“Great Wall” seen in the omega band: full-color digital camera observation from the International Space Station

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Astronauts have been taking a large number of sequential auroral photographs from the International Space Station (ISS) using digital single lens reflex cameras. These images have been published online (Gateway to Astronaut Photography of Earth). We have introduced that a method for projecting such images on the horizontal surface at the altitude of aurora by using city lights as markers [Nanjo et al., 2020, submitted]. This method could also be used for estimating the height structure of aurora. Since ISS orbits the Earth with a period of about 90 min, it is possible to observe large-scale structures of aurora in the MLT direction of 4-5 hours as a snapshot. As one example of such large-scale structures, we investigate omega bands which are wave-like structures in the morning sector. Various terrestrial/satellite observations of aurora from below/above have indicated that the western (night) side of the omega structure tend to be brighter than the eastern (morning) side [e.g. Opgenoorth et al., 1994; Amm et al., 2005]. However, since these observations have captured the omega structure as a two-dimensional image, the vertical structure of omega bands has not yet been revealed. The rim direction observations from ISS enable us to see the aurora obliquely; thus, its vertical structure (i.e., height profile) can be captured.

During several cases of omega bands, we found that there are thin wall-like discrete auroras (“Great Wall”) showing a few hundreds of km height. Great Walls are observed in the borderlines of the western flank of the torch structures and the dark part, and extends in 300-600 km mainly in the north-south direction. As shown in the figure, Great Wall is greenish at the bottom and reddish at the topside. It is also confirmed that the existence of Great Wall in the western side of torch is common in both the hemispheres. The simultaneous appearance of reddish and greenish lights extending in the magnetic field direction infers precipitation of electrons in a broadband energy range. This result is somewhat different from the earlier UV observation by Amm et al (2005) who reported the energy of precipitating electrons in a range of 2-5 keV in the omega structures. This could be because the spatio-temporal resolution of the UVI imager was insufficient and the Great Wall could not be extracted. In addition, active pulsating aurora are seen inside the omega structure. Owing to simultaneous observation of chorus waves at the conjugate area in the magnetosphere with the THEMIS satellite, they are typical pulsating aurora caused by the wave particle interaction. In the presentation, we will show the energy range of electron precipitation in the region of Great Wall estimated from the ISS measurement and discuss the origin of the Wall in the context of current closure in the magnetosphere-ionosphere coupling system.

Keywords: omega band, Magnetosphere-Ionosphere Coupling, pulsating aurora, International Space Station, Digital Single Lens Reflex camera, Field-Aligned Current