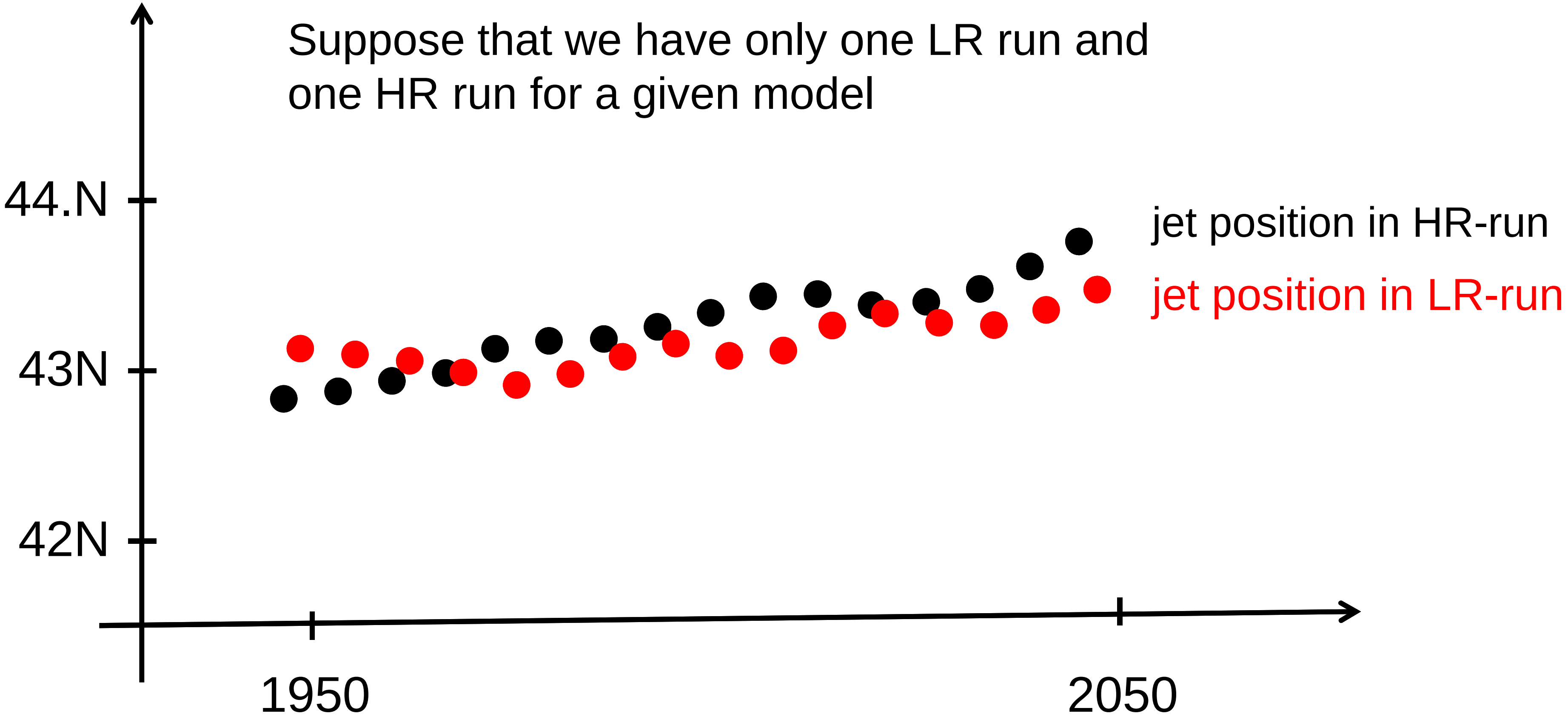
How do we know that the difference in (e.g. the position of North-Atlantic jet) simulated in LR- and HR-run represents the impact of enhanced resolution?

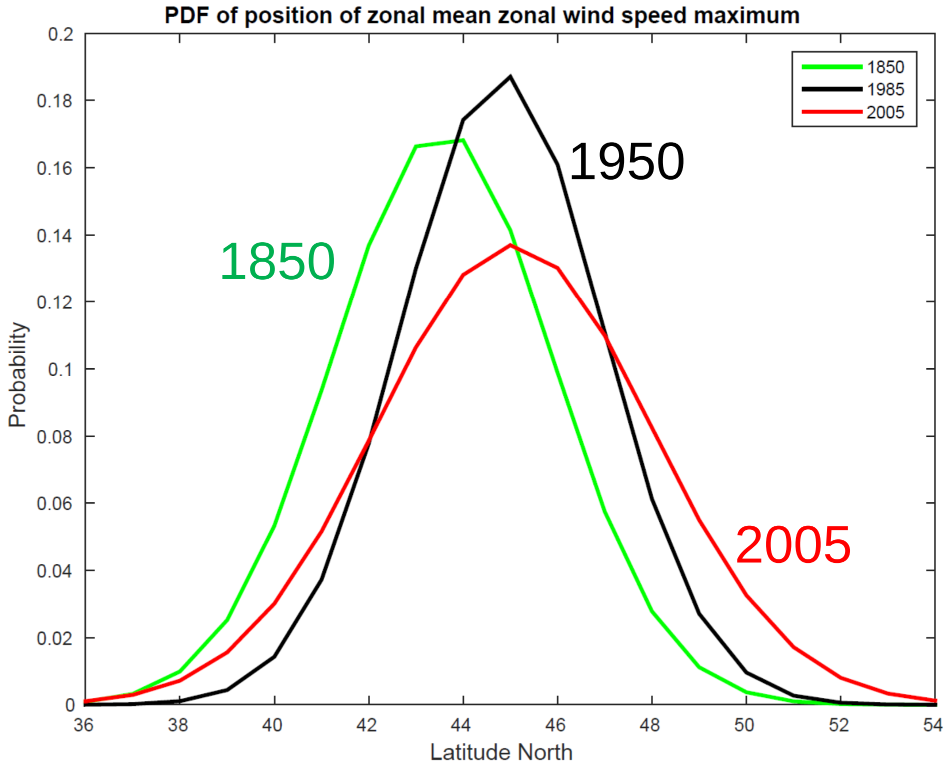
Suppose that we have only one LR run and one HR run for a given model



