Climatological features of the upper atmosphere reproduced by a revised version of a whole atmosphere-ionosphere coupled model GAIA

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Temporal and spatial variations in the ionospheric electron density and thermospheric mass density could have significant impacts on radio communications between ground and space, and particle and atmospheric drag environments around satellites. Origins of such upper atmospheric variations are not only in the solar atmosphere through the emissions of solar radiation, high-speed plasma gas and high-energy particles, but also in the Earth’s lower atmosphere, where meteorological phenomena could give rise to atmospheric waves propagating upward. In order to nowcast and forecast the upper atmospheric variations and disturbances, a whole atmospheric model, GAIA, has been developed, which combines a whole atmospheric GCM, an ionospheric model and an electrodynamics model in a self-consistent manner.

So far, for the purpose of its validation, we have compared climatological features of thermosphere and ionosphere reproduced by GAIA with those from ionospheric observation and observation-based empirical models. The comparison indicates that the model and observations are generally in good agreements, but in some condition such as at solar maximum there are significant disagreements in the ionospheric electron density distribution. In order to improve the accuracy of the model, we have made several updates such as ion chemical processes, energetics, parameterization, and so on. We also have introduced magnetospheric effects into the model, such as electrodynamics coupling with magnetosphere and particle precipitation. In this presentation, we discuss how the upper atmospheric model can improve its accuracy and how they can be validated.

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