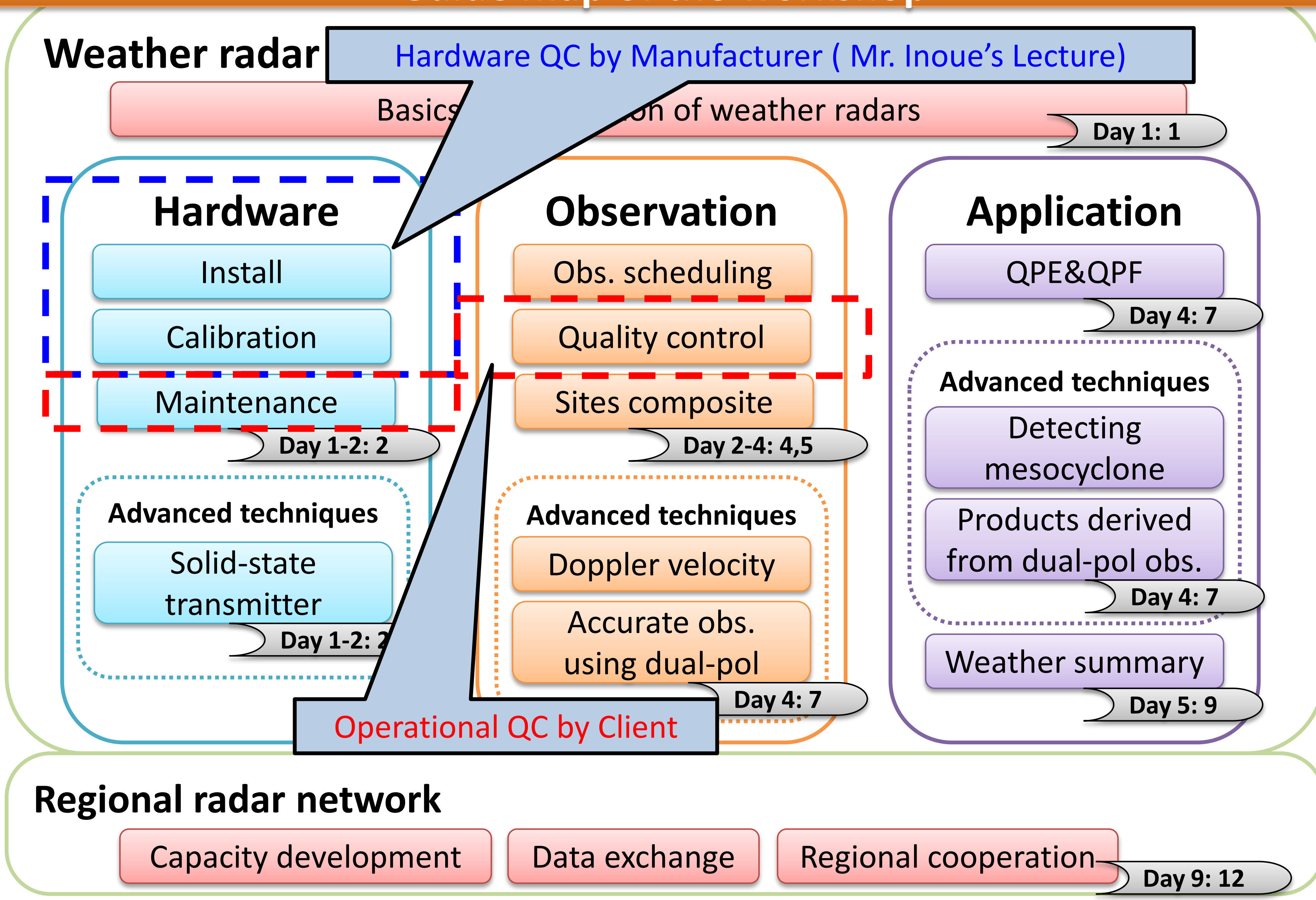
6. Manufacture's QC

12, February 2018

Katsuhiro NAGAYA
Engineering Management Department
Japan Radio Co., Ltd.

Guide map of the workshop



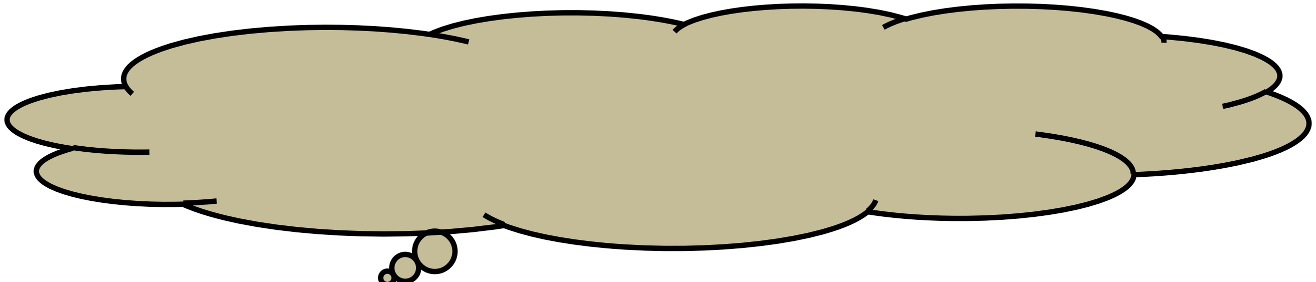
Application Field : QPE

Source : National Institute of Informatics as example of QPE Application

My Profile : Katsuhiro NAGAYA

1951 Born in NAGOYA-city, Japan

1959 ISEWAN Typhoon(Vera)



1982 Get a job at JRC

1982 NAGASAKI Heavy rain

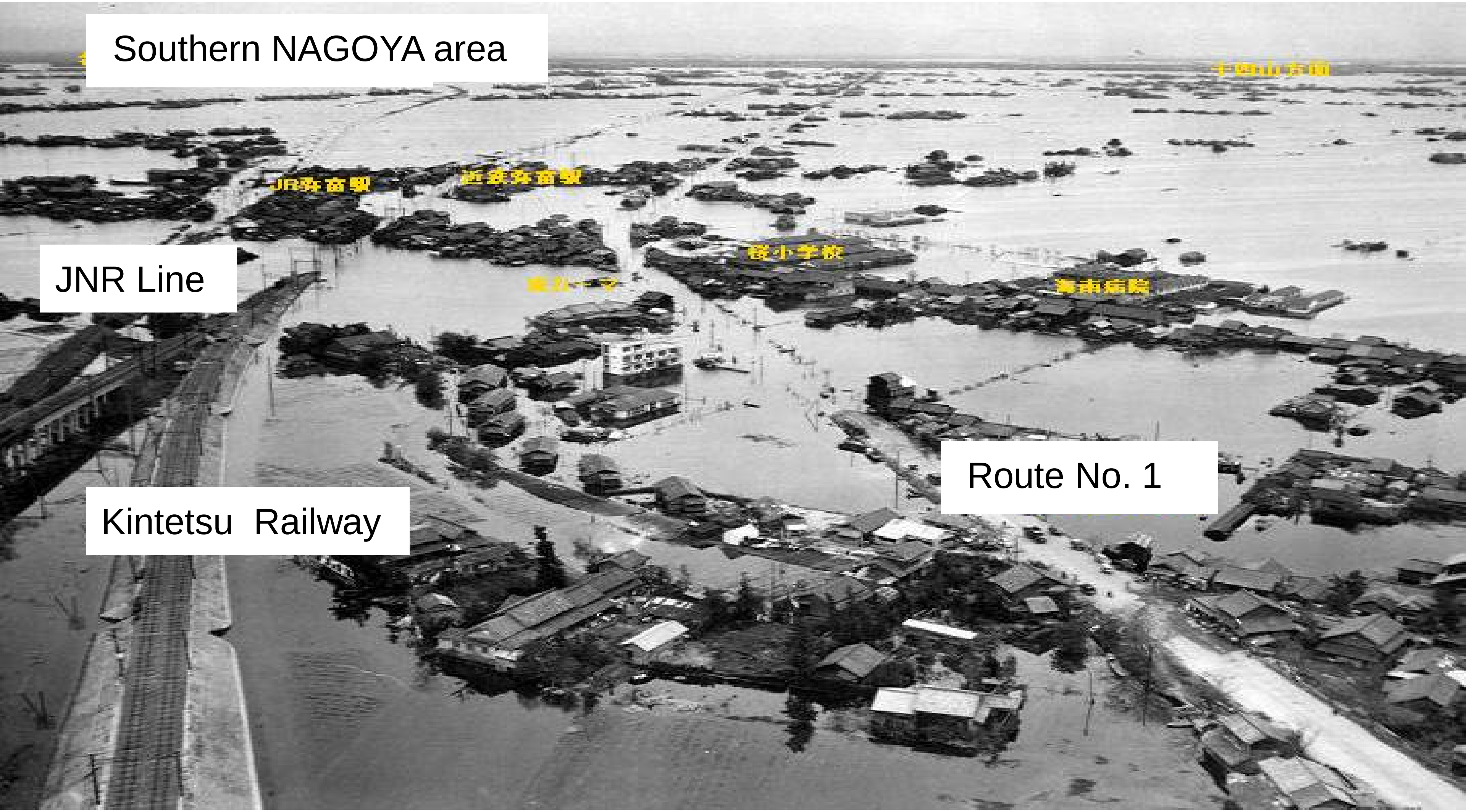
****

1987 First Visit to Thailand

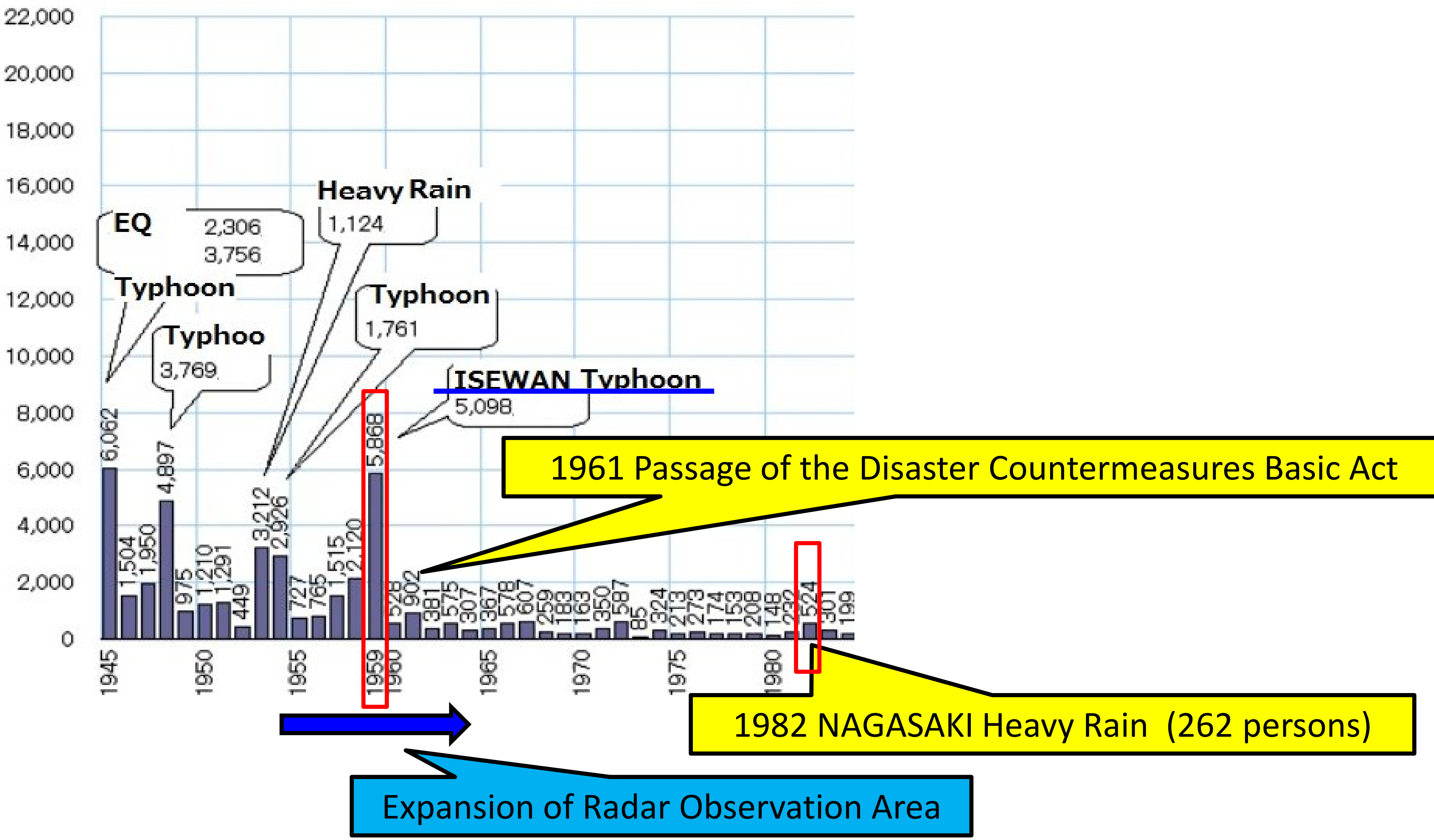
****

2018 (to present)

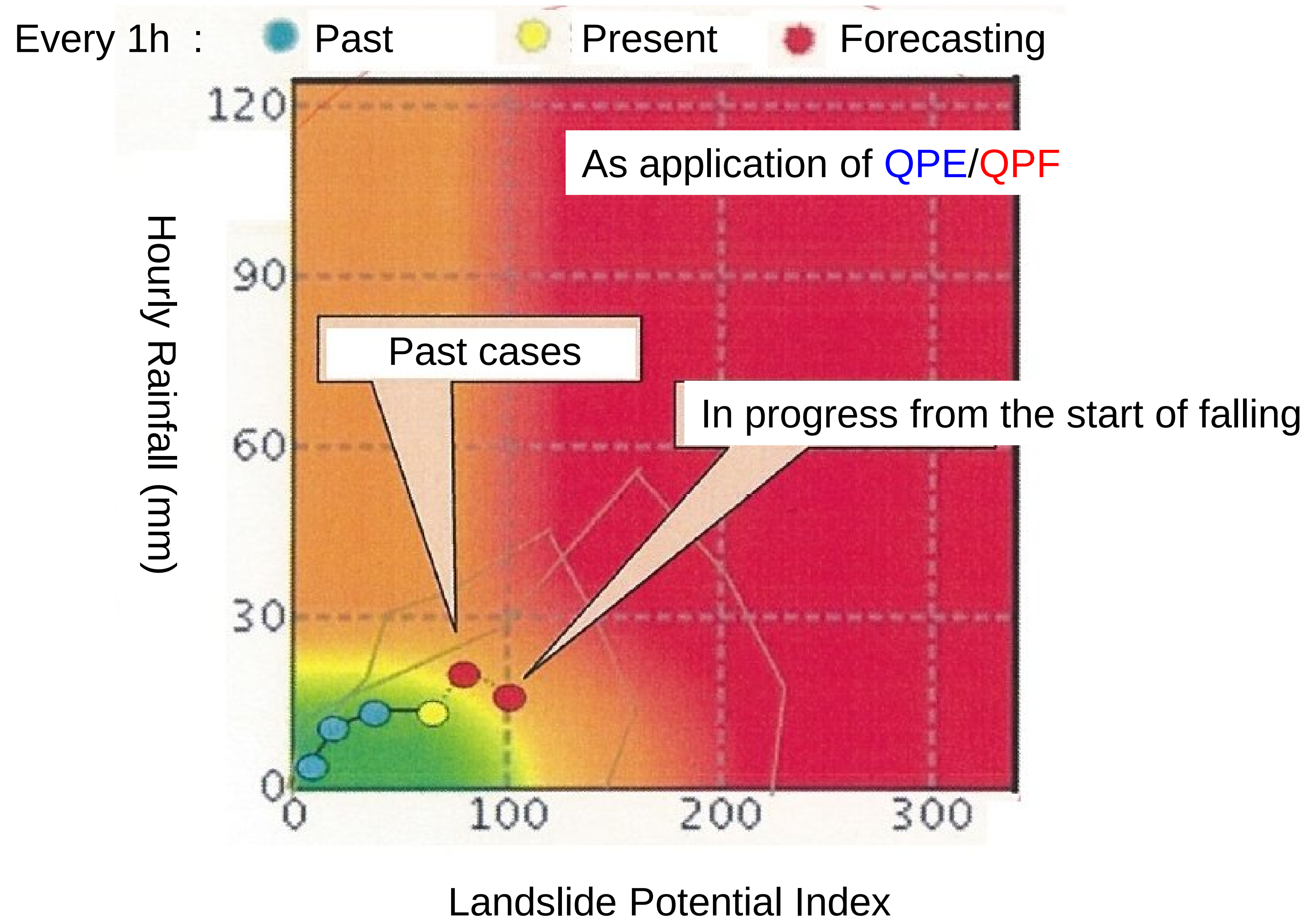
ISEWAN Typhoon (**Typhoon Vera**) :1959



History of Disaster Damage in Japan



Examples of Landslide Potential Index for Local government



Contents

1. Company Profile & QC activity

   Company Profile and Products of JRC

   QC activity in company

2. Example of QC activity for radar in Japan

   including Check by Vertical observation

3. Topics on Calibration

   by using metal sphere

   by Disdrometer

For radar operation

Manufacturer / Supplier Portion

1. Company Profile & QC activity
   Company Profile and Products of JRC
   QC activity in company
2. Example of QC activity for radar in Japan
   including Check by Vertical observation
3. Topics on Calibration
   by using metal sphere
   by Disdrometer

Client (Consultant) Portion

Hard Problem
Site Condition
Natural Phenomena
QC
Observation Error

Hardware
- Radar equipment ☆
- Tower(On-site)
- Power Facility
- Communication Link (On-site)
- Center System
  - LAN Network
  - Processer for
    - Composite Image☆

Software (☆)

Installation work/Adjustment /OJT

Operation & Maintenance

Calibration/Analysis ☆

1. Company Profile & QC activity

Company Profile and Products of JRC

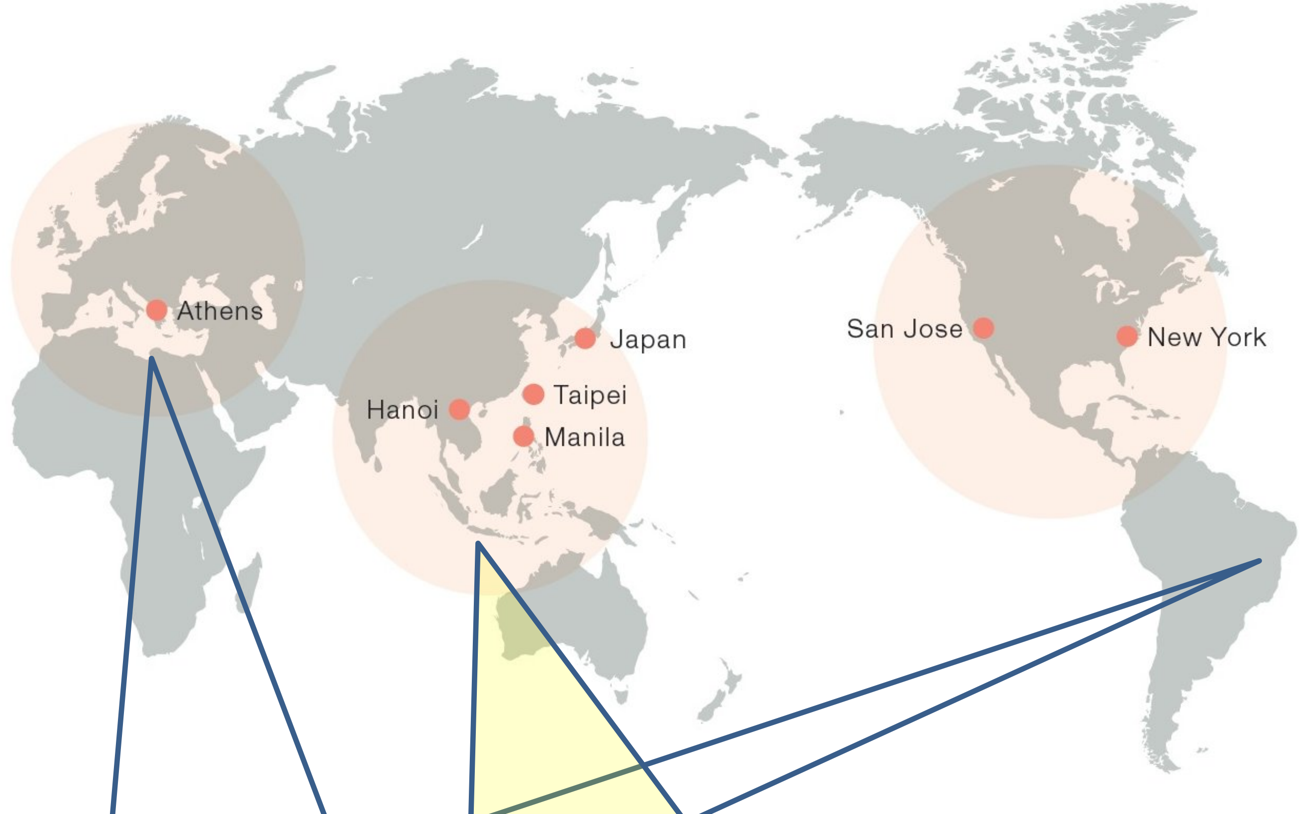
QC activity in company

Company Profile : JRC Radio Co., Ltd.

