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Vertical distribution of meteorological and chemical quantities at Hohenpeißenberg (Germany): Results of SODAR-RASS, tethered balloon and ground based measurements (SALSA 2005)

J.-C. Mayer (1), K. Staudt (2), M. Kortner (1), M. Scheibe (1), S. Gilge (3), T. Foken (2), F.X. Meixner (1)

(1) Max Planck Institute for Chemistry, Biogeochemistry Department, P.O. Box 3060, D-55020 Mainz, Germany, (2) University of Bayreuth, Department of Micrometeorology, D-95440 Bayreuth, Germany, (3) Meteorological observatory Hohenpeißenberg, German meteorological service, Albin-Schwaiger-Weg 10, D-82383 Hohenpeißenberg

Inhomogeneous terrain induces several complexities to measurements within the atmospheric boundary layer. This does not only affect meteorological quantities like wind velocity, turbulence and stability, but also has considerable influence on trace gas mixing ratios.

From mid of August to end of September 2005 a field campaign (SALSA 2005) was performed at Hohenpeißenberg (996 m a.s.l.), an isolated hill in southern Germany. Mixing ratios of non-reactive (CO_2, H_2O) and reactive (O_3, NO, NO_2) trace gases have been continuously measured at the observatory of the German meteorological service at the summit of Hohenpeißenberg and at two foothill stations (750 m and 710 m a.s.l., respectively).

The atmospheric boundary layer was profiled by using a SODAR-RASS system. It provided 5 minute mean profiles of wind velocity, turbulence parameters and acoustic temperature up to 500 m a.g.l. Additional soundings were performed by means of a tethered balloon, providing profiles of wind velocity, temperature, relative humidity, O_3 and CO_2 mixing ratios up to 450 m a.g.l.

Mean wind flow was classified as follows: (a) westerly winds, (b) easterly winds and (c) days with oscillating (East-West) wind directions. For these classes, diel variations

of atmospheric stability and mixing ratios of trace gases are analysed. Furthermore, the occurrence of exceptional patterns in the time series of trace gas mixing ratios is investigated.

The static stability of the nocturnal boundary layer is found to be strongest for case (c), with gradients of potential temperature of 0.15 Km^{-1} for the lowest 40 m a.g.l. and 0.04 Km^{-1} for the first 300 m a.g.l. For cases (a) and (b), potential temperature gradients only reached values of 0.09 Km^{-1} over the lowest 40 m a.g.l. and 0.02 Km^{-1} for the first 300 m a.g.l. The onset of the development of an unstable stratified boundary layer varied clearly between the classes, while the re-establishment of the stable boundary layer (due to radiative cooling) occurred at similar times for all cases.

Nighttime measurements of O_3 at the foothill stations are compared to the (reference) station at the hill top. The depletion of O_3 during night is found to be strongest for class (c) (35 ppb) and weakest for class (a) (13 ppb). For well mixed day time conditions, 2 to 6 ppb O_3 were “missing” at the foothill stations compared to the reference, depending on the case.

Between 09:00 and noon, remarkable drops of O_3 mixing ratio (lasting up to 1.5 hours) at the hill top were frequently observed. They were associated with simultaneous peaks of NO, NO_2 and CO. These patterns are only found in the oscillation case (c).

We will present vertical distributions and mean characteristics of meteorological and chemical quantities for the different classes. An explanation of the exceptional O_3 depletion events will be given.