Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

AAS23-01 Room:101A Time:May 23 14:15-14:30

Convective systems causing heavy rainfall and severe wind damage in Japan in recent years

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In Japan, we have serious damage almost every year by larger-scale heavy rainfalls resulting from typhoons, the Baiu front and midlatitude cyclones. Local heavy rainfalls in less than several ten km2 area during a few hours which come from one or a few thunderstorms also give us flash flooding, particularly in urban areas. Severe winds including tornado also give us pin-point heavy damage. They have been giving us many subjects in the fields of monitoring/forecasting, disaster prevention and information services.

First, the rainfall and severe wind damage which occurred in Japan during seven years from 2006 to 2012 are classified according to the atmospheric situation, characteristics of the heavy rainfalls and severe winds, scale and feature of the damage. Second, focusing on the convective systems and thunderstorms composing the systems which caused the heavy rainfalls and the severe winds, we examine our degree of comprehension about their behavior, types of convection and generation mechanisms of the heavy rainfalls and the severe winds. Finally, what kind of research should be extended and what issues should be solved will be discussed.

Keywords: extreme weather conditions, flooding damage, severe wind damage, convective system

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AAS23-02 Room:101A Time:May 23 14:30-14:45

A review on X-band radar for quantitative precipitation estimate

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Development of X-band weather radar from the end of World War II to the present is reviewed. It has been believed for long time that X-band wavelength was not adequate for QPE, however, this changed drastically after differential phase shift measurements became practical. The sensitivity of differential phase shift to rain rate at X-band wavelength is higher than that that of C- and S-band wavelength. Its smaller size compared to C- and S-band radars and its high spatiotemporal resolution has accelerated its use as a gap-filling radar and a networked radar in urban areas. Multidisciplinary projects are ongoing in Japan, the US, and Europe, with the aim of developing more effective information from X-band polarimetric radar networks. The products from these experiments will provide the variety of information required by end-users, which cannot otherwise be attained from the nation-wide radar network.

Keywords: X-band radar, polarimetric radar, QPE, X-NET, XRAIN

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AAS23-03 Room:101A Time:May 23 14:45-15:00

Development and Observation of the Phased Array Radar

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A new phased array radar system for meteorological application has been developed by Toshiba Corporation and Osaka University under the grant of NICT. It is now well known that the rapidly evolving severe weather phenomena (e.g., microbursts, severe thunderstorms, tornadoes) is a threat to our lives particularly in densely populated area and the number of the phenomena tends to increase as the result of the global warming. Over the past decade, mechanically rotating radar systems at C-band or S-band have been proved to be effective for weather surveillance especially in wide area more than 100 km in rage. However, the rapidly evolving weather phenomena has the temporal and spatial scales comparable to the resolution limit (-10 min. and -500m) of the S-band or C-band radar systems, and cannot be fully resolved with these radar systems. In order to understand the fundamental process and dynamics of such fast changing weather phenomena, volumetric observation with both high temporal and spatial resolution are required.

The phased array radar system developed has the unique capability of scanning the whole sky with 100m and 10 or 30 second resolution up to 60 km in a cost effective manner. The system adopts the digital beam forming technique for elevation scanning and mechanically rotates the array antenna in azimuth direction within 10 or 30 seconds. The radar transmits a broad beam of several degrees with 24 elements and receives the back scattered signal with 128 elements digitizing at each elements. Then by digitally forming the beam in signal processor, the fast scanning is realized.

The system was installed at the top of the building in Osaka University in May 2012, and has been operated continuously since then. In this presentation, the system and the initial observation results will be talked.

Keywords: RADAR, Phase Array

AAS23-04 Room:101A Time:May 23 15:00-15:15

Characteristics of reflectivity cores observed by Ku-band radar

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In Tokyo Metropolitan Area Convection Study(TOMACS) project, we installed a Ku-band radar in Musashino-shi, Tokyo in 2011 in order to clarify mechanisms of extreme weathers such as local heavy rain in an urban area. In this research, our main target is the motion of upper reflectivity cores, since motions of the reflectivity cores must affect the motion of the cumulonimbus itself.

On Sep. 1, 2012, many small cumulonimbi were generated all over Japan although there wasn't significant disturbance in a surface weather map. These were due to warm and humid air and an upper cold low, however, it is difficult to predict motions of cumulonimbi generated in such a condition. In this presentation, characteristics of heights and motions of reflectivity cores observed in this case will be shown.

Keywords: Ku-band radar, cumulonimbus, reflectivity core

AAS23-05 Room:101A Time:May 23 15:15-15:30

Precipitation core behavior and surface rainfall variation in cumulonimbus clouds in the Kanto region, on 18 August 2011

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Descending precipitation cores in cumulonimbus clouds which caused localized heavy rainfall have been reported in several previous studies. The surveillance of precipitation cores aloft is expected to improve nowcast or short-time forecast methods of localized heavy rainfall. In addition, the investigation of correspondence between detailed behavior of precipitation cores and surface rainfall is important to understand developing and maintenance processes of vigorous cumulonimbus clouds. The National Research Institute for Earth Science and Disaster Prevention conducted a three-dimensional observation of cumulonimbus clouds which occurred on 18 August 2011 in Kanto region, Japan, at two-minute intervals using an X-band polarimetric radar at Ebina City. In this study, the detailed behavior of precipitation cores in these cumulonimbus clouds and its correspondence to the time variation of surface rainfall are presented.

