

U022-01

Room:304

Time:May 22 14:20-14:40

Social Experiments on Extreme Weather Resilient Cities

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In 2010, the Japan Science and Technology Agency (JST) started the new program 'Society System Reform Program toward New Society Corresponding to Climate Change' under the 'Special Coordination Funds for Promoting Science and Technology' of the Ministry of Education, Culture, Sports, Science and Technology (MEXT). The program aims to develop elementary technologies that are required not only for reducing greenhouse gases, but also for the adaptation of new societies to the impact of unavoidable global warming. This paper describes the outline and purpose of 'Social Experiments on Extreme Weather Resilient Cities' project, which is one of four research projects adopted by the JST after their screening of forty proposed projects.

It is recognized that large cities with populations of several million people are inherently vulnerable to severe weather events, such as torrential rainfall, lightning, and tornados. Increased occurrences of torrential rain and giant typhoons, due to global warming, can cause extensive damage to large cities. Thus, the development of extreme weather monitoring and prediction systems is urgent. The present research project aims to understand the processes and mechanisms of extreme weather using a dense meteorological observation network in the Tokyo metropolitan district, to develop an extreme weather monitoring and prediction system, and to implement social experiments on extreme weather resilient cities in collaboration with related government institutions, local governments, private companies, and residents.

Keywords: extreme weather, heavy rainfall, radar, nowcast, social experiments, urban flooding

U022-02

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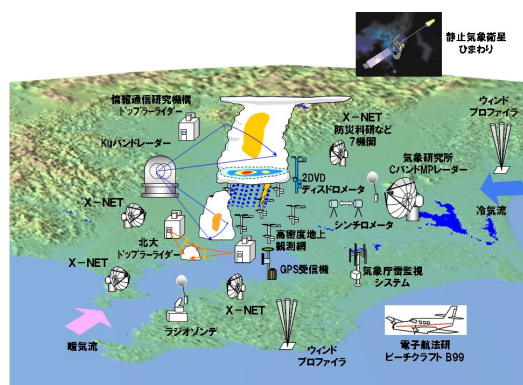
Time:May 22 14:40-15:00

A field campaign project for study of thunderstorm-induced heavy local rainstorms in the Tokyo Metropolitan Area

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A field campaign project will be started from 2011 summer in the Tokyo metropolitan area where 30 million people are living, targeting to reveal the mechanism of initiation and development of thunderstorms evolving in non-organized manner. Thunderstorms occasionally cause heavy local rainstorms in very short period. Urban areas have weakness for such rainstorms due to excess pavement and many buildings. The field experiment consists of an aircraft, a Ku-band very rapid-scan radar, a C-band multiparameter radar, 7X-band radars (X-NET), two Doppler lidars, a 3km-mesh surface meso-net, atmospheric boundary layer measurements, as well as Doppler radar network, two Doppler lidars and GMS rapid-scanning operated by the Japan Meteorological Agency. The field campaign is made as one of three sub-projects under the "Social Experiments on Resilient Cities for Extreme Weather 2010-2014" project funded by The Japan Science and Technology Research Foundation.



Keywords: thunderstorm, dense observation network, urban flooding

Japan Geoscience Union Meeting 2011

(May 22-27 2011 at Makuhari, Chiba, Japan)

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U022-03

Room:304

Time:May 22 15:00-15:20

Introduction of Korean GRL activities for international cooperation field experiments between Korea, Japan and Taiwan

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Environmental atmospheric research such as heavy rainfall and aerosol particles are occurred with severe weather phenomena and transported to Korean peninsula, Japan, Taiwan and China. Natural disasters are concentrated in summer monsoon season in each country and their damages are also increased every year.

Global Research Laboratory of PKNU-HyARC Observation Network for East China Sea (GRL-PHONE) was established on June 1, 2006, for the purpose of reduction and prediction of natural disaster caused by severe weather and understanding of mechanism of heavy precipitation system in the East China Sea. And joint observation research of SoWMEX/TiMREX (Southwest Monsoon Experiment/Terrain-influenced Monsoon Rainfall Experiment) in Taiwan was accomplished to improve the QPE/QPF during monsoon season and we had an intensive field experiment to understand physical process associated with the terrain-influenced heavy precipitation systems near Tokyo metropolitan city. Aerosol particles were observed on the tower of Jeodo ocean research station located in 150km southern area from Jeju to know the fluctuation of oceanic aerosols with horizontal and vertical wind fields.

For these research projects, we continuously plan international field experiments to obtain various data using meteorological instruments such as dual polarimetric radar, AWS, radiosonde, UVW anemometer, rain gauge, LPC aerosol counter, and disdrometers (POSS, Parsivel, JWD and 2DVD).

Keywords: GRL-PHONE, SoWMEX/TiMREX, Terrain-influenced heavy precipitation, Aerosol

U022-04

Room:304

Time:May 22 15:20-15:35

Development of the Phased Array Radar for Meteorological Application

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¹Osaka University, ²Toshiba Corporation, ³NICT

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 range. 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 under developing has the unique capability of scanning the whole sky with 100m and 10 second resolution up to 30 km in a cost effective manner. To achieve this goal, the system adopts the digital beam forming technique for elevation scanning and mechanically rotates the array antenna in azimuth direction within 10 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. In this presentation, concept of the project, current status of the radar development, and some results of the signal processing will be presented.

Keywords: Radar, Thunderstorm

U022-05

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Time:May 22 15:35-15:50

Statistical features of cumulonimbus first echoes generated in the Tokyo Metropolitan Region on mid-summer days

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Heavy rainfall often occurs in the Tokyo Metropolitan Region, Japan during the afternoons on fine mid-summer days. For example, a heavy rainfall event occurred in Nerima-ku, on 21 July 1999 when rain fell at an hourly rate of 131 mm, and heavy rainfalls occasionally occur around the Tokyo Metropolitan Region, with notable peak hourly rainfalls exceeded 50 mm. Such heavy rainfall in the metropolitan region should be seriously considered with respect to disaster mitigation and water circulations in urban areas. X-band Doppler radar observations were carried out to investigate the generation of cumulonimbus in southern Kanto including the Tokyo Metropolitan area on mid-summer days for 9 years.

