Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

AAS24-01 Room:105 Time:May 21 09:02-09:18

Practical Use of the MP Radar by the Tokyo Fire Department

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1. MP Radar Information Experimentally Used by the Tokyo Fire Department (TFD)

In 2009, the TFD concluded with the National Research Institute for Earth Science and Disaster Prevention (NIED) a memorandum about the mutual cooperation in collecting and sharing information on storm and flood damage. Since the conclusion of this disaster information memorandum, the TFD has been experimentally using the MP radar for fact-finding to identify typhoons, localized heavy rains or others most clearly. The radar has been in use mainly for (i) the earlier preparation for flood protection/control and (ii) the better, more specific monitoring of weather conditions.

2. TFD's Flood Protection Activities

The TFD, based on the Flood Protection Law, goes on the alert for the overflow of rivers, and decides on the "areas to be protected from water damage" together with local communities. The TFD, as a fire service organization, is missioned to conduct search and rescue in such disasters according to the related laws and regulations. The Department, then, puts itself on the alert for storms and floods, and may issue the emergency flood protection order after learning overall and judging from the weather conditions, the typhoon's path and severity, the possibilities of major water damage, the actual disaster facts, etc. With a flood protection order given, more firefighters are mobilized, and some of them are incorporated into lifeboat units. The flood protection order is put out based on the weather conditions and the actual disaster damage. Knowing these facts quickly and correctly, emergency responders can get ready for flood protection activities sooner.

3. Access to MP Radar Images

For information about local heavy rains and others, fire stations can have access to the TFD website which is specially opened on the NIED home page showing the images taken by the NIED-operated MP radar. Starting in 2011, the MP radar-provided data can be viewed on the TFD's Disaster Information System (web-GIS) as well as on this "MP radar site."

(1) MP Radar Site
The MP radar site indicates how hard it rains, how much it has rained, which areas will be in the path of the rain, etc. The site, then, activates its alert sound system when precipitation reaches a warning level, showing the fire stations in the "areas of danger" so that they can quickly prepare for an upcoming rainstorm.

(2) TFD's Disaster Information System (web-GIS)
The TFD's Disaster Information System demonstrates both the MP radar information and the detailed area data simultaneously on its map. This duality conveniently helps firefighters quickly decide on the action to take for flood protection.

4. When and How Is the MP Radar Information Used?

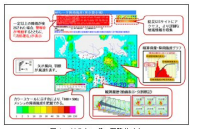
(1) Access for Fact-finding
Under rough weather, in case of necessity, fire stations have access to the MP radar site to check out rainfall continuously.

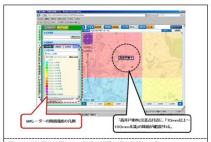
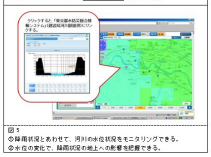
(2) Rainfall "Confirmation" and Rainfall Conditions Assessment
The "sudden rise in water level resulting in inundation" may well occur after the sudden increase in rainfall strength within a short period of time (10 to 20 minutes) which goes beyond the flood control standard (50 mm/h) of the Tokyo Metropolitan Government. Information needs to be collected without fail in the following cases:
a. When the MP radar site activates its alert sound system.
b. When localized heavy rains are observed.

(3) Practical Use of the TFD's Disaster Information System (web-GIS)
When localized heavy rains are expected with the MP radar information given, the TFD's Disaster Information System (web-

GIS) is used to obtain detailed area data. With the following, expected dangers can be understood with ease:
a. Enlarged area maps and the MP radar information are shown simultaneously.
b. River water levels and the MP radar information are shown simultaneously.
c. Past inundation damage and the MP radar information are shown simultaneously.

Keywords: MP radar, Tokyo Fire Department (TFD), Flood protection activities, Method of specific use




Japan Geoscience Union Meeting 2012
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AAS24-02 Room:105 Time:May 21 09:18-09:33

Radiosonde observation network in Tokyo metropolitan area

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Severe weathers such as torrential rainfall is one of the serious atmospheric environmental issues in Tokyo metropolitan area. Intent monitoring network is necessary for understanding mechanism and process of severe meteorological events in cities. Furthermore, improvement of urban weather prediction model is also required.

Torrential rainfall in Tokyo metropolitan area is due to the boundary-layer processes such as convergence of sea breeze, large roughness and heat flux in urban area. In this study, we investigate the relationship between the surface forcing in urban area and the spatial variation of the development of atmospheric boundary-layer height based on the radiosonde observation in Tokyo metropolitan area. This is carried out as a part of the Tokyo Metropolitan Area Convection Study for Extreme Weather Resilient Cities (TOMACS) project.

This experiment was conducted from 27 September to 7 October 2011 at some observational points, where are Tsukuba(Aerological Observatory, Japan Meteorological Agency; 36.05^{o}N, 140.12^{o}E), Ukima(Ukima Water Reclamation Cente; 35.80^{o}N, 139.69^{o}E), Koganei(National Institute of Information and Communications Technology; 35.71^{o}N, 139.49^{o}E) and Yokosuka(National Defense Academy of Japan; 35.26^{o}N, 139.72^{o}E). GPS radiosonde (RS-06G, Meisei Electric Co., Ltd) was launched every 3 hours from 9:00 to 21:00.

On 4 October 2011, it was almost fine weather except at Yokosuka, and inflow of the sea breeze was clearly observed below the height of 1 km after 15:00. Potential temperature profiles show that the mixing layer height was developed about 2 km at Tsukuba, 2.5 km at Ukima and from 2 to 2.5 km at Koganei although it was not clearly determined at Yokosuka due to cloud cover.

