EGU 2020 online conference

Session ITS5.7/CL2.14

"Climate change effects in the UK shelf sea's connectivity and hydrographic properties"

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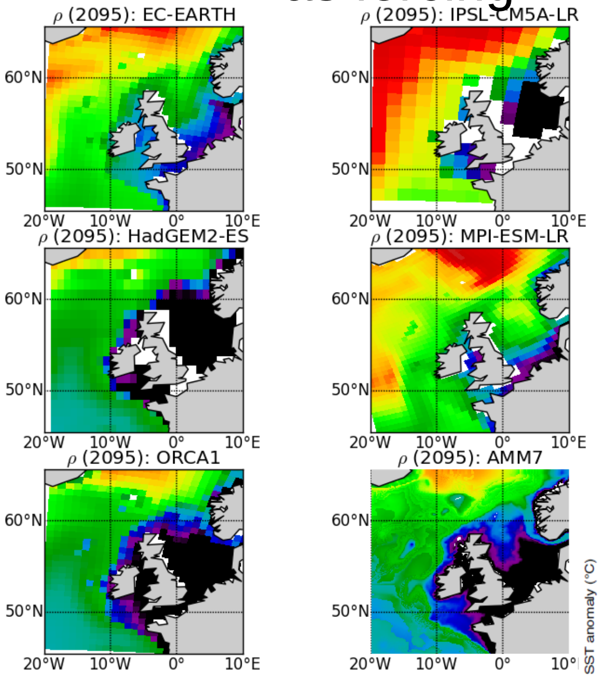
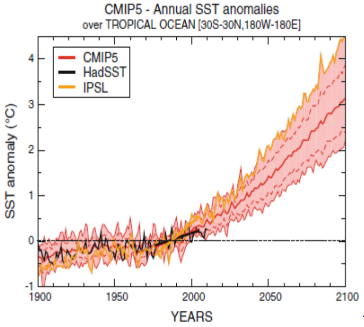
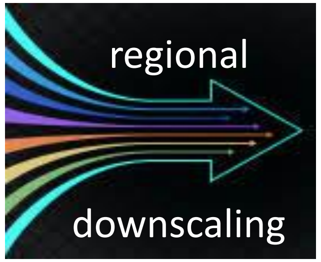
Resolving Climate Impacts on shelf and CoastaL sea Ecosystems (ReCICLE)

- Exploring potential climate impacts on marine ecosystems, including the effects of fine-scale physical processes, non-linear ecosystem interactions and an assessment of the range of likely impacts.

