Barcelona Supercomputing Center
Centro Nacional de Supercomputación

EXCELENCIA SEVERO OCHOA

Sensitivity of future projected precipitation changes over Europe to model resolution

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PRIMAVERA

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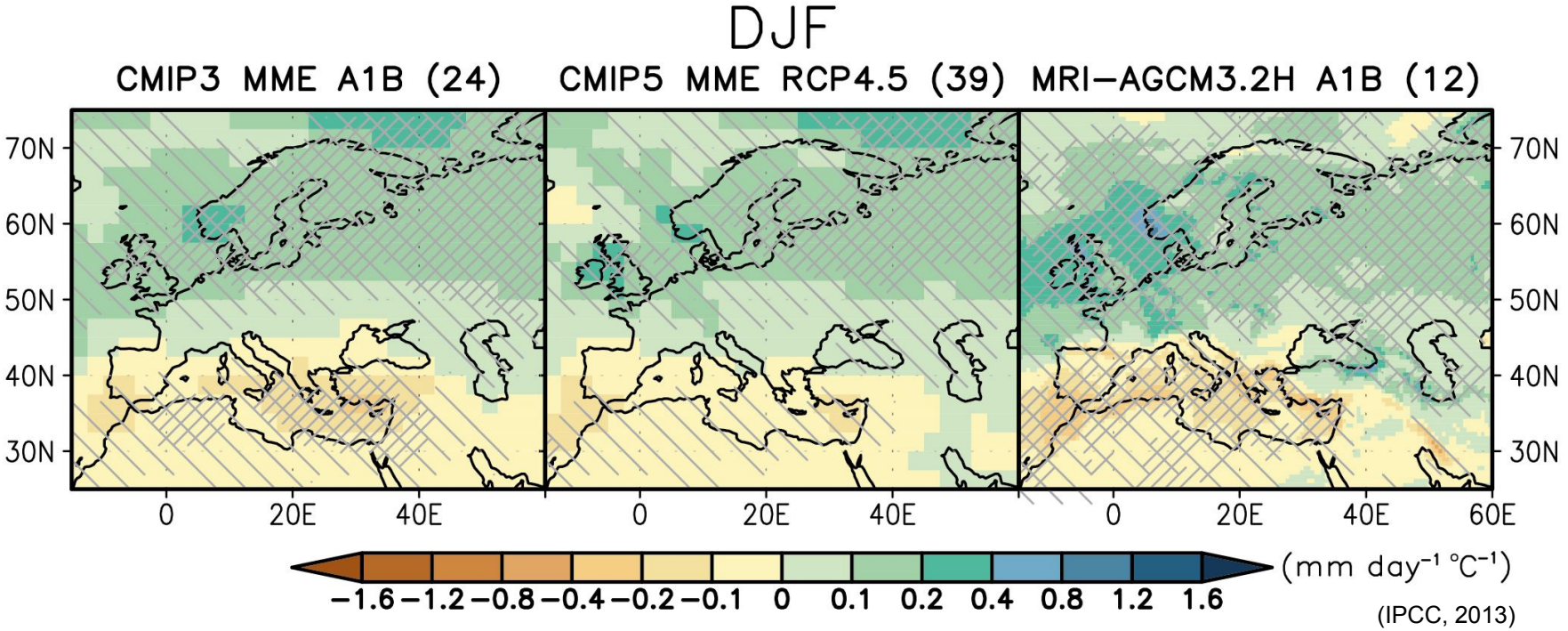
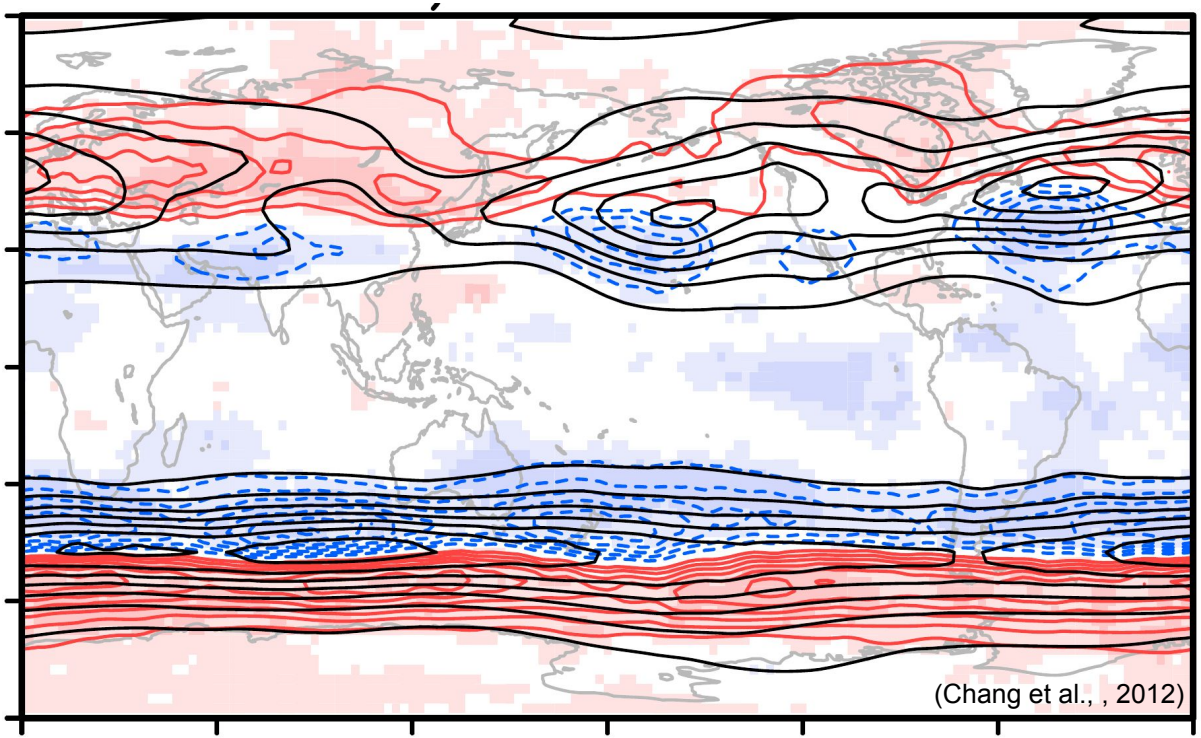
Projected increase in winter precipitation in N. Europe



