

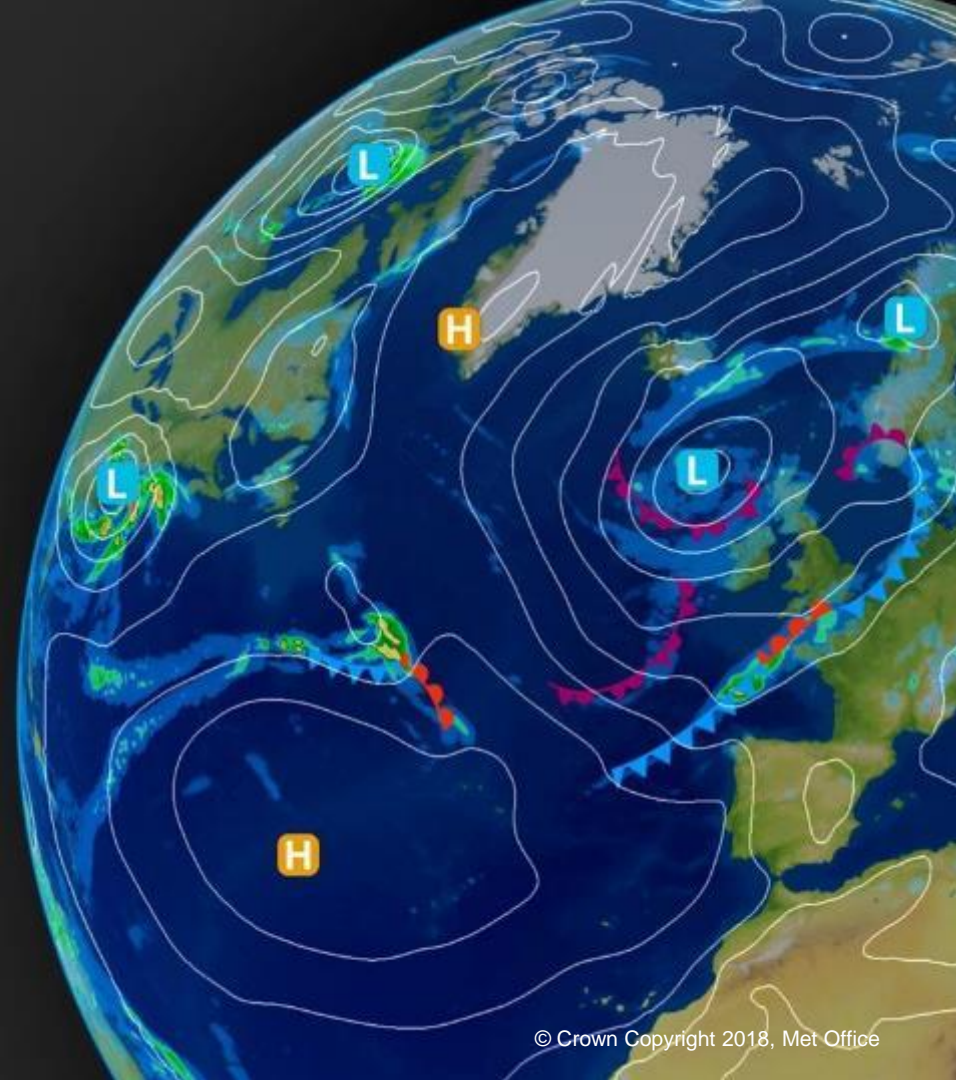
The Tropical Atlantic as a key driver of global climate – implications for observations

Jeff Knight, Anna Maidens, Adam Scaife, Martin Andrews, David Fereday, Stephen Belcher, Chris Folland and Julia Slings
Met Office Hadley Centre

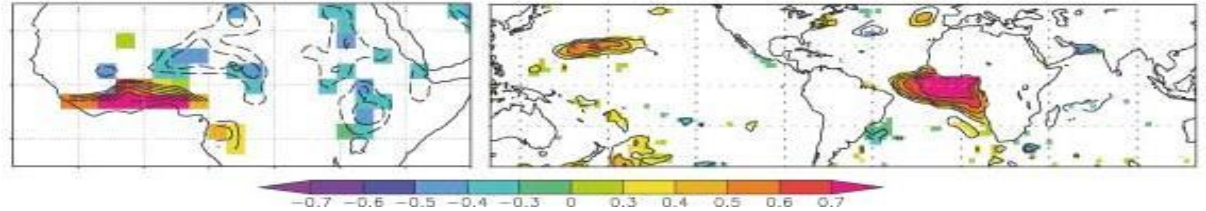
Peter Watson
University of Oxford

Gilbert Brunet
Environment and Climate Change Canada

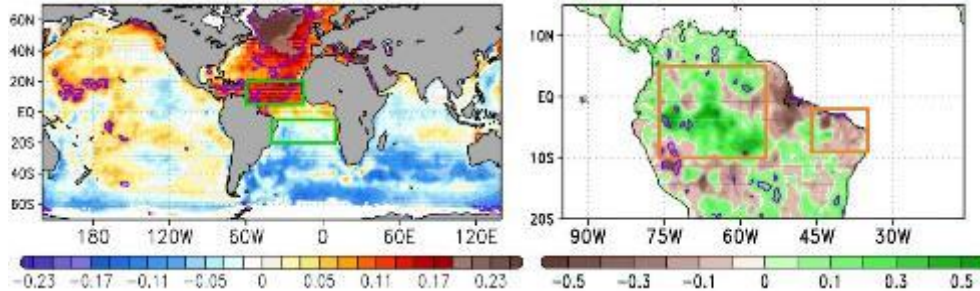
Tropical Atlantic Observing Review, Portland, 8 February 2018



