UP 3: Atmosphere - Aerosols

Time: Tuesday 14:00–15:45 Location: H41

Invited Talk UP 3.1 Tue 14:00 H41

Nucleation, life cycle and climate impact of contrail cirrus - new insights — •Christiane Voigt — Deutsches Zentrum für Luft- und Raumfahrt (DLR) — Johannes Gutenberg-Universität Mainz

Current growth rates in aviation demand a profound scientific data base in order to accurately assess the aviation impact on climate. A major contribution results from contrail cirrus and their radiative forcing is suggested to outbalance aviation CO2 and NOx effects. Direct observations of contrail cirrus throughout their life cycle are scarce and prone to substantial ambiguities currently limiting our understanding of the climate impact by aviation.

Here, we give new insights into the nucleation, growth, life cycle and climate impact from contrail cirrus based on results from suite of recent aircraft experiments. NASAs ACCESSII mission focusses on aircraft emissions and initial stages of contrail formation. Nascent contrails were detected at cruise altitudes near 100 m distance to the engine exit. Contrail growth to 10-min contrail age is investigated during DLRs CONCERT campaigns. Finally, the objective of the ML-CIRRUS experiment with the HALO research aircraft is to study the life cycle and climate impact of contrail cirrus with a novel in-situ/remote sensing payload. The contrail measurements are related to previous observations and discussed in the context of recent developments in contrail modeling. Highlights include the quantification of the effects of aircraft type, engine technology and alternative fuels on contrail microphysics and climate.

UP 3.2 Tue 14:30 H41

Studying the limitations of stratospheric aerosol injections using the IPSL climate model — •Christoph Kleinschmitt[1,2], Olivier Boucher[2], and Ulrich Platt[1] — [1]Institute of Environmental Physics, Heidelberg University, Germany — [2]Laboratoire de Météorologie Dynamique, Paris, France

Climate Engineering (CE) is currently being discussed as an option to prevent or at least reduce the magnitude of global warming. Basically there are two types of CE: 1) removing greenhouse gases (i.e. CO_2) from the atmosphere, 2) direct modifications of the Earth's radiation budget. Of the latter type stratospheric aerosol injection (SAI) in analogy to major volcanic eruptions is probably the most prominent of the proposed techniques. Numerous modeling studies on SAI and its effect on climate have been published during recent years (e.g. in the framework of the geoengineering model intercomparison project), mostly proving its power to reduce the global mean surface temperature significantly, but also revealing potential risks and undesirable side effects on the climate system.

For a robust estimate of the cooling potential of SAI we developed a 3D aerosol model with a sectional approach fully coupled to the radiative scheme and other aspects of the IPSL climate model. This allows us to study physical effects limiting the radiative forcing, such as absorption and reemission of infrared radiation, particle growth through condensation and coagulation and changes in particle lifetime due to transport within the stratosphere. Recent results of climate simulations under various SAI scenarios will be presented.

UP 3.3 Tue 14:45 H41

Potential ice multiplication mechanism associated with freezing of large drizzle droplets — •Annika Lauber, Mona Schätzle, Patricia Handmann, Thomas Pander, Alexei Kiselev, and Thomas Leisner — Atmospheric Aerosol Research Department, Institute for Meteorology and Climate Research, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

At temperatures above -38°C freezing of a cloud droplet requires an ice nucleating particle (INP). However, at temperatures above -12°C ice particles have been found in concentrations exceeding the number of INPs by 10^4. A possible explanation for this discrepancy is the fragmentation of supercooled drizzle drops at freezing.

To investigate this process, we are observing levitated freezing droplets with a high-speed video camera (up to 200,000 fps). Records of more than 10,000 individual freezing events already allowed the identification of two potentially important ice multiplication pathways: the expulsion of bubbles during the ice shell formation and the fragmentation of a droplet due to the growth of internal pressure.