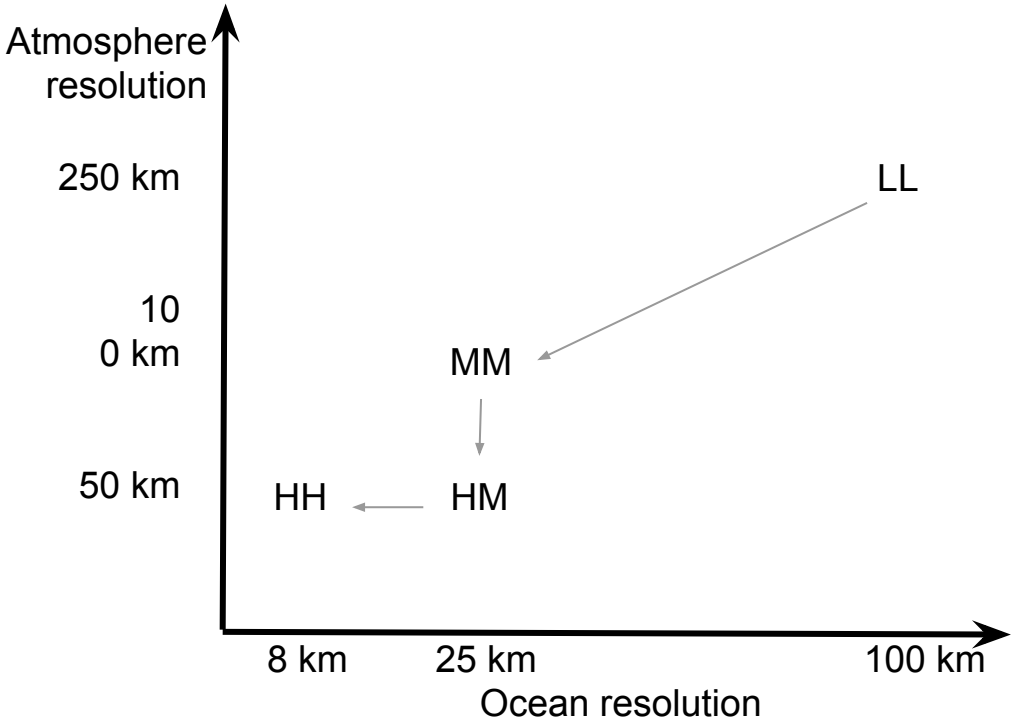
Less certain changes in extratropical eddy activity



Storm tracks change between 1980–1999 and 2081–2100 in DJF CMIP5 RCP8.5 projections
Black contours: model climatology (every 50 m²/s²)
Red and blue contours: projected changes (every 10 m²/s²)
Shadings: ≥80% (light) or 100% (dark) of the models agree on the sign of the change

What is the sensitivity of future projected precipitation changes over Europe to model resolution?