- Head Office : Nakano-ku, Tokyo, Japan
- Founded : December 1915
- Number of Employees
  - Non-consolidated : 2,335
  - Consolidated : 5,571
- Net Sales
  - Non-consolidated : ¥90,876 M (~USD 823M)
  - Consolidated : ¥142,909 M (~USD 1,298M)
- Classification of Business :

  Manufacture and Sale of Radio Communication Equipment
- Parent Company : Nisshinbo Holding Inc.

JRC Sales Bases & International Business Bases



Main Subsidiaries

Nagano Japan Radio Co., Ltd.

Ueda Japan Radio Co., Ltd.

JRC Tokki Co., Ltd.

Japan Radio Glass Co., Ltd.

JRC Engineering Co., Ltd.

JRC MARINFONET CO., Ltd.

JRC System Service Co., Ltd.

JRC (Shanghai) Co., Ltd.

JRC do Brasil Empreendimentos Eletrônicos Ltda.

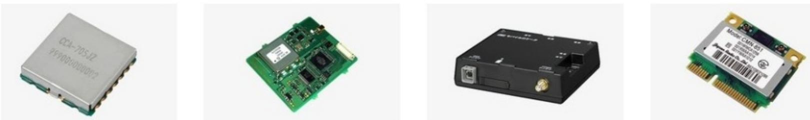
Alphatron Marine Beheer B.V.

Alphatron Marine Korea Co., Ltd.

PT. JRC SPECTRA INDONESIA

Products of JRC

Device/Unit/Equipment ･････ System/Service/Solution

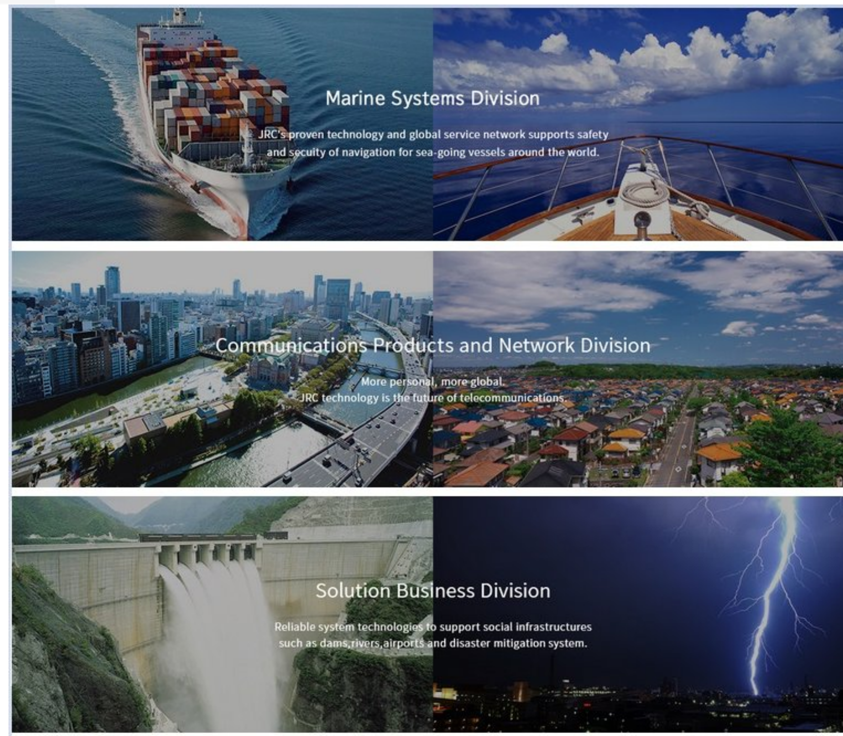


FM Radio Broadcasting ‣ Digital TV Broadcasting ‣ Frequency Standard ‣ Satcomm

2010's ~

For support Client's Activities

1980's ~ 2000's



QC activity in company

Control No.: QD-B1702
Issued: July 2003
Revised: May 2017

General Manager
Quality Assurance Promotion Department

Quality Assurance Outline

History: Corrected in June 2016
Corrected in August 2015
Revised in Apr 2015
Corrected in May 2014
Revised in Oct 2013
Corrected in Aug 2012
Corrected in Jun 2012
Corrected in Jan 2012
Revised in May 2011
Revised in June 2010
Revised in Oct 2009
Corrected in Feb 2009

JRC Japan Radio Co., Ltd.
Quality Assurance Promotion Department

Quality Assurance System

JRC acquired "**ISO 9001 Certification**" in August 1994 for "Quality Assurance System in Entire Company" including **all the stages** from checking on contractual conditions through product development and production to after-sale service in attaching the importance to the needs of each of its customers.

In December 2009, JRC acquired **ISO 9001:2008**.

We will be making efforts to make our quality management system (QMS) more complete in order to respond to the changing needs of customers.

JRC Code of Conduct and Quality Policy

- The JRC Code of Conduct describes

  the proper conduct required from each of our officers and employees to comply with our management philosophy.

- Products and services we provide are described therein as follows;

  We shall fully support and comply with applicable laws and standards relating to the quality and safety of our products, such as the Product Liability Act.

JRC Code of Conduct and Quality Policy

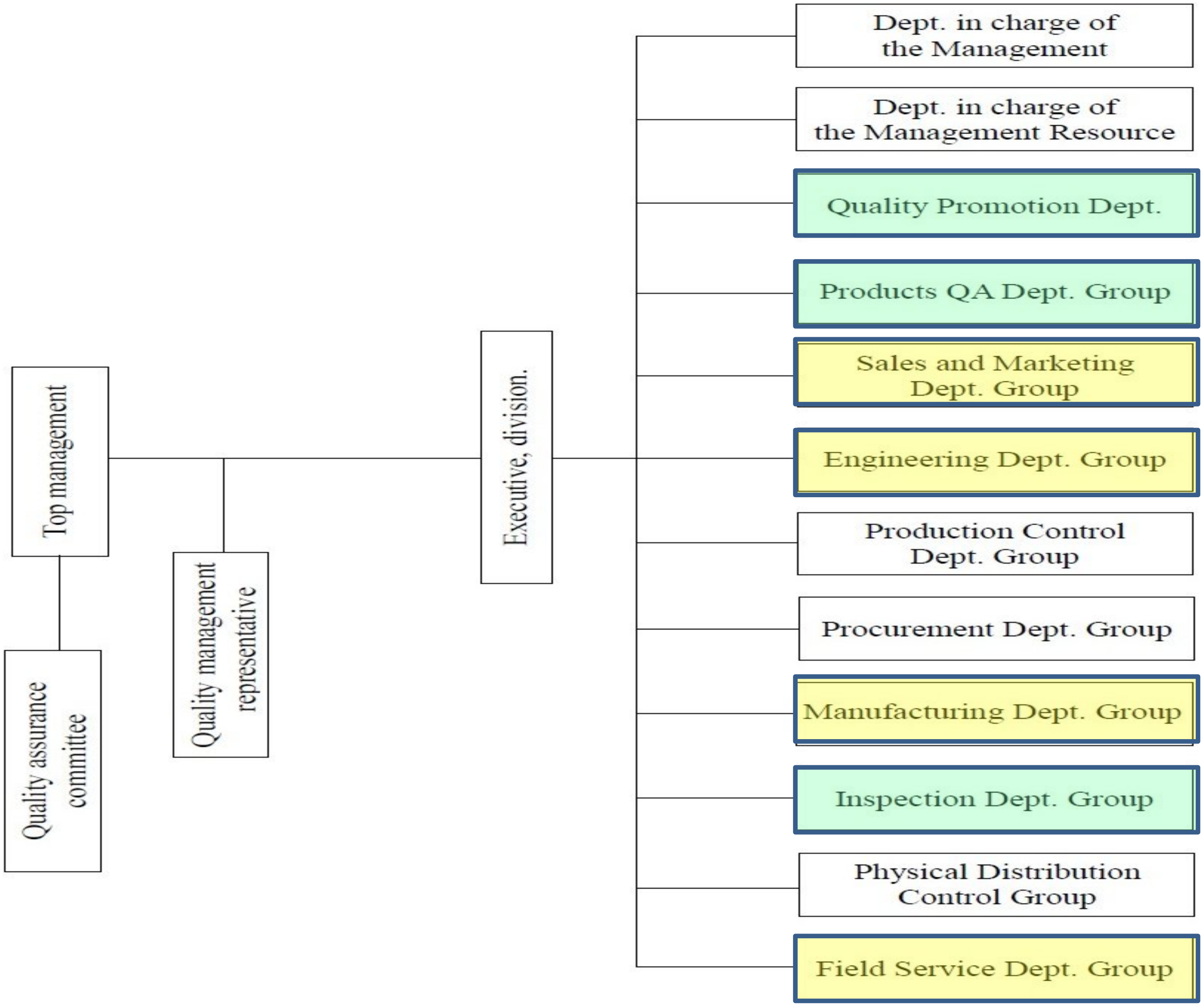
- We will maintain consideration of such laws and regulations throughout the processes of development, design, manufacture, storage, sales, import, export, delivery, repair and maintenance in order to ensure the utmost satisfaction of our customers.

- In addition, quality management system (QMS) set the quality policy of the president “quality improvement of processes to support growth strategy”, based on which quality improvement activities are continuously conducted in whole organization.

QC activity in company

1. INTRODUCTION
2. ORGANIZATION AND QUALITY ASSURANCE SYSTEM
3. DESIGN CONTROL
4. PURCHASE CONTROL
5. PROCESS CONTROL
6. RELIABILITY EVALUATION OF NEW DEVELOPMENTS
7. CONTROL OF MEASURING INSTRUMENTS
8. CONTROL OF NONCONFOMING PRODUCT
9. CORRECTIVE ACTION AND PREVENTIVE ACTION
10. INTERNAL AUDIT
11. CONTINUAL PROCESS IMPROVEMENT
12. AFTER-SALE SERVICE
13. PRODUCTS SAFETY AND QUALITY
14. CUSTOMER SATISFACTION

QC activity in company



Using exhaustive reliability testing and quality control system to deliver higher levels of safety and peace of mind.

JRC uses rigorous quality control and stringent reliability and evaluation testing across all phases of its products and systems—development, design, manufacture, and installation—in order to foster safety and peace of mind for customers. We also implement the plan-do-check-act (PDCA) cycle in an effort to offer products that satisfy customers.

Meticulous quality control system delivers higher levels of safety and peace of mind

Scanning electron microscope

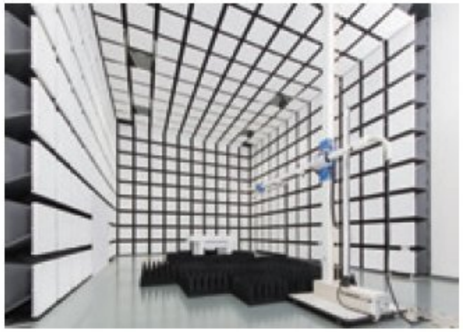
Test samples are irradiated with an electron beam to obtain images with several hundred thousand-fold resolution for detailed surface analysis.

X-ray fluorescence spectrometer

This spectrometer can identify the elements from the fluorescence spectrum generated by irradiating a sample with X-rays.

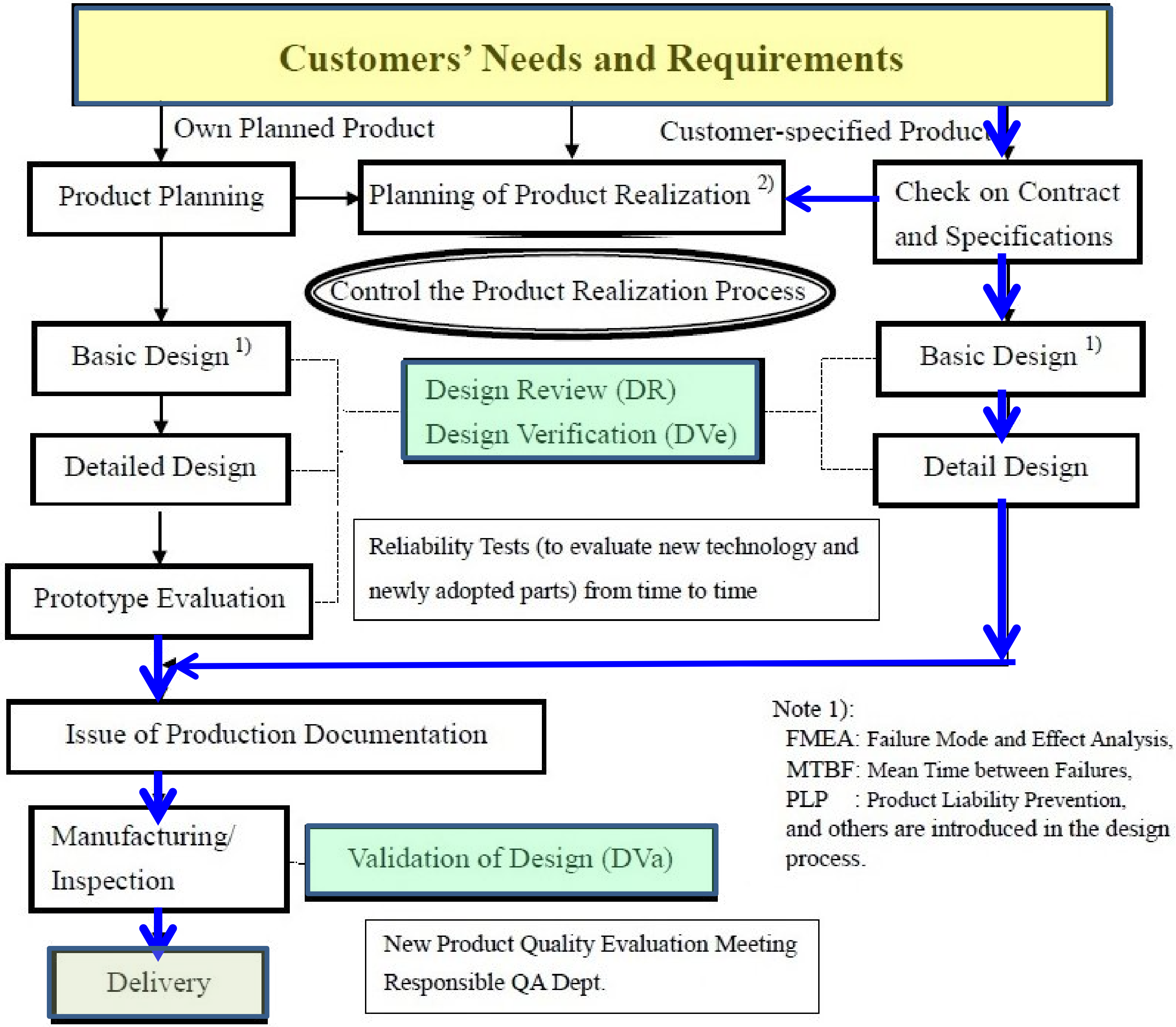
Thermal shock tester

Constant temperature/humidity chamber



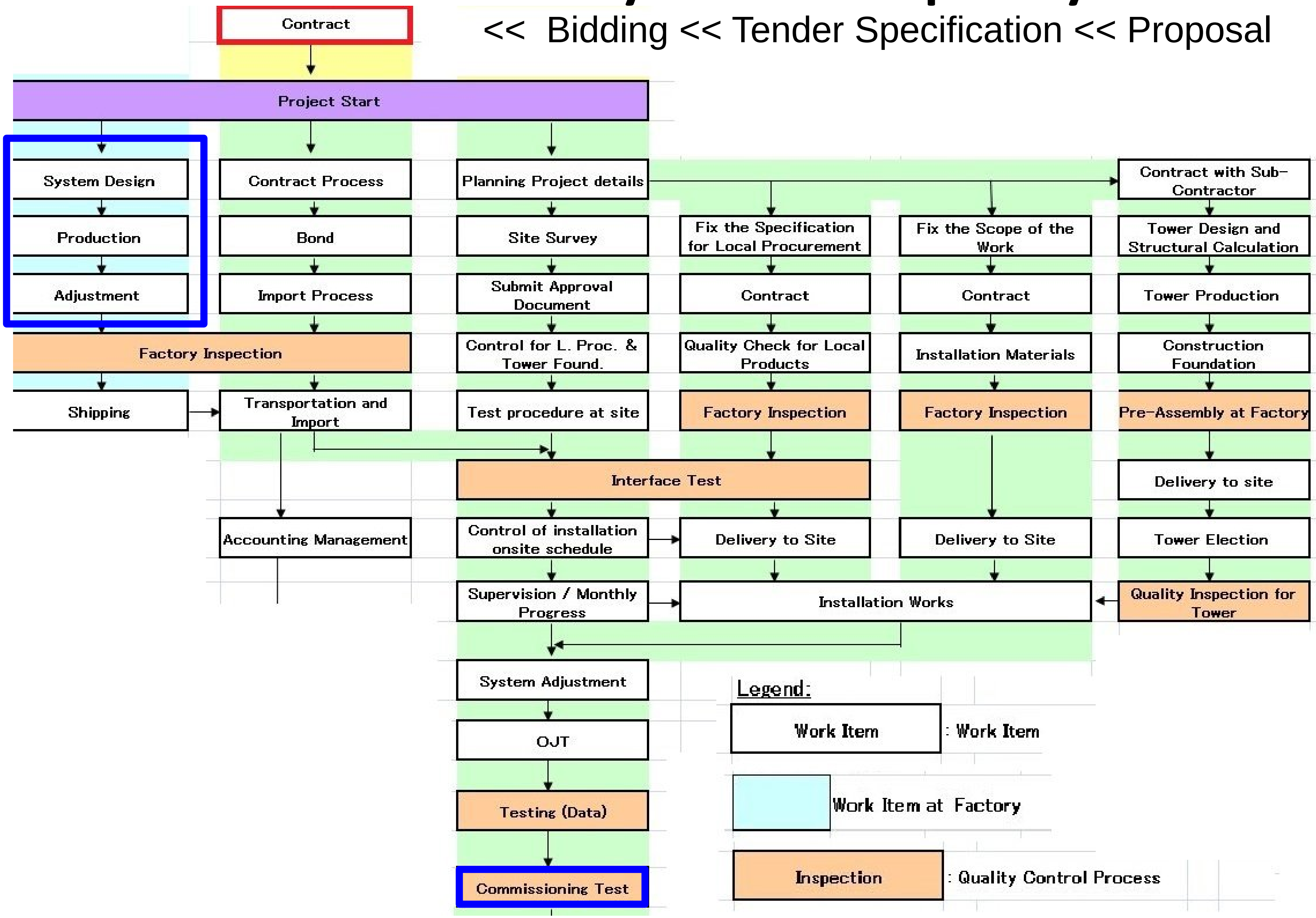
Electromagnetic shield room

QC activity in company



QC activity in company

<< Bidding << Tender Specification << Proposal



QC activity in company

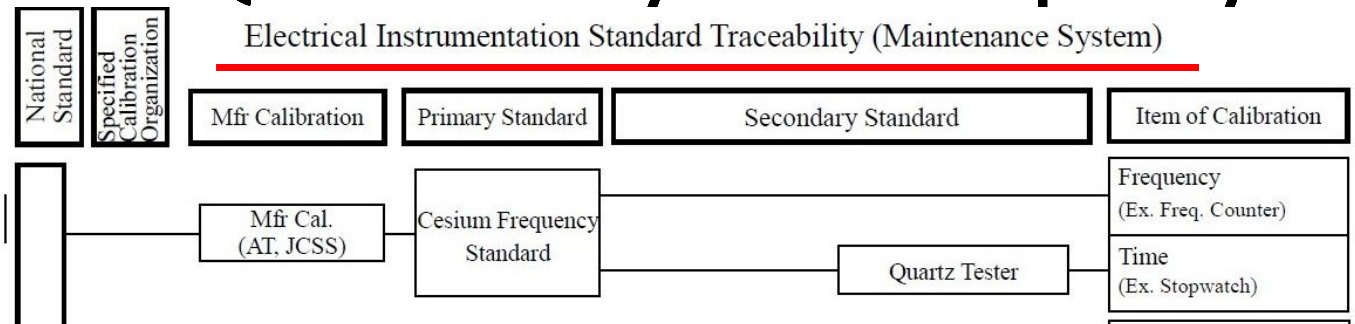
AFTER-SALE SERVICE

(1) Field Installation Work (under a contract with a customer)
The installation work includes a series of processes or limited processes ranging from regular and irregular checks, adjustment, installation, inspection and testing to verification of the functions as required by the customer after transportation of a product to the site.