Climatic Role of the Tropical Atlantic

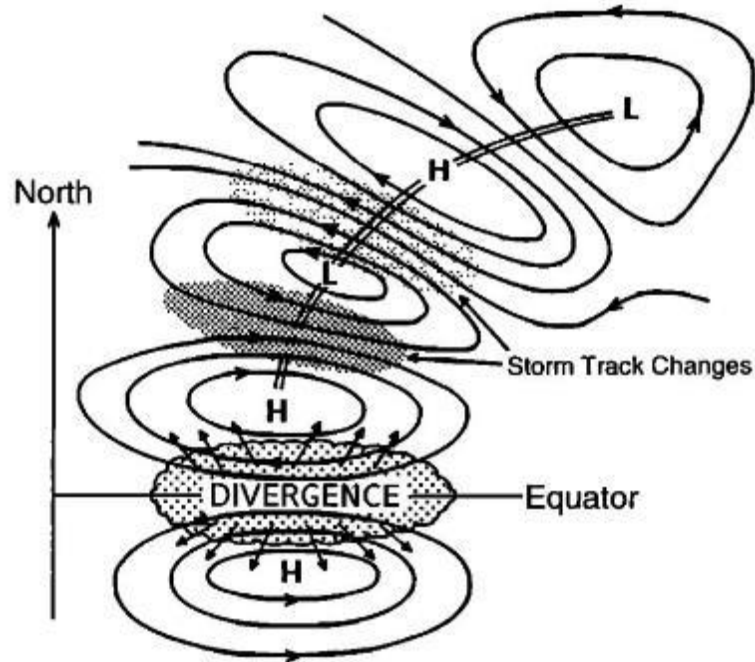


Rodriguez-Fonseca et al. 2011



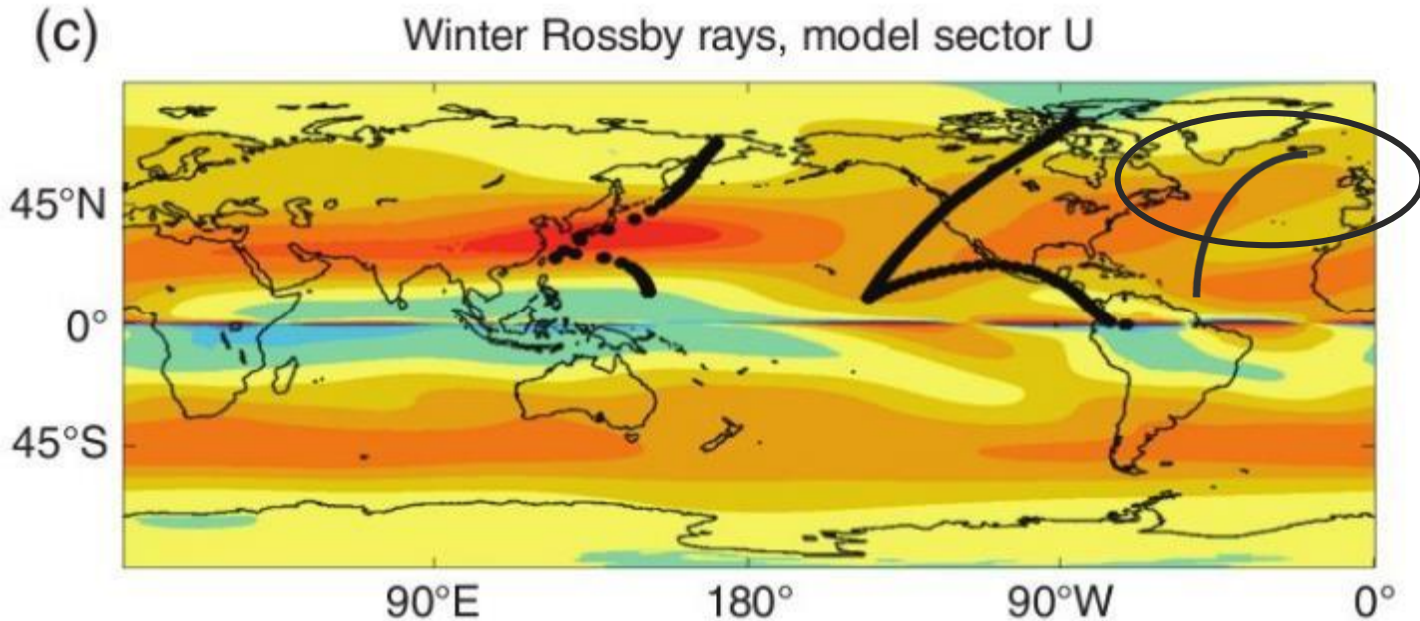
Villamayor et al. 2017

The Atmosphere provides for additional ways for the tropics to influence climate ...

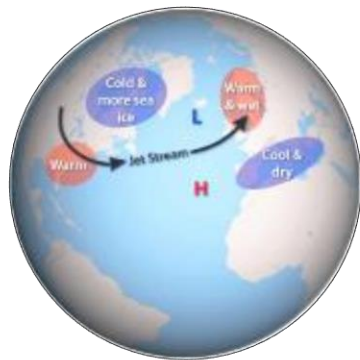


Large scale, low wavenumber Rossby waves propagate polewards and eastwards from tropical disturbances

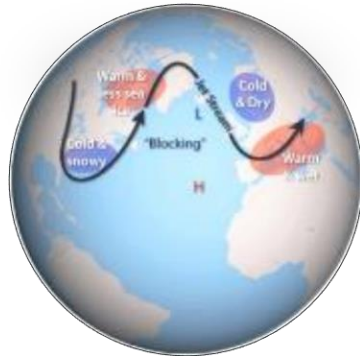
Tropical Atlantic convection also influences mid-latitudes



Winter Predictability in Mid-Latitudes



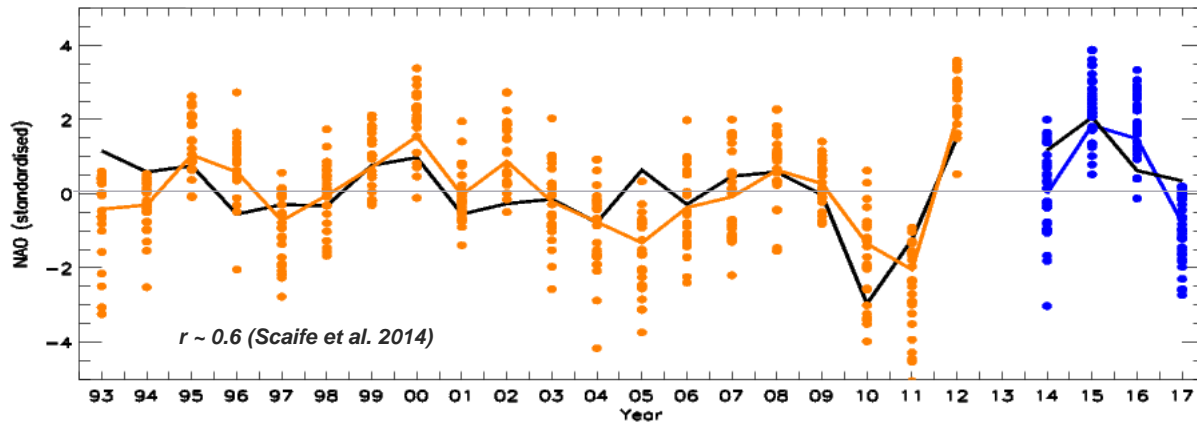
+ NAO



- NAO



Met Office GloSea5 Dec-Jan-Feb average NAO from 1 Nov

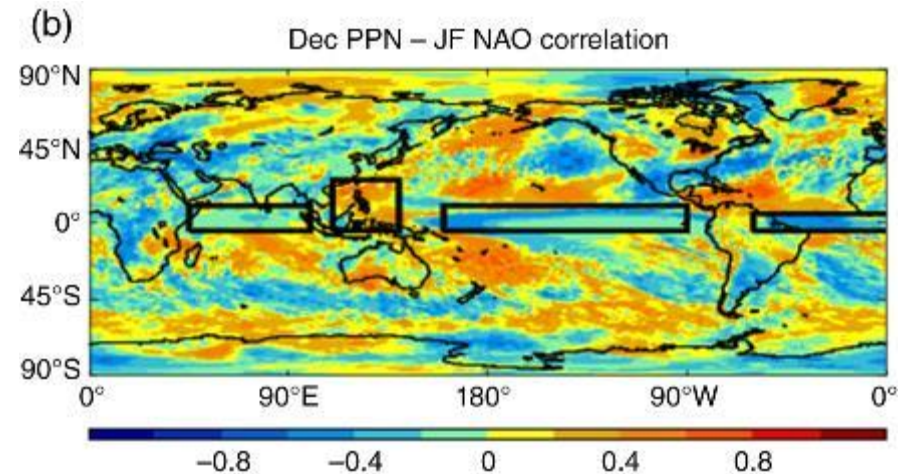
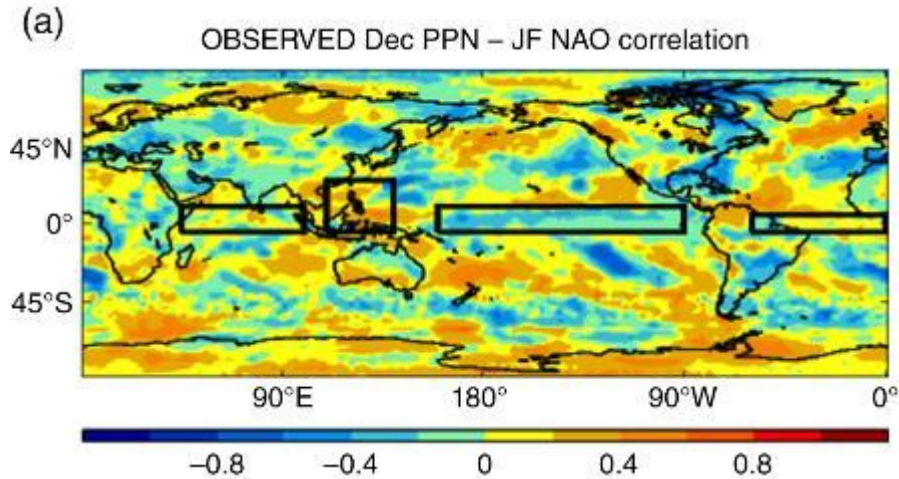


