Towards building up an adaptation strategy against the climate change

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SOUSEI

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Purpose of my presentation

A) It should be emphasized that building up a new philosophy of adaptation for the climate change is very important.

B) It is also important to really re-recognize that improvement of understanding and real-time-forecasting accuracy of extreme weather should be one of the major countermeasure as adaptation.

Contents of my presentation

1. What are important aspects in building up adaptation strategy for coming climate change
2. A trial aiming to realize a next-generation operational observation network with different types of sensors for earlier detection and/or prediction of generating storm from the stage of air plume and/or cloud.

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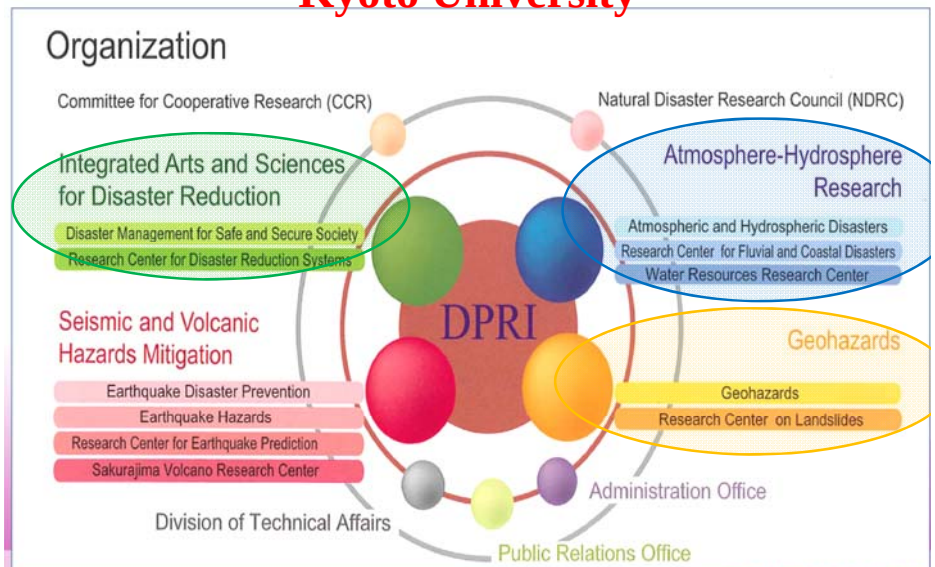
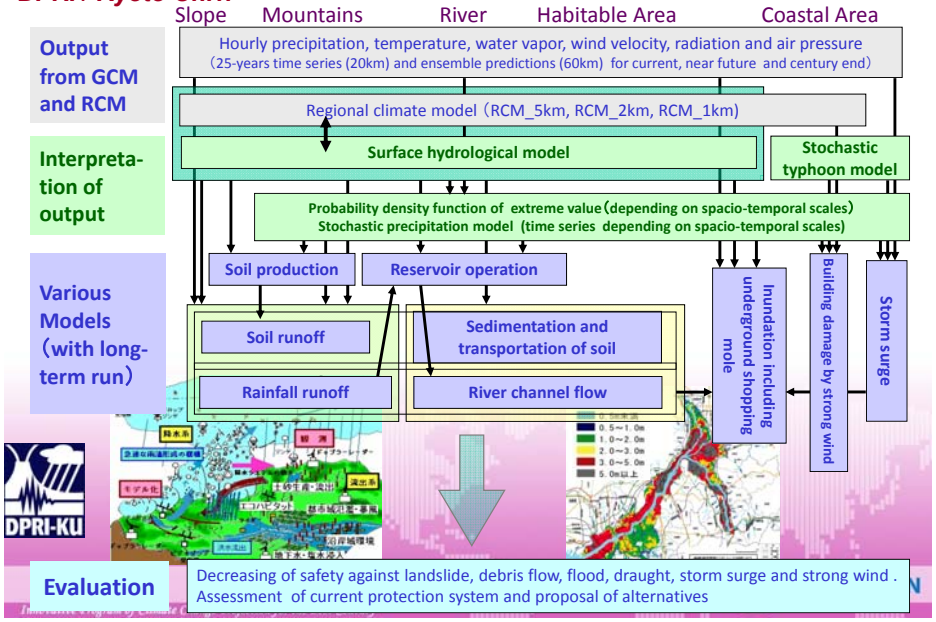
Disaster Prevention Research Institute
Kyoto University



Prediction and evaluation of disaster environment in Japan

DPRI / Kyoto-Univ.



History of CCIA supported by MEXT

- Kyousei(共生)Program:2002-2006
  - 20kmRCM (daily rainfall)
- Kakushin(革新)Program:2007-2011
  - 20kmGCM, 5,2,1kmRCM (hourly rainfall)
  - Natural Disaster (Inc. water resources)
- Sousei(創生)Program:2012-2016
  - Impact assessment and producing adaptation methodologies (First priority)
  - for Natural Disaster, Water resources, Ecosystem and Eco service (Kyoto University will lead the nation wide assessment team)