(2) Check and Maintenance (under a contract with a customer)
The checking and maintenance work includes the processes ranging from regular and irregular checks, adjustment, installation, inspection and testing to verification of the functions of a product as required by the customer after operating the product on site and the work is intended for the long-time stable operation of the product.

(3) Troubleshooting and Repair
If any trouble in a product is reported from a customer after its delivery, its functional and performance recovery is promptly executed. The repair of such trouble may be made within or outside of the company. If the defective product is covered by the warranty period (normally one year after the delivery), it is repaired free of charge.

QC activity in company



Traceability : CONTROL OF MEASURING INSTRUMENTS

Measuring instruments and equipment are subject to centralized management by registration in a computer at Instrument Control Section, Quality Assurance Department.

The control procedure for each type of measuring instrument is prepared for precision maintenance.

The equipment requiring calibration by its manufacturer is administered by the Department.

NIST : National Institute of Standards and Technology
NPL : National Physical Laboratory
JCSS : Japan Calibration Service System

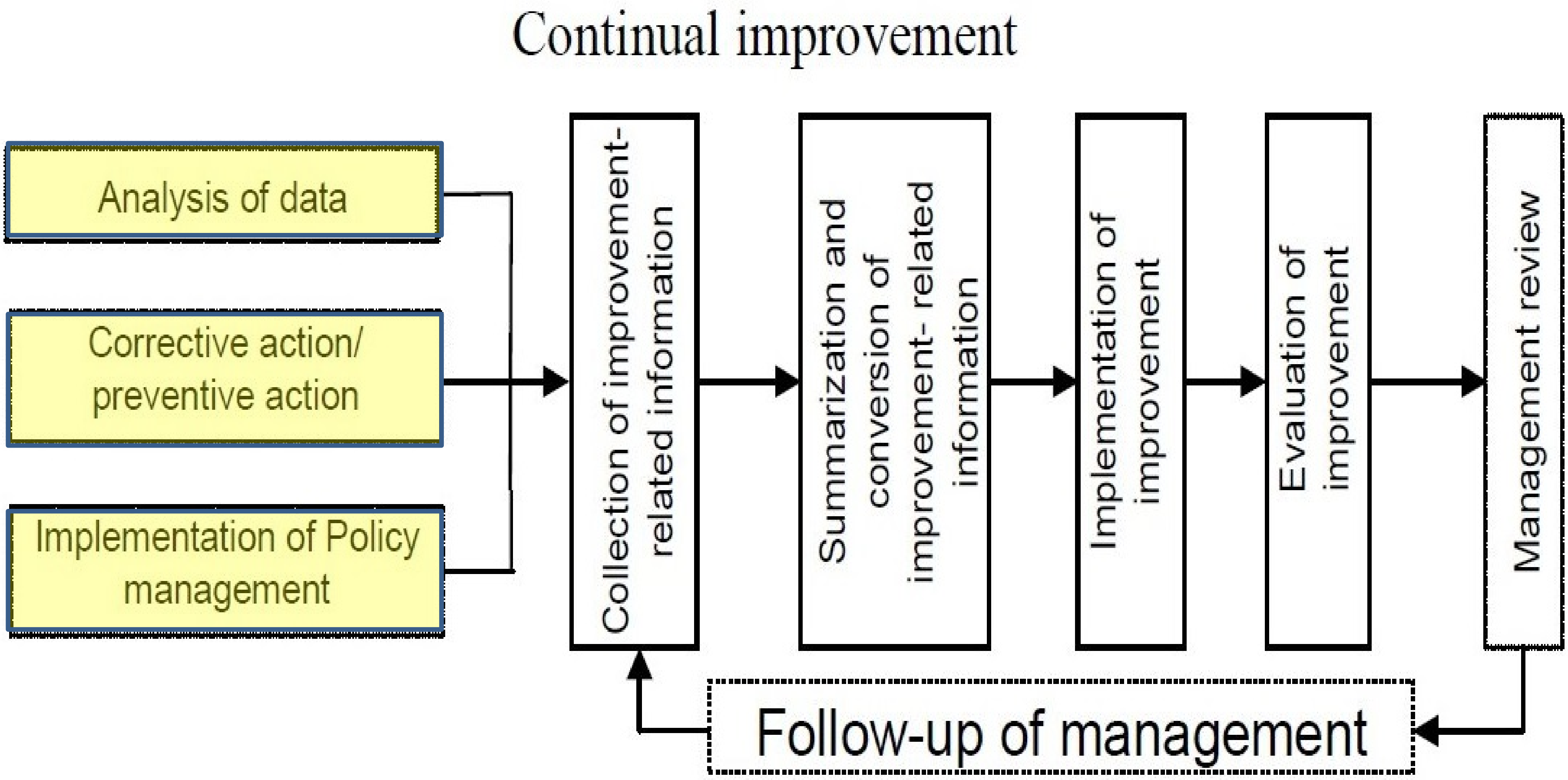
QC activity in company

CORRECTIVE ACTION AND PREVENTIVE ACTION

Corrective action against an incompliance product in the stages **from development to shipment**, the countermeasures such as

1） causal analysis;
2） making up an improvement plan;
3） implementation of such improvement plan;
4） prevention of trouble recurrence are taken;
5） the horizontal development of those countermeasures (to the associated processes including design, manufacture and inspection of any similar product)

QC activity in company



2. Example of QC activity for radar in Japan

Reference :

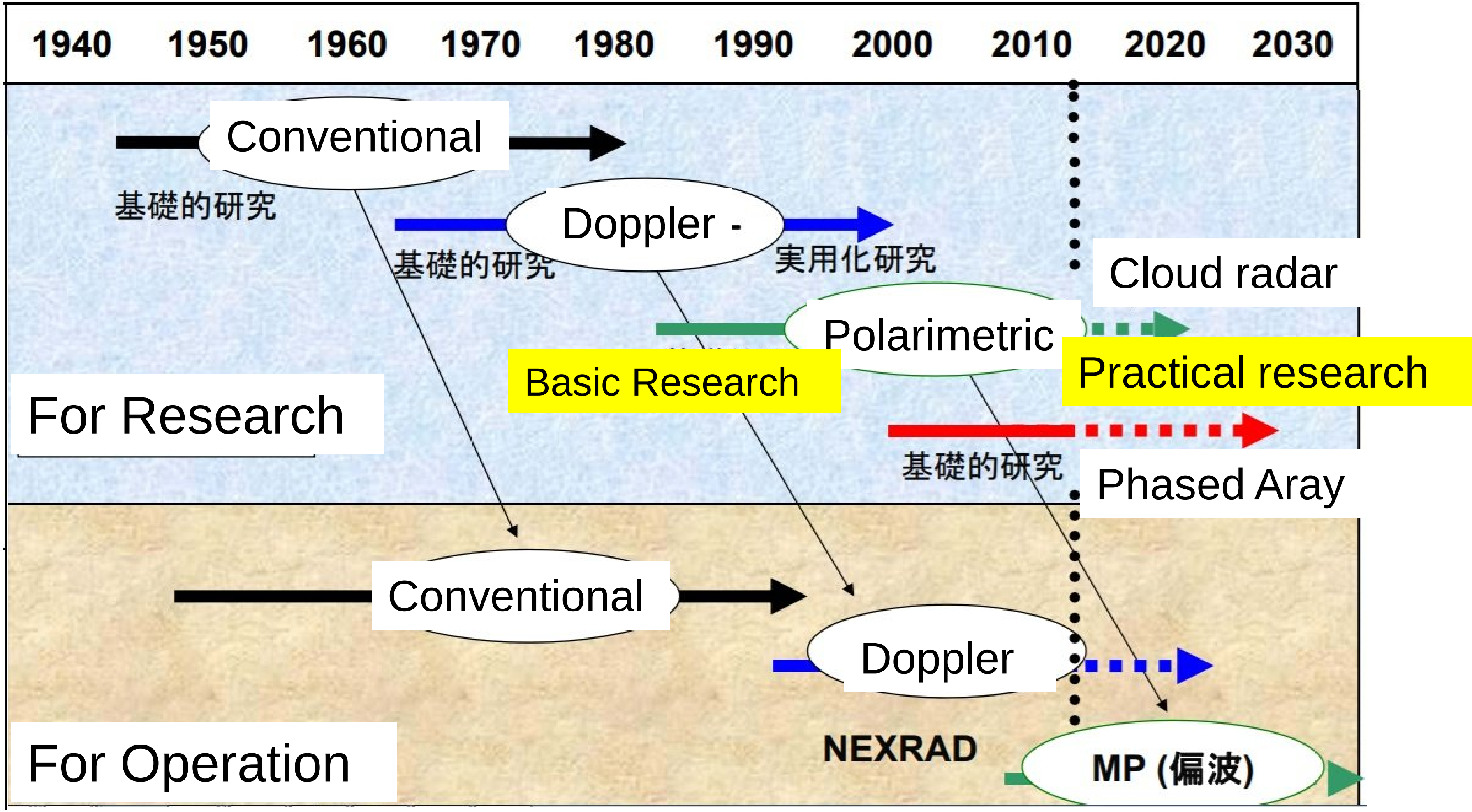
" Technical documentation on the practical application of XRAIN (X-band polarimetric (multi parameter) radar information network) rainfall observation "

TECHNICALNOTE of **National Institute for Land and Infrastructure Management**
No. 909 (May 2016) (in Japanese)

「XRAIN 雨量観測の実用化技術に関する検討資料 」
国総研資料 第 909 号

*) The Institute directly controlled by the MLIT

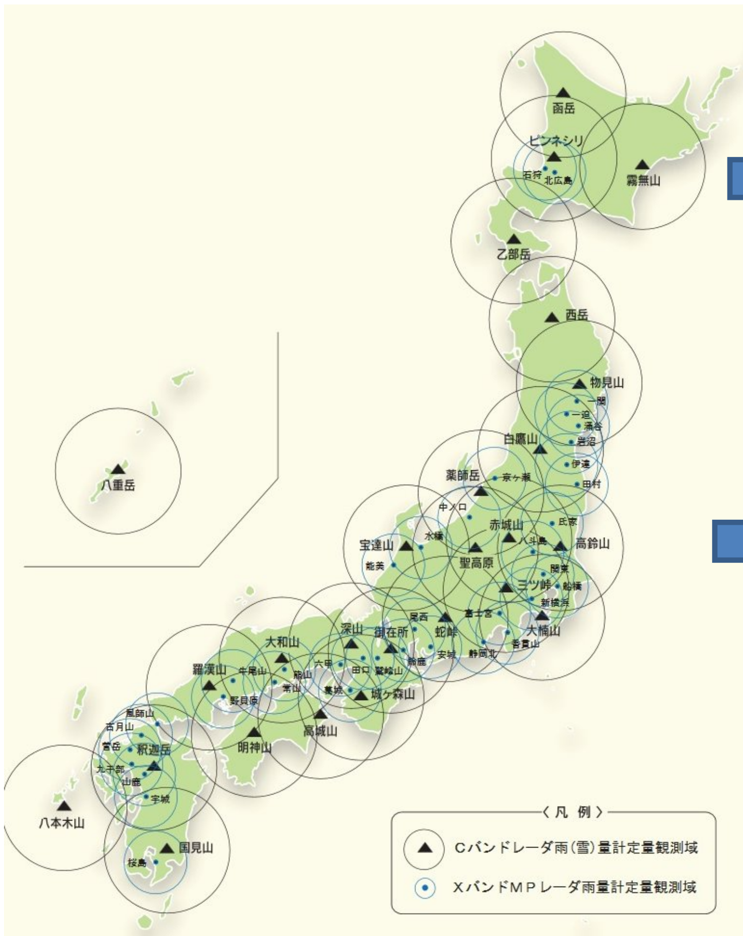
Toward XRAIN
(eXtended Radar Information Network)



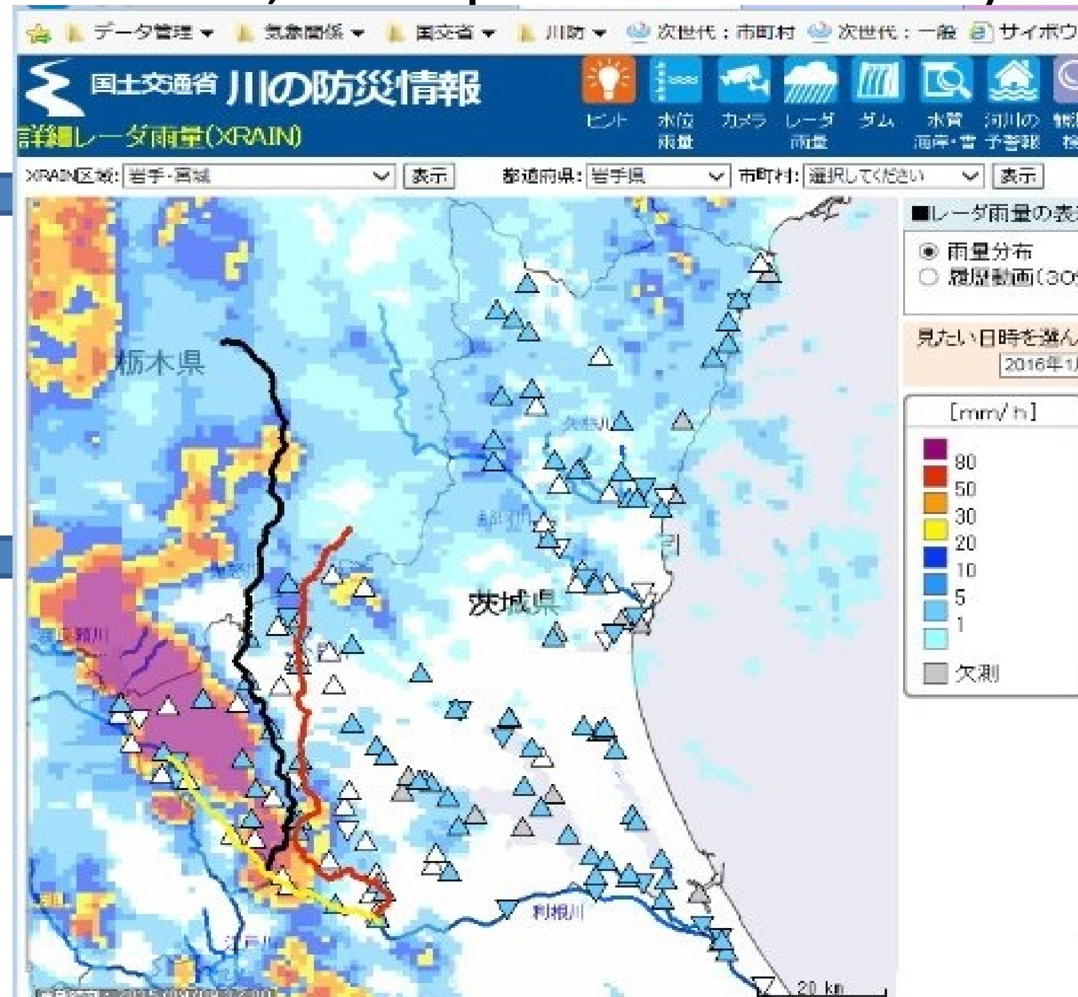
Source : Maki(2012)

Radar Network of MLIT

(Ministry of Land, Infrastructure, Transport and Tourism)



Observation area of C-band and X-band Radar



For River Management

Technologies for Observing Precipitation Amount with XRAIN

- Technologies developed by the NIED were put to practical use as a radar observation network by the NILIM.
- It is necessary to have advanced knowledge to convert the values observed by the radar into rainfall amount. Besides the both institutes, committees organized by hydrometeorological scholars, construction consultants, radar manufacturers, and the MLIT are collaborating to develop a highly precise rainfall conversion method.

* NIED: National Research Institute for Earth Science and Disaster Prevention
NILIM: National Institute for Land and Infrastructure Management
MLIT: Ministry of Land, Infrastructure, Transport and Tourism

Initial development stage of MP Radar
(NIED, 2000)

National Research Institute for Earth Science and Disaster Prevention (NIED)

National Institute for Land and Infrastructure Management (NILIM)

Committee composed of hydrometeorological scholars, and radar specialists.

Under instruction from research institutes and committees, the MLIT technological department, construction consultants, and radar manufacturers collaborated to build the XRAIN system.

Source:http://www.mlit.go.jp/river/pamphlet_jirei/pdf/xrain_en.pdf?0930

From Installing the New XRAIN Radar to Observation of Precipitation

- When installing a new radar, the MLIT and NILIM consider the location, adjust equipment , and verify the observation accuracy together with construction consultants, radar manufacturers, and committees of scholars to achieve highly precise observation of precipitation.

Location of radars

Construction Consultants | MLIT | NILIM

Consider the location of radars to observe target area appropriately.
Consider various conditions, such as observation altitude, influences of mountains, and interference with other radio waves.

↓

Manufacturing, installation and initial adjustment of radars

Radar Manufacturers | MLIT | NILIM

Manufacture radars and install at the locations.
Make the initial adjustment.

↓

Conversion to rainfall, combine multiple radars

Construction Consultants | MLIT | NILIM

Configure the algorithm and parameter to convert observed radar values to rainfall amount and combine with other radars.

↓

Verify accuracy

Construction Consultants | Committee by scholars | MLIT | NILIM

Compare the value between rain gauges and radar rainfall when it rains.
Consolidate the verification result, consult with committees of hydrometeorological researchers, and verify the accuracy of radar rainfall.

