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Thermal tides as important coupling process in the atmosphere

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In this paper we consider the main thermal tidal components, which are the diurnal, the semidiurnal and the terdiurnal tides with periods of 24 h, 12 h and 8 h respectively. These atmospheric waves are forced by solar irradiation in the whole atmosphere and to a large extent by the condensation and convection processes in the troposphere. Tides can propagate up to the mesosphere and lower thermosphere (MLT) with increasing amplitudes. They become unstable in the MLT region and contribute there, via their momentum deposition, to the zonal-wind reversal.

We analyse the tides from a 20 year run of the general circulation model (GCM) HAMMONIA, including chemical interactions, which covers the atmosphere up to about 250 km height, for minimum solar radiation condition. Using the linear model LIN-KMCM with monthly mean background fields in wind and temperature, and the thermal forcings derived from the GCM we can show that the tides simulated by the linear model and the GCM tides are in good agreement with satellite observations. The vertical structure of the diurnal tides shows a wavelike structure with wavelengths of about 27 km concentrated around subtropical latitudes. The largest amplitudes of the semidiurnal and terdiurnal tides are located above the MLT in higher latitudes with values of about 40m/s and 10m/s for the meridional wind. The vertical wavelength for the 12h tide is at 50° of the order of 50km. The vertical structure of the 8h tide seems to be more barotropic.

With the linear model we study for the three main tidal components the dependence of seasonal variations on the tidal forcing processes, on the background winds, and the planetary waves. The results are discussed both for the migrating and the nonmigrating components (i.e.: sun synchronous and non-sun-synchronous travelling waves). It can be shown that the largest influence is due to the monthly mean wind variations throughout the year, but for the nonmigrating components the stationary waves can be shown to be very important as well.

Finally we discuss the influence of different forcing levels on the seasonal tidal variations in the MLT. The most important process to form the diurnal tides is located in the troposphere, whereas the semidiurnal tides due to forcings in the stratosphere interfere with those ones forced in the troposphere. The first part would lead to tides 2.5 times larger than in the complete case, while the second one contributes negatively with amplitude 1.5 times larger than in the complete case. These interactions between tides forced in different altitudes show the strong coupling between lower atmospheric levels and the MLT region by tidal propagation.