Reforecasts (members + mean)

Forecasts

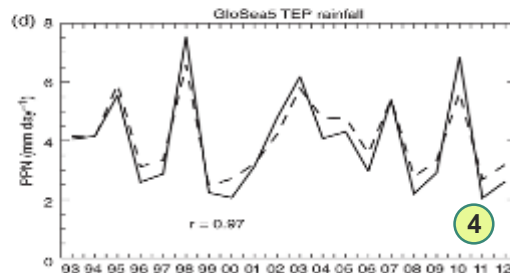
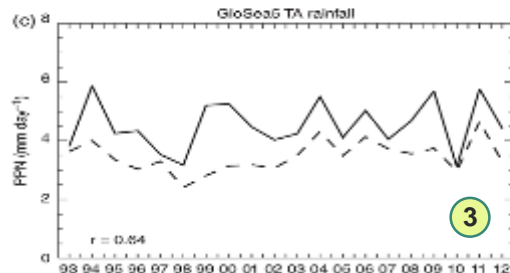
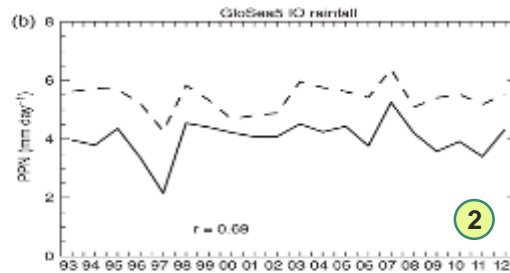
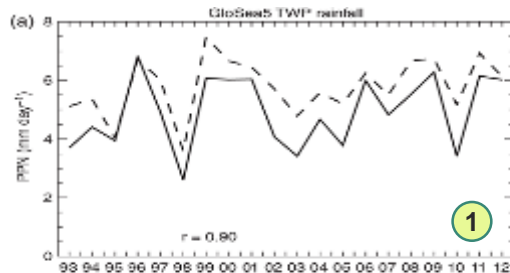
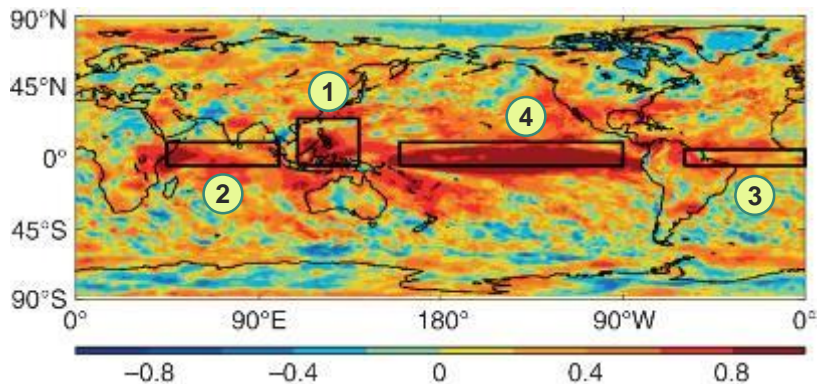
versus Observations

Tropical Oceans have an influence



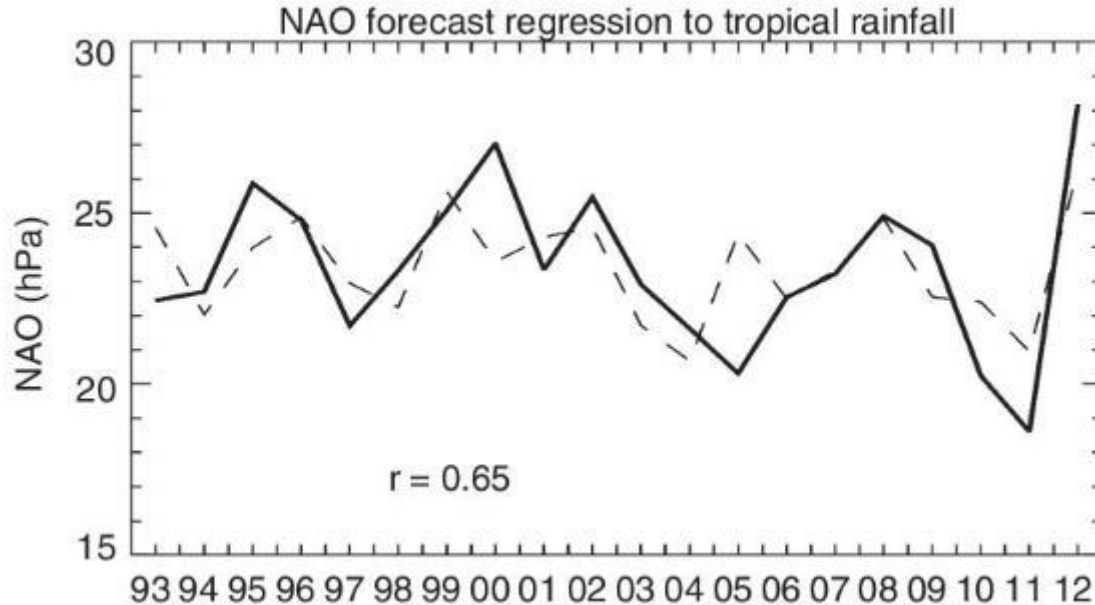
Correlation period 1991- 2011

Tropical Rainfall is well predicted



Obs = solid Seasonal prediction = dashed

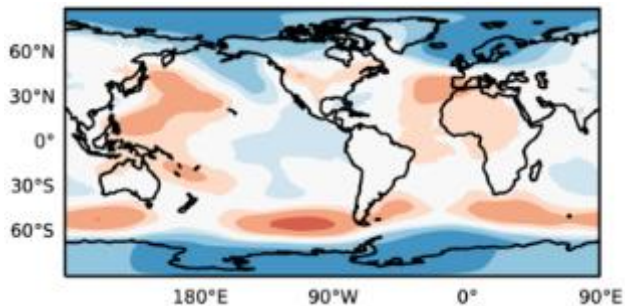
Using tropical rainfall to predict NAO ...