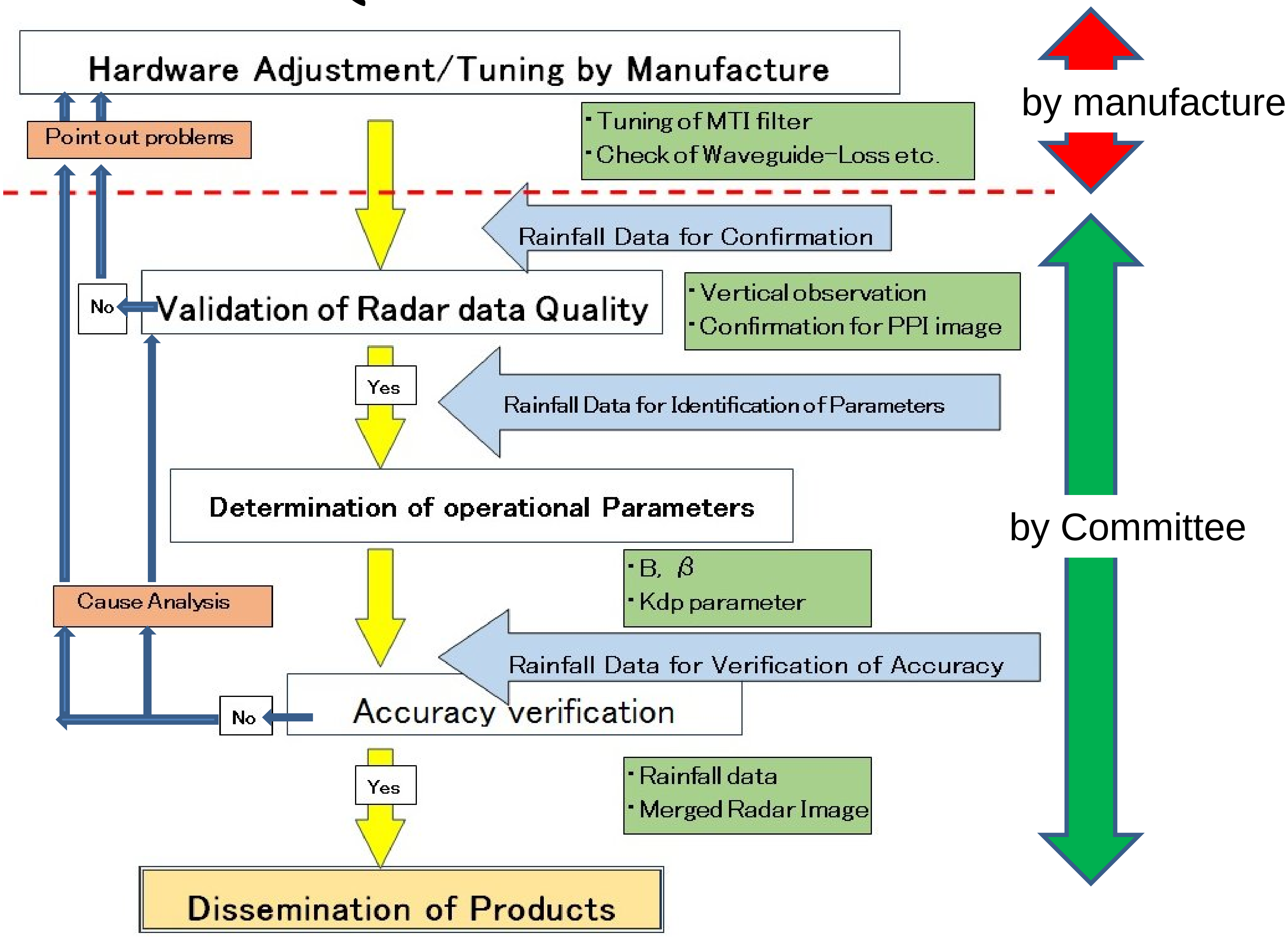
↓

Operation start

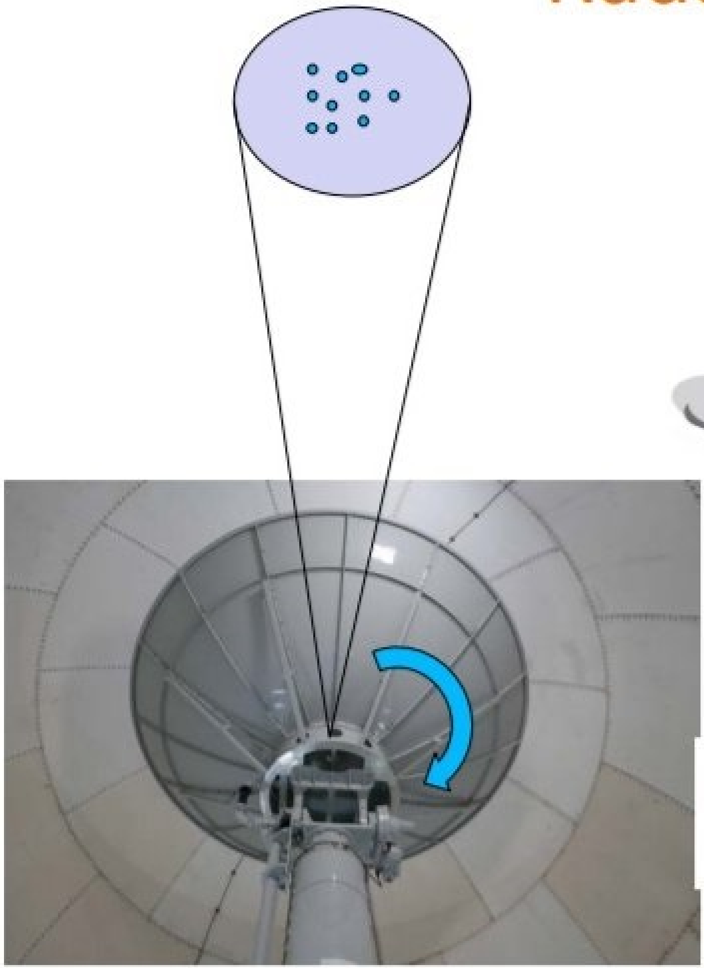
Delivery start

Source:http://www.mlit.go.jp/river/pamphlet_jirei/pdf/xrain_en.pdf?0930

Flow of QC for Radar Products



Radar Calibration

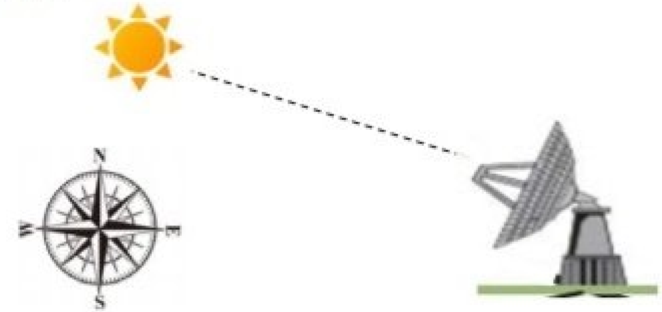


Birdbath Scan at 90° elevation

The key assumption of the method is that ZDR is zero when looking at falling raindrops from below.

1. Solar flux measurement:

   Monitoring the receiver sensitivity, differential offset of the receive path (ZDR), antenna pointing accuracy, beam squint.



2. Absolute calibration:

   Using measurements of Metal Sphere and Disdrometer.

Disdrometer

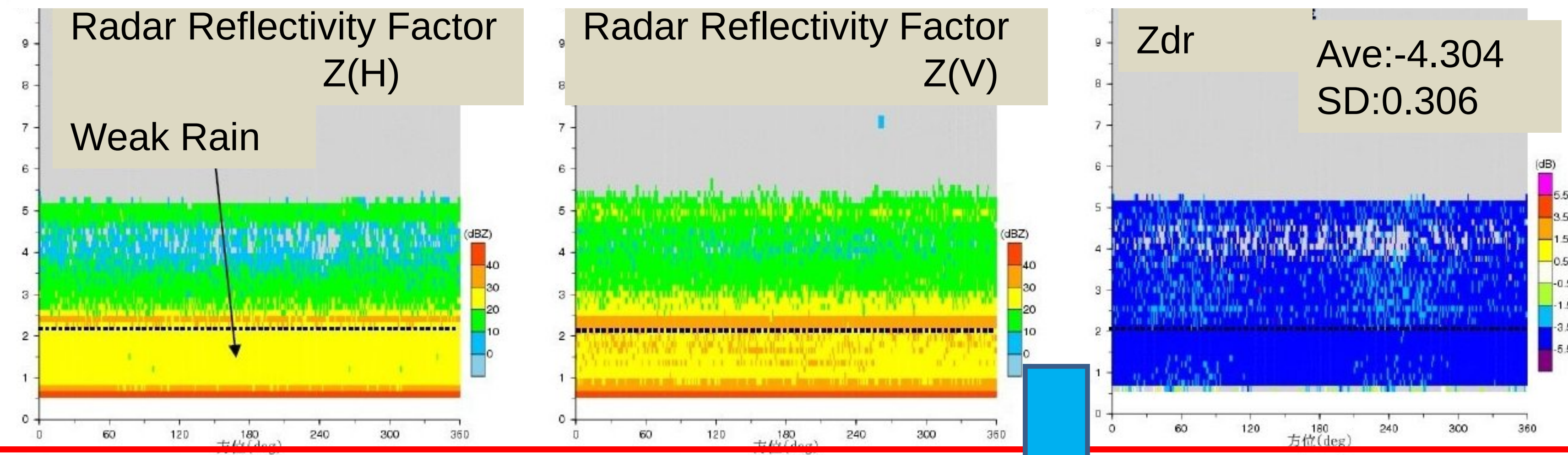
3. System differential offsets of ZDR and ϕ_{DP}:

   Using measurements of an operational birdbath scan at 90° and the detected solar signals in the operational scanning.

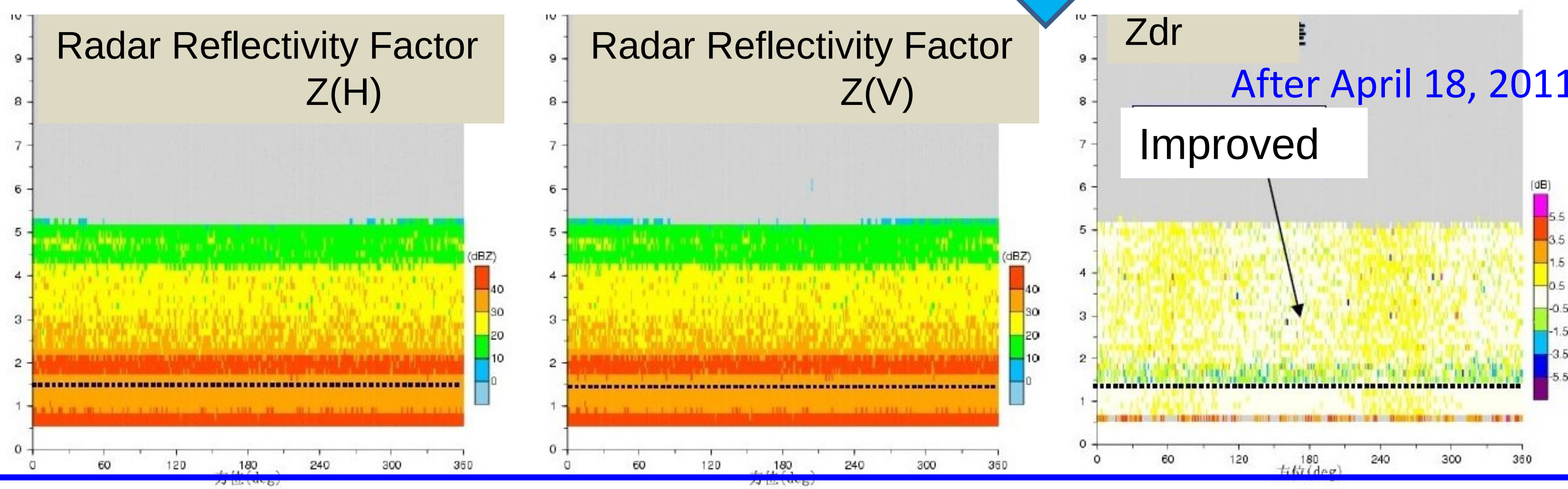
Result of Vertical Scan #1

A site: X-POL MLIT radar

Before April 8, 2011



After April 18, 2011

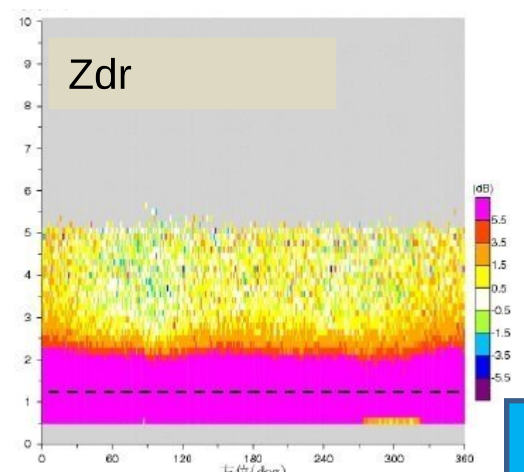


Result of Vertical Scan #2

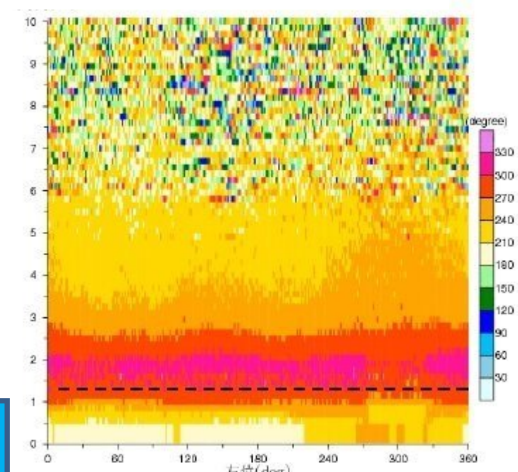
B site: X-POL MLIT radar

Before April 28, 2010

Zdr

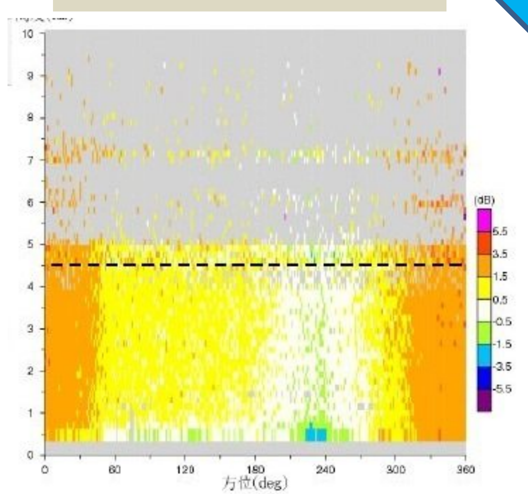


Φdp

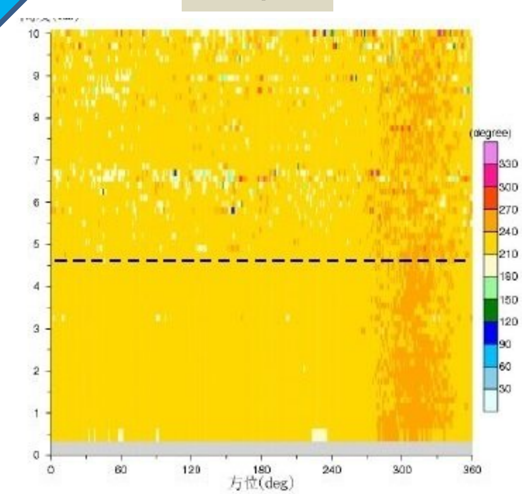


After May 24, 2010

Zdr



Φdp



Criteria for Vertical Scan Data

Site ***

Based on measurement
For POL radars in 2010

Zdr (ave)	within ±1.00 dBZ
Zdr (SD)	less than 0.8 dBz
φdp (SD)	less than 4.1 degree
ρhv (ave)	more than 0.93
ρhv (SD)	less than 0.045

Tentative Value for Trial Observation period

Example of Result for Vertical scan

Site ***	4/8	4/23
Zdr (ave)	-4.304	-0.217
Zdr (SD)	0.306	0.287
φdp (SD)	0.978	0.842
ρhv (ave)	0.990	0.991
ρhv (ave)	0.005	0.004
ANT. Rot. (rpm)	3.5	3.5

C site: X-POL MLIT radar

Procedure of QC for Radar Products

Invalidation for Data in Mask area

Invalidation for Data near radar

Invalidation for Data near noise level

Invalidation for Data affected by GC

Correction for folding data of ϕdp

Invalidation for incontinuous data of ϕdp

Invalidation for Invalid data of ρhv

Invalidation for data in shadow area

Invalidation for Point Echo

Example of QC activity for radar in Japan

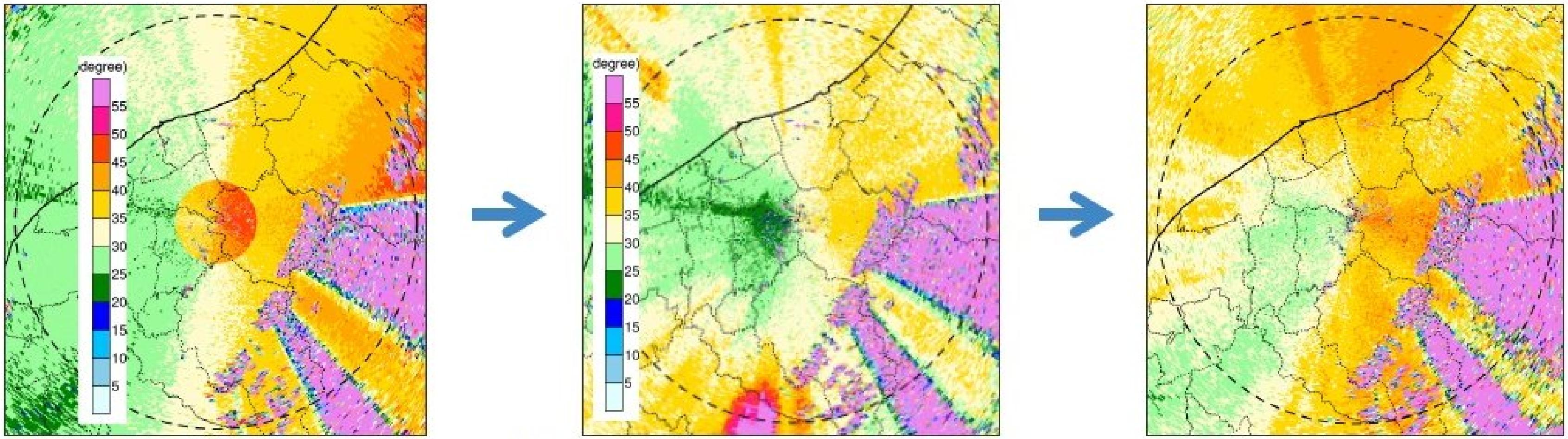
Check Point for PPI observation

- Continuous value between Short and Long pulse
- Suppression/Rejection of Ground Clutter
  - by Selection for Elevation angle & Mask area

Improvement of Discontinuous in ϕdp data

Phase shift by difference between Short Pulse for near range and Long pulse

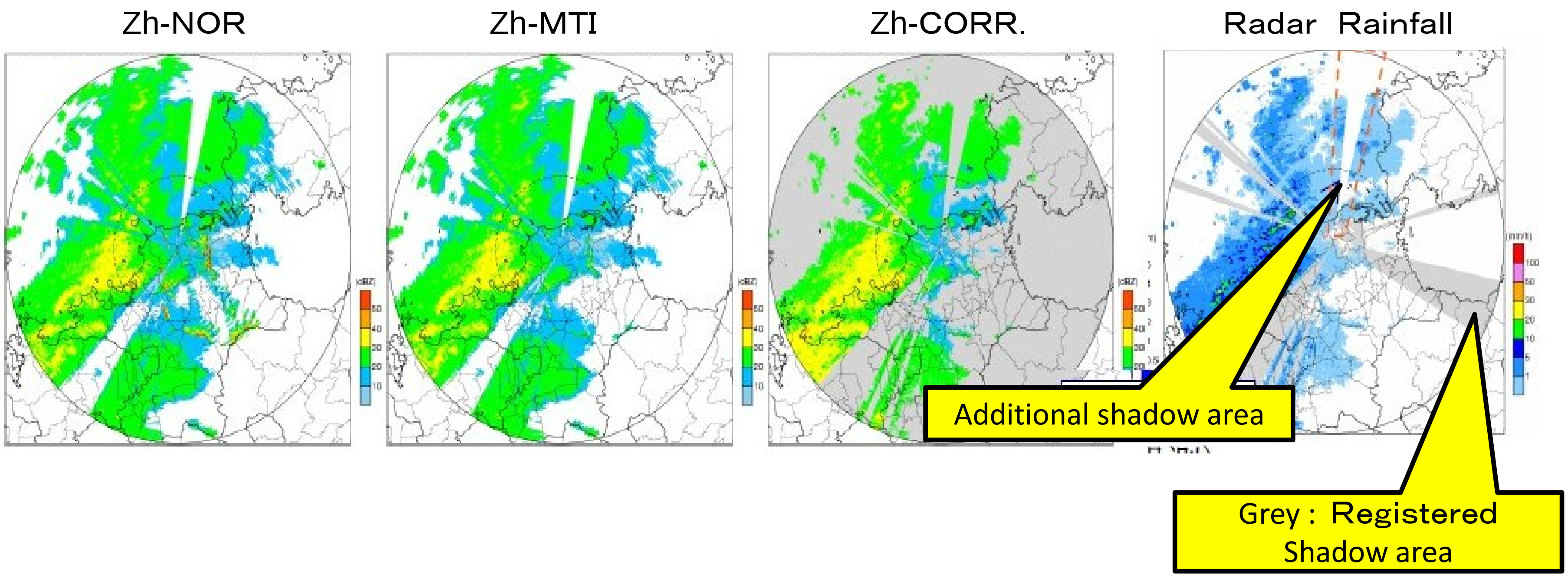
Before Tuning 4/8 After Tuning#1 4/23 After Tuning#2 5/22



