



## Mixing processes at the tropical and sub-tropical tropopause

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We use measurements from the Pre-AVE campaign and backtrajectories including a parametrisation of diffusive processes, to determine the mixing time-scale and to identify the relative cross-tropopause pathways at the tropopause.

In the sub-tropical latitudes, troposphere-stratosphere exchanges generate the so-called extra-tropical tropopause layer where species mix within one to two kilometers above the tropopause. In this region, the observed straight lines in the tracer-tracer space have been previously interpreted as a result from the mixing between tropospheric and stratospheric air. We apply our method at the sub-tropical tropopause to confirm quantitatively this interpretation showing that the mixing line can be described in terms of stratospheric air proportion for turbulent, diffusive, transport over a time scale of a week. This time scale is that of baroclinic perturbations producing quasi-isentropic cross-tropopause motions and subsequent mixing.

Extending our method to the tropical region, we show that tracer profiles above the tropical tropopause can also be described as mixing lines resulting from a combination of average vertical transport and diffusion. Over the range of one month, most of the back-trajectories launched along flight track below  $\theta = 420\text{K}$  come from the TTL, the rest coming from the boundary layer or the lower stratosphere. As a result we emphasize that vertical diffusive processes on the seasonal scale influence the tropospheric air newly entered in the tropical stratosphere, leading to the formation of mixing lines above the tropopause. We discuss also how data from other tropical campaigns (STRAT, CR-AVE) match these findings.