# Transport of European eel larvae in the Sargasso Sea

## Improved understanding of mesoscale dispersion


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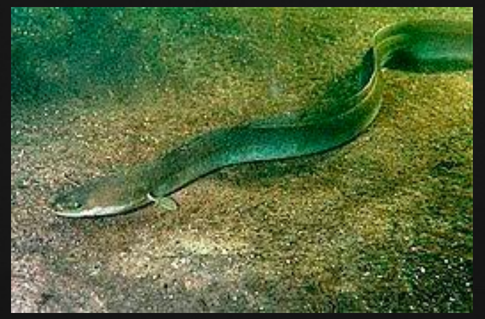
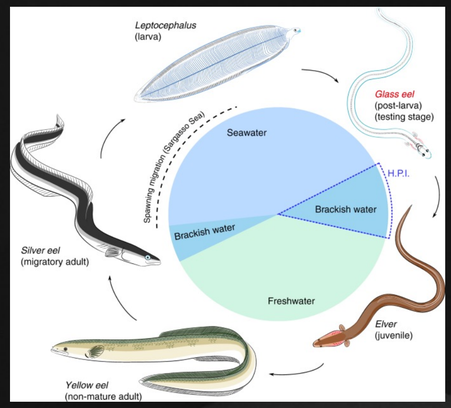
# Outline

- European eel Ecology and Population assessment
- Particle tracking of EEL larvae in the WOC framework
- Results on larval transport in the Atlantic Ocean
- Future steps on applications and data processing