An initial convective echoes, named as first radar echoes, observed by the radar are discussed in this study. Cumulonimbus echoes are here defined as convective radar echoes of greater than 28 dBZ intensity in the mature stage of the echo. These convective echoes were traced back to the formation echoes or initial convective echoes, defined here as the first echoes of cumulonimbus. Total of 85 days over the 5 years from 1999 to 2008 satisfy the above criteria for mid-summer days, and first echoes were observed for 24 of these 85 days, yielding a total of about 520 first echoes. The mean daily frequency of first echo generation for a 10x10 km mesh area during mid-summer days, which was defined as the standardized number of first echoes per mid-summer days (85 days). Many first echoes were observed over Boso Peninsula and at the foot of Tanzawa mountain regions. It is remarkable that first echoes were also generated over the plain that encompasses Tokyo metropolitan region. In this analysis, many of the first echoes were generated over the mountain areas, with 36% of first echoes occurring around Tanzawa and 16% over Boso Peninsula; 15% occurred over the plain upon which Tokyo metropolitan region is located. The regions with the highest frequencies of first echoes (above 0.2 times/day) were the north to northwest parts of the Tokyo metropolitan region.

The temporal distribution of first echoes denotes the occurrences at different times of the day. The most active period of first echo generation was between 1100 and 1700 JST. In the evening, the frequency of first echoes dropped by half relative to that during the daytime, with few recorded after 2100 JST. Many of the first echoes generated in the metropolitan region were observed between 1400 and 1700 JST. First echoes were generated between 0 and 6 km above ground level (AGL), with 75% generated in the altitude range of 0-3 km. The number of first echoes shows an abrupt decrease above 3 km in elevation, accompanied by a marked change in the dominant regions of origin. The fact that the average height of first echoes at Tanzawa (1.5 km AGL) was much less than that at Tokyo metropolitan region (above 3 km AGL) indicates that the mechanism of convection was different between the mountain region and the metropolitan region.

Keywords: cumulonimbus, first radar echo, Doppler radar, heavy rainfall

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U022-06

Room:304

Time:May 22 15:50-16:05

Realities of Air Temperature Distribution in Summer in Tokyo -Observation results since 2007 to 2009 by METROS-

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We examined the realities of urban heat island phenomena in Tokyo in summer by analyzing data of the high density heat island observation net. As a result, it became clear that the detailed reality of heat island in Tokyo. Main results were as follows. Daily maximum air temperature was high in not only Tokyo wards but also the east part of Tama. On the other hand, ratio of Periods T^{max} over 30C which are said to be closely related to heat disorder was low in Tama and high in the area from central Tokyo toward the northern and northwest area. Numbers of T^{min} over 25Cdays(tropical night) was high in the area from central Tokyo toward Tokyo bay; appeared from late mid-night to early morning. By analyzing relationship between distribution of air temperature and ratio of green space, there was negative correlation, especially tropical night and daily minimum air temperature was higher.

Keywords: Urban Heat Island, Air Temperature Distribution, Ratio of Periods Tmax over 30C, Ratio of Green Space

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U022-07

Room:304

Time:May 22 16:30-16:50

Extreme Weather - From a Sociological Perspective

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In recent years, the disaster information is diversifying, getting more detailed, and sending in real time. The MP Radar provides detailed and real time information.

But often, the results of progresses in disaster information do not be used effectively in the real society.

So, we are looking for the ways to use MP radar effectively through some social experiments. The experiments are proceeded in some autonomies, railway company, construction company, high school, and among the general public.

Keywords: weather, MP Radar, social experiment

U022-08

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Time:May 22 16:50-17:05

Approach on research of heavy rainfall with water disasters using X-MP radar of University of Yamanashi

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Heavy rainfall often causes disasters such as inundations in a river basin and an urban. In the part of the Global COE program of University of Yamanashi, "Evolution of research and education on integrated river basin management in Asian region," the X-band multi-parameter radar was installed in University of Yamanashi (hereafter "the UYR") on April, 2009. The UYR has observed the rainfall phenomena occurred on the Kofu Basin and the surrounding for the fundamental studies of precipitation and the applied researches of the prevention of water disasters since the installation. In this presentation, the observing cases of the UYR, the accuracy of estimation of rainfall amount using the UYR and the study of a disaster risk estimation model using the UYR are introduced.

At present, the UYR carries out the volume scan every 5 minutes for 24 hours. The UYR has observed many precipitating phenomena with three-dimensional structures; the heavy rainfall for a short time associated with a cumulonimbus cloud, the heavy rainfall associated Typhoon and so on. We try to indicate the result of the UYR on the web site in real time. This web site is "<http://www.icre.yamanashi.ac.jp/radar/>."

As one of the cases, a thunderstorm developed on the south part of the Kofu Basin on September 4, 2009 was investigated. From the analyses of polarimetric parameters, the thunderstorm was composed of many tall precipitating cells with solid precipitating particles at the upper part and raindrops at the lower part. One of the precipitating cell brought heavy rainfall of 37 mm in 30 minutes at Furuseki on the south part of the Kofu Basin.

To check the accuracy of the estimation of rainfall amount using the UYR, we compared the surface rainfall intensity derived from rangage at Furuseki and the rainfall intensity over Furuseki estimated using KDP observed by the UYR using the above case. Each temporal variation of rainfall intensity had similar tendency. The normalized error between them was 24 %. In the case between May and October, 2010, the normalized error between the surface rainfall intensity and the rainfall intensity estimated by the UYR was 25 %, which was similar to the above result. Thus, it is suggested that the UYR estimated rainfall intensity with high accuracy.

The rainfall intensity estimated by the UYR is applied to hydrological research. The estimation of runoff was improved using the rainfall intensity estimated by the UYR with high-resolution (Hapsari et al. 2010), which proceeded to estimate the risk of inundation by predicting some ensemble short term rainfall forecast using advection model and singular vector method (Hapsari et al. 2011).

We continue to carry out the fundamental studies of precipitation and the applied researches of the prevention of disasters associated with heavy rainfall based on the fundamental knowledge of precipitation using the UYR.