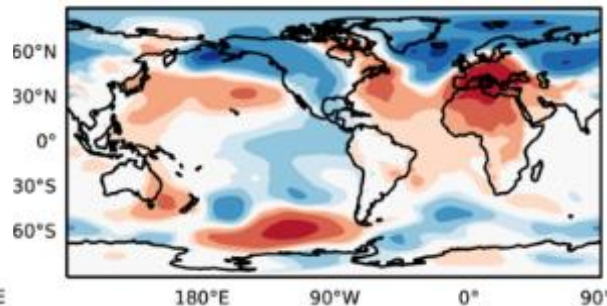
Extreme winters – Dec 2015



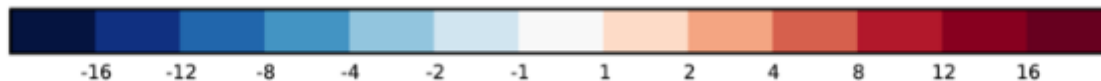
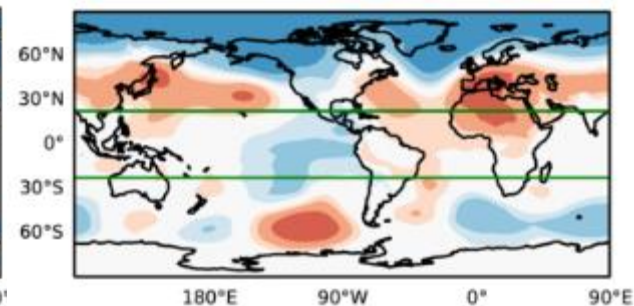
Forecast Prior to Season



Observed MSLP anomaly



Model with tropical relaxation



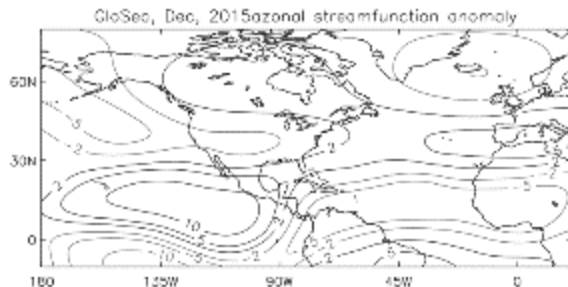
Sea level pressure anomaly (hPa)

