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A Jovian moist convection parametrization

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We have developed a parametrization of Jovian moist convection based on the heat engine model, and tested it with a general circulation model (GCM). The heat engine framework employs the total convective available energy, TCAPE, as closure variable and considers the effects of convective updrafts and downdrafts. This framework seems to be appropriate for Jupiter since the Jovian temperature structure allows the operation of a heat engine between the deep atmosphere and tropopause, and as moist convection on Jupiter is generally believed to take the form of convective plumes extending from the water condensation level to the vicinity of the troposphere. The convection scheme includes the effects of convective heating and moistening, molecular weight changes and the vertical transport of horizontal momentum.

The parametrization is fully interactive with the hosting GCM. It computes the draft characteristics, moist convective parameters, and transport terms from the large scale temperature and moisture fields and modifies these fields in turn. A computational implementation was first coupled with a single-column configuration of OPUS (the Oxford Planetary Unified model System) GCM, and the sensitivity of the scheme to eight factors influencing radiative heating, the vertical extent of the moist convective drafts, the draft parameters and momentum transfer was tested. The general effect of the moist convection scheme was to heat and moisten the subsidence layer in the troposphere. While preset parameters in the scheme and the model have some influence upon the generation of moist convection, the general development and orders of magnitude seem to be robust over a wide range of parameters.

We have also conducted three-dimensional runs with OPUS and the moist convection parametrization. Similar to the results obtained with the one-dimensional model the main effects of moist convection were a considerable increase in the temperature of

the subsidence layer and the transport of water through the atmosphere. The heating of the subsidence layer was accompanied by a smoothing of horizontal temperature variations. Moist convective heating reduced a positive offset of vertical velocity present in the non-convective model and lead to a better preservation of prograde zonal winds. Horizontally the convective energy appeared in localized spots but subsequently organized into zonal bands, with maxima located e.g. in the South Tropical Belt and Zone area.

It can be assumed that small scale turbulence in the subsidence layer caused by convective drafts might lead to an inverse energy cascade into zonally organized flow. We are therefore currently conducting a series of experiments investigating the possible influence of moist convection on the formation of Jovian banded zonal jets.