Geophysical Research Abstracts, Vol. 8, 09259, 2006
SRef-ID: 1607-7962/gra/EGU06-A-09259

Turbulent diffusion and sensitivity of Lagrangian reconstructions in the lower stratosphere

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Vertical (cross-isentropic) mixing is produced by small–scale turbulent processes which are still poorly understood and parameterized in numerical models. In this work we provide estimates of local equivalent diffusion in the lower stratosphere by comparing balloon and airborne high–resolution measurements of chemical tracers with reconstructed mixing ratio from large ensembles of random Lagrangian backward trajectories. ECMWF analyses or reanalyses and REPROBUS CTM are used. We have investigated cases ranging from polar to tropical latitudes using data from SOLVE and HIBISCUS campaigns and balloons flights at mid–latitudes. Upper bounds on the vertical diffusivity are found to be of the order of 0.01 m^2/s inside the wintertime polar vortex, 0.1 m^2/s at mid–latitudes and of the order of 1 m^2/s in the tropical region. Large variations in space and time are found. The relation between diffusion and dispersion is studied by estimating Lyapunov exponents and studying their variation according to the presence of active dynamical structures. Sensivity of the reconstructions to the temporal resolution of the analyses and to using diabatic tendencies instead of analysed vertical wind is discussed.