Keywords: X-MP radar, Heavy rainfall, Estimation of rainfall amount, Prediction of the risk of inundation

U022-09

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Time:May 22 17:05-17:20

Behavior of cold outflow and gust front during a torrential rain occurred in central Tokyo on August 5, 2008

Hideo Takahashi^{1*}, Hiroaki Yamato¹, Shogo Shimizu¹, Sayuri Okubo², Kazuyuki Takahashi³, Hiroto Suzuki⁴

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A center of torrential rain that occurred around noon on August 5, 2008 was located in the vicinity of the boundary of Shinjuku and Bunkyo Wards (109 mm hour⁻¹ was recorded by rain gauge observation). The torrential rain area stagnated there after it headed eastward from the central part of Shinjuku Ward, and brought intense rainfall of ~20 mm (10 min)⁻¹ for about 40 minutes. Marked cold outflows from the torrential rain area were observed both westward and southeastward. The westward cold outflow of which wind velocity was ~3 m s⁻¹ expanded gradually and converged with northerly wind, then another intense rainfall area was formed in the western part of Tokyo wards area. On the other hand, the cold outflow toward the southeast (~7 m s⁻¹) hardly expanded, and a gust front with a large temperature gradient stagnated along the areas of Kanda-Kasumigaseki-Roppongi. According to wind measurements (25 m, 107 m, and 250 m above ground) at the Tokyo Tower near the gust front, though the northwesterly wind that corresponded to the cold outflow was observed in the lower layer, the southeasterly wind from Tokyo Bay toward the intense rainfall area was admitted in the higher layer. It is possible that the stagnation of the gust front in the vicinity of the torrential rain area contributed to stagnate and maintain the torrential rain area through the continuous lifting of the southeasterly wind at the same place. As the gust front stagnated around the overcrowded areas of high-rise buildings such as Kasumigaseki, it should be necessary to examine the effect of large urban canopy on cold outflow and gust front.

Keywords: torrential rain, central Tokyo, cold outflow, gust front, urban canopy

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U022-10

Room:304

Time:May 22 17:20-17:35

Data assimilation experiments of intense rainfall event over western Japan on 28 July 2008 using LETKF system

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We performed data assimilation experiments using data from an intense rainfall event in western Japan on 28 July 2008 with the Local Ensemble Transform Kalman Filter (LETKF) and analyzed fields of the mesoscale 4-dimensional variational assimilation (4DVAR) system of the Japan Meteorological Agency (JMA). We supplemented conventional observation data with precipitable water vapor (PWV) data derived from the Global Positioning System (GPS) Earth Observation Network of the Geospatial Information Authority of Japan. Because the LETKF system assimilates fewer data than the 4DVAR system, ensemble mean fields of the LETKF cycle experiment were replaced with analyzed fields from the 4DVAR system each day at 12 UTC. PWV values were converted to relative humidity profiles for assimilation by the LETKF. The addition of PWV data tended to increase low-level water vapor and improve the precipitation forecast. We attempted to reproduce the intense rainfall band using downscale forecast experiments with the JMA non-hydrostatic model (JMANHM) with grid spacings of 5 km and 1.6 km. The experiment with 5-km resolution generated a rainfall band in western Japan that was not reproduced using conventional data, although the rainfall was smaller than observations. The experiment with 1.6-km resolution faithfully reproduced the observed band of intense rainfall.

Keywords: GPS-derived precipitable water vapor, Data assimilation, Mesoscale ensemble forecast, Heavy rainfall, LETKF

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U022-11

Room:304

Time:May 22 17:35-17:50

Forecast Experiment of Landslides Using a Cloud-Resolving Model -Case Study of Typhoon 0422-

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¹NIED, Japan

Forecast experiment of landslides caused by Typhoon 0422 in Yokohama city is performed by coupling a cloud-resolving model and an estimation model for occurrence of landslide disasters. Results of 11-hour forecast using initial data before the land on of the typhoon agreed well with the observation as for the typhoon track, but forecast of accumulated rainfall was underestimated by 33%. The success ratio of landslide forecast was 9.4% smaller than that estimated by Radar-AMeDAS rainfall analysis.

Keywords: rainfall, landslide, forecast

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U022-12

Room:304

Time:May 22 17:50-18:05

Wind gust phenomena observed by the X-NET (X-band weather radar network)

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¹Nat. Res. Inst. Earth Sci Disaster Prev., ²Japan Weather Association, ³DPRI, Univ. Kyoto, ⁴AES

The X-NET is the weather radar network at X-band which is composed of radars in several institutes and universities. Recently, Ministry of Land, Infrastructure, Transport and Tourism are going to place X-band multi-parameter (MP) radars mainly in urban areas and try to open the rainfall information observed by the radars in their web site. Distribution of the wind information is prospected in the near future. Here, we introduce several cases of wind gust phenomena observed by the X-NET.

On 12 July 2008 around 15 JST, gust winds caused some damages to woods and structures in the Tokyo Metropolitan areas, such as Shibuya, Meguro, Minato and Kohtoh wards. From surveys and analysis of a Doppler radar data, Japan Meteorological Agency (JMA) judged that the gust was associated with a downburst. The storm was well observed by two MP radars which has been operated in Ebina city and Kisarazu city by NIED. The observation results showed that the storm started from Tama area and moved easterly. The convective cells have features of multi-cell types and hail stones aloft.

Tornadoes caused 21 injuries and damages to many houses and cars in Tatebayashi city, Japan, at around 14 JST on 27 July, 2009. The storm was captured by the X-band Doppler radar located in Hanyu city, about 10 km to the east from the damaged area, which is one of radars of the X-NET and operated by Japan Weather Association (JWA). The radar observation revealed the multi-cell structure of the storm, existence of a gust front. Strong vortices were identified in the area of main damage and the other area where a house had damages. They seemed to occur on the gust front.

Keywords: X band radar, downburst, tornado, observation, multi-parameter

U022-13

Room:304

Time:May 22 18:05-18:20

Nowcast of high winds by using X-band doppler radar network

Yasushi SUZUKI^{1*}, Yuri MICHIIHIRO¹, Aritoshi MASUDA², Takeshi MORIYA², Masayuki MAKI³, Takeshi MAESAKA³, Shingo SHIMIZU³, Shin-ichi SUZUKI³

¹DPRI, Kyoto University, ²JWA, ³NIED

1. Introduction

In order to reduce wind disasters, development of the wind monitoring and forecasting method is urgently needed. But it is difficult to predict gust winds by the physical meteorological models. So, as a method to compensate for it, an effective method based on monitoring and prediction by using the observed Doppler winds was proposed. For the purpose of short range forecast of high winds, a new high wind nowcasting method was developed, and its results were verified.

2. Methodology

2.1 Outline of the high wind nowcasting method

The input data are the observed wind speed and direction from the X-band Doppler radar network (X-NET). The resolution of wind data is 500m mesh and 5 minute interval. The high wind nowcasting method has the following steps: 1) motion vector calculation, 2) wind area extrapolation in time, 3) estimation of the surface wind speed. The output is the occurrence time and location of high wind areas up to one hour after the initial time. As for the motion vector calculation, the coefficients of the advection model are estimated from the last three time steps observed data. The high wind areas are linearly extrapolated by using the advection model. As for the estimation of the surface wind speed, wind speeds at the 1000m altitude are corrected of its bias from the initial value. If there is no initial observation, the logarithmic law of the wind profile is applied.

