Poster2-65

DOWNBURST OBSERVATIONS USING A HIGH DENSITY GROUND SURFACE METEOROLOGICAL OBSERVATION NETWORK

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1. INTRODUCTION

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 significant for the aspect of not only for meteorology but also for 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 17 km, it is very difficult to examine these weather changes in detail. Therefore, we have developed a compact weather station (POTEKA). Moreover, we have realized many high density ground surface meteorological observation networks with a resolution of approximately 2 ~ 4 km composed of these compact weather stations all over Japan. These networks would be widely utilized in order to calibrate and validate the observation data of not only the ground surface radars such as phased array but also the space-borne radars such as GPM satellite.

2. POTEKA WEATHER STATION

POTEKA weather station was developed according to the concept that it should be compact, light and capable of being installed anywhere. This compact weather station can observe 7 variables including temperature, pressure, humidity, wind speed, wind direction, sunshine and rain. By utilizing the spare channels, this station can observe other variables such as precipitation, lightning, snowfall, water level, soil index, PM 2.5 and so on. Moreover, temperature, pressure, humidity, wind speed and precipitation passed the JMA's variable verification test.

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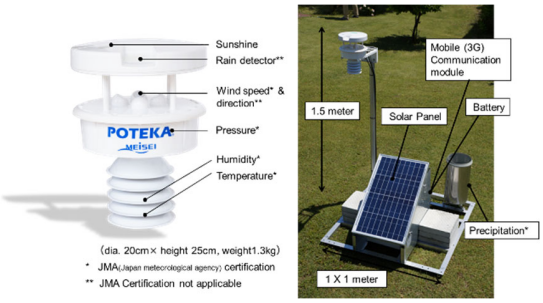

Fig.1 POTEKA weather station and POTEKA weather observation equipment

3. HIGH DENSITY GROUND SURFACE OBSERVATION NETWORK in GUNMA and SAITAMA

As of August 2019, approximately 750 POTEKA weather stations have been installed with a resolution of approximately 2 ~ 4 km all over Japan. In particular, 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 1 ~ 2 km over the wide range 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 downbursts and gust fronts frequently in the summer season. The plains of Gunma and Saitama are characterized by extreme weather changes. 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. We introduce the observation results for three particularly severe downburst events of August 11, 2013, June 15, 2015 and July 14, 2016.

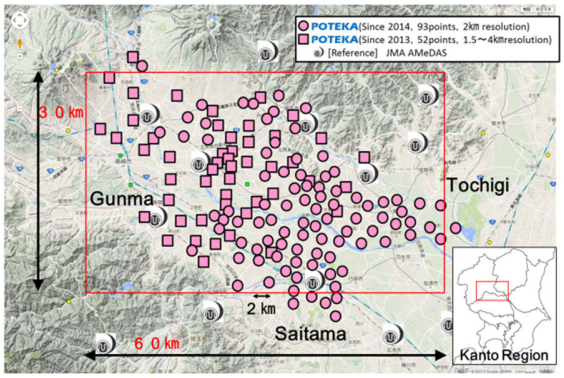

Fig.2 High density ground surface meteorological observation network in Gunma and Saitama (POTEKA network)

4. EXTREME TRANSITION OF OBSERVATION VARIABLES ON THE GROUND SURFACE JUST BELOW A DOWNBURST

Because the existing ground surface observation system such as AMeDAS has the low resolution compared with POTEKA network, it has been relatively difficult that we observe and analyze the extreme transitions of meteorological observation variables in detail just below the localized weather change. But, about these three severe events, POTEKA network could observe the extreme transitions of meteorological variables just below a downburst such as the steep temperature drop and the steep pressure jump. Figure 3, Figure 4 and Figure 5 indicate the POTEKA observation data just below the particularly severe downbursts on August 11, 2013, June 15, 2015 and July 14, 2016 respectively.

