

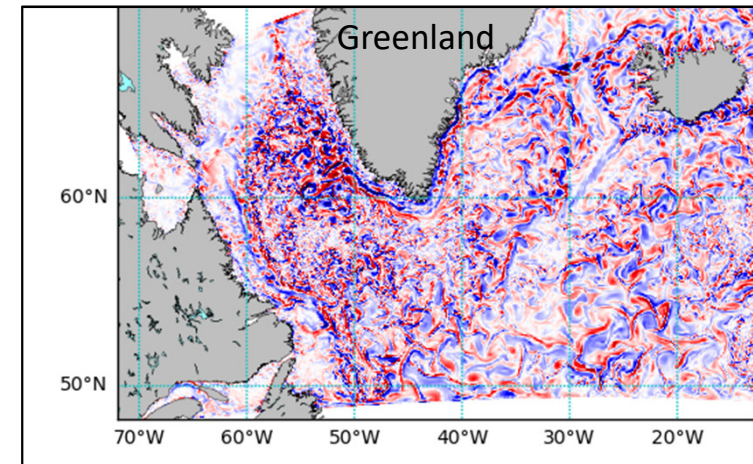
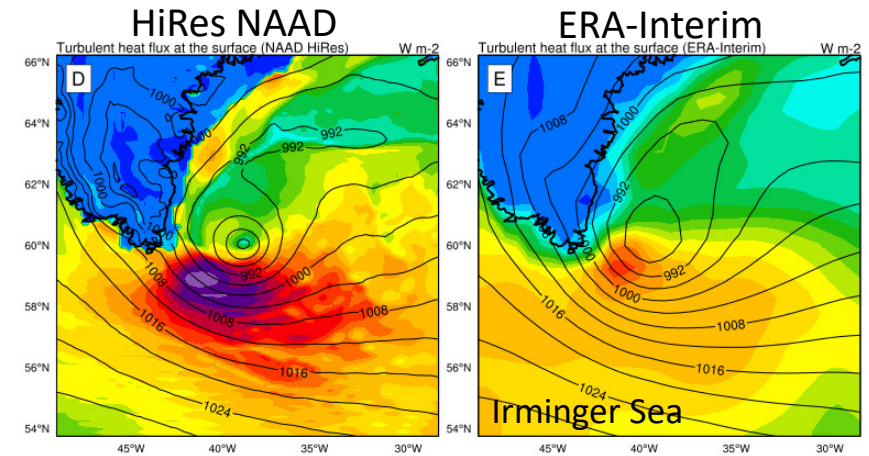
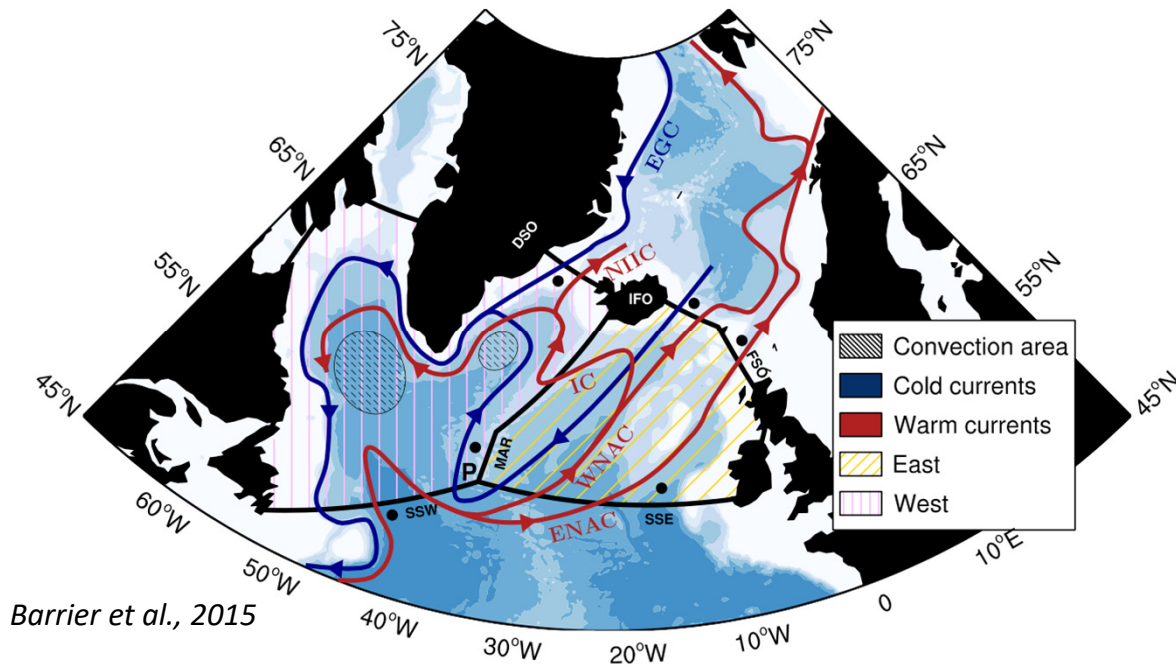
Impact of high-resolution atmospheric dynamics on ocean eddies and deep convection in the Subpolar North Atlantic

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Introduction



Subpolar North Atlantic:

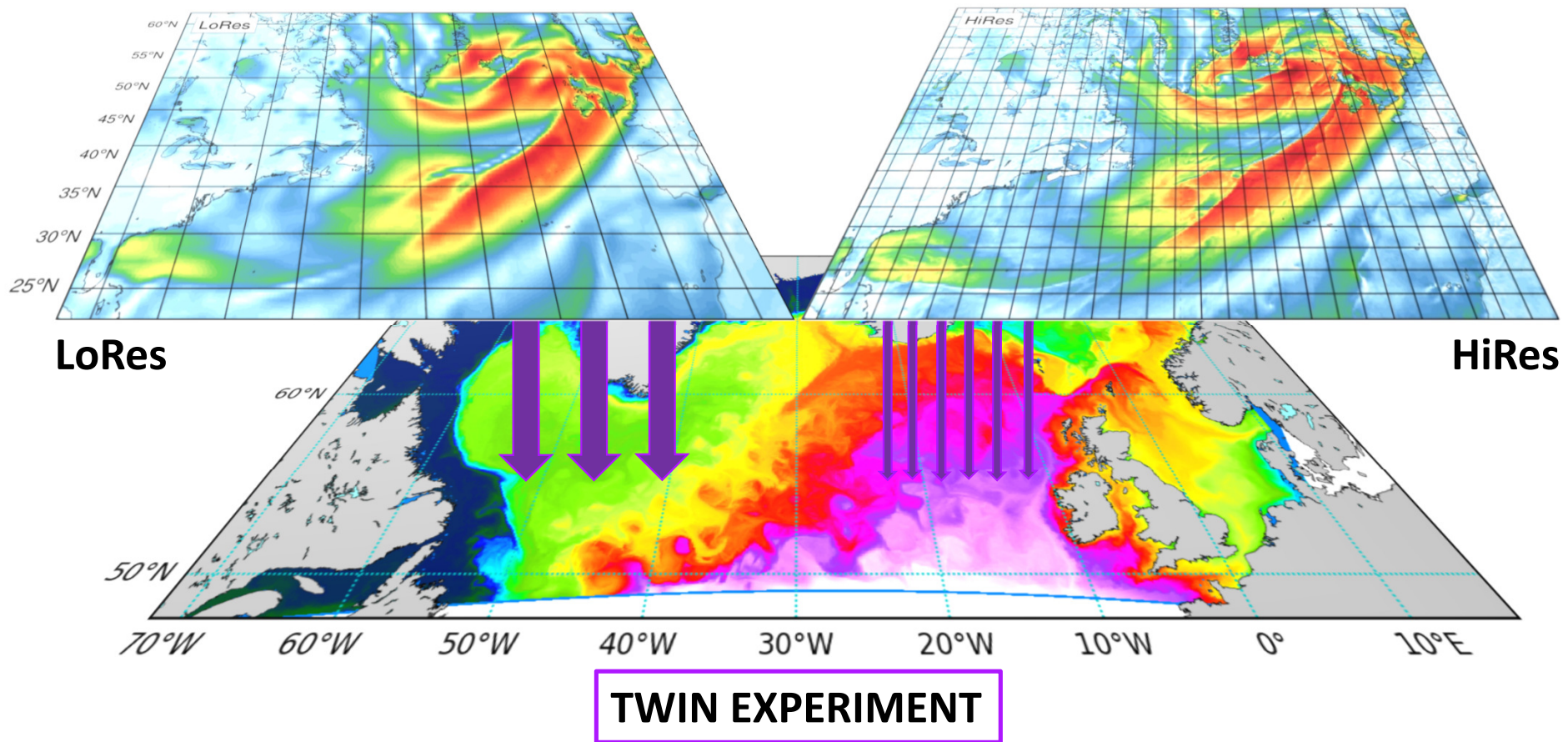
- Driving AMOC (Marzocchi et al. 2015; von Appen et al. 2014 among others)
- **Atmosphere:** strong synoptic and mesoscale dynamics (Condrón and Renfrew, 2013)
- **Ocean:** intense eddy activity, that affect convection processes (Chanut et al. 2008)
- **Interaction between scales:** Poorly known

Goal and concept

Question:

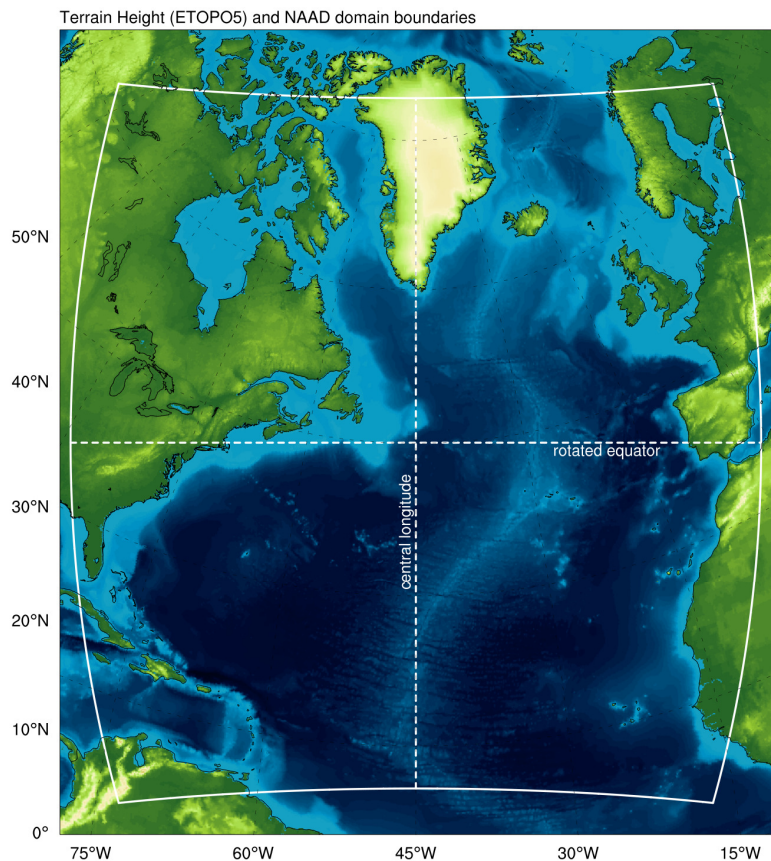
Is the ocean sensitive to different atmospheric scales?

If yes, how?



Experiment design: atmospheric forcing

The IO RAS North Atlantic Atmospheric Downscaling from 1979 to 2018

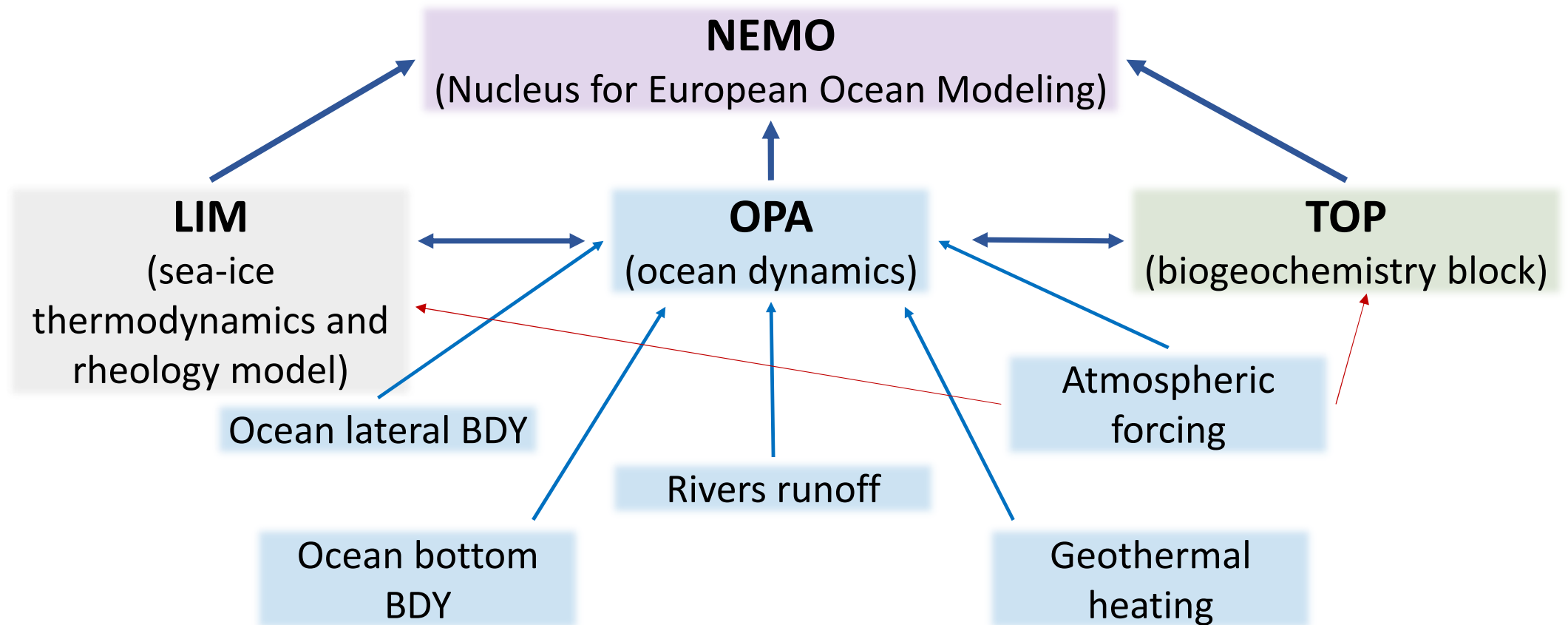


CONFIGURATION	LoRes	HiRes
Model	WRF-ARW 3.8.1	
Core	hydrostatic	non-hydrostatic
Horizontal resolution	77 km	14 km
Vertical levels	50 (from 10 m to 50 hPa)	
RK3 time step	360 s	30 s
Forcing	ERA-Interim [1] + NUDGING [3]	
Parametrizations	new MM5 (with COARE3 for Ch, Cq) + [1,2]	

- 1 – calculating skin temperature based on Zeng and Beljaars (2005)
- 2 – SST updates every 6hr (ERA-Interim)

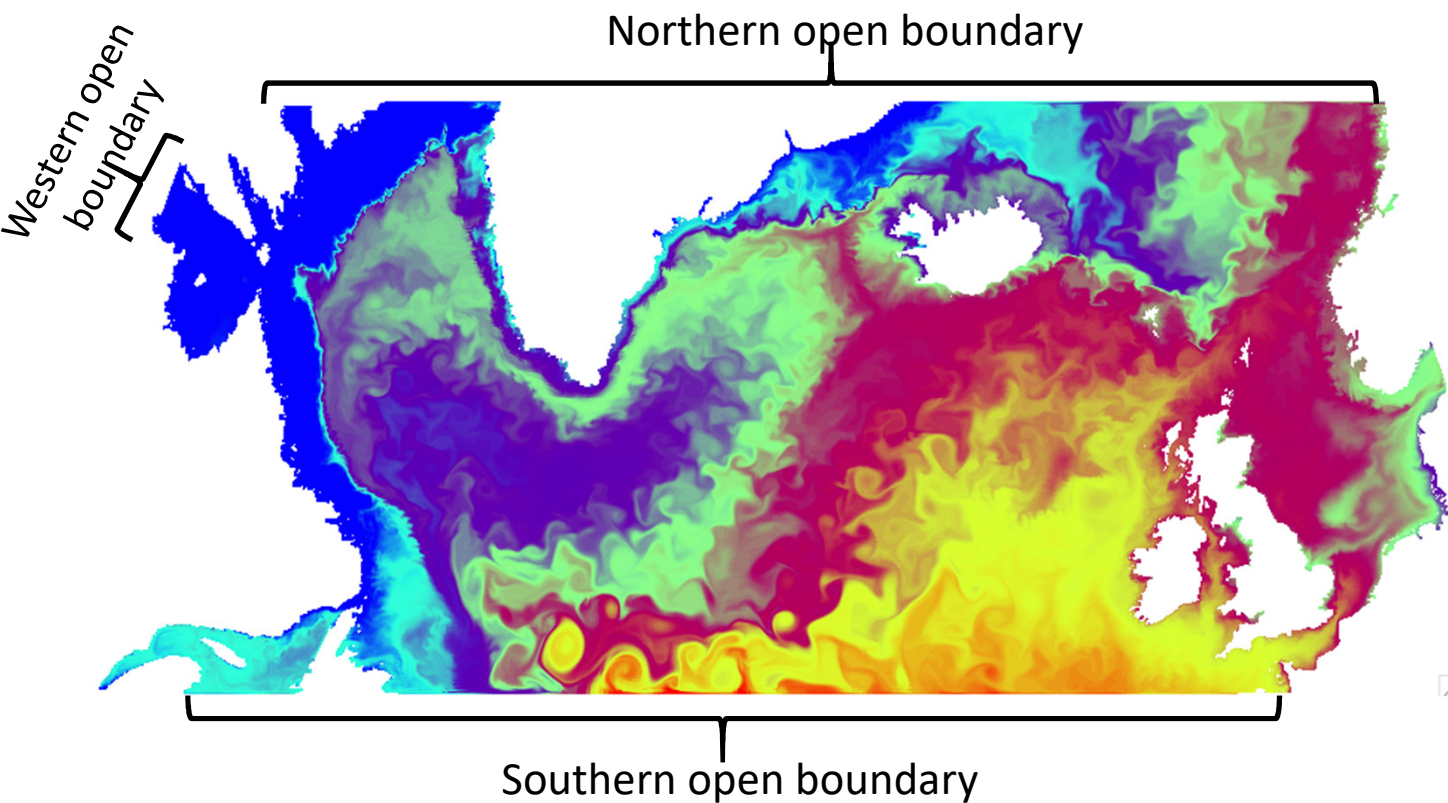
Gavrikov et al.,2019, submitted BAMS

Experiment design: ocean model



Experiment design: model configuration

NEMO v3.6 + XIOS 2 (grid cut from global eORCA12)