Maidens et al. in preparation

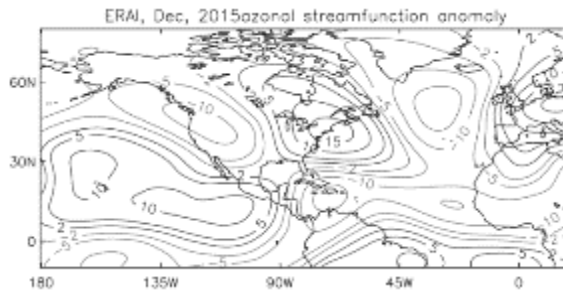
Extreme winters – Dec 2015



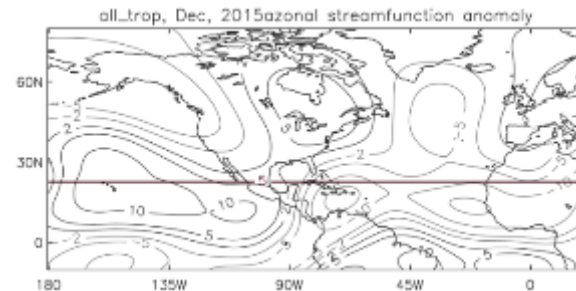
Forecast Prior to Season



Observed anomaly



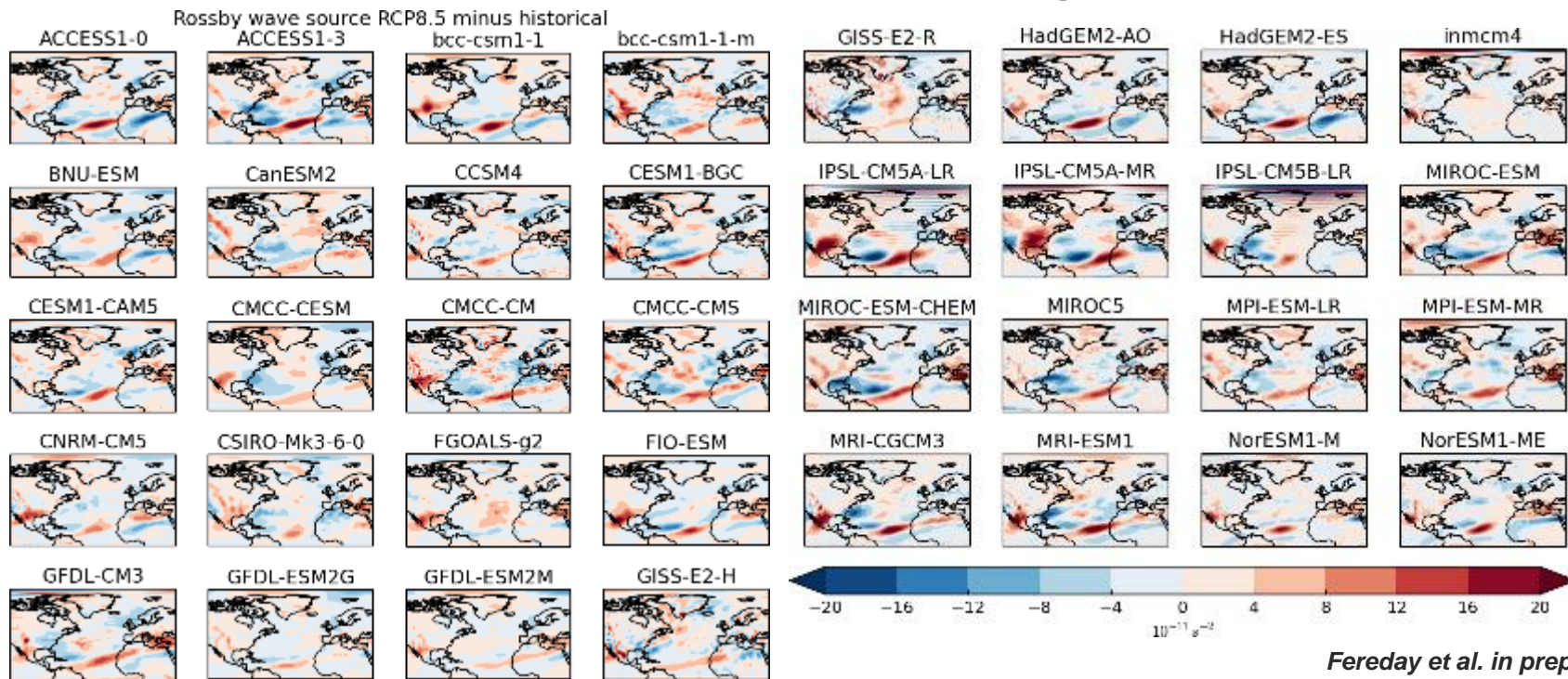
Model with tropical relaxation



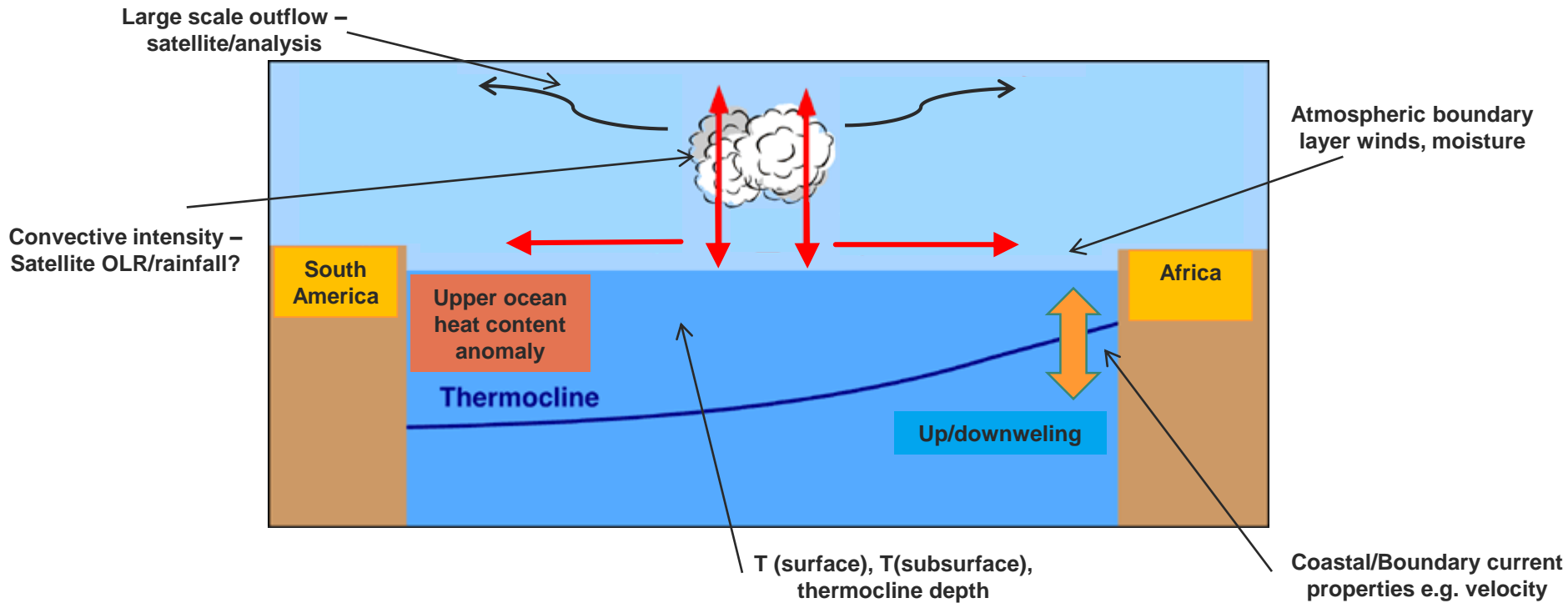
Upper troposphere (200 hPa) streamfunction
($\pm 2, 5, 10, 15 \cdot 10^6 \text{ m}^2 \text{ s}^{-1}$)

Maidens et al. in preparation

From seasonal to climate change timescales ...

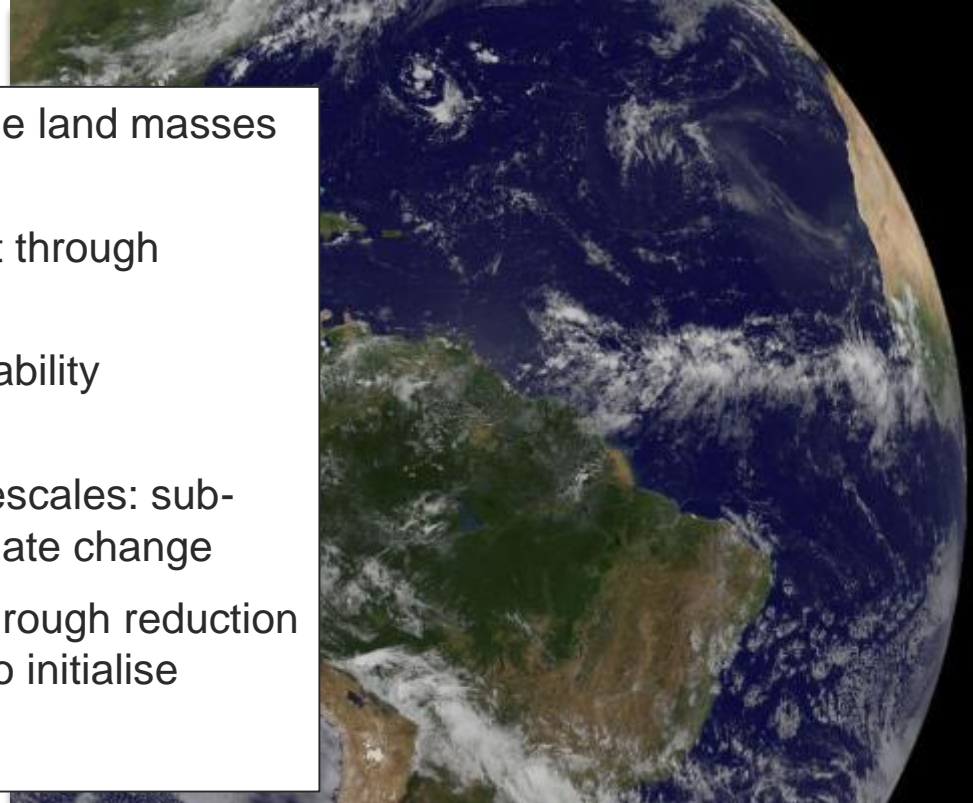


Observations



Summary

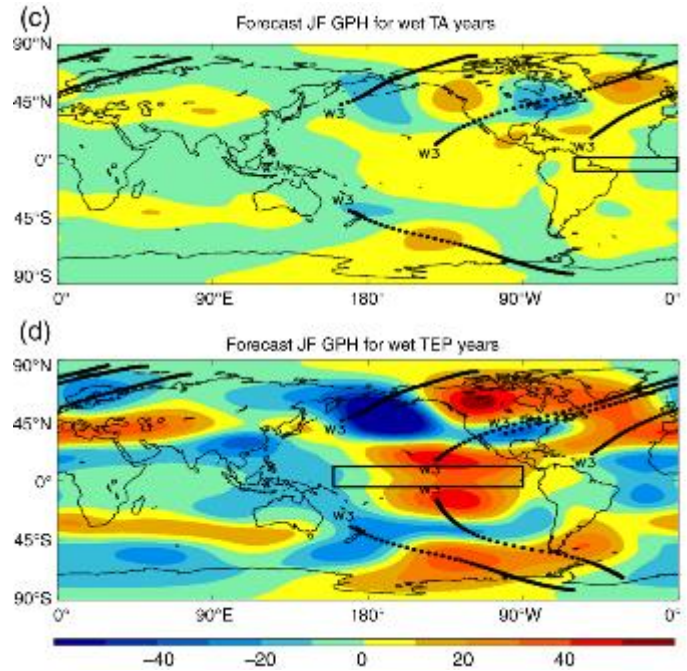
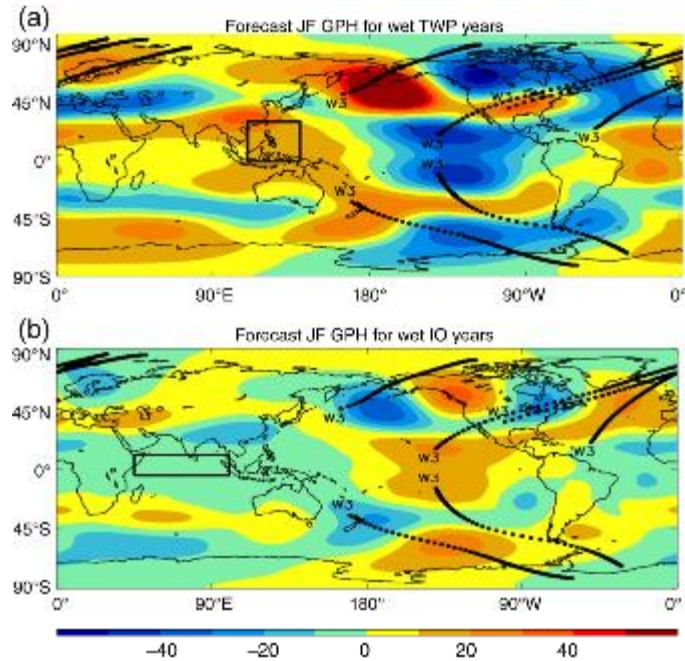
- The Tropical Atlantic has a big impact on the land masses at its margins
- But it also affects the extratropics, not least through atmospheric teleconnections
- These connect to fundamental climate variability components like the mid-latitude jet stream
- Leads to possibility of influences on all timescales: sub-seasonal, seasonal, decadal and even climate change
- Observations needed to improve models through reduction of biases and process improvements and to initialise prediction systems



Many drivers of skill ...

