3 years PhD opportunity

Understanding the variability of ocean salinity from seasonal to climatic scales

Laboratoire d'Océanographie Physique et Spatiale, Plouzané, France

Starting in October 2025, 36 months

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Application Deadline: 18/04/2025

To apply: https://amethis.doctorat.org/amethis-client/prd/consulter/offre/1072

Project overview:

The most intense branches of the hydrological cycle of the planet are the evaporation (E) and precipitation (P) flux over the ocean which receives over 80% of global rainfall[1].

Thermodynamics and climate models suggest that, under global warming, the water-holding capacity of the air will increase and the freshwater cycle will intensify : the regions of net precipitation will become wetter and regions of net evaporation will become dryer. The intensification of the global water cycle will enhance flood and drought, and affect food availability and access to drinkable water, increase the flooding events and therefore pose a significant risk to human societies. **However, efforts to detect this long-term response in sparse rainfall and evaporation observations remain inconclusive and the last IPCC report assigned "low confidence" to the globally averaged trends in P-E over the 20th century**. Additionally, the increase of the global averaged temperature due to human activities leads to the progressive melt of continental ice (glaciers and ice sheet) (IPCC 2021). Similar to the P-E trends, freshwater fluxes due to continental ice and sea ice melt are not well observed and lead to large uncertainties in the amount of freshwater added to the ocean.

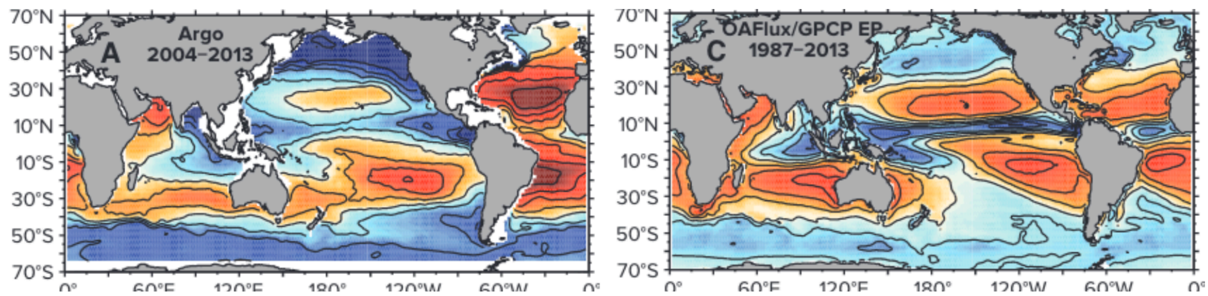

Figure 1: Left time averaged SSS from Argo floats observations (2004-2013). Right: observed E-P evaporation minus precipitations (1987-2013). Adapted from[2]. The differences between the two maps outline the importance of ocean circulation in controlling SSS.

To circumvent these problems, the possibility to use ocean salinity as a proxy for the intensity and change of the hydrological cycle has therefore become an active subject of research [3,4]. Studies show that, in agreement with the intensification of the freshwater cycle, salty ocean regions are getting saltier, while fresh regions are getting fresher[2]. However, salinity is influenced not only by surface freshwater fluxes but also by ocean dynamics which play a crucial role in shaping and maintaining the global salinity distribution[5]. In addition to salinity changes due to the anthropogenic signal, salinity also varies naturally on timescales ranging from seasonal to multi-decadal, further complicating the attribution of observed long-term trends to anthropogenic changes in the hydrological cycle. Climate models are currently our unique tool for projecting future climate under different emission scenarios and for separating the anthropogenic from natural variability signals. However, they suffer from important drifts and biases when compared to existing salinity observations[6] and do not explicitly resolve mesoscale variability, which is an essential component of the natural intrinsic ocean variability. Being able to assess which mechanisms of salinity variability are mis-represented in these models, would provide directions of improvements for our models and allow us to gain confidence in our climate projections. **To this end, this project aims at bringing a new understanding of the mechanisms governing salinity variability at seasonal, interannual and longer time scales.**

The PhD candidate will use a novel diagnostic based on a salinity variance budget. This diagnostic, which has been developed recently at the LOPS by the supervising team, allows us to determine which mechanisms act to maintain or dampen the salinity variability at different time and space scales. It has already been successfully applied in different studies (Hochet et al. 2024, 2025)[7,8].

- In a first phase of the project, the selected candidate will focus on clarifying 1) the role of mesoscales in controlling the salinity variability at different time scales 2) the mechanisms of sub-surface salinity variations which have been identified as two important gaps in the current literature. The candidate will use a combination of high-resolution numerical models and in-situ (ARGO) and satellite (ESA Climate Change Initiative SSS : CCI+SSS) observations.
- In a second phase, the same diagnostic will be applied to the current generation of climate models (CMIP6) and to the future generation of climate models developed within the framework of the European EERIE project to 1) assess their respective representation of salinity mechanisms and 2) understand the impact of climate change on the salinity variability and on its associated mechanisms.

Références:

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