Among the observation points, the highest mixing layer height was observed at Ukima where is located on the northern part of central Tokyo. When the sea breeze (southerly wind) blows over the land in daytime, the evolution of the atmospheric boundary layer is enhanced by the flow stagnation due to large roughness and by anthropogenic heat supply in central Tokyo.

Acknowledgements: This research was financially supported by the Strategic Funds for the Promotion of Science and Technology of the Japan Science and Technology Agency (JST) and the Ministry of Education, Culture, Sports, Science and Technology (MEXT).

Keywords: radiosonde, atmospheric boundary layer, torrential rainfall, sea breeze, urban

Japan Geoscience Union Meeting 2012
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AAS24-03 Room:105 Time:May 21 09:33-09:48

Isolated cumulonimbus initiation observed by 95-GHz cloud radar, X-band radar, MTSAT-1R (rapid scan), and photogrammetry

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Simultaneous observations of cumulonimbi using the MTSAT-1R (rapid scan), the 95-GHz FM-CW cloud radar (the Chiba site), the X-band radar (the Yokosuka site), and photogrammetry were carried out during the summer of 2010 in the Kanto region, Japan to understand the convection initiation (CI) and the structure of heavy rainfall in the Tokyo metropolitan area. The formation process of an isolated cumulonimbus which generated in the afternoon on a fine mid-summer day on 24 July and 23 August 2010 would be presented.

The generation of the cumulonimbus was initiated by cloud turrets. A continuous generation of turrets was observed from the visible images, and a total of four turrets (24 July) and five turrets (23 August) formed. The growth rates of turrets were quite different among the turrets in these cases. The first radar echo of the X-band radar was detected at 3 km AGL, three minutes after the turret reached its maximum height. The cloud radar detected echoes, approximately two minutes after the generation of the turret and 15 minutes before the turret reached its maximum height. The intermittent echo pattern observed by the cloud radar denotes fine structures in the Cb, such as cloud and precipitation.

Based on the rapid scan data, cumulus and cumulonimbus can be detected by the visible brightness data at the formation stage of the cumulonimbus. The temporal change of the visible brightness suggests the evolution of the cumulonimbus turrets.

Keywords: cumulonimbus, turret, first radar echo, cloud radar, MTSAT rapid scan

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AAS24-04 Room:105 Time:May 21 09:48-10:03

Temporal-spatial structure of cumulonimbus of rainband observed by Ku-band radar and surface observation network

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[1]Meteorological Research Institute

We are operating a Ku-band radar with high temporal-spatial resolution (range: 2.38 m, beam width: 3 deg., 1 volume scan : approximately 1 min.) at Musashino city, Tokyo (SEIKEI Univ.) during the field campaign of the Tokyo Metropolitan Area Convection Study for Extreme Weather Resilient Cities (TOMACS). We present the temporal-spatial structure of cumulonimbus clouds of rain band on November, 20, 2011 based on observation of Ku-band radar, dense surface observation network, and AMeDAS (Automated Meteorological Data Acquisition System).

The Ku-band radar observation clearly shows that new cumulonimbus initiated at leading edge of rain band. Analysis of wind field based on surface observation network and AMeDAS shows that the cumulonimbus generated at convergence field. Using reflectivity of Ku-band radar, development of three-dimensional structure of precipitation core of the cumulonimbus was analyzed. The precipitation core initiated at approximately 4 km height and dropped at surface within 6 min.

Keywords: Cumulonimbus, Ku-band radar, surface observation network

Japan Geoscience Union Meeting 2012
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AAS24-05 Room:105 Time:May 21 10:03-10:18

Case study on first echo associated with cumulonimbus development observed by Ka-band radar in the Kanto region, Japan

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cumulonimbus. A cumulonimbus developed in the mountainous area in the west of the Kanto region in the morning on 18 August 2011, and initiation and developing process of the cumulonimbus were observed by the KDR and the XPDR. In this study, we defined an echo newly observed in RHI and PPI scans as ”first echo”. In the developing stage, first echoes occurred one after another, and maximum echo top height and maximum reflectivity of individual first echoes gradually increased. The maximum echo top height of the cumulonimbus grew up to 12 km in height. In the beginning of developing stage, only the KDR could detect several first echoes and no first echo was detected by the XPDR for more than 25 minutes. After first echo was detected by the XPDR, the time lag of first echo detection between the KDR and the XPDR tended to be shorter as the cumulonimbus developed. In the first half of the developing stage, the height of first echo appeared between 2 and 5 km in height. In the latter half of the developing stage, on the other hand, the appearance height of first echo stepped up between 5 and 12 km in height.

Keywords: first echo, Ka-band radar

Japan Geoscience Union Meeting 2012
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AAS24-06 Room:105 Time:May 21 10:45-11:01

A Real-time Monitoring System of Precipitable Water Vapor (PWV) Using a Dense GNSS Receiver Network

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[1]RISH, Kyoto University, [2]CPIER, Kyoto University

Because of on-going global warming, frequency and intensity of abnormal weather are projected to increase, resulting in serious hydrological hazards, such as a land slide, an unexpected increase of river level and so on. A torrential rain in urban area is becoming a serious problem, which is caused by a strong thunderstorm abruptly developing associated with a sudden heavy rainfall.

Horizontal scale of a local heavy rainfall is as small as a few kilometers, which is difficult to predict with a current numerical weather forecast. A weather radar can detect a cloud only after the event becomes evident. It is required, therefore, to develop an observation system to monitor the behavior of water vapor in advance to formation of clouds.