Approach: assess the resolution impact using statistical tests

Problem: where to get the null distribution?
Standard tests (parametric or bootstrapping) not suitable because of the nonstationarity induced by time-varying forcing

Solution: derive the null distribution from an ensemble of LR- or HR-runs



→ Estimate the probability of observing a particular high-res jet position under the H_o that resolution has no effect

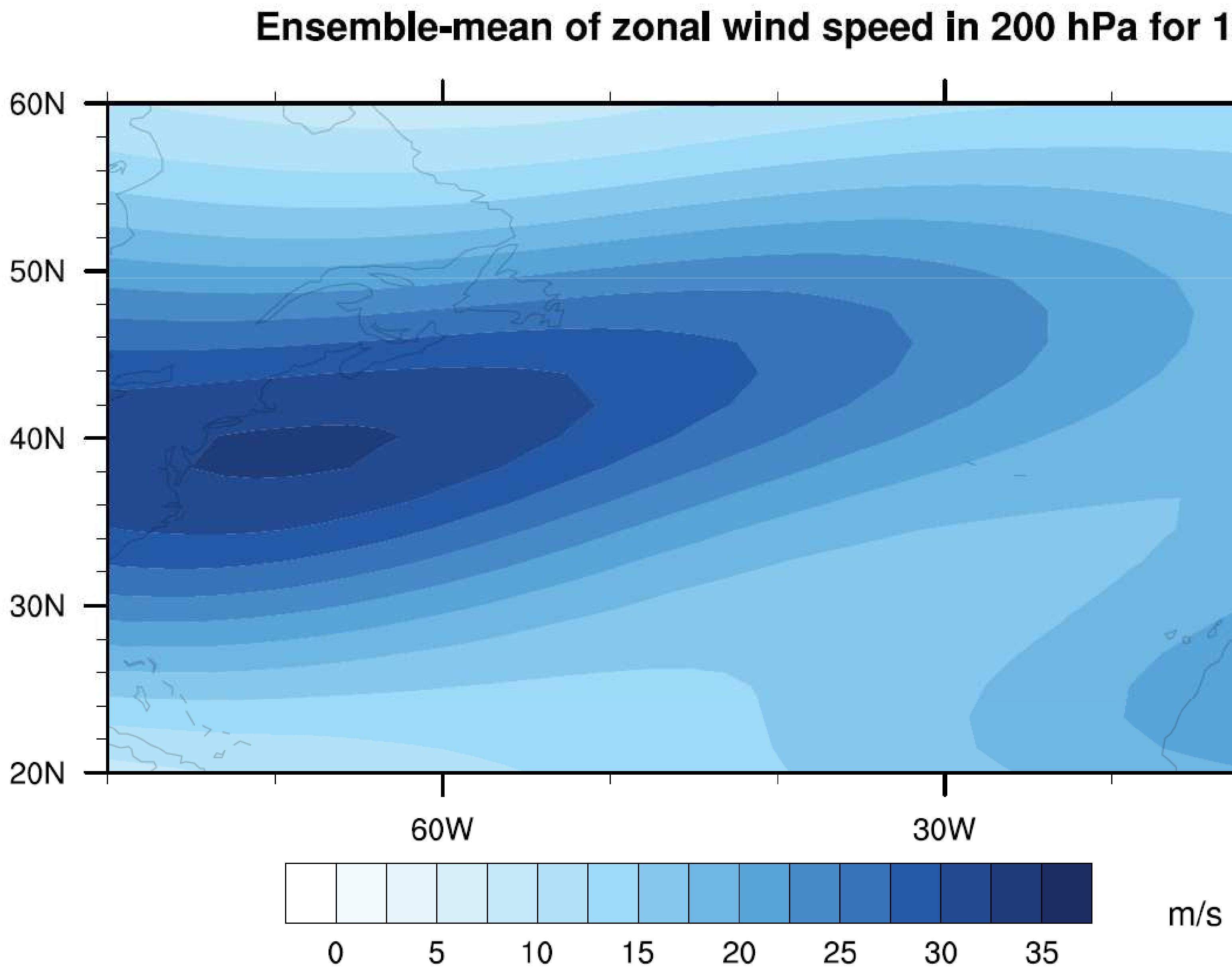
by Lucas Reimann

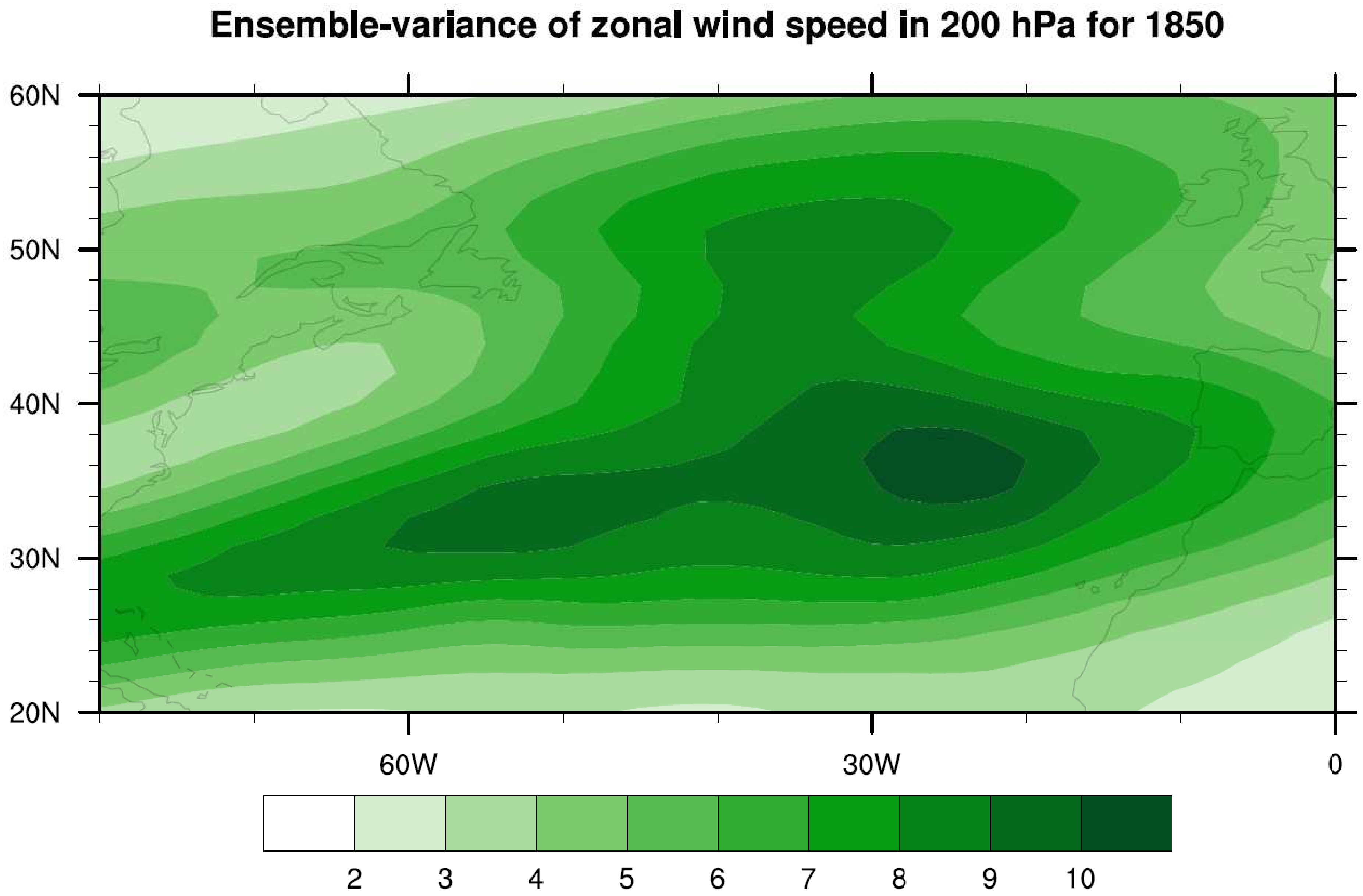
Strategy for detecting robust resolution-effects (assuming that model tuning does not obscure these effects):