The motion vector calculation was applied to the high winds areas (15m/s or more). As a result, we were able to satisfactorily reproduce the moving direction and velocity. In addition, to avoid the risk of missing a high wind prediction by using weak wind observations, we decided to focus on the high wind areas as a prediction target.

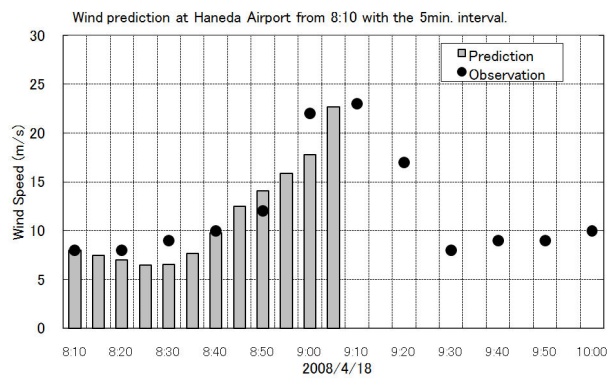
2.2 Verification by the case study

Wind disasters on April 18, 2008 in the Kanto district were verified. High winds associated with the front line of the cyclone caused the wind disasters throughout the Kanagawa and Chiba from 7am to 10am. The nowcast method was applied to this case. The figure shows the comparison of the predicted high winds with the observation at the Haneda Airport. The prediction has good correspondence with the observation. Wind speed at around 8:45 becomes 10m/s over, and then suddenly wind speed exceeds 20m/s at 9:00. The phenomena is almost accurately predicted before about an hour. There are remarkable positive correlation between the 50 minute lag prediction and the observation. The correlation coefficient is 0.81, and the RMS error is 3.9m/s. The relative wind speed error is estimated about 20% against 20m/s wind speed. The prediction has sufficient accuracy for the practical use.

3. Conclusion

By this study, the high wind nowcasting method by using the Doppler radar data was found to be effective as a supplement to the short range forecast, where the physical meteorological models have weak points. However, the subjected case in this study due to the movement of the front is easy to calculate the relative motion vector. In the future, accumulation of case studies by the winds of other meteorological events is necessary for the accurate verification of the high wind nowcasting method. In addition, a data assimilation method with the meteorological models is necessary in order to cover the missing area by the Doppler wind observations.

Acknowledgement: This study was supported by the Special Coordination Funds for Promoting Science and Technology of Japan Science and Technology Agency.



Keywords: nowcasting method, gust wind, X-band doppler radar, X-NET

Japan Geoscience Union Meeting 2011

(May 22-27 2011 at Makuhari, Chiba, Japan)

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U022-P01

Room:Convention Hall

Time:May 22 10:30-13:00

X-band Polarimetric Doppler Radar Network in the Tokyo Metropolitan Area (X-NET)

Masayuki Maki^{1*}, Tsuyoshi Maesaka¹, Koyuru Iwanami¹, Ryohei Misumi¹, Shin-ichi Suzuki¹, Atsushi Kato¹, Shingo Simizu¹, Namiko Sakurai¹, Dong-Soon Kim¹, Yukari Shusse¹, Kohin Hirano¹, Tadashi Yamada², Fumiaki Kobayashi³, Tetsuya Sano⁴, Kengo Sunada⁴, Takeshi Moriya⁵, Akihiko Yamaji⁵, Soichiro Sugimoto⁶, Hiromaru Hiraguchi⁶, Shinya Kawada⁷, Mamoru Yoshii⁷, Dong-In Lee⁸, Kaori Kieda⁹, Ayumi Hoshi⁹

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Since 2006, the National Research Institute for Earth Science and Disaster Prevention has been implementing an advanced X-band radar network, named X-NET, to mitigate urban disasters caused by severe storms. The research radars comprising the X-NET are five polarimetric Doppler radars and three Doppler radars. The goals of X-NET are to develop real-time processing of networked radar data and to provide end-users with the high-resolution precipitation and wind data that are necessary to understand severe storm development mechanisms, improve forecasting accuracy, and develop new urban disaster warning systems. The characteristic of the X-NET are; 1) radar network utilizing an advanced telecommunication network in urban areas, 2) immediate and economical efficiency using existing research radar facilities, 3) the test-bed is the Tokyo Metropolitan Area, where around 30 million people reside, 4) collaboration with end-users (scientists, administrative officers at the disaster prevention coordination divisions of national and local governments, private weather companies, etc.) through an interactive exchange of information, 5) contribution to the operational polarimetric radar networks of the Ministry of Land, Infrastructure, Transport and Tourism, which will be in operation in the Tokyo, Nagoya, Osaka metropolitan and Hokuriku areas in 2010.

Keywords: multi-parameter radar, network, torrential rain, precipitation, strong wind

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U022-P02

Room:Convention Hall

Time:May 22 10:30-13:00

Data processing of MLIT X-band MP radar

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¹NIED, ²NILIM, ³AES

Flood disasters caused by localized heavy rainfall frequently occurred in July and August 2008. National Research Institute for Earth Science and Disaster Prevention's (NIED's) results on monitoring of the heavy rainfall and severe wind by using X-band multi-parameter (MP) radar boosted Ministry of Land, Infrastructure, Transport and Tourism (MLIT) to start deploying the X-band MP radars in Japan. They deployed 11 radars in Tokyo, Nagoya, Kinki, Hokuriku areas in FY 2009, and are deploying 15 radars in other areas in FY 2010. 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 commission from National Institute for Land and Infrastructure Management (NILIM), MLIT.

The observed radar data are transferred to two data processing centers in Kanto and Kinki Regional Development Bureaus, MLIT, and the same processing is done for redundancy in these two centers. After a quality control of the received radar data is performed, K_{DP} is estimated by a differentiation of PHI_{DP} , which is filtered by two different FIR filter for removing the local phase shift by strong backscattering and smoothing. As radio wave attenuation by rainfall is not negligible in X-band, the attenuation is estimated from the K_{DP} to correct Z_H and Z_{DR} . The attenuation is also used for determining radio wave extinction areas, where the radar cannot detect the received power from the precipitation by the rainfall attenuation. Finally, the precipitation intensity is estimated with Z-R and K_{DP} -R relationships. The estimated rainfall data are immediately sent to compositing server. The data of radars that belong to the same area are composited into a quarter third mesh (with a resolution of about 250 m). For this compositing, the modified Cressman interpolation method, which also considers with a weight that becomes greater with the decrease of the height above the ground, is used. These procedures are performed with parallel computing to finish the calculations in several seconds.

