Current topic for a Master's Thesis

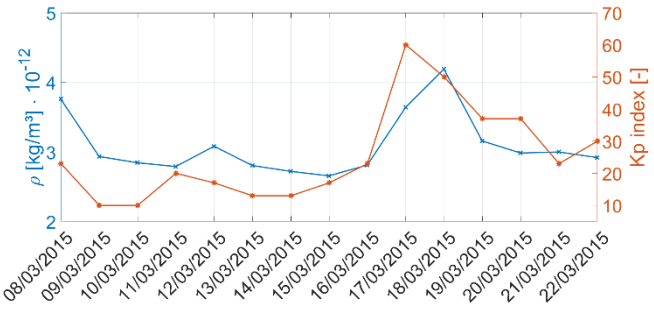
Space weather impact on the thermosphere

Space weather describes physical processes mainly caused by the Sun's radiation of energy. The manifestations of space weather are multiple, e.g., the variations of the Earth's magnetic field or the changing states of the upper atmosphere, i.e. the thermosphere and ionosphere. The most extreme known space weather event happened on September 1st, 1859 – the so-called Carrington Event. Prominent recent, but weaker events are the Bastille Day Event on July 14th, 2000 or the Halloween storm on October 28th to 30th, 2003, and the St. Patrick's storm on March 17th, 2015. The potential strength of severe space weather events and their impact on modern society, e.g. the interruption of satellite services including GNSS and communication systems indicate the necessity of studying these impacts scientifically.

The Earth's atmosphere – between around 100 and 1000 km height – comprising the thermosphere and the ionosphere exhibits a dynamically coupled non-linear system of chemical and physical processes. The neutral density of the thermosphere plays a crucial role within the equation of motion of Earth orbiting objects at low altitudes, since the drag force is the largest non-gravitational perturbations and a function of the thermospheric integral density. Therefore, the knowledge of thermospheric density is of critical consideration for re-entry operations, manoeuvre planning and precise orbit determination (POD).

Precise modelling of the thermospheric density is difficult, because observation data on the thermosphere are quite sparse and the physical structure of the thermosphere is not known accurately, especially the interaction of neutral particles as well as charged particles with the satellite surfaces. Today's thermosphere models are based on data collected at time with different solar conditions and altitudes and finally cause significant different density variations.

Within this master thesis, modelled time series derived from empirical thermosphere models (JB2008, NRLMSIS 2.0 and DTM2013) and solar and geomagnetic indices, like Kp-index should be compared and analysed. Therefore, low solar and high solar activity periods as well as space weather events will be studied. The findings shall lead to a detailed understanding of the complex coupling process between Sun and Earth and will help to improve empirical thermosphere models.



Comparison of daily mean thermospheric density values of JB2008 (blue) and daily mean values of the Kp-index (red)

Main tasks:

- Analysis of modelled time series of thermospheric density and solar / geomagnetic indices, e.g. F10.7 and Kp-index
- Investigation of space weather impact on density variations in the thermosphere

References:

Panzetta, F., Bloßfeld, M., Erdogan, E., Rudenko, S., Schmidt, M., & Müller, H.: Towards thermospheric density estimation from SLR observations of LEO satellites: a case study with ANDE-Pollux satellite. *Journal of Geodesy*, 10.1007/s00190-018-1165-8, 2019.

Zeitler L., Rudenko S., Bloßfeld M., Schmidt M., Kusche J., et al.: Scale factors of the thermospheric density: a comparison of Satellite Laser Ranging and accelerometer solutions. *Journal of Geophysical Research*, 10.1029/2021JA029708, 2021

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