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Improved scheme for parametrization of convection in the Met Office's Numerical Atmospheric-dispersion Modelling Environment (NAME)

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The Met Office uses NAME to predict the dispersion of both natural and man-made contaminants in the atmosphere, including releases of volcanic ash and radioactive particles. A Lagrangian particle-trajectory model is implemented and Numerical Weather Prediction data are provided by the Unified Model (UM).

Prior to the work presented here, the enhanced vertical mixing generated by convection was represented by random redistribution of Lagrangian particles between the cloud base and the cloud top with a probability of 1/25th the UM diagnosed cloud fraction. Such a scheme does not make optimal use of all the information provided by the driving meteorological model.
To avoid this problem and make the parametrization more physically based, the convection scheme has been recently revised by introducing a new model for vertical transport based on vertical mass fluxes specified for each model layer.

The vertical coordinate used is defined in terms of pressure and the model is based on n-vertical levels ranging from surface level to the tropopause. The upward and downward fluxes describe the vertical motion of air in convective clouds while the entrainment and detrainment fluxes represent the exchange of air between the cloud and the environment.
As all mass fluxes are not yet available operationally as UM diagnostics, the vertical mass fluxes are calculated with empirical formulas derived from Cloud Resolving Models (CRM) and using the UM convective precipitation diagnostic to estimate the depth integrated mass flux. This is done under the reasonable assumption that the amount of precipitation should reflect the convective activity inside the cloud within a good approximation and confirmed by the existence of a linear relationship among the two quantities.
The entrainment and detrainment fluxes are estimated using the mass flux profile described by the empirical formulas and ideas inspired by the UM convection scheme.
The conservation of mass applies and the mass fluxes are used to estimate how many particles entrain, move upward and detrain. The scheme is completed by applying a subsidence flux to all the particles to compensate for upward motion.

The update scheme is implemented on a grid of 25 km size (corresponding to the Global model used by the UM) and is successfully tested against the so-called well-mixed criterion according to which particles must remain uniformly mixed in the atmosphere after the convective redistribution. The scheme is evaluated against the previous one and ideas for further development have also been investigated.