Model	NEMO 3.6
Time period	1992 – 2015
Horizontal resolution	1/12° (3-5 km) (402x934 points)
Vertical levels	75 levels
Ocean forcing	GLORYS2v4 (interp. on 1/12°)
Advection scheme	UBS/UBS (momentum/tracers)
Experiments	Ocean – HiRes NAAD
Atmospheric forcing	Ocean – LoRes NAAD

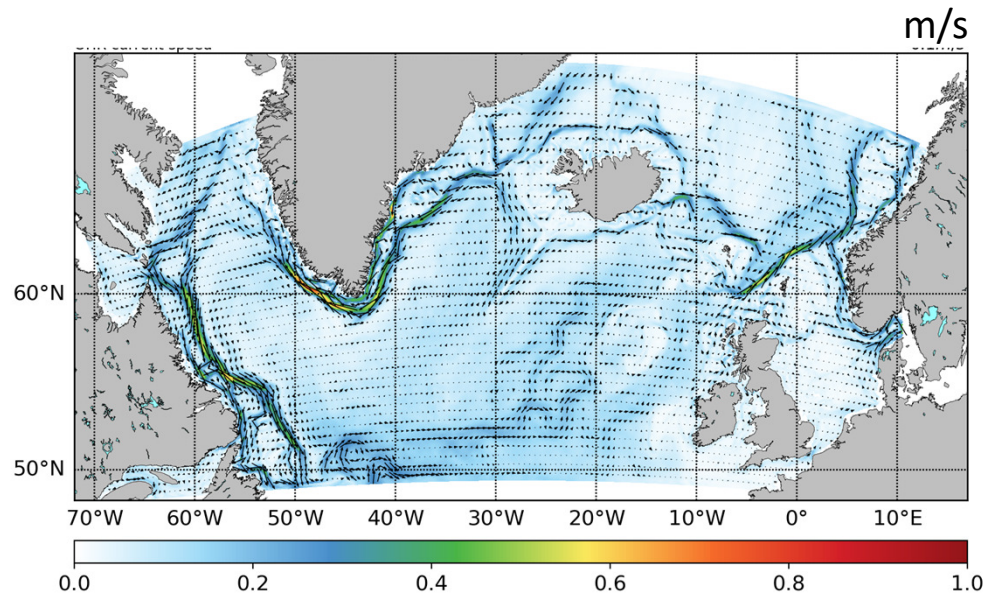
Variables specified at open boundaries:

T, S, U, V, Ice, SSH

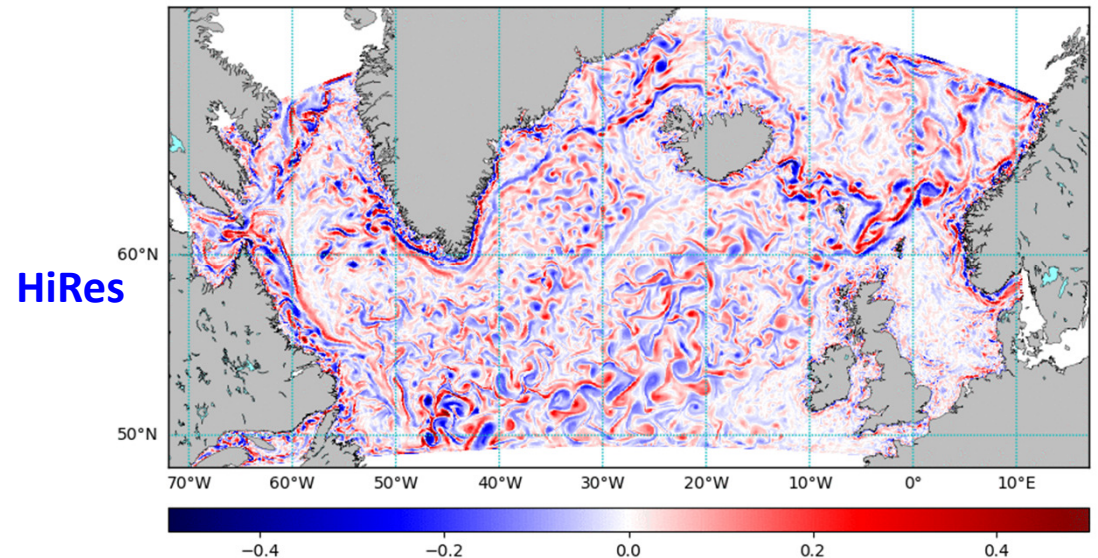
Initialized variables: **T, S, Ice**

Realistically modelled ocean circulation

1992-2015 mean surface current speed



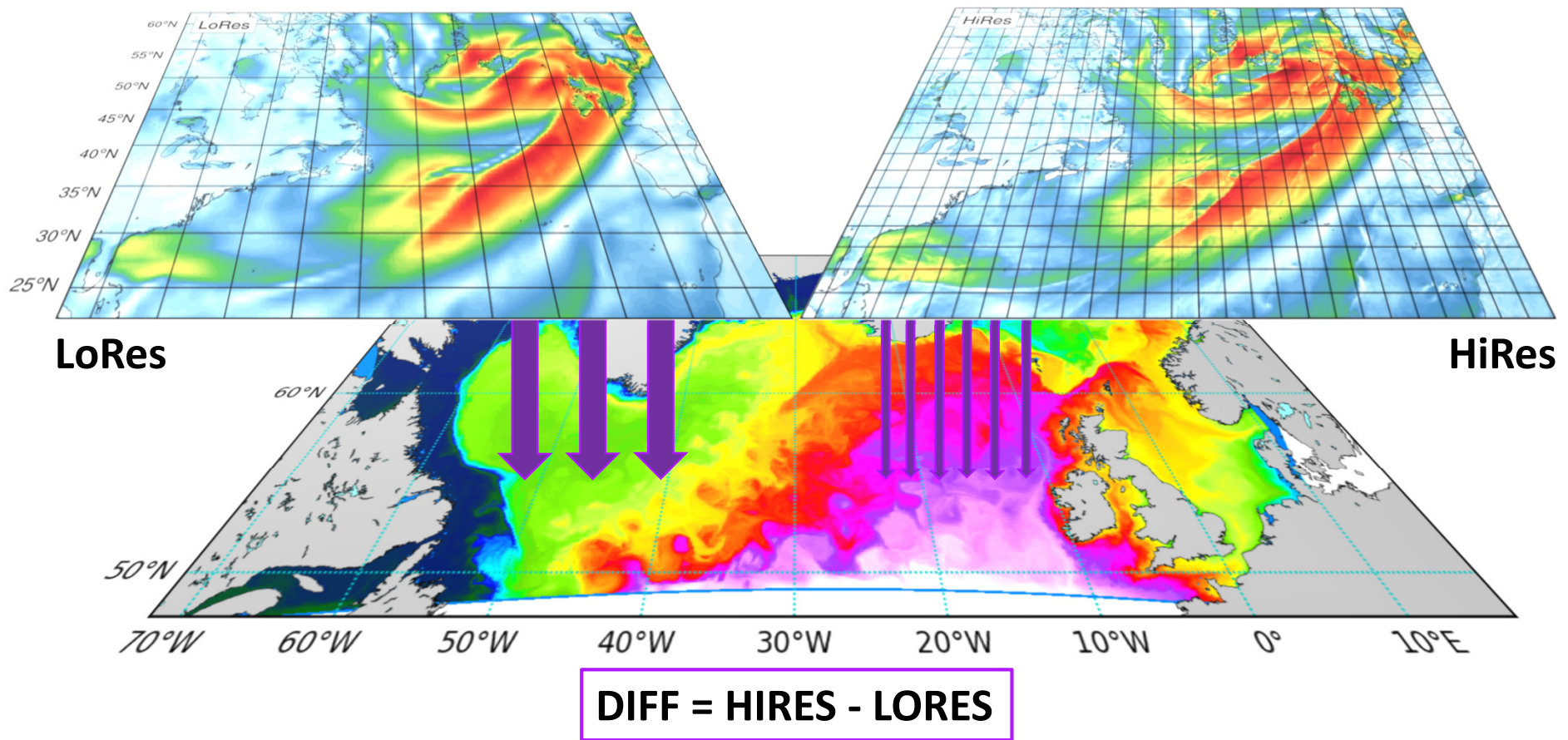
Daily relative vorticity normalized by Coriolis parameter



Modelled circulation is in good agreement with observations and other models

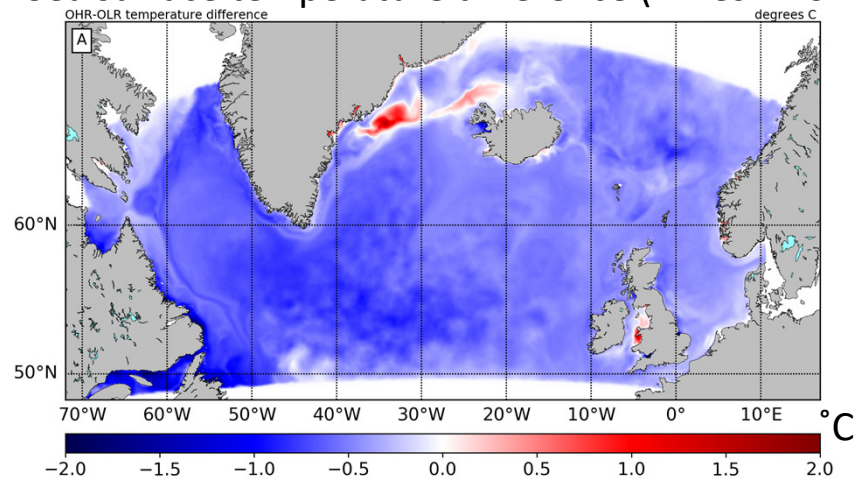
Concept

Method: We investigate sensitivity of the ocean model to representation of atmospheric scales