A Global Navigation Satellite System (GNSS), represented by GPS, is now widely used for precise determination of coordinates. The ultimate error in the satellite positioning comes from the propagation delay of the GNSS radio signal within the atmosphere. The delay can, however, be related to the accumulated water vapor along the ray path, which can be mapped onto the vertical detection to estimate the precipitable water vapor (PWV). This is the basic concept of GPS Meteorology.

In a conventional method of GPS Meteorology, all available GPS satellites seen above an elevation angle of 5-10 degrees are used to estimate PWV, therefore, the horizontal resolution of GPS-PWV is as wide as about 20 km. We here propose to use GNSS satellites at high elevation angle only, then, the horizontal resolution of the PWV estimates is significantly improved. In particular, we will employ Quasi-Zenith Satellite System (QZSS), launched in September 2010 by JAXA. One of QZSS satellites stays overhead of Japan continuously for about eight hours each day, so, it is suitable to monitor PWV with a better horizontal resolution.

We have installed a dense GNSS receiver network (10-17 QZSS receivers) with the horizontal spacing of 1-2 km near the Uji campus of Kyoto Unviersity. In this paper, we report initial results of PWV measurements focusing on the horizontal inhomogeneity of water vapor distribution, and its application for now-casting of a cloud development.

Keywords: GNSS, Precipitable Water Vapor (PWV), QZSS, real-time, dense network, ionosphere

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AAS24-07 Room:105 Time:May 21 11:01-11:16

Characterizing atmospheric turbulence with a dense GNSS network: temporal and spatial analysis of high-rate slant delays

REALINI, Eugenio[1*], TSUDA, Toshitaka[1], SATO, Kazutoshi[1], OHIGAWA, Masanori[1], IWAKI, Yuya[1]

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Forecasting sudden thunderstorms and torrential rain in urban areas is a crucial objective for disaster prevention and mitigation. Such severe storms are often abrupt and highly localized phenomena with a horizontal scale of few kilometers, which makes them difficult to be predicted by current numerical weather models. Short-term predictions on such small scales could potentially benefit from reliable measurements of the temporal and spatial fluctuations of water vapor in the atmosphere. Since most of the atmospheric water vapor is contained in the troposphere, it is possible to estimate the amount of precipitable water vapor (PWV) from the analysis of Global Navigation Satellite System (GNSS) tropospheric delays: the estimated signal delay due to the tropospheric refractivity along each receiver-satellite line-of-sight, or slant delay, is mapped to the zenith direction and divided in its hydrostatic and wet components in order to estimate the PWV over a GNSS station. The water vapor distribution and its variability can be monitored by employing a network of continuously operating stations. Atmospheric turbulence can be characterized by analyzing the temporal and spatial fluctuations of tropospheric delays.

This work focuses on the stochastic analysis of refractivity fluctuations in the wet troposphere by means of temporal and spatial structure functions applied to observed tropospheric delays. High-rate (1 Hz) observations obtained from a dense network of dual frequency GNSS receivers have been processed by precise point positioning, taking into account the effects of satellite clock instability on the estimated tropospheric delay. The resulting structure functions show power-law behaviors varying between 5/3 and 2/3, consistently with Kolmogorov turbulence theory. The impact of different slant delay geometries is evaluated by elevation-based satellite selection. The effect of different tropospheric conditions on the correlation length and magnitude of the measured fluctuations is studied, suggesting the possibility to characterize and monitor turbulence in the wet troposphere at local scale by means of a continuously operating dense GNSS network.

Keywords: GNSS, PPP, troposphere, water vapor, atmospheric turbulence

Japan Geoscience Union Meeting 2012
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AAS24-08 Room:105 Time:May 21 11:16-11:31

Observation system simulation experiments of the meso-scale convergence that causes the local heavy rainfall

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[1]Meteorological Research Institute

One of aims of the project 'Social system reformation program for adaption to climate change' is to observe thunderstorms that caused local heavy rainfalls in the urban area and to clarify mechanisms of their generation, development and decay by using observation data and outputs of the numerical models. In the Nerima local heavy rainfall, which is one of typical local heavy rainfalls, convection cells were generated by the convergence that was caused by the thermodynamic low system. It is expected that thunderstorms can be reproduced when the large-scale convergence is reproduced by the assimilation.

In this study, the observation system simulation experiments on the data of airplane or Doppler Lidar and temperature profiler that deployed in the urban area, which have the information of horizontal convergence of low-level airflows, was conducted. Truth data was reproduced with the LETKF nest system by the assimilations of GPS precipitable water vapor data and of horizontal wind of Doppler radars. The following three simulant observation data which surrounded the thunderstorm were produced from the truth data of 15 JST, 2 hour before the development of the thunderstorm. First one is the airplane data, which is water vapor, temperature and horizontal wind at the height of 400 m surrounding the Osaka Plain with the horizontal interval of 37.5 km. Second one is the Doppler Lidar data which is the horizontal winds below the height of 200 m at the same points of the airplane data. And the last one is the temperature profiler, of which data is the temperature profiles below the height of 600 m. The impact of these simulant data was investigated by their assimilation into the initial condition of 15 JST which were obtained by assimilation of conventional data only. In this study, the thunderstorm was developed where it was reproduced in the truth data, when the airplane data or the Doppler Lidar and temperature profiler data were assimilated. These results show that observation data surrounding the thunderstorm can improve its rainfall forecast even if the direct observation data of the thunderstorm cannot be used.

Keywords: local heavy rainfall, observation system simulation experiment

Japan Geoscience Union Meeting 2012
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AAS24-09 Room:105 Time:May 21 11:31-11:46

Retrieval of buoyancy in thunderstorm from dual-Doppler radar wind with high temporal resolution

SHIMIZU, shingo[1*], IWANAMI, Koyuru[1], MAESAKA, Takeshi[1], SUZUKI, Shin-ichi[1], SAKURAI, Namiko[1], MAKI, Masayuki[1]

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We developed thermodynamical retrieval algorithm using
sector volume scanning observation with high temporal resolution.

