University of Reading

National Centre for Atmospheric Science
NATURAL ENVIRONMENT RESEARCH COUNCIL

# Observational evidence of European summer weather patterns predictable from spring

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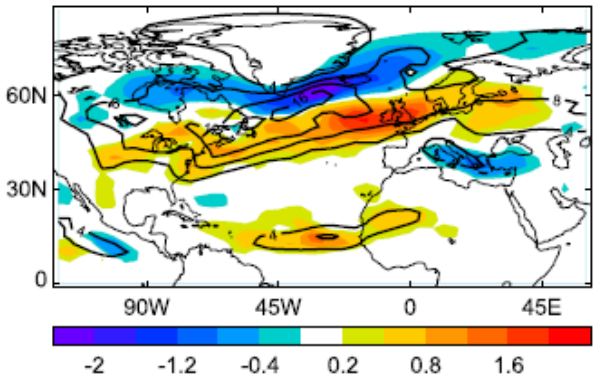
Based on Osso et al, *PNAS*, January 2018 and subsequent research

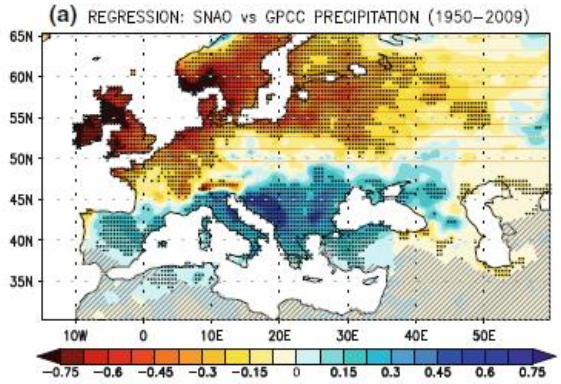
# Motivation: what is the potential for skillful seasonal prediction of European Summer Weather patterns?

