2023 Helmholtz – OCPC – Programme

for the involvement of postdocs in bilateral collaboration projects

PART A

Title of the project:

Investigation of the chemical degradation of volatile organic compounds from cooking emissions in urban air

Helmholtz Centre and/or institute:

Forschungszentrum Jülich GmbH

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

The electrification of cars together with effective governmental policies have strongly improved air quality by reducing the levels of volatile organic compounds (VOC) connected to traffic emissions as well as of nitrogen oxides (NOx) in cities all around the world. Therefore, the chemical composition of air pollutants in urban areas is changing. New chemical molecules are becoming now more relevant such as volatile chemical products (VCP) e.g. from solvent evaporation and cooking emissions (Coggon et al., 2021). Cooking emissions are dominated by long-chained aldehydes (e.g., octanal, nonanal) (Klein et al., 2016) and not much is known about their chemical degradation and potential for formation of harmful secondary pollutants such as ozone and aerosol once they have reacted with the hydroxyl radical (OH), the most important atmospheric day-time oxidant. Recent studies highlighted that the chemistry of the peroxy radicals (RO_2) formed from the reaction chain of these aldehydes with OH have access to fast isomerization reactions which leads to the formation of hydroperoxycarbonyls. These isomerizations pathways will become more prominent with decreasing concentrations of nitric oxide (NO). Theoretical calculation suggest that these hydroperoxycarbonyls can photolyze at a fast rate (~ 10^{-4} s^{-1}) (Liu et al., 2018) with the possibility of forming OH radicals and hence enhancing the oxidation capacity of the atmosphere. Several field campaigns have shown missing OH radical sources in particular for environments with large

concentration of volatile organic compound and low levels of NO (Hofzumahaus et al., 2009; Whalley et al., 2011). Photolysis of hydroperoxycarbonyls could constitute a so far ignore source that could have impacts for global predictions of air pollutants.

Within this project experiments in the outdoor atmospheric simulation chamber SAPHIR located in the host institution will be performed aiming for a better understanding of the chemical degradation pathways of long chained aldehydes emitted from cooking activities. This will include a better characterization of the photolysis rate of hydroperoxycarbonyls and product speciation. The SAPHIR chamber allows for experiments to be performed at ambient-like conditions using sunlight to initiate the chemistry. The impact of results are tested in regional and global model. The chamber is equipped with a large suite of instruments which includes measurements of inorganic species, photolysis frequencies, volatile organic compounds and oxygenated species. It also includes measurements of OH, hydroperoxyl (HO_2) as well as RO_2 radicals. Radical measurements will allow a complete investigation of the chemical OH budget helping to assess the importance of the phototolysis of hydroperoxycarbonyls as source of OH. In addition, the experiments will be embedded in a larger project/campaign which aims to investigate secondary organic aerosol and ozone potential from VCP.
The postdoc will be responsible for the execution of the experiments, the collection of radical data and data analysis and modelling of the results.

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

We have an ongoing cooperation with the College of Environmental Sciences and Engineering, Peking University, Beijing. Within this very fruitful cooperation we are investigating the chemical processes contributing to ozone formation focusing to understanding of pathways of formation and destruction of radicals. Together with our colleagues at PKU we have organized several field campaigns in different Chinese cities as well as several joint campaigns at the SAPHIR chamber. With the current project we hope to deepen the successful collaboration with PKU, especially with groups with interest in developing chemical mechanisms. The partner in the PR of China should be active in experimental work with experience in laboratory studies, preferably with some experience in box modelling.

Required qualification of the postdoc:

- PhD in Chemistry/Physics/Environmental Science
- Knowledge of atmospheric chemistry, experience with analytical instrumentation
- Additional skills in laboratory kinetic studies, box modelling
- Proficiency in English language

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