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Vertical distribution of HO_x concentrations driven by boundary layer dynamics

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The hydroxyl (OH) and hydroperoxy (HO_2) radicals are key compounds for the degradation of pollutants in the atmosphere. Therefore, accurate and precise measurements of HO_x radicals (= OH + HO_2) at different altitudes and in different regions are necessary to test our understanding of atmospheric chemical processes. The planetary boundary layer (PBL) is of special interest as it is chemically the most active part of the atmosphere. Until today, there is a general lack of measurements investigating the distribution of radicals, trace gases, and aerosols in the PBL with high spatial resolution.

Here, we present results of measurements performed in June/July 2012 in the Po valley region in Italy as part of the Pan-European Gas-AeroSOls-climate interaction Study (PEGASOS). A Zeppelin NT was used as an airborne platform for measurements of HO_x radical concentrations and total OH reactivity (kOH) applying a remotely controlled Laser Induced Fluorescence (LIF) instrument. In addition a comprehensive set of other trace gases (O_3, CO, NO, NO_2, HCHO, HONO, VOCs), photolysis frequencies, particle number concentration, and meteorological parameters were measured. During the morning hours, a layered atmospheric structure with vertical gradients in trace gas concentrations was observed. In altitudes larger than 600 m above ground, air masses with low trace gas concentrations (NO_x < 500 ppt, kOH < 3 s^{-1}) were probed, whereas air masses in altitudes below 100 m above ground were influenced by ground emissions resulting in higher trace gas concentrations (NO_x > 6 ppb, kOH > 6 s^{-1}). The airship Zeppelin NT was used to perform localized height profiles between 75 and 900 m above ground in order to investigate the influence of these trace gas gradients on HO_x radical concentrations. Due to changing chemical conditions, the measured OH concentration shows a variability with height up to a factor of 2.5 and for the measured HO_2 concentration up to a factor of 5. Additionally, we present box model calculations of HO_x to identify the processes driving the radical chemistry and its change in concentration with height.