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

U022-01 Room:304 Time:May 22 14:20-14:40

Social Experiments on Extreme Weather Resilient Cities

Masayuki Maki[1*], Ryohei Misumi[1], Shin-ichi Suzuki[1], Takeshi Maesaka[1], Atsushi Kato[1], Takahiro Kayahara[1], Shingo Shimizu[1], Tsuyoshi Wakatsuki[1], Yukari Shusse[1], Kohin Hirano[1], Takeshi Nakatani[1], Koyuru Iwanami[1], Namiko Sakurai[1], Dong-Soon Kim[1], Masayo Ishihara[2], Isao Nakamura[3], Atsushi Hattori[4], Syuichi Tuchiya[4], Takuma Kato[4], Akihijo Yamaji[5], Yasuhiro Murayama[6], Takayuki Yoshiwara[7], Yasushi Fujiyoshi[8], Yasushi Suzuki[9], Tomoo Ushio[10], Kengo Sunada[11], Tadashi Yamada[12], Hiromichi Nakamori[13], Fumiaki Kobayashi[14], Hitoshi Yokoyama[15], Hiromaru Hiraguchi[16], Masanao Tamura[17], Shinya Kawada[17], Mamoru Yoshii[17], Michitaka Ikenoya[18], Akira Hayashi[19], Nobuyuki Tsuchiy[20], Asako Togari[21], Muneharu Goto[22], Kiyotoshi Otsuka [23], Masakazu Wada[24], Dong-In Lee[25], V. Chandrasekar[26]

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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

Japan Geoscience Union Meeting 2011
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U022-02 Room:304 Time:May 22 14:40-15:00

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

Masahito Ishihara[1*], Takahisa Kobayashi[1], Osamu Suzuki[1]

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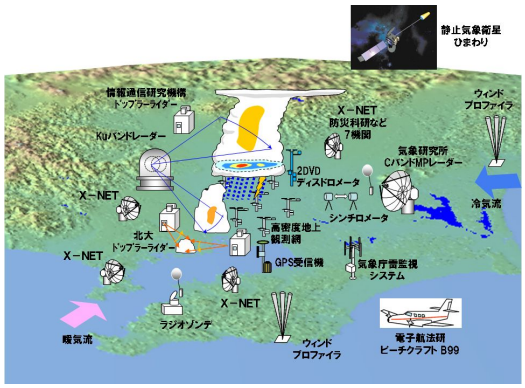
A field campaign project will be started from 2011 summer in the Tokyo metropolitan area where 30 million people are living, targeting to reveal the mechanism of initiation and development of thunderstorms evolving in non-organized manner. Thunderstorms occasionally cause heavy local rainstorms in very 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 liders 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
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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

Dong-In Lee[1*], Hiroshi Uyeda[2], Ben Jong-Dao Jou[3], Masayuki Maki[4], Yasunobu Iwasaka[5]

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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 accom-plished to improve the QPE/QPF during monsoon season and we had an intensive field experi-ment to understand physical process associated with the terrain-influenced heavy precipitation systems near Tokyo metropolitan city. Aerosol particles were observed on the tower of Ieodo ocean research station located in 150km southern area from Jejudo 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

Japan Geoscience Union Meeting 2011
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U022-04 Room:304 Time:May 22 15:20-15:35

Development of the Phased Array Radar for Meteorological Application

Tomoo Ushio[1*], Eiichi Yoshikawa[1], Fumihiko Mizutani[2], Masakazu Wada[2], Shinsuke Satoh[3], Satoru Yoshida[1], Takeshi Morimoto[1], Zen-Ichiro Kawasaki[1]

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

The phased array radar system 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

Japan Geoscience Union Meeting 2011
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U022-05 Room:304 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

Japan Geoscience Union Meeting 2011
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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-

Hitoshi Yokoyama[1*], Haruo Ando[1], Sayuri Ookubo[1], Ikumi Akasaka[1], Kazuyuki Takahashi[1]

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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

Japan Geoscience Union Meeting 2011
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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 thorough 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

Japan Geoscience Union Meeting 2011
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U022-08 Room:304 Time:May 22 16:50-17:05

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

Tetsuya Sano[1*], Kengo Sunada[1], Satoru Oishi[2], Ratih Indri Hapsari[3]

[1]ICRE, University of Yamanashi, [2]RCSUU, Kobe Univesity, [3]University of Yamanashi

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

Japan Geoscience Union Meeting 2011
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U022-09 Room:304 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

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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

Hiromu Seko[1*], Takemasa Miyoshi[2], Yoshinori Shoji[1], Kazuo Saito[1]

[1]Meteorological Research Institute, [2]University of Maryland

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 analyed 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-

Ryohei Misumi[1*], Shingo Shimizu[1]

[1]NIED, 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

Japan Geoscience Union Meeting 2011
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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)

Shin-ichi Suzuki[1*], Koyuru Iwanami[1], Takeshi Maesaka[1], Shingo Shimozu[1], Namiko Sakurai[1], Ryohei Misumi[1], Masayuki Maki[1], Aritoshi Masuda[2], Yasushi Suzuki[3], Akihiko Yamaji[2], Wataru Takeshita[2], Kaori Kieda[4]

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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

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

U022-13 Room:304 Time:May 22 18:05-18:20

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

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[1]DPRI, Kyoto University, [2]JWA, [3]NIED

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.

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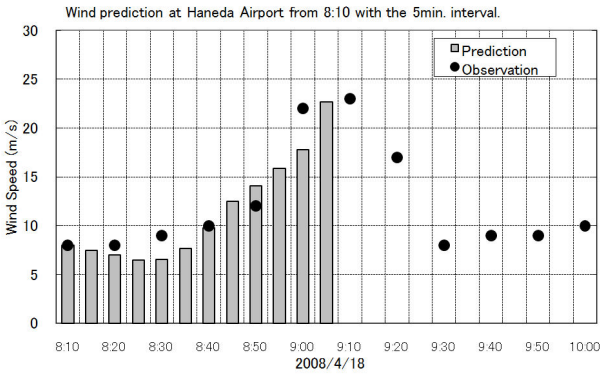

Keywords: nowcasting method, gust wind, X-band doppler radar, X-NET