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# Lagrangian analysis of the inter-hemispheric mass transport in the atmosphere

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The inter-hemispheric exchange of masses in the atmosphere is investigated by Lagrangian analysis. In particular, we examine the timescales, paths and sizes of mass transport from the two hemispheres to the equator, which can not be done by conventional Eulerian methods. We present averages of residence times, transit residence times and ages for different sections of each hemisphere (tropical troposphere, stratosphere midlatitudes, etc.), and explore the spatial and temporal variability of these timescales.

The Lagrangian trajectory code TRACMASS is extended to the atmosphere using fields from the ERA-Interim reanalysis data set. The atmosphere is thus represented by $\sim 2.5$ million trajectories. The hemispheres are considered as two separate domains. The residence time in a point, which is here the time it takes for a particle to go from that point to the equator, is calculated by tracing trajectories forward in time. The age, which is the time it takes for a particle to go from the equator to the point, is calculated by tracing back in time. The transit residence time is then the sum of the residence time and age. From this, we can calculate average age (AvA), average residence time (AvR) and the average transit residence time (ATR) for different sections of each hemisphere.

Preliminary results from trajectories traced from the northern hemisphere on 1 January 1989 show that the inter-hemispheric transport is much slower in the stratosphere than in the troposphere. In the troposphere, the transit time is $\sim 7$ months at high latitudes and $\sim 4$ months in the subtropics. In the stratosphere, the transit time is $\sim 2.5$ years at high latitudes and $\sim 2$ years in the subtropics. They also show a somewhat sharper transit time gradient in the tropospheric subtropics that is tilted from the surface at $30°$N to the tropopause at the equator, indicating a transport barrier. Furthermore we find that surface air over the Sahara Desert and East Pacific Ocean below $850$ hPa has a shorter transit time than the zonal average, which might be an effect of the subtropical highs.