Summary

Based on simulations with the Middle and Upper Atmosphere Model (MUAM) the relative role of those sources of tides that are situated in the middle atmosphere is considered: non-linear interaction between stationary planetary waves and migrating tides, heating due to absorption of solar radiation by ozone distributed in longitude. The vertical propagation of tides is controlled by the background wind. Due to interactions between the tidal components and the zonal mean wind, they are able to influence the background circulation as well. To investigate the generation of secondary tides due to non-linear interaction between the primary thermal tides and to estimate the contribution of the migrating tides into the formation of the zonally averaged circulation the heating parameterisation in the MUAM was modified to allow filtering of the thermal sources of different tidal components.

Middle atmosphere sources of non-migrating tides

When planetary waves are strong in the stratosphere (for instance, during sudden stratospheric warming events), the main middle atmosphere contribution to the generation of non-migrating tides is a non-linear interaction between primary migrating tides and the stationary planetary wave with zonal wave number m=1 (SPW1). Large-scale longitudinal ozone inhomogeneities lead to additional sources of non-migrating semidiurnal (m=1) and diurnal (m=2) tides (SDT1 and DT2).

Non-linear interaction of tidal components

The 3 different Runs were calculated with MUAM for March:

F0 run: without filtering of any harmonics in total heating (control run).
F1 run: with filtering of the 1st harmonic; results: the amplitude of migrating diurnal tide (DT1) is negligible (Fig.2), and the amplitudes of DT2, TD73, QDT4 are a bit smaller than in the F0 run. SDT2 has approximately the same amplitudes as in the F0 run.
F2 run: with filtering of the 2nd harmonic; results: the amplitude of migrating semidiurnal tide (SDT2) is smaller (this tide is generated by self-interaction of DT1, Fig.3) and amplitudes of SDT4, SDT3, QDT4 are smaller.

Both DT1 and SDT2 tides generate circulation cells in the meridional and vertical winds from 40S to 40N that result from accelerations due to tidal dissipation. The filtering of thermal harmonics changes the zonally averaged temperature by about 1.4 K above 100 km, and the mean flow by up to 8 m/s above 60 km (Fig.4), and the circulation cells in the meridional and vertical wind components (Fig.5).

There are daily variations of accelerations due to dissipation of gravity waves distributed through the tidal structure of wind. In the case of filtering of the thermal tidal sources these variations disappear (24h in the F1 run and 12h in the F2 run, not shown).

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