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Nördlinger Ries campaign on Soil Emissions (NORISE) - DOAS measurements of NO_2 and HCHO in an agricultural region

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Soil is a major source of total nitrogen oxide (NO_x = NO + NO_2) emissions with a fraction of about 15% on a global basis. Soil emissions, stemming from bacterial emissions of NO, are controlled by abiotic and microbiological processes which themselves depend on ambient environmental conditions like soil type, moisture content, temperature as well as agricultural management practices such as fertilization. In recent laboratory experiments it was found that dry soils also exhibit enhanced emissions of several volatile organic compounds (VOC) including HCHO when first wetted.

At present, studies on soil emissions in humid climates are limited to point samples and laboratory measurements. Thus, a campaign was organized that is dedicated to the analysis of trace gases which are potentially emitted from soils over an entire area using ground based mini-MAX-DOAS measurements. Since soil emissions are assumed to be highest from lands predominantly used for agriculture, the Nördlinger Ries in Bavaria, Germany, a 25 km wide circular plain formed by a meteor impact about 14.5 million years ago, was chosen which nowadays is dominated by arable land.

The main objective of the NORISE campaign was to characterize trace gas levels in a highly agricultural environment. The time frame, consequently, covered a whole growing season from April 2014 to January 2015. The focus was on trace gases which can be measured using the DOAS approach in the UV/VIS spectral range, i.e. NO_2 and HCHO, using two mini-MAX-DOAS instruments and one long-path DOAS instrument.

The retrieved NO_2 and HCHO column densities were examined for long-term variations over the entire growing season and short-term events which are both linked to environmental conditions like precipitation patterns and temperature changes. In addition, the analysis of soil samples taken from fields, distinguished between organic and conventional cultivation, gives further insights into soil activities.

In this work, we present updated results on data comparisons for the three DOAS-type instruments with special focus on data which is filtered for specific wind directions as well as cloud conditions. Furthermore, to evaluate the sources of NO_2 and HCHO, their height distribution are studied in detail based on profile inversions.