GAIA model simulation of the thermosphere response to SSW

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The GAIA model is utilized to investigate the upper atmosphere response to the dramatic stratosphere sudden warming event in 2009. During the simulation, the geomagnetic activity level is held constantly quiet. Good model-observation (mainly from COSMIC) agreement has been found in the ionospheric responses [Jin et al., 2012]. This report here focuses on the thermospheric responses.

The GAIA model is found to reproduce well major features of the thermosphere observations from CHAMP and GRACE satellites. In particular, the neutral mass density at 05 and 17 LT starts decreasing after the SSW took place (before SSW peak), just like the observations. The neutral temperature at 330 km drops correspondingly, and reaches a peak of 40 K. This is similar to the 50 K estimated from the observations, thus being consistent with the cooling observed in these local time sectors. Furthermore, GAIA could reproduce the simultaneous electron density depletion observed by CHAMP. Small differences are noted in amplitude of the disturbances and the timing of their maxima.

We examined the local time variation of the thermosphere response using GAIA, to overcome the limitation of CHAMP-GRACE observations in local time. It is immediately found that instead of being uniform, the response exhibits a semi-diurnal pattern, with cooling effect in some local time sectors and warming effects in other sectors. Thus, when globally averaged, the thermosphere shows rather insignificant response. This largely explains discrepancy between the model and CHAMP-GRACE observations on the cooling effect previous reported by Fuller-Rowell et al., (2011).

The tidal components are examined to investigate the underlying mechanism. It is found that the SW2 component in the mass density is enhanced and shifted to earlier local time during the SSW. This is likely responsible for the cooling at 05 and 17 LT. The TW3 and stationary components also experience disturbances during the SSW, their effects are rather insignificant due to their much smaller amplitude.