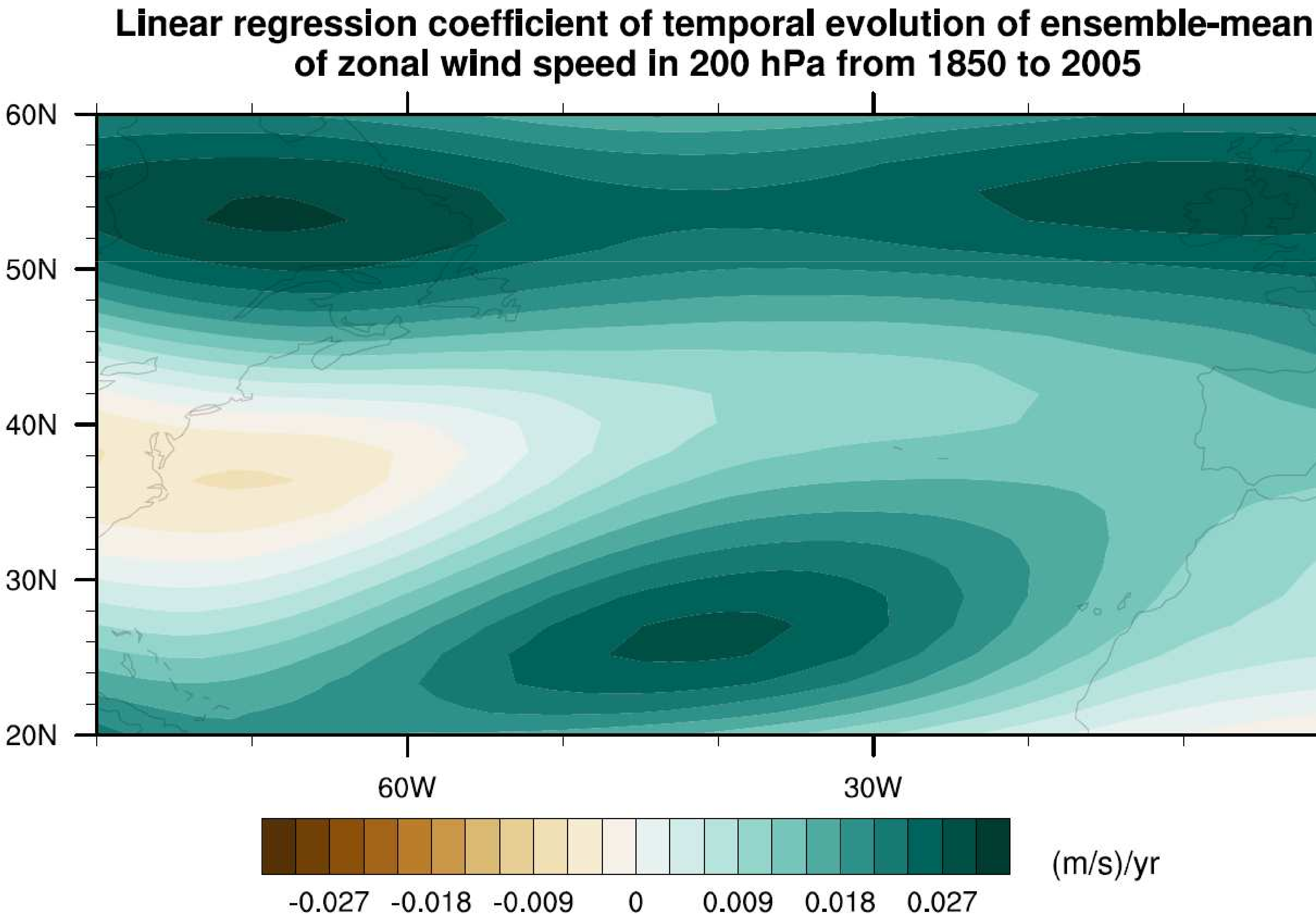
1. For a given model, **perform an ensemble of LR runs** to assess the probability of observing a HR value under the H_o of no effect

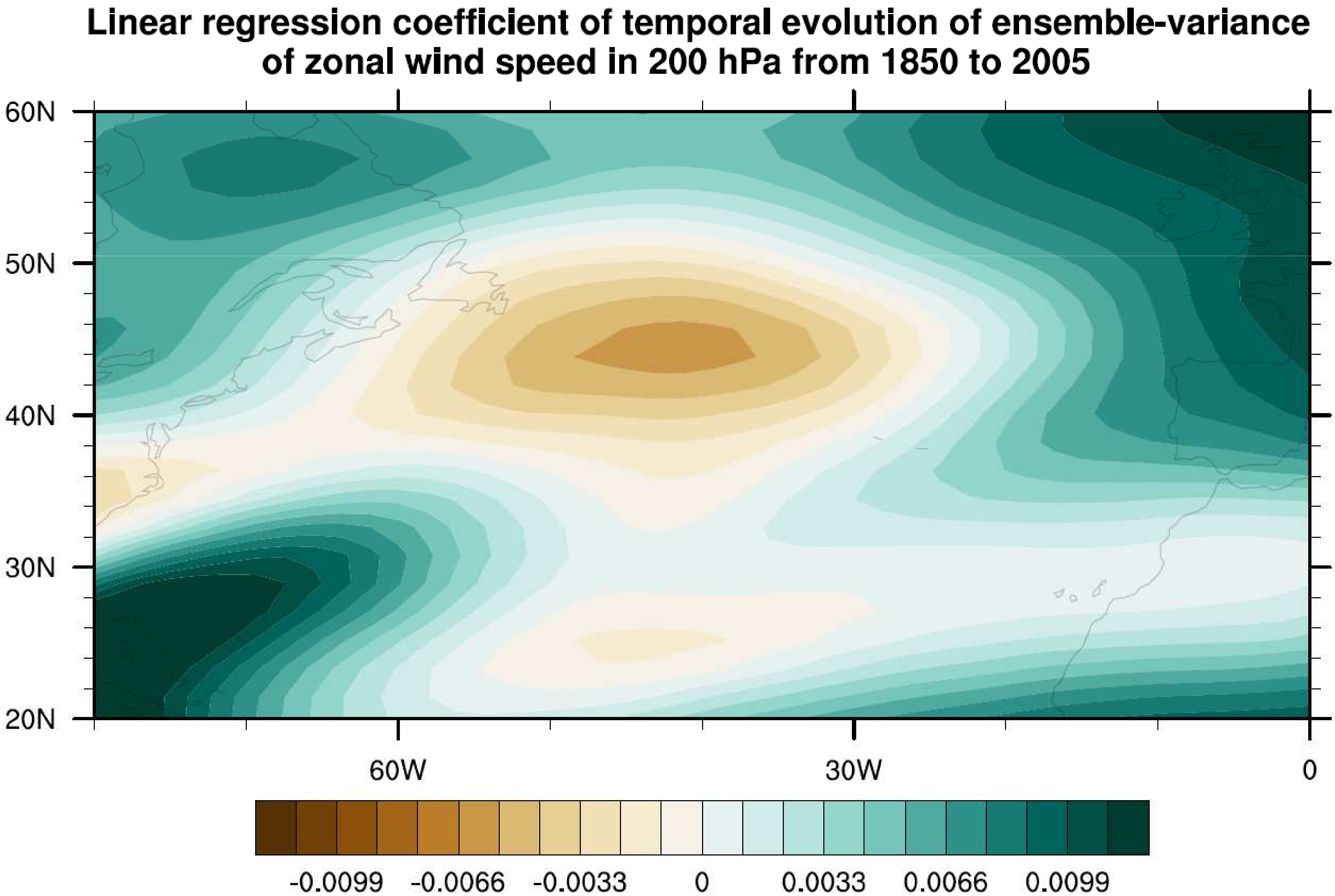
2. Repeat the analysis across different models

Thanks!


