Coordinated EISCAT and optical imaging observations of the omega-band aurora and electron density enhancement in the D-region ionosphere

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We report the coordinated EISCAT and optical observations for omega-band type auroral events.

Omega band and torch auroral structures are characterized by large-scale wavy forms appeared at the poleward boundary of a diffuse aurora mainly in the post-midnight and morning sectors, and pulsating auroral patches are often observed inside the structure. Past studies revealed that pulsating aurora is caused by relatively high-energy (greater than 10 keV) electrons. However, the precise characteristics of precipitating electrons associated with omega-band and torch auroras have not been understood well.

We estimated the emission height of pulsating aurora appered with omega-band and torch structures from triangulation with multiple all-sky imaging data, and the energy distribution of precipitating electrons from EISCAT radar data.

We carried out coordinated observation of omega-band aurora with the EISCAT Tromso UHF radar and MIRACLE all-sky imagers at Kilpisjarvi, Abisko and Tromso with high spatiotemporal resolution at 01:00-02:00 UT (03:30-05:30 MLT) on 6 January and 01:00-02:00 UT (03:30-05:30 MLT) on 13 January, 2016. We obtained the time variation of emission heights for 427.8nm auroras using the triangulation. The results showed that 427.8nm emission height of omega-band aurora was 92-98 km at 6 January and 90-112km at 13 January.

Furthermore, we obtained the time variation of energy fluxes of precipitation electrons for energy bands, i.e., 1-4 keV, 4-10 keV, 15-50 keV, 60-100 keV and 110-170 keV. We found that the electrons with energy up to 100 keV precipitated in the vicitnity of omega-band and torch aurora at 01:00-01:15 UT on event1. On other hand, 15-50 keV electrons were dominant to produce the omega-band aurora at 01:20-01:40 UT on 13 January, and its energy spectrum was similar to that in the pulsating auroral patch at 01:15-01:30 UT on 6 January. Therefore it seems that that there are at least two types of generation mechanisms in the magnetosphere to produce precipitation electrons associated with pulsating patch inside of omega-band auroras. We consider that there are two region where wave-particle interaction occurs, one is the magnetic equatorial plane, the other is that resonance occurs widely from the equatorial plane to the high latitude side in the magnetosphere.

In addition, we quantitatively evaluated the estimation method of auroral emission height developed in this research. The result of the estimating emission height of discrete aurora and the difference between 427.8 nm and 557.7 nm auroral emission height were consistent with past studies. Furthermore, we investigated the positional relationship between the auroral spatial structure and the observation points for the pair of triangulation. Even if the auroral height estimation error is large using a pair of observation points, we found that it is possible to estimate the relatively probable emission height using the other pair. We also found the positive relationship between the electron density peak height estimated from EISCAT radar data and the emission height estimated with optical triangulation.