current status and future direction of the whole atmosphere-ionosphere-electrodynamics coupling model

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Recent atmospheric and/or ionospheric observations have increased the importance of understanding the vertical coupling processes between the atmosphere and the ionosphere. Even during geomagnetically quiet periods, day-to-day variability of ionospheric phenomena, such as the development of EIA (equatorial ionospheric anomaly) and the occurrence of plasma bubble, were observed by ground-based optical imagers, radars, and GPS receivers. Their seasonal and longitudinal dependences were also observed by spacecraft instruments. Such variations in the ionospheric phenomena are believed to be affected by atmospheric variations though the atmospheric dynamo process. In fact, there have been some observations in recent years, which suggest a close relationship between the atmospheric waves originated in the lower atmosphere and the ionospheric variations [e.g., Immel et al., 2006; Takahashi et al., 2005]. In storm time, moreover, atmosphere-ionosphere interactions are considered to play an important role in causing the observed ionospheric/atmospheric disturbances; behaviors of TID/TAD, effects of change in the atmospheric composition and neutral wind circulation, and so on. These observations have made the role played by numerical model which couples the atmosphere and the ionosphere more important.

Development of regional coupling models has been very active in oversea. For example, TIME-GCM (NCAR) has successfully treated the upper atmosphere and the ionosphere, including the electrodynamics. Moreover, there are also projects which couple the whole geospace: the sun, solar wind, magnetosphere, ionosphere, and atmosphere (e.g., CISM and SWMF). In Japan, the troposphere-stratosphere-mesosphere-thermosphere GCM has been developed in Kyushu University and Tohoku University, and the thermosphere-ionosphere model developed in NICT, independently. In this project, we will develop vertical coupling model between the atmospheric regions and the ionosphere by coupling the two models and adding the atmospheric dynamo process.

The main science targets of this project are as it follows: (i) the vertical coupling processes between the lower atmospheric waves and the ionospheric variations, (ii) atmosphere-ionosphere interactions in the mid-and low-latitude regions, (iii) atmospheric and ionospheric disturbances in storm time, (iv) medium-scale thermosphere-ionosphere interactions (e.g., MSTID), (v) long-term trend in the ionospheric variations, and (vi) prediction of the ionospheric phenomena. We think that collaborations with some observation campaigns and the future satellite missions are also meaningful. In this presentation, we will report the outline and current status of our project including some initial results, and future directions.