>>> Improved Data

D site: X-POL MLIT radar

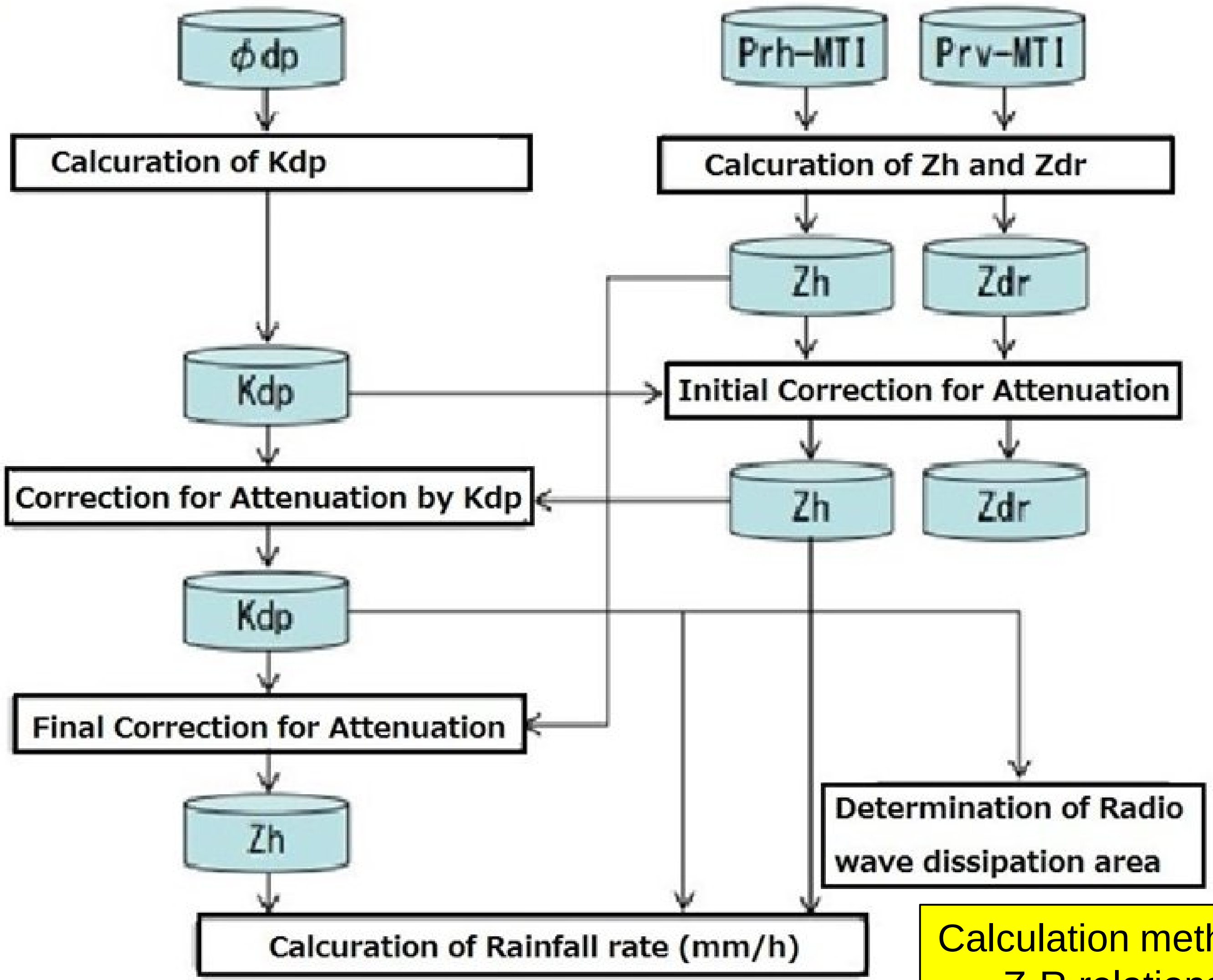
Procedure of QC for Radar Products



Adoption of Mask for Shadow area

E site: X-POL MLIT radar

Example of QC activity for radar in Japan



Calculation method without Z-R relationship (B, β)

Example of QC activity for radar in Japan

Example of Accuracy Evaluation Index

Regression coefficient

$$a = \sqrt{\frac{\sum_{i=1}^{N}(y_i)^2}{\sum_{i=1}^{N}(x_i)^2}}$$

Correlation coefficient

$$r = \frac{\sum_{i=1}^{N}(y_i - \overline{y})(x_i - \overline{x})}{\sqrt{\sum_{i=1}^{N}(y_i - \overline{y})^2}\sqrt{\sum_{i=1}^{N}(x_i - \overline{x})^2}}$$

Total rainfall ratio

$$s = \frac{\sum_{i=1}^{N} y_i}{\sum_{i=1}^{N} x_i}$$

Route mean square error

$$RMSE = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(y_i - x_i)^2}$$

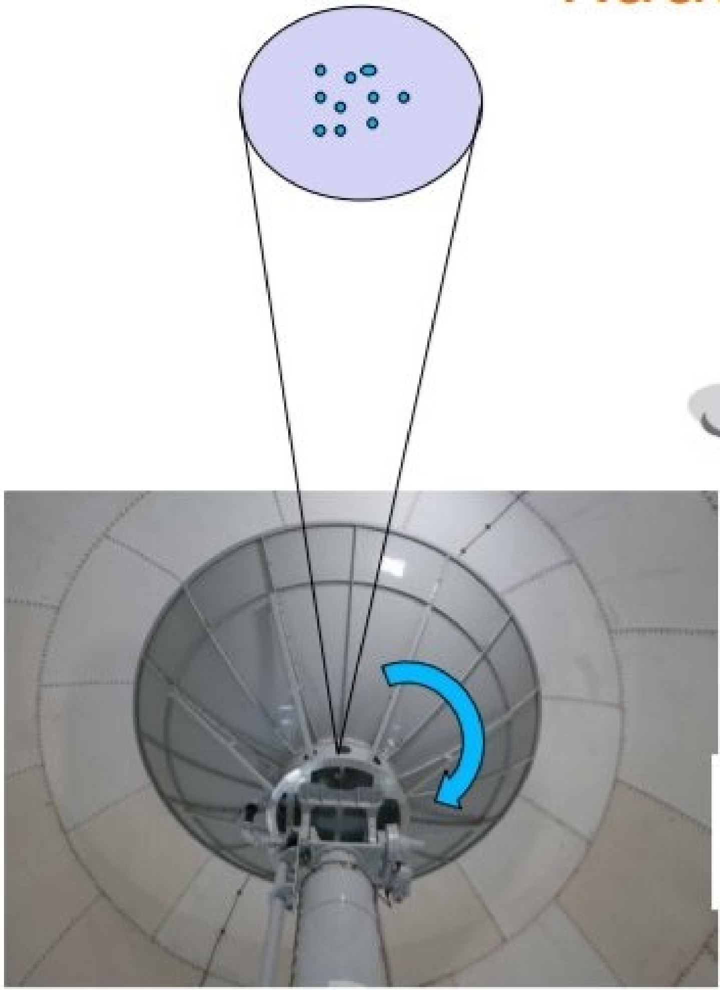
x_i : raingauge (mm/h) y_i : radar rainfall (mm/h)

3. Topics on Calibration

Calibration by using metal sphere

Calibration by Disdrometer

Radar Calibration



Birdbath Scan at 90° elevation

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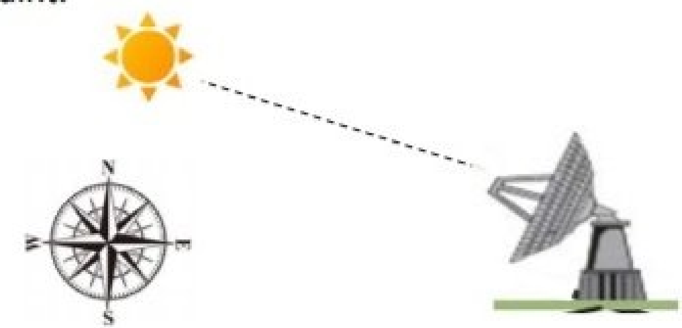
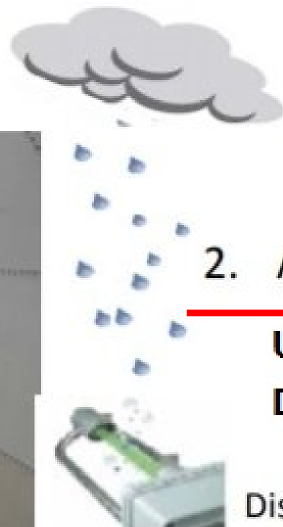


2. Absolute calibration:

   Using measurements of Metal Sphere and Disdrometer.



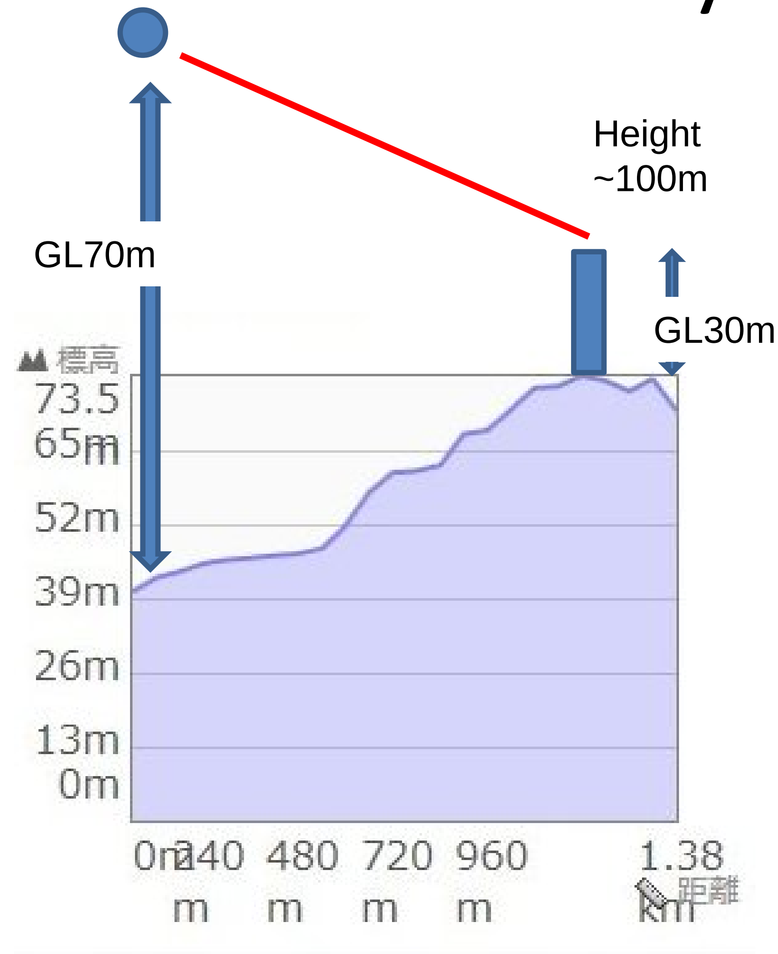
Disdrometer

3. System differential offsets of ZDR and ϕ_{DP}:

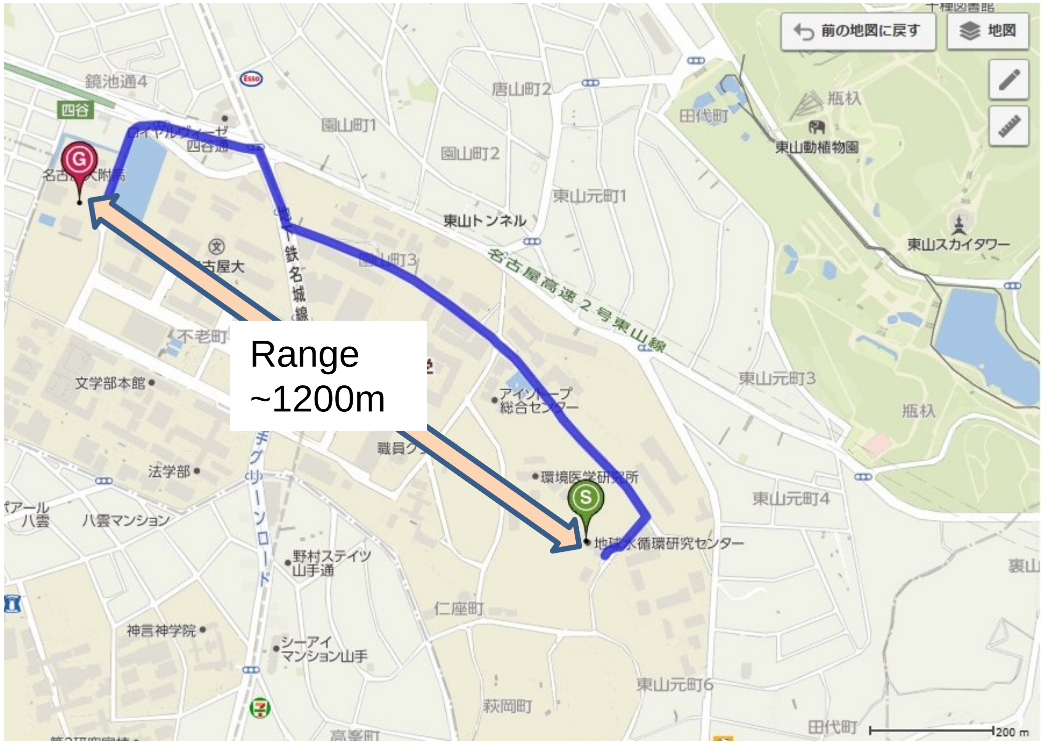
   Using measurements of an operational birdbath scan at 90° and the detected solar signals in the operational scanning.

Calibration by using metal sphere in 1979

Calibration by using metal sphere in 1979



Profile

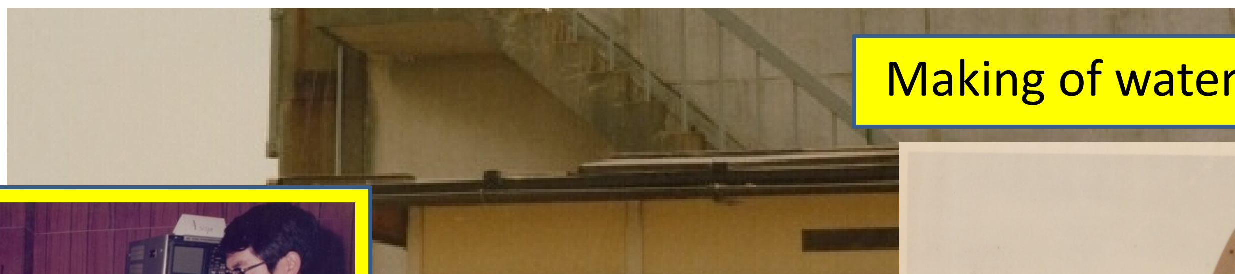


Calibration by using metal sphere in 1979

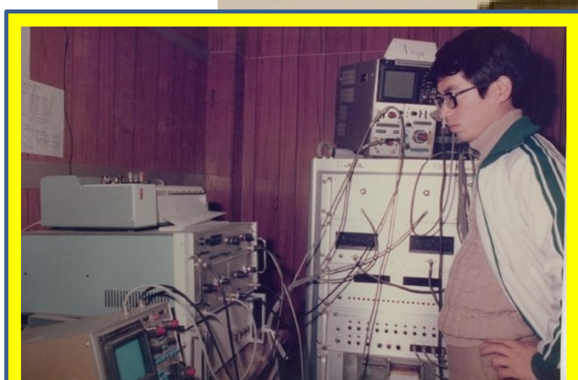
Calibration by using metal sphere in 1979

Positioning
by Prof. TAKEDA

The Result was not published !!



Making of water film on radome

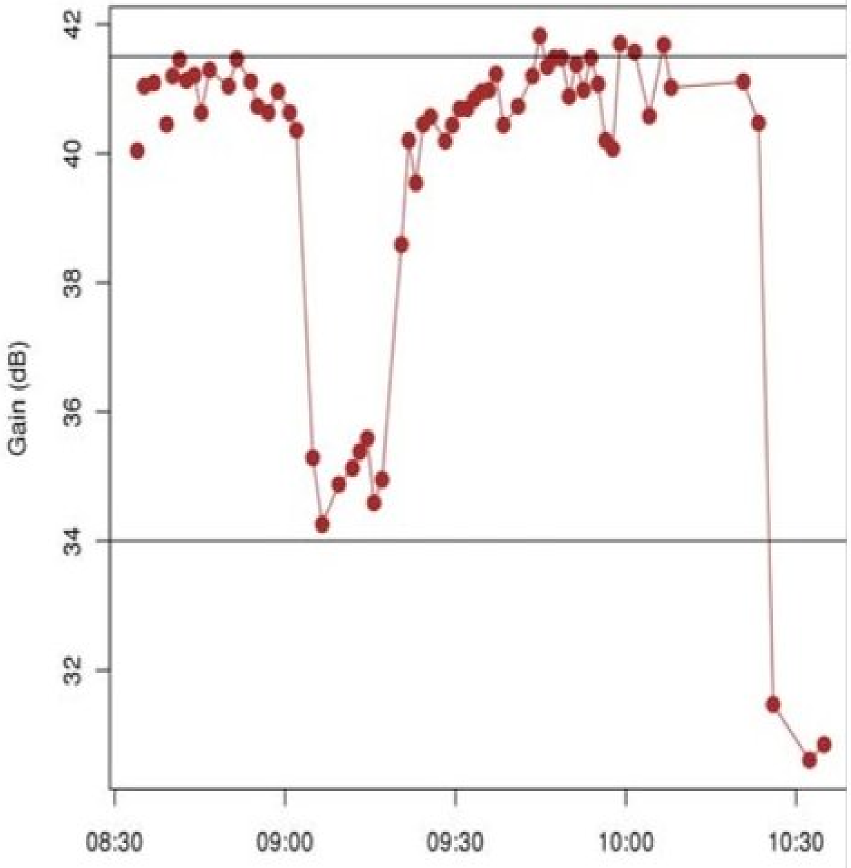


Recording of A-scope Image

Example of Similar Calibration

ANNEXES

OPERA-3 Deliverable OPERA_2012_04

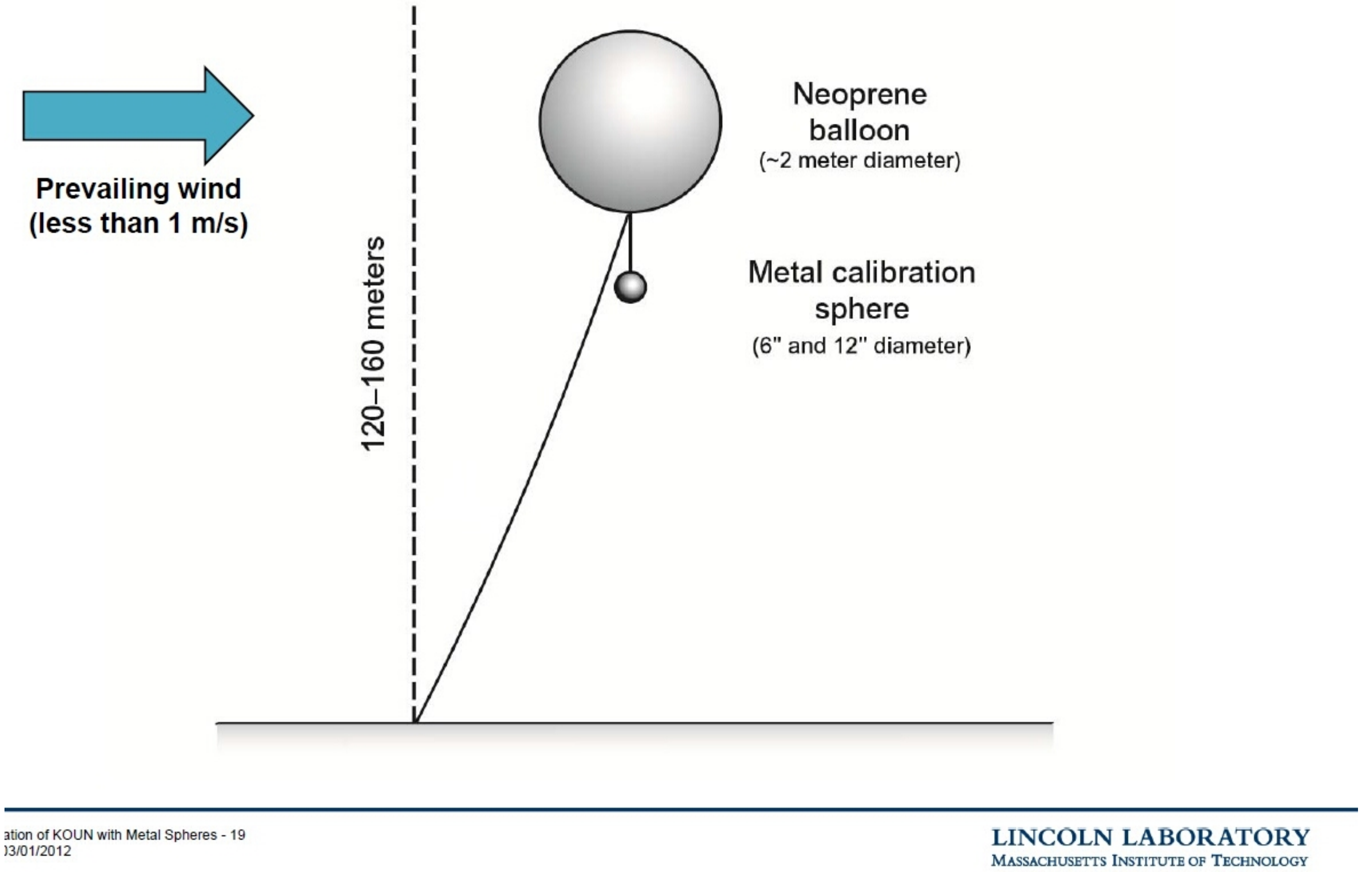


Calibration by using metal sphere in 2012

Metal Calibration Spheres					
Diameter	Composition	Manufacturer	Cost	Sphericity	Maximum Z_{DR}
6”	aluminum	Century Metal Spinning Co.	$400	0.005” in 6”	< 0.007 dB
12”	aluminum	Trimillenium Corp.	$722	0.5%	< 0.043 dB

