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A new continuous radiative transfer scheme from the surface up to the mesopause region (Eine neue kontinuierliche Strahlungsparametrisierung von der Oberfläche bis zur Mesopause)

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A simplified and numerically efficient method to compute radiative flux densities and heating rates in a general circulation model (GCM) is presented. The parameterization extends continuously from the surface up to the lower thermosphere and avoids any merging of radiative heating rates from different schemes, which is the usual approach in omprehensive middle atmosphere GCMs.

In the long-wave regime, frequency-averaged Eddington-type transfer equations are derived for six broad absorber bands. The frequency variation inside each band is parameterized with the Elsasser band model extended by a slowly varying envelope function. This yields additional transfer equations for the perturbation amplitudes which are solved simultaneously together with the mean transfer equations. Deviations from local thermodynamic equilibrium are accommodated in terms of isotropic scattering computed from the two-level model for each band. Solar radiative flux densities are computed for four energetically defined bands using the simple Beer-Bougert-Lambert relation for absorption within the atmosphere. These methods circumvent all the conventionally applied approximations to compute the complicated flux transmission functions that result from formal integration of the radiative transfer equation.

The new scheme is implemented in the Kühlungsborn Mechanistic general Circulation Model (KMCM). First test simulations with prescribed concentrations of the radiatively active constituents show quite reasonable results. In particular, since we take the full surface heat budget into account by means of a swamp ocean, and since the internal dynamics and turbulent diffusion of the model is formulated in accordance with the conservation laws, an equilibrated climatological radiation budget is obtained either at the top of the atmosphere and at the surface. Furthermore, due to its numerical efficiency, the new radiation scheme will allow for high spatial resolutions to explicitly simulate gravity waves and their nonlinear interactions with the radiation field.