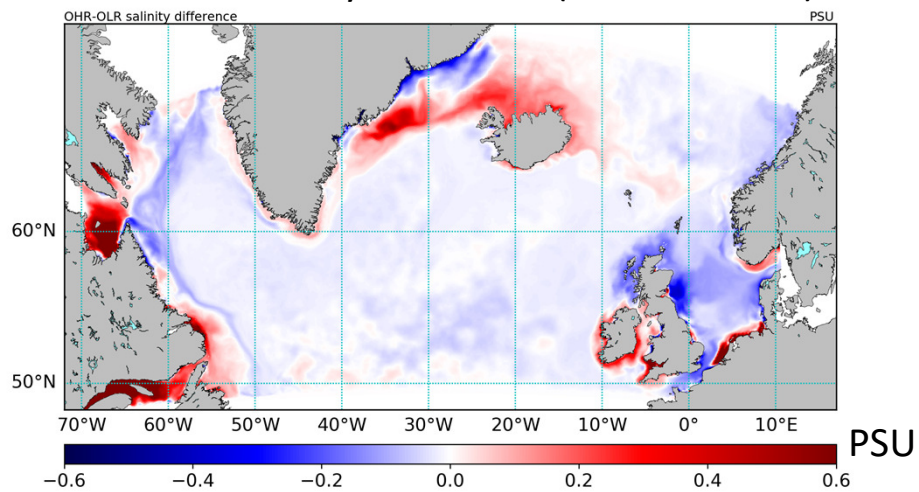


Results: mean ocean state

Sea surface temperature difference (HiRes – LoRes)

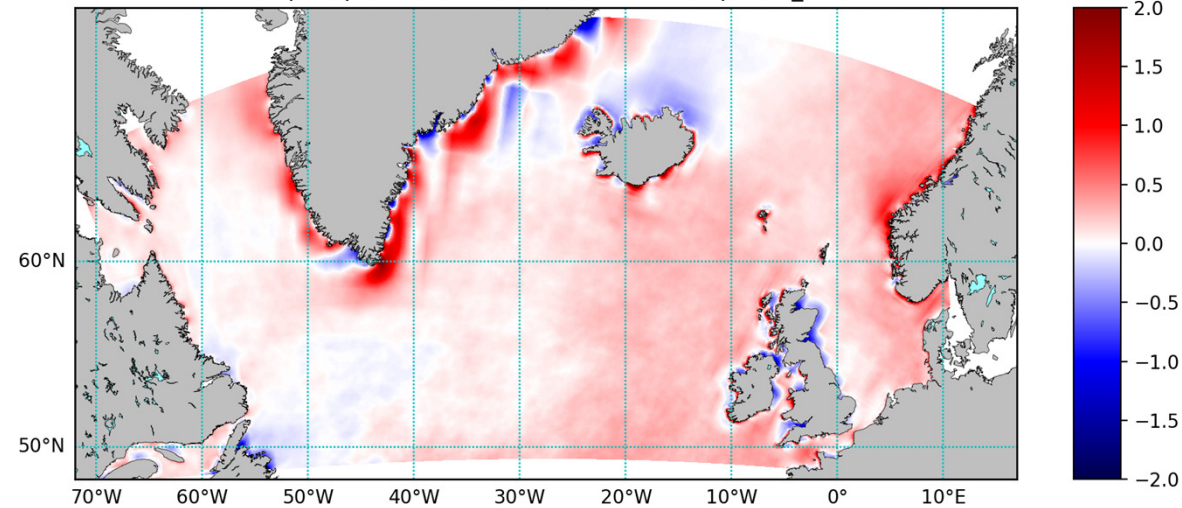


Sea surface salinity difference (HiRes – LoRes)

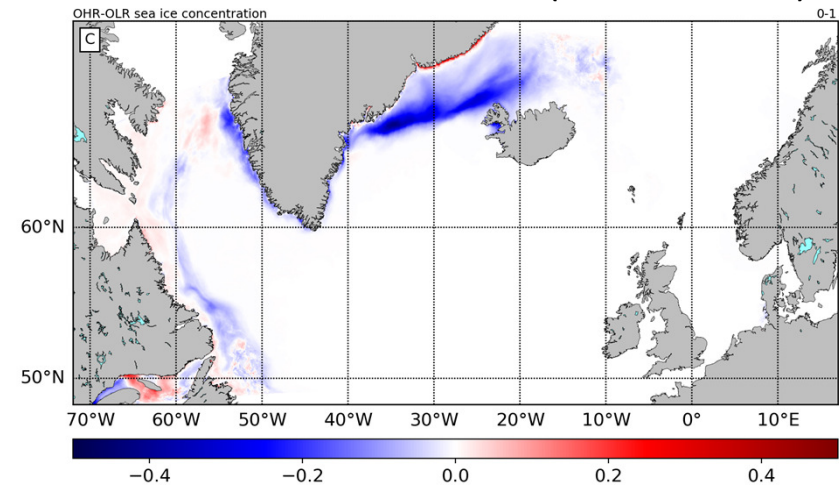


Total precipitation difference HiRes - LoRes period_mean

kg/m²/s

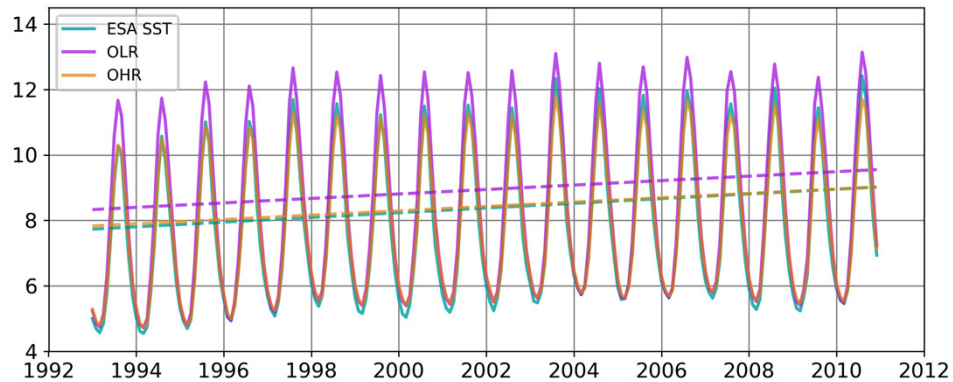


Sea ice fraction difference (HiRes – LoRes)

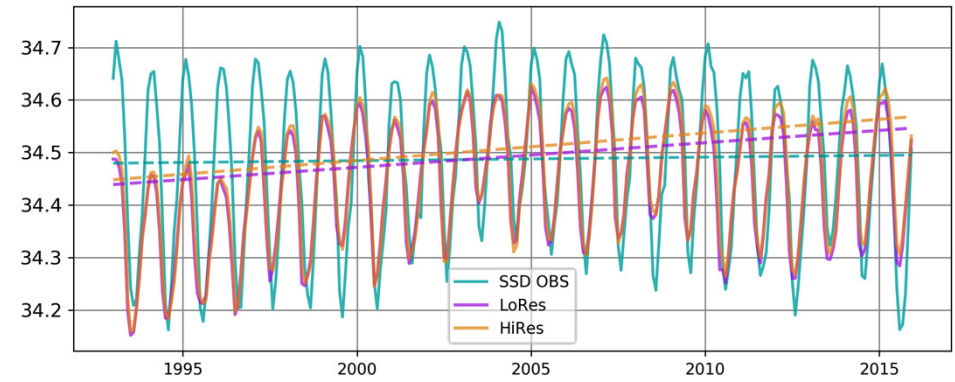


Results: ocean state climate variability

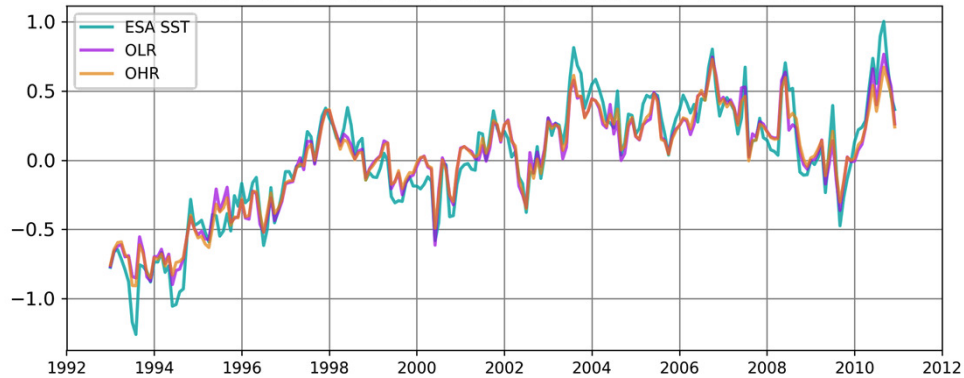
Domain averaged surface temperature, °C



Domain averaged surface salinity, PSU

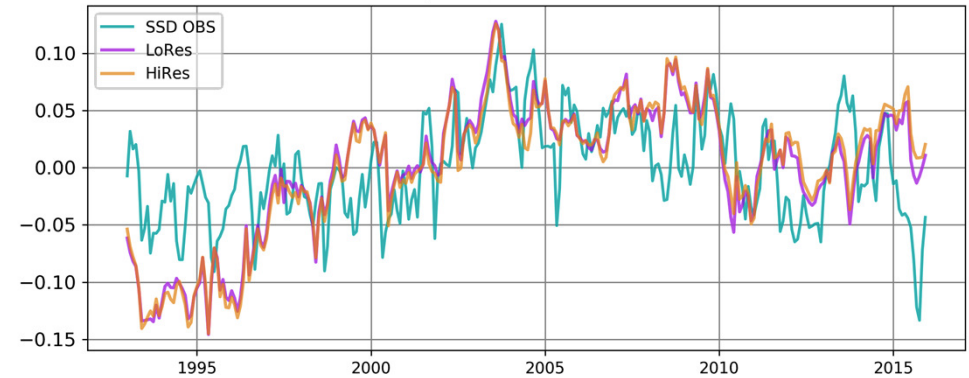


Declimatologized surface temperature
NNATL12 HiRes and LoRes and ESA SST 1993-2010