OR

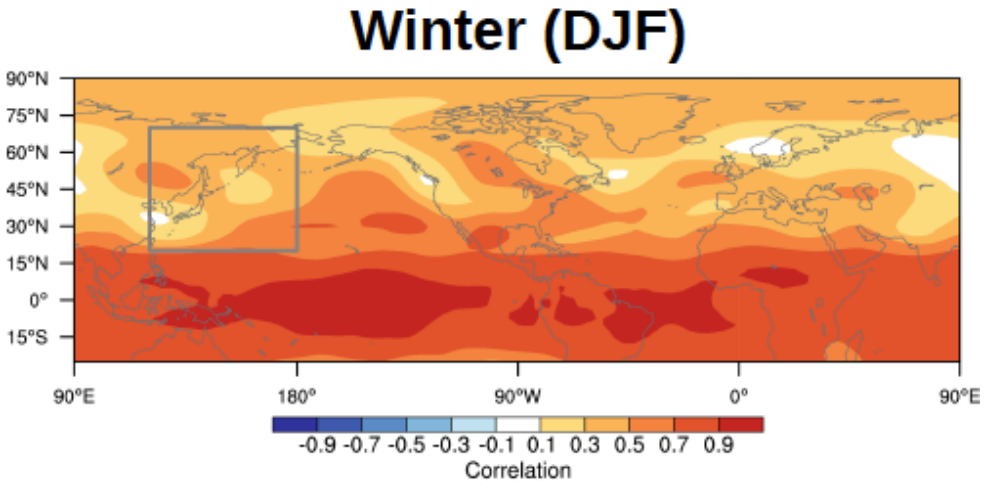

From *Dong et al*. 2013

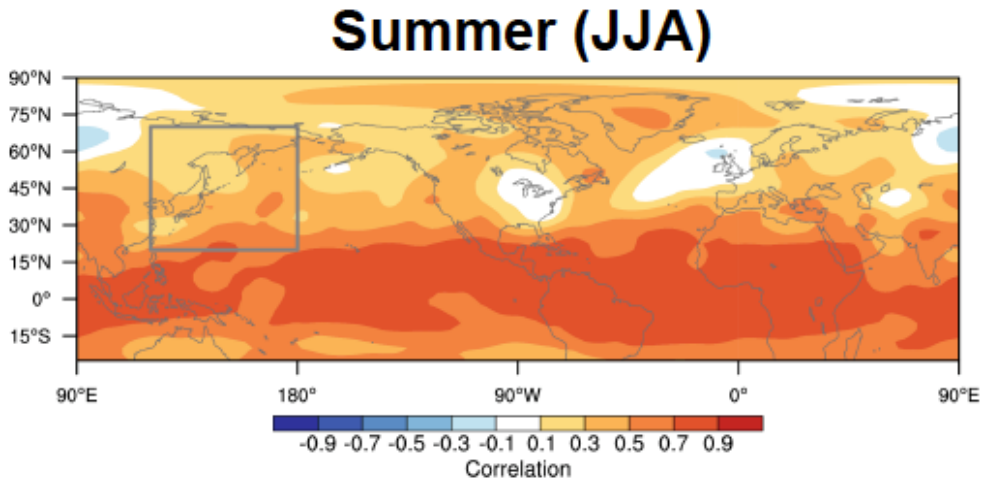
European Summer Weather is closely linked to Variability in the North Storm Track




From *Bladé et al*. 2011

# Motivation: what is the potential for skillful seasonal prediction of European Summer Weather patterns?



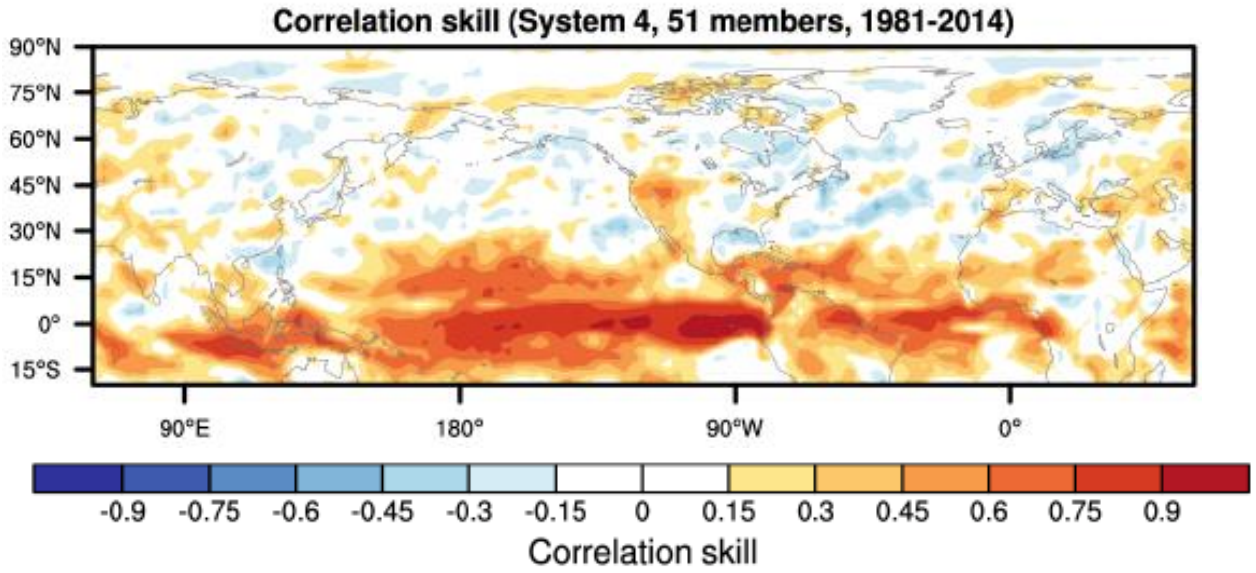




**ECMWF System 4 seasonal forecasts of Z500 (May 1981-2014)**

Based on 51 members

Plots from Chris O'Reilly (Oxford Univ.)