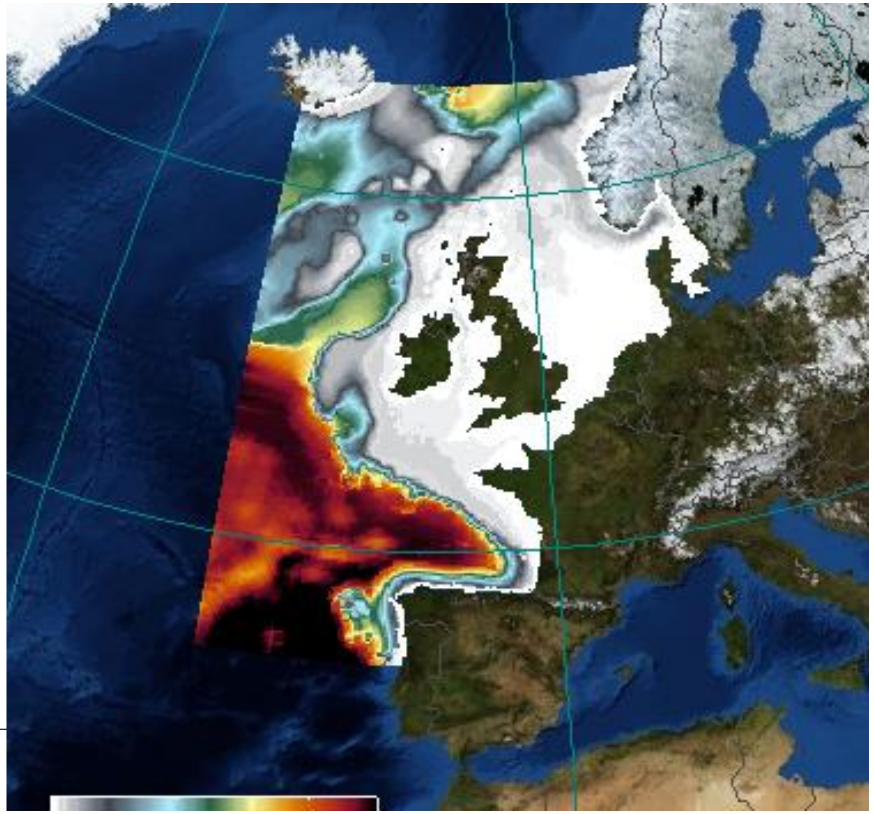
12 global CMIP5 models as forcing







3D regional ocean circulation model NEMO-AMM7



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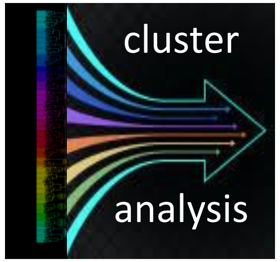
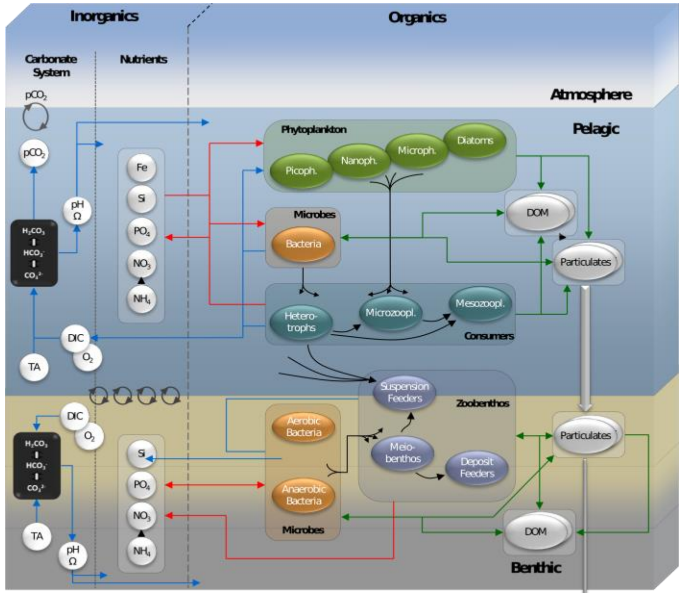
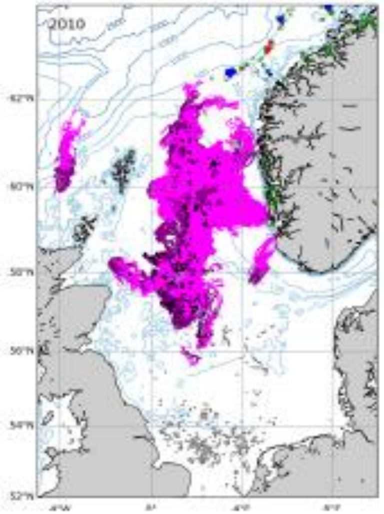
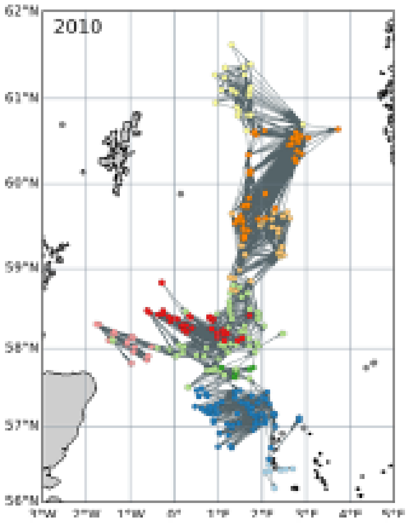
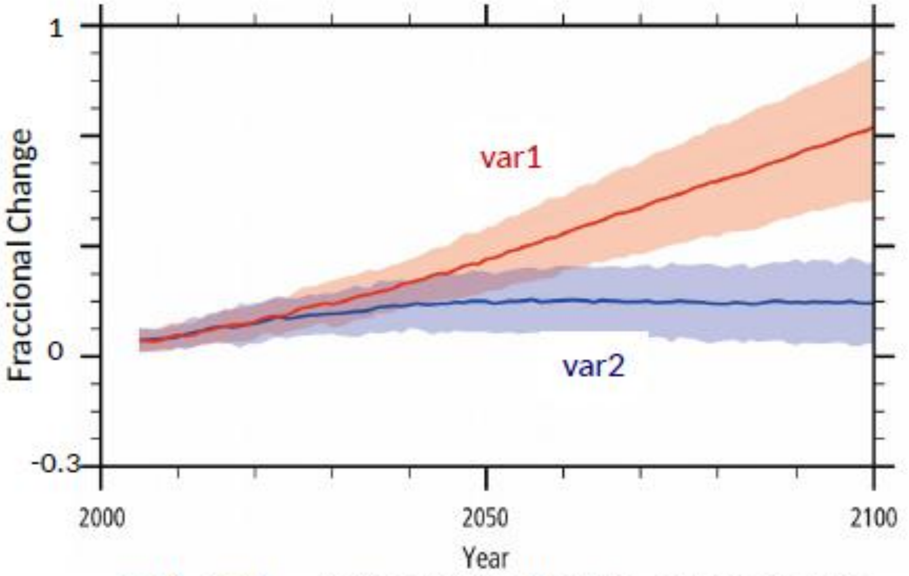




Biogeochemical model
(ERSEM)







var1, var2...= primary production, oxigen uptake, nutrients availability, habitat connectivity, etc.

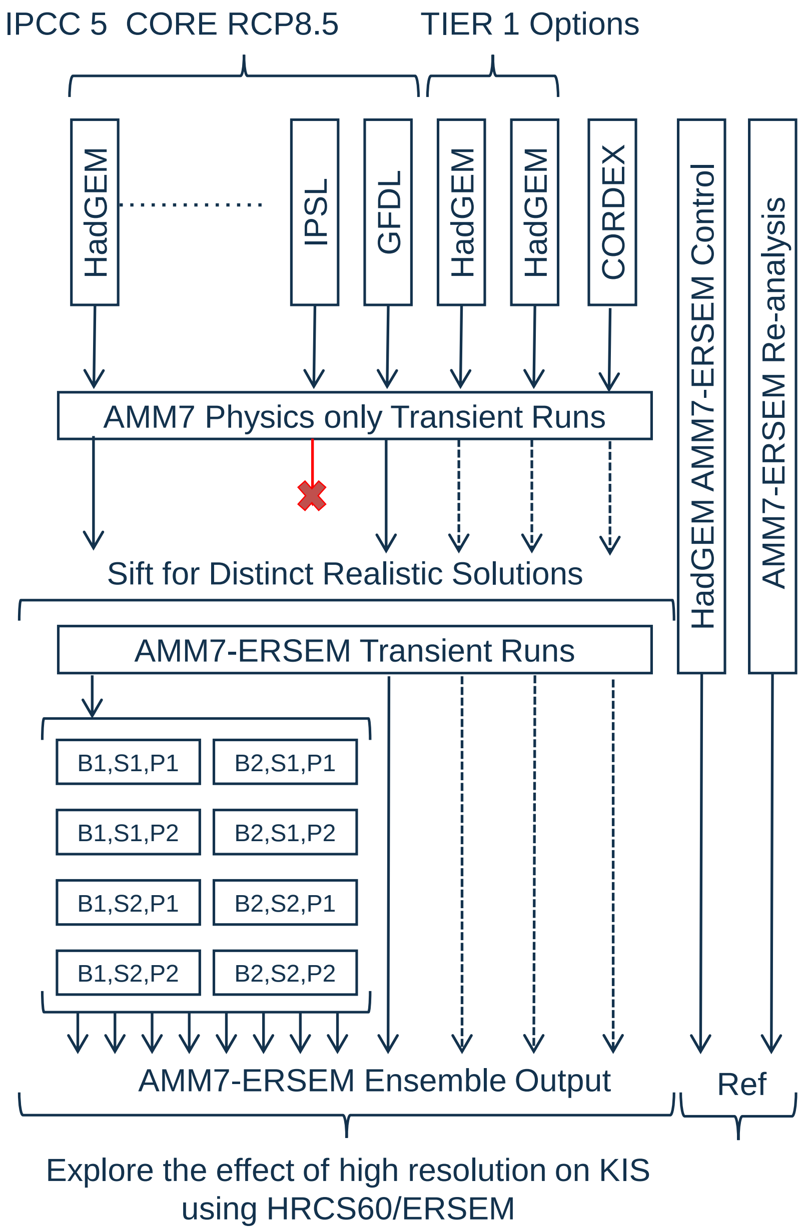
Particle Tracking (PARCELS)
Probably **A** **R**eally **C**omputationally **E**fficient **L**agrangian **S**imulator
http://oceanparcels.org

