Plan of the Field Observation in the Tokyo Metropolitan Area: Lifecycle of Cumulonimbus Experiment (LCbEx)

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**INTRODUCTION**

Droughts caused by low-pressure fields, tornadoes, hail, and lightning are serious social problems especially in urban areas in Japan. It is known that these phenomena are related to cumulonimbi (Cb). Therefore, it is necessary to understand the mechanism of Cb development, and development of prediction method are needed for the reduction of these disasters.

**NEW REMOTE SENSORS**

In 2013 and 2014, ten microwave radiometers, three Doppler lidars, and five Ka-band radars were additionally set up in the Tokyo Metropolitan Area covered by the X-band polarimetric radars for the observation of environment of cumulus (Cu) initiation and Cb development, and cloud before precipitation. We can get information on water vapor, and field in the clear air, and non-precipitating cloud, respectively. All data can be collected and processed in real-time in the NIED.

**PRELIMINARY RESULTS**

In this study, we predicted the formation of Cu and early stage of Cb development, precipitation formation process from cloud, and prediction of Cb development using an NWP model and data assimilation.

**LCbEx-I (2011-13)**

National Research Institute for Earth Science and Disaster Prevention (NIED), Japan started field observation lifecycle of Cb lifecycle of Cb Experiment (LCbEx) in the Tokyo Metropolitan Area from 2011 using a Ka-band Doppler radar, two X-band polarimetric radars, and stereo photography, etc. LCbEx-I was carried out with Ka-band Doppler radar data (Sakurai et al. 2012) and the thermodynamical measurements of Cu and Cb in the vertical direction of 1 km interval. Furthermore, it was shown that the data assimilation of cloud liquid water content (latent heat) and potential temperature deviation had important effects to prediction of Cb development using cloud resolving model.

**MICROWAVE RADIOMETERS (10)**

- **HETEROMATIC RADIOMETERS**
  - **HATPRO, RPG (10-sets)**
    - Measured values 14-ch, TB
    - V-band (7ch; 51-59 GHz)
    - Radiometer: V-band: 1.8 deg
    - Estimated parameters PW, VICLW, Vertical Profile of T, WV, CLW

- **DOPPLER LIDARS (3)**
  - **08/07/28 - Toga R.**
  - **Zoshigaya**
  - **Radiation, : X-band Pol. Radar**
    - rainy: 5 %
  - **06/09/17 - Mobara**
  - **06/11/07 - Nobeoka**
  - **Wavelength 1.55 m (E eye safe)**
  - **Pulse width 500 ns**
  - **PRF 4 kHz**
  - **Pulse energy ≥ 80 km**
  - **Range resolution 30, 75, 150 m**
  - **No. range bin 200**
  - **Obs. range 400 m - 30 km in radius**
  - **Max wind speed**
  - **08/08/13 - Koshigaya**
  - **06/07/15 - Tokyo**
  - **12/05/06 - Ibaraki, Saitama-P**
  - **05/07/07 - Fujisawa**
  - **10/06/30 - Saitama-P**

- **CLOUD RADARS (5) >> see POSTER #174**
  - **Precipitable Water @Tsukuba Radar site**
  - **Z(Cloud Radar) >>> Qc, WV in cloud, and LH for Qc**
  - **Ka-band radar**
    - **circle (broken line): area of dual Doppler synthesis**
    - **○: EBN, KSR X-band polarimetric radar**
      - **= Qc@3-km dBZ@3-km**
      - **Shade: 30-km range**
  - **Panoramic volume scan**
  - **Antenna, Beam width**
    - **Cassegrain, Circ. Parabola, ≤ 0.4 deg**
  - **Transmitter**
    - **Solid state device Klystron Peak power (Duty) 400 W x 2 (5 %) 50 kW (0.8%)**
    - **Pulse width 1.0/32 μs**
    - **Frequency 9.4687/9.4712 GHz 9.415 GHz**
    - **Antenna type 2.0 m Parabola, ≤ 0.4 deg**
  - **Scan range (rate), Az: 0 - 360 deg (36 deg/sec)**
  - **El: -2 deg (12 deg/sec)**
  - **Range: 75 or 150 m**
  - **Min detectable power −109.5 dBm (LNA-input)**
  - **Scan rate 1 - 20 deg/sec**
  - **Output T, Z, V, W, SNR, Doppler Spectra**

- **X-BAND POLARIMETRIC RADARS (2)**
  - **Frequency 8.8/9.6 GHz**
  - **Antenna type**
    - **Ka-band (Precise) 2.2 m Parabola**
    - **Ka-band (Broad) 2.4 m Parabola**
  - **Beam width**
    - **2 deg**
    - **1.2 deg**
  - **Transmitter**
    - **Solid state device Klystron Peak power (pp)**
      - **800 W (1%) 500 W (0.8%)**
    - **Pulse width**
      - **1.0/32 μs**
      - **1.0/16 μs**
    - **Frequency 8.8/9.6 GHz**
    - **Polarization H or V (SHV)**
      - **hv, hv, DP, KDP**
    - **Transmit power**
      - **EIK, 3 kW**
      - **MITSUBISHI (5-sets)**
    - **Antenna gain**
      - **43.4 dB ≥ 0.4 deg**
    - **Transmitter**
      - **Solid state device Klystron Peak power (pp)**
        - **800 W (1%) 500 W (0.8%)**
    - **Beam width**
      - **2 deg**
      - **1.2 deg**
  - **Scan range (rate), Az: 0 - 360 deg (36 deg/sec)**
  - **El: -2 deg (12 deg/sec)**
  - **Range: 75 or 150 m**
  - **Min detectable power −109.5 dBm (LNA-input)**
  - **Scan rate 1 - 20 deg/sec**
  - **Output T, Z, V, W, SNR, Doppler Spectra**

**LCbEx-II**

The field observation LCbEx-II using these new remote sensors is started from the summer season in 2015 for the understanding of development process including initiation of Cu and early stage of Cb development, precipitation formation process from cloud, and prediction of Cb development using an NWP model and data assimilation.

**EXTREME WEATHER CAUSED BY**

- **Heavy Rainfall**
- **Hail**
- **Lightning**

**DATA ASSIMILATION**

- **Plan of the Field Observation in the Tokyo Metropolitan Area:**
  - **Lifecycle of Cumulonimbus Experiment (LCbEx)**
  - **National Research Institute for Earth Science and Disaster Prevention (NIED), JAPAN**