Lunar Tide Contribution to Thermosphere Weather

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Space weather affects military and civilian systems operating in or through space in several ways, including large variations in the atmospheric drag on satellites. As the utilization of low-earth orbit increases, so does the need for more accurate models of atmospheric density, which are currently highly inaccurate. In this project, I quantify the thermosphere variability due to a source not included in any prediction models to date: the lunar gravitational tide. While geomagnetic disturbance is recognized as a major contributor to space weather, scientists recently realized the importance of factors such as the lunar tide, which originates in the lower atmosphere, where the vast majority of the atmosphere's mass is located. This project thus consists of showing the reality of the lunar tidal responses in the day-to-day variability of space weather and measuring their significance in terms of the variation caused by geomagnetic disturbance. The procedure involved an analysis of the neutral densities and cross-track winds gathered by the GOCE (Gravity field and steady-state Ocean Circulation Explorer) satellite. With an innovative method to utilize this unique resource, I isolated the lunar tidal variation from oscillations caused by geomagnetic disturbance. Unequivocal day-to-day global lunar tidal signatures in relative density and zonal wind were ultimately extracted for the first time in the thermosphere at 260 km. On average, the density variability and zonal winds associated with the lunar tide are found to be about 50-60% and 100%, respectively, of those associated with geomagnetic disturbances. Lunar tides are shown to constitute a substantial element of space weather and hence ought to be included in empirical models to reduce their forecast uncertainty.

Awards Won:

Second Award of $2,000