INTERNSHIP PROPOSAL

Laboratory name: LPENS
CNRS identification code: UMR 8023
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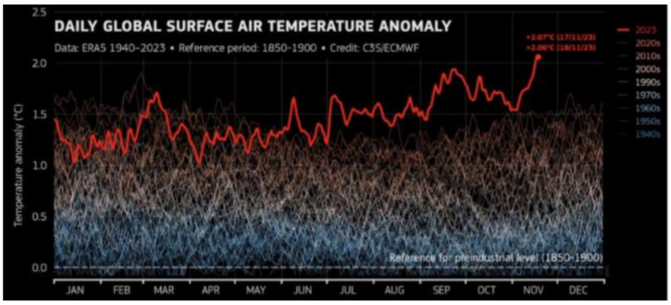
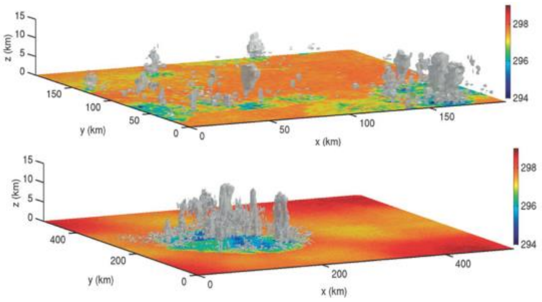
Internship location: LPENS (24 rue Lhomond, 75005, Paris)

Thesis possibility after internship: YES
Funding: POSSIBLY (ANR in course of evaluation)

Cloud microphysics and global warming

Autumn 2023 smashed the previous global temperature record. It implies a strong acceleration of global warming, transient or not, for which the most likely explanation is a decrease of human-made aerosols as a result of reductions in China and from ship emissions. The aim of the internship and the PhD thesis is to investigate cloud physics, in connection to global warming issues, using a combination of experimental, theoretical and numerical work, from the nucleation of nanodrops to the organisation of clouds.





Nucleation — In warm clouds, drops nucleate on condensation nuclei and grow by condensation. The partition of liquid water between the number of drops per unit volume and their size is still an open problem. Collisional aggregation induces a growth of drops in the submicron range, due to Brownian motion and above 10 µm, due to drop inertia. However, the collisional efficiency decreases by three orders of magnitude between 1 and 10 µm, explaining the relative stability of most clouds. In this range of sizes, both inertia and Brownian diffusion are negligible compared to viscous and electrostatic forces. Raindrops grow by accretion of smaller drops during their fall under the effect of gravity but how they cross the 1-10 µm size gap is an open question. Finally, nucleation in stirred environments is very sensitive to the mixing of heat, water vapour and nuclei. The aim of the training period will be to study this problem in a controlled experiment.

Convective aggregation — Satellite observations show that the shallow and deep clouds associated with atmospheric convection tend to cluster and form a wide diversity of spatial organisations, or patterns, at the mesoscale (20-200 km). The mesoscale organisation of convection is spontaneous (a phenomenon referred to as 'convective self-aggregation') and impacts the large-scale atmospheric state and precipitation extremes. Since this impact was subsequently confirmed by observations understanding the physical processes that control convective aggregation has become a Grand Challenge of the World Climate Research Programme. Despite its central role, the origin of convective aggregation remains an active field of research and debate. One open question is how the interplay between small thermal plumes (typically 100 m), clouds and mesoscale circulations contributes to organize convection. To solve this problem, the thesis will combine quantitative analysis of field observations, LES numerical simulations and laboratory experiments designed to guide the development of conceptual process-based models and parametrisations.

Condensed Matter Physics: NO Soft Matter and Biological Physics: YES
Quantum Physics: NO Theoretical Physics: YES