The algorithm was applied to severe storm observed around 13 LST on
3 August 2011. It was found that the
relationship between potential temperature and rapid
development of updraft. The estimated perturbation of potential temperature
will be used for initialization of numerical simulation by 3DVAR.

Keywords: Retrieval of thermodynamic variable, High-temporal-resolution sector scan

Japan Geoscience Union Meeting 2012
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AAS24-10 Room:105 Time:May 21 11:46-12:01

Cloud Resolving Ensemble Forecast for the 2008 August Tokyo Metropolitan Area Local Heavy Rainfalls

SAITO, Kazuo[1*], SHOJI, Yoshinori[1], Seiji Origuchi[1], Le Duc[2], SEKO, Hiromu[1], KAWABATA, Takuya[1]

[1]Meteorological Research Institute, [2]Japan Agency for Marine-Earth Science and Technology

On 5 August 2008, scattering local heavy rainfalls occurred various places over the Tokyo metropolitan area, and five drainage workers were claimed by abrupt flooding. The JMA's operational mesoscale model of the day failed to predict occurrence of the local heavy rainfalls, which were given by deep convective cells developed on unstable atmospheric conditions without strong synoptic/orographic forcing.

The GPS total precipitation water vapor (TPW) analysis showed that the initial field of the operational MSM produced by the hydrostatic Meso-4DVAR underestimated water vapor over the Tokyo metropolitan area. To modify the initial condition, a reanalysis data assimilation experiment was conducted with the JMA nonhydrostatic 4DVAR (JNoVA), where GPS TPW data from GEONET were assimilated 2.5 days with 3-hour data assimilation cycles. The JMA nonhydrostatic model with the JNoVA reanalysis successfully reproduced weak to moderate rains over the Tokyo metropolitan area, but small scale convective cells and the associated intense rains exceeding 20 mm /3 hour were hardly predicted with a horizontal resolution of 10 km.

Cloud resolving (2 km) ensemble prediction with 11 members was conducted using the JNoVA reanalysis as the initial condition of the control run. The 2 km ensemble run fairly predicted the areas of scattering local heavy rains and showed a appreciable detection rate in the ROC area skill score. Fractions skill score indicated the value of the cloud resolving ensemble forecast for such the unforced convective rain case.

Keywords: local heavy rainfall, ensemble prediction, cloud resolving model, 4DVAR data assimilation, GPS Total precipitable water

Japan Geoscience Union Meeting 2012
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AAS24-P01 Room:Convention Hall Time:May 21 17:15-18:30

Extreme Weather Database -MP radar precipitation image information-

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Recently, rapidly developed local heavy rainfall disasters were occurred in large cities. Precipitation information for the monitoring of heavy rainfall is provided from conventional radar network. The information is adjusted by rain gauge data. It needs tens of minutes to process gauge adjusted radar data. It is not appropriate to detect rapidly developed local heavy rainfall. The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) introduced X-band Multi Parameter (MP) radar which does not need to adjust by rain gauge data, to perform monitoring of heavy rainfall. Eleven MP radars are conducted trial operation in Kanto, Chubu, Kinki, and Hokuriku regions since July 2010. Additional fifteen MP radars are conducted trial operation in Kurikoma, Niigata, Shizuoka, Okayama, Hiroshima, Northern Kyushu, and Sakurajima regions since July 2011. The MP radar provides higher spatial (250m mesh) and higher temporal (one minute) resolution rainfall observations than the conventional radar. This radar precipitation information is useful to study the characteristic of extreme weather events. The NIED obtain the radar data from the MLIT on real time, and produce the variety of products which are necessary for analysis, and archive these data. We construct the precipitation image database to find the extreme weather events easier. It includes hourly precipitation rate image, hourly precipitation amount image, and every minute precipitation rate animation image per hour. We will study the characteristics of heavy rainfall in large cities using hourly and every minute precipitation data.

Keywords: Extreme Weather, Database, MP radar, Precipitation image

Japan Geoscience Union Meeting 2012
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AAS24-P02 Room:Convention Hall Time:May 21 17:15-18:30

Ku-band radar observation of cumulonimbi on August 11, 2011

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[1]Meteorological Research Institute

We started a field observation in Tokyo metropolitan area from 2011 with a dense network of various instruments in order to clarify the mechanism of extreme weather such as heavy rain in an urban area, and to predict its occurrence. In this field observation, authors installed a Ku-band radar in Musashino-shi, Tokyo in September, 2011, which can create a volume scan in one minute to acquire the structure of rapidly developing cumulonimbi.

In this presentation, successive creation of cumulonimbi which was observed by the Ku-band radar on August 11, 2011 during a preliminary observation in Tsukuba will be introduced.

Keywords: extreme weather, radar

Japan Geoscience Union Meeting 2012
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AAS24-P03 Room:Convention Hall Time:May 21 17:15-18:30

Formation of localized torrential rainfall associated with a cumulonimbus cloud developed over mountains

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Localized torrential rainfall over mountains in summer is brought by a cumulonimbus cloud maintained for a long time. As the example of such torrential rainfall, the formation process of torrential rainfall brought by the cumulonimbus cloud maintained over Asagiri Highland for a long time on 28 July 2010 was analyzed using the observation of the X-band MP radar of University of Yamanashi (the UYR).

Asagiri Highland with the range of about 10 km is associated with the slope adjoining Mt. Fuji on the east side and the gradual slope toward Mt. Kenashi on the west side; it adjoins Suruga Bay.

