Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

AAS22-P01 Room:Convention Hall Time:May 26 18:15-19:30

Verification of Off-Zenith Observations by Ground-Based Microwave Radiometer under Stratiform Precipitation Conditions

ARAKI, Kentaro[1*] ; MURAKAMI, Masataka[1] ; ISHIMOTO, Hiroshi[1] ; TAJIRI, Takuya[1] ; SHOJI, Yoshinori[1] ; SAITO, Atsushi[1]

[1]Meteorological Research Institute, JMA

The radiometric observation by ground-based microwave radiometer (MWR) has been used for the retrieval of precipitable water vapor (PWV) and liquid water path (LWP) for many decades. However, raindrops cause mainly two critical errors in radiometry; the first is the effect that raindrops wet the radome, which produces absorption losses. The second is the effect of absorption/emission and scattering by large raindrops in the air.

To solve especially the first issue, the effectivity of off-zenith radiometric observations by MWR under the stratiform precipitation conditions in all seasons is investigated. Stratiform precipitation periods were extracted by using the criteria of rainfall rate (RR) observed by an optical disdrometer and LWP retrieved from off-zenith observations at the elevation angle of 15 degrees. By comparing PWVs derived from radiometric observations at the elevation angle of 15 degrees with PWVs derived from global positioning system, it's found that the reliable PWVs are obtained under the stratiform precipitation conditions with RR less than 10 mm h^{-1}. The precipitation particles are mostly classified into snow and graupel at RR over 7 mm h^{-1}, and the particle type of rain is found at small RR. A case study shows that microwave radiometry can be conducted with small errors under the stratiform snow conditions even with RR over 10 mm h^{-1}. By solving a simplified radiative transfer equation applied to the typical stratiform rain cases with small RRs, it's found that the observations at the elevation angles over 30 degrees are affected by the effect of the wetness on the radome. From the result of the fundamental experiments which estimates the errors quantitatively, the errors in zenith observations in the cases are comparable to the error due to the wetness on the radome. The off-zenith observations at low elevation angle are valuable under the stratiform precipitation conditions when the Rayleigh approximation assumed in the retrieval method is appropriate.

Keywords: microwave radiometer, stratiform precipitation, precipitable water vapor, liquid water path, retrieval

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AAS22-P02 Room:Convention Hall Time:May 26 18:15-19:30

Comparison of Tipping-Bucket Rain Gauges in Natural Rainfall Conditions

NAGASE, Tsukasa[1*] ; HAYASHI, Taiichi[2] ; KOMATSU, Ryosuke[3] ; WATANABE, Yoshihiro[1] ; HASHINAMI, Shinji[1] ; YAMAMOTO, Akira[4]

[1]Weather Information & Communications Service LTD., [2]Disaster Prevention Research Institute, Kyoto University, [3]Komatsu Factory Co. LTD., [4]Meteorological Research Institute, Japan Meteorological Agency

On August 2014 three-hour rainfall amount exceeded 200 mm in Hiroshima City, which raised serious damage and loss of life by landslides and debris flows. High-resolution rapid-scan weather radar monitoring systems are obviously effective to mitigate damage by such sediment disaster induced by heavy rain. Radar-estimated rainfall rate has been calibrated by tipping-bucket rain gauges(TBRs) measurement, but there are few comparison studies between radar and TBRs at very high rainfall rate because of localness and scarceness of heavy rain phenomena. Furthermore, accuracy of most of TBRs installed in Japan and Asian rain countries are not guaranteed over 100 mm rainfall rate.

To make sure validity of rainfall rate measured by typical TBRs at high rainfall rate, two field comparisons were carried out in Japan and India. Three resolution types of TBRs, 1.0-, 0.5- and 0.2-mm, were tested at Shionomisaki, Japan and at Cherrapunji in Indian state of Meghalaya, which holds world records of maximum rainfall amount for a month and a year. About 4-month measurement beginning on June 16, 2013 at Shionomisaki and beginning on April 28, 2014 in Cherrapunji were done.