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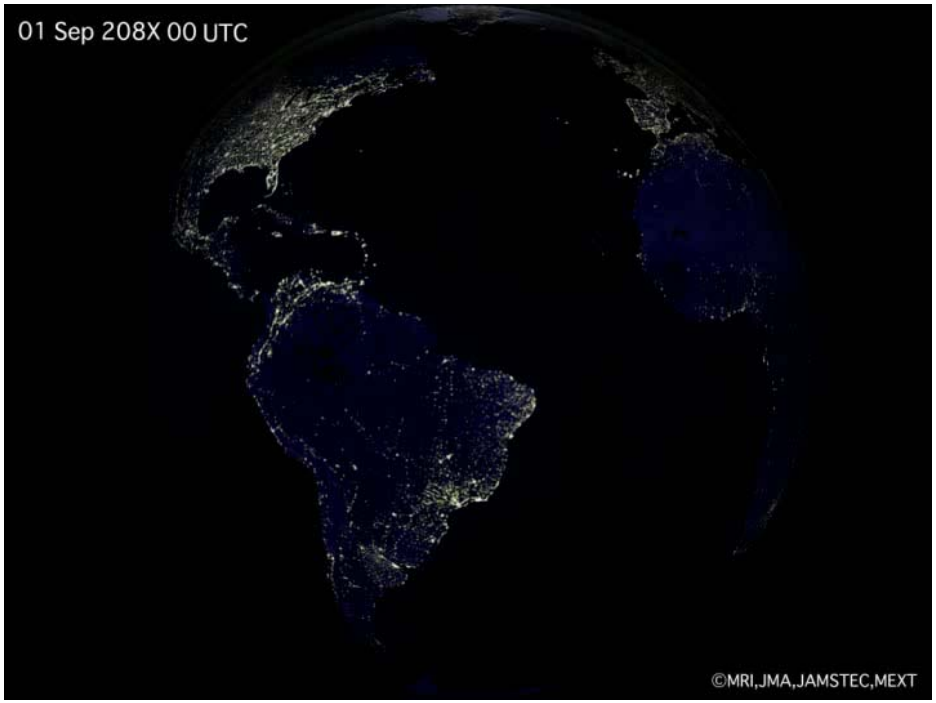
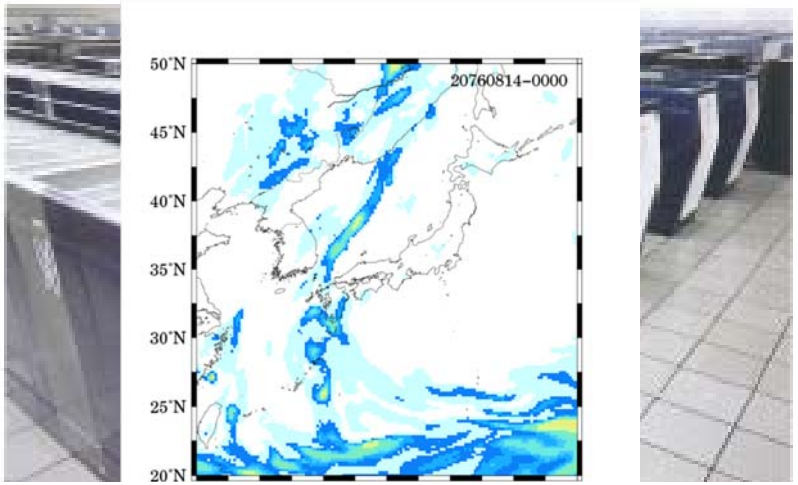
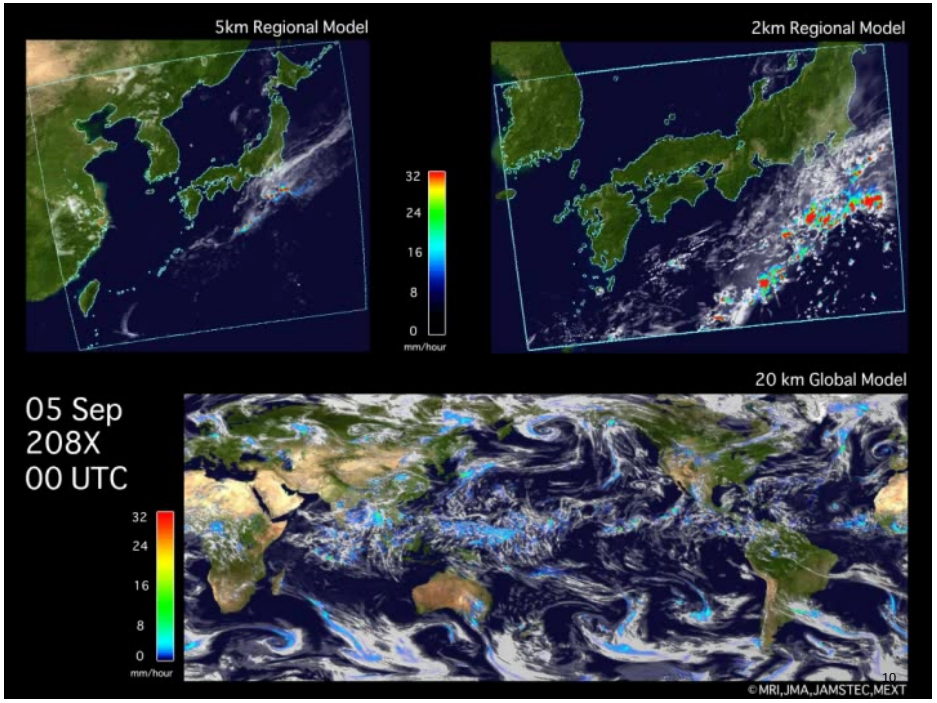


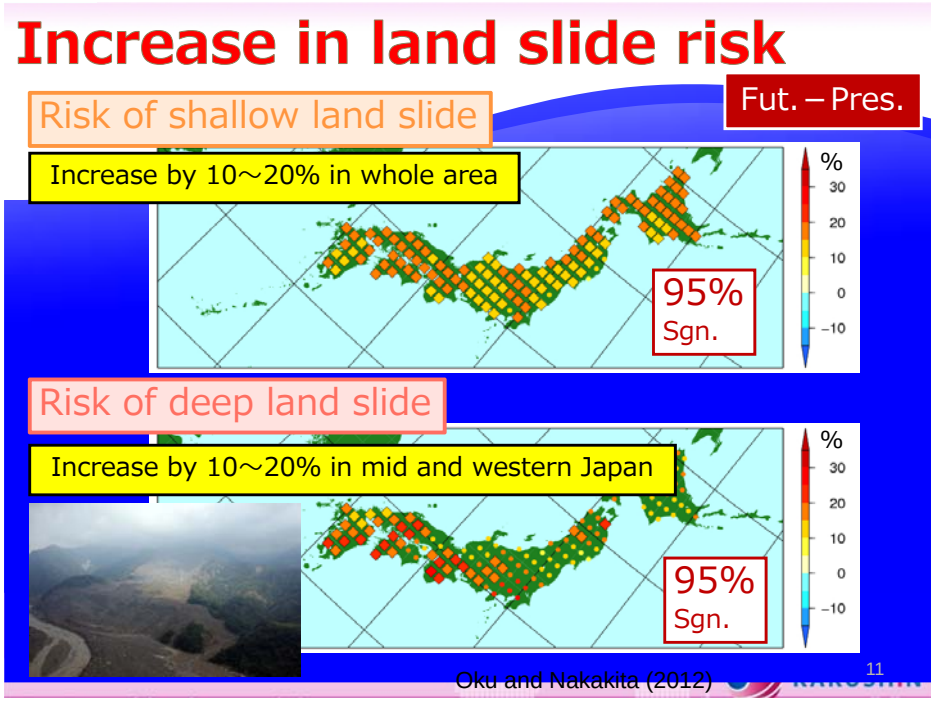
Projected typhoon by GCM20



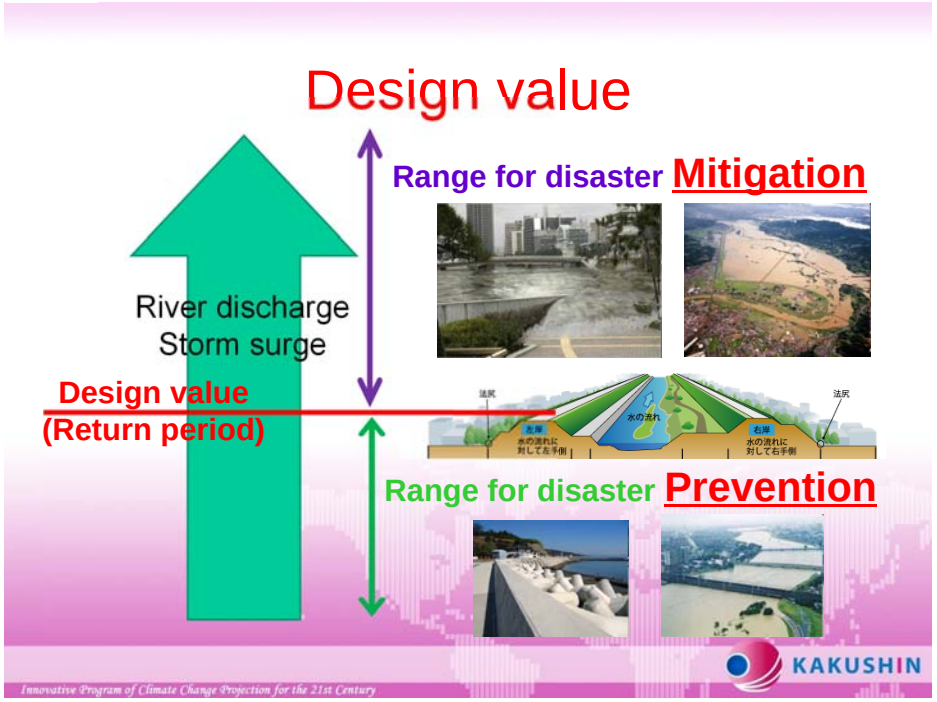
It is the typhoon resolving hourly output from GCM20 that has realized the impact assessment on Japanese river regime



