

The Wizard of $O(z)$ — Thermosphere (LEO) Physics

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Abstract: This seminar is based on an Encyclopedia article that Jia Yue and Wenbin Wang recently wrote. The thermosphere is where many low-Earth-orbit (LEO) objects, including satellites, the International Space Station, and space debris, are flying. Thermospheric density is by far the largest source of uncertainty in forecasting satellite drag and orbit propagation.

In this talk, I will review recent progress in thermosphere physics and the processes driving variability in thermospheric density, composition, temperature, and winds. In particular, mass density in the upper thermosphere is mainly controlled by the abundance of atomic oxygen as a function of geometric height, $O(z)$. Many processes can cause variations in $O(z)$, including solar EUV heating, vertical and meridional advection, eddy and molecular diffusion, and NO and CO₂ cooling.

During geomagnetically active times, Joule heating, enhanced NO cooling, altered circulation, strong EUV heating, and other processes can lead to drastic changes in neutral density. At the end of the talk, I will review fundamental thermosphere physics through the lens of future missions, including GDC and DYNAMIC.