Role of the atmospheric moisture transport in the salinity of the Atlantic Ocean

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One of the main features of present-day climate is the presence of a deep ocean overturning circulation (AMOC) in the Atlantic, but not in the Pacific. The localization of dense water formation in the Atlantic is associated with saltier waters and larger Evaporation-minus-Precipitation in the Atlantic than in the Pacific. This in turn requires that freshwater is transported from the Atlantic to the Pacific by the atmosphere.

We do not have a well accepted theory for these observations. The goal of this PhD is to clarify these ideas, focusing on the atmospheric branch of the hydrological cycle between the Atlantic and Pacific oceans. The student will explore Evaporation/Precipitation asymmetries between the basins, the pathways and mechanisms of the water transport in the atmosphere. Notably, using air mass trajectories, he/she will follow back water parcels to the boundary layer, thus linking water crossing the catchment boundary of the basins to an origin location.

This figure from Broecker (1991) is the basis for arguing that freshwater is carried by the atmosphere from the Atlantic into the Pacific above the Isthmus of Panama. What is wrong with this interpretation?

There are in fact two broad schools of thought on this topic: 1) the North Pacific receives more precipitation than the North Atlantic and 2) evaporation is stronger over the Atlantic than the Pacific. The first view would suggest that the AMOC is a consequence of atmospheric processes modulated by geography (e.g. Rocky mountains, width of the basins etc). In the second view, the problem is fundamentally a coupled ocean-atmosphere one as evaporation is equally controlled by ocean and atmosphere surface properties.

Determining which view is closer to the truth will contribute a significant step toward a theory of the Atlantic/Pacific asymmetry. This will also help understand how the AMOC could change in a warming climate as well as provide a framework to interpret paleo-climate proxies. This work offers an exiting opportunity to explore atmospheric dynamics and understand a problem in oceanography.

Training opportunities:
This project offers opportunities to attend courses in atmospheric dynamics, physical oceanography and numerical modelling. The student will acquire skills in computational technics.

Student profile:
This project would be suitable for students with a degree in physics, mathematics or a closely related environmental or physical science.

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