Increase in land slide risk



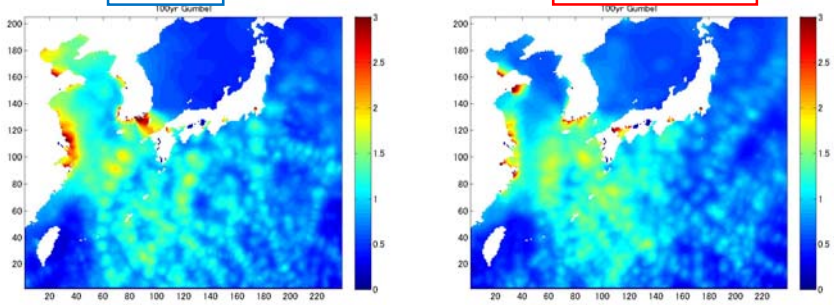
Oku and Nakakita (2012)



100-years return values of Storm surge (deviation from the average year value)

Current

End of century

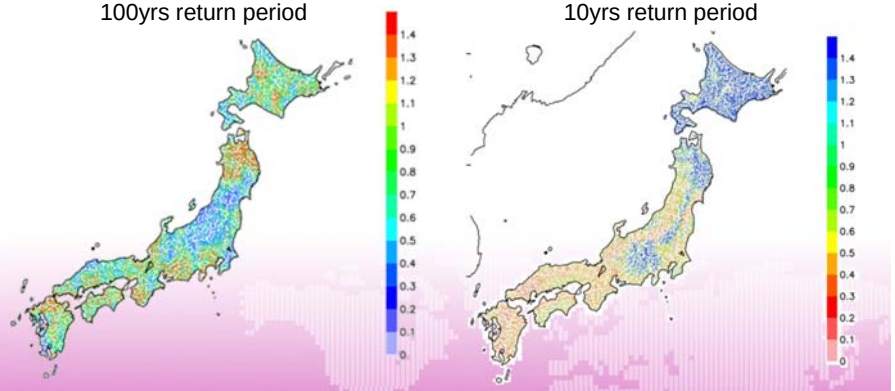


Mase, Mori and Yasuda G. (2011)

River discharge

Flood flow change
(Q_1: Annual Maximum discharge)
100yrs return period

Draught flow change
(Q_{355} discharge)
10yrs return period



Tachikawa et al (2009)

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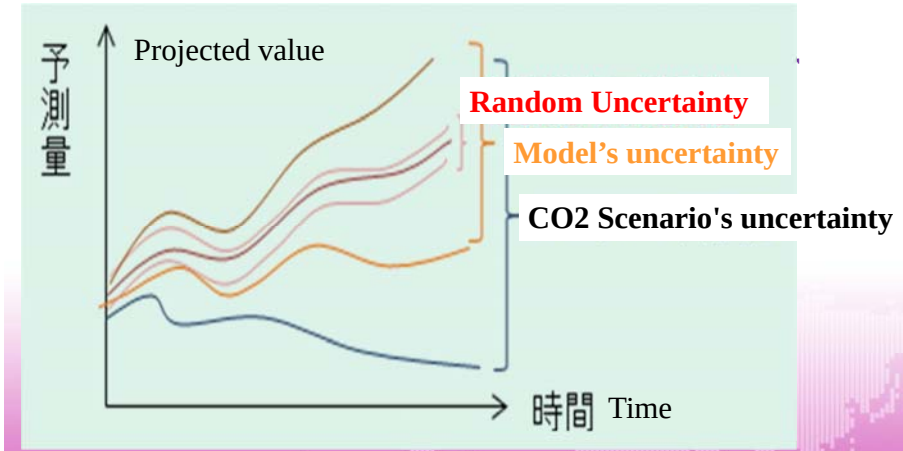
Innovative Program of Climate Change Projection for the 21st Century

Uncertainty inherent to GCM projection



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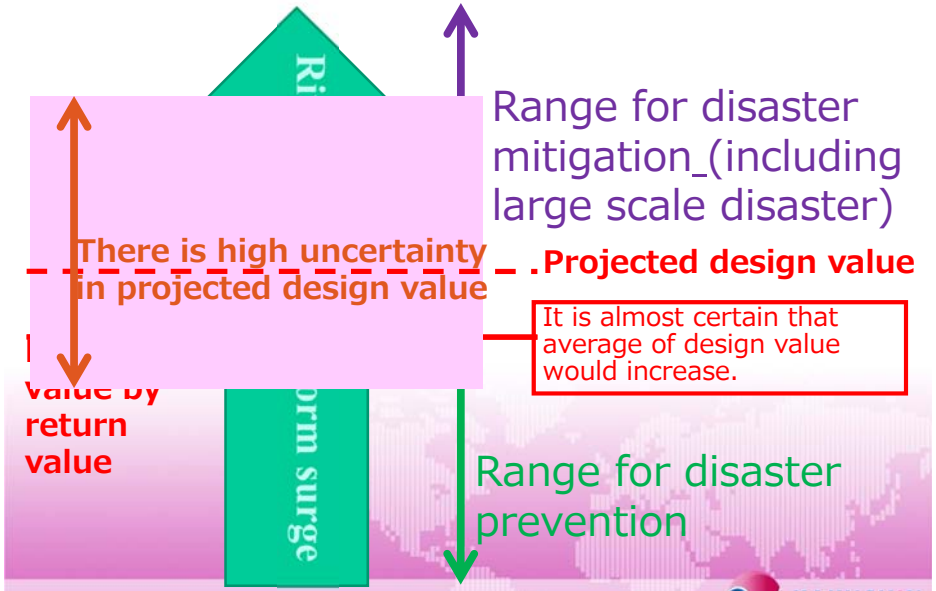
Innovative Program of Climate Change Projection for the 21st Century