The precipitation information calculated by this system is tentatively provided by MLIT since July 2010. The accurate information updated every minute is sure to contribute to the monitoring of extreme weather in urban areas.

Keywords: MP radar, X-band, MLIT

U022-P03

Room:Convention Hall

Time:May 22 10:30-13:00

Correction of Radar Reflectivity and Differential Reflectivity for Rain Attenuation at X-band

Dong-Soon Kim^{1*}, Masayuki Maki¹, Dong-In Lee², Shingo Shimizu¹, Maesaka Takeshi¹, Koyuru Iwanami¹

¹NIED, Japan, ²PKNNU, Korea

Rain attenuation correction is very important to obtain accurate radar reflectivity Z_H and differential reflectivity Z_{DR} , particularly with the X-band wavelength radar. In the case of a dual-polarized radar, Z_H and Z_{DR} can easily be corrected by differential propagation phase measurement (K_{DP} or PHI_{DP}), because phase measurements are not affected by attenuation or calibration errors. In the self-consistent method with constraints proposed by Bringi et al. (2001), an optimal value (alpha) for the specific coefficient between K_{DP} and specific attenuation at h-polarization A_H ($A_H = \alpha * K_{DP}$) is determined by employing a minimization process for each beam of the radar. However, the specific coefficient alpha can vary widely, mainly as a result of natural variations in DSD, temperature, and drop shape in a precipitation system.

The shifted self-consistent (SSC) algorithm based on the self-consistent method for rain-attenuation correction of reflectivity Z_H and differential reflectivity Z_{DR} are presented for X-band polarimetric radar. This SSC algorithm calculates the optimum coefficients for the relation A_H - K_{DP} , every 1 km along a slant range. The advantage of this method is that the natural distribution of DSD along the range of radar can be represented by the optimum alpha distribution. The attenuation-corrected Z_{DR} is calculated from reflectivity at horizontal polarization and from reflectivity at vertical polarization after attenuation correction. The SSC algorithm is applied to RHI (range-height indicator) scans as well as PPI (plan position indicator) volume scan data observed by X-band wavelength (MP-X) radar, as operated by the National Research Institute for Earth Science and Disaster Prevention (NIED) in Japan. The corrected Z_H and Z_{DR} values are in good agreement with those calculated from the drop size distribution (DSD) measured by disdrometers. The developed attenuation correction algorithm can be applied to various situations observed by the NIED MP-X radar.

Keywords: Rain attenuation correction, X-band Polarimetric radar, Reflectivity, Differential reflectivity, Specific attenuation, Differential propagation phase

Japan Geoscience Union Meeting 2011

(May 22-27 2011 at Makuhari, Chiba, Japan)

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U022-P04

Room:Convention Hall

Time:May 22 10:30-13:00

A plan of experimental flights to observe atmospheric conditions for study of severe weather over Kanto area

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¹Electronic Navigation Research Institute

A research project (2010 ? 2014) for development and society experiments of avoidable systems against severe weather disasters around Tokyo metropolitan area is now conducted in cooperation of over twenty organizations (the representative organization: National Research Institute for Earth Science and Disaster Prevention). This project is supported by a grant from the Ministry of Education, Culture, Sports, Science and Technology and consists of three subthemes, which are study of growth mechanism of disturbances with a dense observational network (Subtheme 1), development of disaster prediction system (Subtheme 2) and society experiments (Subtheme3). ENRI participates in Subthemes 1 and 2 and has a plan to observe atmospheric conditions by ENRI's experimental aircraft (Beechcraft 99 Airliner) in Subtheme 1 especially to investigate spatial distribution of water vapor over Kanto area before severe weather occurs in summer. Flight experiments with a cooperation of ground-based measurement systems are coordinated. In this presentation, summary of aircraft equipment and flight plans for metrological observation will be shown.

Keywords: Severe weather, Atmospheric observation, Experimental flight, Water vapor, Spatial distribution

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U022-P05

Room:Convention Hall

Time:May 22 10:30-13:00

Wind field disturbances in the boundary layer over Tokyo suburban area observed with NICT coherent Doppoler lidar

Yasuhiro Murayama^{1*}, Hironori Iwai¹, Ryoko Oda¹, Shoken Ishii¹, Kohei Mizutani¹, Shin'ya Sekizawa¹

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Coherent Doppler lidar is capable of detecting radial wind velocity with error of 0.1-0.2 m/s which is comparable to wind profiler radar errors, by using aerosols in the boundary layer as scsatterer or laser beam's target. Laser beam scan enables us to monitor temporal evolution of disturbed wind fields in the height range from the ground surface to several kilometers. In this study we have analyzed radial wind velocity fluctuation components at the 0-2 km heights, extracted from the Doppler lidar observation on 2 February 2009. Beam scan was carried out in the vertical plane in the north-east direction.

Time series of the height-range cross-section of radial wind speed show that a structure with the 800-m depth standing up from the ground moved toward the lidar with the speed similar to the background wind of 2-3 m/s. The structure may be a thermal or plume flown by the back ground wind field. Associated wind velocity fluctuations are larger around the height of 0.8-1.2 km, where the background wind (radial component) has larger wind shear in the beam scan azimuth direction.

Further analysis is planned to clarify wind disturbance inhomogeneity and/or anisotropy, which may cause significant bias error in wind profiling or VAD technique and dual-beam method of momentum flux estimation used in wind profiler radar and Doppler lidar observations.

Keywords: boundary layer, Doppler lidar, thermal, turbulence

U022-P06

Room:Convention Hall

Time:May 22 10:30-13:00

Structure of nocturnal turbulent mixing in Tokyo

Ryoko Oda^{1*}, Hironori Iwai¹, Shinsuke Satoh¹, Shinya Sekizawa¹, Shoken Ishii¹, Kohei Mizutani¹, Yasuhiro Murayama¹

¹NICT

Localized heavy rain is one of the serious atmospheric environmental issues in urban area. Some recent studies have indicated a possibility that vertical wind velocity is enhanced in the build-up area due to their large roughness and trigger localized heavy rainfall. However, the contribution of the building roughness on the turbulent process is not fully understood especially concerning the height of the mechanical mixing and its time-scale since the field observation has not been enough conducted.