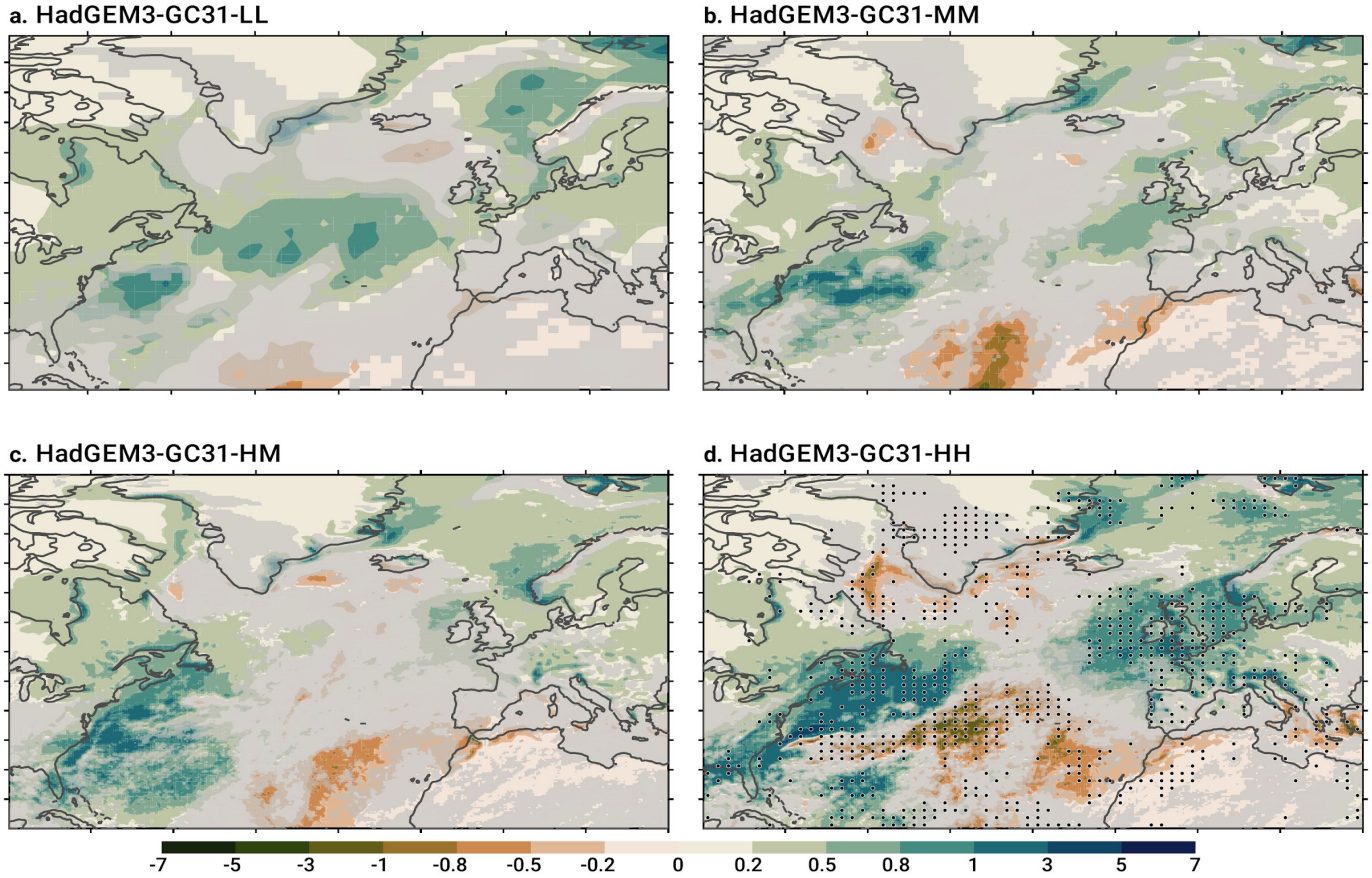
HighResMIP simulations with the coupled model HadGEM3-GC3.1



	Ensemble size	
	hist-1950 (1950–2014)	highres-future (2015–2050)
LL	8	4
MM	3	3
HM	3	3
HH	1	1

Much larger increase in winter precip in HH than at lower res

Anomalies in winter precip. (mm/day) between 2030–2050 and 1960–1980



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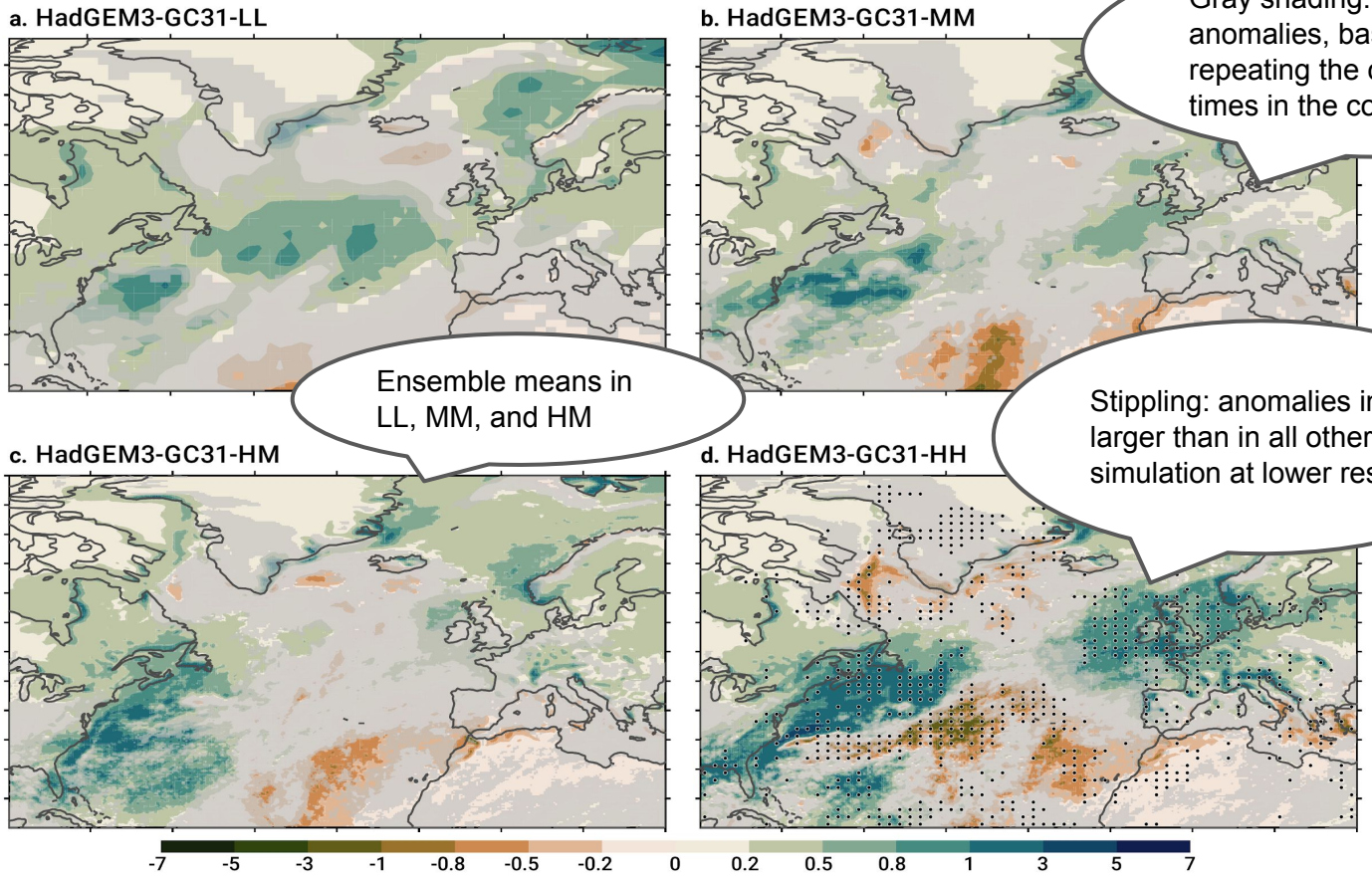


