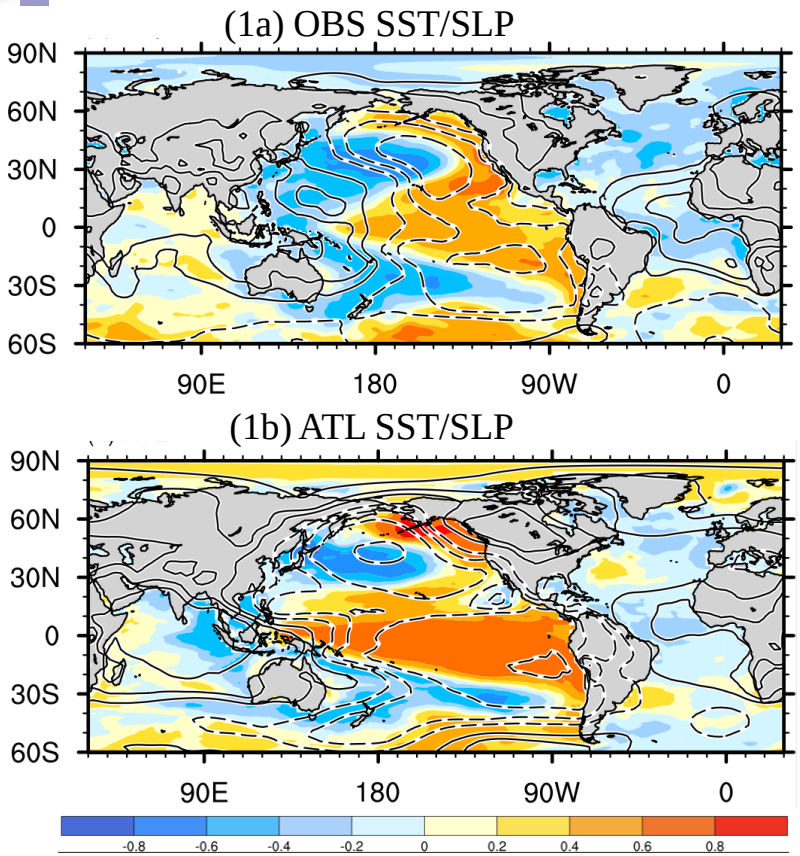
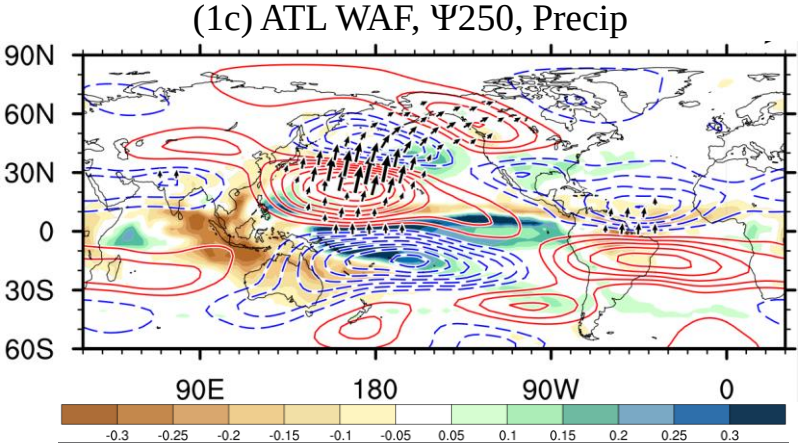
Pacific Decadal Oscillation remotely forced by the Atlantic Ocean

Abstract: The remote impacts on PDO variability are studied. By running climate experiments that constrain the Atlantic Ocean, we found that the Atlantic can affect PDO variability through two processes. The first process is the equatorial pathway where Atlantic SSTs cause a reorganization of the global Walker circulation. The second highlights a Matsuno-Gill type response north of the equator from AMO forcing. These results suggest a significant portion of PDO variance originates from the Atlantic.

Methods: We conduct partial ocean assimilation experiments constraining the Atlantic Ocean by assimilating observed temperature and salinity anomalies in the ocean component of the CESM1.0 and MIROC3.2m. The ocean outside of the assimilated and the atmosphere are free to evolve from Atlantic forcing. Using two fully-coupled climate models and a suite of observational datasets, we plot correlation and regression maps with the PDO index. It is estimated that the effective degrees of freedom are ~15, corresponding to a correlation coefficient of 0.48 at the 95% confidence interval.

Johnson, Z. F., Chikamoto, Y., Wang, S. Y. S., McPhaden, M. J., & Mochizuki, T. (2020). Pacific decadal oscillation remotely forced by the equatorial Pacific and the Atlantic Oceans. *Climate Dynamics*.

