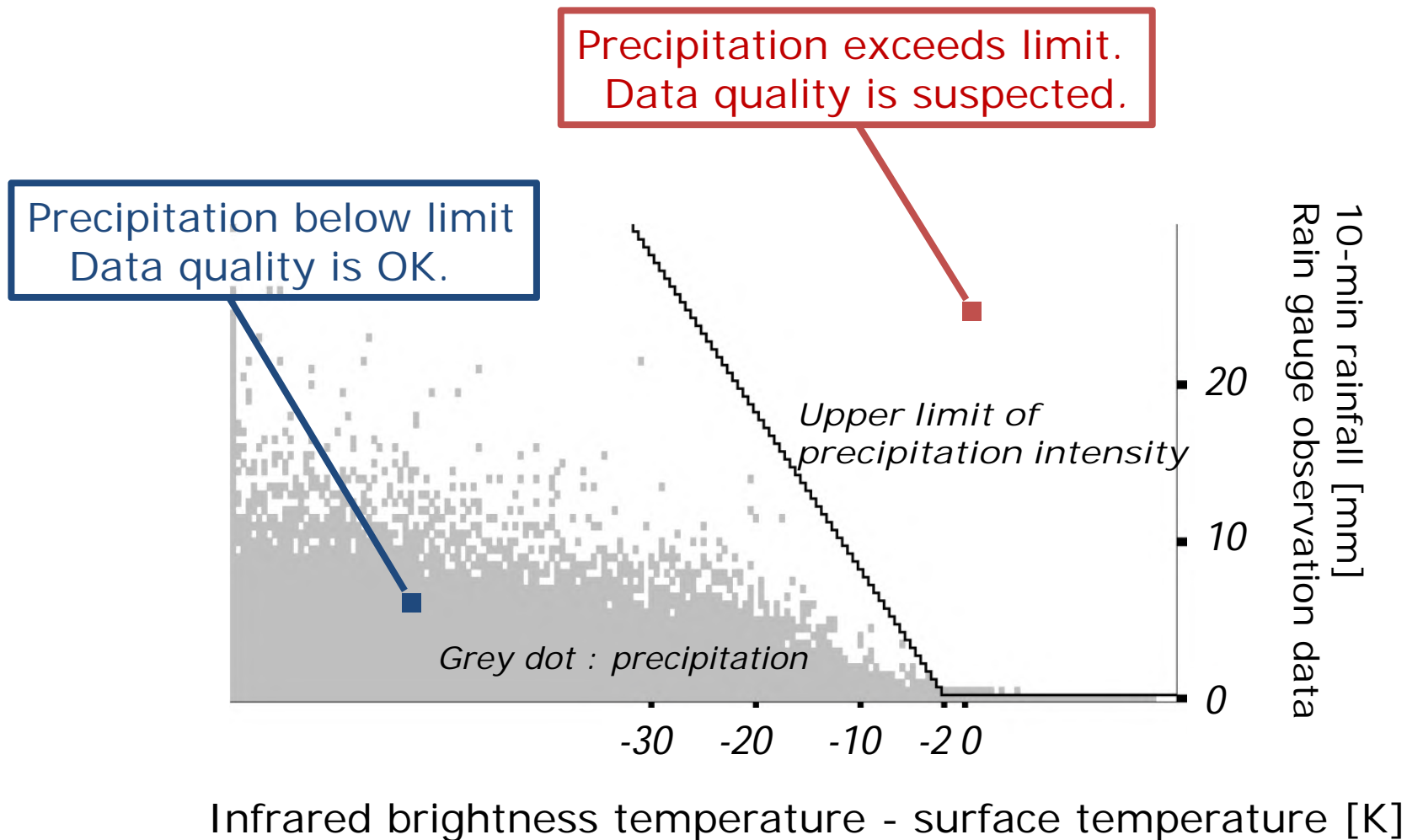
# Visions – integration (1/3)

## Satellite Infrared imagery

In the troposphere, temperature decreases with height. You can estimate cloud top height using infrared brightness temperature.



# Visions – integration (2/3)





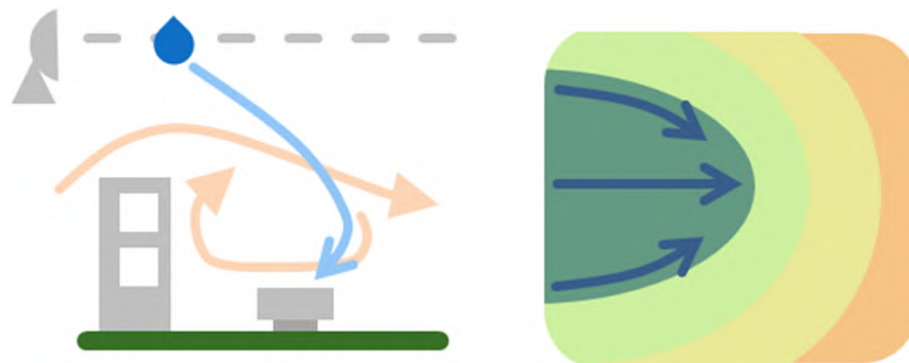
# Visions – integration (3/3)

## Operational



The current HRPN operational algorithm is designed to correct wind-induced horizontal drift that occurs when raindrops fall based on the wind speed of several layers.

## Under research



The nature of complex raindrop tracks associated with air flow (left) and the orographic concentration of raindrops are currently being researched.

# Summary

The questionnaire survey on Quality Management for Surface Meteorological Observations in RA II was conducted in 2016.

Twenty NMHSs in RA II Members responded to the questionnaire.

JMA analyzed the responses and prepared the draft report of the survey results.

It was recognized that many observation stations faced difficulties in both the quality check of observation data and the environment check of the stations.

Improvement in DRR applications of observation data is needed

WE WILL DISCUSS

# Discussions

(A) Visions of surface observation networks

(C) Improvement of on-site quality management

(B) Short-term or long-term goals of the quality of observation data

(D) Approach to training skilled staffs

# Between atmosphere and people



Thank you