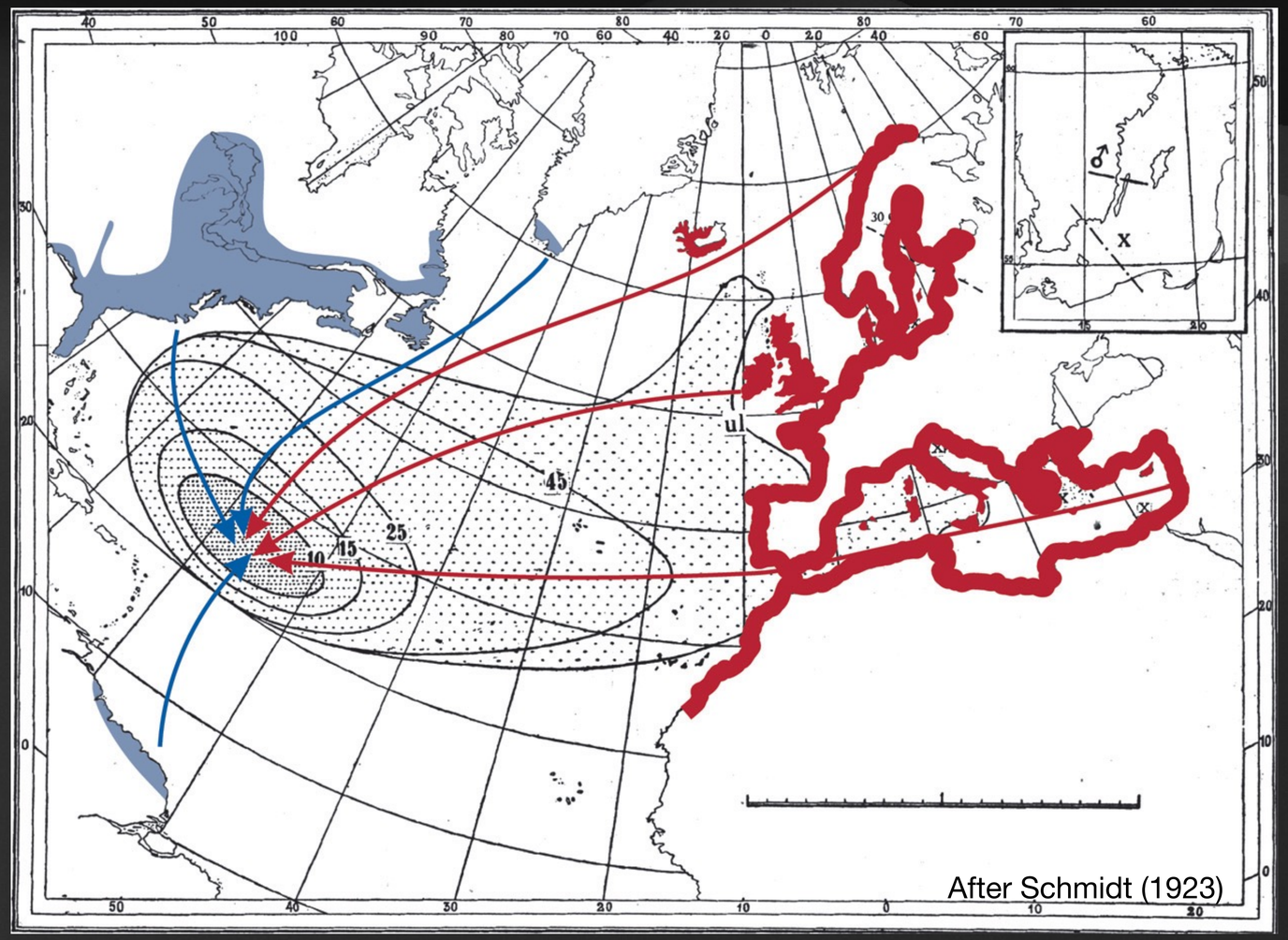
# European eels

## Ecology





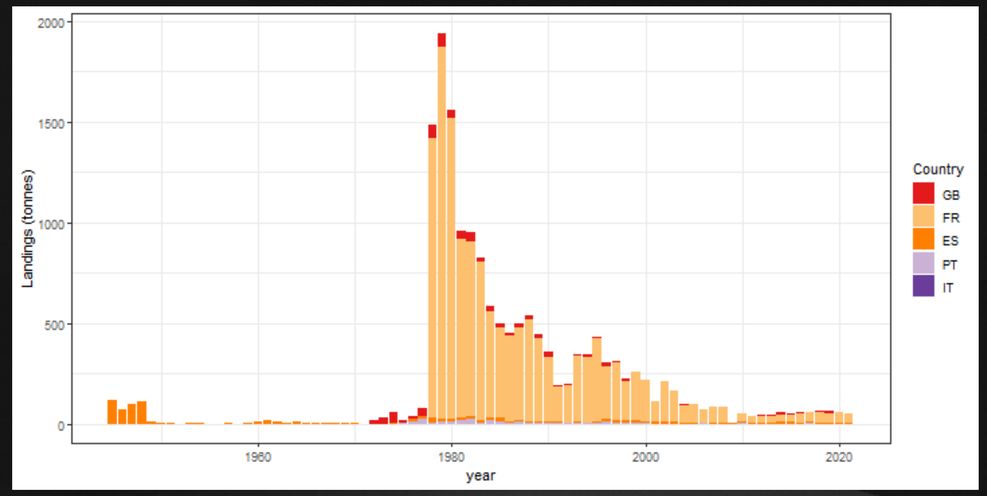

- Freshwater eels of the genus Anguilla migrate to offshore areas for their spawning
- Enigmatic lifecycle: To reproduce the European eels migrate about 5000 km toward the Southern Sargasso Sea
- Spawning areas appear linked to the Subtropical Convergence Zone (STCZ)
- Spawning areas of the species are identified from the distributions of early larval stages

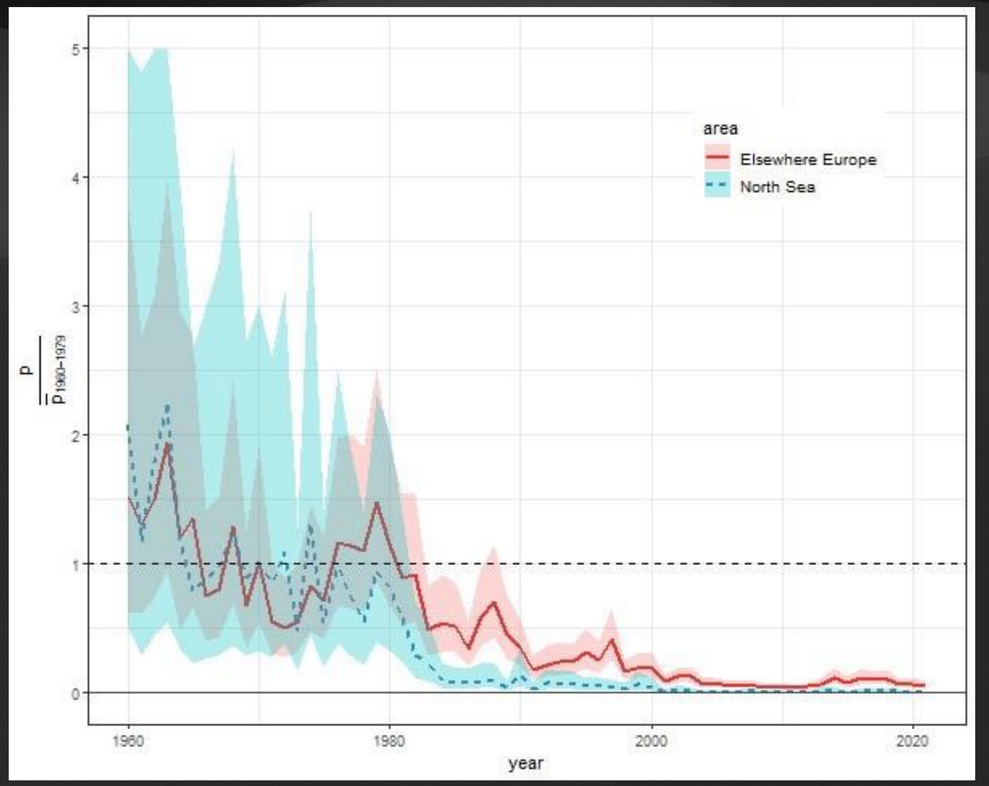


# European eels

## Assessment

- Landings: Glass eel landings show a sharp decline since 1980 from 2,000 tonnes to around 40–60 tonnes since 2009 onwards
- Analyses of provisional 2021 data show recruitment as a percentage of 1960-1979 levels at 0.6 % (North Sea) and 5.4% (elsewhere Europe).
- Recruitment remains among the lowest points on record
- European Eel Anguilla anguilla has most recently been assessed for The IUCN Red List of Threatened Species and listed as Critically Endangered



