Three-dimensional rainfall structure measured in 30 seconds by phased array weather radar

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Introduction

- We developed the X-band phased array weather radar (PAWR) to watch and predict severe weather disasters caused by localized heavy rainfalls or tornadoes. The PAWR measures 3-dimentional fine structure of rainfall with 100 m range resolution and about 100 elevation angles in 30 seconds was developed.

- The first PAWR was installed at Osaka University, Suita in 2012, and the second PAWR was install at NICT advanced ICT Research Institute, Kobe in 2014.

- 3D rainfall structure in 1) an isolated cumulonimbus, 2) a rain band in the Baiu season, and 3) developing convective cloud (dual-Doppler analysis).

3-dim measurement using phased array radar (110 EL angles in 30 sec)

3-dim measurement using a parabolic antenna (15 EL angles in 5 min)
Precipitation development in a cumulonimbus

(1) growth of cloud droplets in cumulus updrafts
(2) increase of droplet size in upper levels
(3) large droplets detected by radar (first echo)
(4) raindrops falls to the ground at a rate of 4-5 km in 10 min.
(5) The life time of a cumulus cloud is 30-60 min.
Localized heavy rainfall in a cumulonimbus

Three-dimensional distribution of precipitation over Kyo-tanabe city observed by PAWR from 17:20:16 to 18:10:46, July 26, 2012. View from the North-East, 100m grid size, and 30 seconds time interval.
Precip. development in an isolated cumulonimbus
(July 26, 2012)
Observation range of the PAWR in Suita

Kyoto
60 km (radius)
Osaka Bay
Suita
Akashi
Kobe
Osaka
Nara
Kansai Airport
Uji
Rain band in the Baiu season (14:00-16:20, July 13, 2013)

3D rain distribution observed by PAWR from 14:00 to 16:20, July 13, 2013. Look-down view from upper Osaka-bay, 250m grid size, and 30 seconds time interval. (10 fps → 300 times speed)
Another view of Rain band (15:20-16:20, July 13, 2013)

3D rain distribution from 15:20 to 16:20, July 13, 2013. Look-up view from the Osaka plain, double scale of topography height.

(10 fps → 300 times speed)
Reflectivity and Doppler vel. in a vertical slice

Ze

2013/07/13/15:08:40

Vr

2013/07/13/15:08:40

Reflectivity and Doppler velocity in a vertical slice.
**PANDA**: Phased Array weather radar and Doppler Lidar Network fusion DA&ta system

@NICT advanced ICT Research Institute (Iwaoka-cho, Kobe)  
@ NICT Okinawa Electromagnetic Technology Center (Onna-son)
PANDA sensor fusion system

- Doppler lidar
- Microwave radiometer
- Sky radiometer
- Ultrasonic wind sensor
- Thermo-hygrometer
- Cloud watching camera
- All-sky camera

Sensor fusion data visualized on a large screen (4K-REGZA) @NICT Koganei
Observation range of Kobe & Suita PAWR

- NICT KARC (Kobe PAWR, DPL)
- Osaka Univ (Suita PAWR)
- Kobe Univ (GV container)

Map showing the observation range with distances:
- 13 km
- 60 km
- 60 km
Developing convective cloud (18:00-10:00, Sep 11, 2014)
30 seconds dual-Doppler analysis (Sep 11, 2014)

Est-West distance from Suita PAWR (km)
PAWR Web Page (http://pawr.nict.go.jp/)

Retrieve archived past data

Real time display (within 1 min of obs)

Google maps display

Rainfall Summary
Summary and future work

- The phased array weather radar (PAWR) measures 3-dim rainfall structure with high spatial-temporal resolution (100 m, 100 EL angles, 30 seconds).

- Three rainfall events observed by PAWR were introduced using 3D visualization images.
  1) An isolated cumulonimbus (July 26, 2012)
  2) Rain band in the Baiu season (July 13, 2013)
  3) Developing convective cloud (Sep 11, 2014)

- For the study of radar data assimilation:
  1) data quality control (to cancel noise/clutter data, to estimate error variance in the observation)
  2) effective preprocessing (dual-Doppler analysis?)
  3) real-time data distribution