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Lunar Tide Variability in Thermosphere Density as Derived from GOCE, CHAMP and GRACE Accelerometer Data

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Study of the lunar tide in the ionosphere has a long history, and new discoveries are still being made, e.g., in connection with sudden stratosphere warmings and the equatorial electrojet, for instance. However, only recently have sufficient observations been available to delineate the neutral-atmosphere lunar tide and its variability on a global scale. In this paper we discuss extraction of the lunar tide from accelerometer measurements on the GOCE, CHAMP and GRACE satellites at nominal altitudes of 260, 350 and 450 km, respectively, from both climatological and space weather perspectives. Despite near-constant forcing, the weather aspects of the lunar tide arise from its sensitivity to background atmosphere conditions, which change in response to meteorological conditions and variable solar and magnetospheric inputs. There are significant challenges in separating the lunar tide from density variability due to changing geomagnetic conditions, especially recurrent geomagnetic activity with a period of 13.5 days, which are briefly described. We find that thermosphere density variations attributable to the lunar tide ($\sim$5-7%) at 260 km during 2009-2011 are about half those due to the the background "weather" due to geomagnetic activity; amplitudes at CHAMP and GRACE altitudes can be twice as large. Although of sufficient magnitude to be relevant to prediction of satellite ephemerides and inherently predictable in a climatological sense, the lunar tide has not been included in any empirical models to date.