



Development of Boundary Layer Observation Apparatus for VHF Atmosphere Radar

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Atmosphere radar is a ground-based instrument that is indispensable to operational works and scientific studies. Some type of atmospheric radars, we have the PANSY radar in the Antarctic and the MU radar, Japan in mind, however, has a missing range R_{miss} (up to 1500 and 1500 m, respectively, from the ground) due to an intentional gap-time between the transmission and reception for protecting the receiver. To observe the missing altitude range, we have developed a versatile instrument that is to be attached to existing radar. This instrument is herein referred to as the boundary layer observation apparatus (BLOA).

Not just like other bi-static receiver systems, the BLOA is equipped with a delay-line that makes the received signal delayed in time corresponding to R_{miss} . For this purpose, we developed a compact optical delay-line using a pair of electronic-optical (E/O) and O/E converters with an optical fiber of 2000 m in between. The first experiments were performed in August 2022, with the Shigaraki MU radar. Whereas the performance of the BLOA is satisfactory, we have bothered from some unknown interfering signals that is imposed to the echoes from the boundary layer altitude seemingly by the existing electronics. At the moment of this manuscript, data analysis is rather limited due to this issue. Yet, we have made some preliminary analyses using a range that has lesser contamination by the artifacts.

For a large aperture VHF radar, the large part of the atmospheric boundary layer is located within the near-field of its aperture. This means that analysis based on the conventional “beam pattern” concept does not hold high accuracy for analyzing wind velocity, particularly for second or higher order statistics. In this study, we have considered the accuracy of the conventional concept and the spectrum observation theory (SOT)[1] for boundary layer observation using VHF radar.

In this talk, we present the theoretical consideration about the accuracy with respect to the boundary layer using large aperture VHF radar, and the latest observational result using the newly developed BLOA.

References

- [1] K. Nishimura, M. Kohma, K. Sato and T. Sato, "Spectral Observation Theory and Beam Debroadening Algorithm for Atmospheric Radar," in IEEE Transactions on Geoscience and Remote Sensing, vol. 58, no. 10, pp. 6767-6775, Oct. 2020, doi: 10.1109/TGRS.2020.2970200.