Resolving Climate Impacts on shelf and CoastaL sea Ecosystems (ReCICLE)

Research Questions:

- Is the ecosystem an amplifier or suppressor of the climate change signal? i.e. do the Key Intermediate Services (KIS; PP, oxygen uptake, nutrient cycling, biological control, and pelagic habitat) respond antagonistically or synergistically to the combination of external climatic drivers?

- What is the range of response of each KIS given likely future climate change scenarios?



The Ensemble Members

- Uncertainty due to Climate Change scenarios → ocean circulation, temperature, salinity

- Biochemical model uncertainty →

  Parametrization and ecosystem complexity

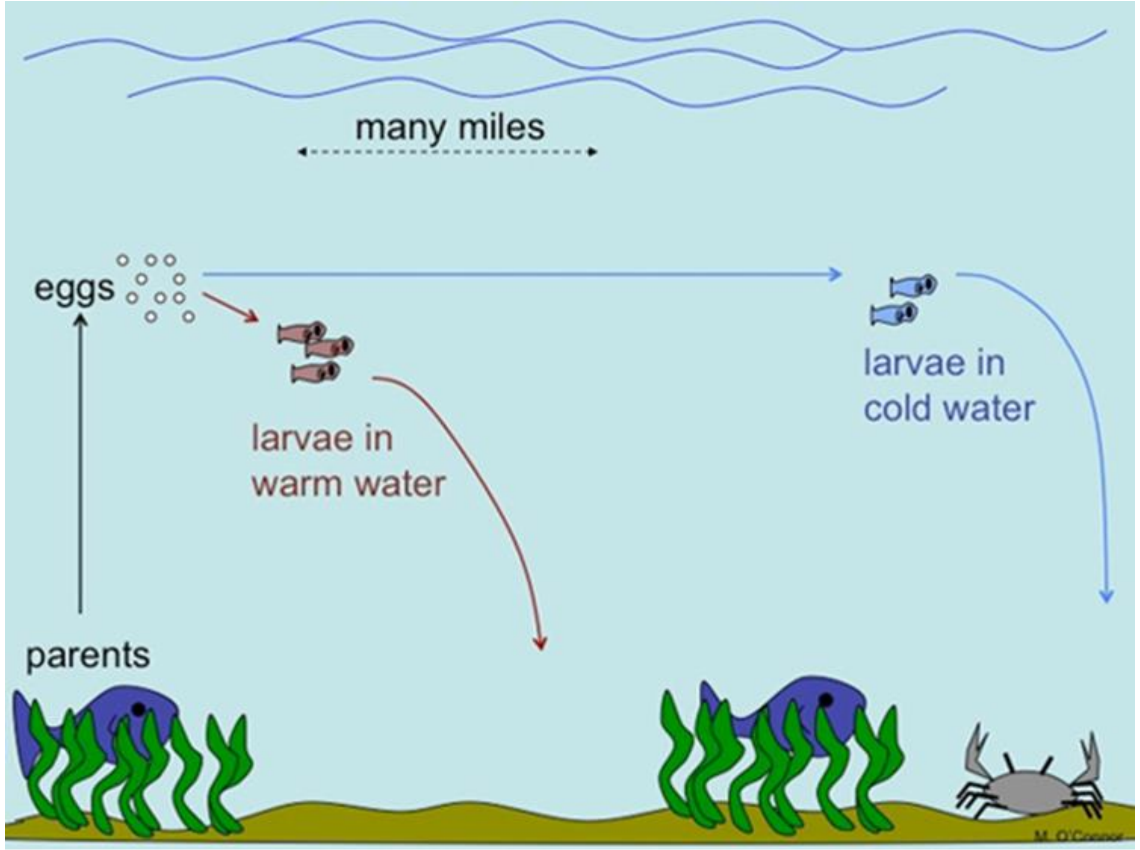
… Modeled connectivity uncertainty:

Sensitivity to ocean models and biological assumptions

Climate change effects on Physical Processes and Ecosystems

Changes in ocean physics will have important effects on the marine ecosystems, particularly on **nutrients re-supply** and **species connectivity.**

The planktonic larval stage allows colonization of new habitat and genetically diverse populations which foster **resilience** to climate change.



