COLLAGE 2023

HW-10

(Submit by Apr 07)

NRLMSIS 2.0 is a whole-atmosphere empirical model of temperature and neutral species densities (Emmert et al., 2020). The model can be accessed: https://kauai.ccmc.gsfc.nasa.gov/instantrun/msis.

1) Obtain and visualize 4 sets of the temperature and neutral species densities and total density profiles (similar to Slide 9, left plot) for solar maximum and solar minimum daytime and nighttime. Summarize the variabilities of temperature, total mass density, and the number density ratios of major constituents. Feel free to select any lat-lon location or [10S, 90W].

2) A satellite in a low-Earth orbit (e.g., 400 km) will experience a drag force and orbital decay. The equation of drag acceleration is given on Slide 18. Using the drag force equation and the Kelper's third law, the orbital decay rate can be derived as:

   $$\frac{dP}{dt} = -\frac{3\pi r \rho C_D A}{m}$$

   where $P$ is the orbital period [s], $r$ is the orbital radius [m], assuming a circular orbit, $\rho$ is the density the spacecraft is flying through [kg/m$^3$], $C_D$=2.2 is the drag coefficient, $m$=20 is the spacecraft mass [kg], and $A$=1 is the spacecraft cross-sectional area m$^2$.

   Use the total mass density profile you generated from MSIS for solar maximum to have a rough estimation of the orbital decay rate from 400km to 150km altitude. Plot the orbital delay period profile and discuss what factors are causing uncertainties in your estimation?