**Title : Ocean-atmosphere coupling in the North-Eastern Tropical Atlantic and impact on precipitation in Senegal**

Doctoral Thesis  
Co-tutoring between **Sorbonne University (Paris, France)** and **Gaston Berger University (Saint-Louis, Senegal)**

Jury Members:

* Prof Alessandra Gianini - Sorbonne University (ENS, LMD, France) - President
* Prof André Lenouo - University of Douala (Cameroon) - Reviewer
* Dr Marco Gaetani - IUSS University School (Italy) - Reviewer
* Dr Samo Diatta - Assane Seck University (LOSEC, Senegal) - Reviewer
* Dr Moussa Diakhaté - Amadou Makhtar Mbow University (Senegal) - Examiner
* Dr Gaëlle de Coëtlogon - Sorbonne University (LATMOS, France) - Supervisor
* Dr Abdou Karim Farota - Gaston Berger University (LSAO-MED, Senegal) - Co-supervisor
* Prof Bouya Diop - Gaston Berger University (LSAO-MED, Senegal) - Co-supervisor

link: <https://theses.hal.science/tel-04705666v1>

Abstract :

The study of ocean-atmosphere coupling in the North-East Tropical Atlantic (NETA) region has long been overlooked, as climate variability in this area and adjacent regions, particularly precipitation in the Sahel, is primarily controlled by large-scale atmospheric circulation. However, the presented research demonstrates that this coupling is significant and explores the influence of Sea Surface Temperature (SST) on moisture transport from the Atlantic Ocean to Senegal and precipitation.The first step involved identifying the main mode characterizing precipitation variability from July to September in Senegal over a 40-year period (1979-2018). Using monthly data for July, August, and September, the derived index from CRU observation data represents two-thirds of the total variance, shared between intraseasonal (summer monthly data) and interannual components. This Senegalese mode was compared to a similar mode obtained for precipitation across the entire Sahel, showing significant correlation (R=0.7) and sharing over 50% of their intermonthly/interannual variance. However, linear regressions on SST anomalies reveal that this Senegalese mode is less influenced by atmospheric teleconnections such as El Niño Southern Oscillation (ENSO) in the Pacific, the North Atlantic, or the Mediterranean, unlike the Sahel. Instead, it appears to be strongly linked to SST in the NETA.In the second part of the thesis, ERA5 reanalysis data were employed to examine SST, wind, pressure, and humidity transport signals in the NETA preceding an increase in precipitation in Senegal. The results suggest the existence of an interesting regional feedback mechanism: one to two months before increased precipitation, a large-scale atmospheric circulation fluctuation leads to a slowdown of the northeast trade winds, resulting in the formation of an SST warm anomaly in the NETA. In July-August-September (JAS), the rise in precipitation in Senegal also coincides with an increase in low-level moisture transport from the Atlantic, linked to an intensification of the West African Westerly Jet (WAWJ) slightly north of its average position (10°N). This corresponds to a geostrophic response to fluctuations in the meridional pressure gradient. As these fluctuations could arise from hydrostatic adjustment to meridional gradients south of the SST anomaly, Senegal's precipitation variability could be significantly influenced by NETA SST through this mechanism.In the final part, a finer-scale examination of a possible feedback between SST and surface wind in NETA was conducted. Despite less pronounced SST variability in this region, a consistent pattern is identified: an SST warm anomaly results from pressure fluctuations in the North Atlantic, coinciding with the passage of a high-pressure system within the wave train crossing the southern West African Westerly Jet (WAWJ). This warm anomaly subsequently leads to a local pressure decrease, with its southern half explaining the increase in wind in the WAWJ region. Thus, a negative feedback between SST and surface wind extends over one to two weeks, likely explaining the previously identified signals at the monthly scale.This mechanism potentially influences intraseasonal to interannual precipitation variability in Senegal. Subsequent steps will involve assessing its significance through forced modeling and verifying its accurate representation in operational forecasting models.