Department of Meteorology

University of Reading

Ocean-atmosphere interaction in the Atlantic storm track response to climate change

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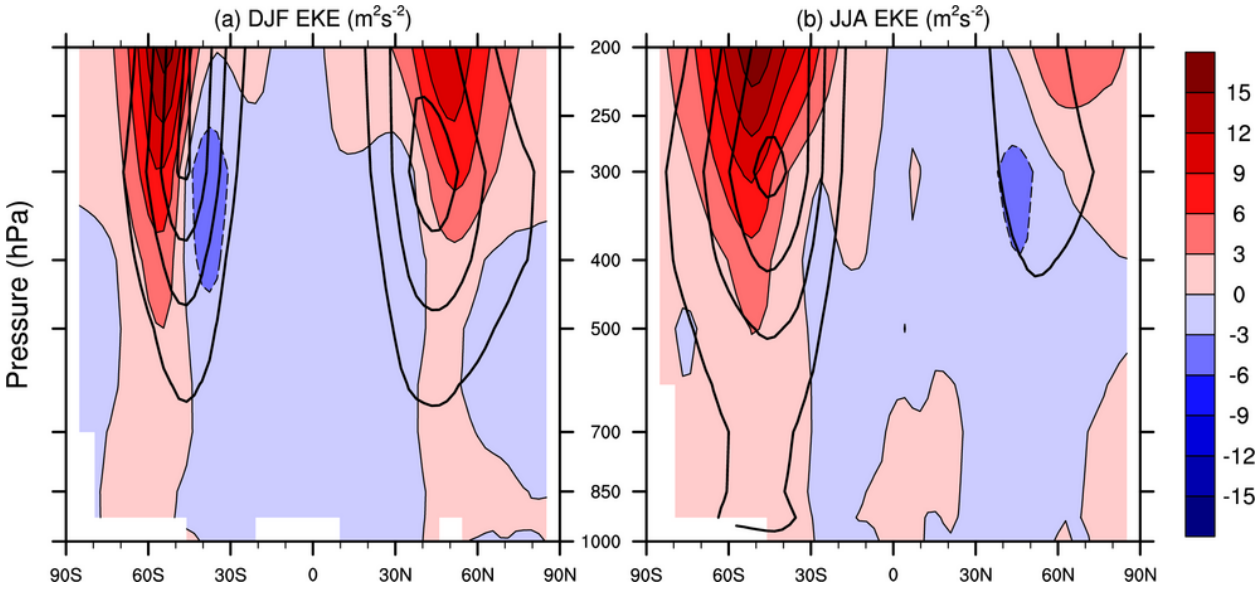
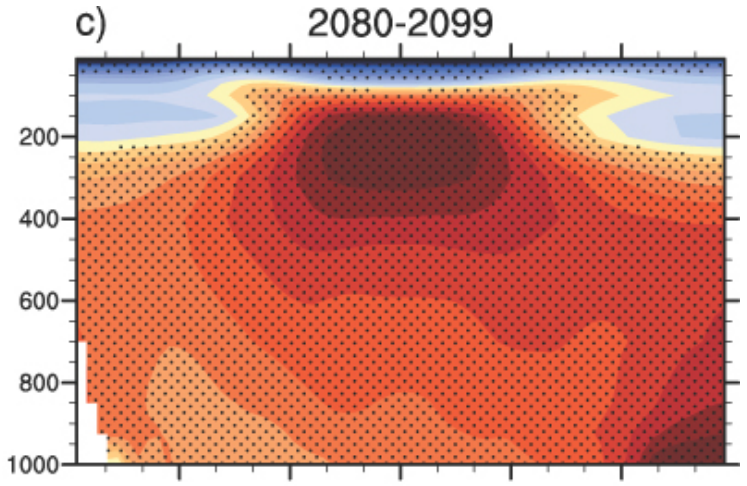
With Jonathan Gregory, Joaquim Pinto, and Mark Reyers