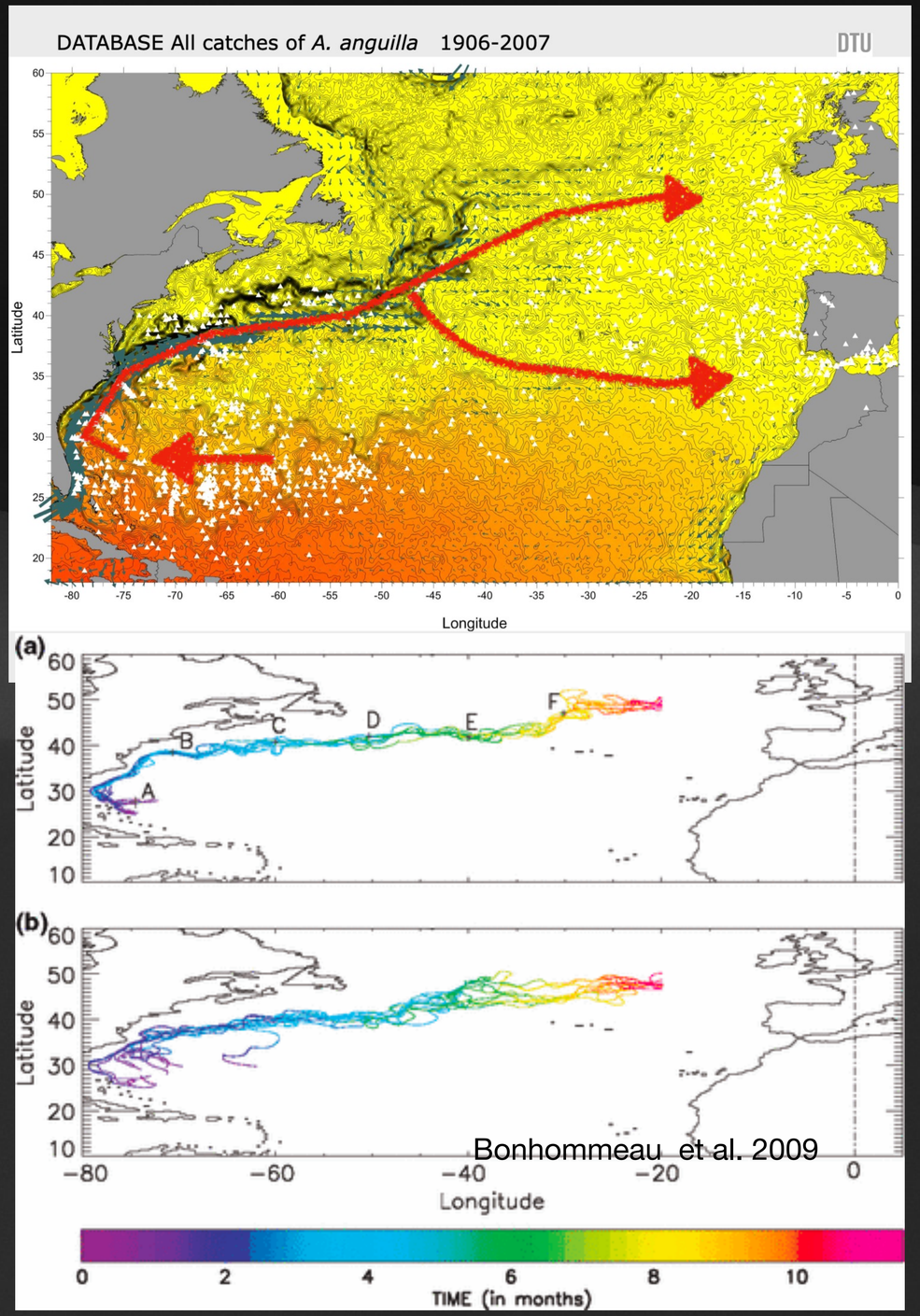

ICES 2021, WGEEL vol. 3 issue 85

# European eels

## Ocean currents

- A number of oceanographic modeling studies propose an initial drift of European eel larvae from their spawning site towards the west, where after these are entrained in the Antilles and Florida currents and subsequently advected by the Gulf Stream and the North Atlantic drift

- The proposed dominance of an initial westerly drift of the larvae contradicts, however, the abovementioned observations of the easterly distributions of European eel larvae



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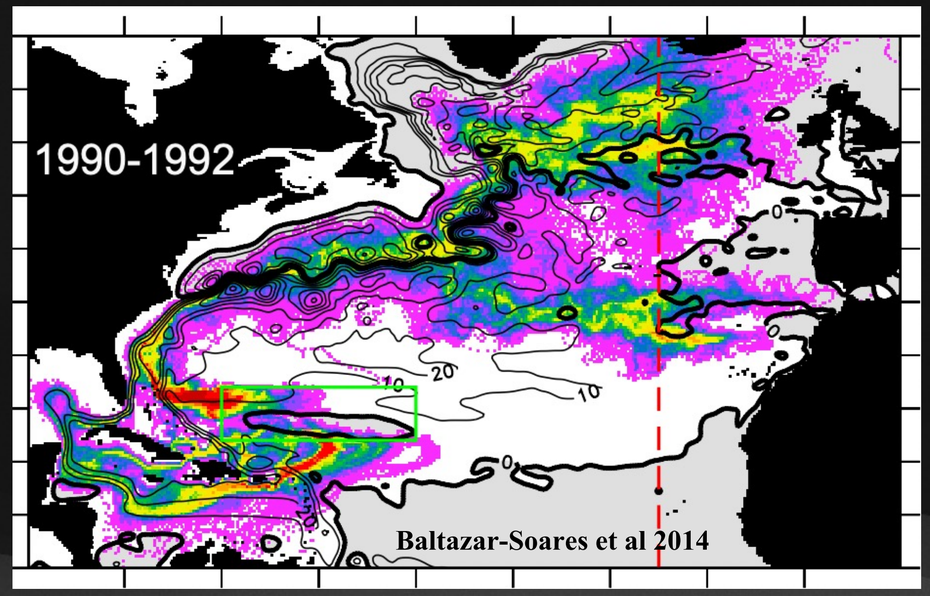
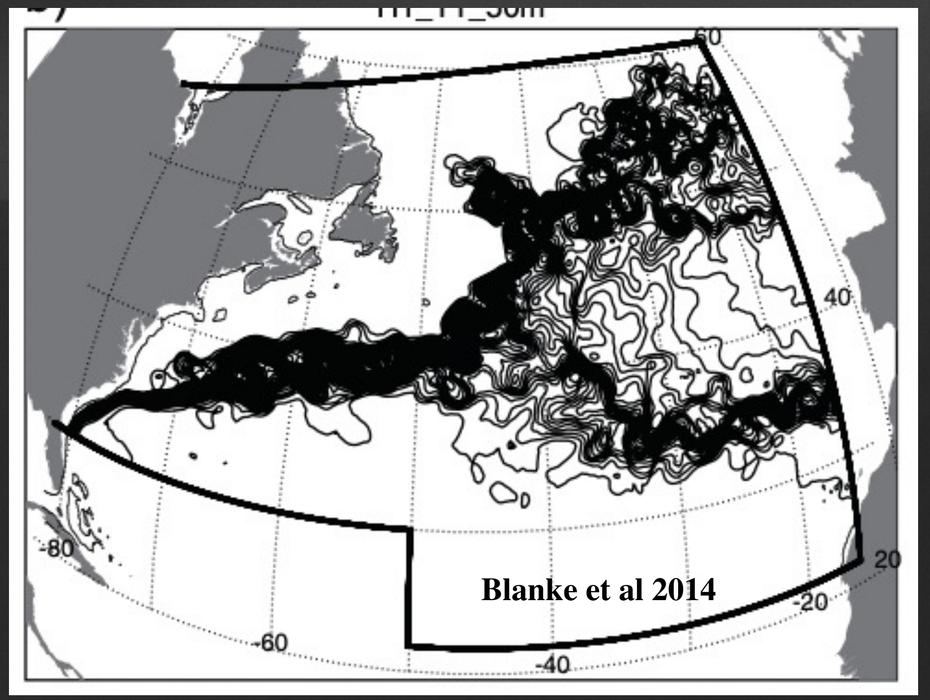
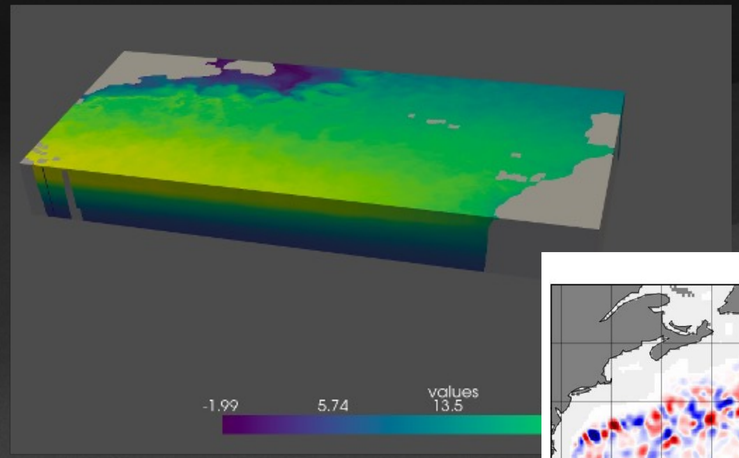