Ensemble-mean of zonal wind speed in 200 hPa for 1850
60N
50N
40N
30N
20N
60W
30W
0
0
5
10
15
20
25
30
35
m/s


Ensemble-variance of zonal wind speed in 200 hPa for 1850
60N
50N
40N
30N
20N
60W
30W
0
2
3
4
5
6
7
8
9
10


Linear regression coefficient of temporal evolution of ensemble-mean
of zonal wind speed in 200 hPa from 1850 to 2005
60N
50N
40N
30N
20N
60W
30W
0
-0.027
-0.018
-0.009
0
0.009
0.018
0.027
(m/s)/yr


Linear regression coefficient of temporal evolution of ensemble-variance of zonal wind speed in 200 hPa from 1850 to 2005
60N
50N
40N
30N
20N
60W
30W
0
-0.0099
-0.0066
-0.0033
0
0.0033
0.0066
0.0099

Cross cutting issues: Jets, storms, mid-latitude interaction

<u>QUESTIONS</u>:
Is the North Atlantic storm track different at high resolution?
positioning and SW to NE “tilt”
interannual variability
storm clustering within track

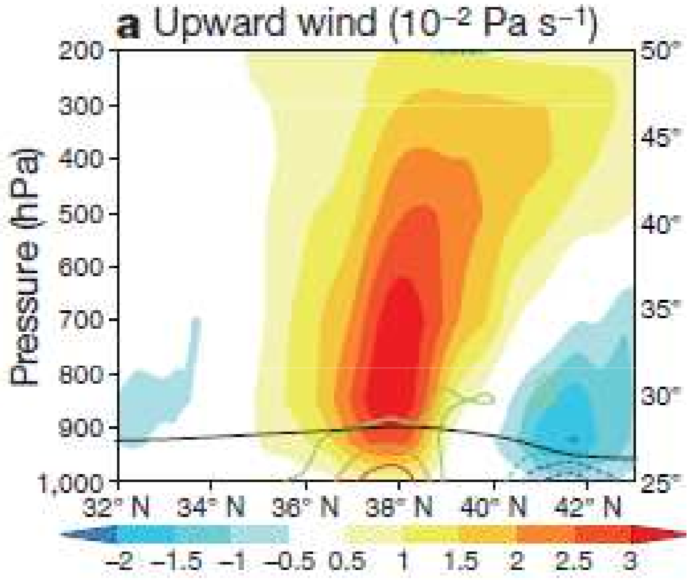
Are jets narrower and/or positioned at different latitudes with HR? Are jets splitting over Europe in different seasons? How does this affect the storm track?

How do SSTs, their gradients, etc. interact with the atmosphere above? What are the impacts for the storm track in terms of storm positioning, intensity, secondary cyclogenesis (including due to orography) etc.

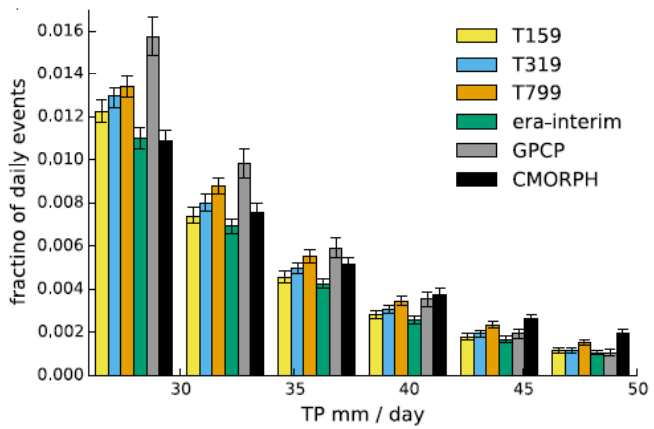
- What can PRIMAVERA add to the understanding?
  - How relevant are small scales for a correct representation of these phenomena
  - Methodologies to separate effects of HR on simulation:
    - Within atmosphere (e.g. latent heat release and cyclogenesis)
    - Air-sea: e.g. smoothing SSTs, flux denial etc.
    - Orography (e.g. smoothing)

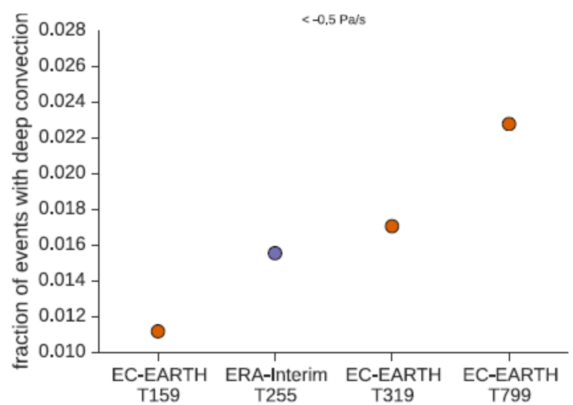
Impact of SST front on free atmospheric dynamics