Storm track changes

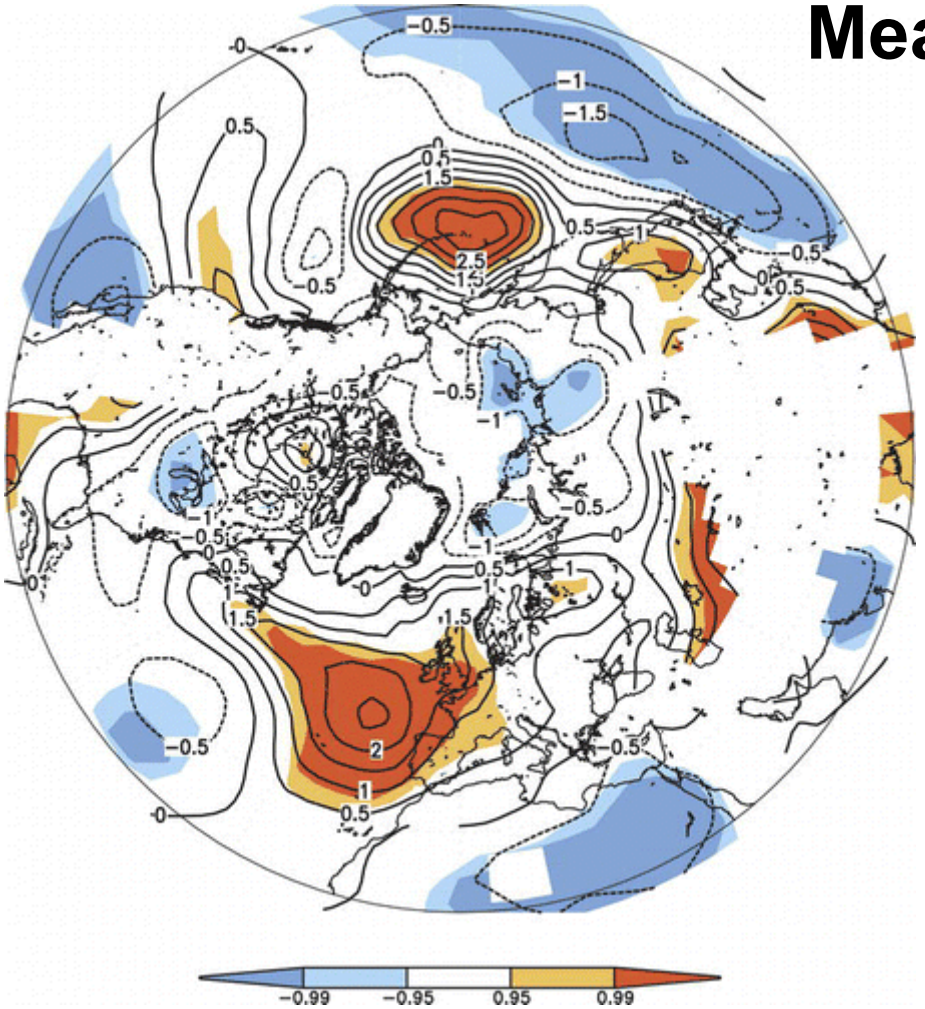


Yin 2005

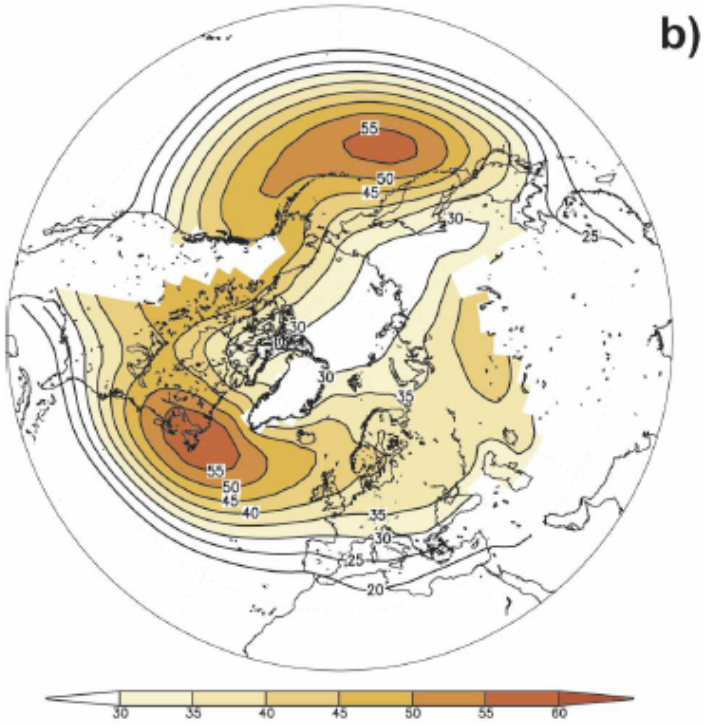
Storm tracks shift polewards, consistent with change in the eddy-driven jets.



Mean storm track response



Standard deviation of 2-6 day MSLP (ctrs 1/10 hPa)
2080-99 (SRESA1B) – 1960-2000 (20C3M)
Ulbrich et al (2008)