The cumulonimbus cloud was composed of 54 precipitating cells which appeared and disappeared repeatedly from 1140 JST to 1740 JST. During the duration, the cumulonimbus cloud maintained including 2 ~ 4 precipitating cells. Then, from the analyses of the echo height and area of radar reflectivity (ZH) larger than 40 dBZ, the precipitating cells appeared from 1300 JST to 1540 JST developed more than those on the other time in the duration.

From the paths of precipitating cells and rainfall amount at 2 km ASL estimated by the UYR observation using Takahori and Maki (2009), from 1300 JST to 1540 JST, 24 precipitating cells which appeared over the gradual slope toward Mt. Kenashi and moved to the northwestern foot of Mt. Fuji formed the maximum rainfall larger than 120 mm in a local region. These suggests to become the dominant factor of the torrential rainfall.

On the other hand, from 1140 JST to 1300 JST, 15 precipitating cells appeared over the slope adjoining Mt. Fuji and moved to the northwestern foot of Mt. Fuji. Then, from 1540 JST to 1740 JST, 15 precipitating cells appeared on the little bit to the north of the appearance position at 1300 JST ~ 1540 JST and moved to the northern west foot of Mt. Fuji. The former and the latter rainfalls, however, formed the maximum rainfalls of about 15 mm and 30 mm, respectively; they were very less than that at 1300 JST ~ 1540 JST. It is suggested that the slight differences in the appearance positions of precipitating cells created a big difference in the development of them, which created a difference of rainfall in the local region.

Acknowledgement: The present study was conducted as part of the Evolution of Research and Education on Integrated River Basin Management in Asian Region project (project leader, Prof. Kengo Sunada) through the Global Centers of Excellence Program of the University of Yamanashi directed by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) of Japan. Then, the study was supported partially by 'Social System Reformation Program for Adaption to Climate Change' under the Japan Science and Technology Agency launched the program of MEXT.

Keywords: cumulonimbus cloud, localized torrential rainfall, mountains

Japan Geoscience Union Meeting 2012
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AAS24-P04 Room:Convention Hall Time:May 21 17:15-18:30

Short-term flood prediction for Ciliwung river basin using C-band Doppler radar and distributed hydrological model

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In order to mitigate flood disasters occurring frequently in Jabodetabek (Jakarta, Bogor, Depok, Tangerang, and Bekasi) area, application of the weather radar technology to an early warning system against extreme weather is needed strongly and urgently. In this study, both observation and model calculation are done using a radar installed in Jabodetabek area.

First, rainfall data have been derived from observations with a C-band Doppler radar (CDR) during the intensive observational period of HARIMAU2010 (14 January to 15 February 2010). Analyzing these data, we have found two types of rainfall propagation patterns: zonal (from west to east) and meridional (from south to north, or from north to south). The latter is more important to cause floods over the major (Ciliwung) river basin in the Jabodetabek area, which is related with convective clouds migrating in the meridional direction with a diurnal cycle.

Next, the data for typical heavy rainfall cases were used to simulate runoff in the Ciliwung river basin by using a distributed hydrological model (the CDRMV3 model). From the radar rainfall data over the Ciliwung river basin, generated runoff has been calculated for each cell of the model. Discharge hydrograph obtained by this runoff simulation has been verified with the discharge observational data. Simulations for the cases of meridional propagation patterns with diurnal cycle provide large discharges as observed actually. Therefore, this approach could provide a useful system for short-term flood prediction in Jabodetabek area.

Keywords: Weather radar, Distributed hydrological model, Rainfall, Runoff, Flood prediction, Ciliwung river basin

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AAS24-P05 Room:Convention Hall Time:May 21 17:15-18:30

Retrieval of Water Vapor Anisotropy using the Japanese Nationwide GPS Array

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[1]Meteorological Research Institute

Retrieval procedure of two indexes indicating the degree of inhomogeneity of water vapor using career phase of Global Positioning System (GPS) are introduced. One index describes spatial gradient of water vapor and another denotes higher order inhomogeneity.

Characteristics of water vapor field in August 2011 over Japan were studied, using temporal-spatial variation of those two indexes along with GPS derived precipitable water vapor (PWV). Monthly averaged indexes show distinct diurnal variation in the mountainous region of central Honshu, and these also show clear coincidences with diurnal variation of precipitation frequencies in the area.

The relation between those indexes and precipitation are statistically examined. The results exhibit that the inhomogeneity indexes have stronger correlation with strong rainfall while PWV shows more relation with weak and/or modest precipitation. This suggests that the GPS derived indexes of water vapor inhomogeneity appear to reflect local variation of water vapor associated with convection phenomenon.

Keywords: GPS Meteorology, Slant Path Delay, Gradient, Convective rain

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(May 20-25 2012 at Makuhari, Chiba, Japan)

AAS24-P06 Room:Convention Hall Time:May 21 17:15-18:30

Basic research of now-casting system for severe storms by using a dense GPS network

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The frequency and intensity of torrential rains are increasing. Though localized horizontal inhomogeneities of water vapor distribution were observed prior to such kind of rainfalls in historical cases, these phenomena occur suddenly and have a horizontal scale of a few kilometers. So, local heavy rainfalls are difficult to predict by current weather forecasting systems or models.

The integrated amounts of water vapor along to the zenith direction (or PWV, precipitable water vapor), can be estimated from the troposphere-induced delays in GPS signals (GPS meteorology). PWV estimation by GPS meteorology, using the nation-wide Japanese GPS network: GEONET cannot achieve enough horizontal resolution to predict local heavy rainfalls since the network is deployed with inter-station distances of about 20 kilometers.