Minobe et al., Nature, 2008



Intense precipitation and deep convection over the Gulf stream region for three resolutions of EC-Earth compared with reanalysis and observations



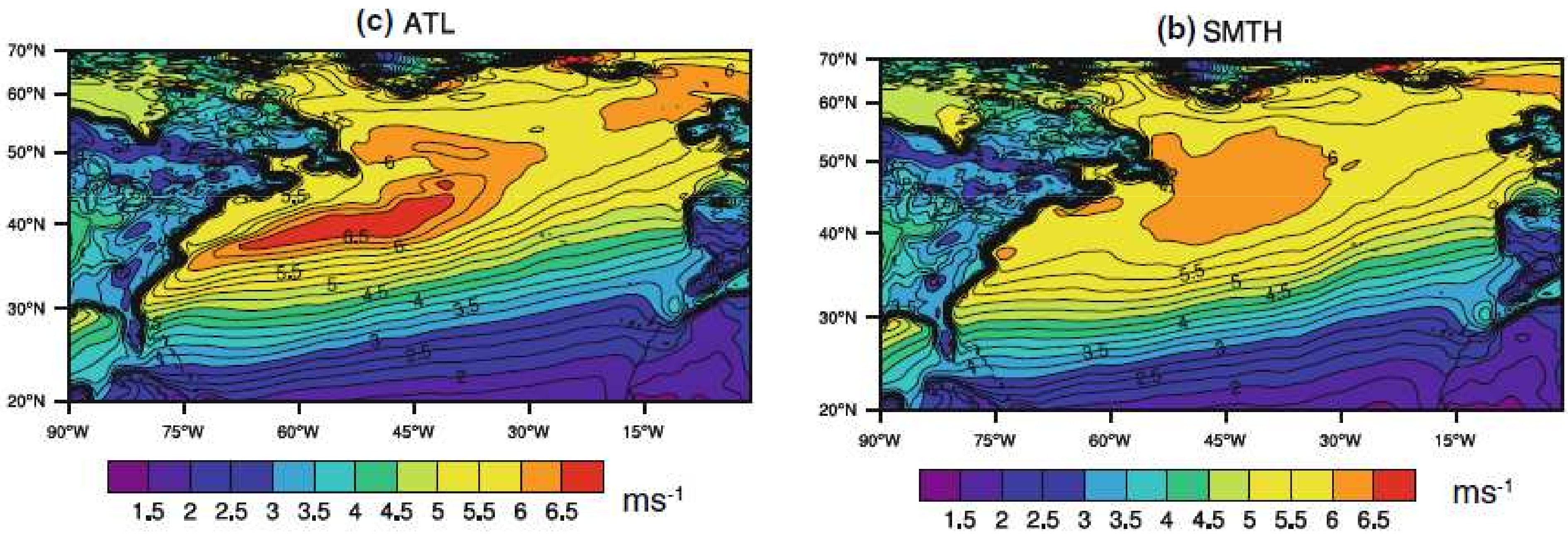


Precipitation

Scher et al., submitted, 2016a

Deep convection

Smoothing SST front over the Gulfstream affects storm tracks



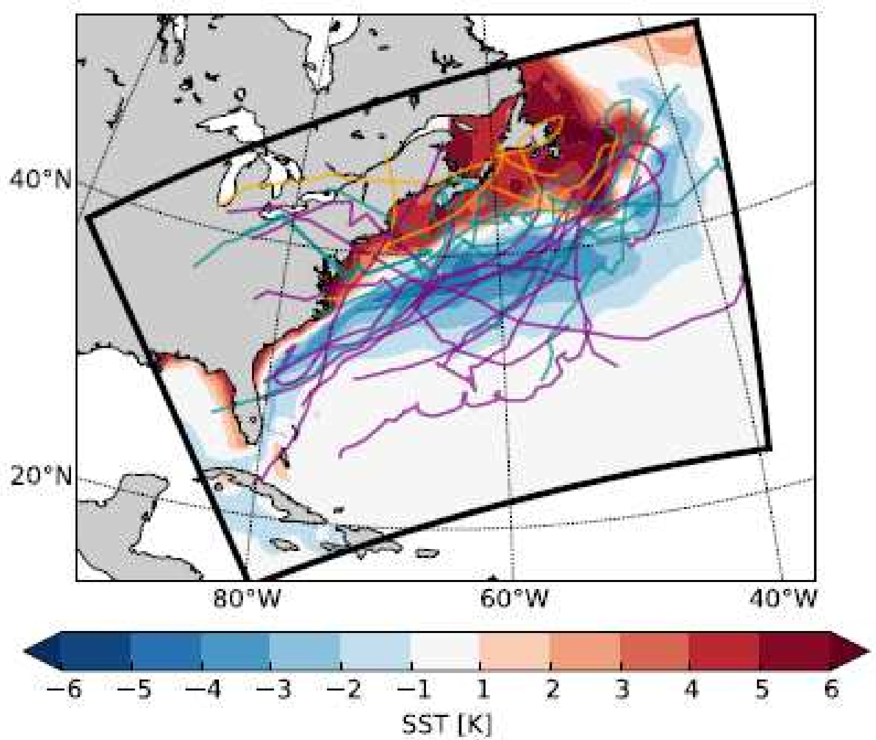
Small et al. 2014

Impact of SST front on storm development

Simulation of observed (ERA-Interim) storms over Gulfstream region

- Smoothing of SST front affects storm development
  - warmer (cooler) SSTs after smoothing intensifies (weakens) the storm
  - reduced baroclinicity weakens the storm

