The atmospheric water cycle in Antarctica: how can novel water isotope measurements improve our understanding of the processes at play?

Future changes in the **Antarctic ice sheet mass balance** are a key source of uncertainty for future global mean sea level rise. In this context, it is critical to advance the understanding of the Antarctic atmospheric water cycle, through accurate reconstructions of its past variations over the last centuries, and reduced uncertainties in projections of its future changes.

This internship is proposed in the framework of the **ERC Synergy AWACA project**, where the overarching goal is to provide a groundbreaking understanding of the past, present and future atmospheric branch of the Antarctic water cycle. It brings together teams from the CNRS, CEA, Ecole Polytechnique and EPFL, working both on comprehensive monitoring along a transect from coastal Adelie Land to the high central plateau with novel measurements (surface meteorology, moisture fluxes, isotopic composition, cloud and precipitation properties), and advances in global and regional modelling.

Water isotopes in ice cores are classical tools to reconstruct past temperature variations in polar regions on a variety of time scales, spanning from the past 800,000 years (Jouzel et al., 2007) to the last millennia and centuries (Stenni et al., 2017; Casado et al, 2023). The physical link between temperature and water isotopic composition in polar regions ($\delta^{18}O$ or δD) results from the fractionation processes occurring along the distillation of water masses from the low latitude evaporation sources to the cold high latitudes. Recent technological developments in optical spectroscopy now offer the opportunity to continuously measure the water vapor isotopic composition thereby constraining the atmospheric pathway of moisture during synoptic meteorological events (e.g. Bonne et al., 2015; Leroy Dos Santos et al., 2023). **Water isotopes** hence come as a primordial tool to document the **past and present Antarctic water cycle**. However, extracting reliable information from water isotopes measurements is challenging as it requires to decipher and constrain multiple processes in the atmospheric column and at the surface, including sublimation, blowing snow, exchanges between surface snow and atmosphere, presence of supercooled liquid water in clouds.

The goal of this internship is to develop methodologies to exploit novel datasets of the isotopic composition of individual snowflakes captured and measured by our **laser spectrometer** running at Dumont d'Urville (coastal station) since December 2022. This will require the **development and implementation of data processing methods** to extract useful information from the continuous record and convert the signal into isotopic composition. **Lab experiments** will be conducted to validate the data processing methodology: small amounts of water with different known isotopic composition will be vaporized and injected in the spectrometer to mimic a snow flake.

The data obtained from the Dumont d'Urville record will be compared to the continuous water vapour measurements as well as discrete measurements performed on collected surface snow samples. This new dataset will also be used to investigate the relationships between the isotopic signals and local meteorological and atmospheric column information provided by other instruments running at DDU (within the CALVA program). The results are expected to provide advances for the interpretation of isotopic records from Antarctic ice cores, and will be exploited together with the team working on the modelling of isotopic processes in the atmospheric column and at the surface-atmosphere interplay.

The internship requires skills in Python language and involves interaction with a large research team.

A PhD position will be opened in fall 2024 in continuation of this study, in particular to enlarge the work to the whole transect from coastal Dumont d'Urville to inland and arid Dome C – Concordia location, following the typical pathways of moist air masses.

Supervisors: Thomas Lauwers, Elise Fourré and Valérie Masson-Delmotte; collaborations with Mathieu Casado, Cécile Agosta and Amaëlle Landais.

Contact: elise.fourre@lsce.ipsl.fr ; thomas.lauwers@lsce.ipsl.fr

Internship host :
Laboratoire des Sciences du Climat et de l'Environnement, CEA, Orme des Merisiers, Saint Aubin (91)
Glaccios Team (https://iceclimiso.cnrs.fr/)