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Dependence of the thermospheric density on solar and magnetic activity

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The thermospheric mass density is dependent on a number of external and internal forces. Here we will focus on the prominent effects of solar extreme ultra-violet (EUV) and magnetic activity. We make use of air density values derived from accelerometer measurements from the two satellites CHAMP and GRACE, thus providing readings from two altitudes. Our aim is to determine the functional relation between the forcing and the thermospheric response. The solar EUV flux is approximated by a composite quantity, P10.7 = 0.5 (F10.7 + F10.7a), where F10.7a is an average of the solar flux index F10.7 averaged over 81 days. For isolating the solar influence only quiet days (Ap < 15) have been considered. As a result we obtain an excellent linear relation between P10.7 and mass density.

In a second step we normalise the density readings to a fixed solar flux level and investigate the response of thermospheric density to magnetic activity. For our investigation 30 magnetic storms have been considered. The solar wind merging electric field turned out to be a suitable controlling parameter. When taking into account some delayed response to the solar wind input we find a linear dependence of the density increase on the merging E-field. Interestingly, the solar wind input causes an additive increase of the density, on top of the quiet time background, whereas the solar flux effect causes a proportional increase. The linear scaling factor between the mass density increase and the merging E-field becomes smaller at higher pressure levels. We will propose a mechanism that may explain the thermospheric variations at the two different measurement heights.