Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

AAS01-P01 Room:Poster Time:April 30 18:15-19:30

Analysis of meso-gamma-scale convection in tropical regions using GPS meteorology

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In tropical regions such as Indonesia, strong wind with severe shower called squall occurs frequently, and has a large impact on residents in a rainy season. To predict accurately local heavy rain (occurring in a short time and in the range of a few km) is difficult today. Therefore, it is important to understand generation and development mechanism of the meso-γ-scale convection that leads to locally heavy rain.

"GPS meteorology" is a method to obtain the "atmospheric information" such as water vapor from atmospheric delay of radio waves based on a satellite "positioning error". We can estimate precipitable water vapor (PWV: integrated amount of water vapor along the zenith direction) with a high time resolution by using this method. Occurrence of rainfall associated with the meso-γ-scale convection has good correlation with the spatial non-uniformity and temporal variation of PWV estimated by the GPS meteorology technique (GPS-PWV).

The purpose of this study is to find out the generation mechanism of meso-γ-scale convection in the tropics by focusing on the GPS-PWV.

We analyzed GPS-PWV, radiosonde and rainfall data obtained from the campaign which was conducted during the rainy season of 2013 in Bandung, Indonesia.

We carried out accuracy validation of GPS-PWV by analyzing the radiosonde data. As a result, the rainfall data showed that precipitation occurred often in the late afternoon together with an increase of PWV. Furthermore, we found the daily cycle of PWV showing minimum and maximum values in the morning and late afternoon, respectively. In addition, there is a difference in an altitude of more than 1000 m in each observation point. The difference has a severe influence on GPS-PWV. Therefore, it is need to correct altitude difference effect.

Keywords: GPS meteorology, local heavy rain, meso-gamma-scale convection, tropical regions, Indonesia

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Development of high resolution spatio-temporal precipitation data using a network of polarimetric X-band radars in Japan

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Localized convective precipitation develops rapidly in a very short time and is conducive to extreme local rainfall amount. The X-band polarimetric radar is useful to analyze the convective precipitation because it can provide us polarimetric radar parameters which are useful to understand microphysical process in the precipitation. However, the radar observation has some limitations in detecting initial stage of rapidly developing convective cell; the radar volume scan strategy adopted in operational radar is 5 minute interval which is not enough for measuring rapidly developing convective precipitation. To detect the early stage of convective cell, we developed the algorithm which is based on the interpolation method both in space and time. The algorithm reproduces higher resolution spatio-temporal volumetric data using the operational network of four X-band polarimetric radars. The mosaic of multiple radars could be benefit for increased sampling into a certain volume. In addition, different scan strategy at each radar also improve spatio-temporal resolution. The algorithm is applied to radar data of convective precipitations observed in Kanto area in 2012. The new volumetric data can recognize more detail about echo which developed rapidly and detect the first appearance of convective echo at upper layer. Early detection of convective precipitation at upper layer can be useful for nowcasting or very short-term forecasting.

Keywords: convective cell, X-band polarimetric radar, high resolution precipitation data

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An Ensemble Nowcasting of Rainfall over the Kanto Region, Japan

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Every year weather-related disasters: extreme rainfall, landslides and flooding destroy livelihoods and damage economics somewhere on the planet. Recently, number of flash flooding is believed to be increasing specially in urban areas. It has being a great challenge to forecast flood warning and urban drainage management. Nowcasting of rainfall (very short-range forecasting) is an important tool to minimize or manage all these weather-related disasters since precipitation is the main input. Common practice to forecast heavy precipitation for hydrological application varies from 0-6 hr and there are different kinds of nowcasting based on different method.

Nowcasting of rainfall comprises the detailed description of the current weather along with forecasts obtained by extrapolation for a different time period ahead. In this study, we focus on ensemble nowcasting of rainfall. It refers to the fact that many forecasts are produced, with the rainfall areas moving at slightly different speeds, and with the small rainfall features represented by slightly different random statistics. By comparing these different nowcasting of rainfall, the forecaster can decide how likely a particular weather event will be. It gives a much better idea of what weather events may occur at a particular time. Short Term Ensemble Prediction System (STEPS), one of the most advanced Quantitative Precipitation Forecast (QPF) systems currently available is considered for nowcasting of rainfall. Japan Meteorological Agency (JMA) and X-band multi-parameter (MP) radar data were considered to produce an ensemble nowcasting of rainfall. First, JMA radar rainfall data of Kanto region was fixed to check the performance of STEPS. Skill scores showed that STEPS can give a good forecast for less than one hour. However, more uncertainties can be seen during the starting and ending of rain event. High resolution of data (MP data) also used in the STEPS under the default condition. Overall, an ensemble nowcasting of rainfall seems close with real time data, which could be interesting to use them in hydrological model.

Keywords: nowcasting, ensemble, weather radar, extreme rainfall, STEPS, hydrological model

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X-band polarimetric radar and C-band conventional radar composite rainfall map with high spatio-temporal resolution

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Radar with shorter wavelength such as the X-band (3-cm) wavelength has several advantages compared to C- and S-band radar. First, X-band wavelength radar has high sensitivity of the specific differential phase of the rain rate. Second, it is possible to achieve finer spatial resolution more economically; for example, X-band wavelength radar can achieve a 1 degree beam width with a 2 m diameter parabolic antenna, while S-band needs a 7 m diameter antenna to achieve the same beam width. Third, due to advantage number two, X-band radar is easier to setup in mountainous areas, and at lower cost compared to S- and C-band wavelength radar. In Japan, success in the detection of torrential rainfall that occurred in Tokyo in 2008 triggered the deployment of 35 operational X-band polarimetric radars in major urban cities by MLIT. This radar network named XRAIN provides rainfall information with high spatio-temporal resolution. In US, the X-band polarimetric radar network is constructed in Dallas Fort Worth, which is a research and innovation network linking academic researchers, local stakeholders, and industry to address water issues as they relate to urban sustainability. In Europe, The project named RAINGAIN is ongoing to improve fine-scale measurement and prediction of rainfall and to enhance urban pluvial flood prediction. Activities include the implementation and use of advanced radar technologies (X Band) in Leuven, London, Paris, and Rotterdam. Although X-band polarimetric radar has the advantages mentioned above and used in hydrological applications, there are essential disadvantages. First, the maximum range is shorter than that of C-band and S-band radar; maximum ranges of 200km or 300km are easily obtained in case of C- and S- band radar, while that of X-band radar is limited to 30km-60km. Second, signal extinction area which is defined as the area where the received signal is below the receiver noise level occurs behind heavy rainfall areas. These disadvantages will be a fatal flaw when extremely heavy rainfalls occur. Authors have experience that the maximum observation range of X-band radar was shorter than 3km when heavy rainfall passed over the radar site. The present paper aims to develop an algorithm to overcome these disadvantages. The method is based on the C-band and X-band radar composite map which attains the 1 minute time resolution and 250m spatial resolution by the interpolation method. The algorithm is applied to the heavy rainfall case observed on 12-14 July, 2012 in northern Kyusyu, Japan. The algorithm is validated with surface raingauge network: the composite radar rainfall estimation agreed well with raingauge data.

Keywords: polarimetric radar, X-band, precipitation, high resolution, MP radar