**WOC-NATL3D product**

daily 3D (0-1500 m) ocean currents (u,v,**w**), at mesoscale-resolving spatial resolution (1/10°x1/10°), over a wide section of the central/North Atlantic Ocean (20°N-50°N, 76°W-6°W)




Three-step algorithm:

1. Collect/develop high resolution surface data:

   Sea Surface Temperature (SST) **->** CMEMS-OSTIA

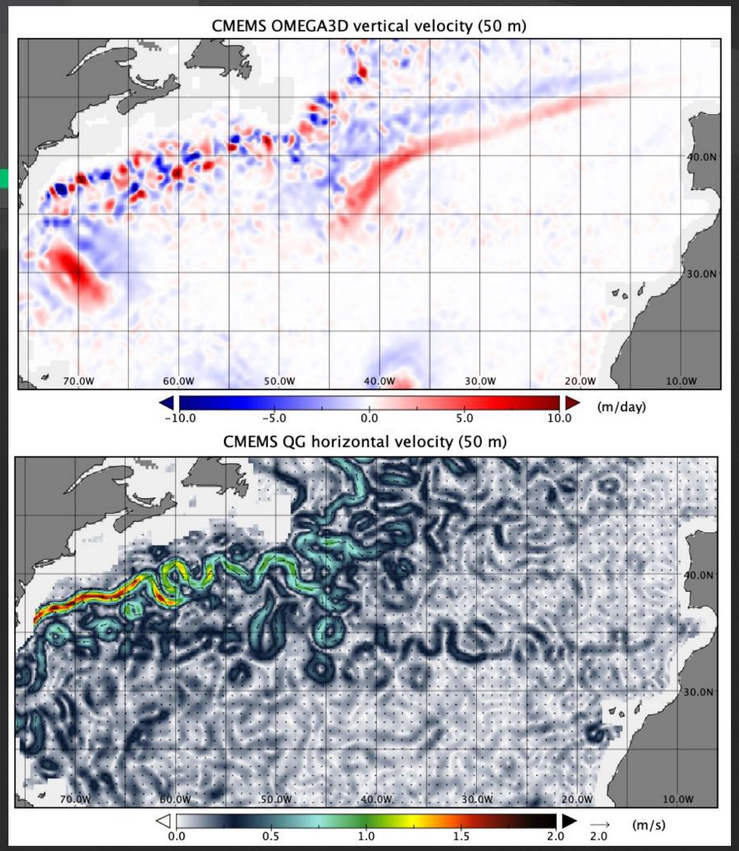
   Sea Surface Salinity (SSS) **->** WOC internal product

   Absolute Dynamic Topography (ADT) **->** WOC-NATL2D

2. Retrieve ocean 3D hydrographic structure from combined surface data and in situ vertical profiles

   Long-Short Term Memory Network

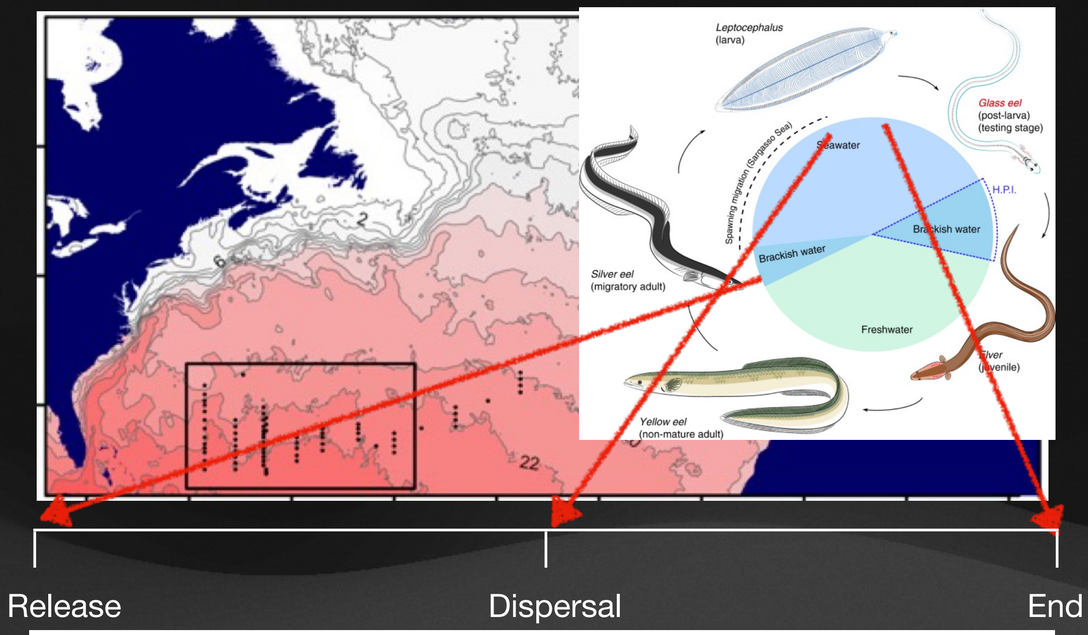
3. Solve diabatic Quasi-Geostrophic Omega equation including surface forcings