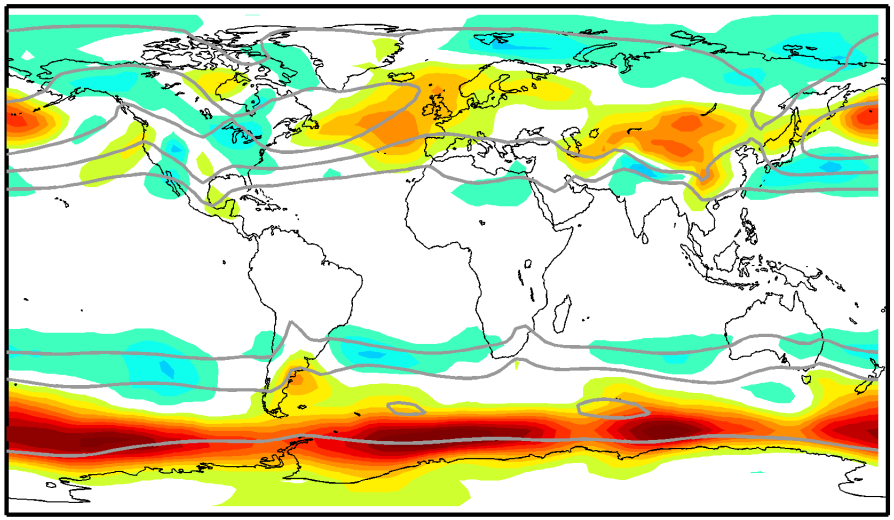


20c3m

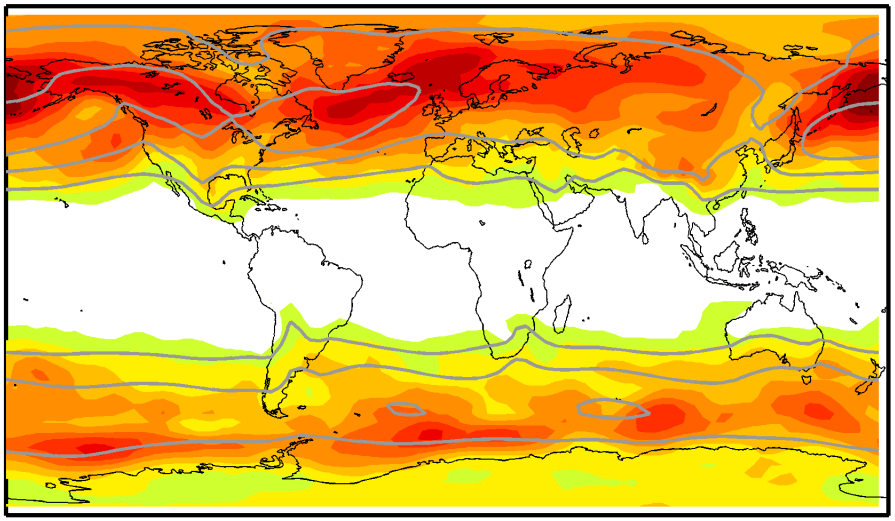
- Mean storm track response is ~ southward shift / zonal extension.

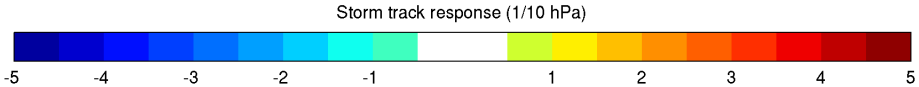
- Large spread between models.

