Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

ACG033-04 Room:201B Time:May 25 15:00-15:15

Studies of the upper atmosphere in the arctic region from observations and numerical simulations

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The polar upper atmosphere shows significant variations due to the energy inputs from the solar X-ray and EUV radiation and from the magnetosphere. The auroral phenomena are manifestation of the energy inputs from the magnetosphere. In addition, recent observational and simulation studies have revealed spatio-temporal variations in the upper atmosphere caused by effects from the lower atmosphere. For example, decrease and increase in temperature are found in the mesosphere and lower-thermosphere, respectively, during sudden stratospheric warming (SSW) events. The ionospheric electrons also vary due to upward-propagating tidal waves during SSW events. The problem of the global warming is one of the main interests in the world in the 21st century. The temperature in the upper atmosphere seems to show decreasing trend during several decades, suggesting the global cooling in the region. The increase of greenhouse gases warms the troposphere while cooling the middle and upper atmosphere. In addition, some people reported visually-apparent noctilucent clouds in the mid-latitude region for several years. This also suggests decrease in temperature in the mesosphere. As mentioned above, the polar upper atmosphere is strongly coupled with the upper and lower regions (the magnetosphere or near Earth space, troposphere, and stratosphere) through the processes of energy and momentum transfer and photochemical processes. The sciences of the coupling regions will enable us to open up the area for the atmospheric science and to take a broad view of the Earth's environment.

We present an overview of our research activities in the arctic region. Some research projects using radars and optical instruments, which have been developed for several decades, and numerical models (e.g., Ground-to-topside model of Atmosphere and Ionosphere for Aeronomy: GAIA) are shown in this presentation as well as some research products.

Keywords: Upper Atmosphere, atmospheric vertical coupling, aurora, noctilucent cloud, radar-optical observations, numerical simulation