In this study, precipitation core is defined as the closed area of radar reflectivity (Zh) right before merging with other closed area when the Zh threshold level is lower from 60 dBZ to 10 dBZ by 1 dB. Precipitation core is automatically detected in three-dimensional data sets (dx = 1 km, dy = 1 km, dz = 0.25 km) every two minutes and manually tracked. Core height is defined by the level of the maximum Zh within the detected precipitation cores at each time. This precipitation-core detection method was applied to the three precipitation cells (Cell A1, B1 and C1) observed on 18 August.

Cells A1 and C1 consisted of a single precipitation core each. Precipitation cores aloft in Cells A1 and C1 were detected 12 and 16 minutes before the time of maximum rainfall intensity at the surface, respectively. Descent of precipitation cores was observed once in Cells A1 and C1 each. Cell B1 composed of 5 precipitation cores. Five surface rainfall peaks were observed for Cell B1. First rainfall peak was observed after 18 minutes of the first detection of precipitation core aloft. At that time, the core height was 5-km altitude, which did not descend to the surface. Other 4 peaks in surface rainfall were observed in association with precipitation core descent. Thus, 6 of 7 rainfall peaks in three precipitation cells were observed in association with descents of precipitation cores.

Keywords: Localized heavy rainfall, precipitation core, Polarimetric radar

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AAS23-06 Room:101A Time:May 23 15:30-15:45

Surface Meteorological Monitoring Network for Observation of Extreme Weather (1):Meteorological Characteristics in Tokyo

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The purpose of this study is to clarify extreme weather in cities including short time heavy rainfall and high temperature in summer. High-density surface meteorological monitoring network were expanded in Tokyo. Meteorological characteristics in summer were examined by using high-density data in Tokyo obtained from this monitoring network.This study is supported by the S-8 Project, Comprehensive Research on Climate Change Impact Assessment and Adaptation Policies, implemented by the Environment Research and Technology Development Fund of the Ministry of the Environment, Japan and Tokyo Metropolitan Area Convection Study for Extreme Weather Resilient Cities (TOMACS) under the Special Coordination Funds for Promoting Science and Technology of the Ministry of Education, Culture, Sports, Science and Technology (MEXT).

Keywords: Extreme Weather, Surface Meteorological Monitoring, Summer Season, Tokyo Metropolitan Area, Meteorological Characteristics

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AAS23-07 Room:101A Time:May 23 15:45-16:00

Relationship between rainfall distribution and surface wind during heavy rainfall occurred in central Tokyo in summer

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In recent years, it has been reported that short time heavy rainfall that occurs in summer tends to increase. The purpose of this study is to clarify the evolution process of short time heavy rainfall towards the short-range forecasting of heavy rainfall that showed clear regional characteristics.

Typical heavy rainfall days were selected and the relationship between rainfall distribution and the convergence of surface winds were examined by using high-density data obtained from meteorological observations in central Tokyo from 2011 to 2012. The values of convergence tended to be larger from several tens of minutes before the occurrence of heavy rainfall in the case of August 26, 2011. The similar temporal change was observed in approximately half of the selected cases. From these results, the possibility to predict the occurrence of heavy rainfall is expected by using the surface wind data obtained from high-density observation network.

This study is supported by the S-8 Project, *Comprehensive Research on Climate Change Impact Assessment and Adaptation Policies*, implemented by the Environment Research and Technology Development Fund of the Ministry of the Environment, Japan and *Tokyo Metropolitan Area Convection Study for Extreme Weather Resilient Cities (TOMACS)* under the *Special Coordination Funds for P* of the Ministry of Education, Culture, Sports, Science and Technology (MEXT).

Keywords: heavy rainfall, convergence field, high-density observation network, central Tokyo

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AAS23-08 Room:101A Time:May 23 16:15-16:30

Retrieval of Water Vapor Anisotropy from GPS and it's Relation with Convective Precipitation

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Procedures for retrieving two indices indicating the degree of inhomogeneity of water vapor using the carrier phase of a Global Positioning System (GPS) have been introduced. One index describes the spatial concentration of water vapor (WVC); the other indicates higher order water vapor inhomogeneity (WVI). Horizontal scales of the two indices are roughly thought of as 60 km and 2-3 km, respectively.

The relationships between these indices and precipitation were examined statistically. The results indicate that the inhomogeneity indices are more strongly correlated with strong rainfall than PWV. PWV seemed to relate to precipitation of less than 10 mm/h but did not exhibit much of a relationship with precipitation greater than 10 mm/h. These relationships hold true for both present and imminent precipitation.

The spatiotemporal variations in the indices associated with an F3 tornado occurred on 6 May 2012 were also examined. WVI showed distinct variation around the event.