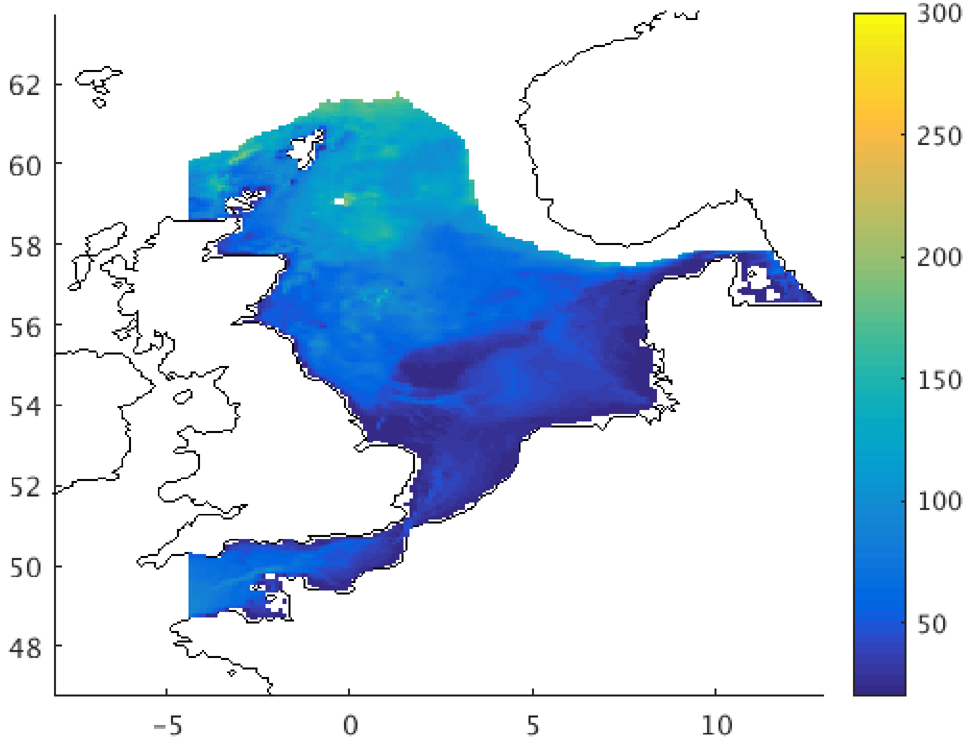
Climate change effects on connectivity

Climate Change Impact	Process	Effect on Connectivity
Temperature increase	Shorter larval durations. More expensive metabolism.	⇓dispersal, ⇓long range connectivity
Salinity changes	Vertical migrations of some larvae (oysters, clams, etc) responds to haloclines to stay locked to the tidal phase and minimaze dispersal.	⇓retention, disperse away from reef habitat
pH changes	Ocean acidification difficults the formation of bivalves 1st shell. Incresed mortality. Migration towards shallow waters.	Forced migration away from prefered habitat, ⇓connectivity
Change in coastal currents	Spawning time and location are tuned to circulation patterns that promote dispersal to specific habitats.	⇧⇓connectivity
Increased stratification	Larvae migrate vertically to take advantage of baroclinic currents. Slower deep currents maybe harder to reach.	⇧dispersal, ⇧⇓connectivity

Particle tracking experiments set up

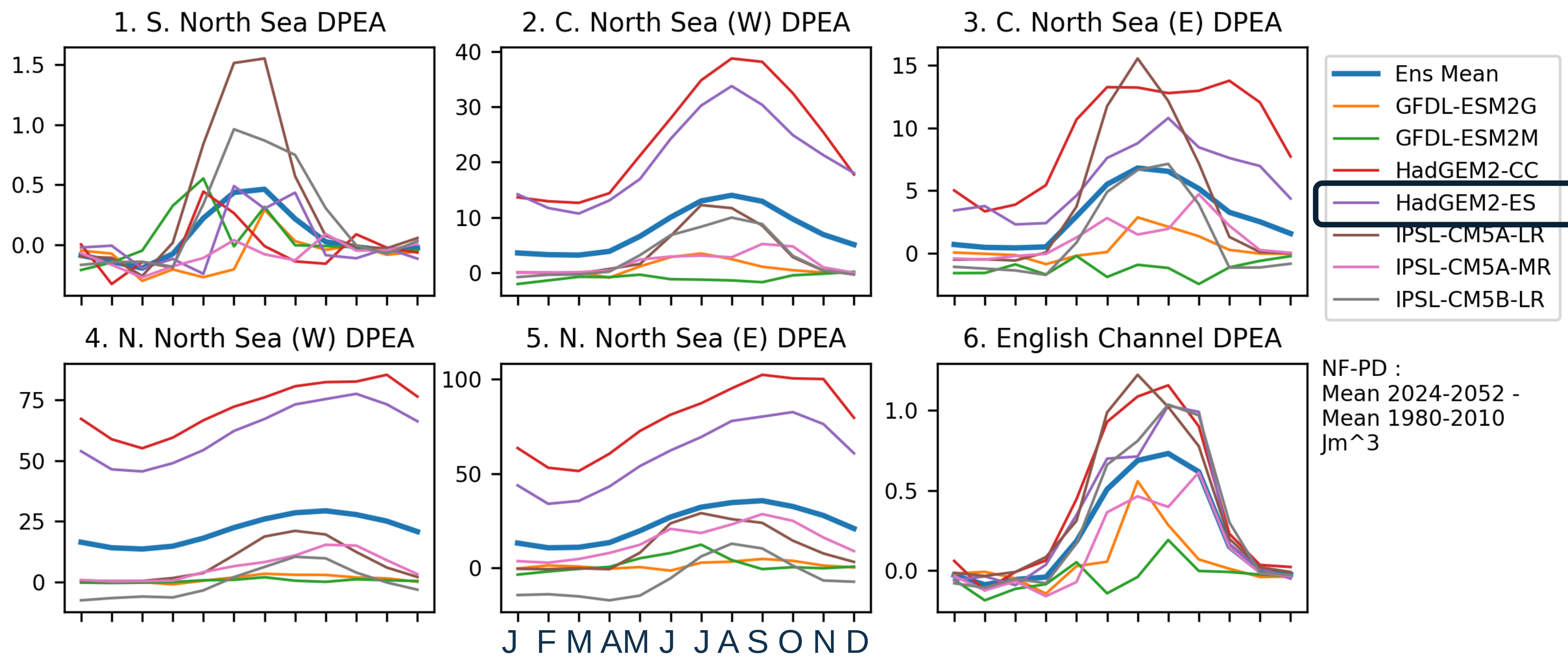
- Past (2000 – 2010) vs. Future (2040 – 2050)
- Warmest ensemble member: HadGem2-ES
- Uniformly seeded North Sea
- Passive particles, advection only, daily surface currents.
- Seasonal releases:
  Jan, Apr, Jul, Oct (40 per decade)
- Tracked for 30 days
- 11510 particles per release
- 448 890 per decade

Depth of seeded area (20-300m)



