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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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NAME is a Lagrangian atmospheric dispersion model used by the Met Office to predict the dispersion of both natural and man-made contaminants in the atmosphere, e.g. volcanic ash, radioactive particles and chemical species. Atmospheric convection is responsible for transport and mixing of air resulting in a large exchange of heat and energy above the boundary layer. Although convection can transport material through the whole troposphere, convective clouds have a small horizontal length scale (of the order of few kilometres). Therefore, for large-scale transport the horizontal scale on which the convection exists is below the global NWP resolution used as input to NAME and convection must be parametrized.

Prior to the work presented here, the enhanced vertical mixing generated by non-resolved convection was reproduced by randomly redistributing Lagrangian particles between the cloud base and cloud top with probability equal to 1/25th of the NWP predicted convective cloud fraction. Such a scheme is essentially diffusive and it does not make optimal use of all the information provided by the driving meteorological model.
To make up for these shortcomings and make the parametrization more physically based, the convection scheme has been recently revised. The resulting version, presented in this paper, is now based on the balance equation between upward, entrainment and detrainment fluxes. In particular, upward mass fluxes are calculated with empirical formulas derived from Cloud Resolving Models and using the NWP convective precipitation diagnostic as closure. The fluxes are used to estimate how many particles entrain, move upward and detrain. Lastly, the scheme is completed by applying a compensating subsidence flux.

The performance of the updated convection scheme is benchmarked against available observational data of passive tracers. In particular, radioxenon is a noble gas that can undergo significant long range transport: this study makes use of observations of the isotope 133Xe available at International Monitoring System stations around the South Pacific Ocean. In addition, timeseries of modelled output concentrations obtained using NAME on a grid of 25 km size are compared with those obtained with FLEXPART, another well-known atmospheric dispersion model used by the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO) and other scientific communities. Findings are discussed and discrepancies investigated.