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Airborne measurements of nitrous acid and its budget in the planetary boundary layer

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Nitrous acid (HONO) is an important trace gas in the atmosphere due to its contribution to the cycles of nitrogen oxides (NO_X) and hydrogen oxides (HO_X). In the past decades, most HONO observations were performed at ground level, and only a few HONO gradient measurements were reported for the lowest 100 m of the planetary boundary layer (PBL). In most field measurements, it is found that the ambient HONO concentrations cannot be explained by the known gas-phase chemistry alone. Additional HONO production is needed, and heterogeneous production at ground and on aerosol surfaces was proposed.

Within the framework of PEGASOS, an instrument for ambient HONO measurement using the LOPAP technique was setup together with instruments measuring HO_X radicals, NO_X, photolysis frequencies, and other parameters on board the airship Zeppelin NT. During two field campaigns in the Netherlands and in Italy, HONO and its gas phase sources and sinks were measured continuously in each flight, covering the altitude range from ground to 1 km. The measured daytime HONO mixing ratios ranged from 50 ppt to 1.2 ppb with an average value of 140 ppt. While a strong HONO gradient was found in early morning hours, it was vanishing with the breakup of the nocturnal boundary layer. Elevated HONO to NO_X ratios were observed at higher altitudes, indicating an enhanced HONO production. HONO simulations using a 1-D model indicate that the HONO production at higher altitudes cannot be explained by known processes, neither by gas-phase reactions nor by vertical mixing of HONO produced at ground surface. Therefore, in addition to the current knowledge of the atmospheric HONO budget, other HONO formation pathways are need to explain the field observations.