Downburst observations using a high density ground surface meteorological observation network

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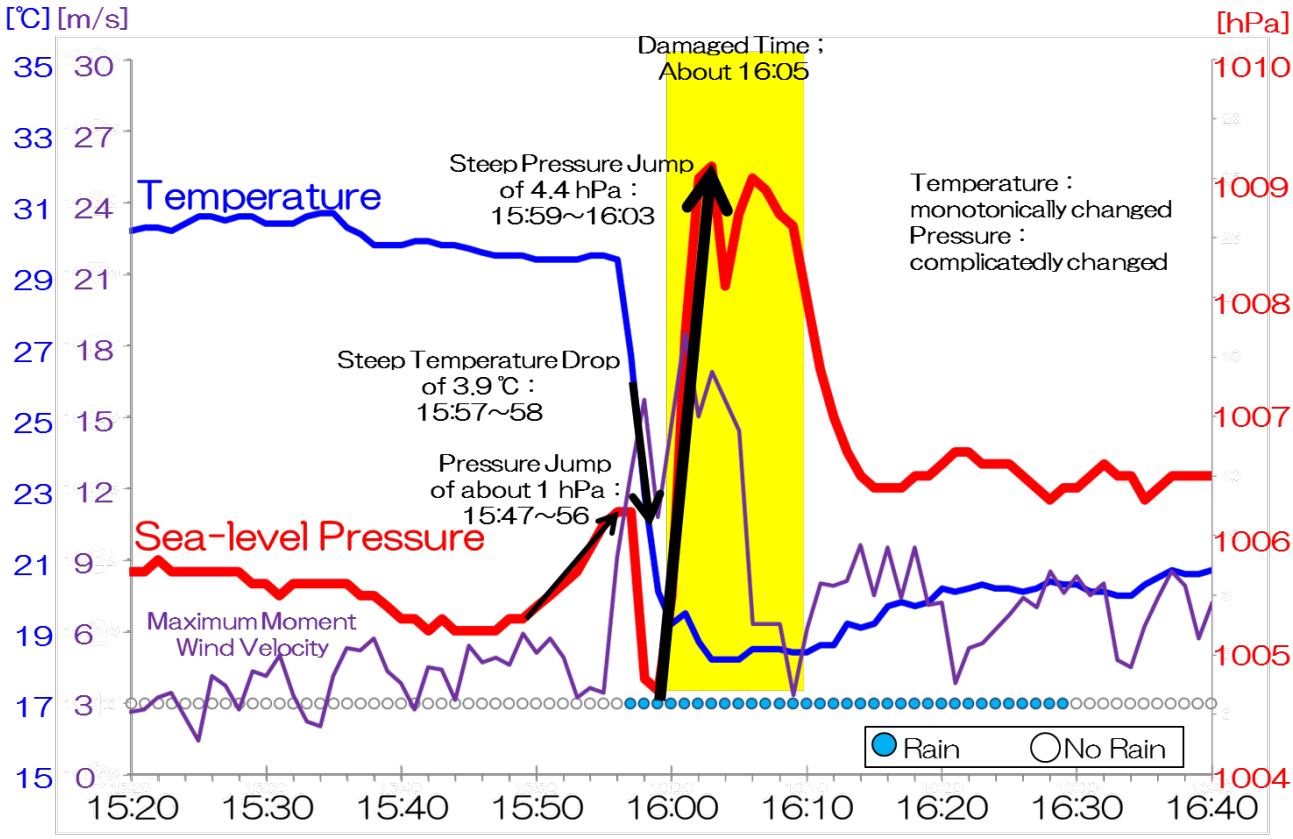
In recent years, global warming and extreme weather are of great interest to researchers and society for not only Japan but also all over the world. Especially, rapid weather changes such as localized heavy rainfall, torrential rain, downburst, tornado, and so on are of great concern as they threaten human life and property. Comprehension of the reasons for these localized extreme weather changes is very significant for the aspect of not only meteorology but also disaster prevention. However, these weather events are said to be meso-γ scale and the size is defined as from 2 to 20 km. Because the installation resolution of the Japan Meteorological Agency' s (JMA) Automated Meteorological Data Acquisition System (AMeDAS) is approximately 17km, it is very difficult to examine these events in detail. Therefore, we have realized a high density ground surface meteorological observation network with utilizing POTEKA weather stations. A POTEKA weather station can observe 7 variables including temperature, humidity, pressure, wind speed, wind direction, rain and sunshine and can be installed anywhere because of its very light and compact size. Particularly, in the case of Gunma and Saitama prefectures in Kanto region, Japan, where the observation network of the phased array radars is developed, the very high density ground surface meteorological observation network (hereinafter, the POTEKA network) has been realized with approximately 150 POTEKA weather stations and has obtained the resolution of approximately 2 km over the wide ranges of about 30 km in the north-south direction and about 60 km in the east-west direction. The plains of Gunma and Saitama prefectures have a climatological feature that a cumulonimbus is generated over the surrounding mountains and advances over the plains accompanied by the growth. Moreover, the developing cumulonimbus causes severe gusts such as tornados, downbursts and gust fronts frequently in the summer season. Actually, the POTEKA network has succeeded in observing 13 severe gust events, which included 5 events in the F1 category (Fujita Scale) and the JEF1 category (Japan Enhanced Fujita Scale) for about 6 years since July, 2013. By the detailed analysis of the particular damaging downbursts such as on August 11, 2013, on June 15, 2015 and on July 14, 2016, the POTEKA network has clarified the advancing characteristics of the cumulonimbi which were estimated to have caused these downbursts. It was confirmed that these cumulonimbi which were entering from the outside had been advancing over the POTEKA network. Also, the POTEKA network has observed the localized transition of observation variables such as temperature, pressure, wind direction / speed and so on around the damaged area. In particular, the very steep variables changes were observed at the nearest observation point from the most damaged point. Moreover, with identifying the observation points of steep temperature drop and steep pressure jump, the contour line about temperature and pressure could have been drawn. The actual scale of a downburst could have been estimated to be the radius of approximately 5 km. The observation results of a high density ground surface meteorological observation network indicated the structure of a localized extreme weather change. We believe that these observation data would be very significant for the aspect of the supplement of meteorological radar observation.

Keywords: High density, Ground surface, Observation network, Extreme weather change, Gust, Downburst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15:59~16:03
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Steep Temperature Drop
of 3.9 ℃ :
15:57~58
Pressure Jump
of about 1 hPa :
15:47~56
Sea-level Pressure
Maximum Moment
Wind Velocity
Rain
No Rain
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