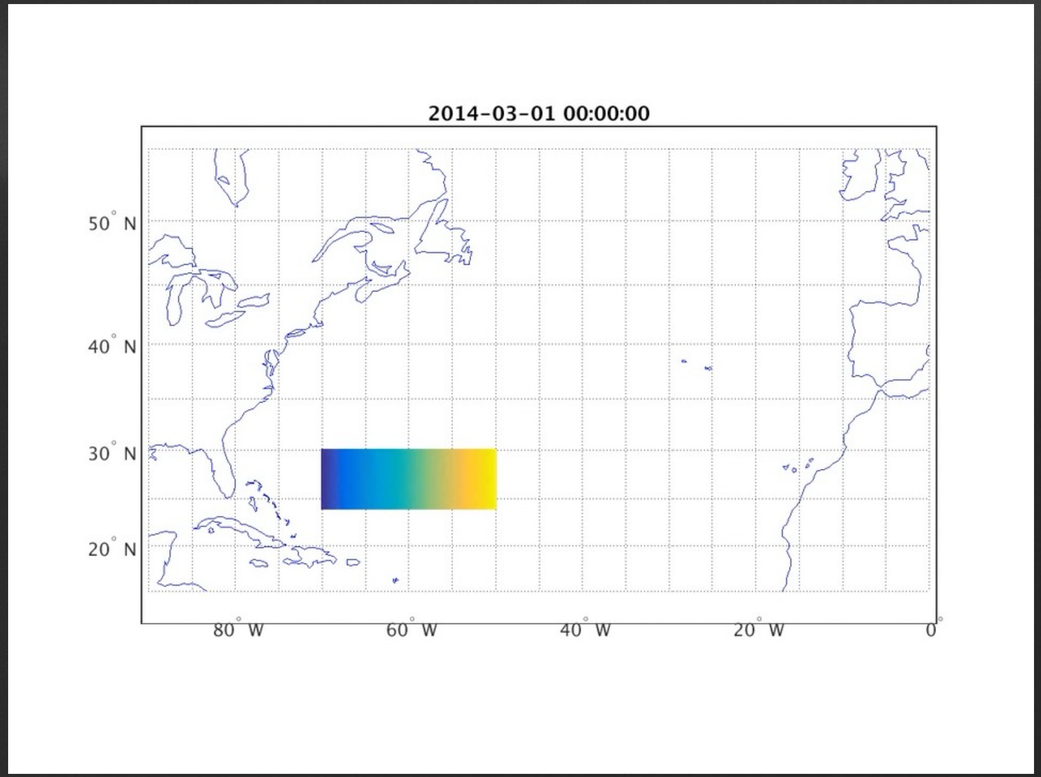


# Particle tracking

## Individual based model for European EEL

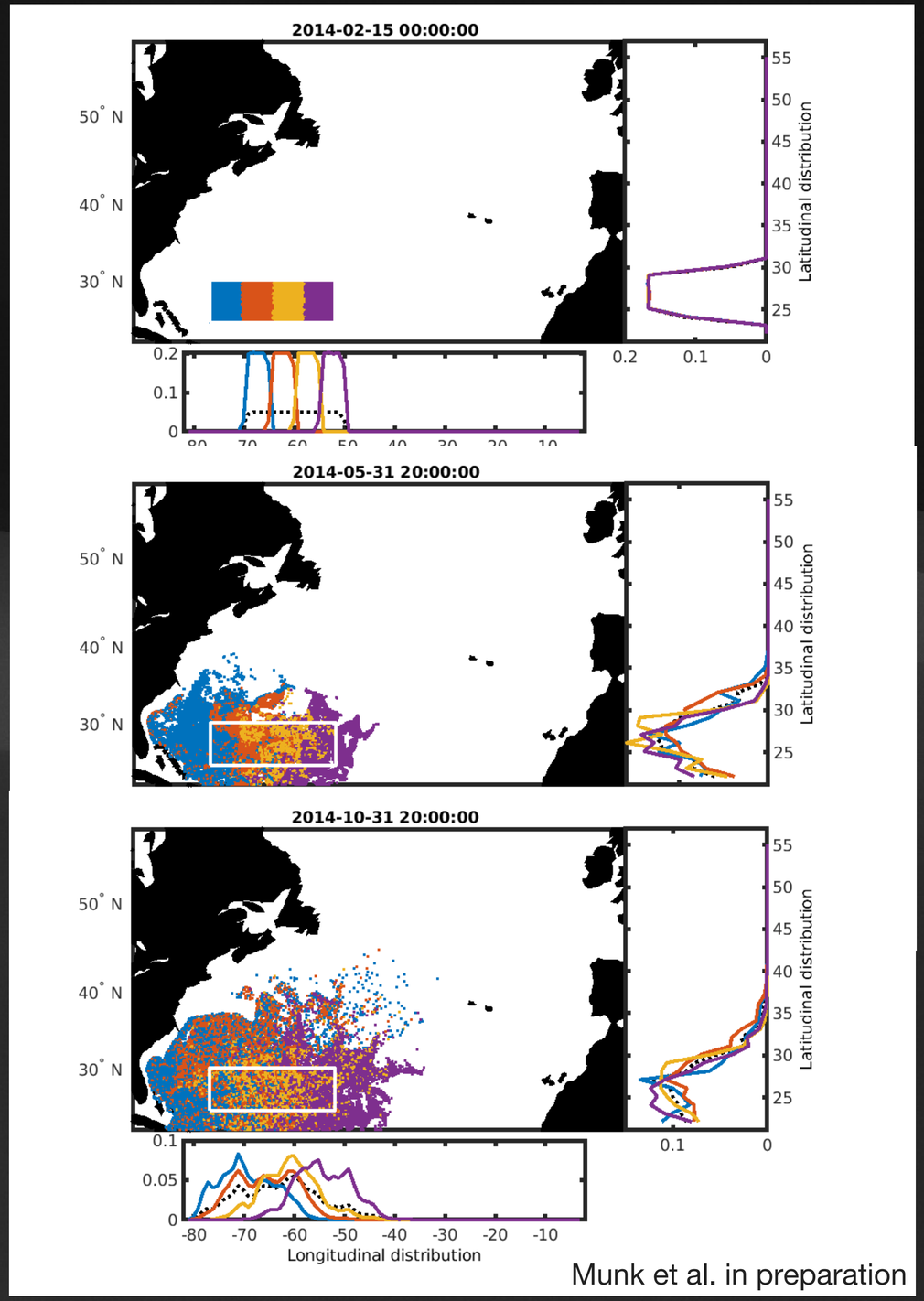
- Reproduction period February 2014
- Particles were uniformly released in a vertical layer between 10 m and 150 m and over the area of European larvae distribution as observed during the cruise
- Dispersal 10 months
- Diel vertical migrations 50 m (night) - 150 m (day)
- Subgrid diffusivity (smagorinsky scheme



