



The Interaction of Solar and Geomagnetic Activity with Climate Change in the Thermosphere

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The problem of unraveling secular change in the thermosphere from the solar cycle emphasizes the large changes driven by solar extreme-ultraviolet irradiance, but the effect of geomagnetic activity on thermospheric density is also important. During the declining phase of the solar cycle and extending into solar minimum, high-speed streams in the solar wind cause perturbations in the interplanetary magnetic field, known as co-rotating interaction regions. These cause modest geomagnetic disturbances, typically with periodicities that are harmonics of the 27-day solar rotation. The strength and persistence of this phenomenon during 2005-2008 has shown that these disturbances can have a surprisingly large effect on thermosphere and ionosphere densities, particularly in the polar regions, but extending over the entire globe. This can be significant even at solar minimum, when geomagnetic perturbations are often thought to be relatively small.

In this work, we compare neutral density simulations using the NCAR Thermosphere-Ionosphere-Electrodynamics General Circulation Model (TIE-GCM) to measurements derived from satellite drag and accelerometer analyses. We find that geomagnetic heating can account for more than 20% of global thermospheric density at 400 km during solar minimum periods, and most of its day-to-day variation. Changes in geomagnetic activity are a small component of mean density differences between solar minimum periods, but need to be taken into account when calculating secular trends.