Impact of tidal variability on the mean state of the ionosphere and thermosphere during sudden stratosphere warmings

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Observations from the Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC) satellites reveal a global reduction in the zonal and diurnal mean F-region peak electron density (NmF2) during sudden stratosphere warmings (SSWs). In the present study we investigate the source of the global NmF2 decrease using Thermosphere-Ionosphere-Mesosphere-Electrodynamics General Circulation Model (TIME-GCM) and Thermosphere-Ionosphere-Electrodynamics Global Circulation Model (TIE-GCM) simulations. The TIME-GCM simulations demonstrate that the reduction in the mean NmF2 coincides with an [O]/[N2] decrease, indicating that changes in thermosphere composition during SSWs drive the decrease in NmF2. To understand the source of the [O]/[N2] variability, we perform numerical experiments in the TIE-GCM using different forcing conditions at the model lower boundary (~97 km). The numerical experiments illustrate that variability in the migrating semidiurnal solar tide (SW2) during SSWs drives the changes in thermosphere composition. In particular, the enhancement of the SW2 during SSWs appears to alter the mean circulation in the MLT, leading to a reduction in atomic oxygen throughout the thermosphere. The results demonstrate that, in addition to modulating the low latitude electrodynamics, tidal variability during SSWs significantly impacts the mean state of the ionosphere and thermosphere.

Keywords: sudden stratosphere warming, ionosphere variability, thermosphere composition