Accumulated rainfall measured by the three different resolution TBRs for the comparison period were 1258.0 mm for 1.0-mm resolution type, 1244.5 mm for 0.5-mm type, and 1209.4 mm for 0.2-mm type at Shionomisaki, while those were 8643.0 mm, 8379.5 mm and 8154.0 mm, respectively at Cherrapunji. It means 1 and 4 percent deficit of rainfall amount measured by 0.5-mm and 0.2-mm resolution TBRs compared to 1.0-mm TBRs at Shimonoseki, and 3 and 6 percent deficit at Cherrapunji, which implies higher resolution TBRs measure less rainfall amount than lower ones.

Frequency of 80 mm/h or higher rainfall intensity estimated by tipping rate of the 1.0 mm TBR were 5 percent (72 cases) at Shimonoseki and 14 percent (1249 cases) at Cherrapunji, while cases of 200 mm/h or higher intensity were 3 and 15, respectively. Maximum rainfall intensity at Shionomisaki was 225mm/h and that at Cherrapunji was 300mm/h.

0.2-mm resolution TBRs measure 1.0 mm rainfall intensity by five tippings, however, number of tippings for 1.0 mm rainfall at higher intensity than 80 mm/h were frequently less than five, which means underestimation for heavy rain. Similarly 0.5-mm TBRs measure 1.0 mm rainfall intensity by two tippings and showed no underestimation for rainfall intensity ranging from 80 mm/h to 200 mm/h. But there were some underestimated cases for higher intensity than 200 mm/h.

In conclusion we found higher resolution TBRs underestimated at higher rainfall intensity than 80 mm/h in two field comparisons. Lower resolution TBRs are recommended to measure rainfall accurately at locations where heavy rain is possible.

Keywords: tipping-bucket rain gauges, local heavy rain, meteorological observation, India

AAS22-P03 Room:Convention Hall Time:May 26 18:15-19:30

Surface Pressure Distributions of Downburst captured by High Dense Ground Observation Network "POTEKA" on 22 August 2014

SATO, Kae[1*] ; YADA, Takuya[1] ; KURE, Hirotaka[1] ; KOBAYASHI, Humiaki[2]

[1]Meisei Electric Co. Ltd., [2]National Defense Academy

Meisei developed low-cost compact weather sensor (POTEKA Sta., hereinafter referred to as the POTEKA), which can measure temperature, relative humidity, pressure, sunlight, and rain detection per one minute and we installed high ground observation network (total 55 stations, 1.5~4km-mesh) in Gunma in FY2013. The following year, we further improved POTEKA to observe wind direction, wind speed and rainfall. Additionally, we added 93 locations, about 2km intervals, around the elementary school in order to achieve higher density than the existing observation network. Therefore, we can obtain real-time meteorological information per one minute in total 145 stations. This paper presents observation of downburst around Takasaki city and Maebashi city on 22 August 2014.

Downburst, accompanied with well-developed cumulonimbus, occurred and passed from Takasaki city to Maebashi city around 18:10. A significant drop in temperature is noticed around 17:45, (-0.47 ℃ per one minute on average). The distributions and occurrence time of cold air captured by POTEKA network well coincide with field survey results of the Japan Meteorological Agency. In addition, the first temperature drop was confirmed about 25 minutes before damage occurrence time of the downburst. Pressure jumps of 1-2 hPa were recorded at the same time as the temperature drop, and the average increase rate was +0.34hPa per minute. The pressure jump is regarded as a cool and high dense downdraft under the thunderstorms.

In comparison with the case of downburst on 11 August 2013 (Sato et al. 2014, Norose et al. 2014), the temperature decrease rate at last time and at this time are the average -1.15 ℃ and -0.47 ℃ per minute, the last case is 2 times larger than this time. Both sudden drops in temperature can be captured by POTEKA in advance to the occurrence of downburst hazard. Furthermore, such pressure jumps were recorded in both 2013 and 2014. But the surface pressure after the occurrence of downburst is maintained at the higher level than the pre-occurrence of downburst in 2014. Several downbursts seem to be continuously generated by the larger and more active cumulonimbus in 2014 than these of 2013, which produced the strong winds and kept the surface high pressure after the first downburst occurrence. We are going to further investigate the surface characteristics during downburst by using other meteorological elements (relative humidity, wind velocity, and etc.).