# ECMWF System 4 seasonal forecasts of precipitation




- Does low skill reflect inherent unpredictability?

OR

- Incomplete understanding of the drivers of summer weather patterns, and the imperfect representation of these drivers in current forecast systems?

# Potential drivers of predictable variability in European summers

**From sub-seasonal to seasonal timescales:**

1. Tropical oceans and atmospheric Circulation (e.g. MJO, ENSO, monsoons)
2. Extratropical Oceans, especially the North Atlantic
3. Soil moisture anomalies and feedbacks

**From Seasonal to decadal timescales:**

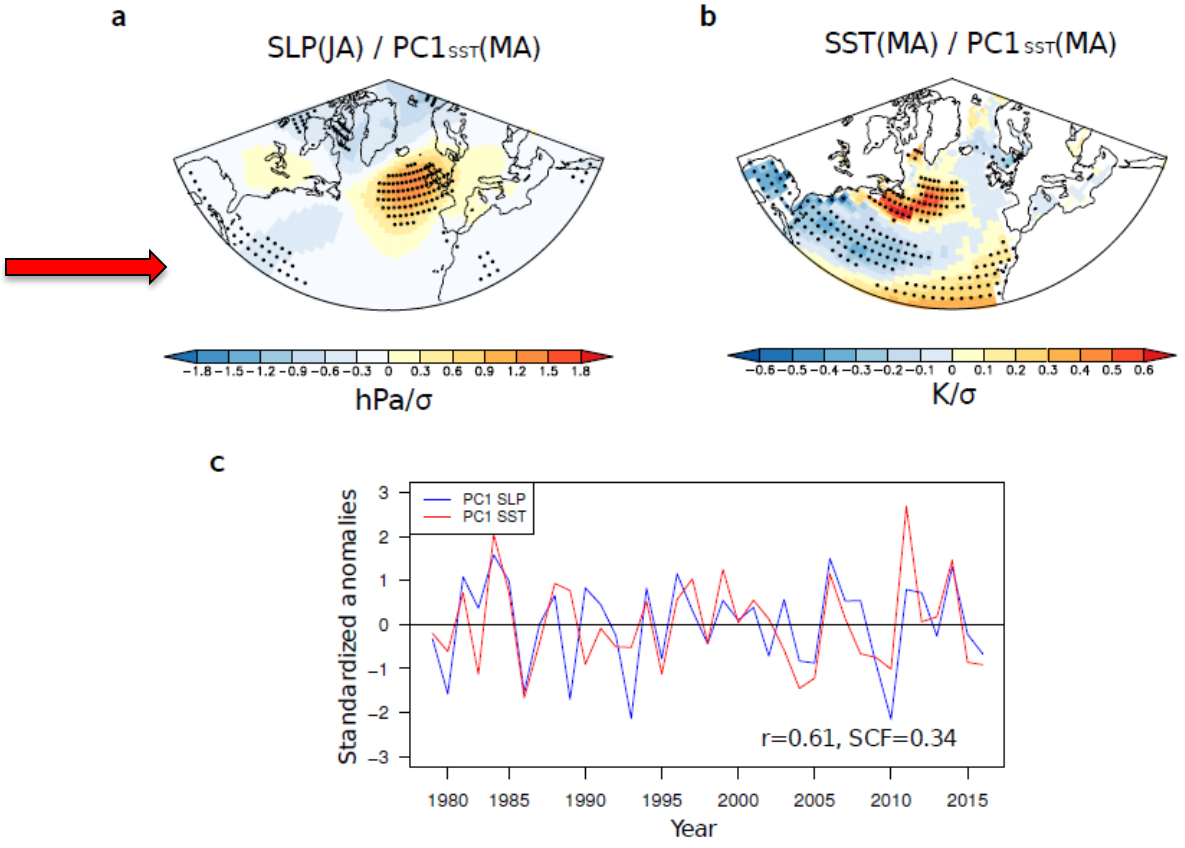
1. Atlantic Multidecadal Variability (AMV)
2. Arctic sea ice
3. Stratospheric variability
4. Volcanic eruptions
5. Greenhouse gases and aerosols