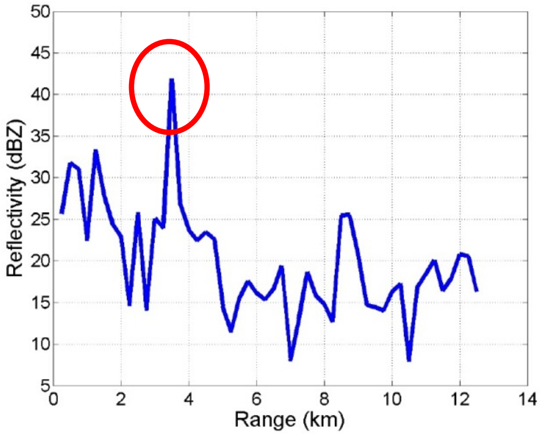
Source : LINCOLN LABORATORY MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Calibration by using metal sphere in 2012

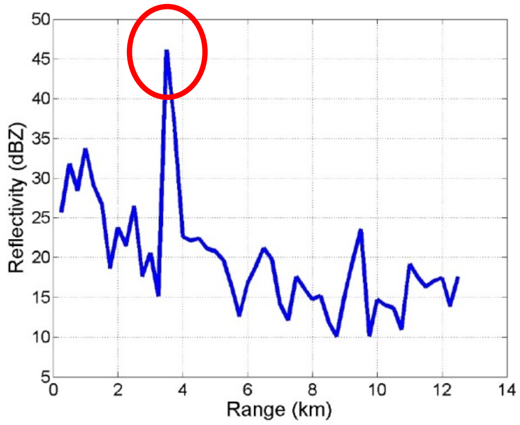


Calibration by using metal sphere in 2012

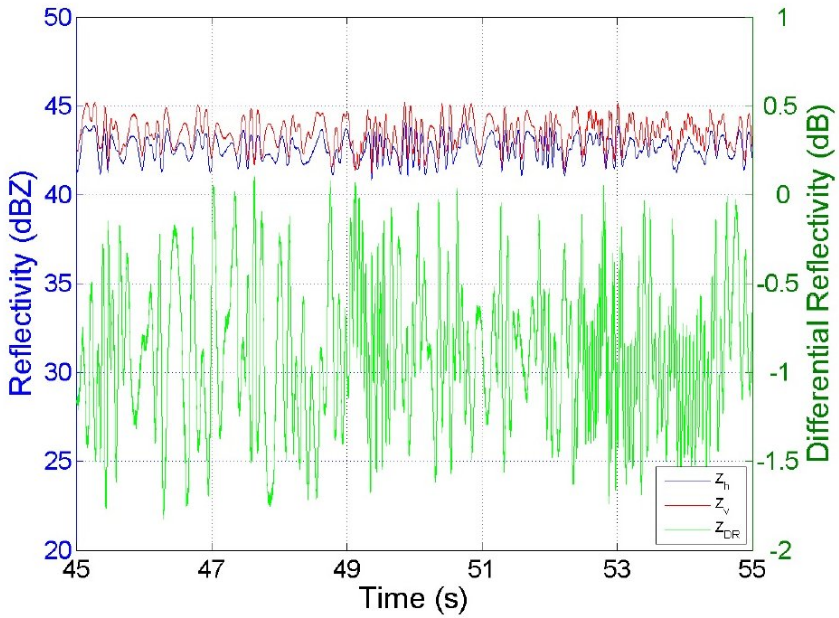
6" Sphere Signal versus Slant Range



12" Sphere Signal versus Slant Range



Z_H, Z_V, and Z_{DR} (Pulse-to-Pulse) for 6" Sphere



Source: LINCOLN LABORATORY MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Calibration by using metal sphere in 2012

Theory: $Z = (8\lambda^4 / \theta\,\varphi\,h\,\pi^5\,|k|^2)\,r^2/R^2$ mm^6/m^3

$\lambda = 11.08$ cm

$\theta = \varphi = 0.95$ deg $= 1.66 \times 10^{-2}$ rad

$h = 1.50\ \mu s$

$|k|^2 = 0.93$

6" sphere

R = 3400 meters

$Z = 17200\ mm^6/m^3$

$10 \log Z = 42.3$ dBZ

	Predicted Z (dBZ)	Measured Z (dBZ)	Std. Dev. Z (dB)	Predicted Z_{DR} (dB)	Measured Z_{DR} (dB)	Std. Dev. Z_{DR} (dB)
6" Sphere	42.3	42.5	0.47	0	-0.90	0.25
12" Sphere	48.3	46.7	0.36	0	-0.87	0.20

- **Z_{DR} offset biased negative**
- **Standard deviation based on 128 samples**
- **0.43 dB standard deviation on Z_{DR} pulse-to-pulse for 6" sphere**
- **0.33 dB standard deviation on Z_{DR} pulse-to-pulse for 12" sphere**

Source : LINCOLN LABORATORY Massachusetts Institute of Technology

3. Topics on Calibration

Calibration by using metal sphere

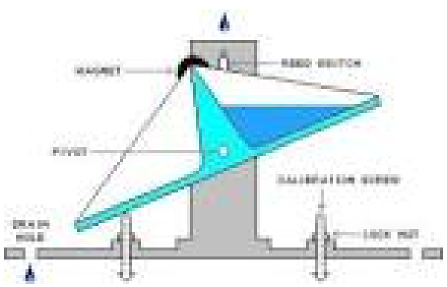
Calibration by Disdrometer

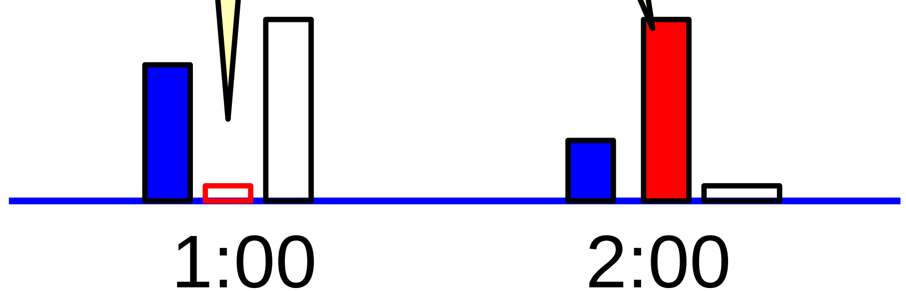
Accuracy of Rain gauge Data especially for comparison to Radar data

Tipping Bucket Type Rain gauge

Unit: 1mm
Every 1hour

Case1	Time	1:00	2:00
	Rainfall (True)	0.8	0.3
	Rain gauge	0	1
	Radar	1	0

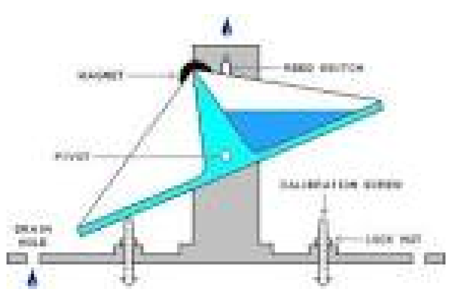


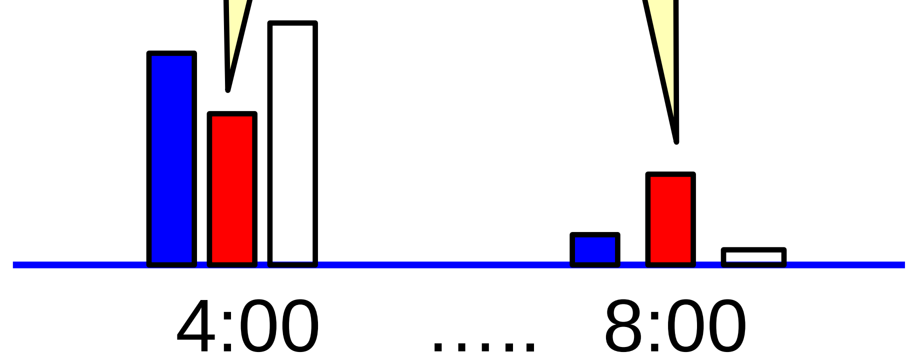


Accuracy of Rain gauge Data especially for comparison to Radar data

Tipping Bucket Type Rain gauge — Unit: 1mm, Every 1hour

Case2				
	Time	4:00	…	8:00
	Rainfall (True)	2.8	…	0.3
	Rain gauge	2	…	1
	Radar	3	….	0





Example of Radar Data QC Activity

Radar rainfall analysis in the middle of Indochina peninsular

Nattapon Mahavik[1*], Takehiko Satomura[1] and Somchai Baimuang[2]
[1]Graduate School of Science, Kyoto University
[2]Thai Meteorological Department
E-mail: mnattapon@kugi.kyoto-u.ac.jp

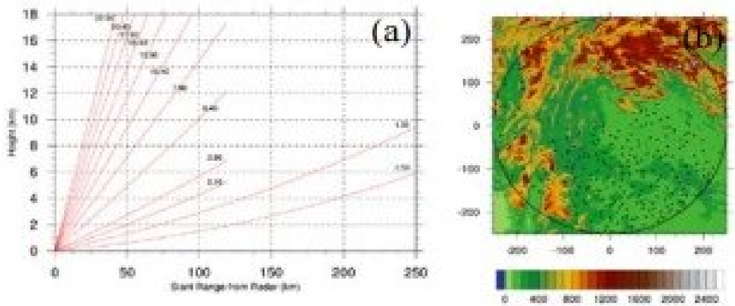


Fig. 1. (a) range-height diagram (b) topography, radar radius and gauge rainfall distribution

standard deviation of daily mean of rainfall near the Annam range.

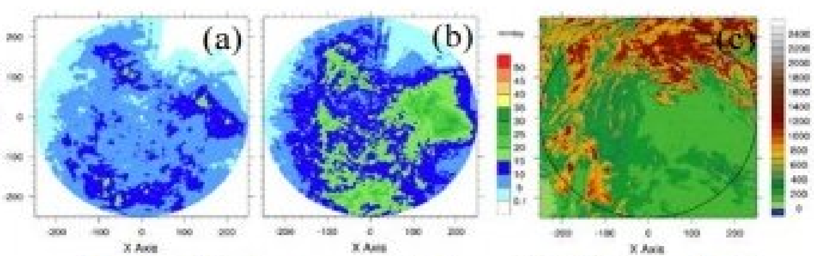


Fig. 4 (a) Daily mean of radar rainfall (b) standard deviation radar rainfall by using the calculated Z-R (c) Geographical terrain and radar radius

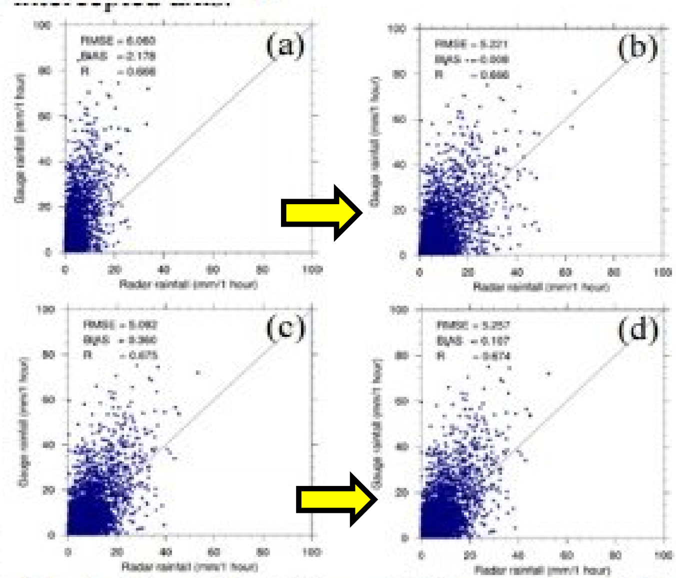


Fig. 2. (a) and (b) before and after applying C.F of the standard Z-R (c) and (d) before and after applying C.F of the calculated Z-R

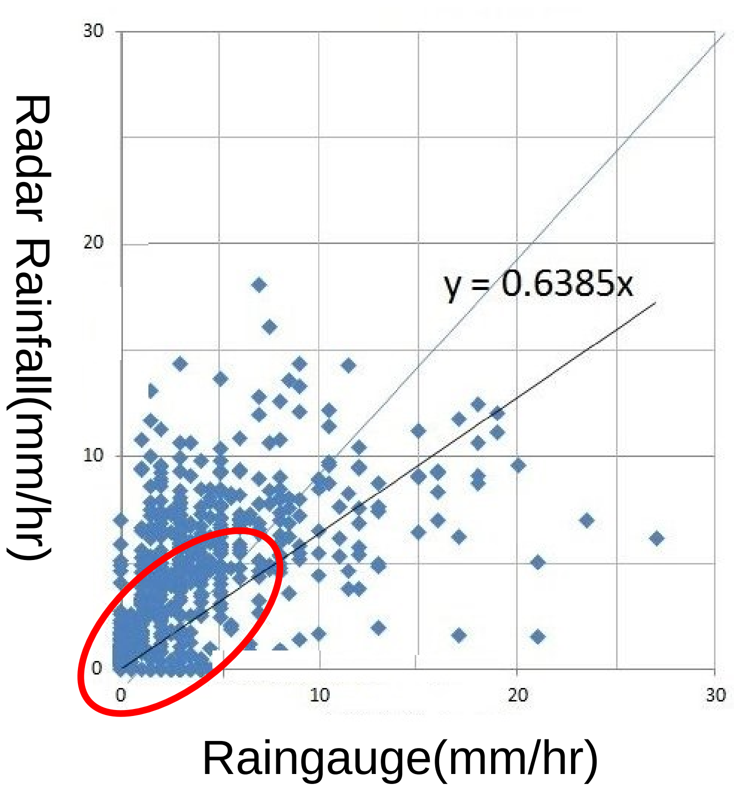
Journal of Disaster Research (2013), 8 (1): 187-188

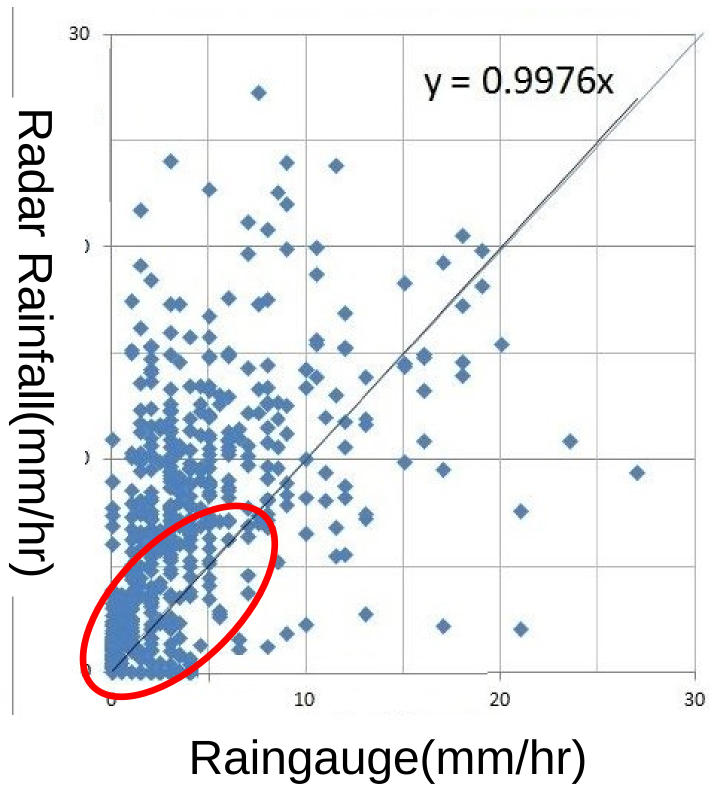
Example of Radar Data QC Activity

Weighting for numbers of small rainfall value

- light rain case : many

- heavy rain case : rather than light rain

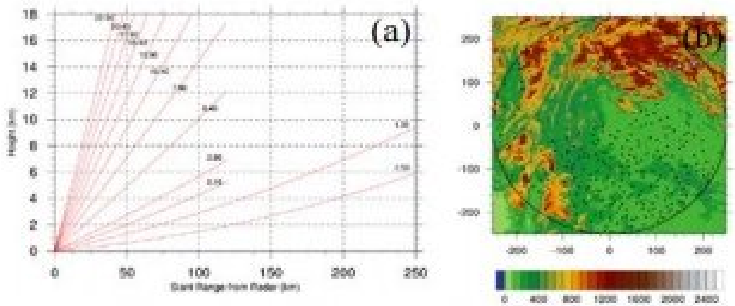




Example of Radar Data QC Activity

Radar rainfall analysis in the middle of Indochina peninsular

Nattapon Mahavik[1*], Takehiko Satomura[1] and Somchai Baimuang[2]
[1]Graduate School of Science, Kyoto University
[2]Thai Meteorological Department
E-mail: mnattapon@kugi.kyoto-u.ac.jp



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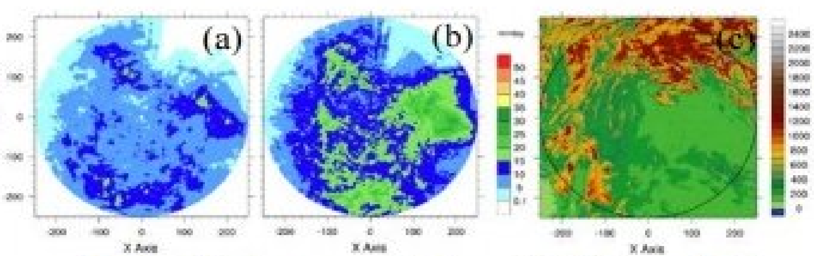
standard deviation of daily mean of rainfall near the Annam range.



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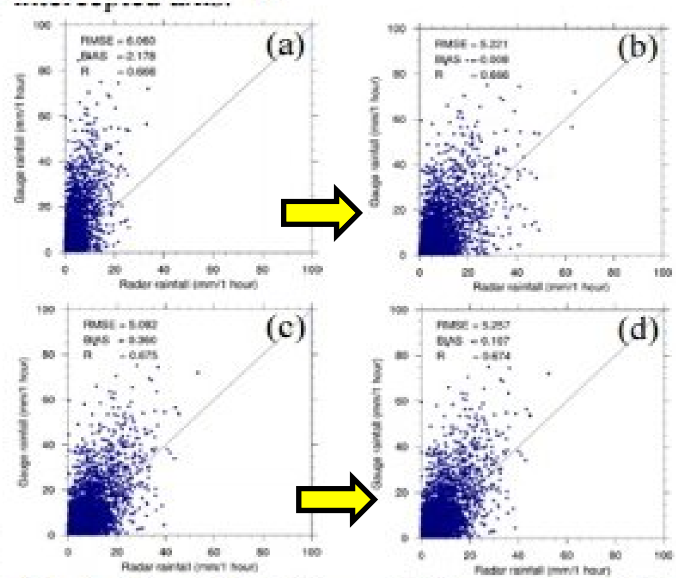
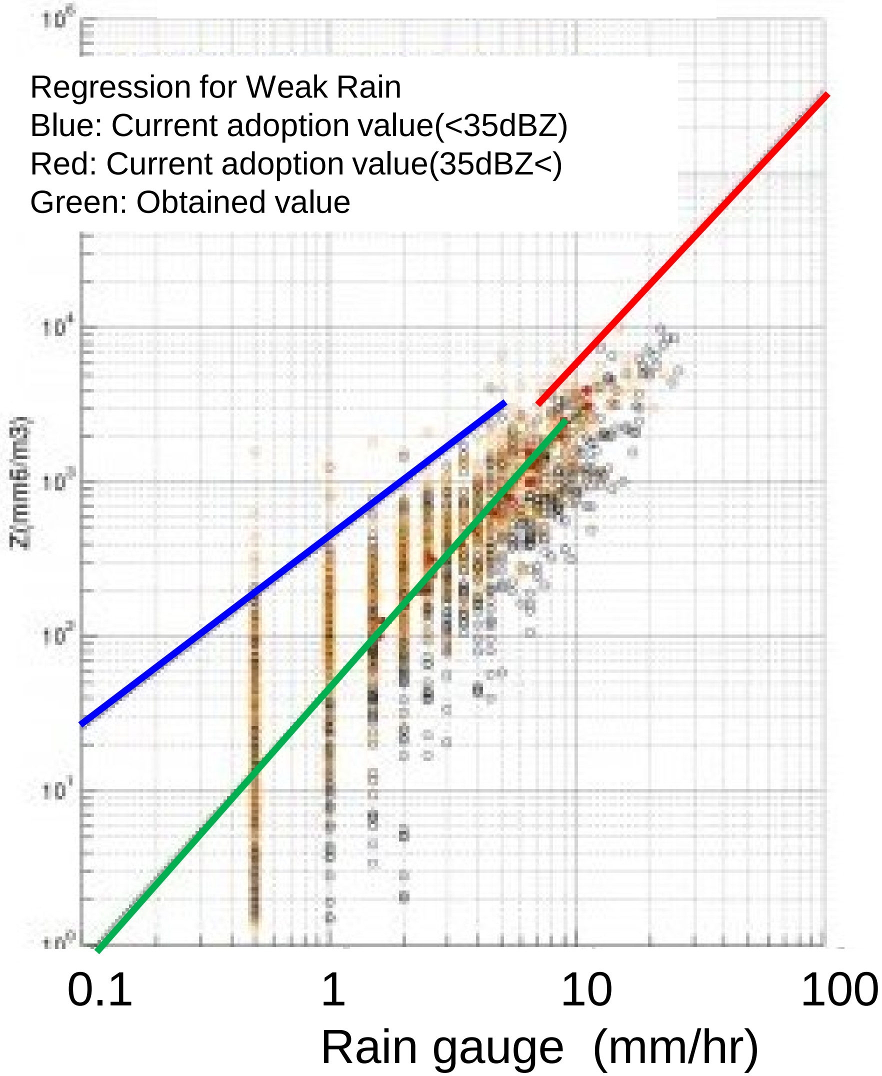


