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LUAMI – Tomography of a Deep Stratospheric Air Intrusion

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Extensive vertical sounding of water vapour, ozone and aerosol during LUAMI (Lindenberg Upper-Air Methods Intercomparison), combined with transport modelling, yielded a detailed three-dimensional picture of a deep stratospheric intrusion event over Central Europe on October 17, 2008. The measurements were carried out at four observational sites, Payerne (Switzerland), Bilthoven (The Netherlands), Lindenberg (North-East Germany) and the Zugspitze mountain (Garmisch-Partenkichen, German Alps) and by an air-borne water-vapour lidar system creating a transect of humidity profiles between all four stations. A high data quality was verified that strongly underlines the scientific findings. The intrusion layer was very dry with minimum mixing ratios of 0 to 65 ppm on its lower west side, but did not drop below 120 ppm on the higher-lying east side (Lindenberg). The dryness hardens the findings of a recent study (T. Trickl, et al., Atmos. Chem. Phys. 14 (2014), 9941-9961) that, e.g., 73 % of deep intrusions reaching the German Alps and travelling six days and less exhibit minimum mixing ratios of 50 ppm and less. These values reflect mixing ratios found in the lowermost stratosphere, which suggests very low free-troposphere mixing during the descent of the air mass. The peak ozone values were around 70 ppb, confirming the idea that intrusion layers depart from the lowermost edge of the stratosphere. The data suggest an increase of ozone from the lower to the higher edge of the intrusion layer. This behaviour is also confirmed by the vertical distribution of stratospheric aerosol of presumably volcanic origin caught in the layer. Both observations are in agreement with the idea that sections of the vertical distributions of these constituents in the source region were transferred to Central Europe without major change. Cross sections of the tropopause fold were prepared along the transport path, implying intersections with LAGRANTO trajectories. The trajectories confirmed the rather shallow outflow the stratosphere from just above the dynamical tropopause, for the first time confirming the conclusions of Trickl et al. (2014) from the Zugspitze CO observations. The trajectories qualitatively explain the temporal evolution of the intrusion layers above the four stations participating in the campaign.