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Causes of Low Thermospheric Density During the 2007-2009 Solar Minimum

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Satellite drag data indicate that the thermosphere was lower in density, and therefore cooler, during the protracted solar minimum period of 2007-2009, than at other time in the past 47 years. Measurements indicate that solar EUV levels were also lower than they were during the previous solar minimum. However, secular change due to increasing levels of carbon dioxide and other greenhouse gases, which cool the upper atmosphere, also plays a role in thermospheric climate, and changes in geomagnetic activity could also contribute to the lower density. In recent work [Solomon et al., GRL, 2010] we used solar EUV measurements from the SEM instrument on the SOHO spacecraft to perform simulations by the NCAR Thermosphere-Ionosphere-Electrodynamics General Circulation Model, and found good agreement between the density changes between 1996 and 2008 and the changes in solar EUV. Since there may be some uncertainty in the long-term calibration of SEM measurements, we here perform model calculations using the MgII core-to-wing ratio as a solar EUV proxy index. We also quantify the contributions of increased carbon dioxide and decreased geomagnetic activity to the changes. In these simulations, carbon dioxide and geomagnetic activity play small but significant roles, and the primary cause of the low temperatures and densities remains the unusually low levels of solar extreme-ultraviolet irradiance.