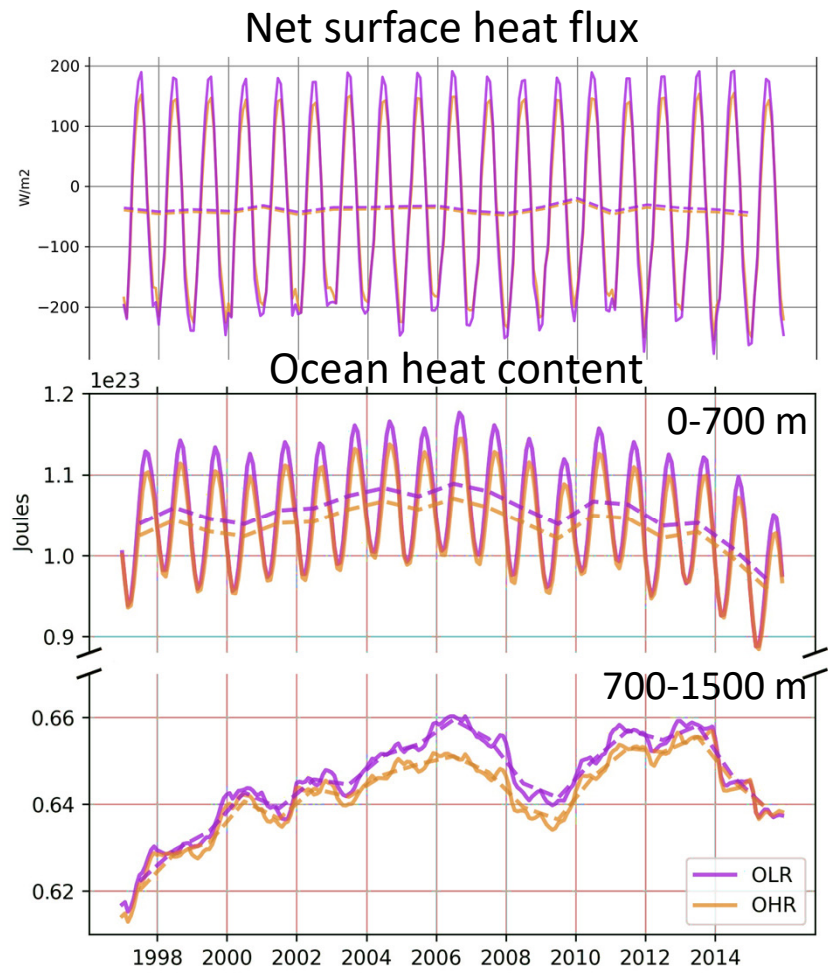
Observations: ESA SST

Decimated surface salinity
NNATL12 HiRes, LoRes and SSD OBS 1993-2015

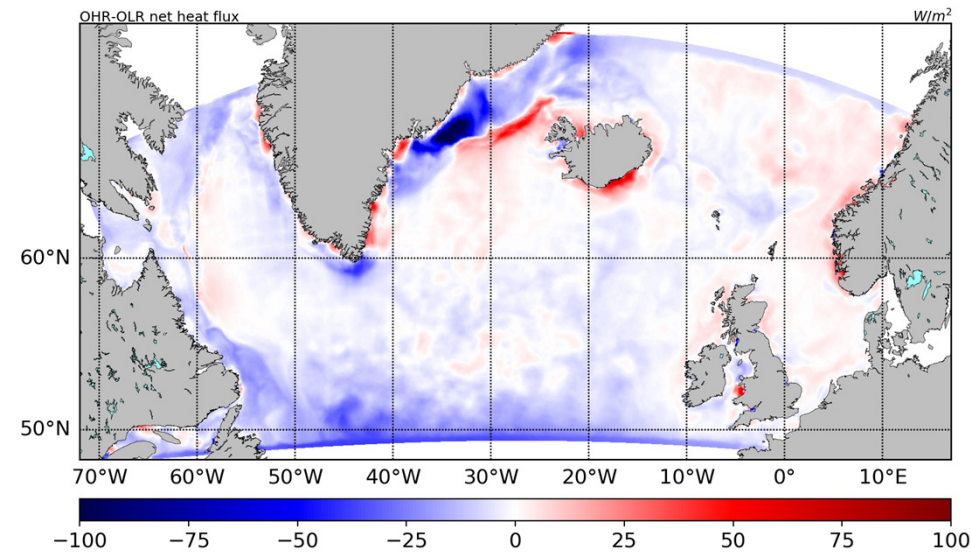


Observations: ARMOR3D

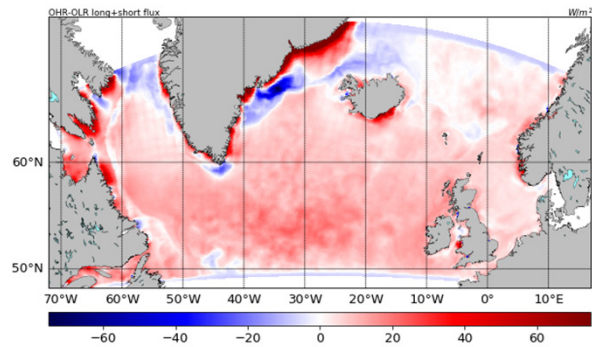
Results: ocean heat content



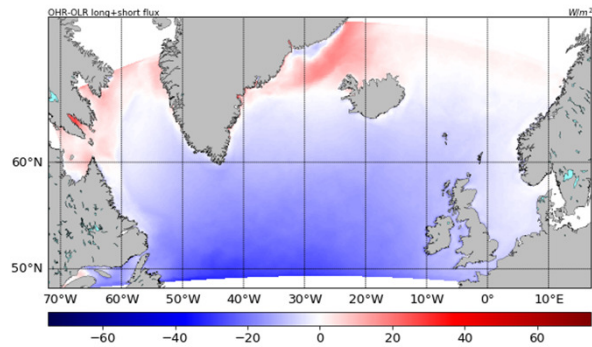
HiRes – LoRes Net Heat Flux difference



Turbulent Heat Flux difference

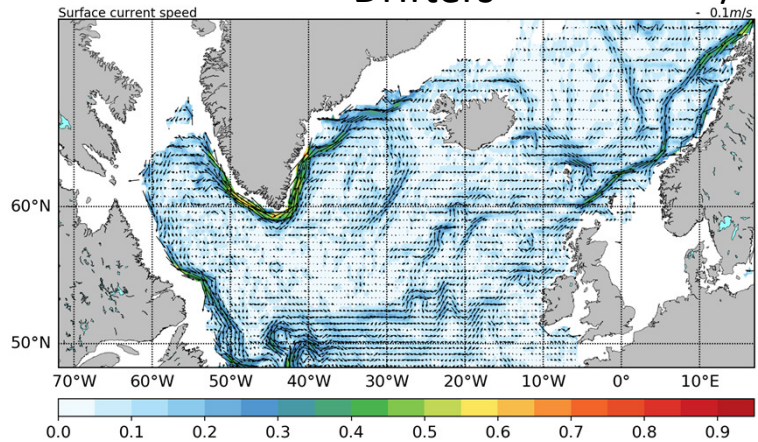


Short+Longwave flux difference