Heading to adaptation



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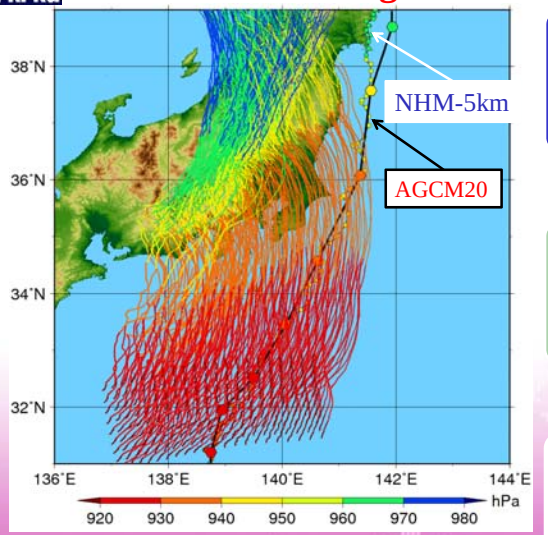
Virtual Shifting of typhoon's initial position - for making a worst scenario -



Virtual Shifting of typhoons initial position by keeping potential vorticity same (a vorgas method)

Dynamic downscale by RCM

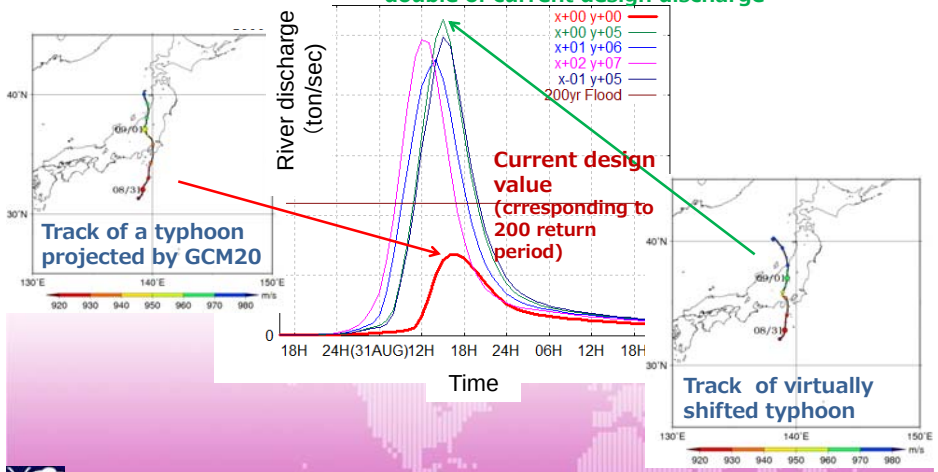
Worst case impact assessment on

- Land: extreme wind and rainfall
- Ocean: storm surge and wave height

Ishikawa et al (2009)

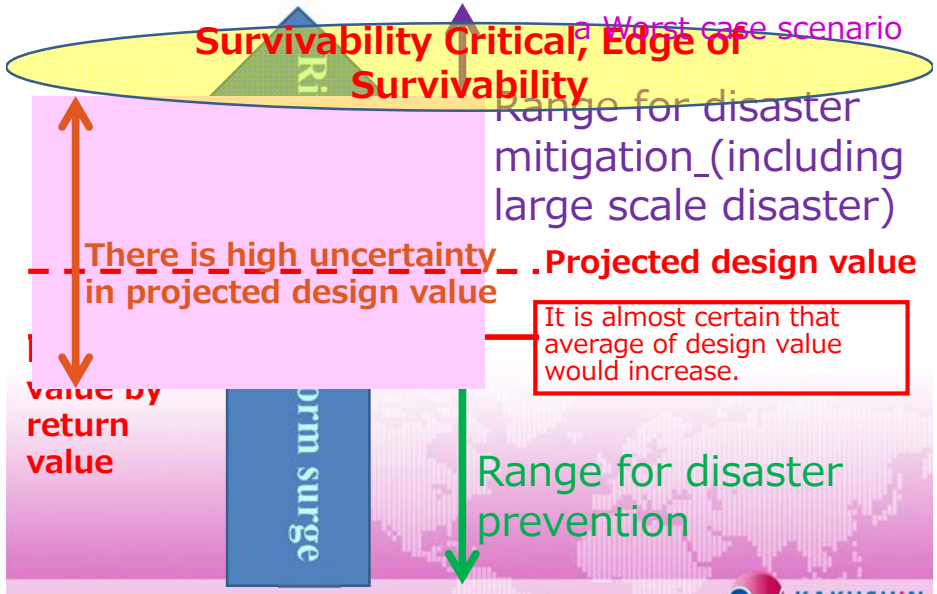
River Discharge by the virtual shifting of typhoon which was projected by GCM

Possibility of peak discharge of almost double of current design discharge



Oku et al (2009)

Heading to adaptation



Launching of Sousei Program

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Groups in SOUSEI Program (Program for Risk Information on Climate Change)

- A: **Prediction and diagnosis of imminent global climate change (Univ. of Tokyo)**
- B: **Climate change projection contributing to stabilization target setting (JAMSTEC)**
- C: **Development of Basic Technology for Risk Information on Climate Change (MRI)**
- D: **Precise impact assessments on climate change (Kyoto Univ.)**

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Innovative Program of Climate Change Projection for the 21st Century

Precise impact assessments on climate change (PI: E. Nakakita, KU (Kyoto University))

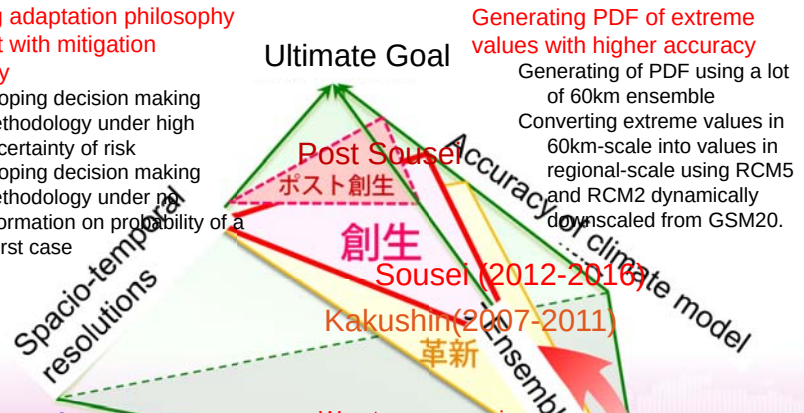
SOUSEI

- i. Climate change impacts on natural hazards (E. Nakakita, KU)
  - i-a Risk assessment of meteorological disasters under climate change (T. Takemi, KU)
  - i-b Risk assessment of water-related disasters under climate change (Y. Tachikawa, KU)
  - i-c Risk assessment of coastal disasters under climate change (N.Mori, KU)
  - i-d Measuring socio-economic impacts of climate change and effectiveness of adaptation strategies (H. Tatano, KU)
  - i-e Development of risk assessment and adaptation strategies for water-related disaster in Asia (N. Yasuda, ICHARM, PWRI)
- ii. Climate change impacts on water resources (K. Tanaka, KU)
  - ii-a Assessment of socio-economic impacts on water resources and their uncertainties under changing climate (K. Tanaka, KU)
  - ii-b Assessment of climate change impacts on the social-ecological systems of water resources and hydrological cycles (T. Oki, UT)
- iii. Climate change impacts on ecosystem and biodiversity (T. Nakashizuka, TU)
  - iii-a Assessment of climatic impacts on ecosystem and biodiversity (T. Nakashizuka, TU)
  - iii-b Economic evaluation of ecosystem service (S. Managi, TU)
  - iii-c Eco-climate system in Northeastern Eurasia and Southeast Asian tropics: impacts of global climate change (T. Kumagai, NU)
  - iii-d Assessment of multiple effects of climate change on coastal marine ecosystem (Y. Yamanaka, HU)

Sousei (創生) Program (2012-2016)

Proposing adaptation philosophy consistent with mitigation philosophy
- Developing decision making methodology under high uncertainty of risk
- Developing decision making methodology under no information on probability of a worst case

Generating PDF of extreme values with higher accuracy
- Generating of PDF using a lot of 60km ensemble
- Converting extreme values in 60km-scale into values in regional-scale using RCM5 and RCM2 dynamically downscaled from GSM20.