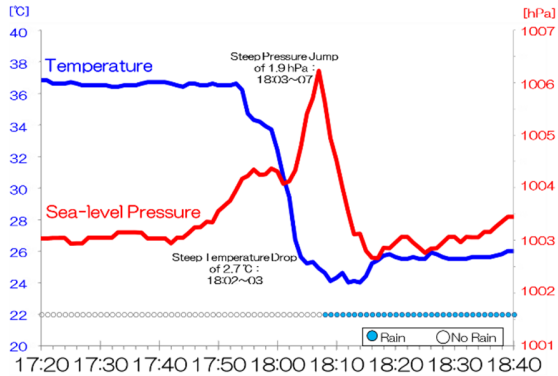

Fig.3 POTEKA observation data just below the downburst on August 11, 2013

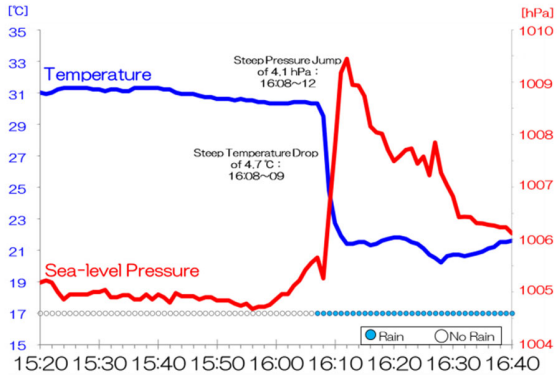

Fig.4 POTEKA observation data just below the downburst on June 15, 2015

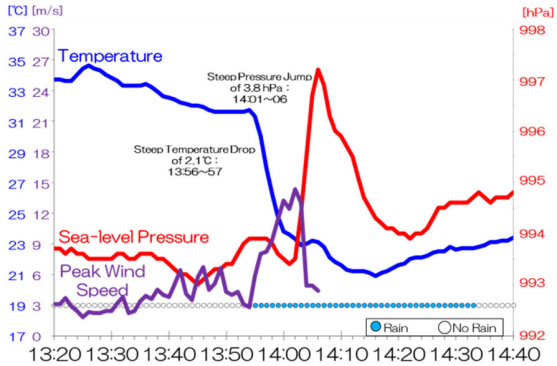

Fig.5 POTEKA observation data just below the downburst on July 14, 2016

5. CLARIFIED ADVANCING CHARACTERISTICS OF CUMULONIMBUS WHICH CAUSED A SEVERE DOWNBURST

Even if some observation point could observe the localized weather change coincidentally in the existing ground surface observation system such as AMeDAS, it had been difficult to clarify the characteristics of the phenomenon causing the localized weather change such as the advancing speed and direction. But, POTEKA network could obtain the detailed observation data although it was a very localized extreme weather change such as a downburst. The contour plot data of Fig.6, Fig.7 and Fig.8 are associated with the particularly severe downbursts on August 11, 2013, June 15, 2015 and July 14, 2016 respectively. For example, in the case of Fig.7 of June 15, 2015, POTEKA network has clarified that the advancing speed and direction are 0.58 km per a minute and the southeast respectively about the cumulonimbus which caused the severe downburst.