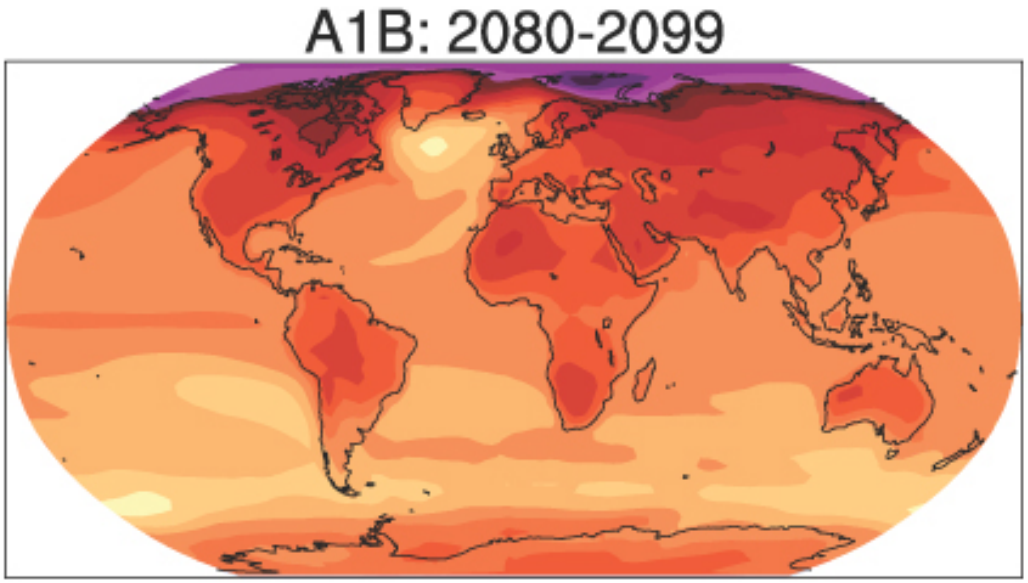
MEAN RESPONSE



STANDARD DEVIATION OF RESPONSE

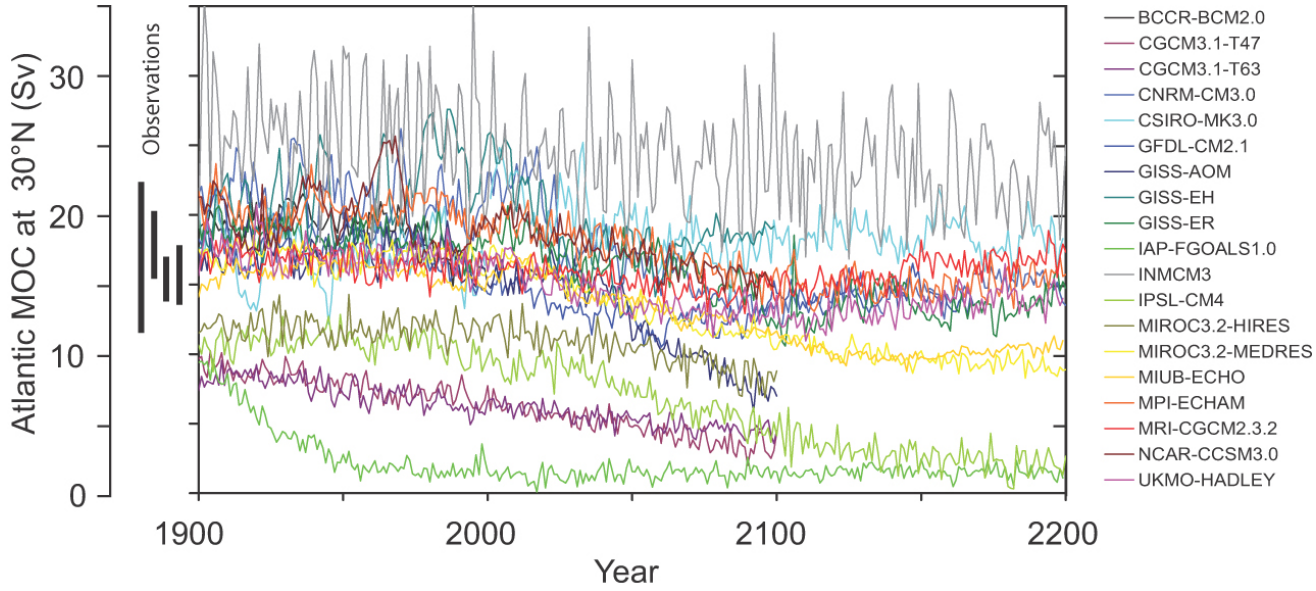






How much uncertainty arises from differing MOC responses?

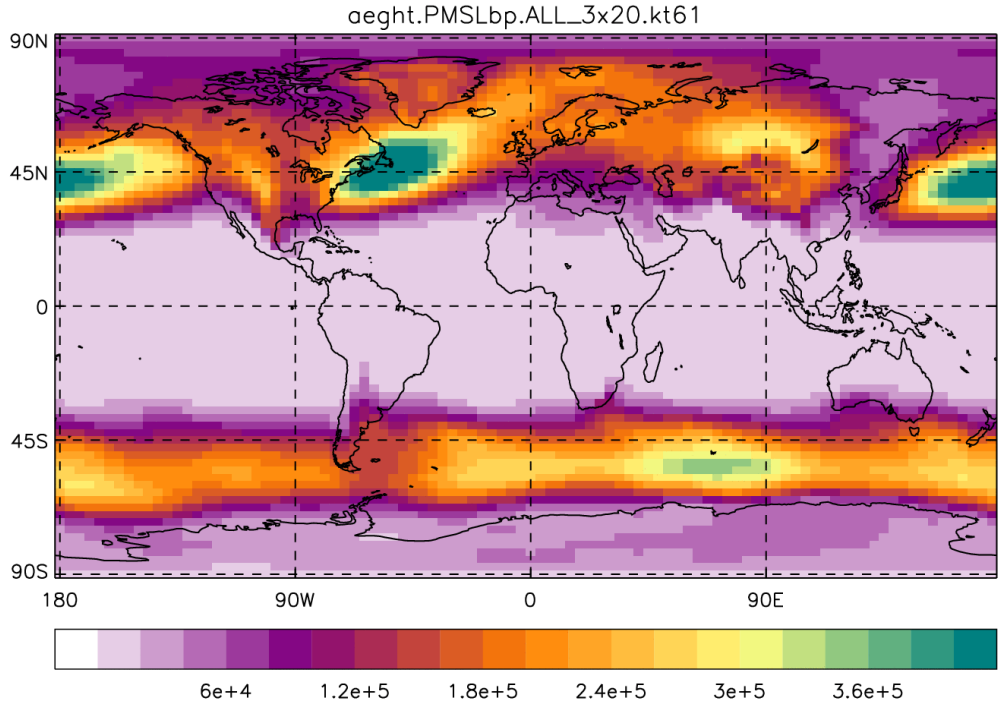
Use 20c3m (20th century control) 1960-99 and sresa1b 2060-99.



