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THE VALIDITY OF A NEW CLOSURE ASSUPTION FOR THE PARAMETRISATION OF DEEP CONVECTION

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In many parametrisations for deep convection in general circulation models, the energy released by parcels during their moist ascent through the free troposphere is estimated. The "convective available potential energy" (CAPE) measures the buoyancy of parcels associated with the latent heating from condensation. The total large-scale forcing of the CAPE is utilised in predicting the occurrence of deep convection and consists of two components. Firstly, there is the component of the CAPE change due to modification of the vertical environmental profiles of temperature and humidity by large-scale advection within the free troposphere. Secondly, there is a component due to the modification of the temperature and humidity of parcels at their starting level in the planetary boundary layer (Eg. by surface fluxes of heat and moisture).

The conventional quasi-equilibrium assumption asserts that deep convection consumes CAPE at approximately the same rate as it is generated by the total large-scale forcing. This implies that the net CAPE change is assumed to be at least an order of magnitude less than the component of the CAPE change due only to the total large-scale forcing. When the observed data is averaged over long time-scales of a day or more, there is observational evidence supporting this assumption. However, on the time-scale of one or two hours, cloud-system model simulations and observations show considerable variability of the CAPE, with the net CAPE change being - usually - only modestly lower than the CAPE change due to the total large-scale forcing.

Hence, there appears to be a need to find an improved closure assumption that is accurate at the time-scale of the typical GCM time-step : about one hour.

In this presentation, an assessment of the degree of adequacy of a new closure assumption suggested by Guang Zhang will be provided. This closure assumption proposes that the changes in CAPE due to deep convection balance only changes in CAPE not linked to the planetary boundary layer.
Insofar as this assumption is realistic on the time-scale of an hour or so, one possible reason for its validity could be that deep convection in the free troposphere tends to develop too slowly to be driven primarily by the relatively high-frequency variablity of surface parcel properties.