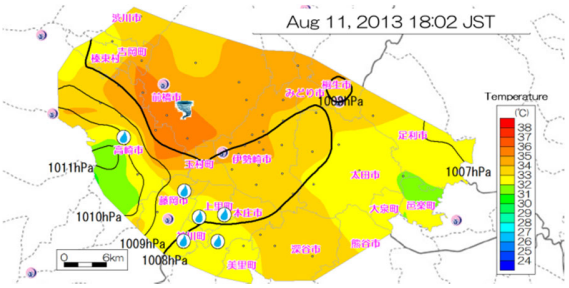

Fig.6-1 18:02 JST

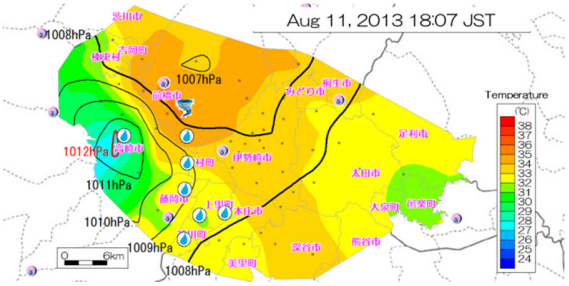

Fig.6-2 18:07 JST

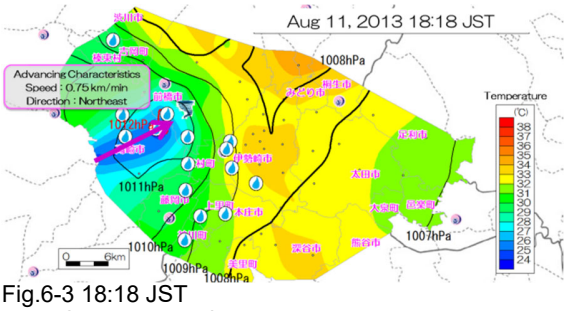

Fig.6-3 18:18 JST
Fig.6 Contour plot of the advancing characteristics about the downburst on August 11, 2013

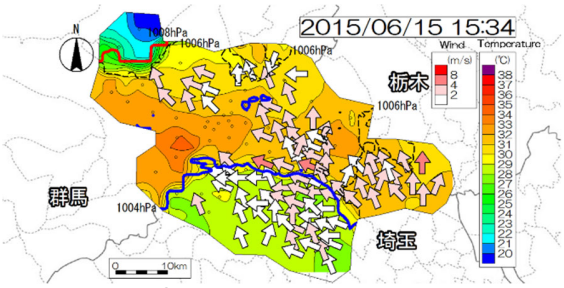

Fig.7-1 15:34 JST

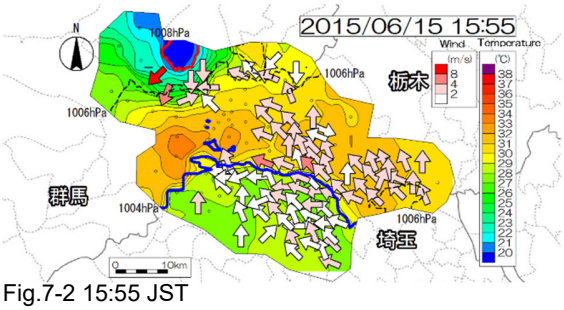

Fig.7-2 15:55 JST

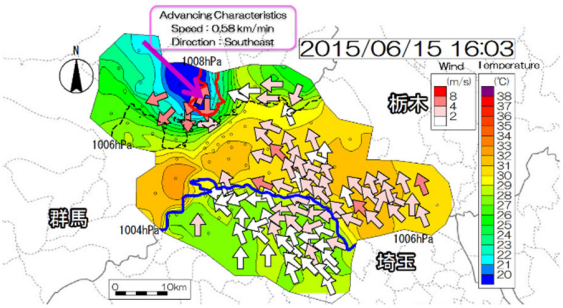

Fig.7-3 16:03 JST
Fig.7 Contour plot of the advancing characteristics about the downburst on June 15, 2015