In this study, Doppler lidar measurement was conducted in urban area to investigate the characteristics of the turbulent mixing process during nocturnal periods. The Doppler lidar developed by National Institute of Information and Communications Technology (NICT) is stationed on the rooftop of NICT's building at Koganei-shi, Tokyo.

Vertical distribution of the vertical velocity was measured above 150m from the ground. This experiment was carried out in February and October 2010. The horizontal wind and temperature profile were also measured by radiosonde during the same experimental period.

The timescale of the mechanical turbulence was about seconds to few minutes up to 300m from the ground, in which nocturnal jet has a maximum wind speed (neutral case). In case of the stably thermal stratification which extends from 100 to 300m at close to the ground, the mixing height cannot be explicitly determined from the turbulent signals obtained by the Doppler lidar measurement. These results indicate that the mixing height determined by the Doppler lidar measurement depends strongly on the meso-scale atmospheric condition.

In the presentation, a nocturnal turbulent mixing determined from the Doppler lidar measurement and that from the in situ sonic anemometer measurement at 60m on the NICT's tower are compared.

Keywords: nocturnal turbulent mixing, Doppler Lidar, roughness, urban

U022-P07

Room:Convention Hall

Time:May 22 10:30-13:00

Mitigation effect of small paddy fields in urban area on summer temperature

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Because of development of building lots, mixing of paddy fields and building estates is distinguished in rapid population growth area. Since paddy fields have high effect on mitigation of temperature, now urban heat island is viewed with suspicion, it is the critical issue how maintain paddy fields and how to make effective use of them. To solve these problems, it may make more sense for us to reveal the scale and layout of paddy fields that effective for mitigation of temperature. So this report intends to reveal the feature of mitigation effect on temperature of small paddy fields that exist in urban area.

Moving temperature observation was conducted at the surrounding area of Nonoichi town hall, Ishikawa Prefecture where large suburban paddy fields and small paddy fields that are mixed with building estates. As a result, distinct low-temperature range appeared at night and it spread 7.5 times as large as the total area of paddy fields. Then it was revealed that even small paddy fields have efficient effect on mitigation of temperature, if they exist at proper intervals. Besides heat balance observations at the small paddy field suggest that small paddy field have a greater tendency to exert mitigation effect at night than during daytime, because advection from urban zone have greater influence on small paddy fields during daytime than during nighttime. Furthermore it was suggested that mitigation effect fluctuate by growing stage of rice plants. That is, the mitigation effect of small paddy fields that are scattered consecutively is very efficient but not constant. So, it is the most effective way for mitigation of temperature to spread small paddy field consecutively over the leeward side of large suburban paddy fields.

Keywords: paddy field, mitigation effect on temperature, urban heat island, heat balance, moving observation

U022-P08

Room:Convention Hall

Time:May 22 10:30-13:00

Case study on the evolution of a severe thunderstorm observed in the south of Saitama Prefecture on 29 June, 2010

Namiko Sakurai^{1*}, shingo shimizu¹, Koyuru Iwanami¹, Takeshi Maesaka¹, Ryohei Misumi¹, Atsushi Kato¹, Shin-ichi Suzuki¹, Kaori Kieda², Masayuki Maki¹

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The evolution and structure of the convective system that caused widespread power outages and heavy rainfall in the south of Saitama Prefecture, Kanto, Japan on 29 June 2010 were investigated using two X-band polarimetric radars, a C-band Doppler radar, and dataset of cloud-to-ground (CG) lightning strike locations.

The convective system developed from 1930 LT in the southwestern part of Saitama Prefecture and migrated eastward slowly at a speed of about 2.5 m/s. The system matured during 2030 and 2100 LT and caused heavy rainfall (62.5 mm/hr from 2020 to 2120LT) at Tokorozawa. The system decayed after 2100 JST, when its migration speed was accelerated than that in mature stage.

Three dimensional wind fields of the system in the mature stage were investigated by triple Doppler radar analysis. Northerly and easterly winds were dominant in the northern side of the system, and southerly wind dominated in the southern side of the system. These different winds converged around the center of the system, and caused updrafts to the south of the convergence region. In contrast, downdrafts were dominant in the northern side of the convergence region. Consequently, the system had suitable structure for maintaining the system for long time since updraft region and downdraft one were separated. After 2100 LT, the area of northerly wind associated with the downdraft was expanded and southerly wind became weaker, thereby causing the decay of the system.

Associated with the heavy rainfall around Tokorozawa, 1,068 CG lightning were observed during 2009 and 2209 LT. Most of the lightning had negative charge. The peak time of the number of the negative lightning (the positive lightning) was around 2040 LT (2035 LT), corresponding to the mature stage of the system and widespread power outages. The lightning was mainly observed in the north-side region of radar reflectivity core of the system where the downdraft was dominated.

This study provided preliminary results of the structure and evolution of the convective system observed in the southern part of Saitama Prefecture on 29 June, 2010 using triple Doppler radar analysis and CG lightning dataset. Utilizing these radar data, the relationship of CG lightning strikes to polarimetric radar parameters or the stages of updraft/downdraft evolution will be investigated.

Keywords: thunderstorm, lightning

U022-P09

Room:Convention Hall

Time:May 22 10:30-13:00

Doppler lidar and wind profiler observation of a localized heavy rainfall event on 5 July 2010

Hironori Iwai^{1*}, Yasuhiro Murayama¹, Shinya Sekizawa¹, Katsuhiro Nakagawa¹, Ryoko Oda¹, Shoken Ishii¹, Kohei Mizutani¹

¹NICT

Heavy rainfall increasingly occurred last decades, and urban floods caused by those events. Localized rainfalls are often observed, which has been also increasingly of concern to the general society. Such heavy rainfall has small horizontal scales of 1-10 km, occurring in apparently a random manner in a course of cloud system development, thus forecasting those events is a subject of meteorological research. Doppler radars can observe regions and temporal development of the rainfall events in detail, however non-precipitation region around the rainfall region could not be studied because of little observation therein. Once we can observe wind field surrounding the rain region, air circulation in and out of the cloud and precipitation systems is expected to significantly improve the model, and thus would contribute to improvement of forecasting of the localized rainfall events. There have been significant advances in Doppler lidar and wind profiler, which can observe wind fields under clear air conditions or non-precipitation. So those instruments are expected to improve forecasting the small-scale cloud and precipitation systems. In this study, we will show the NICT Doppler lidar and wind profiler observation results of a localized heavy rainfall that occurred on 5 July 2010 in the Tokyo metropolitan area.