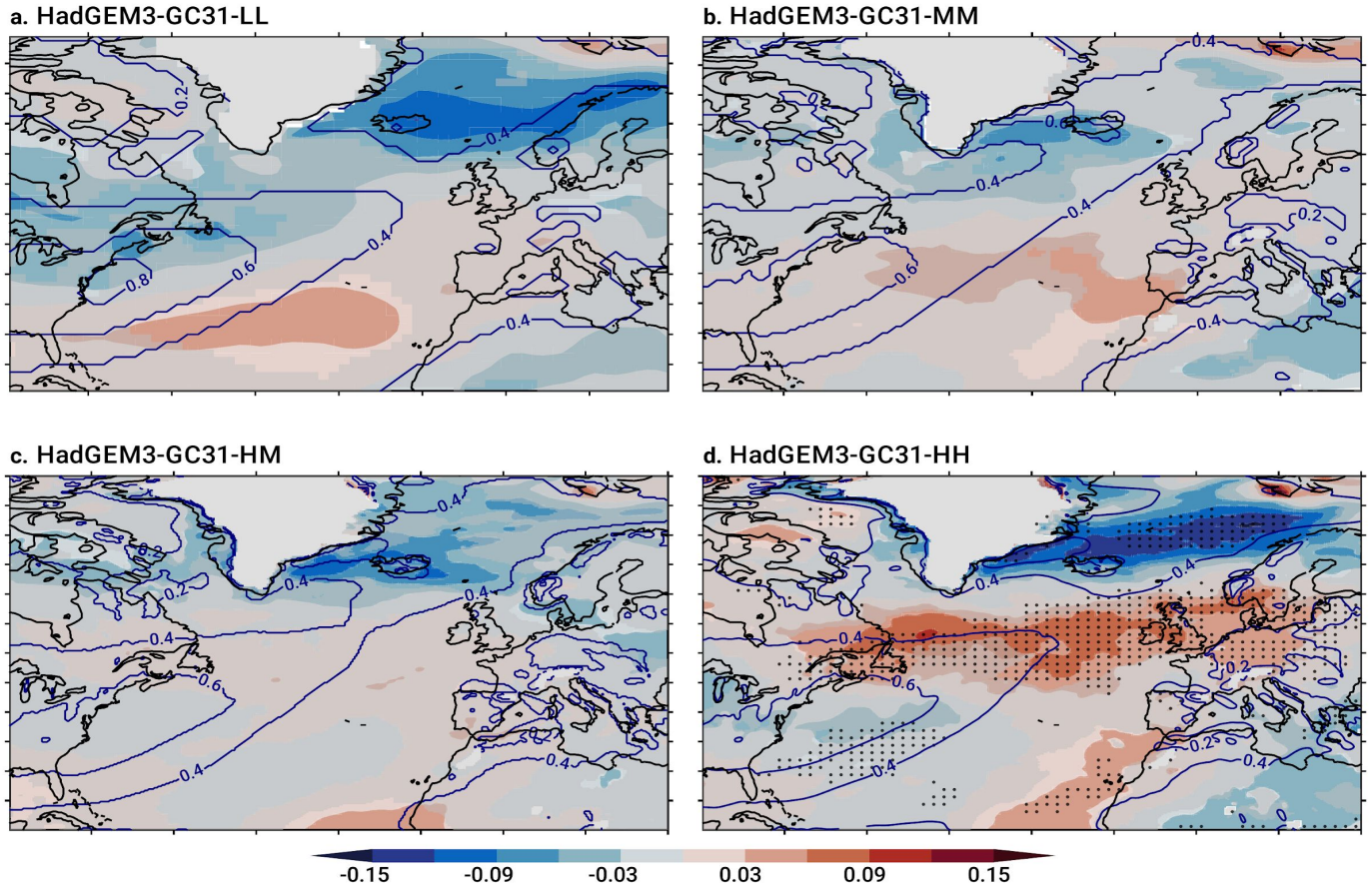
Gray shading: non-significant anomalies, based on repeating the calculation 500 times in the control simulation

Ensemble means in LL, MM, and HM

Stippling: anomalies in HH larger than in all other simulation at lower res.

