Multidecadal Modulations of Tropical Atlantic impacts on the global climate. Contributions from TROPA-UCM

Atmospheric response to tropical atlantic variability

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Research Interest

SST-forced atmospheric variability

Tropical regions

- Air-sea interactions in the Tropical Atlantic
- Interbasin teleconnections
- West African Monsoon
- Multidecadal Modulation

Extratropical regions

Interannual variability
Multidecadal Modulation

Colaborations:

Roberto Mechoso
Alban Lazar
Fred Kucharski

http://tropa.fis.ucm.es
The impact of the Atlantic Equatorial Mode on the global climate has not been stationary

The impacts changes on multidecadal time scales depending on the Atl-Pac Niños connection

This interbasin connection takes place under negative phases of the AMO

The tropical convection enhances when having a warmer basic state (AMO negative)

Some couple modes are able to find this ATL-PAC connection

It seems that the Western Equatorial Atlantic plays a Key role

The AMO role in the modulation of the interannual variability could be through changes in the climatological ITCZ

The interannual rainfall variability over Europe increased its predictability at multidecal timescales.
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Tropical regions: West African Monsoon

1957-1978

Before the 1970’s, the response of the rainfall to the EM is an anomalous rainfall dipole.

1979-1998

From the 1970’s, the anomalous rainfall associated with the EM is an anomalous rainfall monopole.

Mohino et al., 2011 (under revision in Clim. Dyn)
Before the 1970’s: The Atlantic Equatorial Mode appears isolated from the rest of the tropical regions. From 1970’s: Summer Atlantic 3, anticorrelates with Eq Pacific. This correlation increases 6 months ENSO predictability. The Atlantic anomalous SSTs reaches the eastern Brasil.

Rodríguez-Fonseca et al., 2009 (GRL)
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The extratropical response to this tropical influence become significant over Europe.
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Tropical regions West African Monsoon


Polo et al., 2008 (J. Climate), Rodriguez-Fonseca et al., 2010, (Atmos. Sci. Lett.)
Losada et al., 2010a, (Clim Dyn) Mohino et al., 2011 (J Climate)
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**Tropical regions: Atl-Pac connection on WAM**

Atlantic influence (warm)
- **May** and **July**: dipolar rainfall. As in Losada et al. (2010a).

Pacific influence (cold)
- **May** through Walker, dipolar anom. rain.
- **July** through Rossby W. Increa. Rainfall Sahel. As in Mohino et al. (2011)

Atl-Pac influence
- **May**: Atl and Pac add their influence. Stronger dipole
- **July**: Atl and Pac counteract their effects. No dipole

Simulations with Atl Pos, Pac Neg, AtlPac
10 members  2 AGCMs: IPSL, UCLA

Losada et al., 2011 (in preparation)
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The interannual rainfall variability over Europe increased its predictability at multidecal timescales.
The correlations are not stationary. Significant and negative in negative AMO.

GG-ATL3 relation is stationary.

Sahel and Guinea rainfall are related to Niño 3 for negative AMO. MONOPOLE CASES.

Sahel and Guinea are related to each other in positive AMO periods. DIPOLE CASES.
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Tropical regions: Interbasin teleconnections

AGCM simulations for 1979-2003 Equatorial Model
The response to the Atlantic Equatorial mode is an anomalous rainfall dipole
From the 70’s, the Atlantic Equatorial mode is able to alter the Walker circulation and the anomalous surface divergence over the central Pacific.

Losada et al., 2010a. Clim. Dyn AMMA Special Issue
Losada et al., 2010b. Clim. Dyn AMMA Special Issue
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The tropical convection enhances when having a warmer basic state (AMO negative).

**Some coupled modes are able to reproduce this ATL-PAC connection and the multidecal modulation.**

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Sensitivity Experiments

Period 1949-2002 SPEEDO model

The model is coupled in the Indo-Pacific region.

In the Atlantic, 1949-2002 SSTs are prescribed (observed HadSSTs)

Tropical Regions: multidecadal modulations

Rodríguez-Fonseca et al., 2009 (GRL)
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**Interbasin teleconnections. Multidecadal Modulation**

ATL3 JJAS - Niño3 JJAS correlation (20 yr sliding window correlation)
ATL3 JJAS - Niño 3 DJFM correlation (20 yr sliding window correlation)

The correlations are not stationary
Significant and negative in negative AMO

SIMULATION SPEEDO Pacific coupled model, prescribing observed Atlantic SSTs
As in Rodriguez-Fonseca et al., (2009, GRL) but extended from 1874 to 1997
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Interbasin teleconnections. Multidecadal Modulation

IPSCL coupled model (LMDZ+OPA)

Control:
constant pre-industrial GHG concentration
500 years of simulation

Courtesy of Irene Polo, in collaboration with A. Lazar and J. Mignot
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Air-sea interactions in the Tropical Atlantic

SPEEDO sim: Atl prescribed. Pac coupled

The difference between the leading SST EOF of the simulated Pac SST is located in the central and western Pacific and in relation to a cooling in the western equatorial Atlantic in June (for a warming in the Pacific)

Marta Martin del Rey et al., 2011
Scientia Marina (submitted)
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Polo et al., 2008, J Climate

Chiang et al., 2000 (GRL)

1979-2003
HIPO: in the western Eq Atl, when reaching the deep convection threshold, models response and the Atl-Pac connection takes place. This happens at multidecadal time scales, in agreement with Chiang et al., 2000. Negative AMO is related to a warming in the E Atlantic that, superimposed to an Atlantic El Niño, helps to reach this convection threshold.
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The 2 leading modes of the North Atlantic 200 hPa streamfunction resembles locally the NAO. The modes are stationary on time. Globally, they have 2 different dynamics: internal and ENSO-forced.

Garcia Serrano et al., 2011 Clim Dyn
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Extratropical regions: Multidecadal Modulation

1906-2002: leading rainfall interannual mode JFM

The relation between the SLP pattern and rainfall is stationary (blue line).
The origin of the SLP ondulatory pattern is not stationary, being forced by ENSO for negative AMO periods. Thus, the PC1-ENSO is also not stationary.

Concluding Remarks

The impacts of the Atlantic Equatorial Mode on the global climate have not been stationary. These impacts change on multidecadal time scales depending on the Atl-Pac Niños connection. This interbasin connection takes place under negative phases of the AMO. The tropical convection enhances when having a warmer basic state (AMO negative). Some coupled modes are able to find this ATL-PAC connection. It seems that the Western Equatorial Atlantic plays a key role. The AMO role in the modulation of the interannual variability could be through changes in the climatological ITCZ. The interannual rainfall variability over Europe increased its predictability at multidecadal timescales.