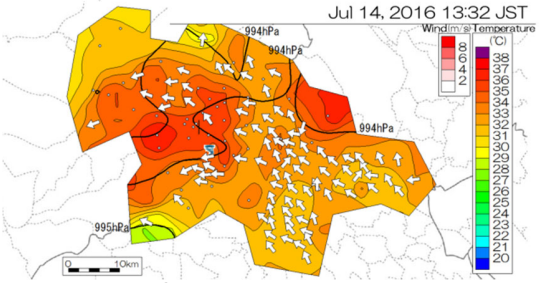

Fig.8-1 13:32 JST

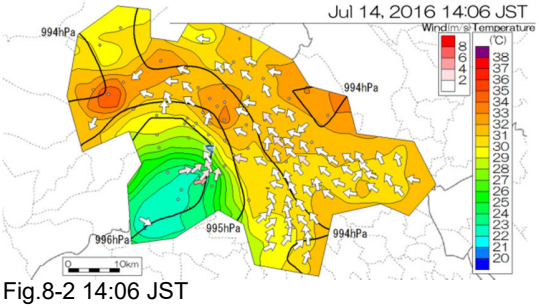

Fig.8-2 14:06 JST

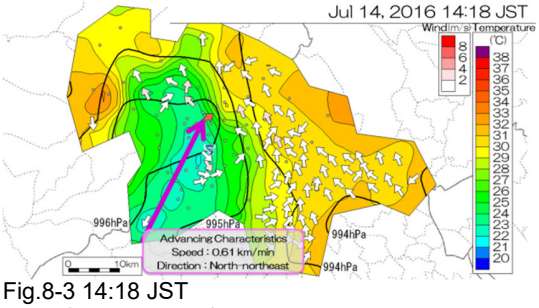

Fig.8-3 14:18 JST
Fig.8 Contour plot of the advancing characteristics about the downburst on July 14, 2016

6. ESTIMATED RESULT OF A DOWNBURST SCALE BY THE GROUND SURFACE OBSERVATION DATA

Figure 9 and Figure 10 indicate the pressure contour line at the just damaged time (16:03 and 14:06 JST respectively) about the particularly severe downbursts on June 15, 2015 and July

14, 2016 respectively. The localized high pressure area of more than 1007 hPa and 996 hPa respectively have the scale of approximately 5 km. Therefore, the downburst scale could be estimated to be a radius of approximately 5 km. POTEKA network have revealed the detail situation on the ground surface just below the localized extreme weather change.

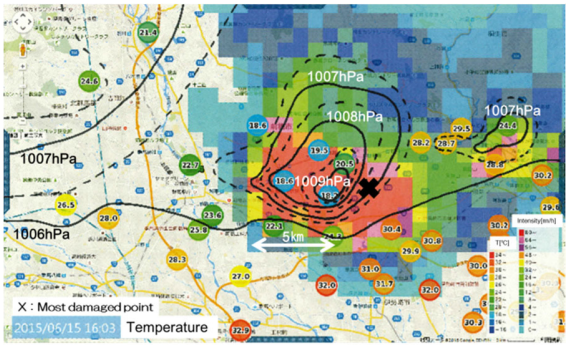

Fig.9 Pressure contour at the actual damage time (16:03 JST) about the downburst on June 15, 2015

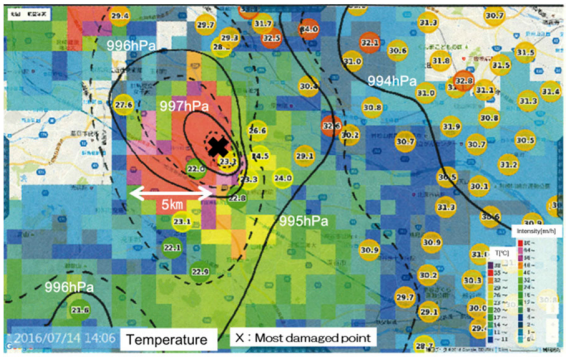

Fig.10 Pressure contour at the actual damage time (14:06 JST) about the downburst on July 14, 2016

7. CONCLUSION

A high density ground surface meteorological observation network is considered to have indicated the actual truth data on the ground surface for the aspect of meteorology development. In a fact, these actual truth data have been utilized in order to supplement the ground surface radar observation such as phased array and contribute to solve the riddle of the localized extreme weather changes such as downbursts and so on.

We hope that a high density ground surface meteorological observation network will be widely utilized in order to calibrate and validate the observation data for many aspects such as phased array radars and space-borne radars.

References

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Norose, K., F. Kobayashi, H. Kure, T. Yada, and H. Iwasaki, 2016: Observation of downburst event in Gunma prefecture on August 11, 2013 using a surface dense observation network, *J. Atmos. Electr.,* 35, 31–41