2023 Helmholtz – OCPC – Programme

for the involvement of postdocs in bilateral collaboration projects

PART A

Title of the project:

Physico-chemical characterization of formation and aging processes of secondary organic aerosols

Helmholtz Centre and/or institute:

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Description of the project (max. 1 page)**:**

Secondary organic aerosol (SOA) components represent a large fraction of tropospheric aerosol particles with a strong impact on atmospheric chemistry, climate, and air quality (Hallquist et al., 2009). While gas phase oxidation of biogenic volatile organic compounds is their major source, also anthropogenic emissions of volatile organic compounds as well as NO_x, SO_2 and NH_3 have significant impact on their properties. Furthermore, they typically mix with salts like ammonium sulfate, nitrate or primary particles like mineral dust during their atmospheric lifetime. Understanding the role of SOA for our atmosphere cannot simply be achieved by detailed model approaches due to the vast number of chemical components involved and the complexity of their mixing state, which strongly depends on temperature and relative humidity. Therefore, realistic simulation chamber experiments and dedicated field studies are required to improve aerosol process parameterizations in transport models and to validate them, respectively.

Goal of this project is to do field and simulation chamber studies of SOA formation and aging for typical marine and continental precursor mixtures and seed particles to develop and validate corresponding transport model parameterizations. In recent years, multiphase reactions that happen on the surface and in the bulk of aerosol have been proven to be important to impact aerosol formation, composition, as well as their optical and cloud formation properties (Pöschl and Shiraiwa, 2015; Bianco et al., 2020). However, many parameters of such kind of reactions are still lacking and not been considered in models. In this project, we will pay attention to some key multiphase reactions to investigate their mechanisms and resulting aerosol properties. Aerosol photochemistry and cloud processing will be studied in well-defined scenarios (e.g. marine, urban) in the unique AIDA aerosol and cloud simulation chamber at KIT but also in field campaigns at dedicated locations with significant emissions of BVOC, NO_x and ammonia. Aerosol chemical composition will be measured on-line by modern mass spectrometers (FIGAERO-CIMS, CHARON-PTR-MS, and AMS) in gas and particle phase (Huang et al., 2019). Furthermore, particle absorption, volatility, and hygroscopicity will be observed. Based on the analysis of this data, major chemical aging processes will be identified for different scenarios and weather conditions and parameterized. These parameterizations will potentially be implemented in the modern transport model ICON-ART for improved prediction of formation and aging of tropospheric aerosol (Shen et al., 2019).

The research objectives will be focused depending on the qualifications of the Postdoc so that publication of first results is possible within the project time.

Bianco et al., 2020, Photochemistry of the cloud aqueous phase: A review, Molecules 25, 1–23, https://doi.org/10.3390/molecules25020423.

Hallquist et al., 2009, The formation, properties and impact of secondary organic aerosol: current and emerging issues, Atmos. Chem. Phys., 9, 5155–5236, https://doi.org/10.5194/acp-9-5155-2009.

Huang et al., 2019, Chemical Characterization of Highly Functionalized Organonitrates Contributing to Night-time Organic Aerosol Mass Loadings and Particle Growth, Environ. Sci. Technol., 53, 1165-1174, DOI: 10.1021/acs.est.8b05826.

Pöschl and Shiraiwa, 2015, Multiphase chemistry at the atmosphere−biosphere interface influencing climate and public health in the Anthropocene, Chem. Rev., 115, 4440−4475, https://doi.org/10.1021/cr500487s.

Shen et al., 2019, Composition and origin of PM2.5 aerosol particles in the upper Rhine valley in summer, Atmos. Chem. Phys., 19, 13189–13208, https://doi.org/10.5194/acp-19-13189-2019.

Description of existing or sought Chinese collaboration partner institute (max. half page)**:**

We plan to have a cooperation with the Shanghai Key Laboratory of Atmospheric Particle Pollution and Prevention (LAP) and the Department of Environmental Science and Engineering, Fudan University, Shanghai. They are studying the impact of atmospheric chemistry and aerosols on air quality and regional climate using field measurement, modelling and remote sensing with great success. With the project, we hope to build collaboration with Fudan University and LAP on studying atmospheric chemistry, aerosols and cloud processes employing the complementary capabilities and scientific experiences of the partners.

Required qualification of the postdoc:

- PhD in Environmental Sciences, Atmospheric Chemistry or related fields
- Experience with atmospheric chemical processes and aerosols
- Additional skills in chemical analytics (MS) and field studies
- Language requirement: fluent in English

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