Comparative study of atmospheric particle formation using laboratory tools - COMPASS

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Abstract
A novel gas- and particle phase twin chamber has been constructed and tested for its use under real atmospheric conditions. It allows investigation of particle formation mechanisms as well as of the impact of certain parameters on the present conditions. It applies laboratory tools but uses ambient concentrations and conditions. In a first set of experiments particle formation in the urban area of Frankfurt have been conducted comparatively by either enhancing ozone in one of the chambers or by reducing the solar radiation intensity. Both parameters revealed significant effects on number and mass concentration resulting in a remarkable potential aerosol number and mass currently not produced. This has important implications for future emission budget calculations, local traffic and pollution strategies and for human health.

Introduction
New aerosol number and mass formation in the atmosphere includes a variety of precursor gases and processes with some of them known and intensively studies and others so far unknown or unexplained. This derives of the basic problem that there is currently no instrument that can accurately chemically analyse clusters and smallest particles in the ambient. However a notable fraction of these particles can affect human health and can grow to sizes beyond around 70 nm in diameter, at which it may act as cloud condensation nuclei and modifies the regional radiation budget. Because of this a better understanding of the chemistry and the controlling processes for the particles formation is required.

Methods
In order to bypass the analytical problem of small particle composition a novel twin chamber transparent to light was constructed. Both chambers consisted of ETFE foil, cylindrical in shape and acted as vertical laminar flow chambers with a total volume of 400 L and a residence time of (26.4±0.3) min. Both chambers were positioned in that way that they faced similar sunlight intensity and temperature and used the comparative method. Therefore one chamber was used as a reference (no. 2), while the conditions in the first one were modified to test the impact of certain parameters.

Experimental
First ambient experiments have been conducted at urban conditions (Campus Riedberg, Frankfurt/Main) during October and November. Intercomparison experiments using both chambers unmodified displayed no significant difference in the measurements of both chambers. Next, we enriched the present ozone level in chamber 2, while in a second period the second chamber was darkened to study the influence of OH chemistry.

Both parameters clearly displayed notable effects under urban conditions. Enhanced ozone (up to 70 ppb_v) increased both, i.e. particle number concentration and particle mass above 10 nm in diameter within 26 min residence time substantial (more than 40%, see Fig. 1). On the contrary, darkening of one of both chambers led to a decrease of number and mass concentration although temperature in the particular chamber was reduced due to the coverage with aluminium foil. Investigation of organic gases by proton transfer reaction-mass spectrometry revealed several potential candidates for precursors.

In total the new movable twin chamber displayed its functionality and capability to study ambient particle formation under different atmospheric conditions.

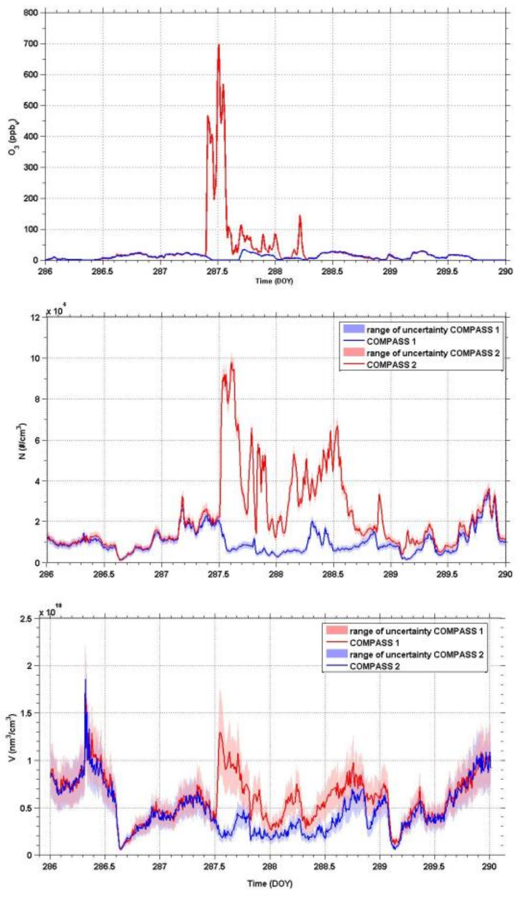

Figure 1. O_3 mixing ratio, particle number and volume concentration in both chambers during O_3-enrichment.