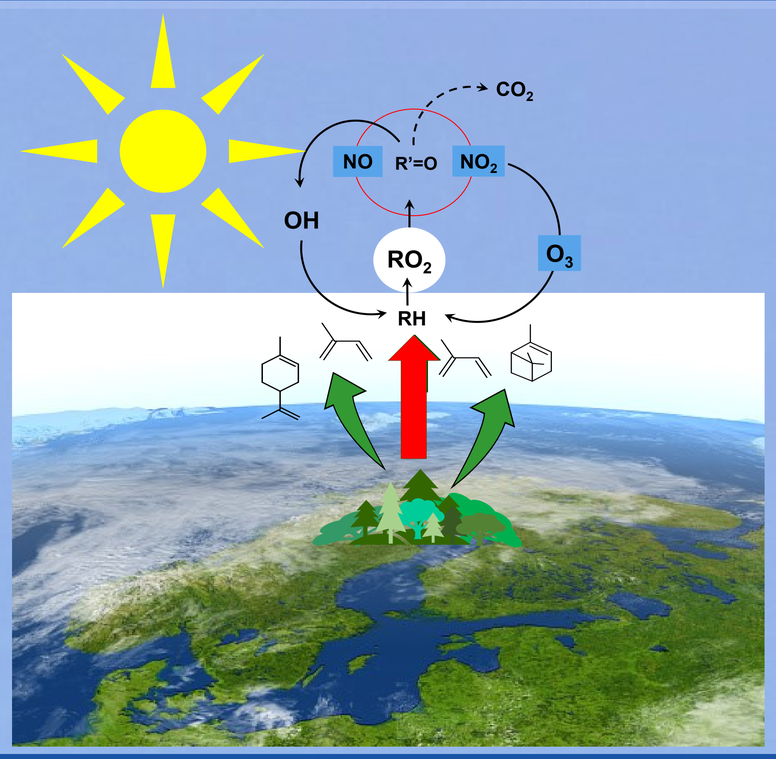
Physical Chemistry of the Atmosphere

Activities

Study chemical reactions and processes in Earth's atmosphere to

- understand the natural atmosphere
- understand air pollution
- characterize chemical drivers to climate change
- develop new techniques to monitor trace gases and particles in ambient air



The group

- Barbara Nozière, Professor
- Olivier Durif, Postdoc
- Manuella El. Haber, PhD student (co-sup. CNRS Lyon, France)

Soon:

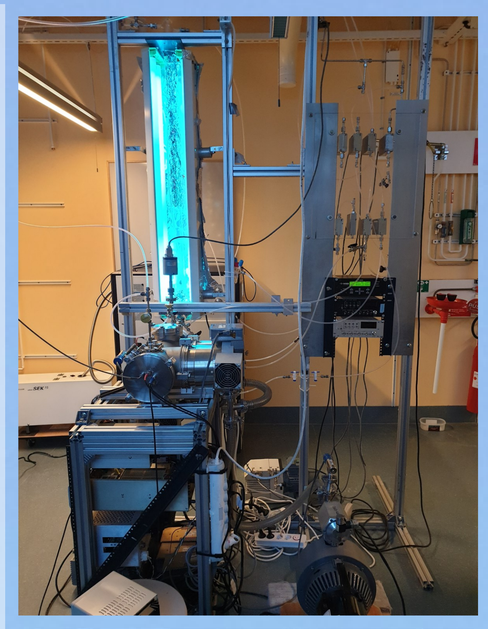
- Lauren Cork, PhD student
- Clara Strunz, PhD student (co-sup. IMT Lille, France)

Current projects

Chemistry & detection of organic radicals in ambient air
EPHEMERAL - ERC Advanced Grant (884532, 2021-2026)

Context: thousands of different organic radicals (peroxy, "RO_2" and Criegee intermediates) present in Earth's atmosphere and control its oxidizing capacity. Yet, never detected in the atmosphere (Criegees) or not individually (RO_2s detected as "total RO_2")

$\Rightarrow$ major uncertainties in the understanding of atmospheric chemistry

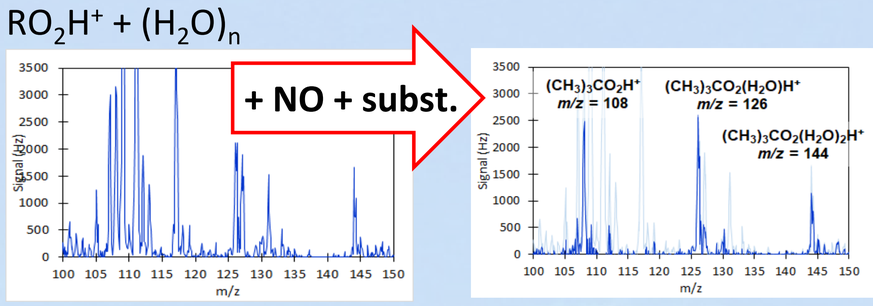


Objective: use/adapt Proton-Transfer-Reaction Mass Spectrometry, used until now for stable organic compounds, to the detection of individual radicals in ambient air and the study of their reactions in laboratory.