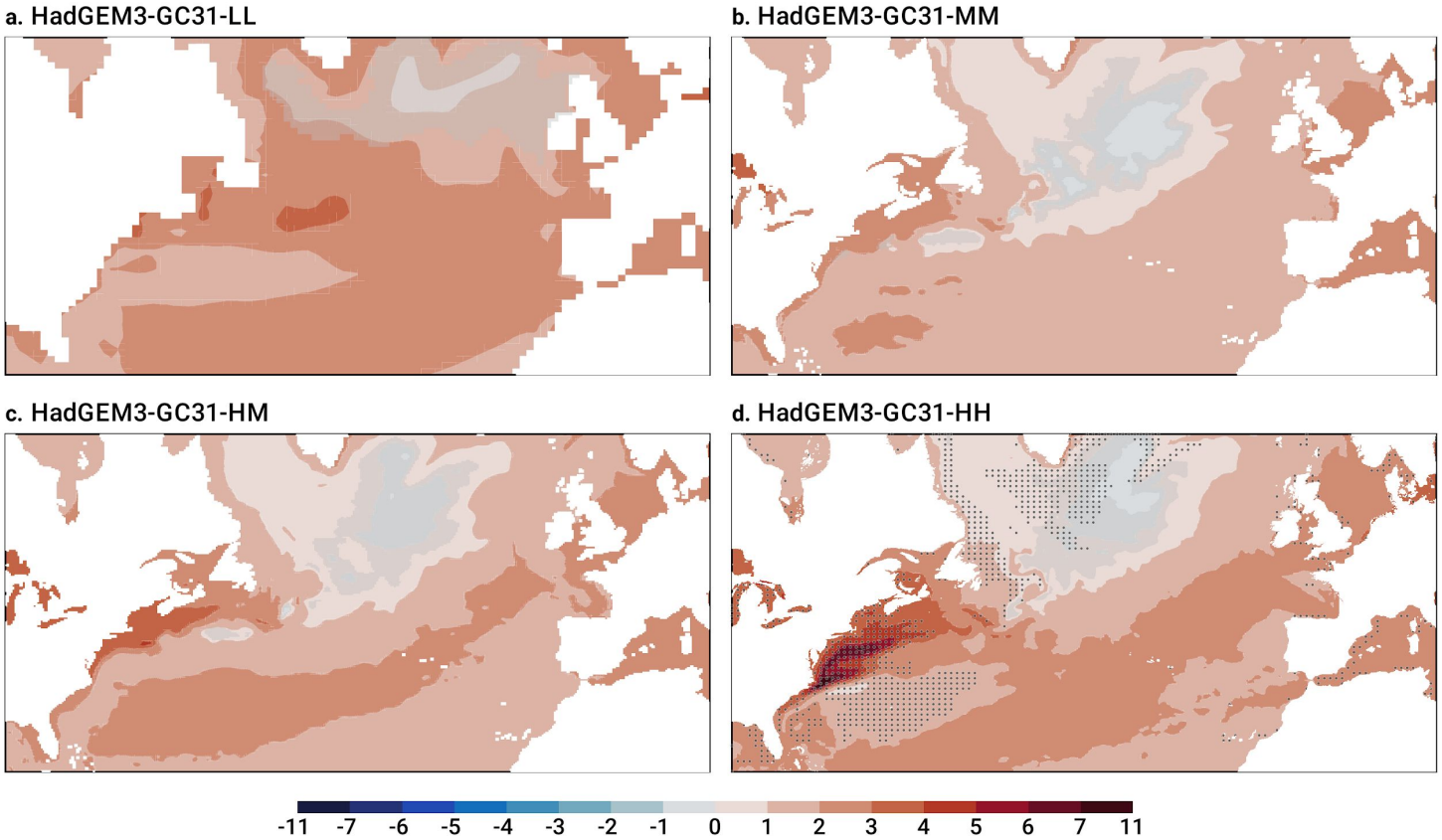
Strongest increase in eddy activity in HH

