Dynamical response in the upper atmosphere: GAIA simulation with doubled CO2

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It is known that increasing CO2 in the atmosphere will produce global cooling in the thermosphere, in contrast to global warming in the troposphere. However, how will thermosphere dynamics and wave activity change remain unclear. In this study, we explore these aspects via a doubled-CO_2 numerical experiment using the whole atmosphere model GAIA. Model simulations were done for solar minimum under geomagnetic quiet conditions, with the CO2 mixing ratio set at 345 ppm and 690 ppm, respectively. The results reveal three major features in the doubled-CO_2 impacts. 1. The thermosphere cools about 10K more around solstices than equinoxes, more at the summer pole than the winter pole. 2. The meridional circulation strongly accelerates by 5--15 m/s. 3. The tidal activity experiences dramatic changes, with a 40--60% reduction in the semi-diurnal tides (SW2) throughout the thermosphere, but an 30-50% enhancement in diurnal tides (DW1) below 200 km altitude. The non-migrating tide DE3 changes only about 3K. These changes in meridional circulation and tides are robust features in all seasons, and can profoundly affect the spatial and local time distribution of the ionospheric responses via composition and electrodynamics.

Keywords: green house gas, global cooling, thermosphere circulation, thermosphere dynamics