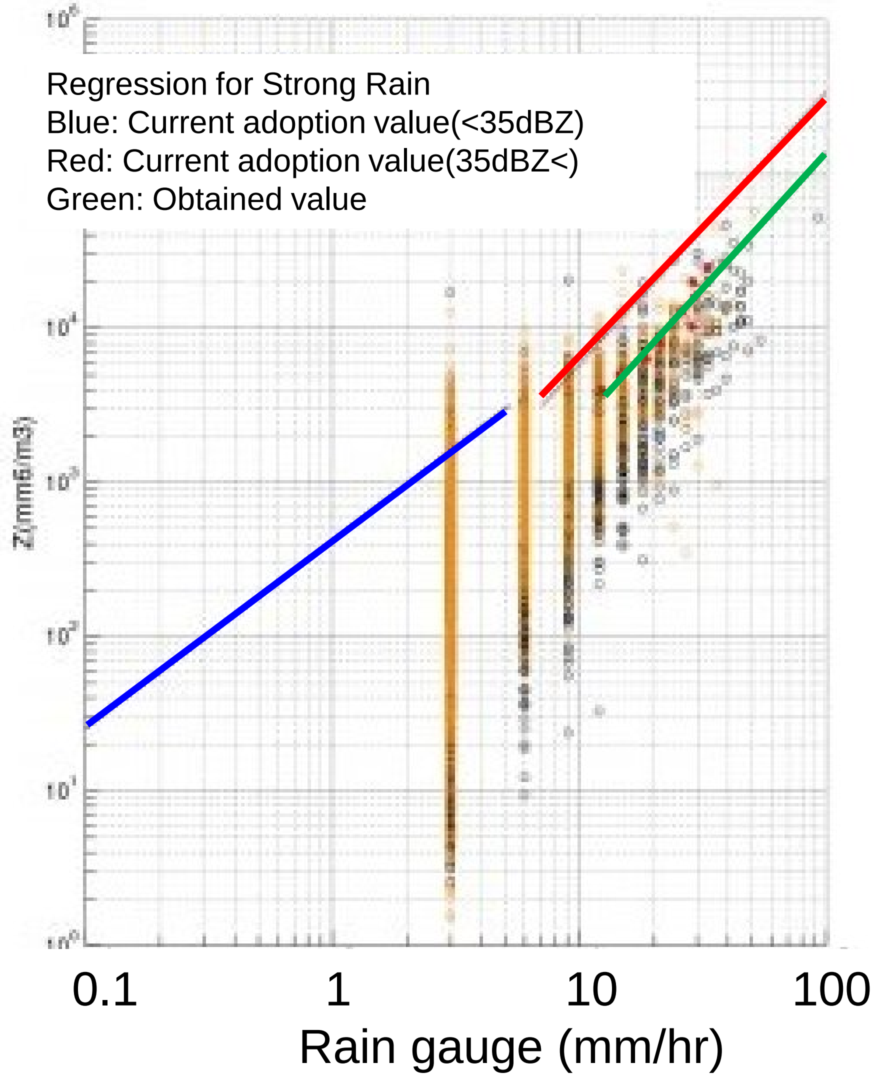
Fig. 2. (a) and (b) before and after applying C.F of the standard Z-R (c) and (d) before and after applying C.F of the calculated Z-R

Journal of Disaster Research (2013), 8(1): 187–188

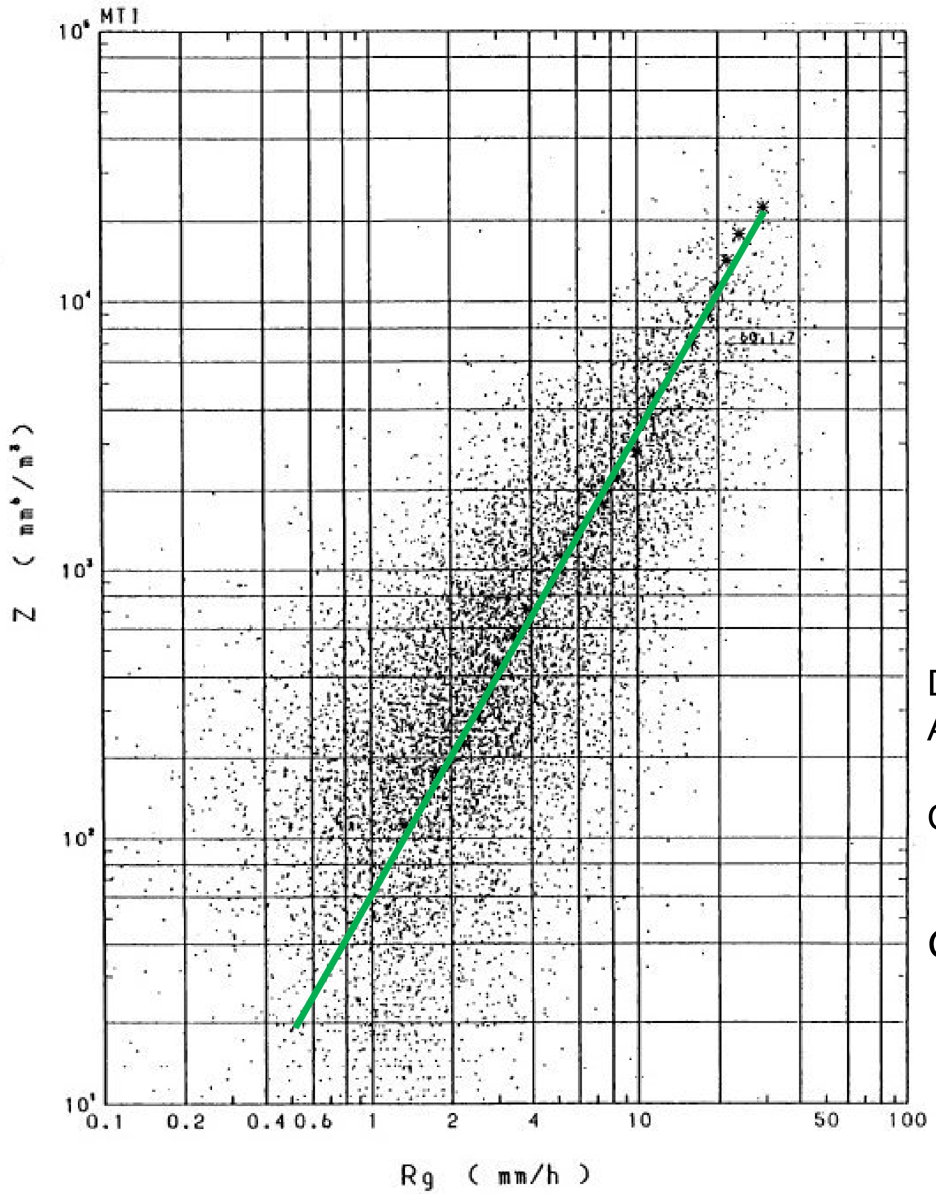
Example of QC activity for radar in Japan

F site: X-POL MLIT radar





Example of Radar Data QC Activity



Dot : observed data
Asterisk : averaged reflectivity for each gauge value
Green: Regression line for asterisk value

G site:
C-Conventional MLIT radar

Example of Radar Data QC Activity

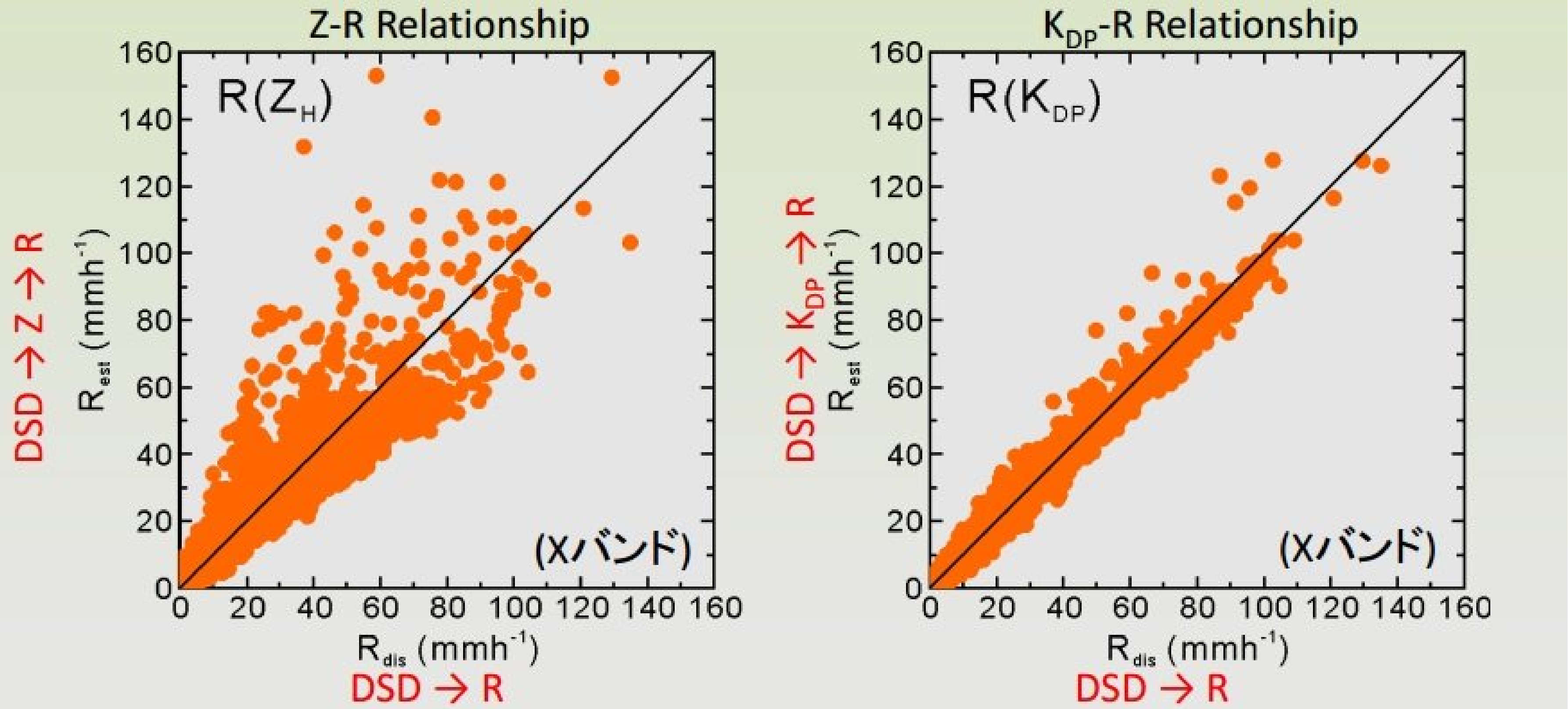
Problems of regression
between rain gauge value and radar reflectivity

1) Difference in each values
- Quantization error included in rain gauge value for weak rain
- Temporal deviation in gauge data

2) Representative of each value based on occurrence probability
Weak rain: commonly occurring >> strong rain: rare

3) Regression line for Linear value or Logarithmic value

Example of Radar Data QC Activity



The accuracy of Kdp method based on dual polarization is better than that of B,β method.

Source:http://www.soumu.go.jp/main_content/000526163.pdf

Example of Radar Data QC Activity

SEPTEMBER 1965 MIYUKI FUJIWARA 591

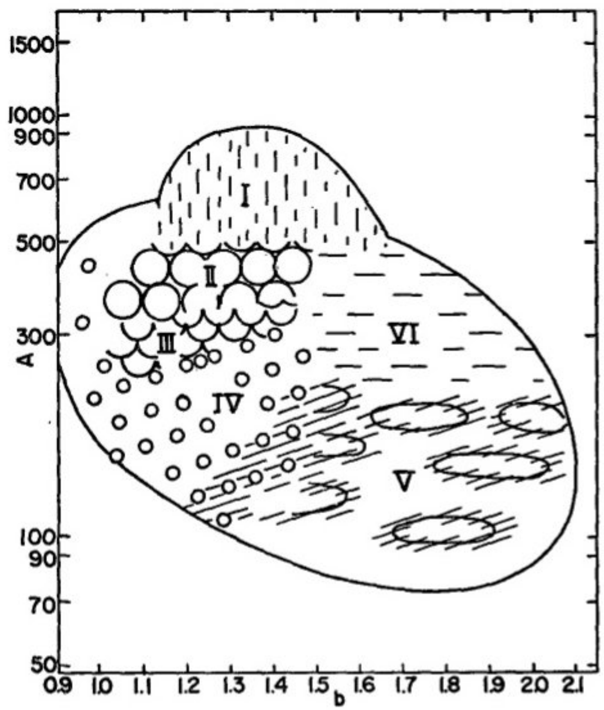


FIG. 6. Schematic illustration of echo characteristics in the A–b plane. The classification and definition are given in the text

Variety of Z-R Relationships

$Z=200R^{1.6}$	Marshall and Palmer, 1955, Stratiform rain
$Z=150R^{1.5}$	Kodaira, 1972, Summer, Maebashi
$Z=205R^{1.48}$	Fujiwara, 1965, Continuous rain, Miami
$Z=300R^{1.35}$	Sekhon and Srivastava, 1971, Thunderstorm, by vertical Doppler radar
$Z=300R^{1.37}$	Fujiwara, 1965, rainshowers, Miami
$Z=300R^{1.5}$	Joss and Waldvogel, 1970, 47 days in 1947
$Z=310R^{1.56}$	Gunn and East, 1954, for λ=3.21 cm
$Z=400R^{1.4}$	Laws and Parsons
$Z=450R^{1.46}$	Fujiwara, 1965, thunderstorms, Miami

It is not appropriate to obtain the result of the regression since the values of B and β tend to change in season or rainy stage. For dual polarization radar, the rainfall estimation based on Kdp method is better than that based on Z-R relation. Therefore the development of QC techniques shall be carried out rather than to estimate the values of B and β for each case.

6-10 If yes, by what method does your Service monitor quality of dual polarization parameters? (Multiple answers allowed)

6-7	Does your Service calibrate dual polarization parameters?	
	No	6
	Yes	1
6-8	If yes, by what method does your Service calibrate dual polarization parameters?	
	Metal sphere	0
	Bird-bath scan	1
	Solar signal	0
	Comparison with disdrometer	1
	Others (please specify below)	0
6-9	Does your Service monitor quality of dual polarization parameters?	
	No	6
	Yes	1
6-10	If yes, by what method does your Service monitor quality of dual polarization parameters? (Multiple answers	
	Analyzing weak weather echo (drizzle)	0
	Bird-bath scan	1
	Solar signal	0
	Comparison with disdrometer	0
	Others (please specify below)	0

(

Analyzing weak

(driz

cify below)

Calibration by using disdrometer

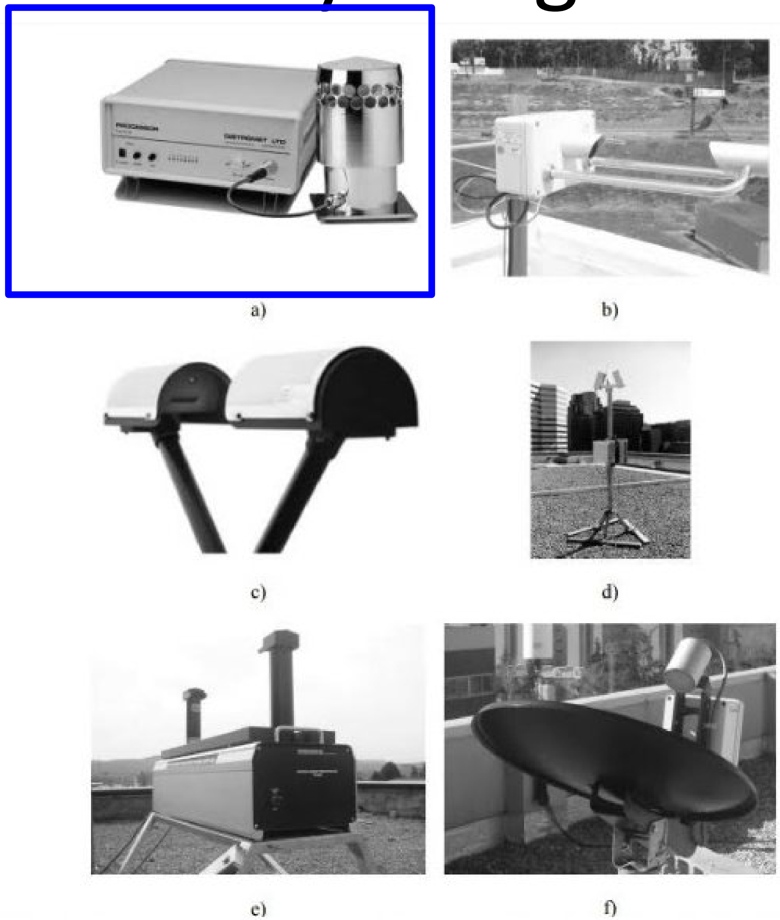


Fig. 1. Some of the disdrometers used in rain research: **(a)** Joss-Waldvogel (photo from www.distromet.com); **(b)** Laser Precipitation Monitor (Thies Clima); **(c)** Parsivel Laser Optical Disdrometer (photo from www.hotfrog.es/Empresas/OTT-Medioambiente-Iberia_2621606/OTT-Parsivel-22738), **(d)** Precipitation Occurrence Sensor System, POSS, (photo from www.radar.mcgill.ca/facilities/poss.html); **(e)** Ground Based Precipitation Probe, **(f)** Micro Rain Radar.

