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INSIGHT (interaction of low-orbiting satellites with the surrounding ionosphere and thermosphere)

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In the framework of the DFG special program “Dynamic Earth” the project INSIGHT, started in September 2015, is studying the interactions between the ionosphere and thermosphere as well as the role of the satellites and their instruments in observing the space environment.
Accelerometers on low-Earth orbiters (LEOs) are flown to separate non-gravitational forces acting on the satellite from influences of gravitational effects. Amongst others these instruments provide valuable information for improving our understanding of thermospheric properties like densities and winds. An unexpected result, for example, is the clear evidence of geomagnetic field control on the neutral upper atmosphere. The charged particles of the ionosphere act as mediators between the magnetic field and the thermosphere. In the framework of INSIGHT the climatology of the thermosphere will be established and the coupling between the ionosphere and thermosphere is studied.
There are indications that the accelerometers are influenced by systematic errors not identified up to now. For GRACE it is one of the discussed reasons, why this mission so far did not reach the baseline accuracy. Beutler et al. 2010 discussed the limited use of the GRACE accelerometer measurements in comparison to stochastic pulses in gravity field recovery. Analysis of the accelerometer measurements show many structures in the high frequency region which can be traced back to switching processes of electric circuits in the spacecraft, like heater and magnetic torquer switching, or so called twangs, which can be associated with discharging of non-conducting surfaces of the satellite. As all observed signals have the same time dependency a common origin is very likely, namely the coupling of time variable electric currents into the accelerometer signal. In GOCE gravity field gradients non-gravitational signatures around the magnetic poles are found indicating that even at lower frequencies problems occur. INSIGHT will identify systematic errors in the accelerometer measurements and establish an algorithm to separate these errors from real accelerations with the analysis of satellite rotations on GOCE. A transfer to other accelerometer missions will be studied.
Accelerometer missions are characterized by satellites of a complex geometry and surface structure making it necessary to take their shape and surface interactions into account. On the other hand accelerometers have to be calibrated in space as biases and bias drifts are inherent. These two facts make it difficult to scale thermospheric densities. To overcome this problem a high precision orbit determination of satellites of simpler structure is more suitable. In the framework of INSIGHT a multi-satellite solution of satellite laser ranging (SLR) measurements is aimed for absolute density determination of the thermosphere. Besides, due to the coupling processes between the ionosphere and thermosphere it shall be studied how ionospheric target quantities such as the electron density can be used to improve thermospheric density modeling.
This presentation provides the overall structure of the project INSIGHT as well as first results.