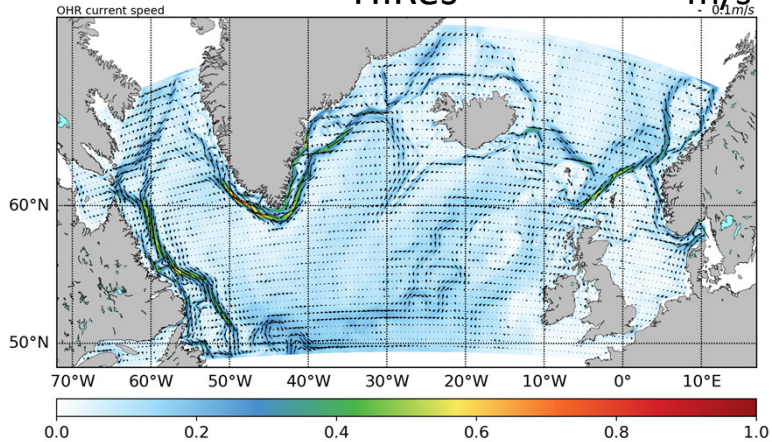


Results: mean surface ocean currents

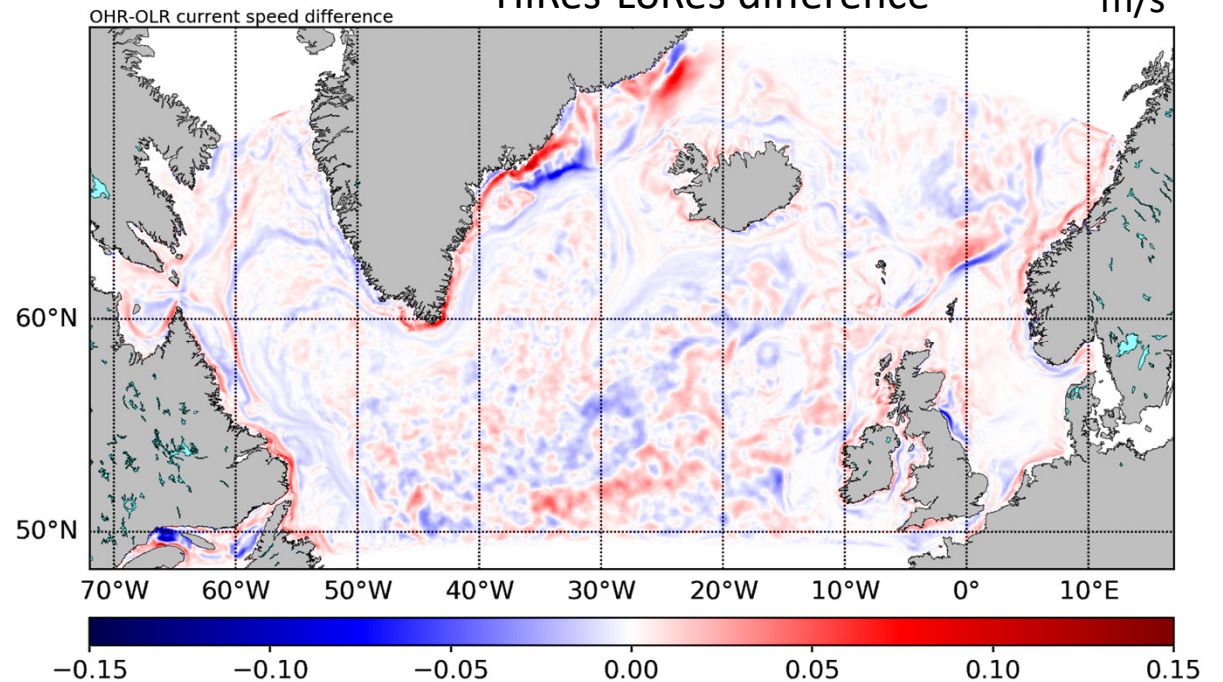
Drifters m/s



HiRes m/s

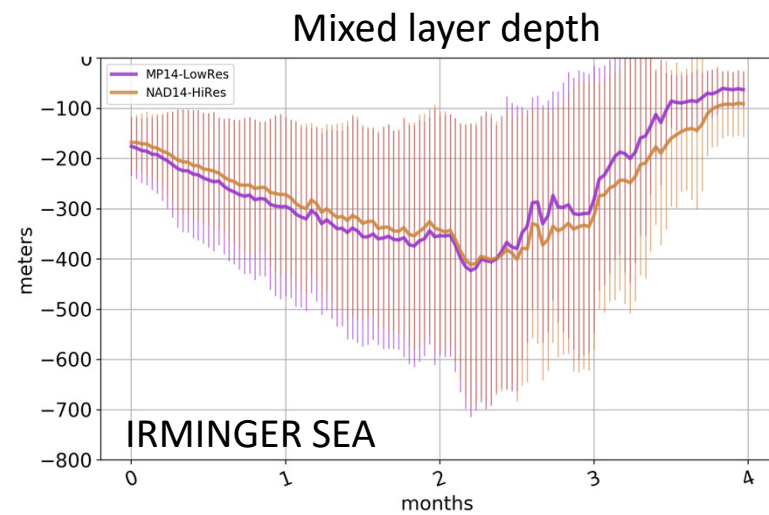
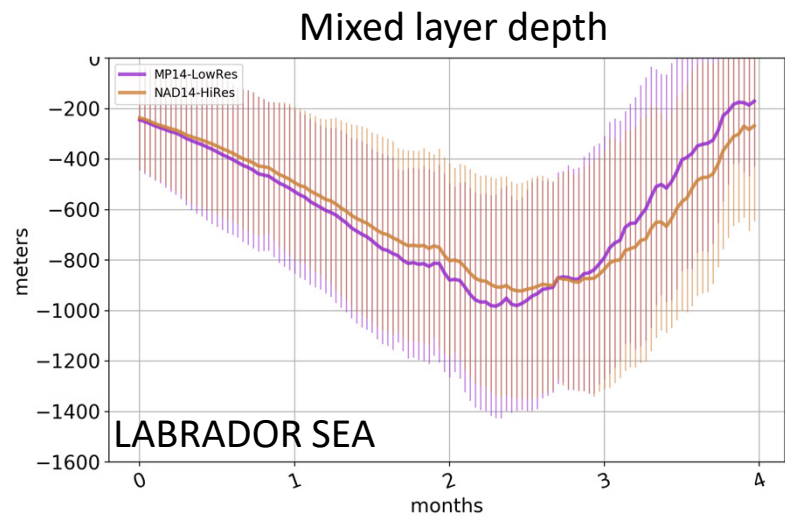
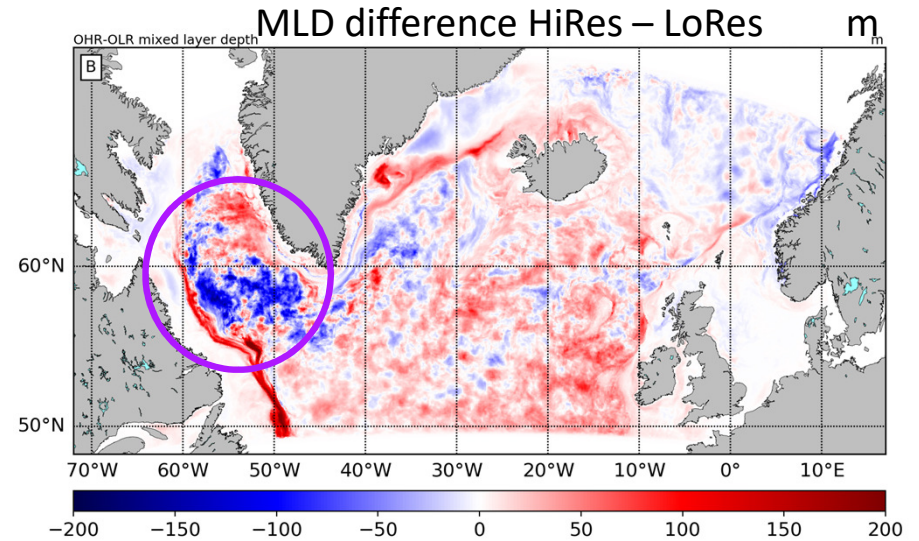
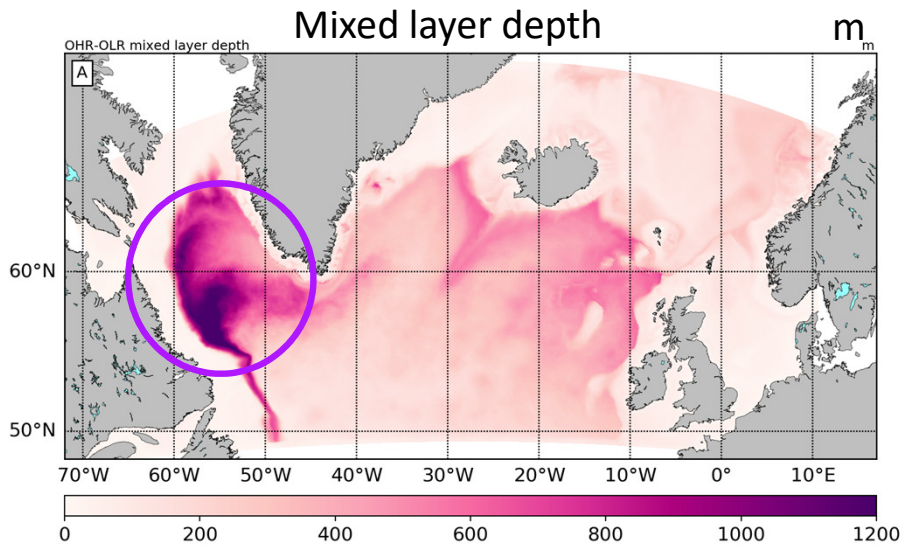


HiRes-LoRes difference m/s



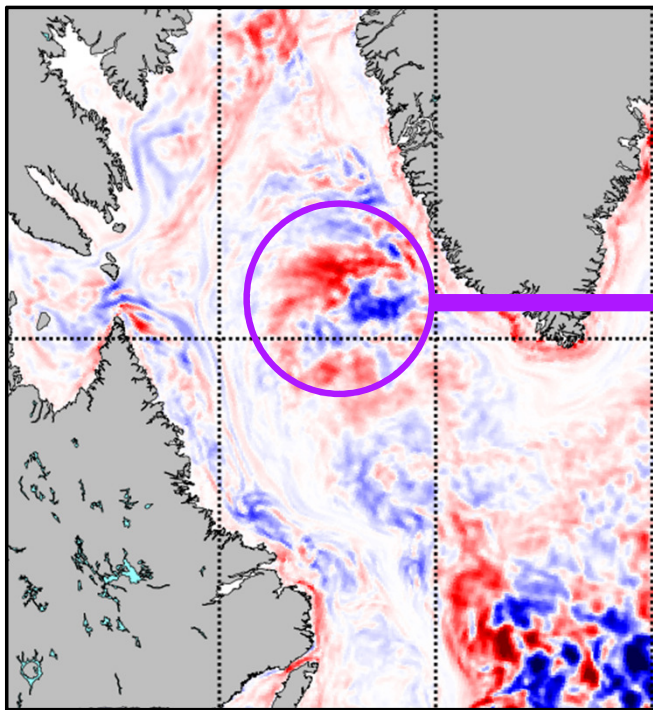
- More intensive boundary currents
 - No shift in NAC