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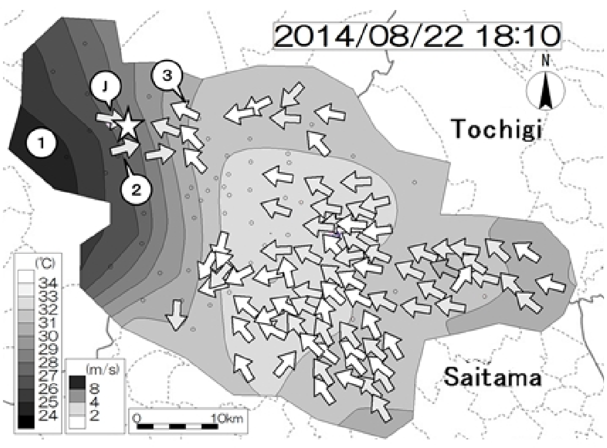
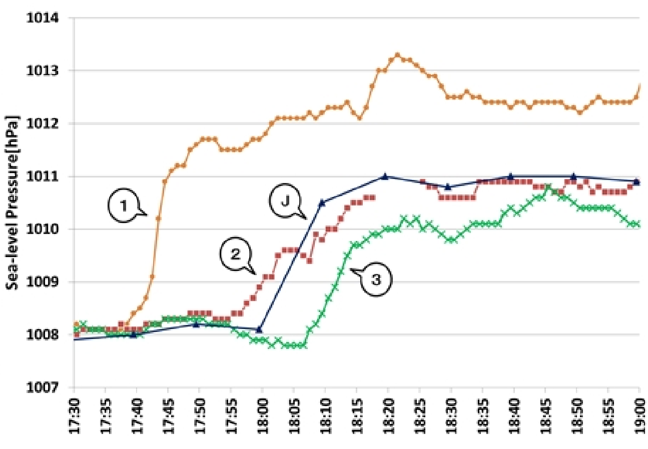
Keywords: High Dence observation network, Downburst





Japan Geoscience Union Meeting 2015
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AAS22-P04 Room:Convention Hall Time:May 26 18:15-19:30

A Study on the development of forecast system for the downstream wind by Hira Oroshi

SAKAMOTO, Hiroto[1*] ; HIGASHI, Kuniaki[1] ; FURUMOTO, Jun-ichi[1] ; HASHIGUCHI, Hiroyuki[1]

[1]Research Institute for Sustainable Humanosphere,Kyoto University

This study aims to develop the precise forecast system of “Hira Oroshi” (hereafter, called as HO), the downstream gust wind blowing down from the Hira mountain range to the West coast of Biwa Lake in Shiga prefecture, Japan. Our system improved the forecast score of gust occurrence to about 80% from 50%.

In this study, the occurrence of downstream gust wind in HO region is defined as the maximum wind speed exceeds to 20 m/s with the wind direction of WEW-NNE.

The intensive observation network was constructed to monitor the detailed behavior of downstream gust and selected four observation points, which can represent the wind field in the whole HO region.

The non-hydrostatic meteorological forecast system with the horizontal resolution of 200 m is constructed by installing WRF (Weather Research and Forecast) to the A-KDK system in Kyoto University. The initial and boundary data is automatically obtained from JMA and other meteorological agencies every six hours. A long-term computational experiment from October 1, 2013 to March 31, 2014 shows very interesting characteristics of wind speed pattern, which appears, only when the gust wind was actually observed.

Narrow strong wind regions extending from the Lake Biwa toward the foot of Hira Mountain range appears and extends to the land in HO region. This structure is used to identify the appearance of gust wind in HO region.

The threshold of strong wind in the forecast model is defined as 14 m/s in this study by considering the model wind velocity represents the averaged wind speed in horizontal grid and integral period. The new method by using this threshold shows very good forecast performance of hit ratio of about 80%.

A performance of time series forecast every three hours was investigated. The forecast predicts longer gust wind period than the actual observation in the whole case. A potential of the precise time series forecast is intensively expected by adjusting the threshold.

