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A stochastic and prognostic convective parameterisation scheme for the "grey-zone"

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Representing deep convection is a challenging aspect of numerical atmospheric simulation at kilometre-scale (1 km to 10 km) resolution. In this range of grid-lengths, often referred to as the grey-zone, numerical models must be able to represent convection in both explicit (resolved) and implicit (sub-grid) manner. Employing a conventional convective parametrisation, which purposely suppresses explicit convection via assumptions suitable for coarser resolutions, is far from ideal for grey-zone convective modelling. Nevertheless, the lack of any representation of sub-grid convection will lead to unrealistic accumulation of instability and the delayed and consequently abrupt onset of convection. Thus, a new approach towards convective parametrisation is required for grey-zone resolution simulations to produce physical results for convective development.
A new convective parametrisation scheme for the grey-zone has been proposed, which takes into account the development of a limited number of sub-grid convective updraughts over a small physical area that is represented by the grid in grey-zone resolution simulations. The scheme employs a stochastic boundary-layer based closure to quantify the cloud base mass flux. The conventional quasi-equilibrium assumption is relaxed by calculating the vertical extent of sub-grid convection according to a parcel ascent of the bulk plume. Parametrisation of convection is only applied within the vertical extent of the sub-grid bulk plume, the properties of which are saved for the scheme to continue the vertical growth in the next model time step. This procedure is designed to trigger an earlier onset of explicit convection in the diurnal cycle by representing strong thermals in the boundary layer which are able to overcome any grid-mean convective inhibition (CIN).
The performance of the scheme is being tested in the latest Met-Office NERC Cloud (MONC) model, the next-generation large eddy model developed by the Met Office. The evaluation will be based on the performance of idealised simulations of the Large Biosphere Atmosphere (LBA) as well as a Atmospheric Radiation Measurement Southern Great Plain test cases which describe a diurnal cycle of land convection. The ultimate goal of the project is to develop a convective scheme which allows simulations at grey-zone resolution to produce comparable results to that from large eddy simulations.