# Results

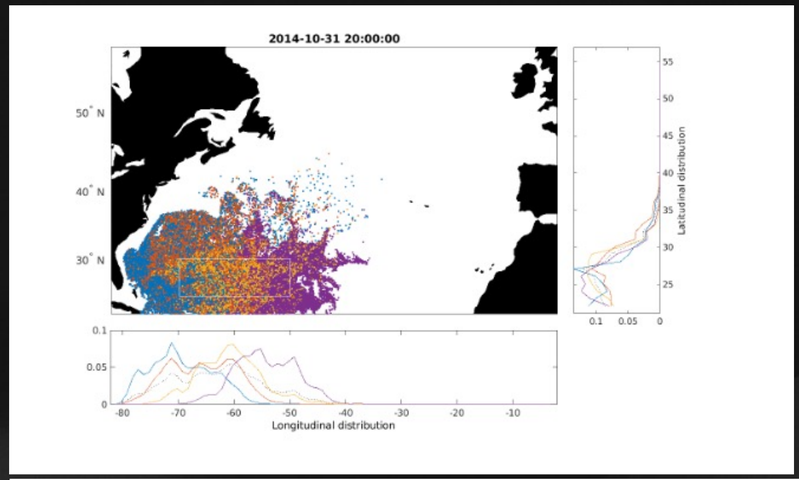
- Slowly evolving mesoscale turbulent field
- Tracers are not constrained in the interior of the observed structures, but rather dispersed almost isotropically in all directions
- Larvae which originated in the central and eastern part of the spawning area followed different pathways including northern and eastern directions
- The resulting larvae dispersal was generally isotropic with his retention (40% of the particles still in the release area after 250 days)
- Larvae stemming from the eastern part of the spawning area were not found west of 70 W