Topics:
Natural hazard, Water Resources and Ecosystem and Eco-service

Worst case senario
- Worst case typhoon
- Multi-hazard
- Social Senario

For adaptation decision making
Deterministic, Probabilistic and Beyond

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Innovative Program of Climate Change Projection for the 21st Century

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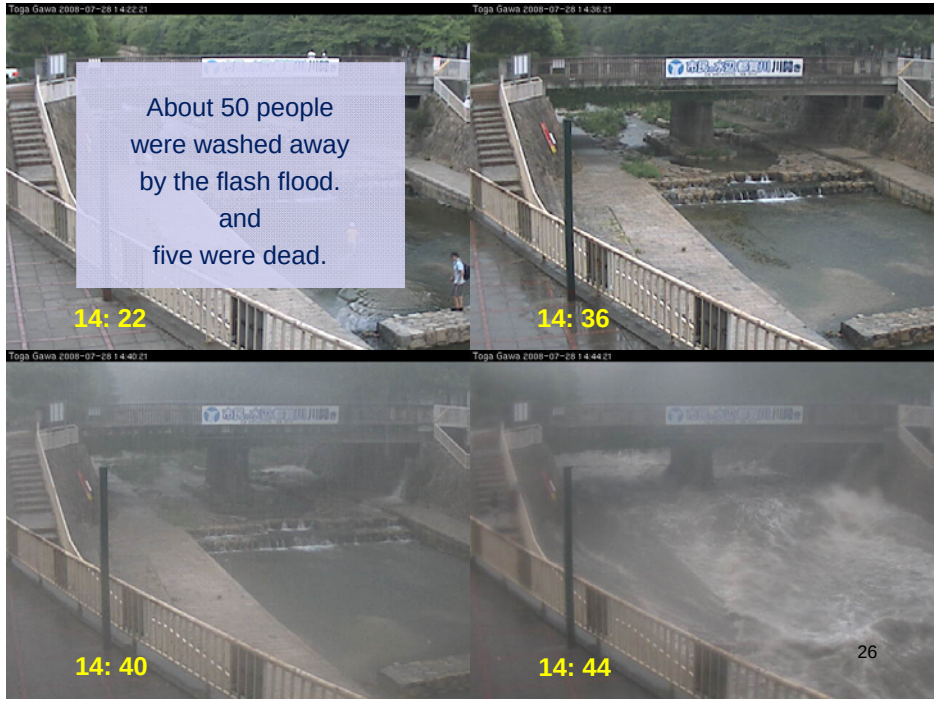
Urban Flash Flood

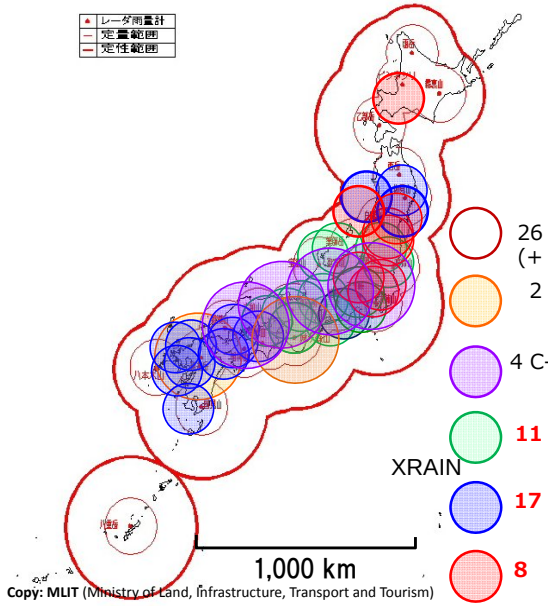



(Ministry of Land, Infrastructure , Transportation, and Tourism, MLIT)

Japanese Government decided to equip X-band (compact type) dual-polarization Doppler radar around the main cities.

C and X band operational network by MLIT



Copy: MLIT (Ministry of Land, Infrastructure, Transport and Tourism)

C-band Radar
Obs.: every 5 min
Distrib.: 5-10 min

X-band Radar
Obs.: every 1 min
Distrib.: 1-2 min

26 C-band Conventional (+ 20 JMA C-band Doppler)

2 C-band full Polarimetric since April 2009

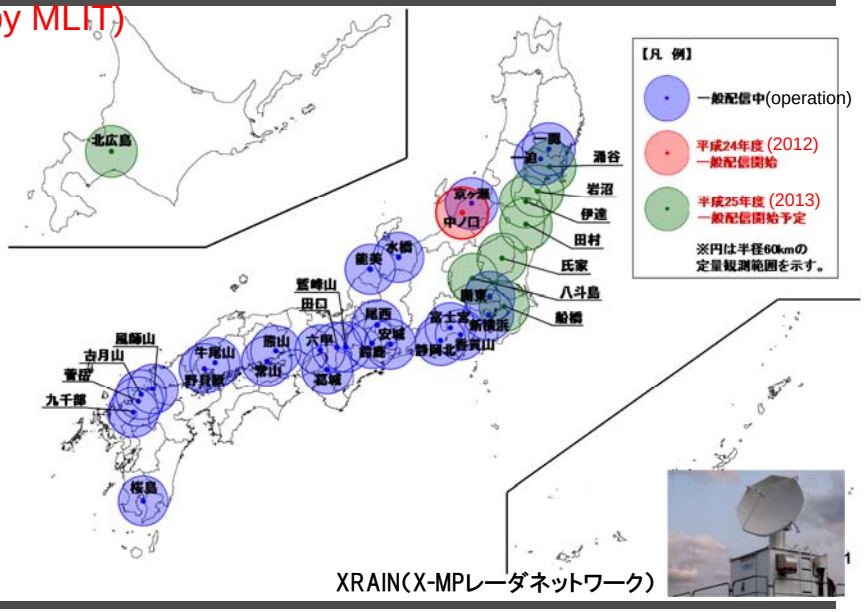
4 C-band Doppler full Polarimetric within 1 year

