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Cross-isentropic mixing: A DEEPWAVE case study

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The tropopause acts as a transport barrier between the upper troposphere and the lower stratosphere. Non-conservative (i.e. PV changing) processes are required to overcome this barrier. Orographically generated gravity waves (i.e. mountain waves) can potentially lead to cross-isentropic fluxes of trace gases via the generation of turbulence. Thus they may alter the isentropic gradient of these trace species across the tropopause.

The specific goal of this study is to identify cross-isentropic mixing processes at the tropopause based on the distribution of trace gases (i.e. tracer-tracer correlations). Based on airborne in-situ trace gas measurements of CO and N₂O during the DEEPWAVE (Deep Propagating Gravity Wave Experiment) campaign in July 2014 we identified mixing regions above the Southern Alps during periods of gravity wave activity. These in-situ data show that the composition of the air above the Southern Alps change from the upstream to the leeward side of the mountains indicating cross isentropic mixing of trace gases in the region of gravity wave activity.

We complement our analysis of the measurement data with high resolution operational analysis data from the ECMWF (European Centre for Medium-Range Weather Forecasts). Furthermore, using potential vorticity and stability parameters.

Using 3D wind fields, data from Graphical Turbulence Guidance (GTG) system and in-situ measurements of the vertical wind we identify occurrence of turbulence in the region of mixing events. Using wavelet analysis, we could identify the spatial and temporal scales of local trace gas fluxes. We also give estimates of cross-isentropic flux, i.e. we want to quantify the mixing in terms of exchange.