Anomalies in winter eady growth rate (day^{-1}) between 2030–2050 and 1960–1980



Strongest surface warming in the Gulf Stream in HH

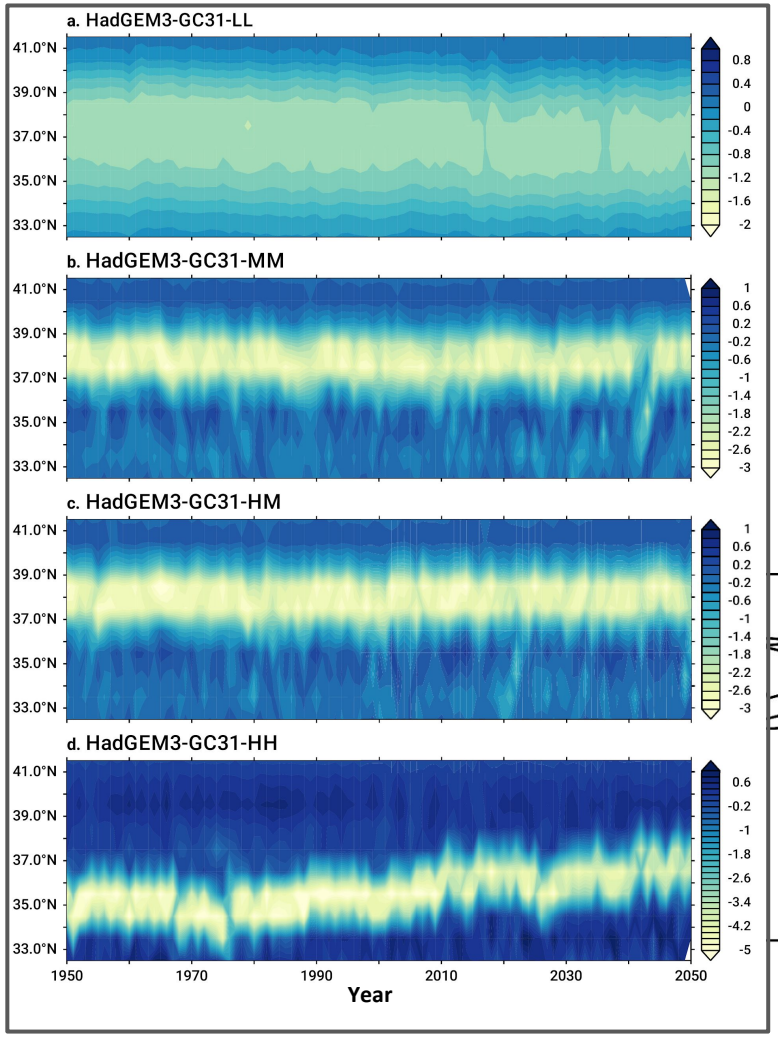
Anomalies in SST (K) between 2030–2050 and 1960–1980

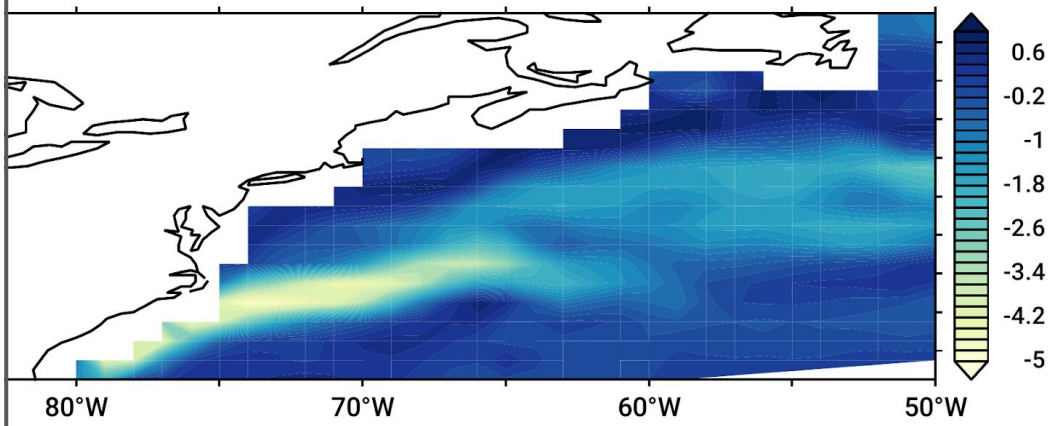


Gulf Stream shifts northward in HH, allowing the penetration of slope waters and surface warming

← Change in meridional gradient in sea-surface height. Similar mechanism in Saba et al., 2016.

