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Responses of the lower thermospheric temperature to the 9 day and 13.5 day oscillations of recurrent geomagnetic activity

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Responses of the lower thermospheric temperature to the 9 day and 13.5 day oscillations of recurrent geomagnetic activity and solar EUV radiation have been investigated using neutral temperature data observed by the TIMED/SABER (Thermosphere IonosphereMesosphere Energetics and Dynamics/Sounding of the Atmosphere using Broadband Emission Radiometry) instrument and numerical experiments by the NCAR-TIME-GCM (National Center for Atmospheric Research–thermosphere-ionosphere-mesosphere electrodynamics–general circulation model). The TIMED/SABER data analyzed were for the period from 2002 to 2007 during the declining phase of solar cycle 23. The observations show that the zonal mean temperature in the lower thermosphere oscillated with periods of near 9 and 13.5 days in the height range of 100–120 km. These oscillations were more strongly correlated with the recurrent geomagnetic activity than with the solar EUV variability of the same periods. The 9 day and 13.5 day oscillations of lower thermospheric temperature had greater amplitudes at high latitudes than at low latitudes; they also had larger amplitudes at higher altitudes, and the oscillations could penetrate down to $\sim$105 km, depending on the strength of the recurrent geomagnetic activity for a particular time period. The data further show that the periodic responses of the lower thermospheric temperature to recurrent geomagnetic activity were different in the two hemispheres. In addition, numerical experiments have been carried out using the NCAR-TIME-GCM to investigate the causal relationship between the temperature oscillations and the geomagnetic activity and solar EUV variations of the same periods. Model simulations showed the same periodic oscillations as those seen in the observations when the real geomagnetic activity index, Kp, was used to drive the model. These numerical results show that recurrent geomagnetic activity is the main cause of the 9 day and 13.5 day variations in the lower thermosphere temperature, and the contribution from solar EUV variations is minor. Furthermore, we also found that consecutive coronal mass ejection events could cause long-duration enhancements in the lower thermospheric temperature that strengthen the 9 day and 13.5 day signals, and this kind of phenomenon mostly occurred between 2002 and 2005 during the declining phase of solar cycle 23.