We propose the system for real-time monitoring of high accuracy PWV horizontal distribution with a few kilometers scale which is considered to be beneficial to predict localized heavy rainfall by using a dense GPS network.

We deployed a dual-frequency GPS receiver network for PWV estimation around Uji campus of Kyoto University with inter-station distances of a couple of kilometers. We executed an observation campaign on July and August 2011 to test the accuracy of GPS-derived PWV, by comparison with radiosondes, LIDAR and radiometer. PWV comparison between GPS and LIDAR showed a significant difference: 4.0 mm in RMSE due to the height limit of LIDAR observations. GPS-derived PWV difference with radiosondes and radiometer was at most 3.00mm in RMSE.

We have developed the basic components of a system for monitoring, interpolating, and visualizing PWV derived from the GPS receiver network. Semi-real time data from dual frequency GPS receiver network can be visualize.

The impact of real-time satellite orbits and clocks, such as IGS ultra-rapid products which are needed if we run this system for real-time analyses was tested. The error introduced by the use of ultra-rapid orbits and clocks was considered to be avoidable by differential positioning.

For turning this system to practical use, we can reduce cost for GPS network significantly, at least about 70%, if single frequency receiver could be deployed instead of dual frequency receiver. However, in single frequency receiver processing ionospheric delay information is required to achieve high accuracy troposphere-induced delay solution because small scale perturbation of ionospheric delay between two GPS stations cannot be removed even with differential processing.

We thus investigated the performance of a local ionosphere model, which is needed to build up the system with single frequency GPS receivers, generated with the dual frequency GPS stations around the single frequency receiver network.

The results showed that interpolated ionospheric model at 10-20km scale, using stations in the GEONET, can work as well as an ionospheric model generated by dense GPS network used in this work. Even when TEC(total electron content) in ionosphere varies much, difference of estimated troposphere-induced delay between single frequency analysis with ionospheric model and dual frequency analysis was less than 4.5 mm in RMSE. Since this amount of deference in delay of GPS microwave is equal to 0.7 mm difference in PWV, it seems to be possible to build now-casting system for severe storms by using single frequency GPS network.

From 30 minutes before the time of sunset/sunrise estimated at the height of the ionosphere to 30 minutes after that time, the error of the ionospheric model was observed to change significantly. These results suggest that there is about 1 hour latency from the time which sunray starts or ends up to light ionosphere to the time which TEC variation becomes much, at the estimated height of ionosphere.

Keywords: Extreme weather, GPS meteorology, Precipitable Water Vapor, Severe storms, Now-casting, Ionospheric disturbance

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Formation Mechanisms of the Extreme High Surface Air Temperature of 40.9oC Observed in the Tokyo Metroplitan Area

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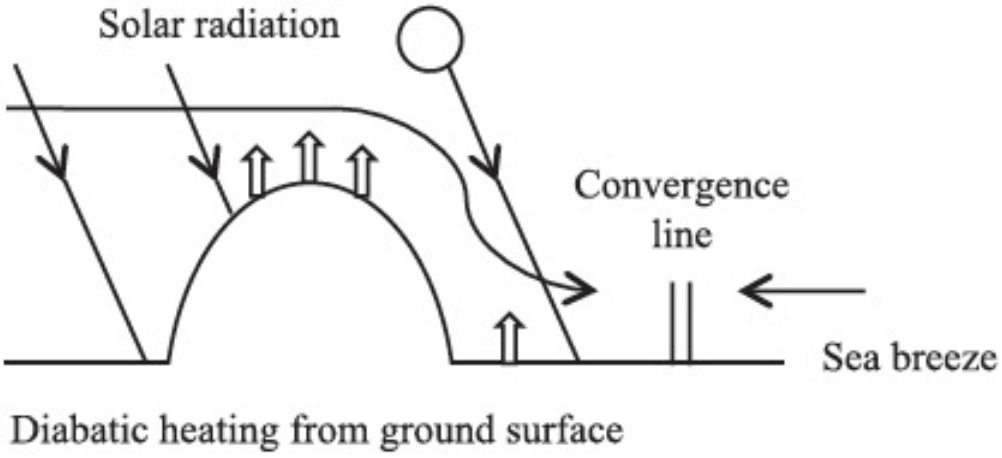
A record-breaking high surface air temperature in Japan of 40.9oC was observed on 16 August 2007 in Kumagaya, located 60 km northwest of central Tokyo. In this study, the formation mechanisms of this extreme high temperature event are statistically and numerically investigated using observational data and the Weather Research and Forecasting (WRF) model. The extreme event is caused by a combination of two particular factors: 1) Persistent sunshine and a lack of precipitation during the seven consecutive days preceding 16 August 2007 were seen in Kumagaya. This was the 12th-longest stretch of clear-sky days in July and August from 1998 up to 2008. Persistent clear-sky days allow the ground surface to dry out, which produces an increase in sensible heat flux from the ground surface. This contributes to the extreme event, and its mechanism is qualitatively supported by the results of sensitivity experiments of soil moisture on surface air temperature. 2) A foehnlike wind (Fig.1) appears in the numerical simulation, which is caused by diabatic heating with subgrid-scale turbulent diffusion and sensible heat flux from the ground surface when this airflow passes in the mixed layer over the Chubu Mountains and the inland of the Tokyo metropolitan area. Backward trajectory analysis and Lagrangian energy budget analysis show that the foehnlike wind plays a more important role in the extreme event than the adiabatic dynamic foehn pointed out by previous studies.