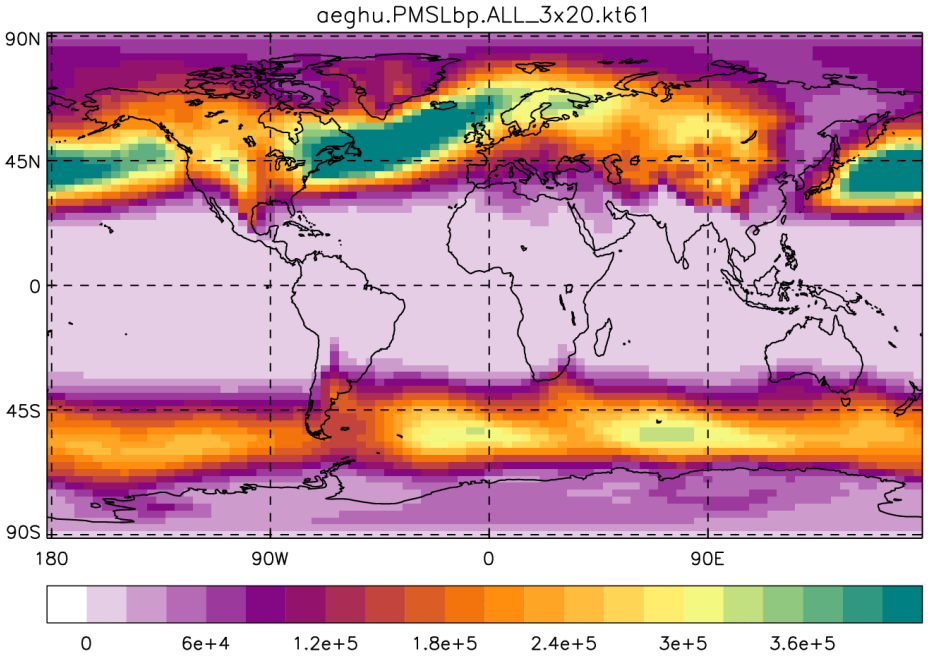
IPCC AR4

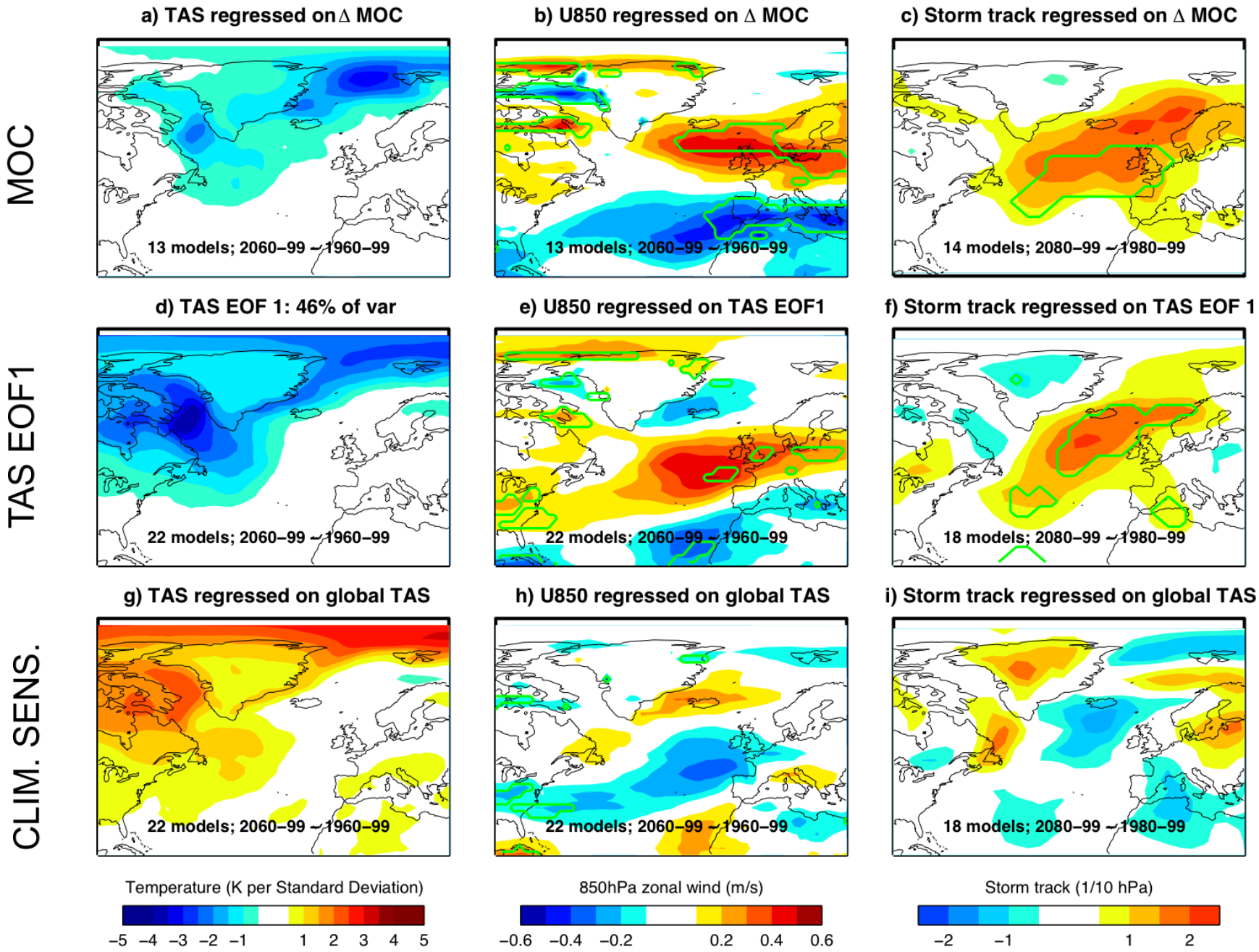
Storm track response to MOC hosing in HadCM3 (Brayshaw et al 2009)