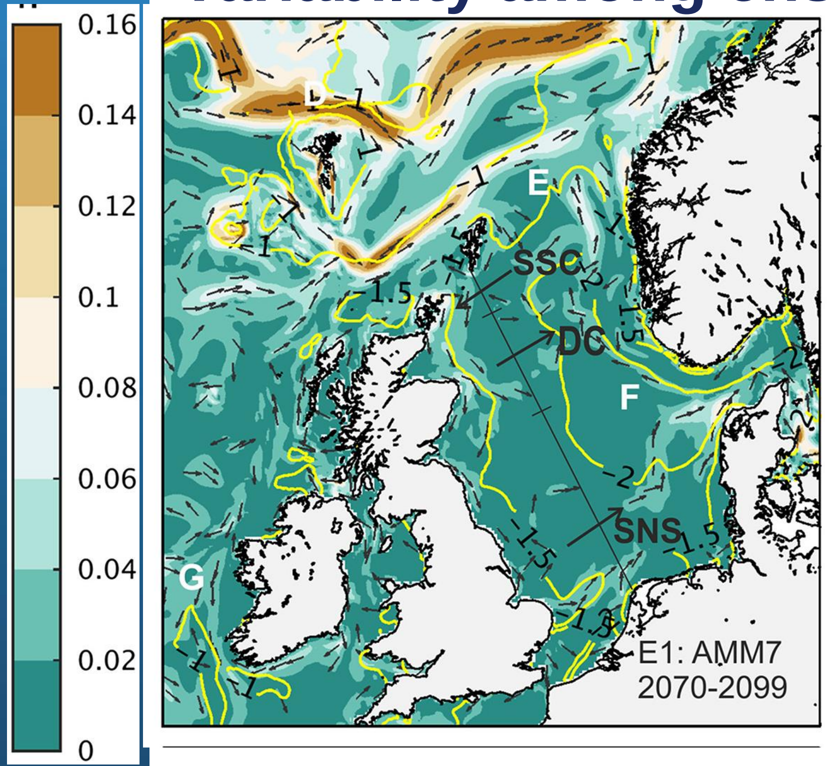
Variability among ensemble members

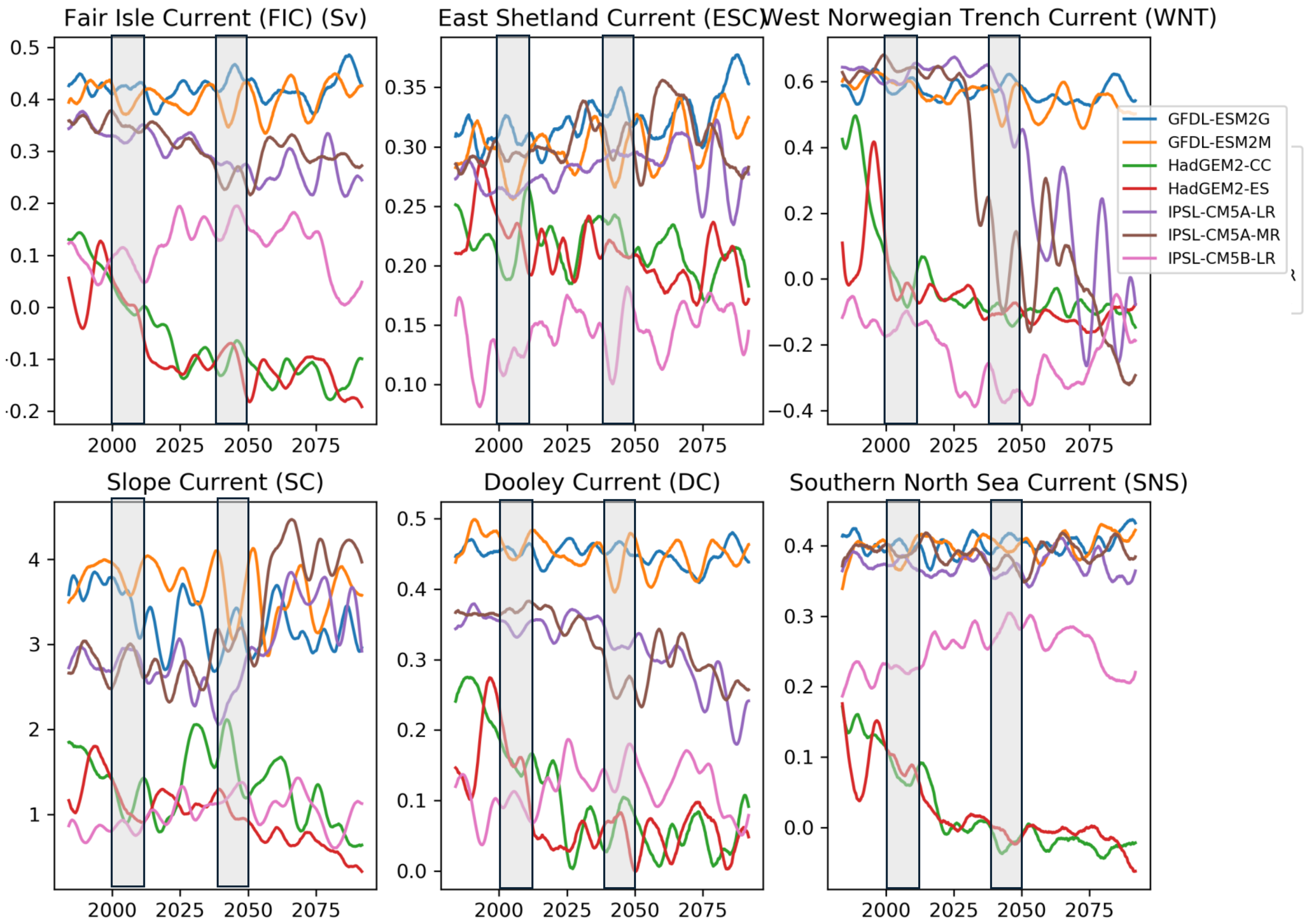
Δ (future – past) Potential Energy Anomaly