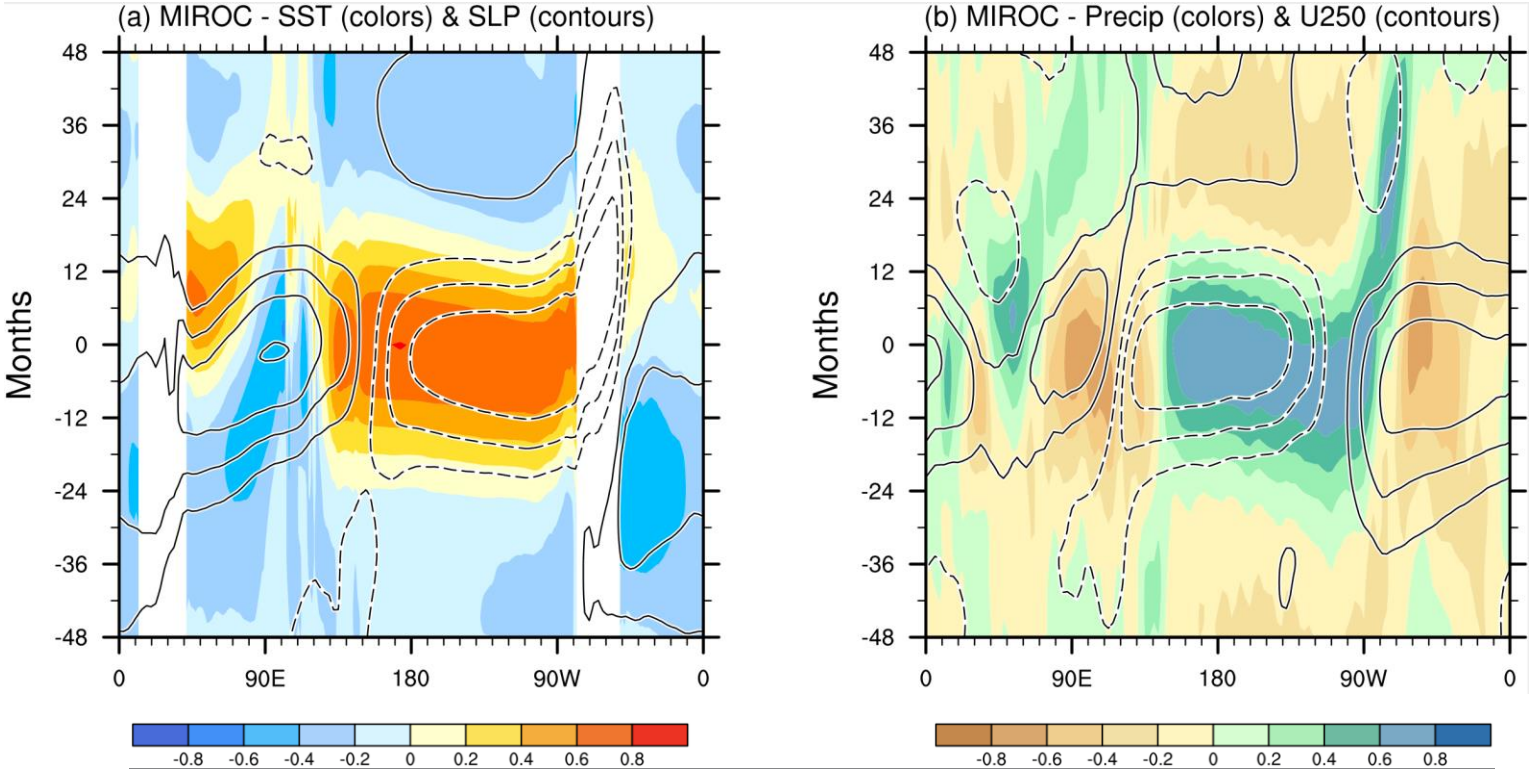




- These figures highlight the inter-basin interaction between the Atlantic and Pacific through a reorganization of the global Walker circulation forced by Atlantic SSTAs (Fig. 1b). Warm tropical Pacific SSTs, forced by the tropical Atlantic, enhance local precipitation and trigger a Rossby wave train in the form of a PNA-like pattern (Fig. 1c).