Source: https://www.atmos-meas-tech-discuss.net/amt-2011-132/amtd-4-6041-2011.pdf

Calibration by using disdrometer

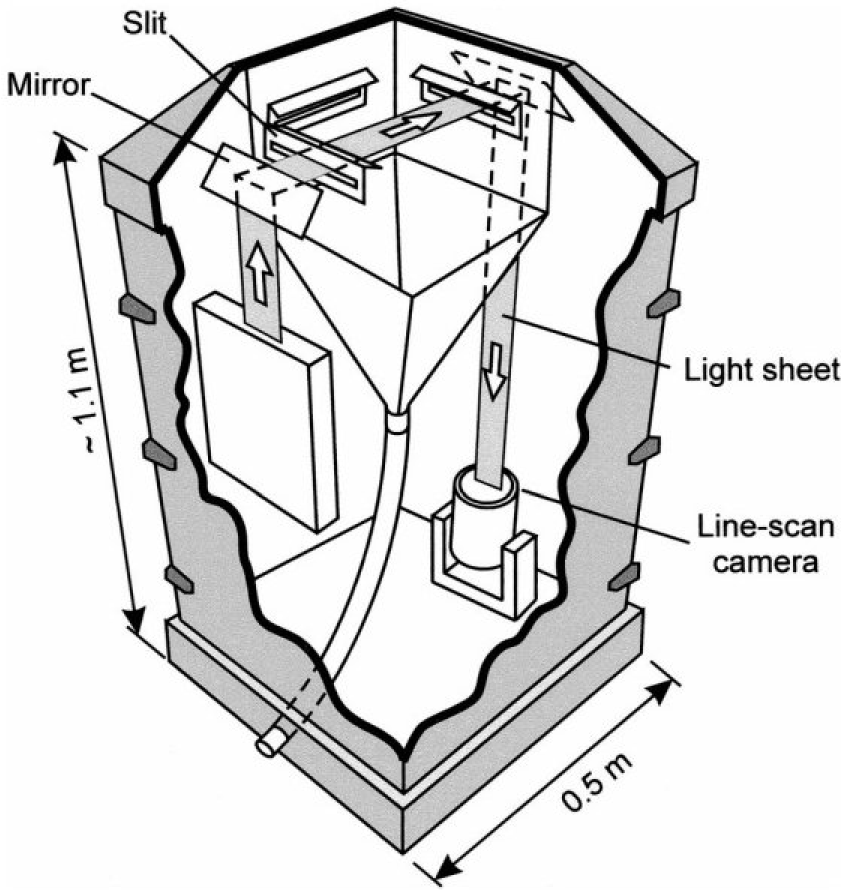
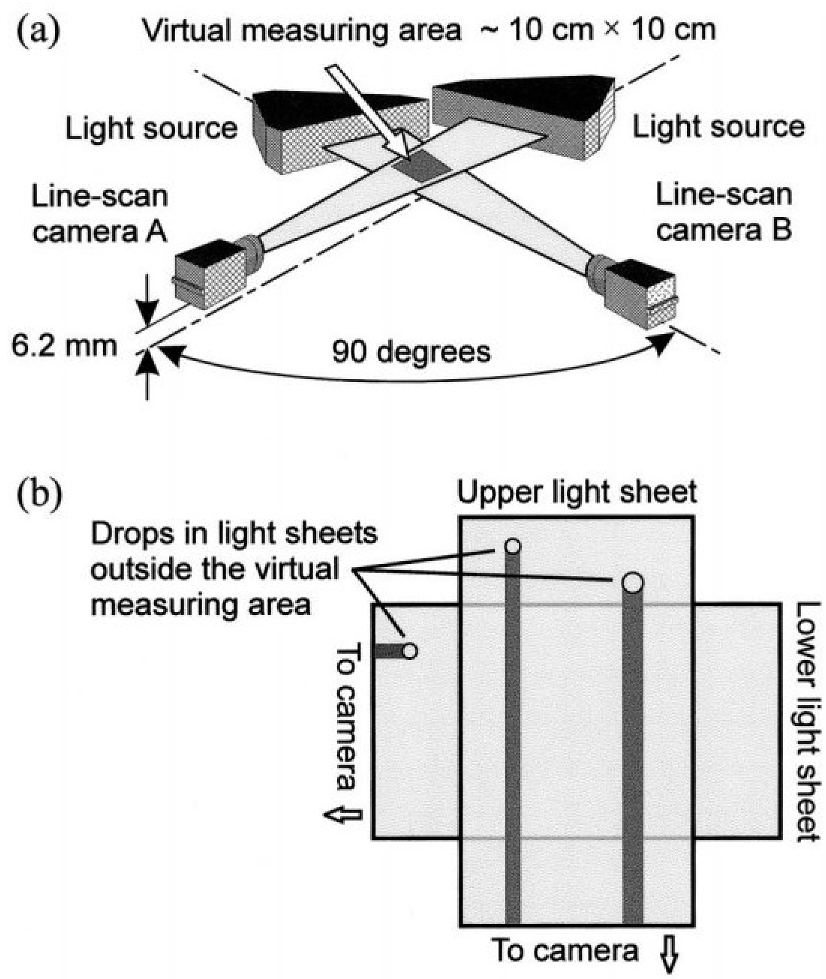


FIG. 2. The construction of the 2DVD sensor unit showing one of the two orthogonal light sheets and associated optics.



Calibration by using metal sphere

J. Grazioli et al.: Hydrometeor classification from 2-D video disdrometer data **2873**

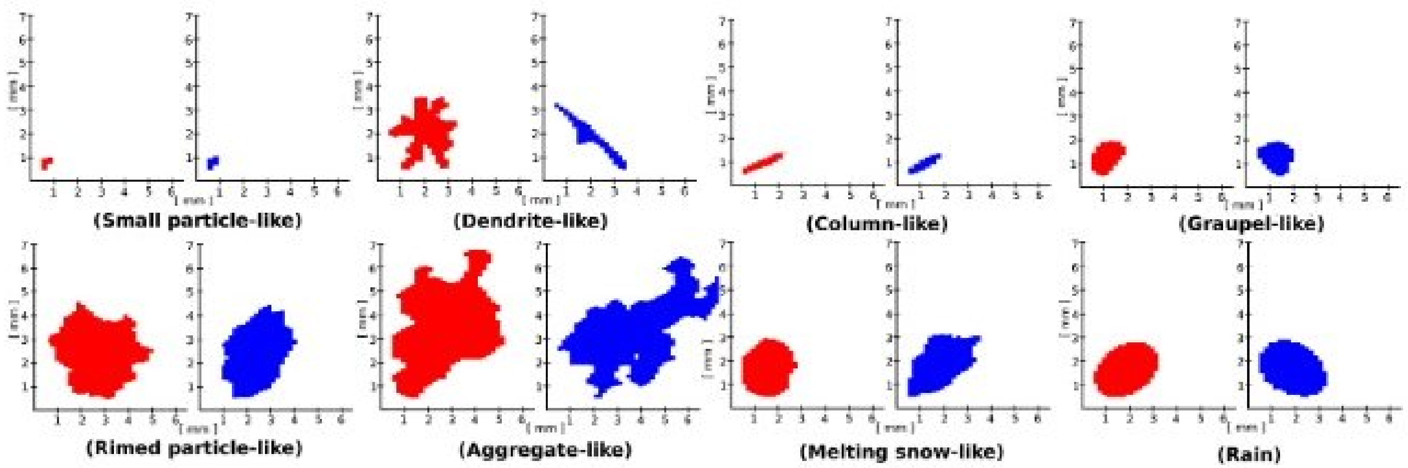


Figure 4. Examples of particle images (two camera views: A left, B right) belonging to time steps dominated by a particular hydrometeor class.

Calibration by using disdrometer

Summary of the Characteristics of Rain Droplet Measurement Techniques.

	Stain Method	JWD RD 80 & RD 69 Disdrometer	VR—WXT520 Disdrometer	2 Dimensional Video Disdrometer	OTT Parsivel Disdrometer	Laser Optical Disdrometer
Principle	Manual	Impact Displacement Technology	Impact Acoustic Technology	Optical Technology	Optical Laser Technology	Optical Laser Technology
Measurability of larger drops	2.0 mm	5.0–5.5 mm	5.0 mm	Yes Range not reported	5.0–5.5 mm	8.5 mm
Measurability of smaller drops	0.3 mm	1.0 mm	0.8 mm	Yes Range not reported	0.2 mm	0.125 mm
Measurability of counting the number of droplets	Yes	No	No	Yes	Yes	Yes
Measurability of the rain fall velocity	No	No	No	Yes	20 m/s	11 m/s
Measurability of the rain kinetic energy	No	No	No	No	Yes up to 30 kJ	No
Measurability of the rain intensity	No	No	No	Yes	Yes	Yes
Ability to account the oblateness	No	No	No	Yes	No	No
Ability to sampling continuously for longer durations	No	Yes	Yes	Yes	Yes	Yes
Resilience to the wind effects	No	No	No	No	No	No
* Resolution		127 classes	8 classes		1014 (32 size × 32 velocity)	430 classes (23 × 20)
Temporal resolution		1 min	1 min		10 s to 60 min	1 min

* The resolution is defined as the number of classes into which the drops can be classified.

Source : Gopinath Kathiravelu (2016) "Rain Drop Measurement Techniques: A Review"

Calibration by using Disdrometer

Table 2.3 Recorded data of drop numbers and lower and upper limits of the respective 20 classes of diameters

Limits of diameter classes (mm)			22/2/2013	22/2/2013	22/2/2013	22/2/2013	22/2/2013	22/2/2013	22/2/2013	22/2/2013
d1 (min)	0.313	Class	7:48:00 p.m.	7:50:00 p.m.	7:52:00 p.m.	7:54:00 p.m.	7:56:00 p.m.	7:58:00 p.m.	8:00:00 p.m.	8:02:00 p.m.
d1 (max)	0.405	1	2	16	19	5	0	0	0	0
d2 (max)	0.506	2	10	11	15	19	0	0	1	3
d3 (max)	0.597	3	1	3	6	10	0	11	8	4
d4 (max)	0.715	4	4	19	25	11	0	19	34	29
d5 (max)	0.827	5	4	37	19	20	0	23	54	66
d6 (max)	1.000	6	33	59	29	32	0	75	229	223
d7 (max)	1.232	7	27	52	48	48	20	210	349	381
d8 (max)	1.43	8	3	15	21	28	64	205	247	343
d9 (max)	1.582	9	2	5	12	29	120	155	161	218
d10 (max)	1.747	10	0	1	8	33	134	132	102	141
d11 (max)	2.077	11	0	1	6	31	243	133	87	103
d12 (max)	2.441	12	0	0	1	23	153	76	16	30
d13 (max)	2.727	13	0	0	0	15	78	28	4	5
d14 (max)	3.011	14	0	0	0	7	72	20	0	0
d15 (max)	3.385	15	0	0	0	8	46	16	0	0
d16 (max)	3.705	16	0	0	0	1	16	10	0	0
d17 (max)	4.127	17	0	0	0	0	12	1	0	0
d18 (max)	4.573	18	0	0	0	0	9	2	0	0
d19 (max)	5.101	19	0	0	0	0	2	0	0	0
d20 (max)	5.645	20	0	0	0	0	0	0	0	0

Source：Hydrology and water Resource Systems Analysis

Calibration by using Disdrometer

Table 2.10 N_0 and Λ values

Time		N_0 *(1/m³ mm)*	*Lambda (1/mm)*
22/2/2013	7:48:00 p.m.	2,948.697	2.599
22/2/2013	7:50:00 p.m.	3,735.054	2.687
22/2/2013	7:52:00 p.m.	4,819.560	2.794
22/2/2013	7:54:00 p.m.	2,715.052	2.389
22/2/2013	7:56:00 p.m.	4,398.741	2.679
22/2/2013	7:58:00 p.m.	10,300.557	2.908
22/2/2013	8:00:00 p.m.	11,668.312	3.541
22/2/2013	8:02:00 p.m.	21,994.359	4.517

Source : Hydrology and water Resource Systems Analysis

Calibration by using Disdrometer

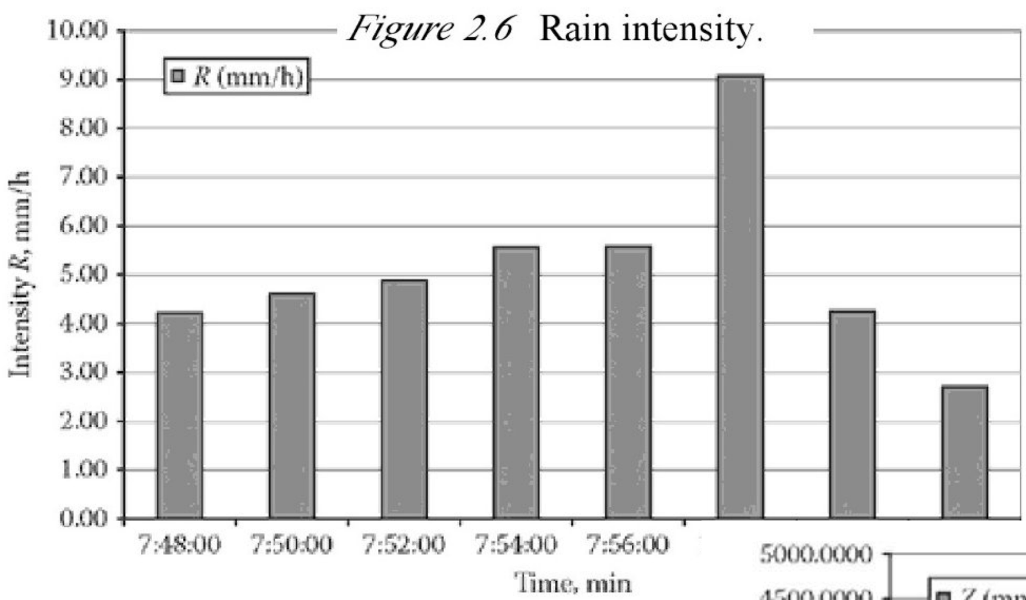


Figure 2.6 Rain intensity.

Source：Hydrology and water Resourc

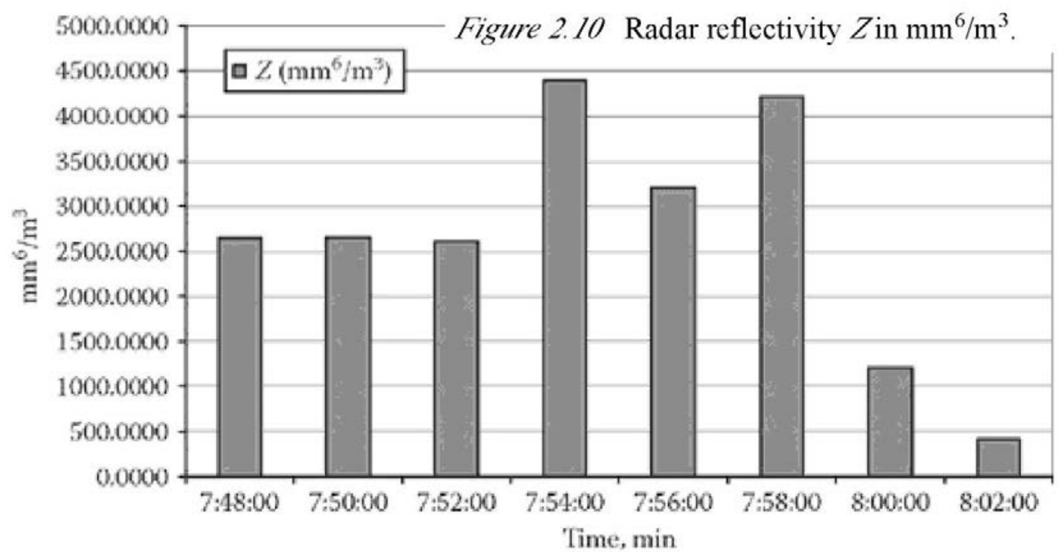


Figure 2.10 Radar reflectivity Z in mm^6/m^3.

Source：Hydrology and water Resource Systems Analysis

Calibration by using disdrometer

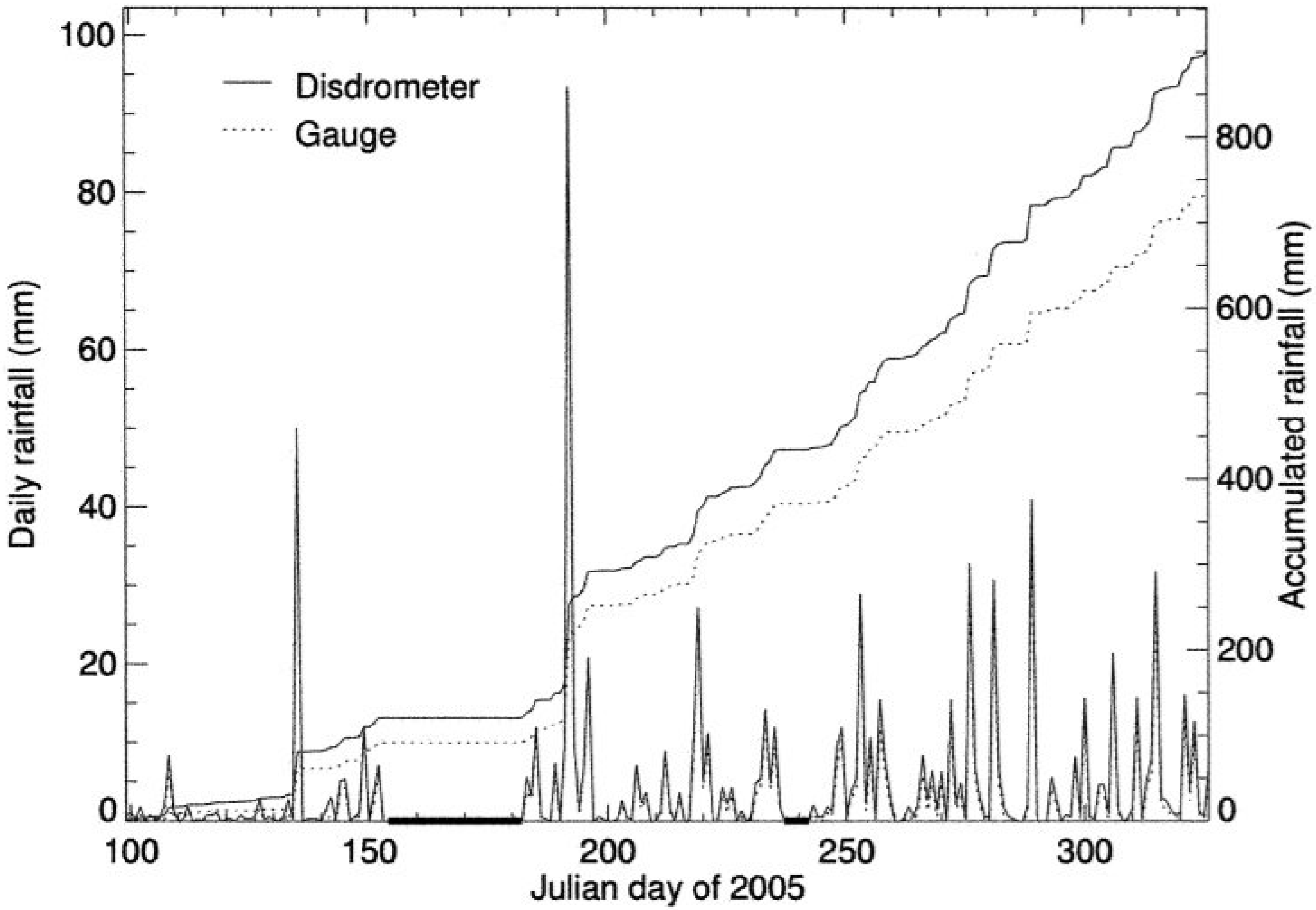
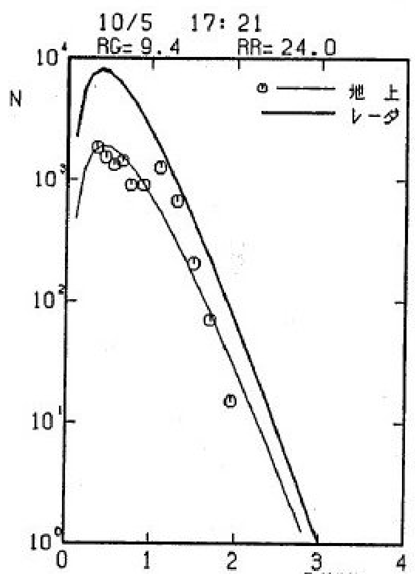


Figure 1. Comparison of gauge and disdrometer rainfall measurements from 09 April to 22 November 2005, excluding the periods from 3 June to 1 July and from 25 August to 30 August. The daily rainfall (left ordinate) and accumulated rainfall (right ordinate) from the gauge (dot line) and disdrometer (solid line) are shown. Two heavy lines on the abscissa denote two excluded periods.

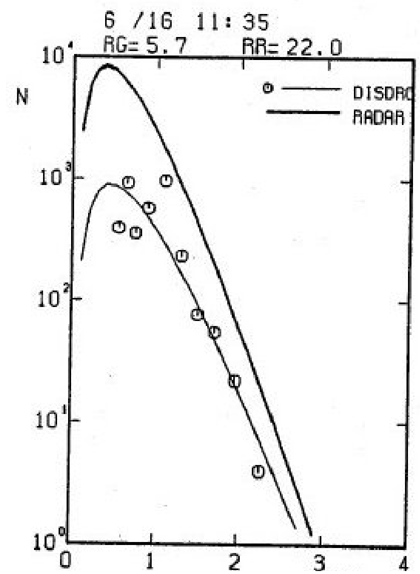
Calibration by using Disdrometer in 1989

Source: Experimental Observation by
DND multi parameter radar in Kyusyu area

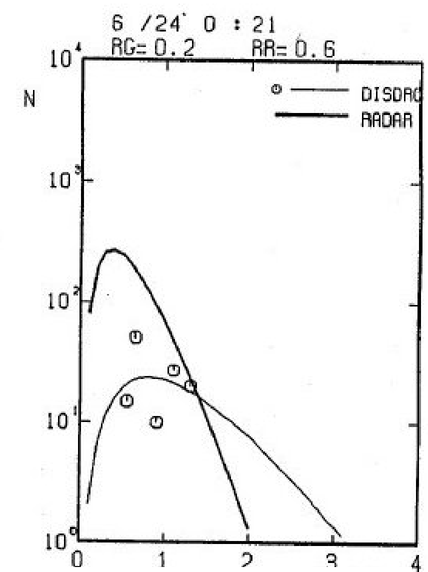
Manufacturer Heterogeneous radar system
- M : Antenna & Polarized wave switching unit
- J : Transmitter/Receiver & Power Facility
- T : Data processor & Display Unit



d(mm)
Case 1



d(mm)
Case 2



d(mm)
Case 3

For Next Stage

1. Company Profile & QC activity
   - Company Profile and Products of JRC
   - QC activity in company
2. Example of QC activity for radar in Japan
   - including Check by Vertical observation
3. Topics on Calibration
   - by using metal sphere
   - by Disdrometer

<u>Important Remarks</u>

>> Hardware Maintenance for Operation

Successful Example by Consortium & Expert opinion committee with manufacturers

>> Composite Image Data Exchange nation-wide & International

>> QC for Accuracy Improvement

Thank you very much for your attention !!