Control: MOC on

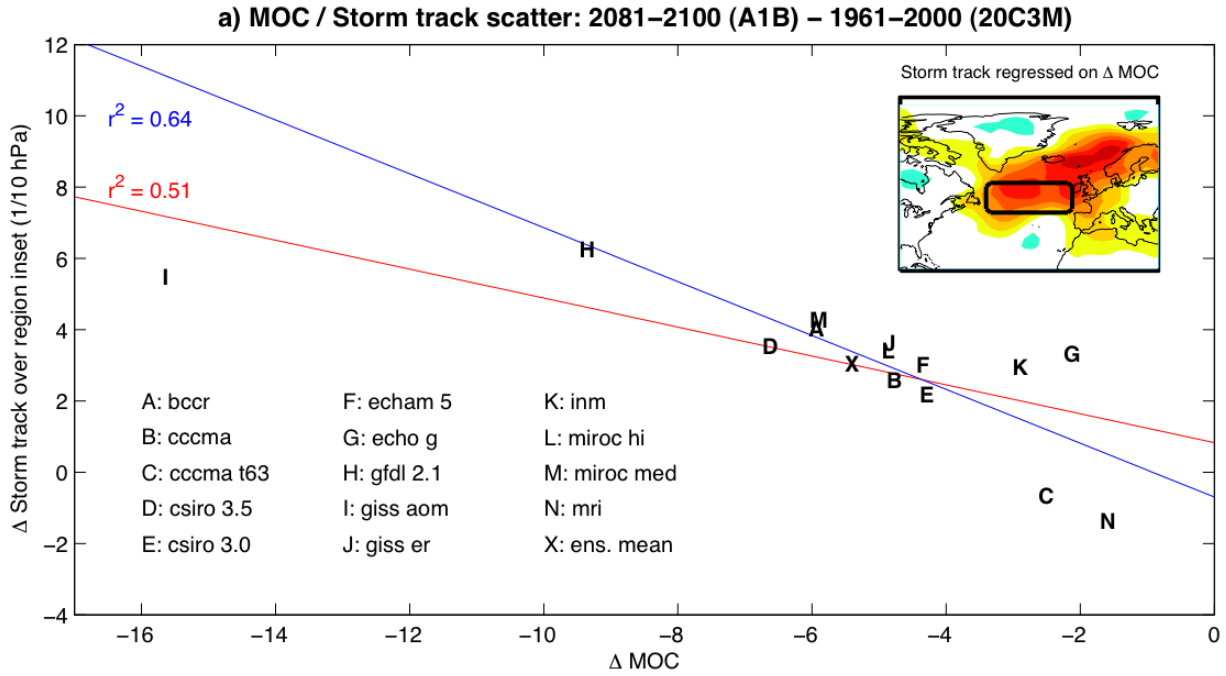


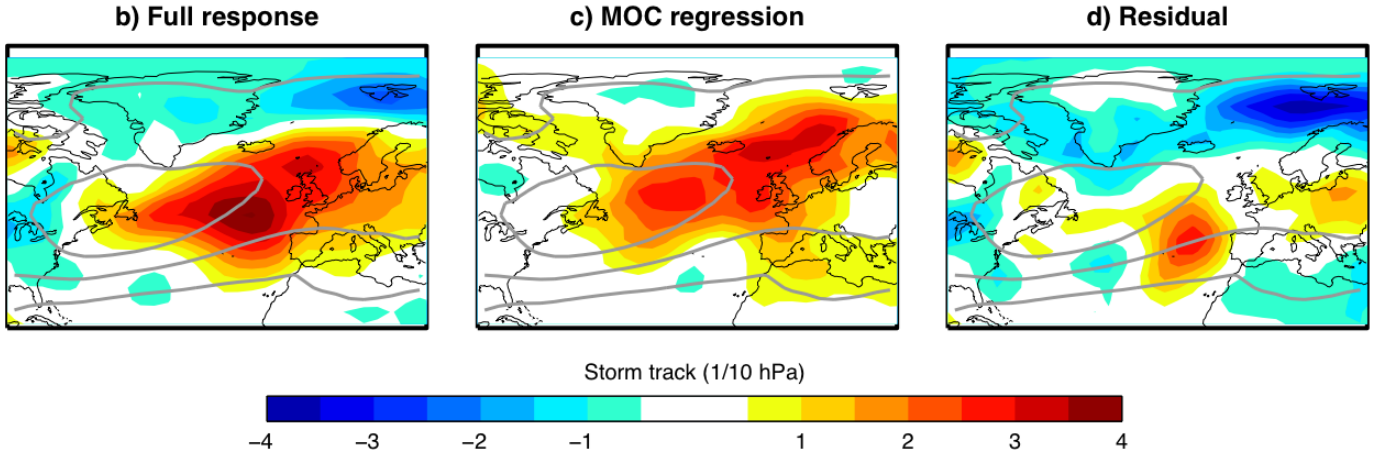
Hosing: MOC off



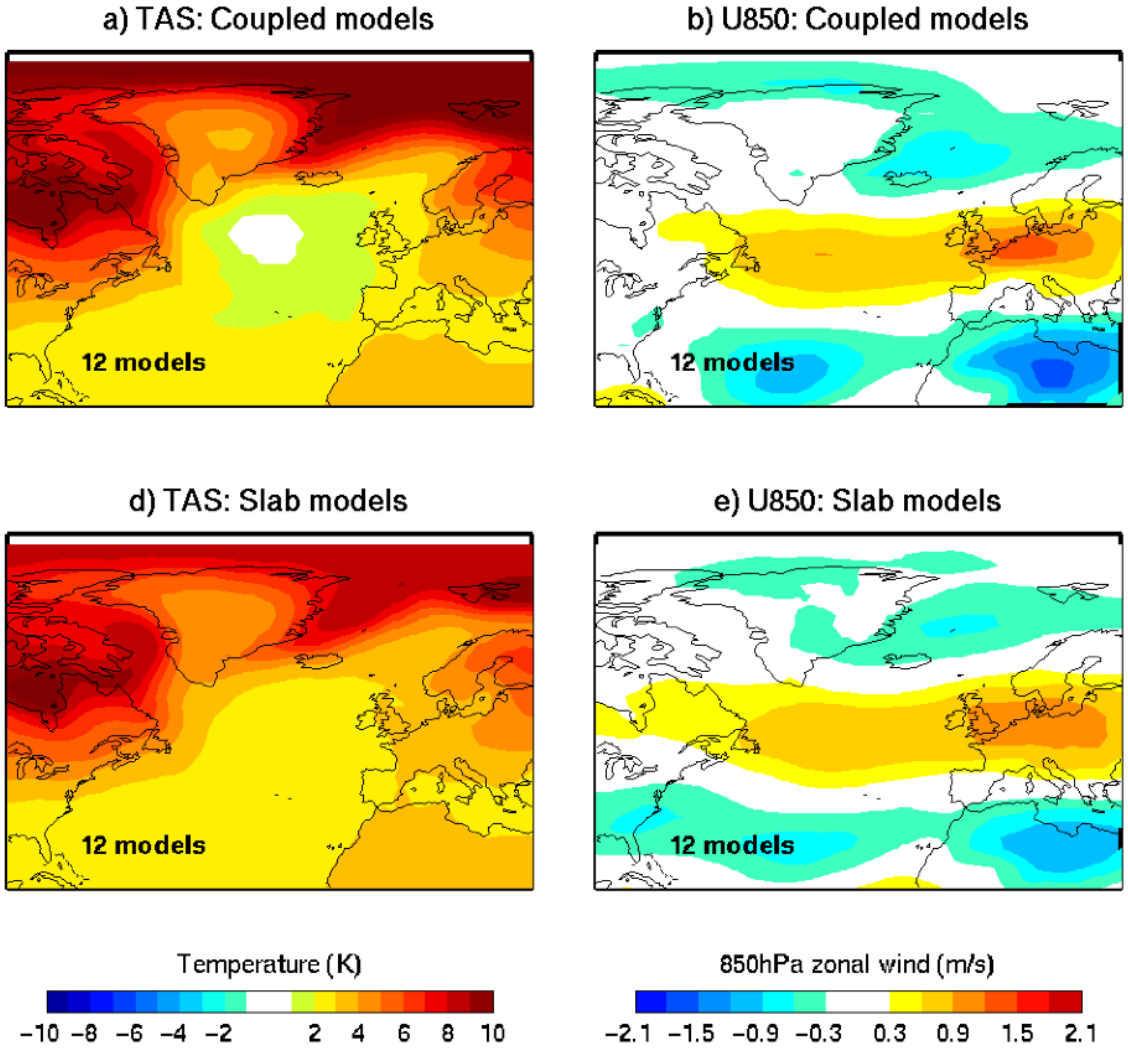

MOC
TAS EOF1
CLIM. SENS.
a) TAS regressed on Δ MOC
b) U850 regressed on Δ MOC
c) Storm track regressed on Δ MOC
13 models; 2060–99 – 1960–99
13 models; 2060–99 – 1960–99
14 models; 2080–99 – 1980–99
d) TAS EOF 1: 46% of var
e) U850 regressed on TAS EOF1
f) Storm track regressed on TAS EOF 1
22 models; 2060–99 – 1960–99
22 models; 2060–99 – 1960–99
18 models; 2080–99 – 1980–99
g) TAS regressed on global TAS
h) U850 regressed on global TAS
i) Storm track regressed on global TAS
22 models; 2060–99 – 1960–99
22 models; 2060–99 – 1960–99
18 models; 2080–99 – 1980–99
Temperature (K per Standard Deviation)
−5 −4 −3 −2 −1 1 2 3 4 5
850hPa zonal wind (m/s)
−0.6 −0.4 −0.2 0.2 0.4 0.6
Storm track (1/10 hPa)
−2 −1 1 2

