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# Inter-cycle minima differences in thermospheric mass density, exospheric temperature, and ionospheric total electron content

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We investigate differences in thermospheric and ionospheric behavior between two different minima of the 11-year solar cycle, using mass densities and exospheric temperatures derived from orbital drag, and ionospheric total electron content (TEC) derived from Global Positioning System (GPS) signals. At 400 km altitude during the year centered on the cycle 23/24 solar minimum (epoch 2008.8), global thermospheric mass density was 36% lower than during the cycle 22/23 minimum. Ten percent of this difference is attributable to lower average solar extreme ultraviolet (EUV) irradiance levels, 7% to lower average geomagnetic activity levels, but the remaining 19% is anomalous. An exospheric temperature anomaly of –14 K and a global TEC anomaly of +2% accompanied the anomalous 400 km density difference during the cycle 23/24 minimum, relative to the cycle 22/23 minimum. Following the solar cycle minimum at epoch 2008.8, the mass density began to increase, but the density anomalies continued to decrease to a minimum of 24% at epoch 2009.6. The density abruptly recovered to expected levels at 2010.1, an event apparently independent of solar activity. We explore the range of thermosphere-ionosphere states that are consistent with our data, and the sensitivity of the inferred inter-minima anomaly differences to the solar EUV specification used in the analysis.