11 X-band Doppler full Polarimetric since April 2010

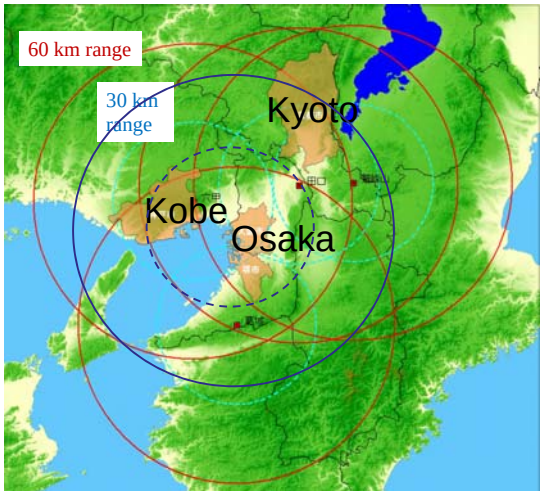
17 X-band Doppler full Polarimetric since April 2011

8 X-band Doppler full Polarimetric since Sept. 2013

X-RAIN (Network by 35 X-band pol. Doppler radars) (by MLIT)

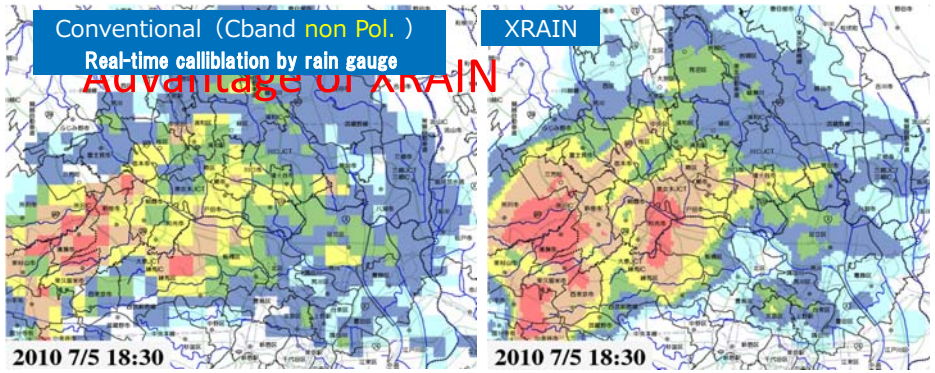


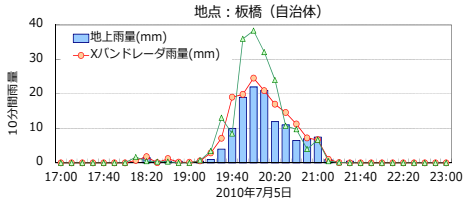
New operational network by X-RAIN and
New Osaka City radar



- **Higher sensitivity by :**
  X band radar
- **Higher spatial resolution by :**
  X band radar (250~500 m)
  Dense network
- **Free from attenuation by :**
  Polarimetric function (K_{DP})
  Dense network together with C-band
- **Higher accuracy by :**
  Polarimetric function (Z_{DR}, K_{DP})
- **Shorter scan interval with low elevation :**
  1 minutes
- **Shorter transmission time :**
  2 minute
- **Earlier detection of baby cell:**
  Volume scan (3D image)

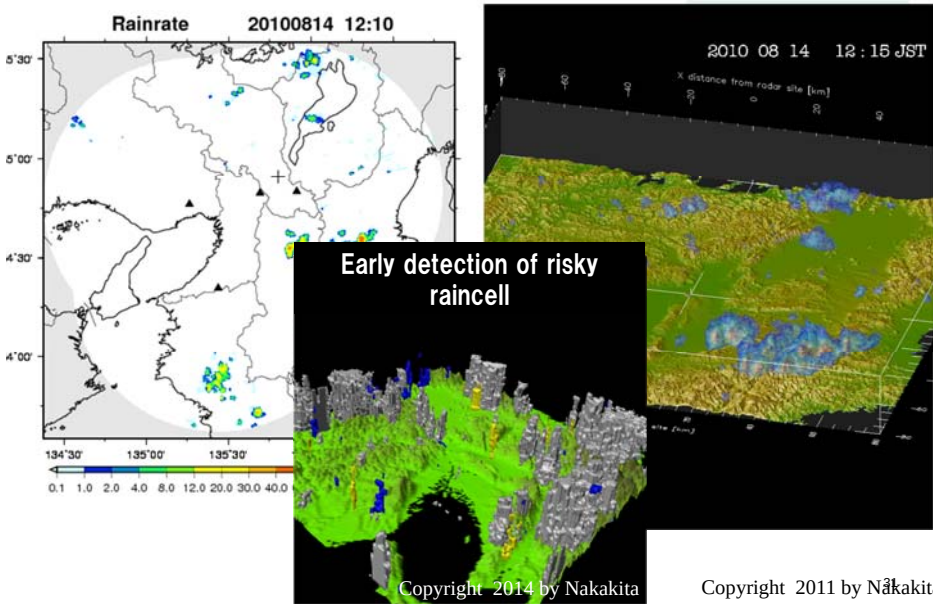
Advantage of XRAIN





⇒ QPE for 10 min rainfall has been very improved by K_{DP}.
⇒ Discrimination and movement of individual storm cell has been made clearer.
⇒Nowcast has been improved.

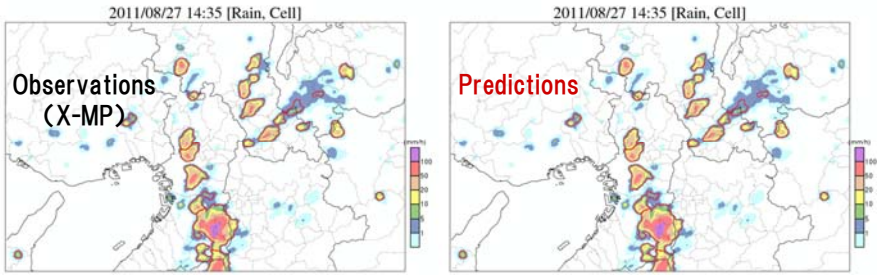
Radar images by XRAIN



Advances in nowcasting： 2D Cell Tracking

■Advantages

- Advances in nowcasting within 30 – 60 munities prediction (with in a life time of single cell)
- Growth and decay of individual cell can be easier identified and predicted because higher spatio-temporal observation resolutions



京都大学・日本気象協会・日水コン 共同研究チーム

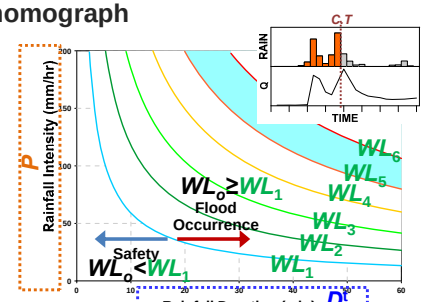
Masuda and Yamaji (2012)

Rain-based urban flood forecasting method

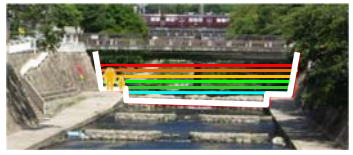
■ Concept of urban flood alert criteria nomograph

