

Two Different Types of 3D Lightning Mapping Systems Developed for Observing Winter Lightning in Japan

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Abstract—We have developed two different types of 3D lightning mapping systems for observing winter lightning in Japan. One of the systems consists of 12 stations. At each of the station, a discone antenna is used for the sensor and its output is sampled at 25 MS/s with 16 bits. This system uses time-of-arrival technique and is called DALMA (Discone Antenna Lightning Mapping Array). Another system consists of 3 stations. At each of the stations, a broadband interferometer with 3 discone antennas as sensors was deployed. In this system, the outputs from all antenna are sampled at 1GS/s with 16 bits. The latter system primarily uses interferometry technique and is called InLMA (Interferometer-type of Lightning Mapping Array). Both systems are GPS-synchronized. Using these two systems, we have recorded many winter lightning discharges. This paper is to report the two systems and one example result obtained.

Keywords- Lightning, Lightning mapping, Winter lightning, Upward lightning

I. INTRODUCTION

As it is well known, winter thunderstorms in Japan are usually much lower than summer thunderstorms. In addition, many upward lightning and positive lightning occurred during winter thunderstorms in Japan. These factors make 3D mapping of winter lightning in Japan a very challenging issue since all lightning mapping systems suffer an intrinsic deterioration in the uncertainty for locating low altitude sources, particularly sources of positive leaders. As a matter of fact, we have tried to use the FALMA (Fast Antenna Lightning Mapping Array) for 3D mappings of winter lightning but failed [1]. In this study, we have developed and deployed two systems which are capable of doing 3D mapping of winter lightning within the area covered by the FALMA. This paper is to report the two systems and one interesting flash observed by the two

systems.

II. RESULT

As an example, a lightning flash mapped by DALMA [2] is shown in Fig.1. Unlike summer lightning, this winter lightning exhibited very complicated progression features. During the conference, we will report the detail of the complicated features with the result by InLMA included.

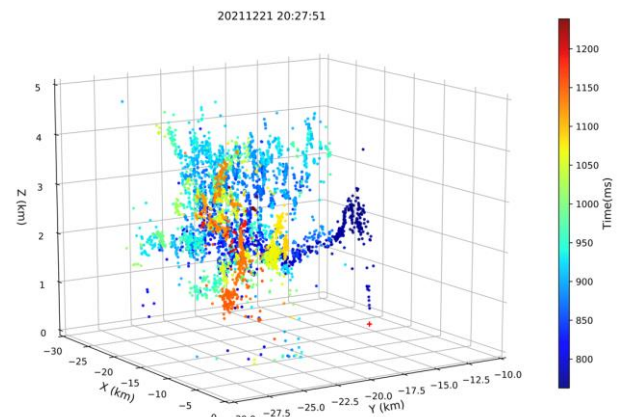


Figure 1. 3D mapping of an interesting lightning flash

REFERENCES

- [1] Wu, T., Wang, D., & Takagi, N. (2020). Multiple - stroke positive cloud - to - ground lightning observed by the FALMA in winter thunderstorms in Japan. *Journal of Geophysical Research: Atmospheres*, 125, e2020JD033039.
- [2] Wang, D., Wu, T., Huang, H., Yang, J., & Yamamoto, K. (2022). 3D Mapping of Winter Lightning in Japan with an Array of Discone Antennas. *IEEJ*. <https://onlinelibrary.wiley.com/doi/full/10.1002/tee.23667>

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