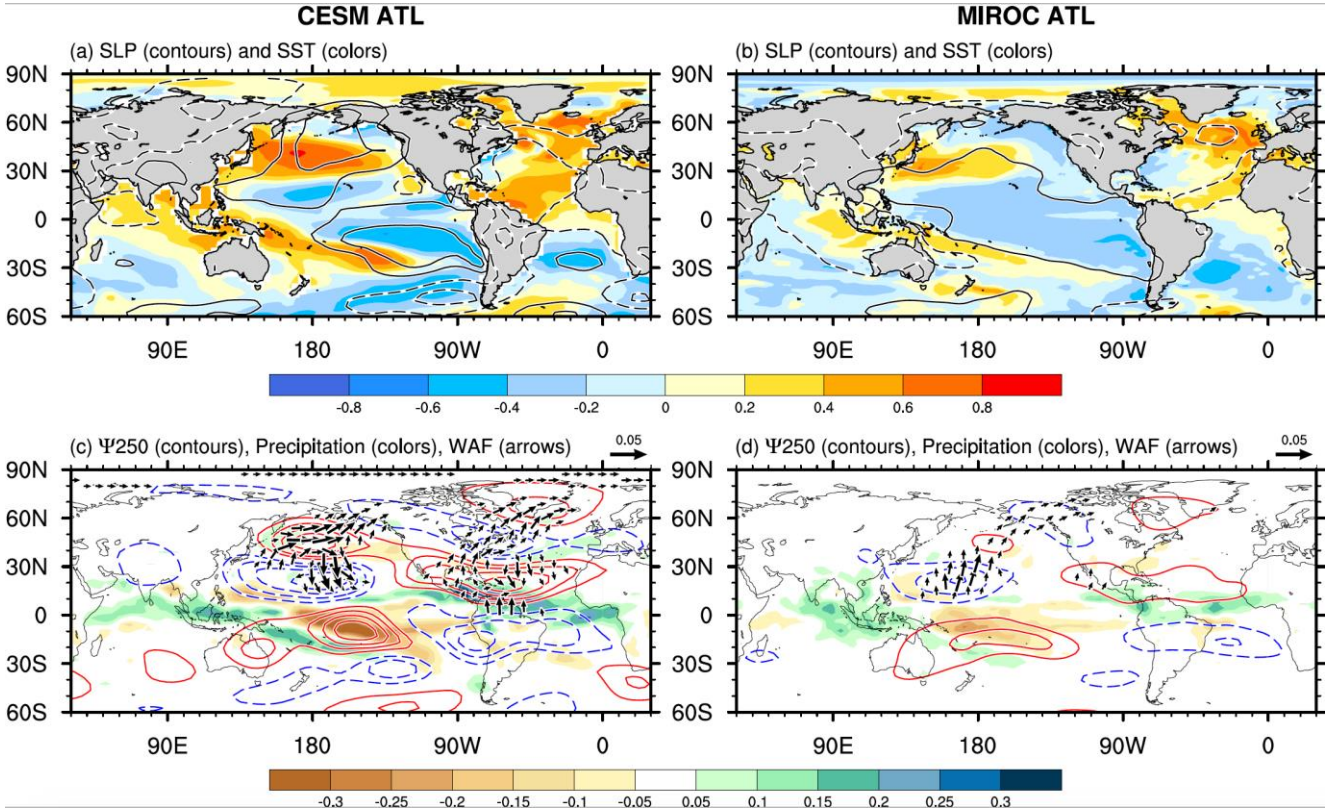
Figure **1a** and **1b**: Correlation maps of SLPAs (contours) and SSTAs (colors) 5 months leading the PDO in (1a) observations and the (1b) Atlantic Partial Assimilation (MIROC).

Figure **1c**: Regression map of 250 hPa streamfunction (contours) and precipitation anomalies (shaded) 5 months leading the PDO in the Atlantic Partial Assimilation (MIROC). Vectors represent wave-activity flux at 250 hPa regressed on the PDO index.



Hovmöller diagrams for the lead-lag correlations of (**a**) SLP (contours), SST(colors), (**b**) 250 hPa zonal wind (contours), and precipitation anomalies (colors) averaged over the 5S-5N latitude band with the PDO index (MIROC).