# Influence of the North Atlantic SST Variability on the Atmospheric Circulation during the Twentieth Century

GUILLAUME GASTINEAU AND CLAUDE FRANKIGNOUL

*LOCEAN Laboratory, Sorbonne Universités-UPMC, CNRS, IRD, and MNHN, Paris, France*

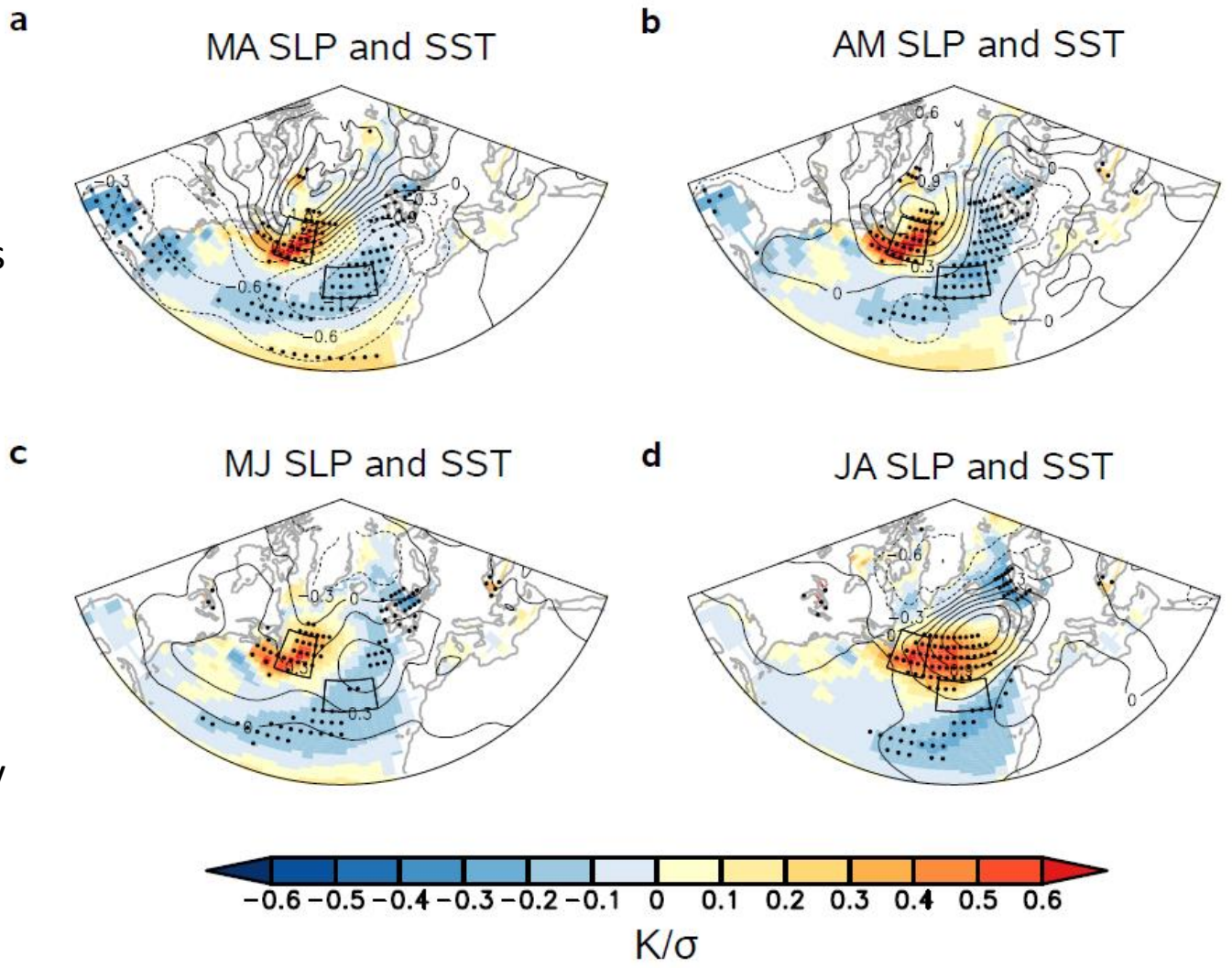
**The Summer East Atlantic Pattern (SEA)**



