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Estimation of mixing in the troposphere from Lagrangian trace gas reconstructions during long-range pollution plume transport

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The dispersion and mixing of pollutant plumes during long range transport across the North Atlantic is studied using ensembles of diffusive backward trajectories in order to estimate turbulent diffusivity coefficients in the free troposphere. Values of the order of $0.5 - 1 m^2 s^{-1}$ and $1 \times 10^4 m^2 s^{-1}$ for the vertical and horizontal diffusivity coefficients D_v and D_h respectively have been derived. Uncertainties related to the method are discussed and results compared with previous estimates of mixing rates in the atmosphere. These diffusivity estimates also yield an estimate of the vertical:horizontal aspect ratio of tracer structures in the troposphere. The representation of sub-grid mixing in the global Eulerian 3D Chemical Transport Model MOCAGE is also assessed, and optimal time and space grid resolutions required to simulate the long-range transport of pollutants are investigated on inter-continental scales, suggesting the need for vertical/horizontal resolutions of the order of 500m/40 km for this case study. This work is the basis of a detailed study including chemical transformations along ensembles of diffusive backward trajectories.