Spatial-temporal distribution of anomalous enhancement of ambipolar diffusion coefficient observed by meteor radars installed in the polar region

*Toru Takahashi[1], Masaki Tsutsumi[1,2], Yasunobu Ogawa[1,2,3], Satonori Nozawa[3], Chris Hall[4], Hiroshi Miyaoka[1,2]

1. National Institute of Polar Research, 2. SOKENDAI, 3. Institute for Space-Earth Environmental Research, 4. TGO, The Arctic University of Norway

The meteor radar detected echoes of meteor tails as a tracer of neutral wind from 75 to 100 km altitudes (Hall et al., 2005). In addition, by using a decay time of the echo power, the meteor radar also estimated the ambipolar diffusion coefficient, which depends on the ion and electron temperature. The ambipolar diffusion coefficient was utilized to estimate the neutral temperature because the ion and electron temperature are generally in the thermal equilibrium with the neutral temperature. Recently, an anomalous enhancement of the ambipolar diffusion coefficient which could not be explained by the neutral temperature enhancement (hereafter called the anomalous enhancement) was observed by the meteor radar installed at Tromsoe, Norway (69.6 deg. N, 19.2 deg. E)
A previous study compared the anomalous enhancement with the ion velocity and the ion and electron temperature observed by EISCAT radar (Tsutsumi et al. 2017, Proceedings of the 30th Atmospheric Science Symposium, 2017). They reported that the anomalous enhancement tended to appear with the enhancement of ion velocity and electron temperature and frequently appeared at 16 UT. Furthermore, the anomalous enhancement was not seen during an event of the high energy particle precipitation on November 17, 2012 although one case study. Thus, the anomalous enhancement seems to be generated by the intense electric field and the high energy particle precipitation is not always necessary for its generation. As mentioned above, the previous study revealed a fundamental characteristics of the anomalous enhancement, however the generation mechanisms of the anomalous enhancement is still unclear. To clarify this, the comparison the spatial distribution of the anomalous enhancement with the convective electric field are needed. However, to date the latitudinal and local time occurrence of the anomalous enhancement was not revealed in the polar region.
Three meteor radars have been installed at Tromsoe, Bear island (74.5 deg. N, 19.0 deg. E), and Longyearbyen (78.2 deg. N, 16.2 deg. E). These meteor radars almost align on the same longitude line and can provide the spatial distribution of the anomalous enhancement. All meteor radars are a commercially produced VHF system (ENDR8-20) manufactured by ATRAD Pty Ltd. The antennas were produced by the Arctic University of Norway (Nozawa et al., 2012, JGR; Hall et al., 2002, GRL, Hall et al., 2006, JASTP). In this study, the spatial distribution and the occurrence rate of the anomalous enhancement was derived by these meteor radars.
Peaks of occurrence rate was seen at 20-22, 19-21, 16-19 MLT (~UT+3) at Tromsoe, Bear island, and Longyearbyen latitudes, respectively. This indicates that the anomalous enhancement appeared sequentially from high to low latitudes. In the morning sector, the peak of occurrence rate was only seen at 2-6 MLT above Bear island. In the case of high geomagnetic activity (Kp>3), the evening peaks of the occurrence rate shifted to an earlier time. On the other hand, clear peaks of the occurrence rate in the morning sector appeared at 3-5, 4-8, 7-10 MLT, respectively. Furthermore, the anomalous enhancement appeared with high possibility of 90% around 100 km south of Tromsoe. These characteristics which are seen during the time interval of high geomagnetic activity showed good agreement with the geomagnetic activity dependences of convective electric field.

We found another interesting characteristic in the geomagnetic dependence of the occurrence of the anomalous enhancement. The peak of occurrence rate in the evening sector was larger than it observed in the morning sector. This is considered to be related that auroral arcs appearing with intense electric field mainly observed in the evening sector. Thus, the generation of anomalous enhancement seems to relate both the convective electric field and the appearance of auroral arcs.
In this presentation, we will show the spatial distribution, MLT and geomagnetic activity dependence of the anomalous enhancement. We will also intend to present the comparison it with the electric filed observed by EISCAT and EISCAT Svalbard radars

Keywords: meteor radar, Tromsø, EISCAT radar

