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Long range transport of Peroxy acetyl nitrate (PAN) at Jungfraujoch from different source regions

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PAN (Peroxyacetyl nitrate) is a major constituent of photochemical pollution, formed from NOx and volatile organic compounds (VOC) photochemistry. The lifetime of PAN is a strong function of temperature, hence in the cold upper troposphere it acts as reservoir for NOx and plays a key role in transporting nitrogen species during intercontinental transport. However, PAN from intercontinental sources is not well quantified and long term continuous PAN measurements are still lacking at global scale. In our study we present all the available PAN measurements performed at high alpine observatory, Jungfraujoch (Switzerland, 3580 m asl) including the years 1997-1998, 2008 and 2009-2010. In addition, the time series of PAN (2004 - 2008) from another alpine site, Zugspitze (Germany, 2960 m asl) is also evaluated and compared with Jungfraujoch measurements. PAN measurements from both alpine sites show a strong seasonal variation with strongly peaking values in spring. In order to trace the origin of air masses, backward trajectory analysis was performed at hemispheric and continental scale. To evaluate the contribution of long range (intercontinental) transport on the PAN concentrations at Jungfraujoch, 20 day backward trajectories were calculated based on the global ECMWF data with horizontal resolution 1 deg x 1 deg. PAN measurements were attributed mainly to three continental source regions; Europe, North America and Asia based on the recent boundary layer contact of air masses. The results show that the largest concentrations of PAN were found in the air advected from the European planetary boundary layer, while the North American source region showed about a factor 2 lower concentrations than the European air masses. The largest contribution of North American air masses was found in spring and summer season. The frequency of Asian air masses at JFJ was found to be very small, but these air masses were associated with significant PAN concentrations. The most important contributor, Europe, was characterized by means of continental scale trajectories using COSMO (Consortium for Small-scale Modeling) model data, which cover the European domain with a horizontal resolution of 7 km x 7 km. The trajectory analysis showed that the high PAN concentrations of spring 2008 at both sites were related to the air masses coming from north-easterly advection and having contact in the northern Italy including Po valley. However, the results indicate also that the high PAN concentrations of spring 2008 were strongly related to blocking anticyclonic conditions, which persisted in Central Europe for several days. These special conditions may lead to a meteorological bias that needs to be taken into account when interpreting the measurements.