↓Climatology in 1960–1980 in HH





Summary so far

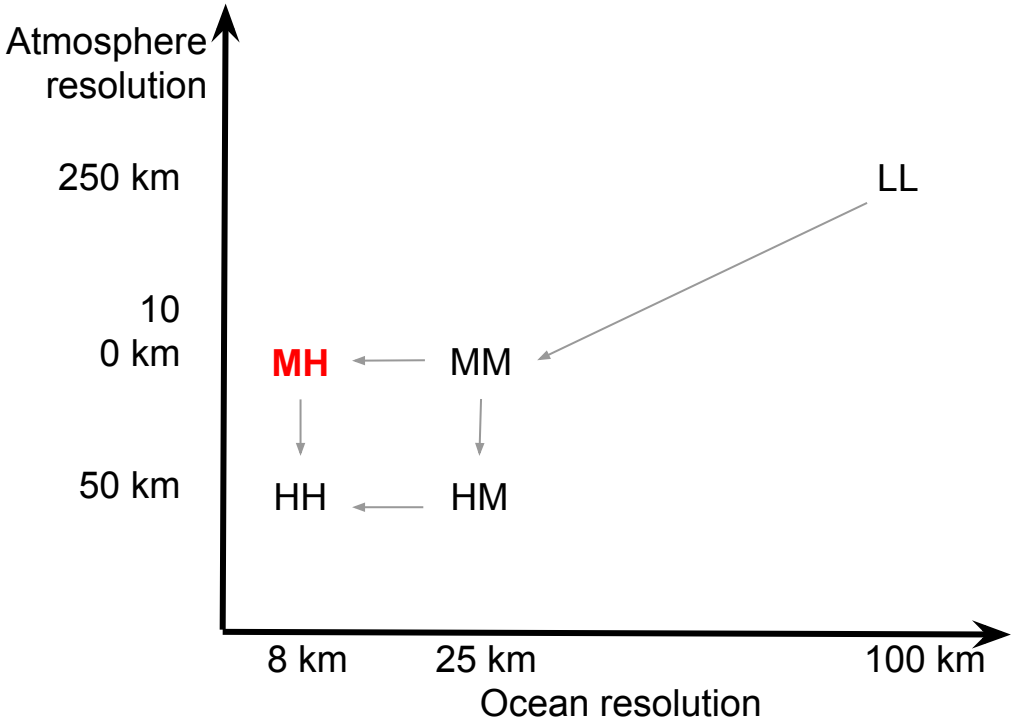
- Increased winter precipitation larger in HH than at lower resolution in NW Europe by 2050

- Associated with more active extratropical cyclones in the North Atlantic
  - Intensified eady growth rate, storm tracks, and upper-troposphere jet

- SST warming in the Gulf Stream
  - Enhanced surface heating increasing baroclinicity
  - Northward shift in the Gulf Stream and slope waters
  - Increased ocean resolution key to this