Keywords: Extreme high temperature, Foehn, Persistent clear-sky days, WRF, Kumagaya city



Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

AAS24-P08 Room:Convention Hall Time:May 21 17:15-18:30

Climate Projection in the Tokyo Metropolis in Summer and Impact Assessment to Human Health

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Urban heat island has a negative effect on residents health, thus national and local governments initiated mitigation plans. Urban climate projection is needed to mitigate the heat island from a long-term standpoint. Kusaka et al. (2012) performed urban climate projection by the dynamical downscaling method with WRF model under IPCC SRES A1b Scenario and predicted heat stress for the 2070s August for Tokyo, Osaka, and Nagoya Metropolises.

The present study conducts urban climate projection in 2030s, 2050s, and 2070s Augusts and evaluates the impact of urban planning on the urban temperature by the dynamical downscaling method. Furthermore, impact assessment to human health is performed. First, a hindcast experiment is conducted to assess the ability of WRF to reproduce the observed climatology for 2000s August. Next, climate change experiments are performed with dynamical downscale for 2030's, 2050s and 2070s. The future climate forcing is provided from several CMIP3 models with IPCC SRES A1B scenarios.

We present the predicted changes in duration (in hours per day) with WBGT exceeding 28 degree Celsius, and the number of nights with midnight temperature exceeding 26 degree Celsius. Finally, health impact of global warming is assessed using the midpoint-type impact assessment methodology. Detail results and discussion will be given.

Keywords: WRF, urban climate, regional climate projection, extreme high temperature event, heat stroke, sleep disorders

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AAS24-P09 Room:Convention Hall Time:May 21 17:15-18:30

Composite Map of X-band Polarimetric Radar Parameters and Rainfall Amounts in the Tokyo Metropolitan Area

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Due to severe rainfall attenuation, all the X-band radars in the network suffered a loss of received signal power. In severe cases, signal extinction occurred in the area behind a strong precipitation area; signal extinction area being defined herein as an area where the backscattered signal is below the receiver noise level. The present study examines the accuracy of composite polarimetric parameters (Z_H, Z_{DR}, and K_{DR}) and rainrate (RR) from an X-band polarimetric radar network situated in the Tokyo Metropolitan area.

The case analyzed is one of localized convective precipitation that was observed on 28 Sep. 2010 by 4 X-band polarimetric radars (EBN, KSR, SAT, and SYK), a 2-dimensional video disdrometer (2DVD), a Joss-Waldvogel type disdrometer, and a surface rain gauge network. When the precipitation system passed over the disdrometer sites, a peak rain rate of 88.9 mm h^{-1} was observed. Four X-band radars which compose the radar network successfully compensated each other for the signal extinction and provided composite maps of the polarimetric radar parameters and the rain rate. Validations of the polarimetric parameters and rain rate of the composite map were done by inter-comparisons of four X-band radars. Validations were also made by comparing radar parameters with those calculated from disdrometers. The results of the inter-comparisons show reasonably good agreement. The results of the validations of composite Z_H, Z_{DR}, and K_{DR} and RR with disdrometers show good agreement; the normalized biases (correlation) of those parameters were 3.9 % (0.92), 21.3 % (0.82), -2.18 % (0.94), and 1.35 % (0.90), respectively.

It is concluded that a network of radars is essential when X-band polarimetric radar is used for heavy rainfall observations. Composite polarimetric radar parameters can provide useful information, not only for hydrology applications but also for microphysical studies. However, the radar composite 10 minute rainfall amounts obtained were about 22 % smaller than surface rain gauge data. The possible reasons are discussed.

Keywords: X-band Polarimetric Radar, Composite Map, Rainfall amounts, Signal extinction area

Japan Geoscience Union Meeting 2012
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AAS24-P10 Room:Convention Hall Time:May 21 17:15-18:30

Analysis of convective precipitations using one-minute rainfall rate dataset by X-band MP radar network in MLIT, Japan

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The convective precipitation which comprised of several convective cells develops very rapidly and sometimes it concentrates in a small area and, as a result, causes urban flooding. A number of radar observation studies have reported that individual convective cells have average lifetimes of about 30 minutes. To investigate the three-dimensional structure of precipitation cell and system, volume scan radar data can provide useful dataset, but it takes about 5-10 minutes at the least. This time-consuming volume scan could not trace a violent change of convective precipitation entirely. Therefore, to understand convective precipitation, high spatiotemporal observations are essential.

Recently, National Research Institute for Earth Science and Disaster Prevention (NIED) developed an operational data processing system, which estimates the rainfall intensity from the radar data, and which creates regional composite data every one minute, under a Ministry of Land, Infrastructure, Transport and Tourism (MLIT) in Japan. This system provides a very high temporal resolution rainfall intensity data in the large area, which is useful to study violent convective precipitation. The purpose of present study is to clarify statistical characteristics of spatiotemporal structure of convective precipitation using X-band multi-parameter (MP) radar data.

The present study uses one minute rainfall intensity data obtained by X-band MP radar network situated in the Tokyo Metropolitan area from July to September 2010. The data has the spatial resolution of longitudinal 45/4” and latitudinal 30/4” (250 m, approximately). In the analysis, 1) rainfall duration, 2) number of peak in each rainfall duration, 3) accumulated rainfall amount, 4) rainrate intensity of each rainfall peak, etc are calculated based on time change of rainfall rate at each grid point, and spatial patterns of 6) rainfall area and 7) distribution of rainfall peak are also analyzed.

Results of analysis of one peak continuous precipitation which has one peak during the rainfall period show the average lifetime is less than 30 minutes, the maximum rainrate is 20-70 mm h^{-1}, the accumulated rainfall amount is less than 10 mm and the rainfall area is 8-9 km^2. The statistical analysis of two or more peak continuous precipitation (multi-peak continuous precipitation cell) is undergoing and the results will be presented at the conference.