Storm track response regressed on MOC response



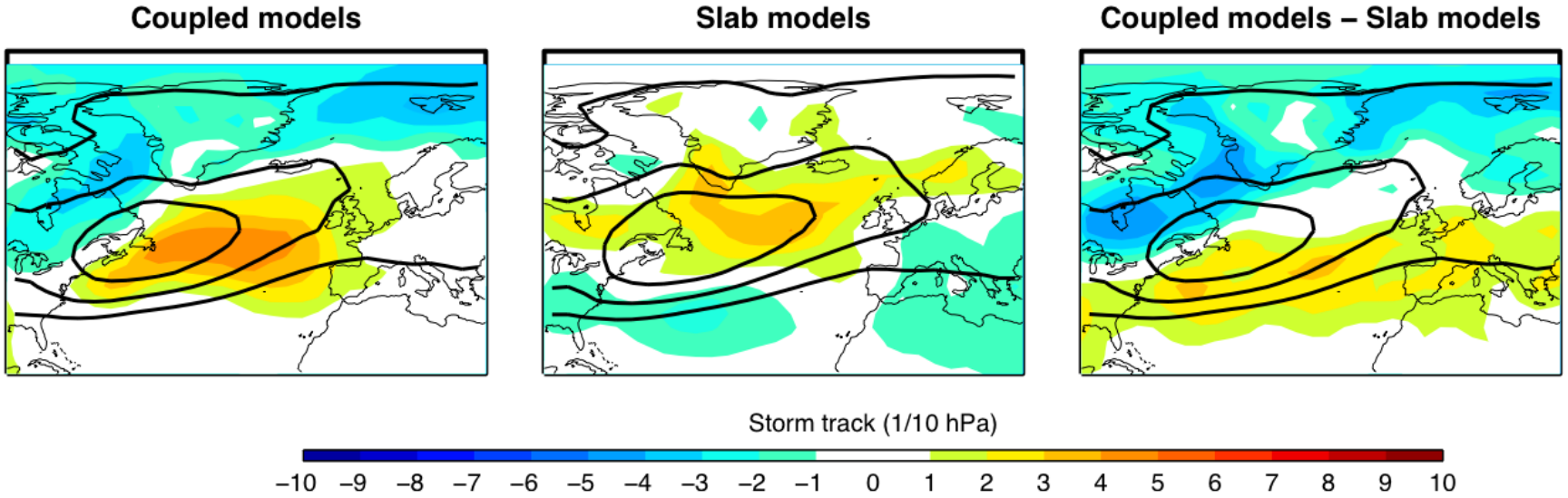


Coupled versus slab models



- Responses scaled by global warming.
- Atlantic minimum in warming not seen in slab models.
- U850 response is very similar in slabs and coupled models…

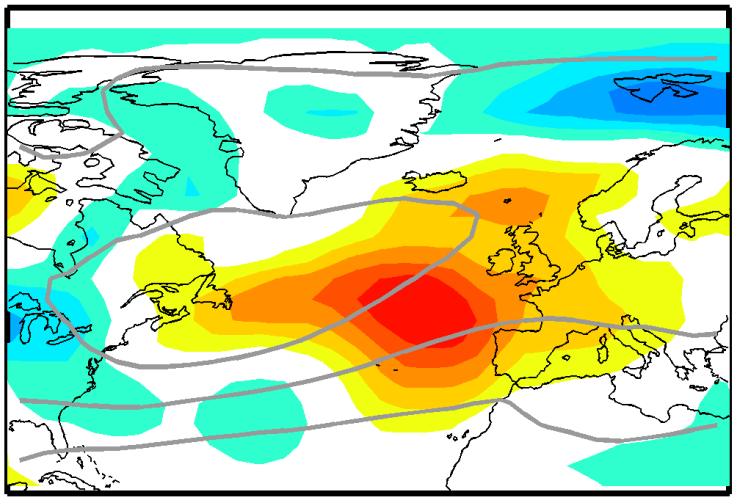
Storm track: Coupled versus slabs



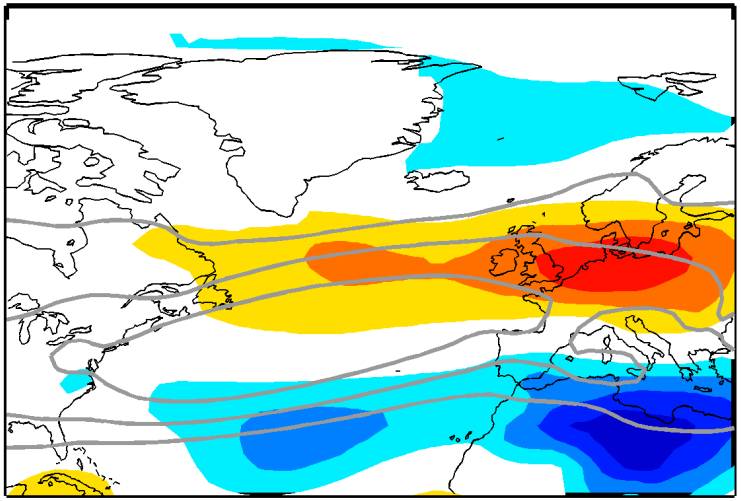
- Only models with > 4Sv MOC change in coupled version.
- Coupled ocean acts to shift storm track south in the response.

Decoupling of jet stream and storm track responses…?

Storm track response



U850 response



Summary

- The Atlantic storm track response should be considered a coupled problem.

- Differing MOC responses account for about half of the spread between different climate models.

- Slab runs show that there is some causality from ocean to atmosphere.

- Even without ocean changes the response is a strengthening rather than a poleward shift.

- Storm track and zonal wind responses seem curiously decoupled.