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Cloud-Aerosol Interactions under high reactive Nitrogen concentrations: First highlights from chamber and field experiments of the CAINA project

Ulrike Dusek¹, Jinglan Fu^{1,2}, Marije van de Born¹, Harald Saathoff², Willem Kroese³, Rupert Holzinger³, Juliane Fry⁴, Birgit Wehner⁵, Namita Sinha⁶, Herman Russchenberg⁶, George Biskos⁷, Tuija Jokinen⁷, Johannes Schneider⁸, and the the CAINA team*

¹Centre of Isotope Research, University of Groningen, Groningen, the Netherlands

²Institute of Meteorology and Climate Research-Atmospheric Aerosol Research (IMK-AAF), Karlsruhe Institute of Technology, Karlsruhe, Germany

³Institute for Marine and Atmospheric research Utrecht (IMAU), Utrecht University, Utrecht, The Netherlands

⁴Meteorology and Air Quality, Wageningen University and Research, Wageningen, the Netherlands

⁵Department of Atmospheric Microphysics, Leibniz Institute for Tropospheric Research, Leipzig, Germany

⁶Faculty of Civil Engineering and Geosciences, Delft University of Technology, Delft, the Netherlands

⁷Climate and Atmosphere Research Center (CARE-C), The Cyprus Institute, Nicosia, Cyprus

⁸Aerosol Chemistry Department, Max Planck Institute for Chemistry, Mainz, Germany

*A full list of authors appears at the end of the abstract

The goal of the CAINA (Cloud-Aerosol Interactions in a Nitrogen-dominated Atmosphere) project is to investigate multiple aspects of aerosol-cloud interactions under high concentrations of reactive nitrogen. This chemical regime is starting to emerge in many regions following the strong reduction of SO₂ emissions, but is already firmly established at our study location in the Netherlands. CAINA is a consortium project that aims to combine in-situ and remote sensing observations of aerosols and clouds with chamber experiments and high-resolution modelling to study the formation of CCN, cloud chemistry, and aerosol effects on clouds.

This talk will present first highlights of the CAINA project focussing on the cloud chamber experiments and the field campaign conducted in March/April 2025.

Extensive studies in the AIDA cloud chamber have shown that substantially more secondary organic aerosol is formed under high humidity (80-90%) than at dry conditions, when liquid seed particles are present. This is accompanied with distinct differences in the chemical composition of the formed SOA. We can show considerable formation of secondary organic aerosol in the aqueous phase and that the presence of ammonium nitrate in the particles causes the formation of organic nitrogen species and other higher-order reaction products.

First results from the field campaign at a coastal and a regional background site in the Netherlands highlight the high ammonium nitrate contributions to the aerosol mass concentration and especially high gas-phase NH₃ concentrations (up to 50 mg m⁻³) during the field campaign,

indicating a chemical regime dominated by reactive nitrogen and relatively high aerosol pH. Further highlights include strong new particle formation events, as well as distinct differences in particle chemical composition between the ground and at 250 m height, particularly when clouds were overhead. A potential effect of nitrogen pollution on cloud properties will be investigated, combining ground-based data, remote sensing by cloud profilers, and in-situ cloud measurements using the helicopter-borne cloud probe ACTOS.

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CAINA: <https://sites.google.com/view/cainaproject/>

the CAINA team: Isabelle Steinke, Barbara Ervens, Mira Pöhlker, Maarten Krol, Pascale Ooms, Holger Siebert, Hans-Christian Clemen, Laurie Novak