# Regression of SST and SLP on March-April SST index

SST anomalies:

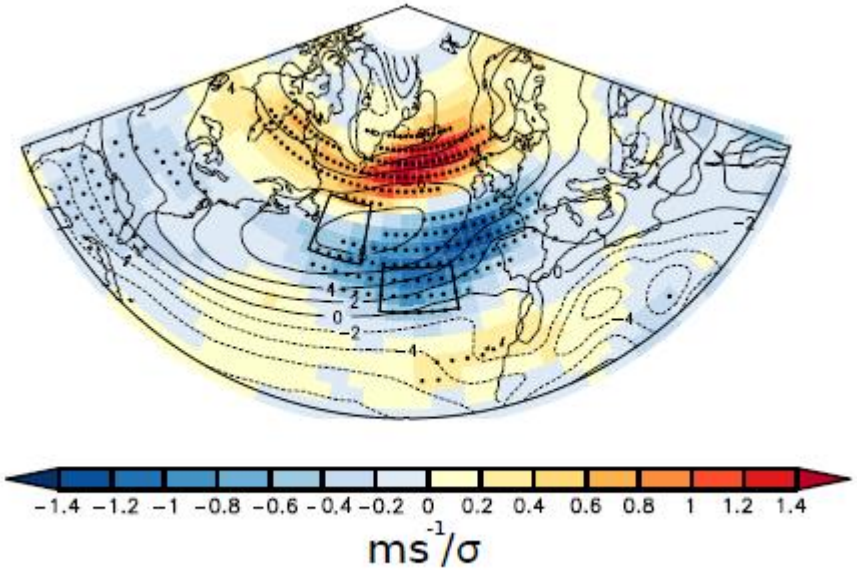
- generated in winter and spring by wind anomalies causing anomalies in surface fluxes and Ekman currents
- persist and evolve through spring and summer
- Correlation with SLP *minimum* in May-June
- Influence atmospheric circulation primarily in July-August

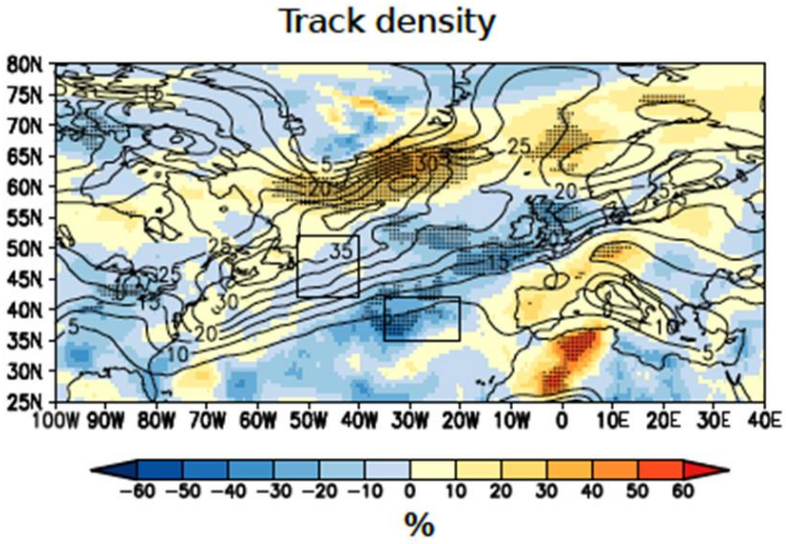


# Physical mechanism

The SEA pattern is the surface fingerprint of a poleward displacement of the North Atlantic jet stream forced by changes in baroclinicity and associated with the anomalous meridional SST gradient