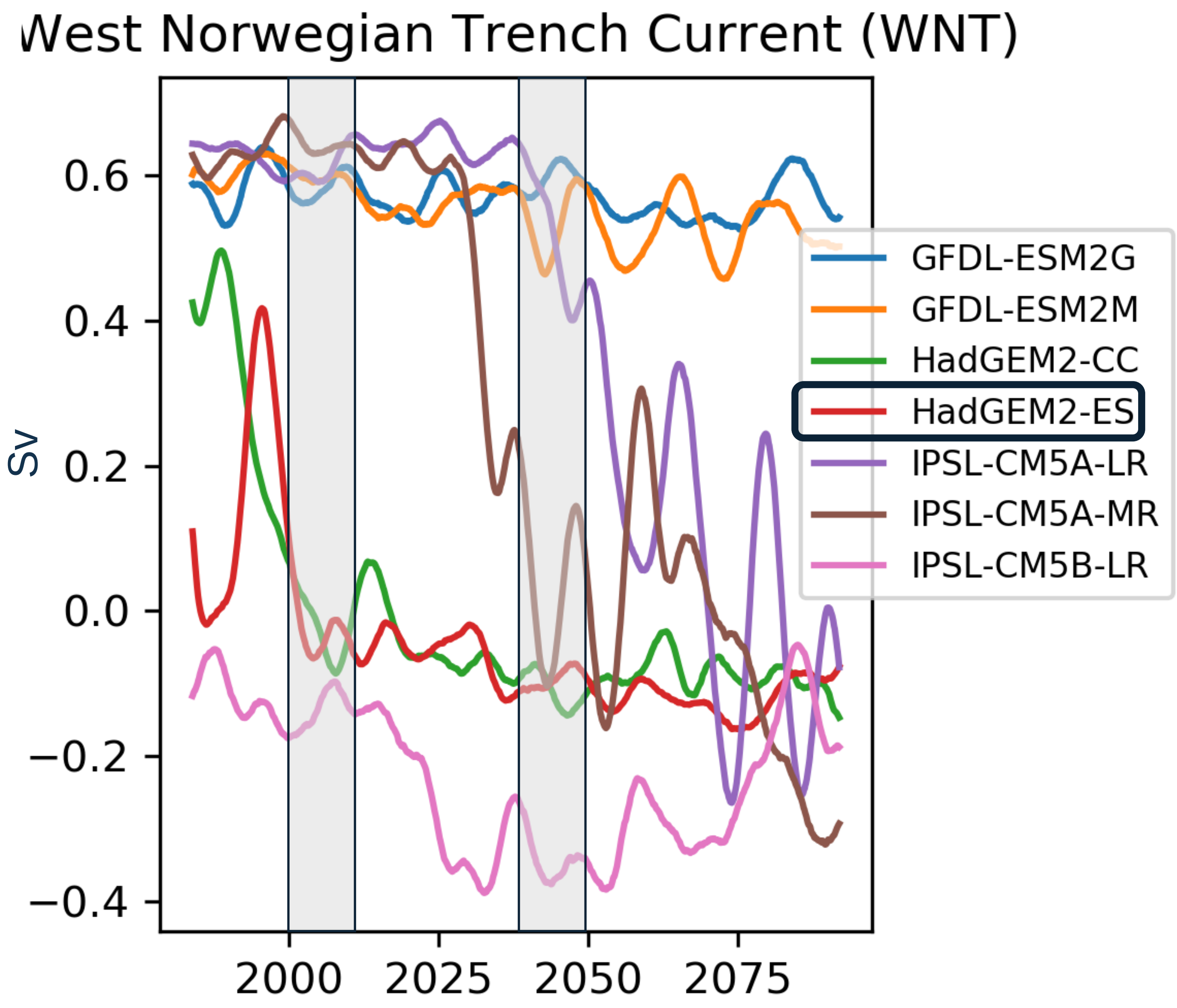
NF-PD :
Mean 2024-2052 -
Mean 1980-2010
Jm^3