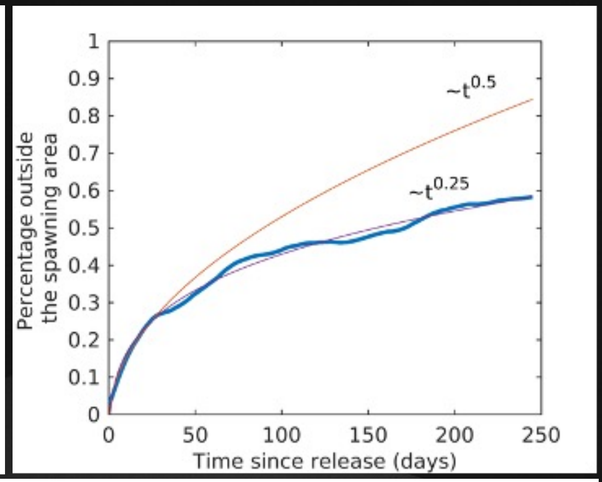


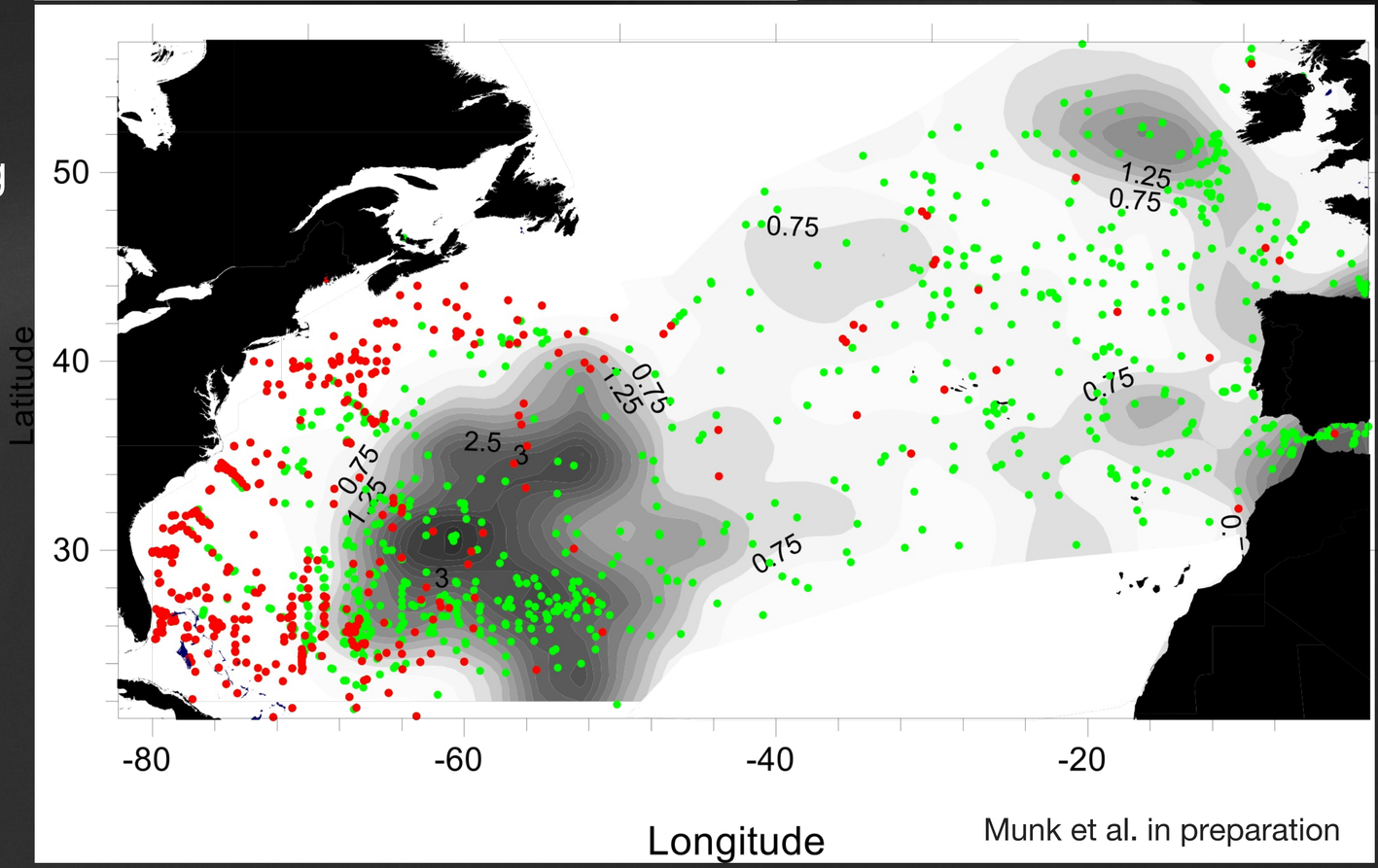

Munk et al. in preparation

# Results

- Model results in diffusive transport with high retention
- The historical data on larval abundances show peak concentrations in the spawning area and towards northeast from there
- Only few larvae of the European eel (A. anguilla) were observed west of the spawning area
- Specific observations of zero abundances of this species are available from the reported hauls containing American eel

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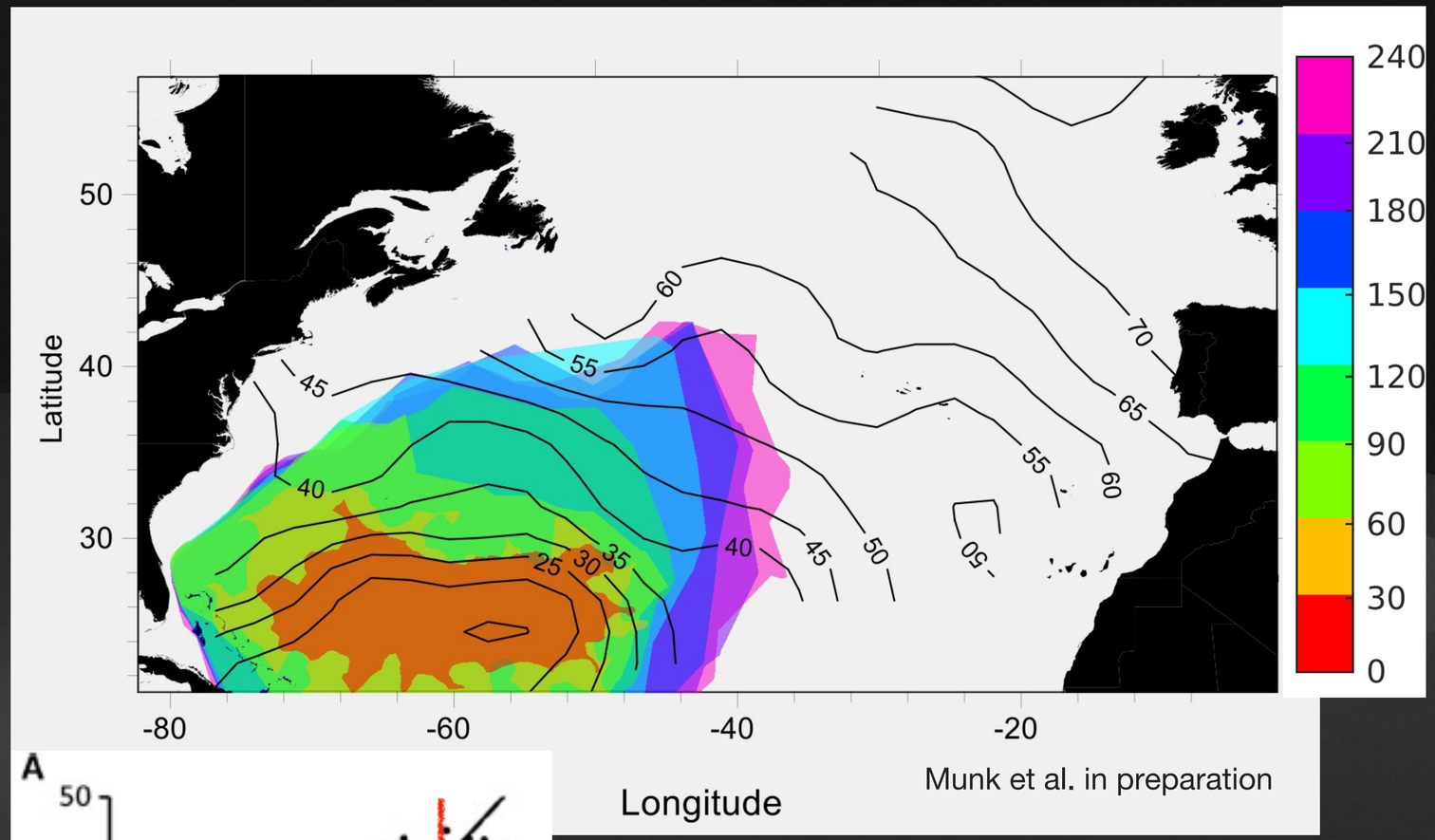
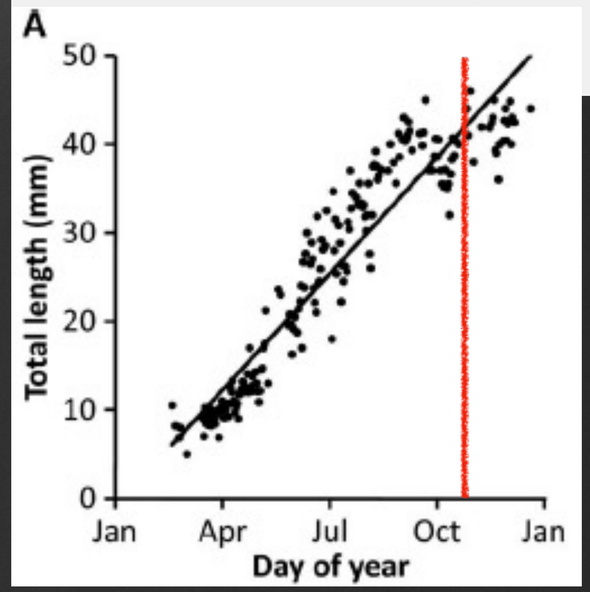
# Results

