Geophysical Research Abstracts,
Vol. 11, EGU2009-10098, 2009
EGU General Assembly 2009

Dynamical response of the summer MLT to tropospheric global warming: Results from a mechanistic GCM with resolved gravity waves

E. Becker
Leibniz-Institute of Atmospheric Physics, Theory and Modeling, Kuehlungsborn, Germany (becker@iap-kborn.de)

The sensitivity of the mesosphere and lower thermosphere (MLT) to climate variability of the troposphere is largely controlled by the generation, propagation, and dissipation of gravity waves (GWs). Conventional climate models cannot fully describe this sensitivity since GWs must be parameterized by invoking strong assumptions. Since the Eliassen-Palm flux (EPF) of low-frequency inertia GWs is negligible, the main contribution to the EPF divergence at high latitudes of the MLT is due to mid- and high-frequency GWs with periods of a few hours or less. In order to resolve at least a good portion of these waves in a GCM, a high spatial resolution from the boundary layer to the lower thermosphere is required. Furthermore, both the generation and dissipation of resolved GWs is expected to
depend strongly on the details of the parameterization of turbulence. The present study proposes a new formulation of the Kuehlungsborn mechanistic general circulation model (KMCM) with high spatial resolution and Smagorinsky-type horizontal and vertical diffusion coefficients that are both scaled by the Richardson criterion. This model version allows for an explicit and self-consistent simulation of the gravity-wave drag in the MLT.

A sensitivity experiment is conducted in which the main changes associated with tropospheric global warming are imposed by the differential heating, i.e., reduced static stability in the lower troposphere along with a reduced equator-to-pole temperature difference and enhanced latent heating in the intertropical convergence
zone. These changes result in both a stronger Lorenz energy cycle and enhanced gravity-wave activity in the upper troposphere at middle latitudes. The altered gravity-wave sources result in the following remote effects in the summer MLT: downward shift of the residual circulation, as well as lower temperatures and reduced easterlies below the mesopause. These changes are consistent with enhanced
turbulent diffusion and dissipation below the mesopause due to larger gravity-wave amplitudes.