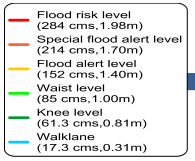
- The urban flood alert criteria nomograph is assembled and comprised by the relationship with the flood discharge and water level from the various rainfall scenarios (rainfall intensity and duration time) based on rainfall information.
- $WL_i = f(P_i, D_i^t)$
- $f(P_o, D_i^t) \geq WL_i$ → **Flood forecasting**

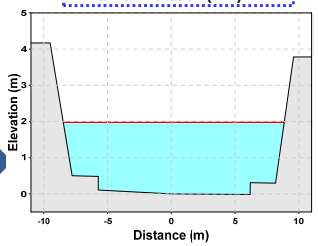
i : reference flood levels, P_i : rainfall intensity at i
D_i^t : rainfall duration at i, WL_i : iso-waterlevel at i
P_o : rainfall intensity at real-time
D_o^t: rainfall duration at real-time



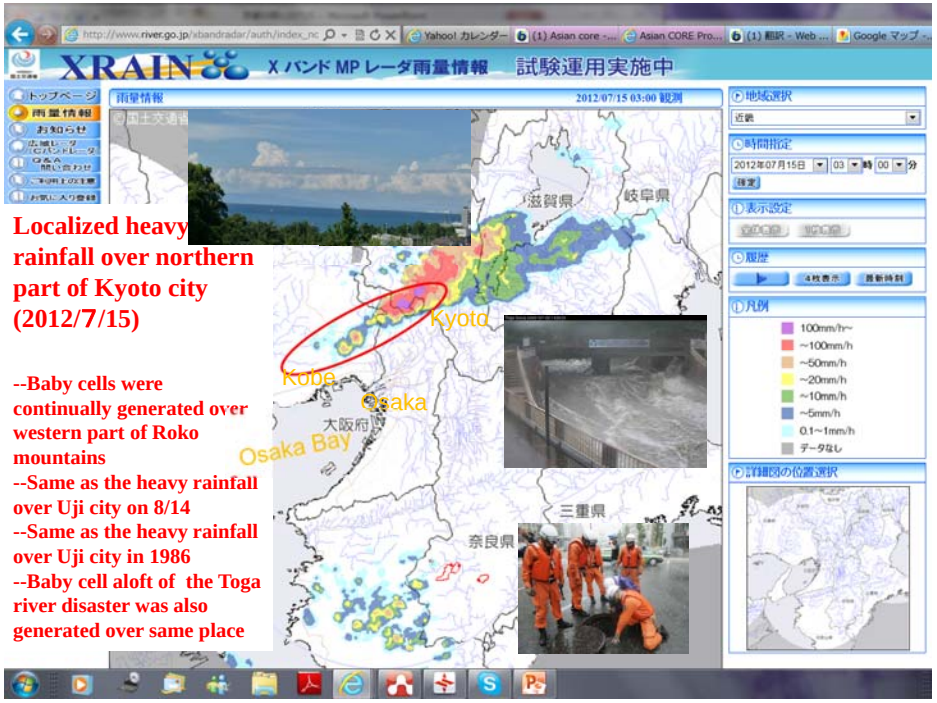
- We can forecast the flood using the location that is determined by rainfall intensity and duration. If the location is exceeded some flood level, we can guess there would be some possibility of the flood risk.



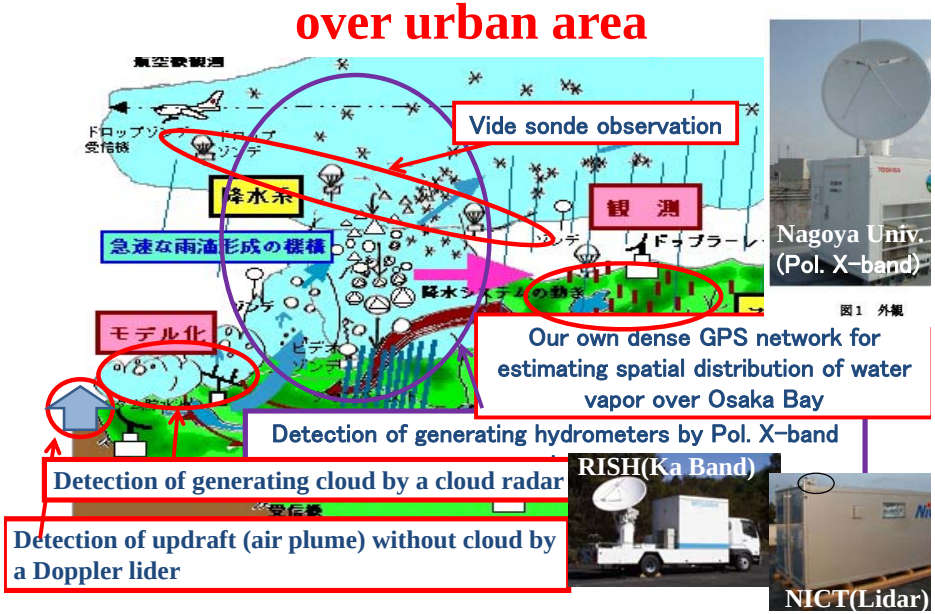




Yoon and Nakakita (2013)



Multi-sensor observation of storm genesis over urban area



Chains of clouds along Rokko mountains
Milli wave（Ka-band, cloud）radar (next to Kobe Int. Univ.)

北北西向きに撮影

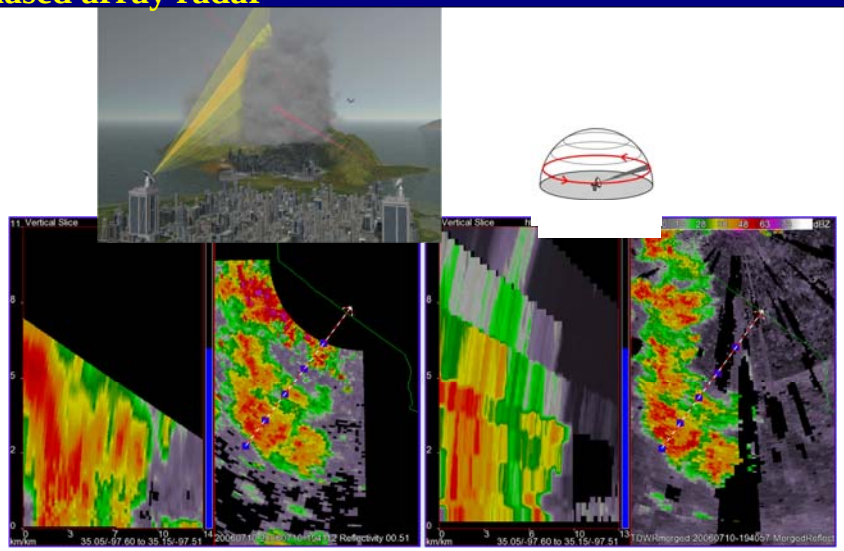
Ka-band (cloud) radar(RISH）

Doppler Lidar and X-band Pol. Doppler radar (on the roof of Kobe International Univ.)