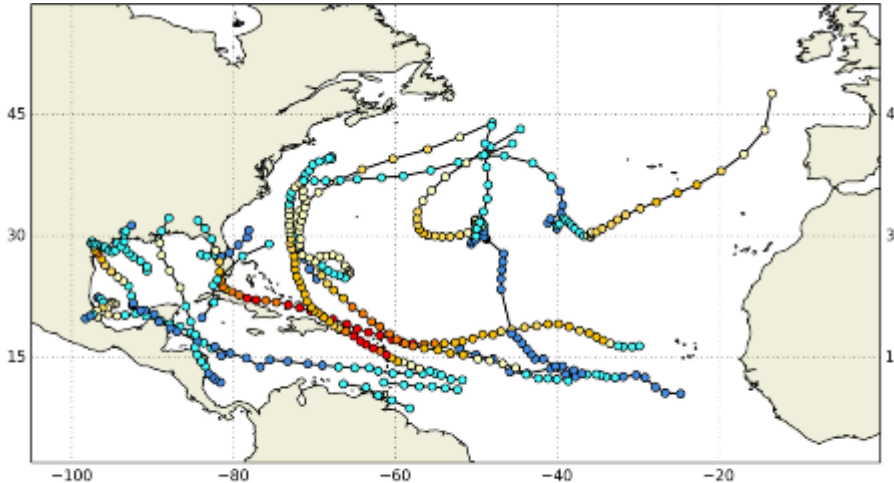


Tropical Oceans have an influence



Climatic Role of the Tropical Atlantic

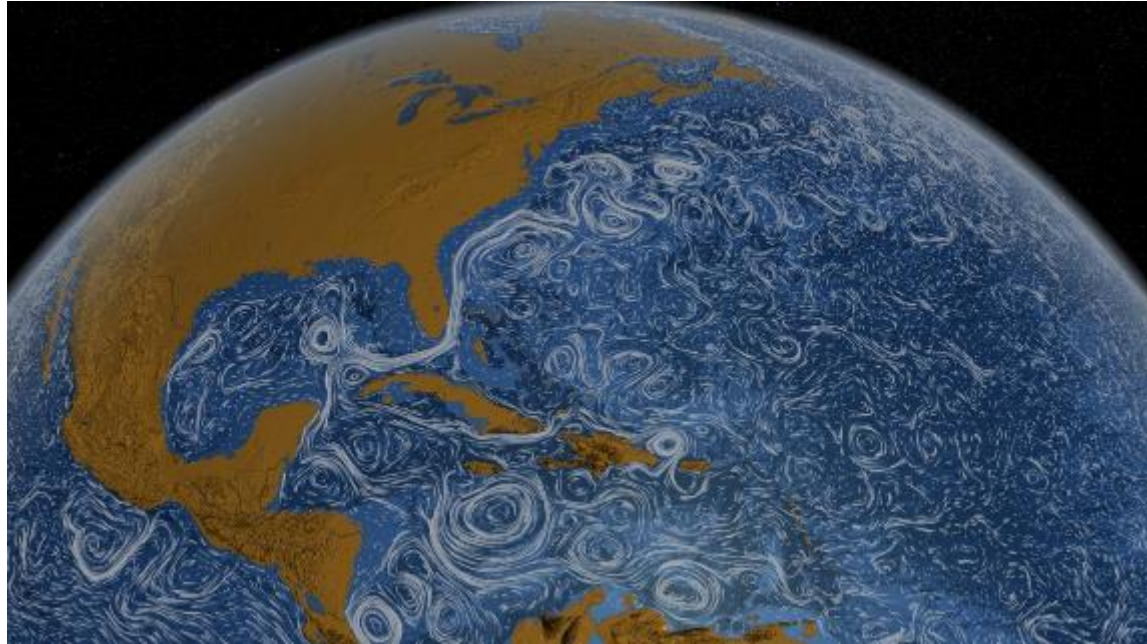
2017 hurricane season costliest on record



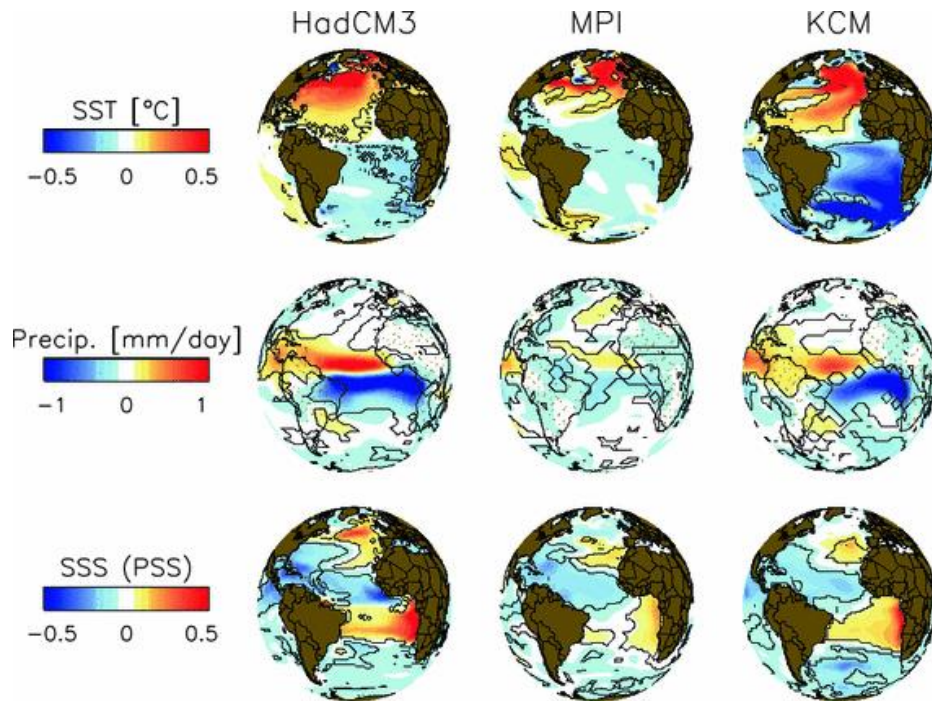
- Tropical depression
- Tropical storm
- Hurricane (cat 1)
- Hurricane (cat 2)
- Hurricane (cat 3)
- Hurricane (cat 4)
- Hurricane (cat 5)



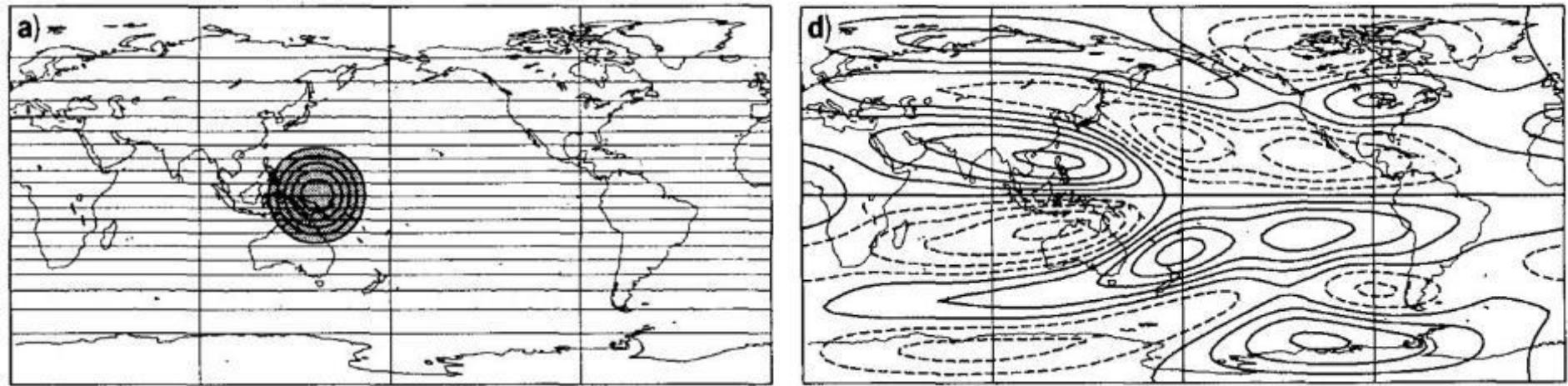
AMOC goes through the tropical Atlantic



Tropical Atlantic feedback on AMOC?