This precise meteorological forecast system is based only on general purpose technology and does not adopt heuristics. Therefore, this forecast system is expected to be valid to the regional gust wind every part of the world.

Keywords: gust wind, MesoScale Model, dense observation, boundary layer

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AAS22-P05 Room:Convention Hall Time:May 26 18:15-19:30

Development of high performance and low cost coherent doppler lidar.

YANO, Kenya[1*] ; FURUMOTO, Jun-ichi[1] ; HIGASHI, Kuniaki[1] ; YABUKI, Masanori[1] ; HASHIGUCHI, Hiroyuki[1]

[1]Research Institute for Sustainable Humanosphere, Kyoto University.

In the summer season, the disastrous severe rain frequently occurs in Japan. The small-scale convergence of humidity in the boundary layer is considered as one of the most important factor to determine the generation of such a disastrous rainstorm.

Recently, the development of new metrological radar has been developing for monitor the rainstorm. It is, however, noteworthy that the result of the weather radar shows the echo from precipitation, which is falling down to ground in a couple of minutes. The forecast of rainstorm prior to 15-30 minutes is very difficult by using the weather radar only.

This paper develops the Coherent Doppler Lidar (CDL) to monitor the two-dimensional wind field in the atmospheric boundary layer. The new system improves the output power to increase the maximum height range. The high-performance and low-cost CDL will be realized by assembling the general fiber laser components, Dual polarization and multi-frequency observation is also included in the scope of this study to elucidate the characteristics of aerosol particles.

Keywords: Coherent Doppler Lidar, severe weather, Dual polarization, multi-frequency, aerosol

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Temperature profiling with a rotational Raman lidar using a multispectral detector

OKATANI, Yoshikazu[1*] ; YOSHIKAWA, Kenichi[1] ; YABUKI, Masanori[1] ; TSUKAMOTO, Makoto[2] ; HASEGAWA, Toshikazu[2] ; TSUDA, Toshitaka[1]

[1]Research Institute for Sustainable Humanosphere (RISH), Kyoto University, [2]EKO INSTRUMENTS CO., LTD.

Temperature profiling in the atmospheric boundary layer is essential for understanding atmospheric processes and for meteorological studies, such as precise weather forecasting with particular reference to heat-island phenomena, relative humidity retrievals, and transport characteristics of atmospheric pollutants in urban environments. Lidar has been considered one of the more powerful techniques for remote sensing of atmospheric parameters providing continuous observations with high spatiotemporal resolution. The temperature lidar method detects the temperature dependence of the intensities of the rotational Raman spectrum lines of atmospheric nitrogen and oxygen molecules. The polychromator design for conventional temperature lidar, which is much more complex than that for other lidar techniques, detects the ratio of two rotational Raman lidar signals of opposite temperature dependence using several edge and interference filters. In this study, we developed a temperature lidar with a multispectral detector (MSD), in order to construct a system that is compact, robust, and easy to align for the detection of rotational Raman signals. The multispectral detector enables simultaneous acquisition of multichannel photon counts and it provides spectral and range-resolved data by applying lidar techniques. The multispectral lidar detector can resolve the shape of the rotational Raman spectrum and therefore, temperature estimation can be accomplished by direct fitting of the observed lidar signals to the shape of the theoretical values of rotational Raman spectra that exhibit different dependencies on temperature.

To evaluate the accuracy of temperatures estimated by the proposed method, we constructed the temperature lidar, equipped with a 35-cm receiving telescope, with an MSD that has 0.34-nm spectral resolution at a laser wavelength of 355 nm. Two methods were considered for removing the leakage effects caused by strong elastic scattering in the detector. First, we covered one photomultiplier cathode strip of the elastic scattering channel to reduce crosstalk effects. Second, we blocked the major portion of elastic scattering from the polarization beam splitter using the polarization properties for spherical particles. Simultaneous measurements with the proposed rotational Raman lidar and radiosonde were conducted during January and February 2015 at the middle and upper (MU) radar observatory (34.8 N, 136.1 E) in Shigaraki, Japan. Here, we report the preliminary results of the temperature observations and the calibration process of the photon detection efficiency for each MSD channel.

Keywords: temperature lidar, multispectral detector