The results suggest that the two GPS-derived indices of water vapor inhomogeneity reflect local variations in the water vapor associated with the convection phenomena and could potentially be used for the monitoring of extreme weather like thunderstorms and tornados.

Keywords: Extreme weather, GPS, Water vapor, inhomogeneity, convective precipitation

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AAS23-09 Room:101A Time:May 23 16:30-16:45

Numerical study on precipitable water vapor variation associated with heavy rainfall using a non-hydrostatic model

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The frequency of weather disasters caused by local heavy rainfall is increasing due to the global warming. For the mitigation of these disasters, it is important to monitor the variation of water vapor before the rainfall.

Global Navigation Satellite Systems (GNSS), that include GPS, are now widely used to perform precise positioning. In addition to this, the vertically accumulated water vapor amount, precipitable water vapor (PWV) can be estimated from GNSS observations. The Geospatial Information Authority of Japan is operating a nationwide GNSS network, called GPS Earth Observation Network System (GEONET), and PWV from GEONET can be estimated with a mean horizontal spacing of about 20 km. To improve the horizontal resolution of PWV, we have installed a dense GNSS receiver network with horizontal spacing of 1-2 km near the Uji campus of Kyoto University.

In parallel to dense GNSS observations, down-scale experiments using a non-hydrostatic regional model (JMANHM) with grid intervals of 2 km and 250 m were performed to investigate the PWV variation associated with a thunderstorm observed on 28 July 2011 and 14 August 2012 within the dense GNSS network.

In the 250 m forecast for the case on 14 August 2012, a rainband located south of Kyoto was roughly reproduced. In the model, small regions in which PWV values started to increase about 10 minutes before the rainfall were found. At the 850 hPa surface over these regions, vertical wind velocity and cloud water content became large in conjunction with the rapid increase of PWV. It is expected that the increase of pwv value was occured because low level moist air was lifted up by the upward wind. Similarly, increasing of PWV value before rainfall was observed by the GNSS receiver at the Uji campus. These results suggest that PWV variation could be predictive of heavy rainfall.

Keywords: heavy rainfall, GPS meteorology, non-hydrostatic model

AAS23-10 Room:101A Time:May 23 16:45-17:00

Cloud resolving ensemble prediction of a local heavy rainfall event on 26 August 2011 observed by TOMACS

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On 26 August 2011, a local heavy rainfall event occurred in the Tokyo metropolitan area. In Tokyo and Kanagawa prefectures, very intense rains more than 90 mm hr-1 were observed (Fig. 1a) and several houses were inundated. This heavy rainfall event was caused by a mesoscale convective system (MCS) which was triggered by low level convergence, and its characteristics were captured by a dense observation network deployed by the Tokyo Metropolitan Area Convection Study (TOMACS). Despite its relatively larger spatial scale as a local rainfall in Japan and existence of well-defined low level convergence by a front, operational mesoscale model (MSM) of JMA failed to predict this event. Studies on model physics, predictability, and data assimilation should be conducted to improve the forecasts.

Preliminary numerical experiments for this event have been performed. As a first trial, a downscale ensemble experiment from the mesoscale analysis of JMA was conducted using the JMA nonhydrostatic model (NHM) with horizontal resolutions of 10 km and 2 km. With perturbations from the JMA one-week global ensemble prediction system (WEP) at 12 UTC 25 August, only a few members intensified the rainfall around Tokyo and some fake precipitations appeared in the Hokuriku district.

In NHM, the model cloud amount to compute radiation processes is evaluated from relative humidity considering subgrid scale partial condensation. Magnitude of the subgrid fluctuation is determined by the MYNN3 turbulent closure model. Recently, JMA has changed the lower limit of the fluctuation in their operational local model (LFM) to ameliorate an overestimation tendency of the cloud amount. When the lower limit was changed, surface temperatures increase about 1 C in southern part of the Kanto Plain, and modify the position of low level convergence which triggered the MCS.

Additional mesoscale ensemble experiment was conducted using a mesoscale singular vector method (MSV) based on the adjoint model of NHM. A 2 km simulation using MSV perturbation reproduced the intrusion of sea breezes and associated surface convergence which triggered the mesoscale convective system.

Keywords: local heavy rainfall, mesoscale ensemble prediction, singluar vector, TOMACS

AAS23-11 Room:101A Time:May 23 17:00-17:15

Ensemble forecast experiments of tornadoes occurred on 6th May 2012 using a nested-LETKF system

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This presentation is regarding the tornadoes that occurred on 6th May 2012. Some research has already been carried out using Doppler radar data and outputs of the numerical forecast from this event. The analysis of the Doppler radar data showed that the tornadoes occurred in super cell convections. Low level warm moist airflow was supplied into the convections. An intense downdraft from the western sides of the convection cell triggered the tornadoes. If an ensemble forecast was applied to this event, we could obtain the probability of the outbreak of super cell convections and tornadoes. The several scenarios provided by an ensemble forecast also give us the factors that influence the outbreak and duration of tornadoes. In this presentation, the results of an ensemble forecast by the nested-LETKF system will be presented.

Keywords: Ensemble forecast, Data assimilation, Tornado