To explore the fragmentation of large freezing drops, we have modified our setup to allow levitation of water drops with diameters of up to 500 μm. Based on the former and recently obtained measurement data, we discuss the size and temperature dependence of the suggested ice multiplication mechanism and its potential implication for cloud microphysics.

UP 3.4 Tue 15:00 H41

Diesel vehicle generated nanoparticles with maximum lung intrusion efficiency: Formation, effects, and recent findings — •Frank Arnold[1,5], Liisa Pirjola[2,3], Topi Roenkoe[4], Ulrike Reichl[1], Hans Schlager[5], Tero Laehde[2,4], Jirki Heikkilae[4], and Jorma Keskinen[4] — [1]Max Planck Institute for Nuclear Physics (MPIK), Heidelberg, Germany — [2]Department of Technology, Metropolia University of Applied Sciences, Helsinki, Finland — [3]Department of Physics, University of Helsinki, Finland — [4]Aerosol Physics Laboratory, Department of Physics, Tampere University of Technology, P.O. Box 692, FIN-33101 Tampere, Finland — [5]Deutsches Zentrum fuer Luft und Raumfahrt (DLR), Oberpfaffenhofen, Germany

Modern Diesel vehicle exhaust after-treatment systems (ATS) can promote formation of low-vapor-pressure gases, which may undergo nucleation and condensation, leading to nucleation particles(NUP). NUP have diameters around 10-20 nm, which allow intrusion, with maximum efficiency, of the deepest and most vulnerable region of the hunman lung. Indications for adverse health effects of NUP have increased during recent time. However, NUP are presently not regulated by legislation. The chemical nature and formation mechanism of NUP are only poorly explored. Here, we present novel online measurements of NUP precursor gases and NUP, conducted in Diesel vehicle exhaust. We find that strong acids (particularly sulfuric acid and certain di-carboxylic acids)are efficient drivers of NUP formation and early growth. Interestingly, their formation is increased by modern Diesel exhaust after-treatment systems. Diesel NUP deserve increased future attention.

UP 3.5 Tue 15:15 H41

Temperature-dependent formation of NaCl dihydrate in levitated sea salt aerosol particles — •Andreas Peckhaus, Alexei Kiselev, and Thomas Leisner — Karlsruher Institut für Technologie (KIT), Karlsruhe, Deutschland

The temperature-dependent formation of NaCl dihydrate in effloresc-ing pure NaCl solution droplets and synthetic sea salt aerosol (SSA) particles was investigated with an electrodynamic balance (EDB). A higher formation of NaCl dihydrate at warmer temperatures (>-20°C) was obtained for SSA particles. A possible mechanism triggering the formation of NaCl dihydrate in SSA particles is discussed. Furthermore a comprehensive derivation of the temperature-dependent homogeneous nucleation rate coefficients for pure NaCl solution droplets is given and used to reconcile previous results.

UP 3.6 Tue 15:30 H41

Meteorology and ultrafine aerosols, an airborne study — •Wolfgang Junkermann — Karlsruhe Institut für Technologie, IMK-IFU

The horizontal and vertical distribution of aerosols in the lower troposphere and planetary boundary layer is affected by efficient transport and mixing processes. For example aerosol transport can be followed over several hundred km with small airborne platforms in case of well defined aerosol sources which increase the particle number concentrations significantly above typical background values. Such *plume* studies also allow compare with and to investigate the spatial and temporal patterns of particle number and size distributions as observed from ground based field studies. Airborne measurements using ultralight aircraft were performed all over Germany covering in situ fine and ultrafine particle size distributions and (micro)meteorological data. Based on in situ data and additional HYSPLIT backtrajectories major individual particle sources were identified and quantified and their impact on rural and urban environments on a regional scale downwind studied. The results are well in agreement with recent observations of aerosol spatial, temporal and size distributions in the ultrafine size spectrum and confirm the dominant role of meteorological processes on aerosols not only in the lower troposphere but also for ground level investigations.