Perturbations of Global Wave Dynamics During Stratospheric Warming Events of the Solar Cycle 24

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The paper presents analysis and interpretation of observed perturbations of global wave dynamics in the Ionosphere-Thermosphere-Mesosphere (ITM) during the recent mid-winter Arctic Sudden Stratospheric Warming (SSW) events under solar minimum (2009, 2010, 2018, and 2019), transition to solar maximum (2012) and solar maximum (2013) conditions of the Solar Cycle 24. Employing the 116-level configuration of the thermosphere extension of Whole Atmosphere Community Climate Model (WACCMX-116L), constrained by the meteorological troposphere-stratosphere analyses of Goddard Earth Observing System, version 5 (GEOS-5) of Global Modeling and Data Assimilation Office, we study and characterize the striking amplifications of the solar thermal semidiurnal tide, as one of the main drivers of the ITM variability, after onsets of major and minor SSW events. The dominance and growth of the semidiurnal tide over the diurnal and terdiurnal modes in the lower thermosphere above ~100 km are typical features of the tidal dynamics during major SSW events of the Solar Cycle 24 as suggested by model predictions. The growth of the semidiurnal tidal mode during SSW events is also supported by observational analysis of diurnal cycles from temperature space-borne observations (SABER/TIMED). In the vertical domain of the meteor radar observations at the Southern extra-tropics and low latitudes the model and data revealed the systematic presence of the strong quasi two-day wave wind oscillations that prevail over the tidal winds between 80 and 100 km during mid-January SSW events. In the high and middle latitudes of the Northern Hemisphere model simulations are capable to reproduce the day-to-day variability of tidal and PW oscillations deduced from satellite temperature data. The self-consistent whole atmosphere predictions of global-scale components of neutral dynamics (prevailing winds, planetary waves and tides) become important factor to reproduce and forecast the perturbed state of the ITM as observed from the ground and the space during SSW events of the Solar Cycle 24. The SSW-driven global perturbations of tides can significantly change diurnal cycles of the plasma in the low-latitude and extra-tropical E-region of the ionosphere as will be briefly illustrated by day-day variations of observed and simulated total electron content and plasma drifts.

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