A new resolution comes into play: MH

HighResMIP simulations with the coupled model HadGEM3-GC3.1



	Ensemble size hist-1950 (1950–2014)	Ensemble size highres-future (2015–2050)
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MH	**1**	**1**
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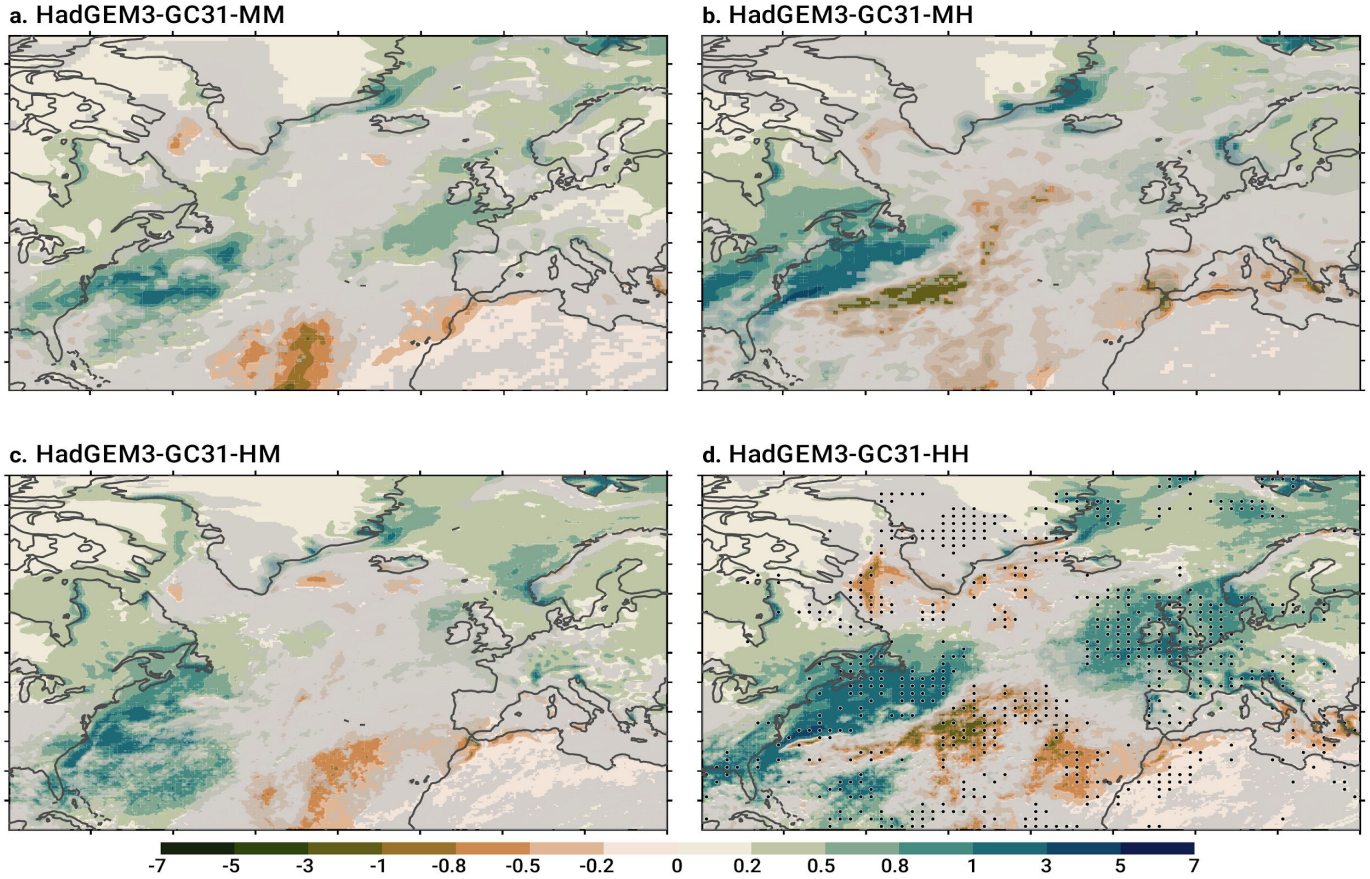
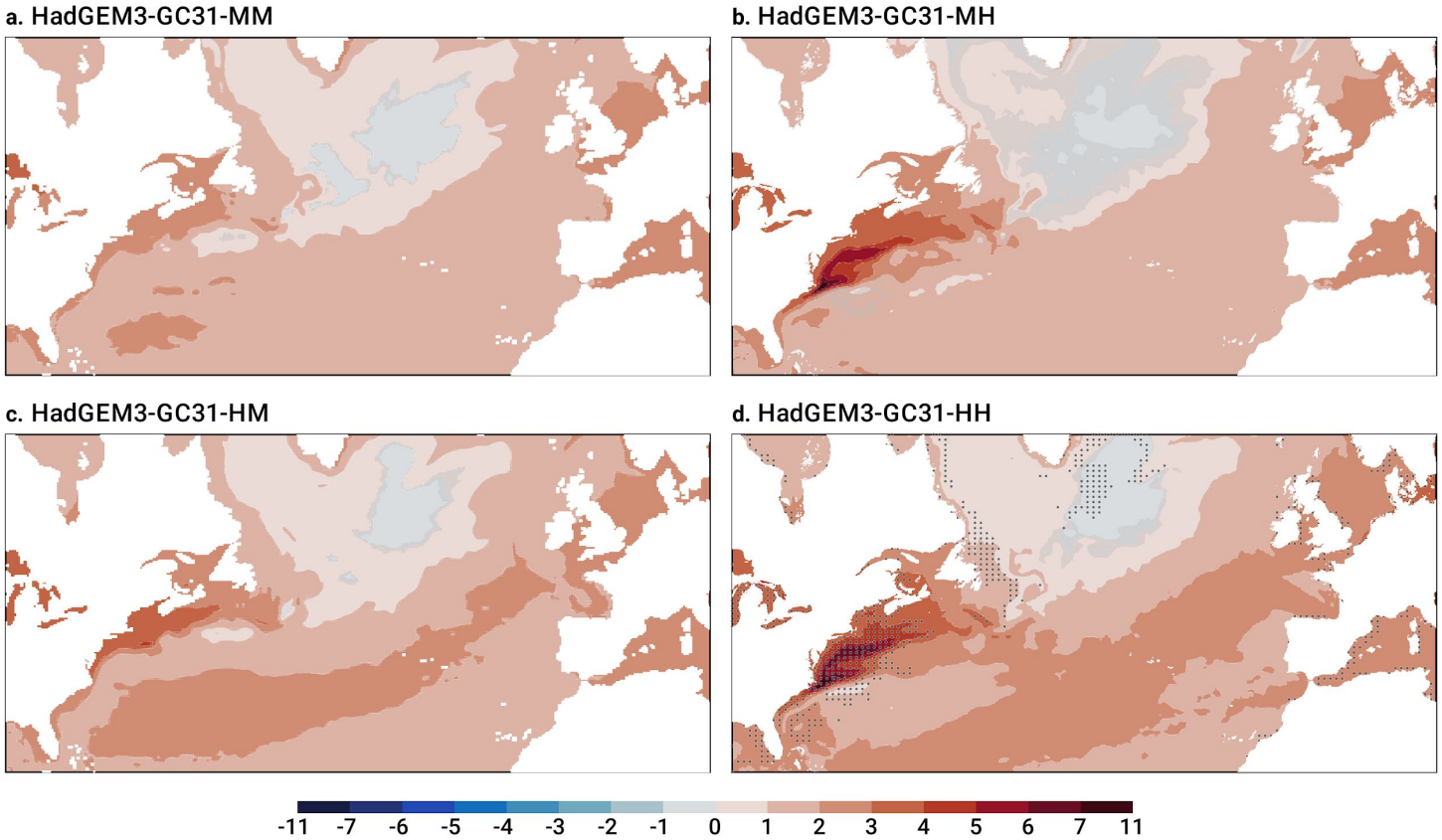
Much larger increase in winter precip still in HH than at lower res

Anomalies in winter precip. (mm/day) between 2030–2050 and 1960–1980



Strongest surface warming in the Gulf Stream still in HH, but …

Anomalies in SST (K) between 2030–2050 and 1960–1980



Summary and thoughts

- Increased winter precipitation larger in HH than at lower resolution in NW Europe by 2050

- Associated with more active extratropical cyclones in the North Atlantic
  - Intensified eady growth rate, storm tracks, and upper-troposphere jet

- SST warming in the Gulf Stream
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- Atmosphere resolution also important
  - Willison et al., 2015: Resolution-enhanced nonlinear diabatic feedback at mesoscales: Stronger precip enhances cyclone activity. Cyclones release more latent heat at higher resolutions, increasing eady growth rate and favoring further cyclone development.