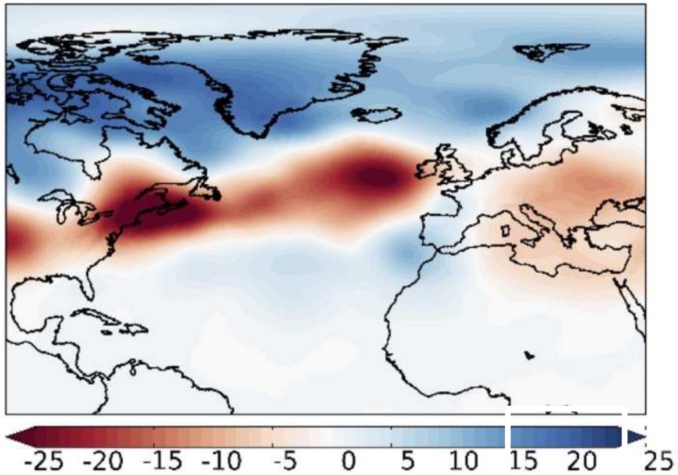
Total effect of those two mechanisms depends on relative magnitude



Scher et al., submitted, 2016b

Impact of atmospheric resolution on storm tracks and blockings

Band pass filtered Z500 variance
Difference between T799 and
T159 for EC-Earth



(d) T799 - T159

Van Haren et al., 2015

Cyclone track density

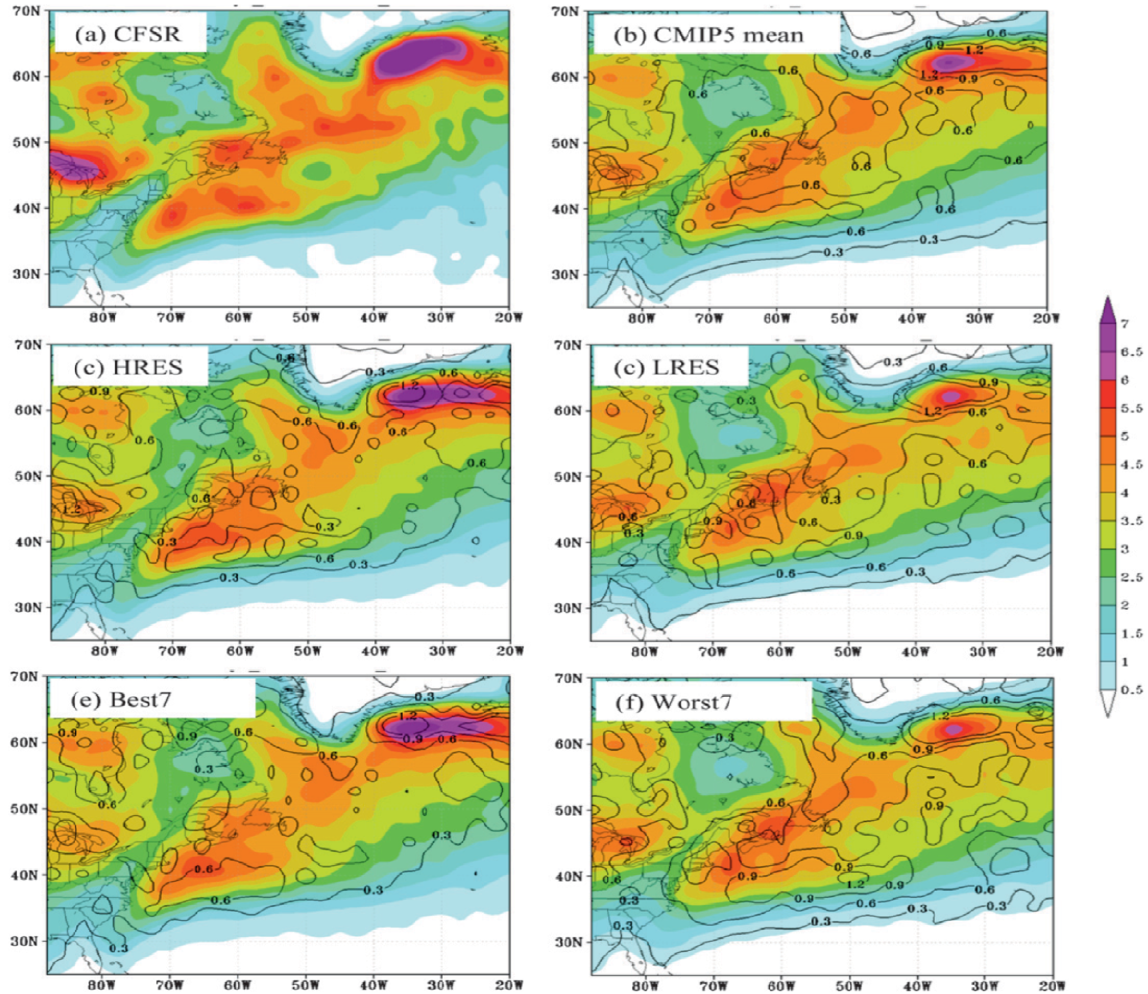
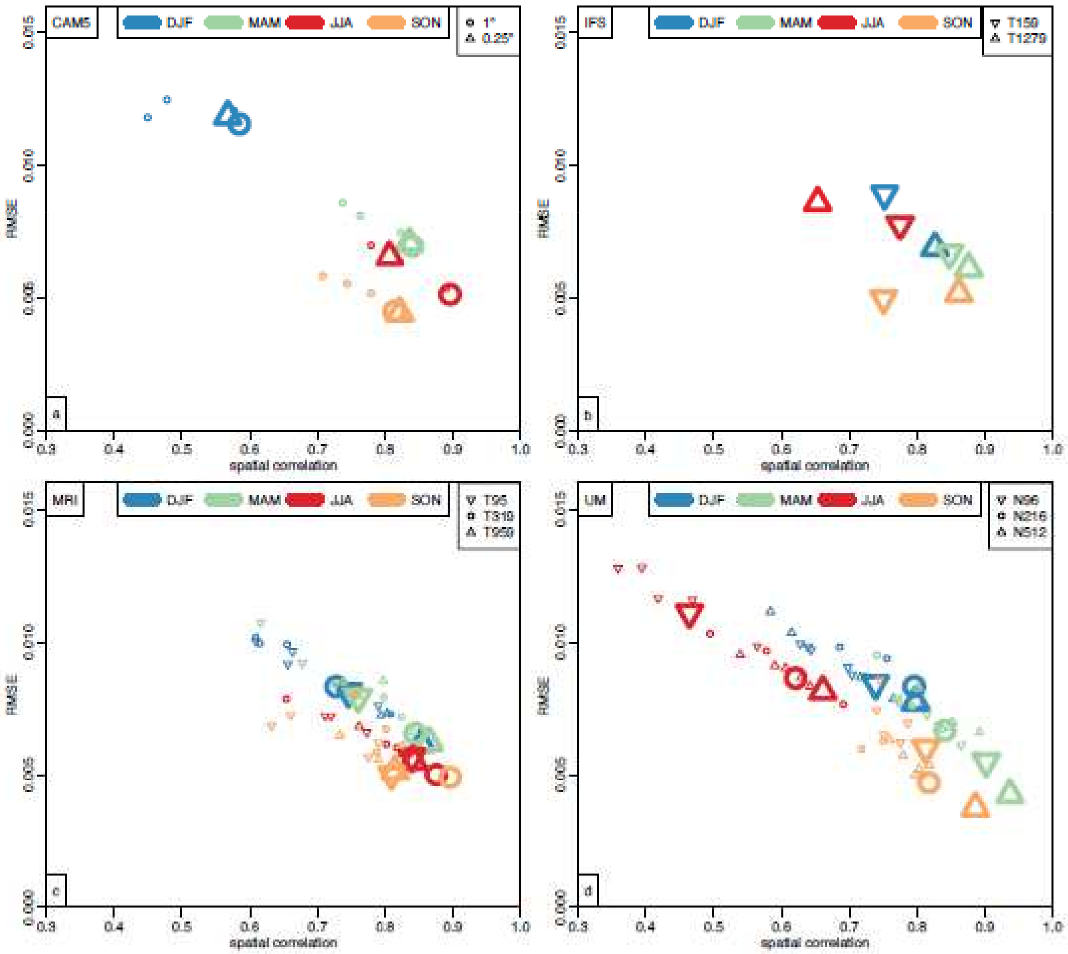


