

## Magnetosphere-ionosphere-thermosphere-middle atmosphere coupling in the polar region

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Recently, many coupling processes between the magnetosphere, ionosphere, thermosphere, and lower atmosphere have been shown from observations and numerical simulations. In particular, it is known that some meteorological phenomena would have impacts on the thermosphere and ionosphere; for example, typhoon and sudden stratospheric warming events. The coupling between neutrals and plasmas is wellknown and important processes to understand various ionospheric and thermospheric variations. When we understand all the coupling processes between the regions, we would come close to realizing the predictions of the ionospheric and thermospheric weathers.

In the present study, we focus our attention on the polar ionosphere and thermosphere where various coupling processes would exist. Among the coupling processes, chemical ones caused by the precipitating particles in the polar region seem to be far from complete understandings for us. We have made observations of the dayside polar cap ionosphere using the EISCAT radar system to monitor ionospheric disturbances due to the particle and energy inputs from the magnetosphere. The polar cap ionospheric disturbances in the higher latitude have been observed at almost all the time even during geomagnetically quiet periods. We will show some fundamental features of the polar cap ionosphere revealed from the EISCAT observations. In addition, we have performed modelling studies to understand physics and chemistry of the polar ionosphere and thermosphere. In the present study, we will introduce our attempt to estimate productions of ions, NO<sub>x</sub>, and HO<sub>x</sub> in the altitude of 50-500 km due to precipitating particles. The results from the EISCAT observations and modelling studies will be included in our whole atmosphere and ionosphere GCM, GAIA, in the future.

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