On accuracy of the 15 μm CO_2 band cooling rate values reproduced by matrix parameterization in the MLT taking account for the temperature variations caused by planetary waves

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Calculation of the radiative cooling rate of the mesosphere and lower thermosphere (MLT) in the 15 μm CO_2 band is a time consuming task due to breakdown of the local thermodynamic equilibrium (non-LTE) in this altitude region. So, the more simple calculation schemes (so-called parameterizations) still remain a useful tool to take account of the radiative cooling in general circulation models (GCM) of the upper atmosphere. Such effective matrix parameterization [1] can reproduce the 15 μm CO_2 band cooling rate with a good accuracy (1$\div$3 K/day) for a wide range of temperature (T) vertical profiles in the MLT. Nevertheless, the parameterization has been developed basing on the cooling rate values calculated for only the smoothed climatological T-profiles. Global planetary waves of different types permanently spread throughout the atmosphere. In particular, the solar diurnal and semidiurnal tides result in wave-like perturbations in T-profiles in the MLT, which have the most significant amplitudes (up to 25K near about 120 km). The 15 μm CO_2 band radiative cooling is caused by a transfer of thermal energy of air molecules during collisions into the energy of excited CO_2 molecular states followed by radiative de-excitation of these states. That results in the tidal temperature variations influence nonlinearly on the radiative cooling rate. So, there is a necessity to test the accuracy of the parameterization [1] for the realistic T-profiles.

In the present investigation, the temperature distributions with and without solar tides were modeled using the COMMA-LIM GCM (COlogne Model of the Middle Atmosphere – Leipzig Institute for Meteorology) within the 0$\div$135 km altitude region. An ability of the parameterization [1] to reproduce the values of the 15 μm CO_2 band cooling rate for T-profiles perturbed by planetary waves of different types with practically the same accuracy as for the climatological T-profiles was found out.

The investigation has been supported by the Russian Foundation for Basic Research through the grant 03-05-64700a.

[1] Fomichev, V.I., et al. // *J. Geophys. Res.*,**103**, No. D3, P.11505-11528, 1998.