西向きに撮影

Doppler Lidar（NICT） **X-band Pol. Dop,. Radar**（Naogya Univ.）

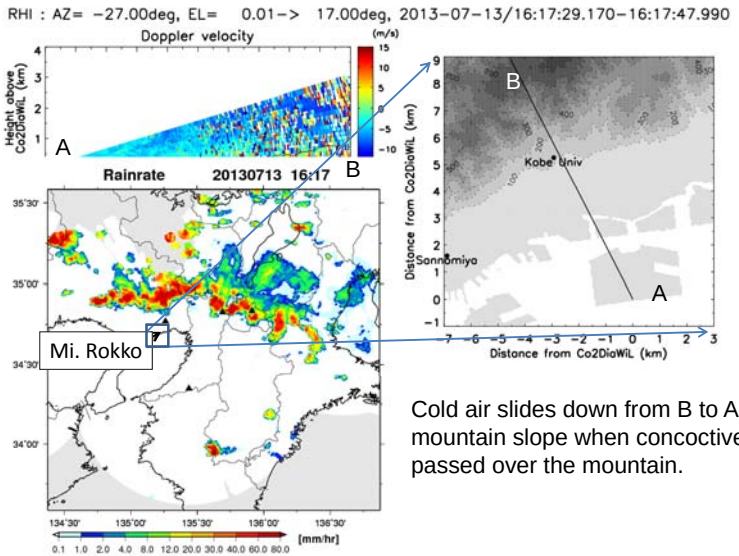
Further technology – almost at onece observation by phased array radar



Phased Array Radar　　Mechanical antenna operation

National Severe Storms Laboratory (2007)

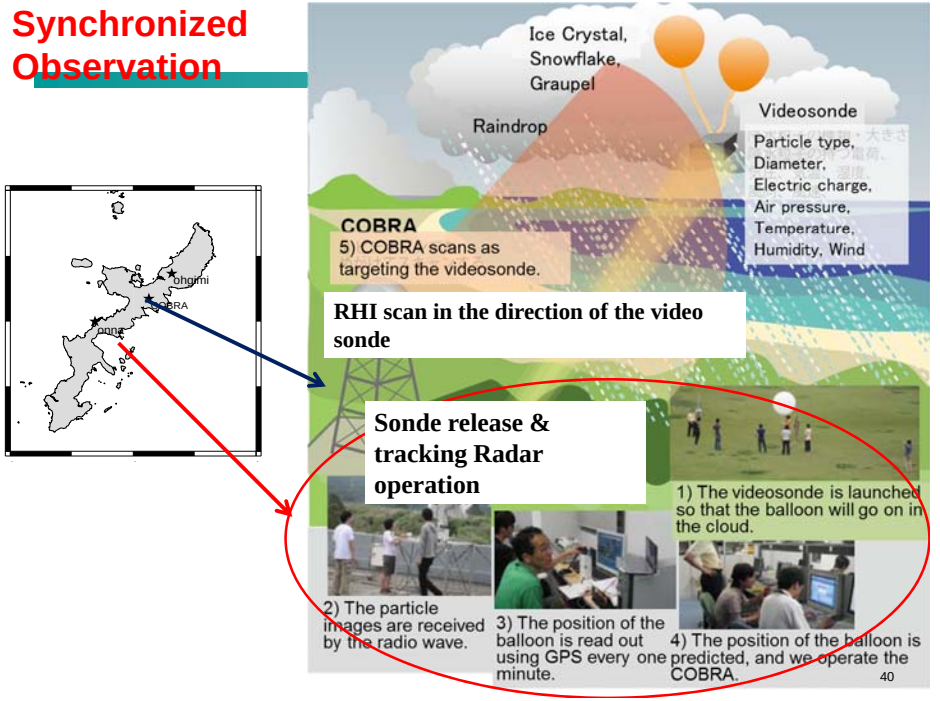
LIDAR Obserabtions



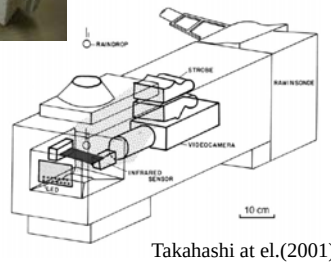
Cold air slides down from B to A along mountain slope when concoctive system passed over the mountain.

Yamaguchi et al. (2013)

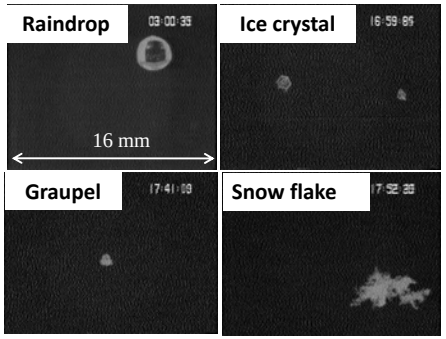
Synchronized Observation



Video-Sonde and Hydrometeor types



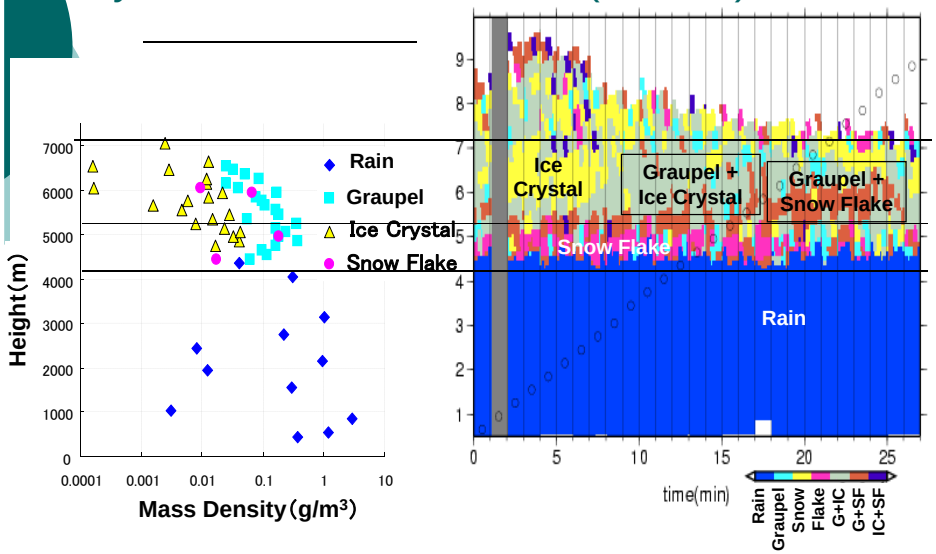
Takahashi at el.(2001)



- Video-sonde is the radiosonde with a video camera.
- The video-sonde is launched with the balloon, and it can directly observe hydrometeors in the cloud.

Real particle images, Electric charge, Air temperature, Atmospheric pressure, Humidity

Hydrometeor Classification (mixture)



An idealized experimental observation network over Kobe, Osaka, Kyoto area.

We wish this combined observation to be operational!! within five years

Thank you for your kind attention!

Middle and ending ceremonies of the "Okinawa Campaign Observation" with young researchers and students from various universities. (since 2007)