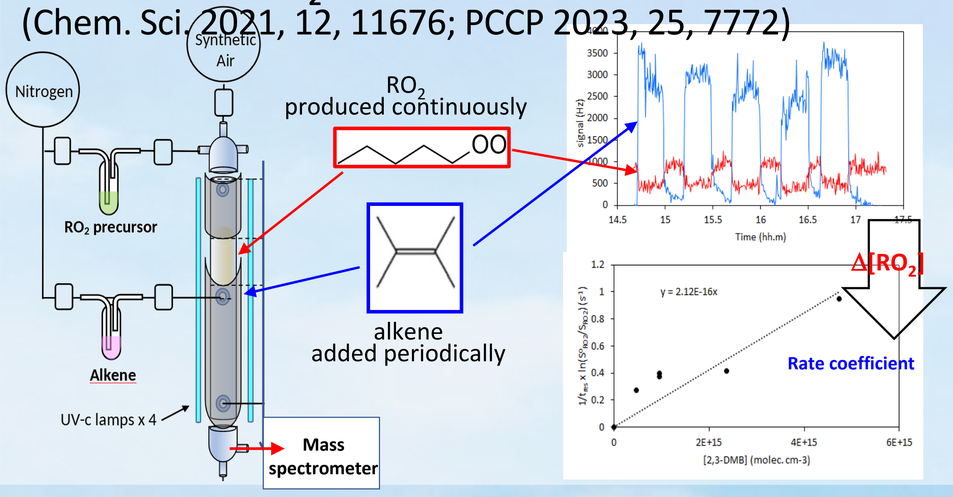
Ionization principle: $RO_2 + (H_2O)_nH^+ \rightarrow RO_2H^+ + (H_2O)_n$

Adding NO in the sampling line instantly supresses all RO_2 and allows, by subtraction, to identify them selectively in complex mixtures. Ex. $(CH_3)_3CO_2$ radical:

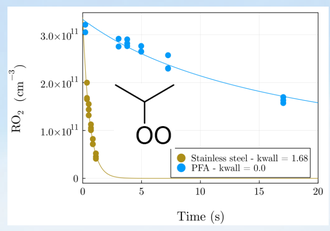
This allows to monitor these radicals in real time and study little-known reactions and processes, such as below.



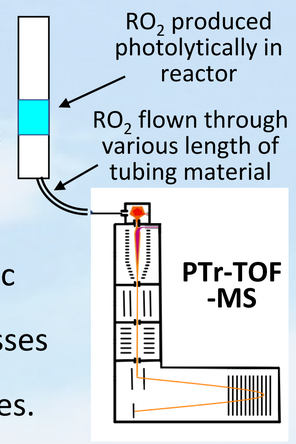
1. Reactions of RO_2 with alkenes in air
(Chem. Sci. 2021, 12, 11676; PCCP 2023, 25, 7772)

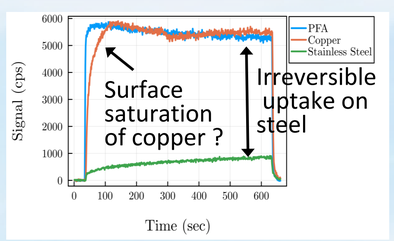


2. Real-time uptake of RO_2 by solid surfaces



The uptake of RO_2 was much larger on metallic surfaces (steel, copper) than on glass or polymers (PFA)



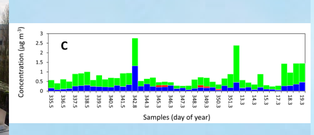


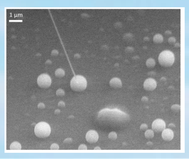
Real-time kinetic profiles show different processes occurring on different surfaces.

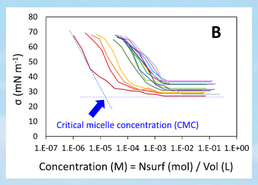
Organic surfactants in aerosol and their role in cloud formation (2021-2025)

Cloud droplets are formed exclusively by the condensation of water on aerosol particles. While surface tension is a key parameter in these processes, its role has long been neglected and little is known on the surfactants present in atmospheric aerosols.

The project has for objective to characterize the surfactants present in atmospheric aerosols and their properties.







anr French National Agency for Research

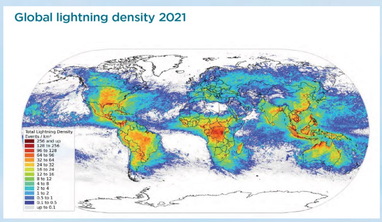
Swiss National Science Foundation

The role of lightning in Atmospheric Chemistry (2023-2026)

VETENSKAPSRÅDET THE SWEDISH RESEARCH COUNCIL

Although 1.5 billion lightning strokes occur every year in the atmosphere, their impact on atmospheric chemistry has hardly been studied.

The objective of this project is to study the effects of lightning on the chemistry of organic compounds In the atmosphere.



KTH – Chemistry Day, 26th May 2023