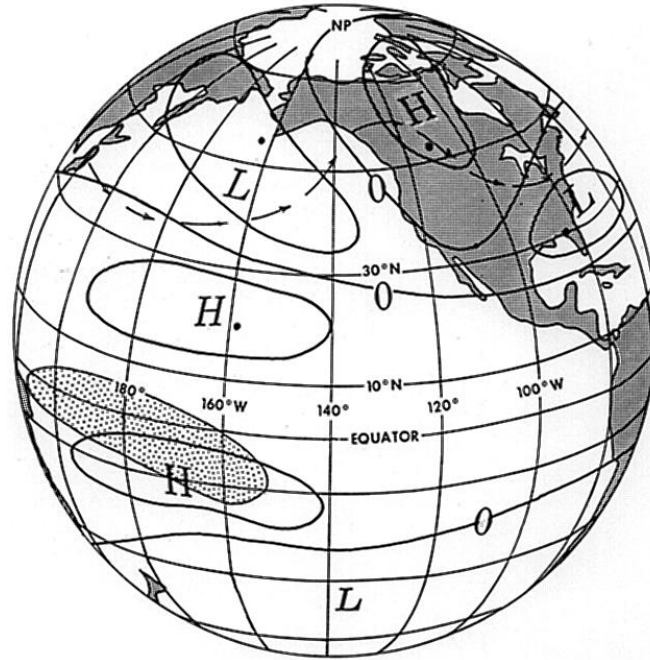


The Atmosphere provides for additional ways for the tropics to influence climate ...

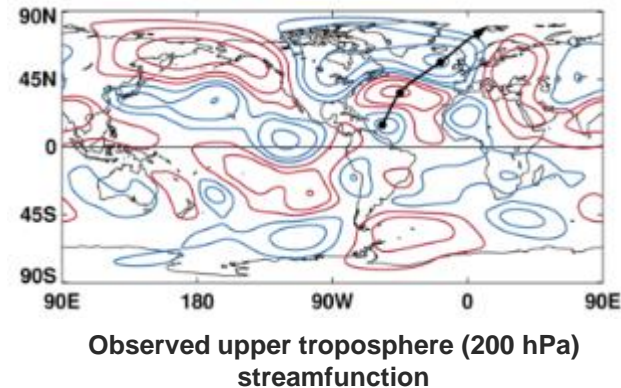
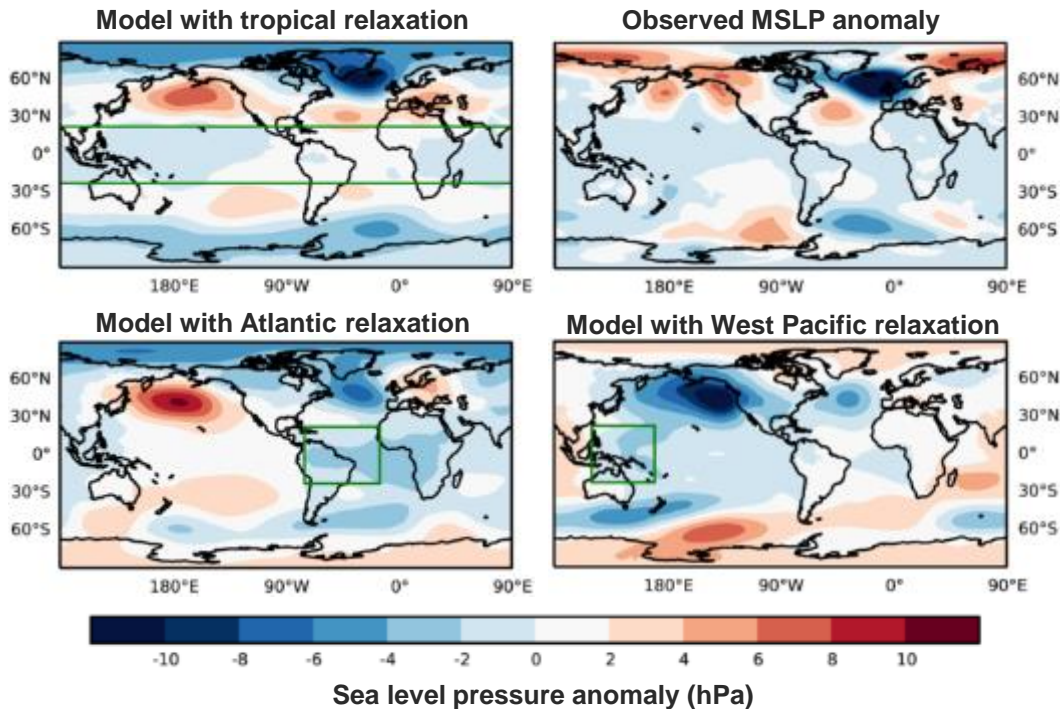


Large scale low-wavenumber Rossby wave propagation

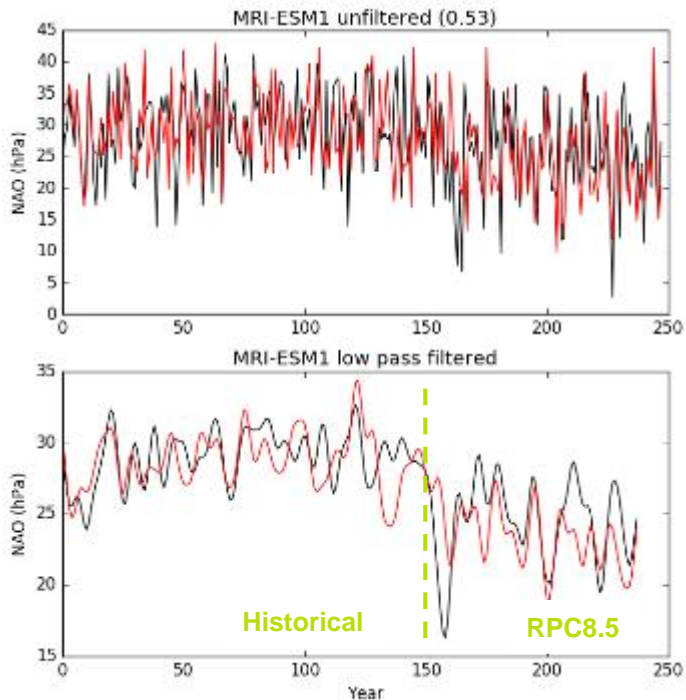
For Example, Pacific-North America pattern