Results: mixed layer depth and deep convection

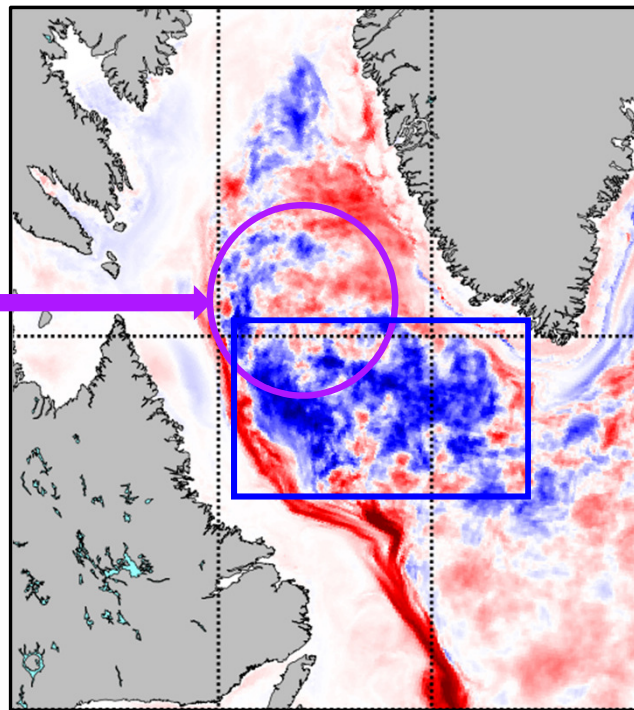


Ocean eddies and deep convection

Eddy kinetic energy difference

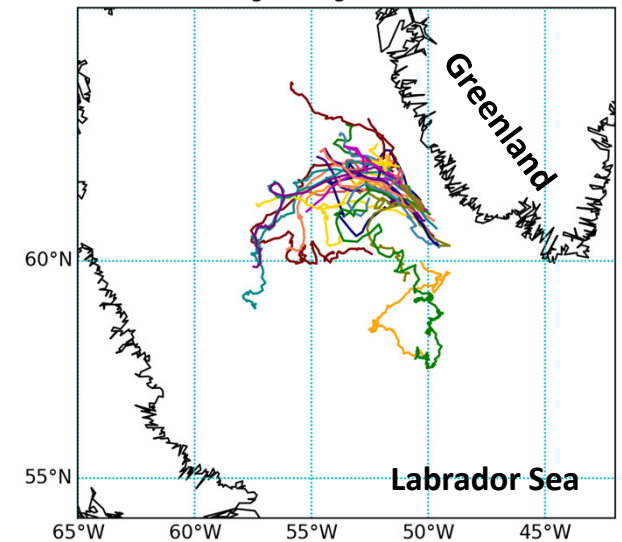


Mixed layer depth difference

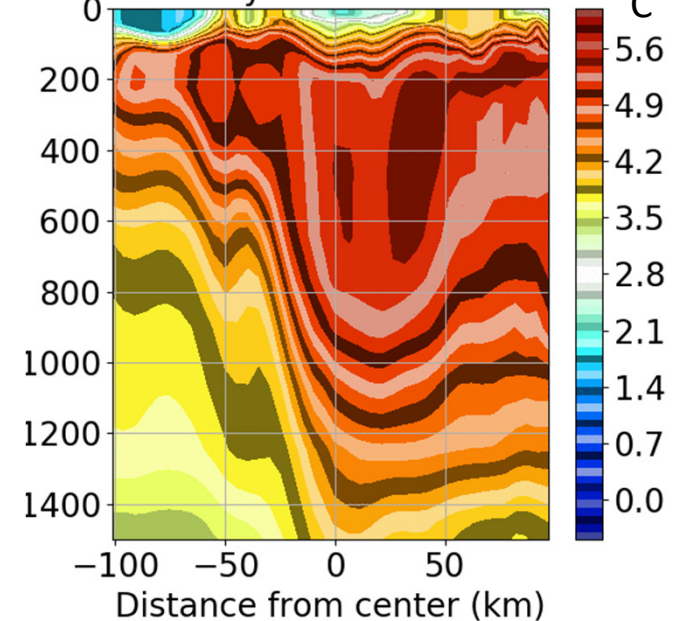


HiRes – LoRes

Irminger Rings tracks 2014



Eddy stratification



Summary and conclusion

- New **regional high-resolution model** configuration is developed for Subpolar North Atlantic
- **Mean ocean state** in both experiments is in good **agreement with observational data**
- **Twin experiments** were used to investigate **the sensitivity of the ocean** to the scales of the atmospheric forcing
- Atmospheric forcing **scales** have **significant impacts** on:
 - **Processes: ocean eddies, winter deep convection, turbulence and vertical mixing**
 - **Surface characteristics: SST, SSS, sea ice cover, ocean heat content, mean current patterns**

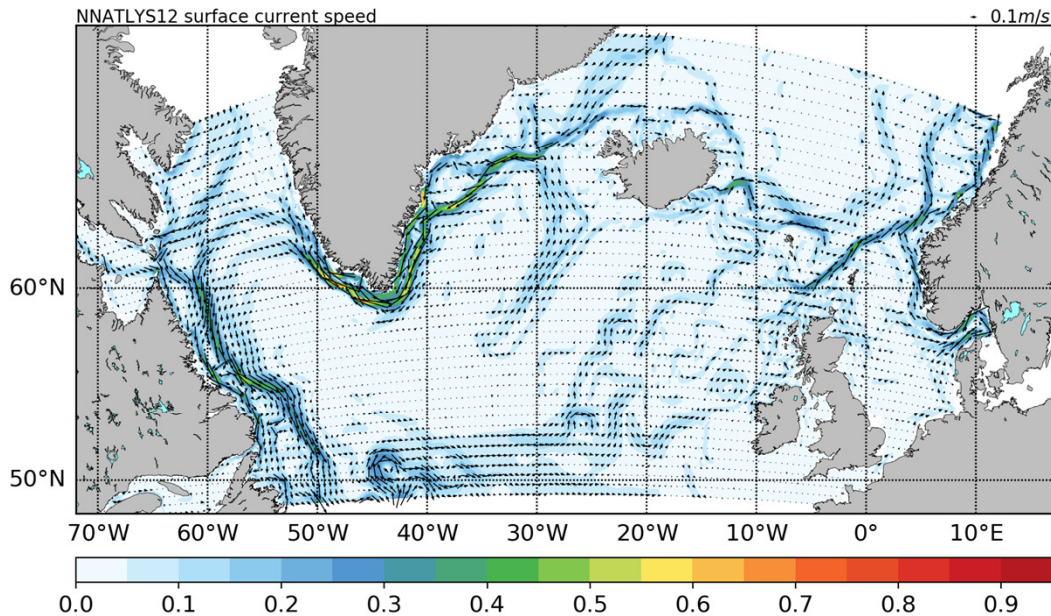
Small atmospheric scales matter for the ocean!

- Remaining question:

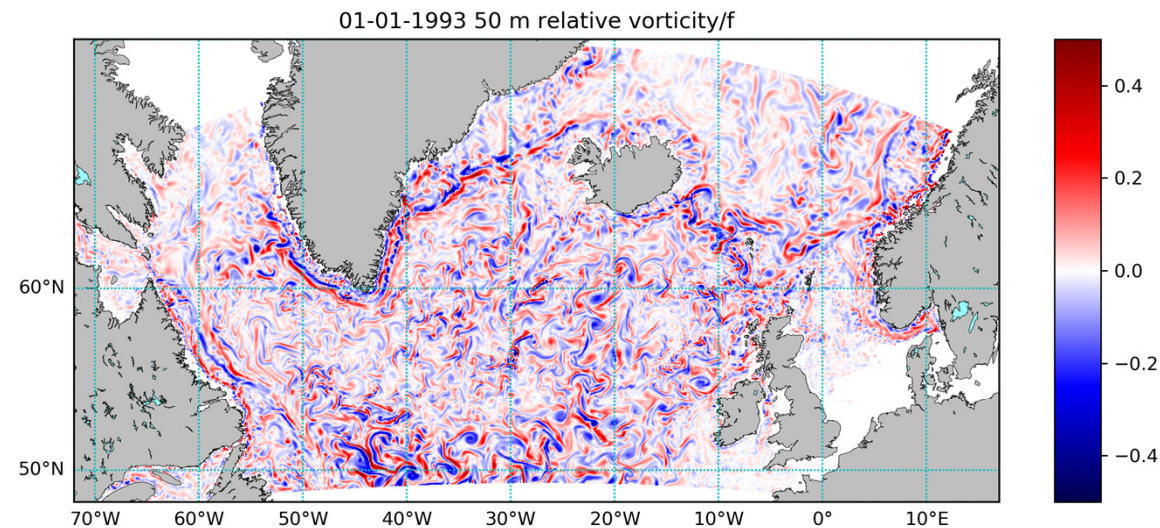
To which atmospheric processes of which scale to attribute ocean changes?