FIG. 3. (a) Cyclone track density for the CFSR analysis showing the number of cyclones per cool season (November–March) per 50000 km^2 for 1979–2004. (b) As in (a), but for the mean (shaded) and spread (contoured every 0.3) of all CMIP5 models in Table 1. As in (b), but for the (c) high-resolution (HRES), (d) low-resolution (LRES), (e) Best7, and (f) Worst7 models.

Colbe et al. 2016

Atlantic blocking in 4 models for different resolutions



Schiemann et al., J. Clim., 2016

Impact of Gulfstream SST front on winter time Atlantic blocking

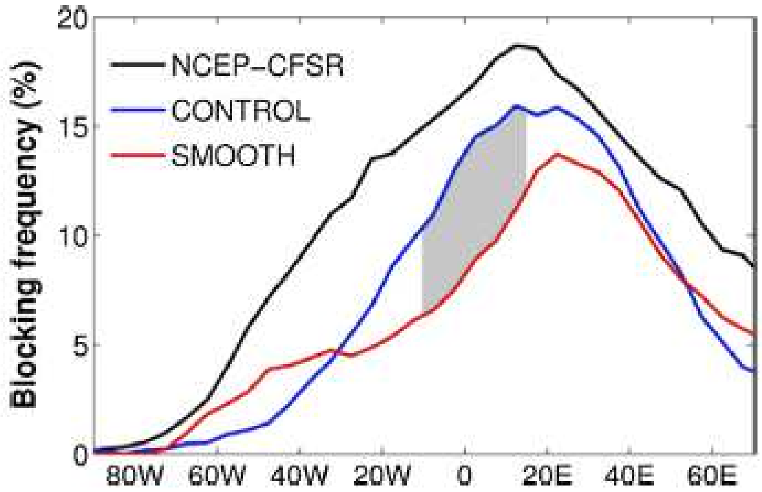


Fig. 3 The wintertime (DJF) blocking frequencies in the NCEP-CFSR (*black*), CONTROL (*blue*) and SMOOTH (*red*). The *grey shaded region* indicates where the difference is significant at the 10 % significance level

O'Reilly et al. Clim Dyn, 2016

Low-level zonal wind, 10-day low-pass

Time: 1953-03-10 18:00