Keywords: X-band MP radar, Convective precipitations, One-minute rainfall rate dataset

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AAS24-P11 Room:Convention Hall Time:May 21 17:15-18:30

Severe Weather Occurrence on the State of Sao Paulo caused by Upper Levels Cyclonic Vortices: A Case Study

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This work presents a case study on Upper Levels Cyclonic Vortices (ULCV) that act on the May 4th 2009 causing major impacts in the metropolitan region of Sao Paulo and in the Vale do Paraiba, Brazil. The interest of this case was the fact that only few papers about ULCV in the subtropical latitudes of South America were published and due to the occurrence of a severe hailstorm on cities of the state of Sao Paulo, used to evaluate the numerical model ETA20 to identify these extreme events. The synoptic analysis fields of wind, vertical velocity (omega) and geopotential height were carried out, also a simple evaluation of the numerical model ETA20 predictions. The results showed that the cyclonic vorticity is slightly increased during the morning until dawn and follows eastwards as a dipole shape with a wide range of trough and the rear edge. The severe weather observed in the most of the State of Sao Paulo was associated with the behavior of the atmosphere in the middle and upper troposphere, specifically with the presence of anomalous cold air at these levels. There were a maximum gradient of zonal and meridional wind and intense upward movements in the eastern cone of the State of Sao Paulo with rainfall and hail mainly in the Vale do Paraiba. The thermodynamic analysis indicated the presence of a very moist mass and unstable air over much of the State of Sao Paulo. The numerical model ETA20 identified the favorable area to the occurrence of storms with 18 hours in advance.

Keywords: ULCV, instability index, weather forecast

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Okazaki heavy rainfall reproduced by LETKF nest system

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Okazaki heavy rainfall that occurred on 28-29 Aug. 2008, was simulated by the Local Ensemble Transform Kalman Filter (LETKF) nest system. The LETKF nest system is composed of outer and inner LETKFs to reproduce the mesoscale-convergence and the observed large rainfall amount, simultaneously. In this experiment, the grid intervals of the inner and outer LETKFs were 15 km and 1.875 km, respectively. The boundary data of the inner LETKF was produced by the interpolation of the outputs of the outer LETKF, which is similar manner of down scale experiments. The analyzed fields of the outer LETKF were modified by those of the inner LETKF every 6 hours. The conventional data of Japan Meteorological Agency, such as upper sounding data, were assimilated in both LETKFs.

When ensemble forecasts were conducted by LETKF nest system, the line-shaped rainfall systems were reproduced in most of ensemble members, though their positions and rainfall intensities were varied among the members. Besides the probability of the generation of the intense convection systems, the relationships between the rainfall and other variables, such as water vapor flux and low-level and middle-level equivalent potential temperature, can be investigated with the outputs of the ensemble forecasts. In the presentation, the outline of LETKF nest system, the structure of the rainfall system of Okazaki heavy rainfall and the relationship between the rainfall and other variables will be explained.

Keywords: Heavy rainfall, Ensemble Kalman Filter

Japan Geoscience Union Meeting 2012
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A Consideration of Nowcast with the use of Vertically Integrated Liquid Water Content (VIL)

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An X-band MP radar network is increasing its members in Japan with purpose to determine the mechanism of local severe weather and to develop the algorithm for estimating various rainfall and microphysical parameters from radar measurements.Meanwhile, Tokyo Metropolitan Area, where approximately 30 million people live at, has a high risk of inland flooding because of the large asphalt pavement ratio and the closely spaced concrete buildings it contains, the early warning of local severe storm for managing urban flood risk becomes one of the important roles for the network. Vertically Integrated Liquid water content (VIL) is a convenient parameter that includes vertical information on total water but does not need to consider the microphysical processes of rainfall. In this research, authors derived VIL values from X-band MP radar and compared them to surface rain-gauge observations to evaluate the potential of using VIL as an indicator of local severe storms in forecast or nowcast systems.

Keywords: VIL, concentrated heavy rain, X-band, MP radar, nowcast

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Projected regional-scale changes in environmental stability for summertime convective rain in Tokyo under global warming

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Understanding and forecasting of summertime afternoon precipitation due to rapidly developing cumulonimbus clouds without any significant synoptic-scale influences are important to prevent and mitigate the induced disasters. Future changes in the behavior of such precipitation events have recently gained scientific and societal interests. This study investigates the environmental stability for afternoon precipitation that develops under synoptically undisturbed conditions in summer by using the outputs of 20-km-mesh, super-high-resolution atmospheric general circulation model (GCM) simulations for a present, a near-future, and a future climate under global warming with the Intergovernmental Panel on Climate Change A1B emission scenario. The Kanto Plain was chosen as the analysis area. After verifying the usefulness of the GCM present-climate outputs with observations and gridded mesoscale analyses, we examine the future changes in the environmental stability for the afternoon precipitation by conducting statistical analyses. In the future climates, temperature lapse rate decreased in the lower troposphere, while water vapor mixing ratio increased throughout the deep troposphere. The changes in the temperature and moisture profiles resulted in the increase in both precipitable water vapor and convective available potential energy. These projected changes will be enhanced with the future period. Furthermore, the statistical analyses for the differences of the stability parameters between no-rain and rain days under the synoptically undisturbed condition in each simulated climate period indicated that the representations of the stability parameters that distinguish no-rain and rain events are basically unchanged between the present and the future climates. This result suggests that the environmental characteristics favorable for afternoon precipitation in the synoptically undisturbed environments will not change under global warming.

Keywords: convective rain, global warming, regional climate, Tokyo, environmental stability