Mercator Reanalysis (Copernicus Marine Service)

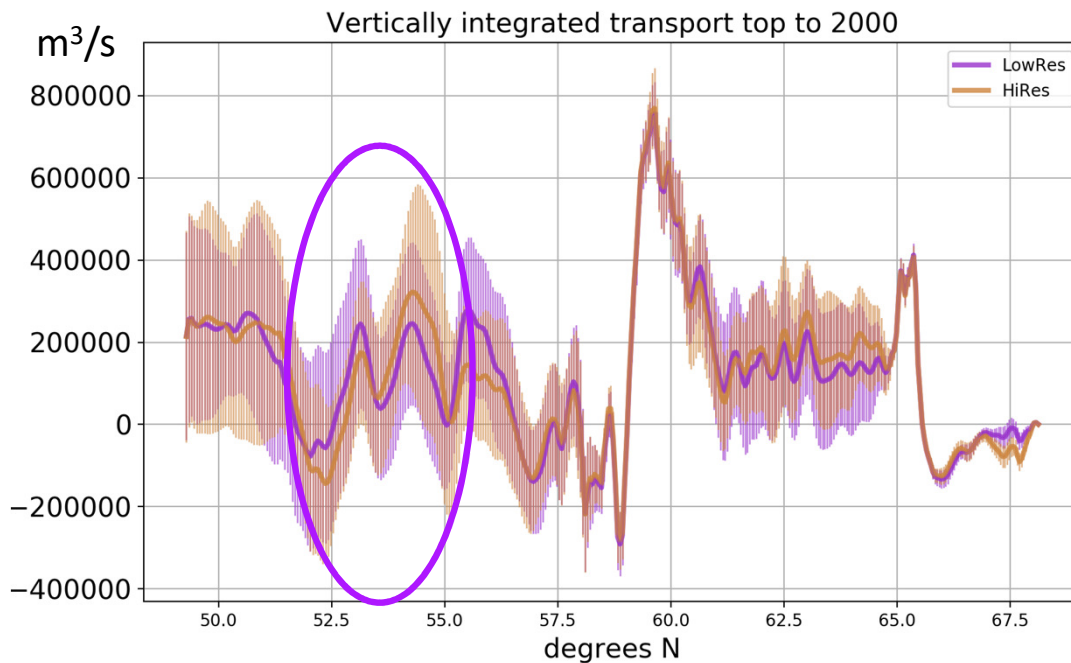
1992-2015 mean surface current speed



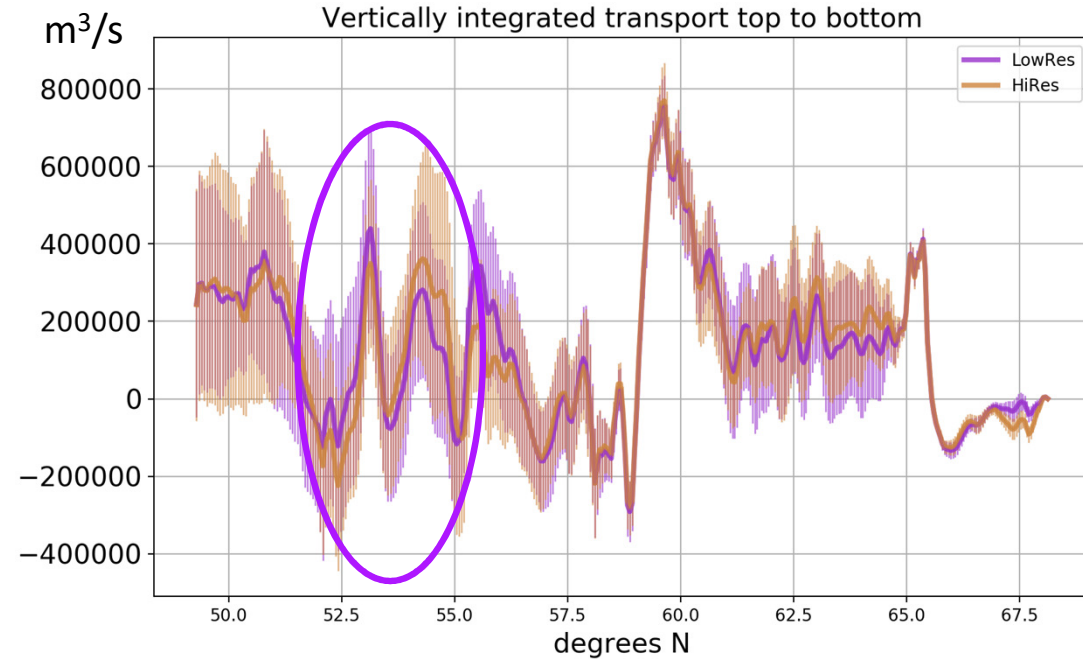
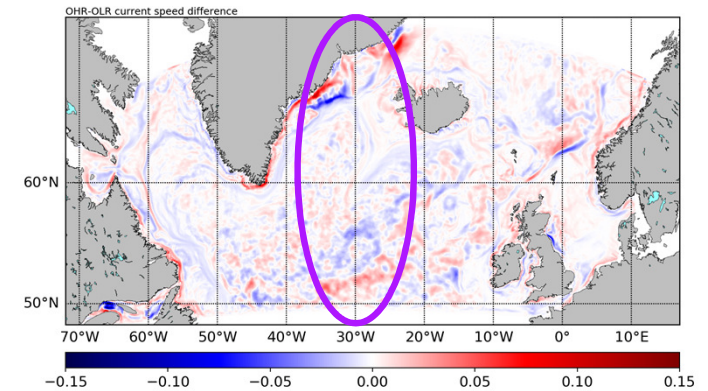
Daily relative vorticity normalized by Coriolis parameter



Mean current shift: North Atlantic Current

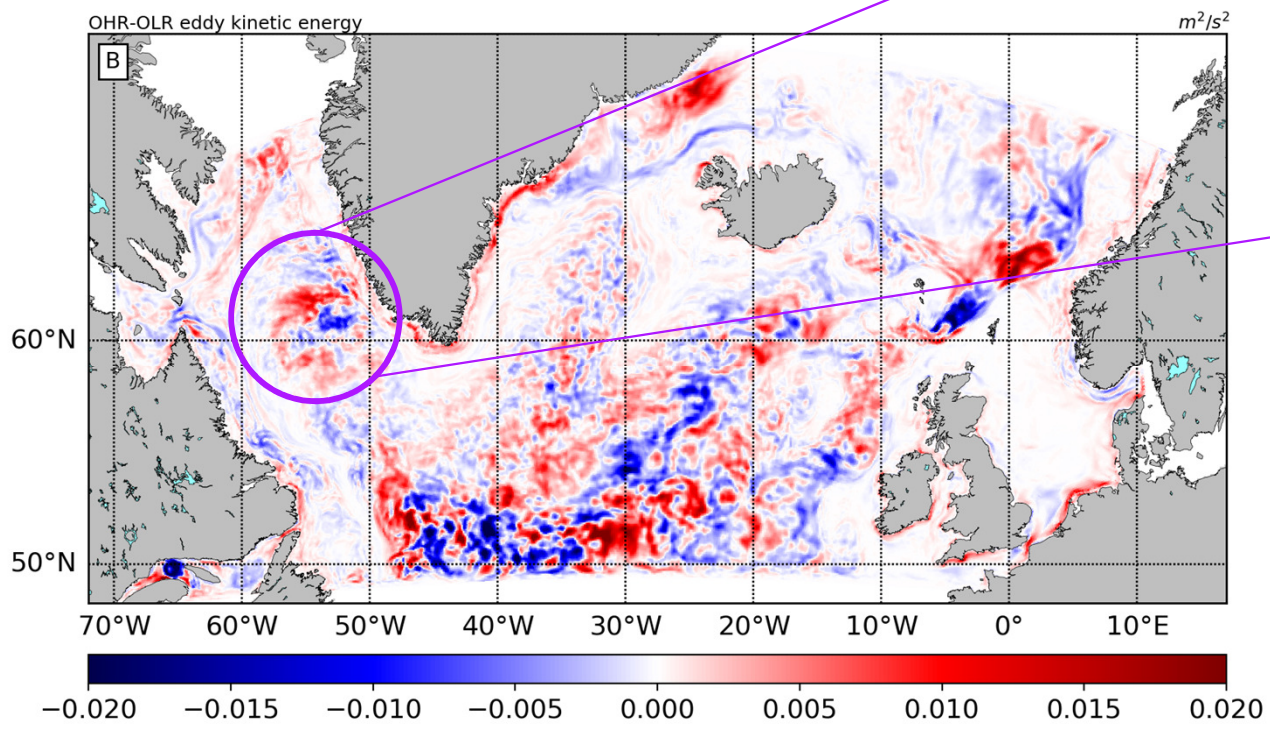


No shift is observed in the integrated volume transport through the 30W: The total transport is compensated by different branches

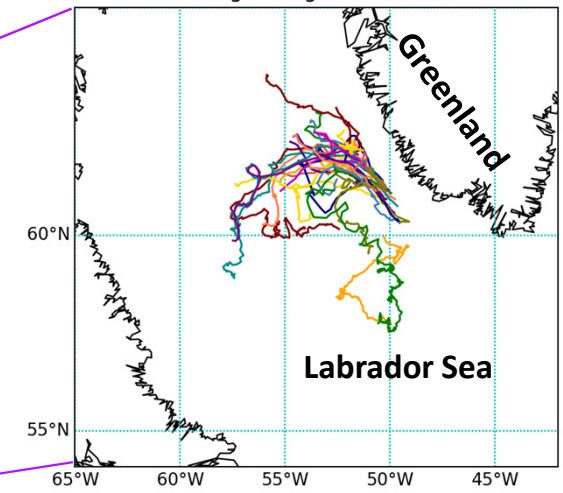


Results: ocean eddies

HiRes – LoRes eddy kinetic energy difference



Irminger Rings tracks 2014



20140119 days
Eddy stratification