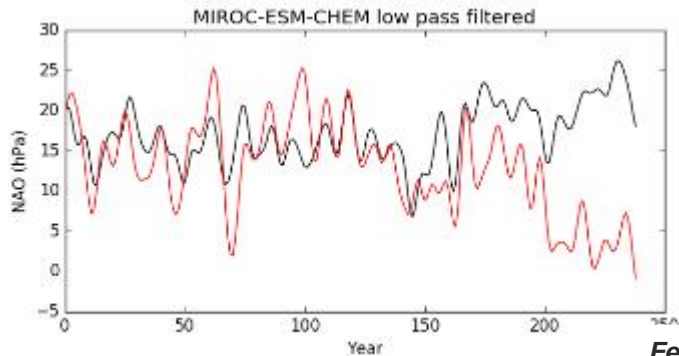
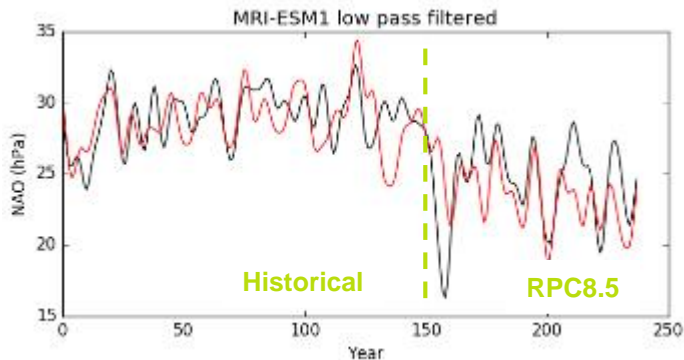
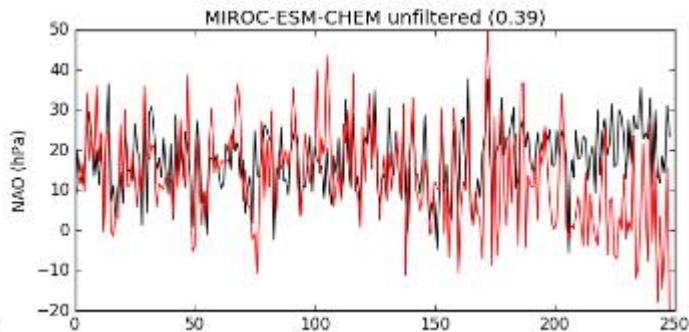
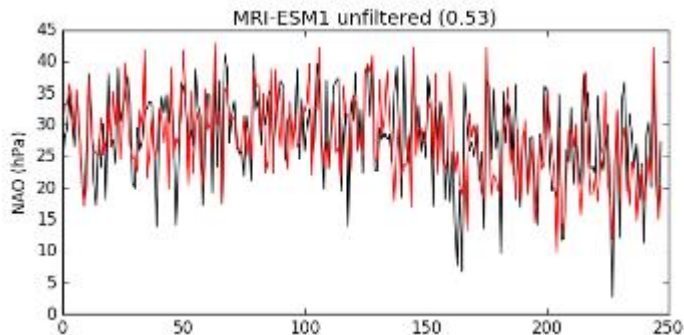
Extreme winters – DJF 2013/14



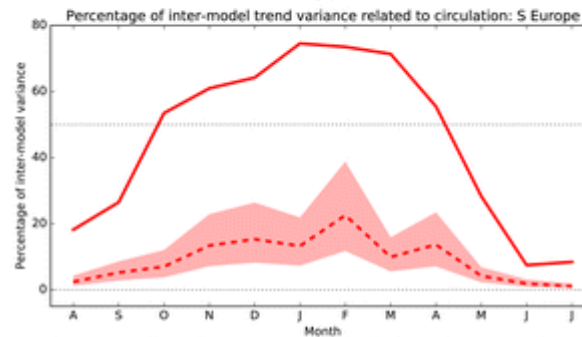
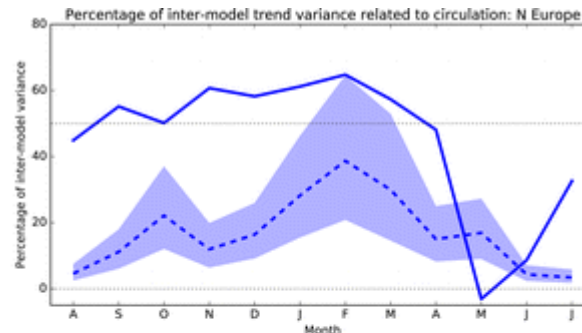
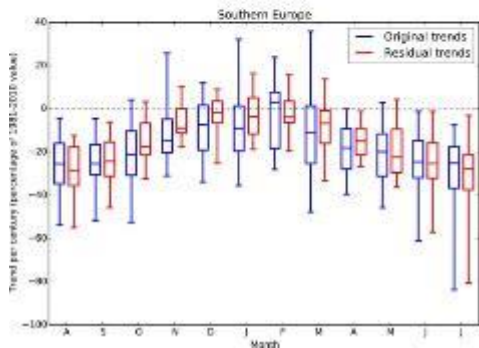
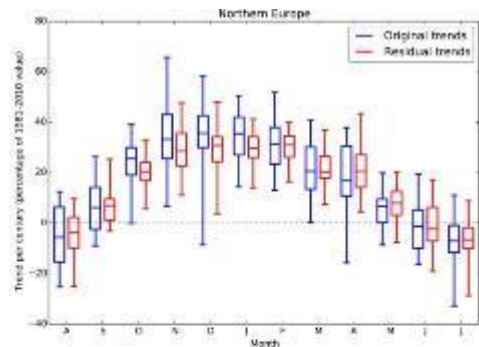
From seasonal to climate change timescales ...



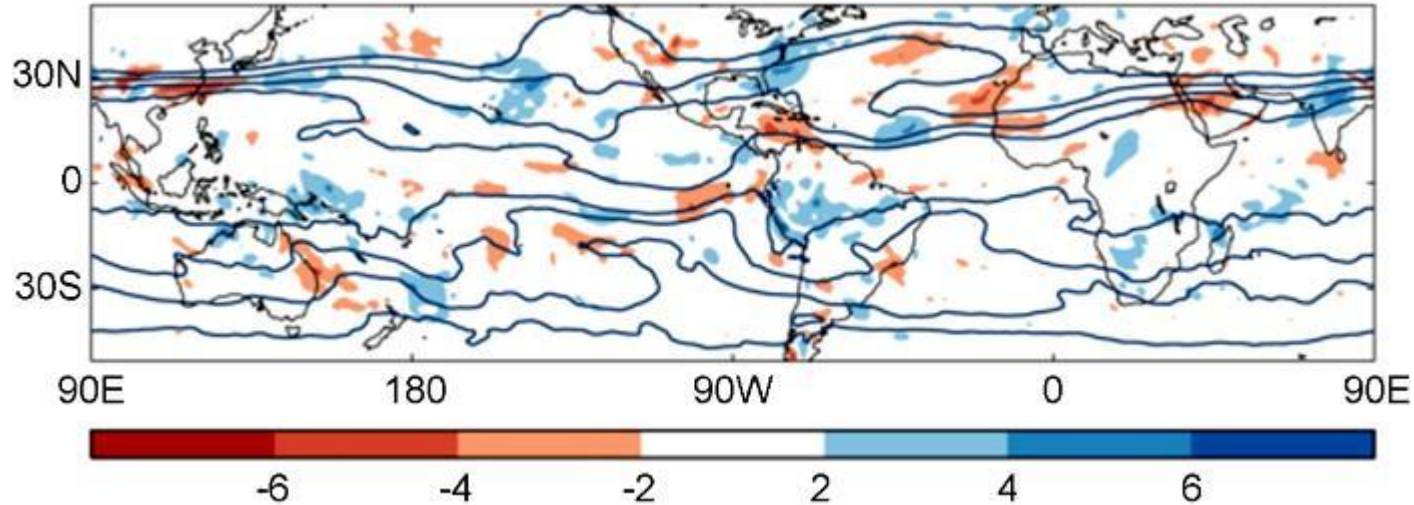
From seasonal to climate change timescales ...



Constraining climate change



The Tropical Atlantic has special features ...



$$RWS = -\zeta \nabla \cdot v_{\chi} - v_{\chi} \cdot \nabla \zeta$$