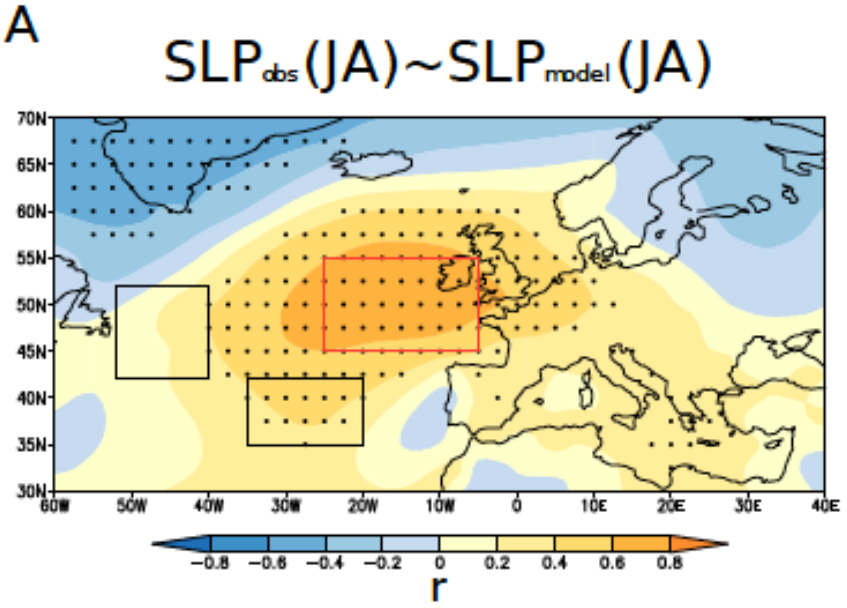
Regression of July –August 850hPa zonal wind anomalies onto the March-April SST Index




with thanks to Kevin Hodges

A

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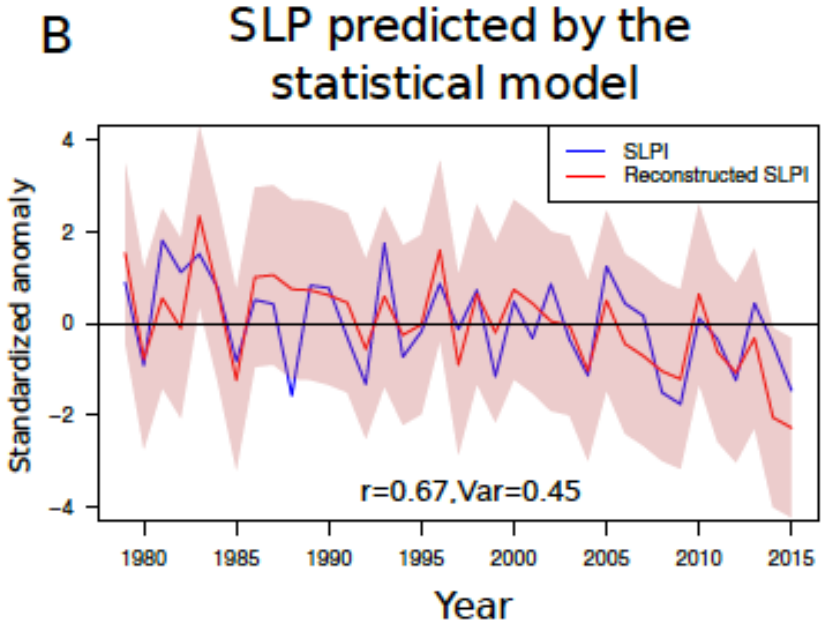