A coherent 2-micron differential absorption and wind Doppler lidar was developed by NICT to measure CO₂ concentration and radial wind velocity. Wind profilers to which the radio interference reduction techniques such as digital coding and frequency multiplexing are applied were also developed to measure radial wind velocity in the lower troposphere. The Doppler lidar and wind profilers were deployed at the NICT headquarters located in the Tokyo metropolitan area. The Doppler lidar performed plane position indicator scans (horizontal scan) at a 4-degree elevation angle which provided information about the horizontal variability below several hundred meters above ground level (AGL). The wind profilers were operated in Doppler beam swinging mode at a 14-degree zenith angle which provided information about the horizontal and vertical wind up to 8 km AGL. The rainfall data used for the present study comes from the operational X-band polarimetric radar networks of the River Bureau, Ministry of Land, Infrastructure, Transport and Tourism.

A heavy rainfall area moved eastward across the central part of Kanto Plain from 15 JST to 21 JST on 5 July 2010 and came close to the observation site at about 18 JST. Both Doppler lidar and wind profiler observed that the southeasterly wind blowing toward the heavy rainfall area gradually intensified at several hundred meters AGL. In presentation, we will show the results of detailed analysis of the heavy rainfall.

Keywords: Doppler lidar, Wind profiler, Localized heavy rainfall

U022-P10

Room:Convention Hall

Time:May 22 10:30-13:00

Behavior of precipitation cores in the 5 July 2010 torrential rainfall system in northern Tokyo

Yukari Shusse^{1*}, Masayuki Maki¹, Koyuru Iwanami¹, Ryohei Misumi¹, Shinichi Suzuki¹, Atsushi Kato¹, Takeshi Maesaka¹, Shingo Shimizu¹, Kohin Hirano¹, Namiko Sakurai¹, Kaori Kieda²

¹NIED, ²A. E. S

Local torrential rainfall event occurred on 5 July 2010 in northern Tokyo. Shakujii river basin was flooded by the rainfall event. National Research Institute for Earth Science and Disaster Prevention (NIED) conducted two X-band polarimetric radar observation for a rainfall system that caused the local heavy rainfall.

The rainfall system appeared around 14 LST (LST = UTC + 9h) in the western Tokyo, and propagated eastward, then disappeared on around the border among Tokyo, Saitama, and Chiba Prefectures at around 22 LST. The rainfall system showed significant intensification at around 1730 and 1930 LST. Heavy rainfall in Shakujii river basin was associated with the development at around 1930 LST. Echo-top heights of 20 dBZ at these intense periods were about 7-km altitude each. The height of precipitation cores were from 2 to 3-km altitudes. Values of differential reflectivity (Z_{DR}) in the precipitation cores were larger than 3.5 dB, and those of specific differential phase (K_{DP}) were larger than 9deg km^{-1} . These values indicate that the precipitation cores in the intense periods of this rainfall system contained a number of large raindrops.

Horizontal distributions of accumulated rainfall amount in two periods, A) from 1520 to 1850 LST and B) from 1850 to 2120 LST which include two intense periods each, are compared to examine the characteristics of the rainfall system. In period B, intense rainfall area with accumulated rainfall amount more than 60 mm was concentrated in a smaller area (20km(east-west) x 5km(north-south)) than in period A. Around Nerima Ward, accumulated rainfall amount more than 100 mm was observed in period B. In this study, behavior of precipitation cores appeared and developed in the of concentrated heavy rainfall area in period B.

Three-dimensional distribution of polarimetric radar measurements and wind fields indicate that the multiple precipitation cores aligned in the east-west direction in the concentrated heavy rainfall area in period B. The precipitation cores in the area moved eastward slowly. But several new precipitation cores appeared in the west (upshear) side of the preexisted precipitation cores. In consequence, intense rainfall area in the precipitation system was stalled in the Shakujii river basin.

Keywords: Local heavy rainfall, Urban flood, Polarimetric radar

U022-P11

Room: Convention Hall

Time: May 22 10:30-13:00

Short-range forecast using MPradar network and 3DVAR assimilation for the heavy rainfall in north Tokyo on July 5th 2010

shingo shimizu^{1*}, Masayuki Maki¹, Takeshi Maesaka¹, Koyuru Iwanami¹, Seiichi Shimada¹

¹NIED

Title : Short-range forecast using MP-radar network and 3DVAR assimilation for the heavy rainfall in north Tokyo on July 5th 2010

National Research Institute for Earth Science and Disaster Prevention, Japan (NIED) designed a real-time radar network (X-NET) consisting of MP radars and Doppler radars over Kanto Plain, Japan. We developed a real-time 3DVAR assimilation system using radial velocity of radar and GPS precipitable water (PWV) for a short-range (up to 1-3 hours) forecast of severe weather. The 3DVAR assimilation procedure was developed in non-hydrostatic cloud-resolving storm simulation (CReSS) model. A thunderstorm observed in 5th July 2010 was simulated with radial velocity and precipitable water vapor derived from GPS assimilation.

The thunderstorm provided heavy rainfall (107 mm/hr) at Itabashi city from 19:30 to 20:30 Japan Standard Time (JST). The thunderstorm rapidly developed from 17:00 to 19:00 JST. We tried to forecast the heavy rainfall between 19:00 and 20:00 JST using initial condition obtained at 18:00 JST. From 18:00 to 18:30 JST, the thunderstorm was gradually dissipated, but it soon developed again after 18:30 JST. Therefore, short-range forecast around 18:00 JST such as a nowcasting that assumes the conservation of rainfall area and constant migration speed would be difficult for such thunderstorms with large temporal variation of rainfall. 3DVAR assimilation is one of most suitable method for the short-range forecast of such non-steady thunderstorms in terms of calculation cost.

Optimization for our 3DVAR was implemented by Limited-memory quasi-Newton method (L-BFGS), which provides optical state quickly with small iterations. It takes only a few minutes to obtain optical initial condition. CReSS users can optionally use Semi-Lagrangian advection scheme to utilize large time-step for reducing calculation times for real-time forecasting. As a result, it takes 10-15 minutes for the forecast up to 4 hours with 3DVAR initialization. GPS-PWV dataset is available after about one-hour. Therefore, GPS-PWV-3DVAR provides forecast starting from 1 hour and a few tens of minutes to 4 hours.

