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Ionospheric Response to Stratospheric Sudden Warming Studied by Realistic Whole Atmosphere-Ionosphere Coupled Simulation

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It has been known recently that the effects of stratospheric sudden warming (SSW) appear not only within the middle atmosphere but extend even to the upper atmosphere. SSW itself is known to occur as a result of the interaction between the upward propagating planetary waves and background meridional circulation. The interaction basically occurs in the polar stratosphere. On the other hand, recent observation and modeling studies have shown that tidal property at low latitudes as well as global thermal structure change in the upper atmosphere in response to stratospheric warming. Physical processes have not been established yet for the connection between the polar stratosphere and the upper atmospheric variations. In this study, we utilized a whole atmosphere-ionosphere coupled model, named as Ground-to-topside model of Atmosphere and Ionosphere for Aeronomy (GAIA). The model has recently assimilated meteorological reanalysis data (JRA25, provided by Japanese Meteorological Agency) so it could reproduce upper atmosphere driven by realistic lower atmosphere. The comparison of the model result with satellite observations has shown that the model successfully reproduces general features from the drastic change of the polar middle atmospheric dynamics during the major stratospheric warming in 2009 and the predominant semidiurnal behaviors of ionosphere and thermosphere as its response. The detail analysis of the model result has revealed that the ionospheric variations are mainly caused by the (2, 2) and (2, 3) modes of the semidiurnal migrating tide which originally enhanced in the middle atmosphere due to the change in the global circulation. Cases of other SSWs are also studied.

Keywords: stratospheric sudden warming, modeling, ionosphere, thermosphere, middle atmosphere, atmospheric tide