High resolution wind observations based on MF radar meteor echo measurements in the northern and southern high latitudes

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The MF (middle frequency) radar at Syowa Station (69S, 39E), Antarctic, has been applied to meteor wind observations since 1999 [Tsutsumi and Aso, JGR, 2005]. The technique has recently been redeveloped further to improve its time/spatial resolutions. Because the duration of meteor echoes is proportional to the square of the radio wavelength, the duration of MF (2-3 MHz) meteor echoes is more than 100 times longer than that of usual VHF (~30 MHz) meteor echoes, indicating that the actual observation time of MF radar meteor measurement can be significantly longer than that of a VHF system and that a more continuous and dense measurement is possible under a geomagnetically quiet condition where MF radio wave can travel without significant absorption or retardation. The redeveloped technique shows that horizontal wind velocities can be estimated with a highly improved time resolution of about 10 minutes in the height region of 80-115 km, and can even be resolved horizontally every 50 km or so within the 10 minutes at around 90 km, the centroid height of meteor echo distribution. Such resolutions are unprecedentedly high as meteor wind measurements [Tsutsumi, SGPESS fall meeting, 2022; Tsutsumi et al., JPGU 2023].

This technique is now being further applied to MF radars at the northern hemisphere, Saura (69N, 16E) and Juliusruh (54N, 13E), routinely operated by Leibniz Institute of Atmospheric Physics. These radars are well equipped with an interferometer capability with 9 and 6 receiver channels, respectively (https://www.iap-kborn.de/en/research/department-radar-remote-sensing/instruments/mf-radars/). We have found that existing archived data of these radar systems can, at least partly, be applicable to the meteor echo analyses as those we have done with the Syowa system. Some preliminary results of wind analyses are to be presented, and a future plan is also to be discussed. The high resolution wind measurements by these radars would especially be beneficial for the studies of small scale atmospheric gravity waves and even turbulences in the mesosphere and lower thermosphere.

References

M. Tsutsumi, M. and T. Aso, MF radar observations of meteors and meteor-derived winds at Syowa (69 degrees S, 39 degrees E), Antarctica: A comparison with simultaneous spaced antenna winds, Journal of Geophyiscal Research-Atmospheres, 110, doi:10.1029/2005JD005849, 2005.