Variability among ensemble members



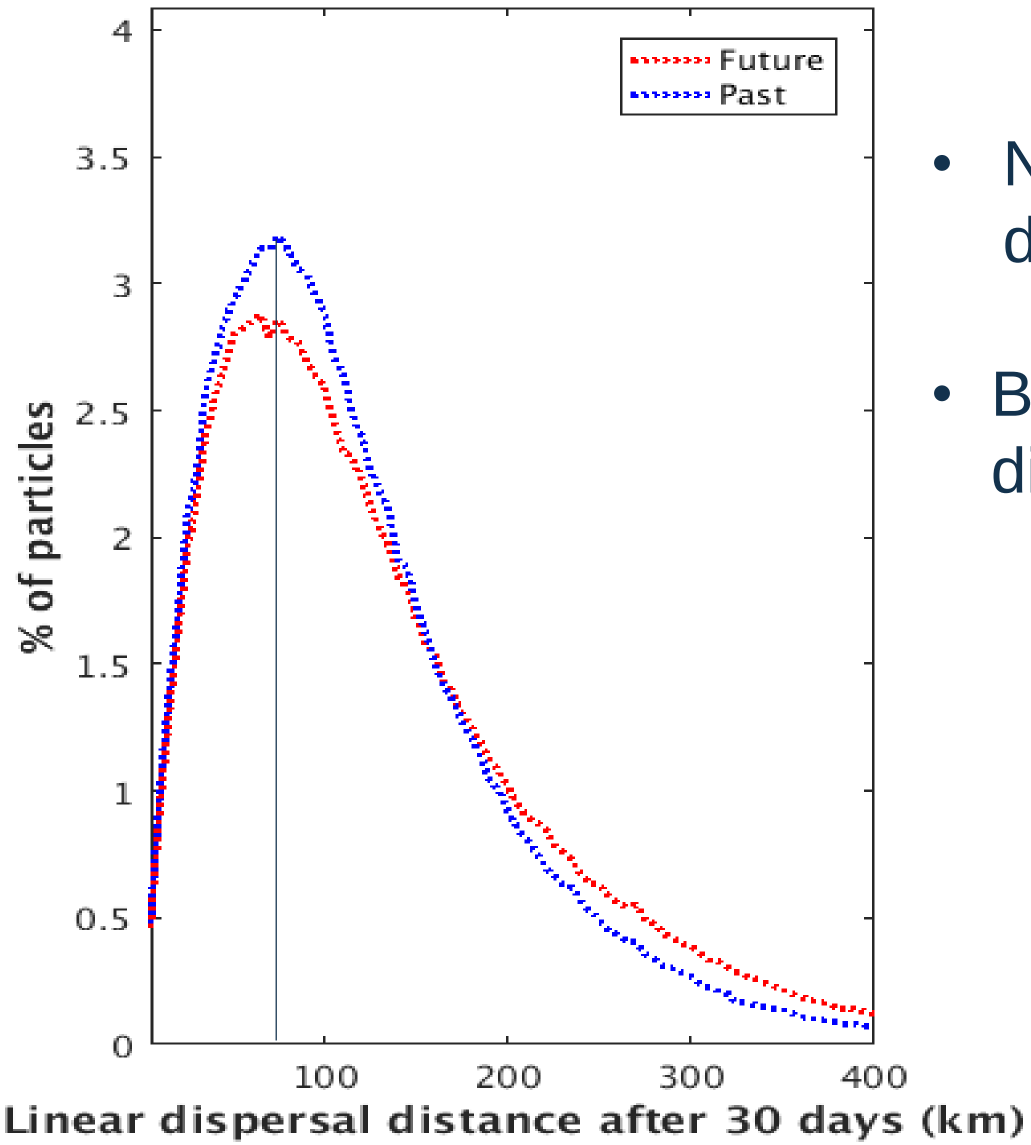


Variability among ensemble members



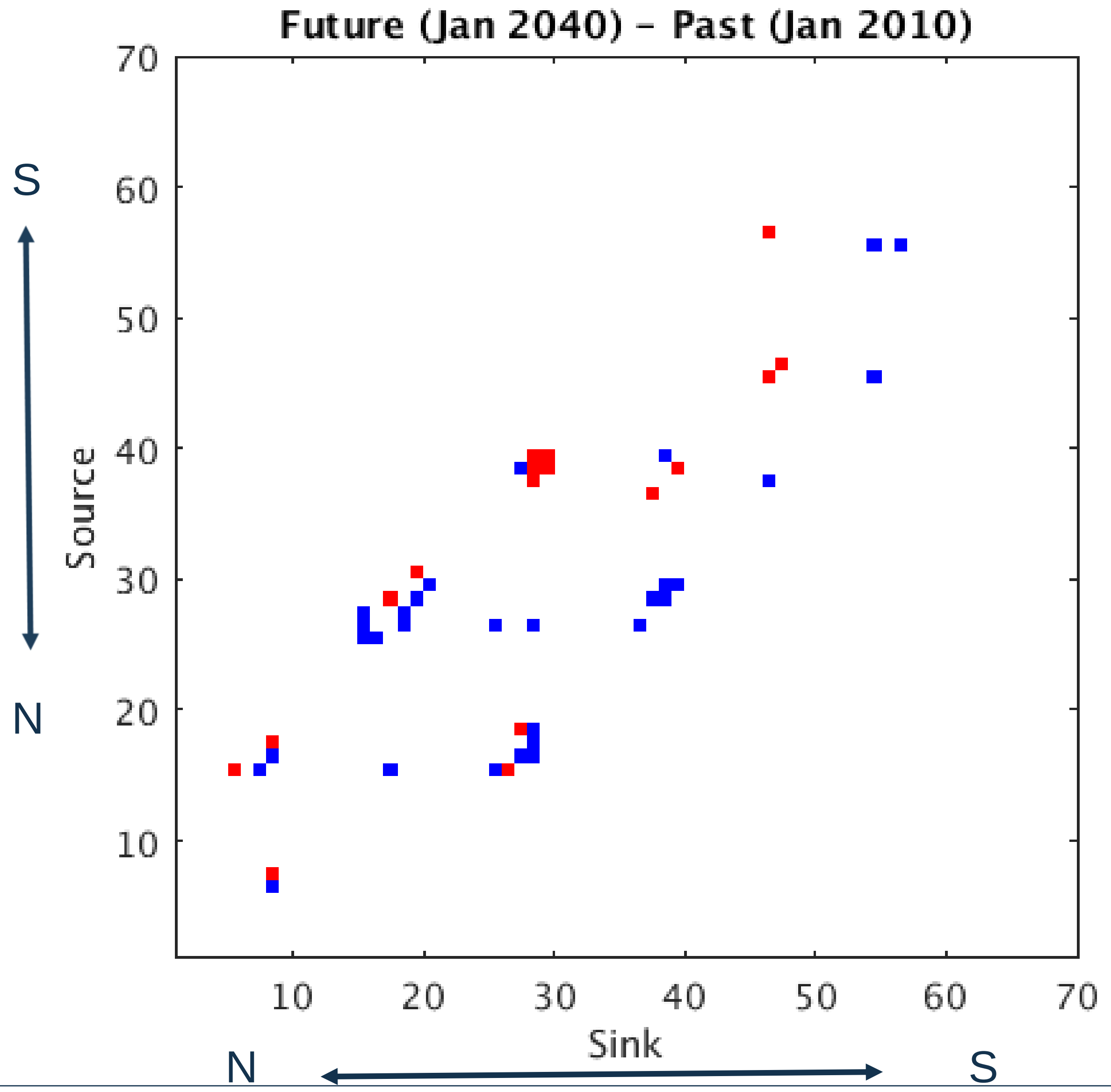
Preliminary Results

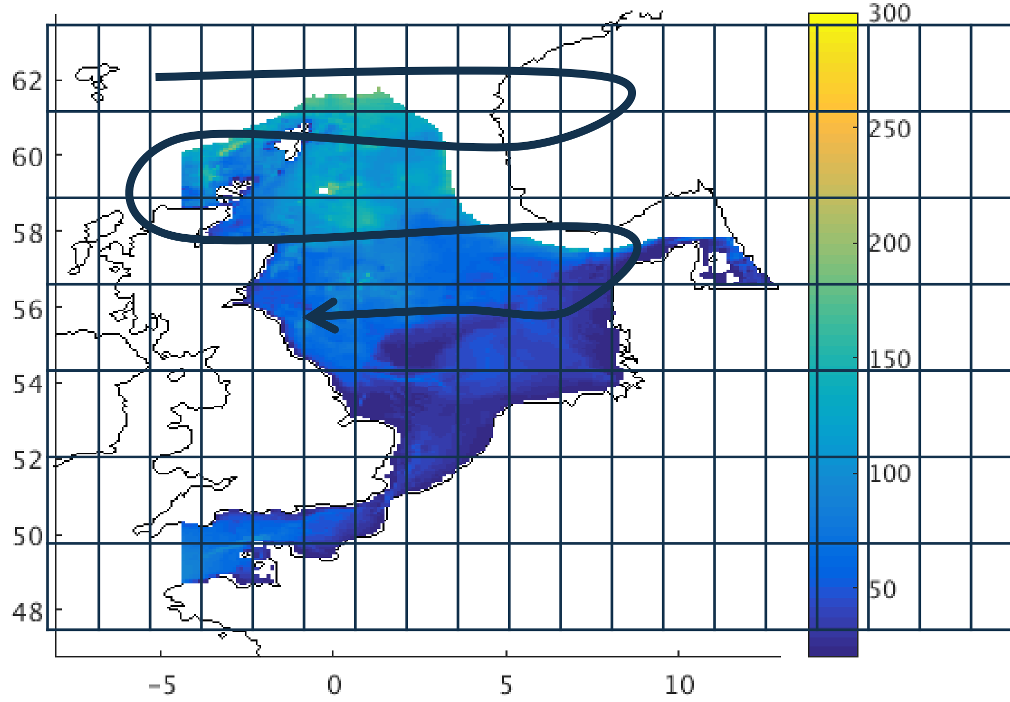
Linear Dispersal Distance HadGEM2-ES



- No significant difference in dispersal distance mode ~75km.
- Broader spread on dispersal distance in the future.

Connectivity Changes HadGem2-ES



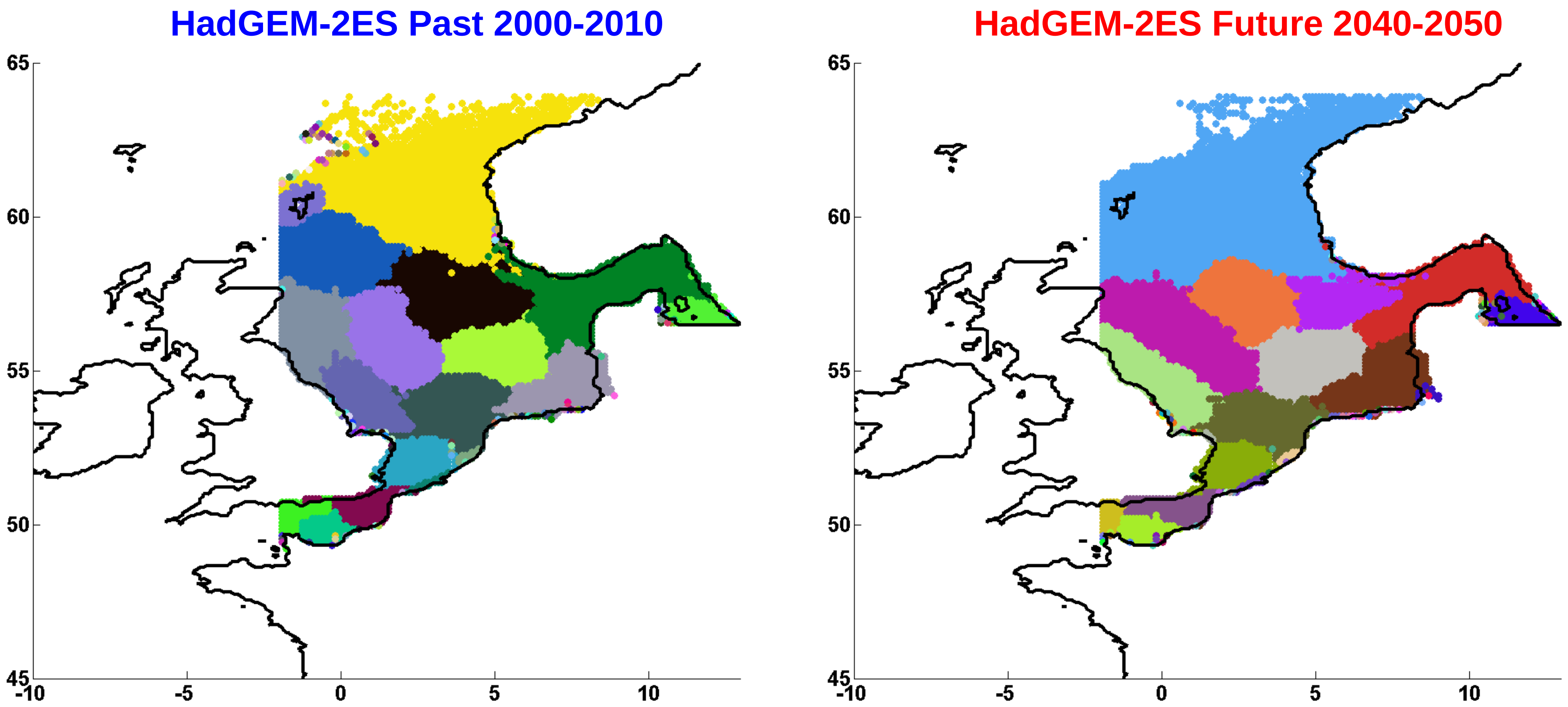


Connections lost in the future

New connections gain in the future

Preliminary Results

Ocean Provinces based on Lagrangian Flow Networks



Following Monroy et al., 2017 methodology

- More detailed analysis: at finer resolution and using network metrics.
- More particle tracking experiments with other ensemble members.
- Along track environmental variability (temperature, salinity, pH, phytoplankton, zooplankton).
- Investigate changes in oceanographic barriers to dispersal, define ocean provinces.
- Scale of uncertainty due to climate change in comparison to other model uncertainties → sensitivity analysis to horizontal resolution and biological assumptions (release dates, PLD, etc).

Thanks for listening!

Questions