Geophysical Research Abstracts
Vol. 13, EGU2011-13597, 2011
EGU General Assembly 2011

Seasonal Variation of Effective Diffusivity on Isentropic Surfaces in the UTLS and the Annual March of Stratosphere-Troposphere Exchange of Ozone

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Data from HIRDLS (High Resolution Dynamics Limb Sounder) with a vertical resolution of about 1 km, have shown the existence of thin layers of low ozone extending from low toward high latitudes, often above thin layers of high ozone extending from high to low latitudes. These have been used to study possible isentropic exchange between the troposphere and lower-most stratosphere. Here we concentrate on the Northern Hemisphere. Nakamura's (1996) modified Lagrangian mean diagnostic has been applied to HIRDLS Version 5 ozone data after these have been gridded, translated to potential temperature (θ) surfaces, and the equivalent latitude determined. The results are Equivalent Lengths vs. time and latitude in the Upper Troposphere Lower Stratosphere that agree well with previous theoretical determinations. Combining these with observed latitudinal and temporal gradients in the continuity equation leads to estimates of the effective diffusivity vs. latitude at different levels. Monthly averages show there is a narrow region about 10° wide centered around 35°N with minimum values $\sim$ 5 105 m2/sec (slow mixing) in February, compared with values > 30 105 (fast mixing) outside this region. In summer the region of minimum values is much broader, with higher values at all latitudes.

This is closely related to the seasonal variation in UTLS ozone; in the winter season the stronger meridional overturning creates a large equator to pole difference Δ, that maximizes in spring, maintained by the strong barrier region. As the barrier weakens later in the year, (and the meridional circulation also weakens) Δ relaxes to a much smaller difference.

As a by-product of these calculations, the parameter κ, the minimum effective diffusivity, is determined. For the conditions and grid spacing here, these values are $\sim$ 0.5- 2 105 in this altitude region, generally increasing slightly from low to high latitudes.