Figure 1 shows radar observation (Fig. 1a), control run (no assimilation experiment: Fig. 1b), 3DVAR forecast (Fig. 1c) and increment of vapor by GPS-PWV 3DVAR (Fig. 1d) at 19:20 JST. The increment of vapor around Itabashi city (Fig. 1d) and wind convergence at lower level (not shown) improved the forecasted location of severe thunderstorm rather than CNTL (Fig 1b and 1c). Further improvements (e.g., assimilation of radar reflectivity) should be made for accurate forecast of severe thunderstorm.

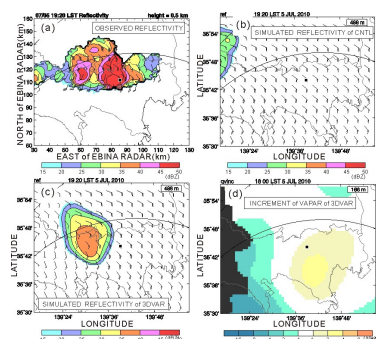


Fig. 1 (a) observed radar reflectivity at 19:20 JST at a height of 500 m, (b) simulated radar reflectivity in control run, (c) simulated radar reflectivity in GPS-PWV and WIND 3DVAR, and (d) increment of vapor at 1600m at 18:00 JST in GPS-PWV 3DVAR

Keywords: MPradar, 3DVAR, Doppler velocity, GPS precipitable water

U022-P12

Room:Convention Hall

Time:May 22 10:30-13:00

Typhoon Disaster Database System

Takahiro Kayahara^{1*}, Shinya Shimokawa¹

¹NIED

When typhoon disasters occurred, the organizations for disaster management of national and local governments corrected the disaster information, and published the disaster reports. Information on past typhoon disasters is important for mitigation of future disasters. The disaster reports published by the organizations are stored in the public libraries. Some reports are found on the Web page of the organizations. However, these reports are widely distributed, it is very difficult to see many reports. Therefore, we have developed the typhoon disaster database system (<http://ccwd05.bosai.go.jp/DTD/>) to store data on typhoons and associated disasters in Japan. Anyone can access the system through the internet.

The system is composed of 3 servers, the database server, the geographic information system (GIS) server, Web server. The database server stores information on typhoons and associated disasters occurred in Japan since 1951, list of disaster reports, list of organizations for disaster management of local governments, and list of typhoon or disaster homepage. The GIS server provides GIS functions which display information with regard to typhoon tracks and disasters on a map through web browser.

The database stores the typhoon number, name, GLIDE number, track data, central pressure, maximum wind speed, outline, sea level pressure map, satellite image map, precipitation map for typhoon related information. The database also stores the affected area address, date, the kind of disaster, damage number, and outline of damage.

We can search the typhoon and associated disasters in Japan, and browse these information on web browser. We can select typhoon to specify typhoon number or name, period, the affected area, or typhoon passing points. The outline page of selected typhoon shows information of the description of typhoon, maps, and time series line graphs of the central pressure and the maximum wind speed. The geographical information page of selected typhoons shows typhoon tracks and the affected area and/or damaged points of associated disasters by using WebGIS functions.

We will continue to collect and store information of typhoon and associated disaster, and we have a plan to update the hardware and software to contribute to provide the typhoon disaster information.

Keywords: Typhoon disasters, Database, Internet, WebGIS

U022-P13

Room:Convention Hall

Time:May 22 10:30-13:00

Marginary for the engineering works of the urban flood

Naomi Ando^{1*}

¹NPO River Basin

In our country where a lot of people have come to live from the convenience of traffic and the industrial production in the flood plain, the measure that confines the water as much as possible and flows out early has been taken. Moreover, the drainage road (newer rain water sewage separation type) is maintained upper and lower water service for the city resident's drinking water securing, usually decreases the river flow rate in normal circumstances.

River and sewage improvement have designed to have capacity to flow in probability rainfall according to regional importance. Probability rainfalls have been calculated from rainfall data of meteorological observatory where the data of the amount of rainfall per hour becomes complete for years by the diagram and the expression is made to flow. According to the importance of the basin, kinematical wave method to reflect land-use, reservoir function to reflect dam, or the distribution type model considering saturation etc.

Such rivers have protected to overflow flood up to the probability rainfall, not a few concreted three sides, deep bed though is also the criticism on an environmental side. Where main stream banks are too high to flow down drainage the pumps must be operated to prevent inland water disaster. The city hardened with concrete evaporates at once the moisture of the soil, and becomes it is easy to cause the heat island phenomenon. After 1997 The river law mending, in main river basins plans are researched. Even the overall plan it is assumed to be a public works reduction in nonessential from financial matters, and it is the realities to require the long tract of years.

The flood control that doesn't depend on a dam alone is said, and as for the report of IPCC, an extreme phenomenon such as extremely big rain and winds comes to happen frequently by global warming, and correspondence to the flood that exceeds what decided in year of the probability is requested. Overflow bank, flood hazard maps, river rangers, etc. are taken for the river of general people becomes familiar, but many people are interesting only in own house soak down, own child drowned in a river to death or the purchase of the apartment house landscape etc.

Removing barrier earth science and engineering, it is quite important to catch hazard rainfall by the residents. In the education of the physical geography of the elementary school to be taken, and to change because of not only piling up and the transportation action but also the erosion of the river and diastrophism due to the earthquake. When the danger of becoming it impossibility for my house to run away by being flooded up to the second floor or the levee breach judged because there is a possibility that the house collapses high when hazard rain falls, where outside the house should run away or does it run away to the second floor and does it only have to be given the thing?

Catching and the forecast system of the rainfall go up by improving the concept and the physical forecasting of radar that can catch the narrow zone accuracy, there is a possibility to be able to use if regional reception facilities that can be used with resident's senses are installed. A real-time display of the rainfall and the water level is also advanced, and it is useful for the river user though the observation of the temperature and the wind is little in the diplomatic relation ministry.

Take shelter to a private building such as apartment houses and offices should be likely to be done if there is no public, high building to be near. It is necessary to set the right by sectional surface.

Ohtaki-Dam extreme rainfall experience and rescue training in canoe or fishing are useful to raise five senses to catch hazards rain and flow.

Considering more harmful debris hazards, ground water center flow notion which sucking out soil pore moving up water pressure is important.

Keywords: City flood flow, soil moisture, hazard rainfall, the five senses education, refuge compensation, ground water stream