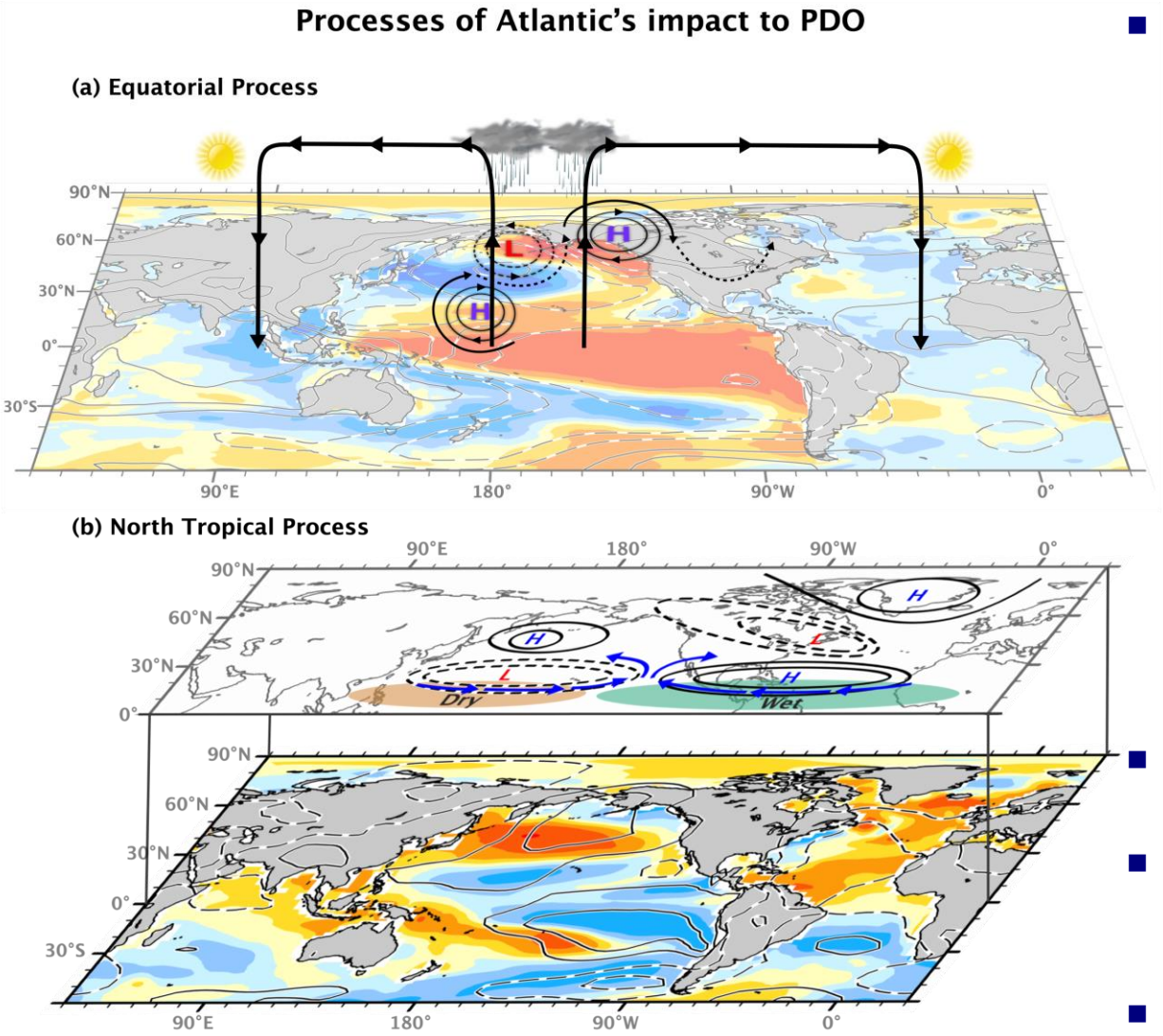
- SST cooling in the equatorial Atlantic begins 36 months before the PDO and is associated with high pressure. An eastward propagation of high pressure from the Atlantic to the Indo-Pacific is associated with a compensating atmospheric dynamical response in the equatorial Pacific (warm SSTs, enhanced rainfall, and low pressure). These atmospheric changes imply the Atlantic triggers Bjerknes feedback through inter-basin interactions.



(**top**) Correlation maps of SLPAs (contours) and SSTAs (colors) 9 months lagging the AMO in the Atlantic Partial Assimilations. (**bottom**) Regression maps of 250 hPa streamfunction (contours) and precipitation anomalies (shaded) 5 months leading the PDO in the Atlantic Partial Assimilation. Vectors represent wave-activity flux at 250 hPa regressed on the AMO index.

- The AMO can also cause changes in PDO variability. Warm AMO SSTs north of the equator trigger lower SLP, increases in precipitation, and Rossby wave propagation to the North Atlantic. A Matsuno-Gill type response north of the equator triggers the Western Pacific (WP) pattern. This WP pattern forced by Atlantic SSTs causes changes in Aleutian low variability and a PDO response

Schematic of processes



- Schematic figure showing the two Atlantic processes that impact the PDO.
  - The equatorial process occurs when tropical Atlantic SST variability causes an El Niño-like response in the Pacific through the reorganization of the global Walker circulation.
  - The north tropical process highlights the AMO impact on the PDO through a Matsuno-Gill type atmospheric response in the north tropical Atlantic-Pacific sectors
- 40-44% of PDO variability originates from tropical Pacific
- 12-29% of PDO variability originates from Atlantic through two processes
- Remaining 27-48% of PDO variability originates from other