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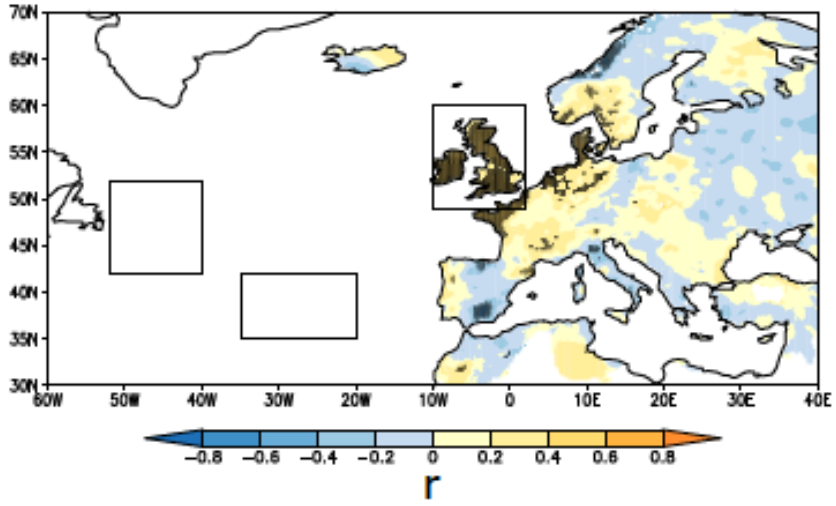


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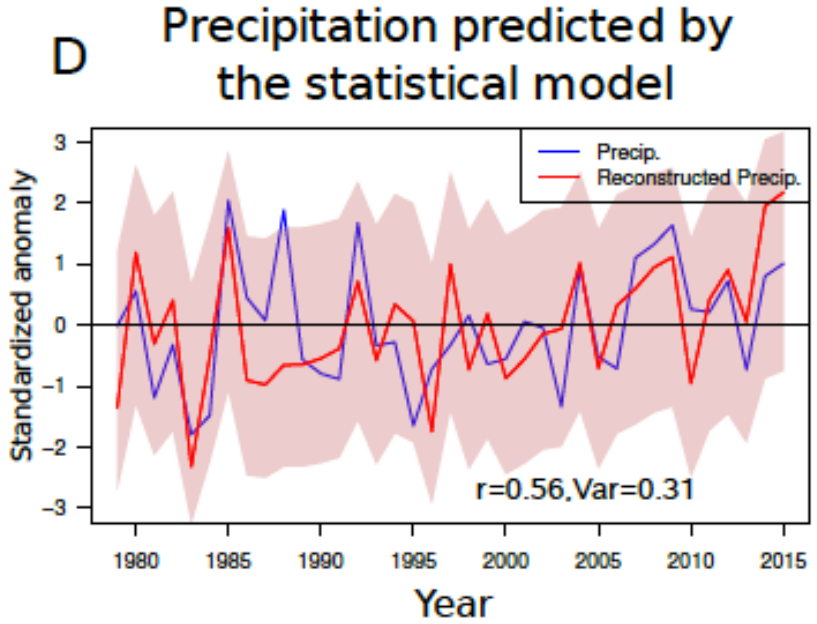


Predicts correct sign of precipitation anomaly 2 times out of 3

# Conclusions

- Evidence that North Atlantic SST anomalies generated in winter and spring influence summer atmospheric circulation in July and August
- Physical mechanism involves displacements of the storm track in response to anomalous baroclinicity
- Empirical forecasts have useful skill
- Evidence for amplification of the predictable atmospheric signal through coupled air-sea interactions involving SST-cloud feedbacks
- A climate forecast model (GC2) captures a similar if weak signal in July, but *not* the amplification into August.
- If this failure reflects model error it could contribute to explaining the apparent signal-to-noise problem in summer.