Transport of Chemical Minor Constituents in the MLT-Region by Gravity Waves

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It is believed that in the domain below about 80 km the vertical transport of long-lived chemical minor constituents, such as water vapor, and chemical families, such as odd oxygen, takes mainly place by vertical winds. The turbulent diffusion is a slow process and the molecular diffusion acts effectively only above the turbopause. However, there is also nonlinear transport by internal gravity waves. In order to show the efficiency of this phenomenon, we use our GCM KMCM (Kühlungsborn Mechanistic general Circulation Model) to describe atmospheric flow of dry air under physically idealized conditions. This model was coupled with a chemistry transport model of the MLT-region. We investigate the impact of gravity waves on the distribution of minor constituents on the basis of this coupled model. In two numerical experiments we calculated the distributions of minor chemical constituents under the conditions of truncation of gravity waves with wavelength larger than 350 km and larger than 1000 km. We calculated the absolute and relative differences of the mixing ratios of the most relevant minor constituents for these model runs. The calculations show that transport initiated by internal gravity waves is a very robust effect comparable with transport by advection or diffusion. The response is strongest in the mesopause region, where the largest gradients of the mixing ratios of the minor constituents occur. Additionally, we discuss the impact of gravity waves on the chemical heating rate. The change in the chemistry by gravity waves feeds back to the dynamics.

Keywords: internal gravity waves; MLT-region; minor chemical constituents; truncation; chemical heating rate.