- The distribution of average sizes across the area is coherent with the simulated dispersion and hence consistent with a semi-isotropic dispersal of eel larvae from the spawning area



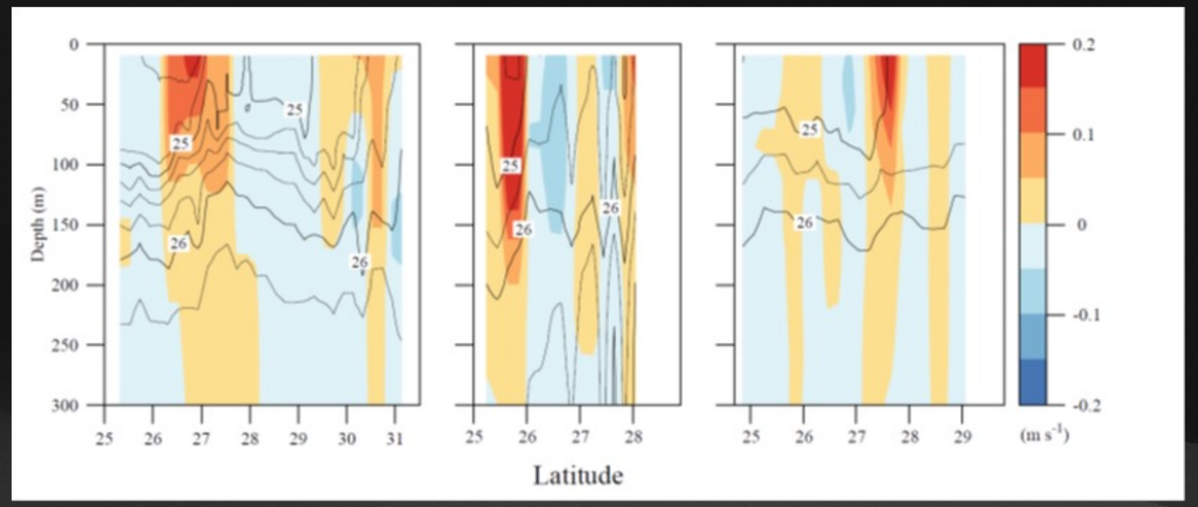



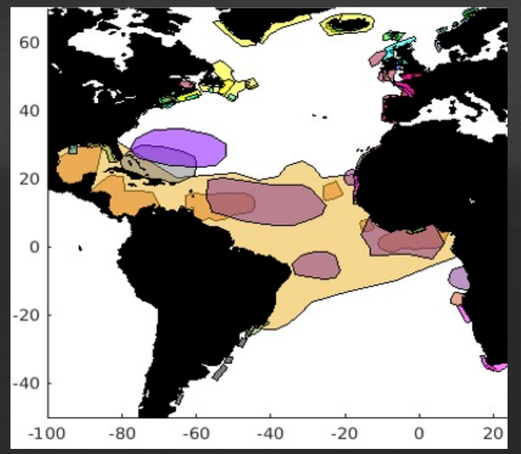
# Conclusions

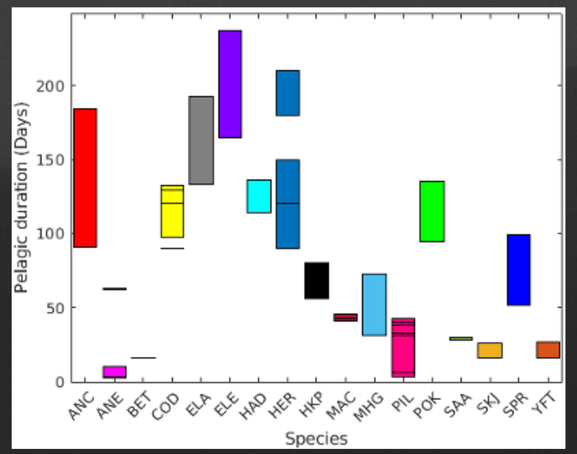
- Results appeared to be consistent with proposals that the Sargasso Sea could be  a major retention area in the first year of eel larvae
- Significant transport outside the spawning area both towards West and North, entering regions dominated by the Gulf Stream
- Significant transport also to the East and South - which were not reported before in similar modeling studies
- Data-driven modelling approaches have the potential to reveal previously overlooked European eel larvae dispersion dynamics

# Next steps

- Longer simulations and repeated over multiple years
- Compare hydrography with high resolution data collected in 2007 and 2014
- Apply the model to other regions
- Combine ocean current reconstructions with other satellite derived products to support Integrated Ecosystem Assessment procedures across the Atlantic Ocean (North and South)



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