

Decadal predictions of the environmental conditions at North Atlantic Sponge habitats

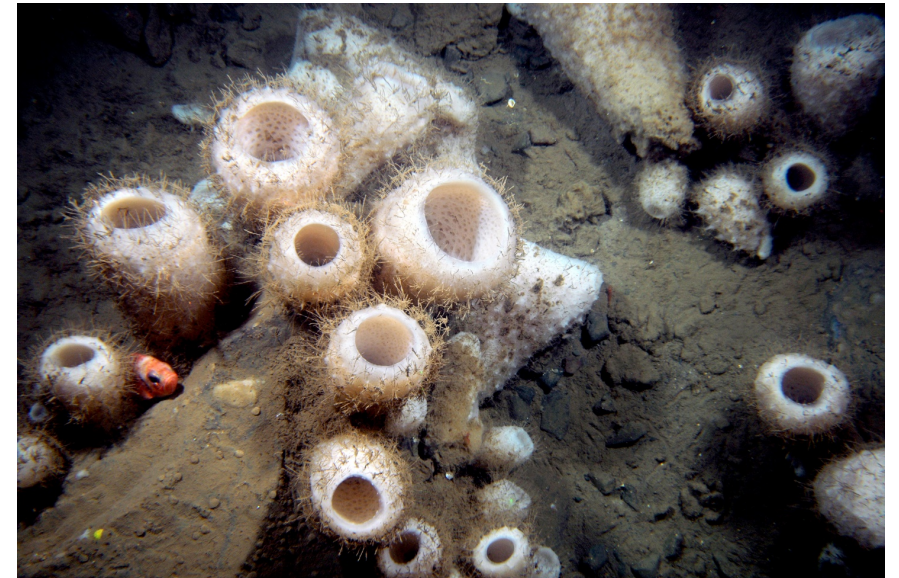
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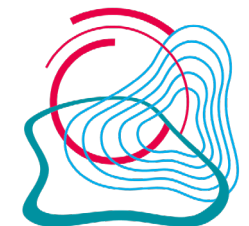
Blue-action prediction Workshop
Copenhagen, 22.09.2021



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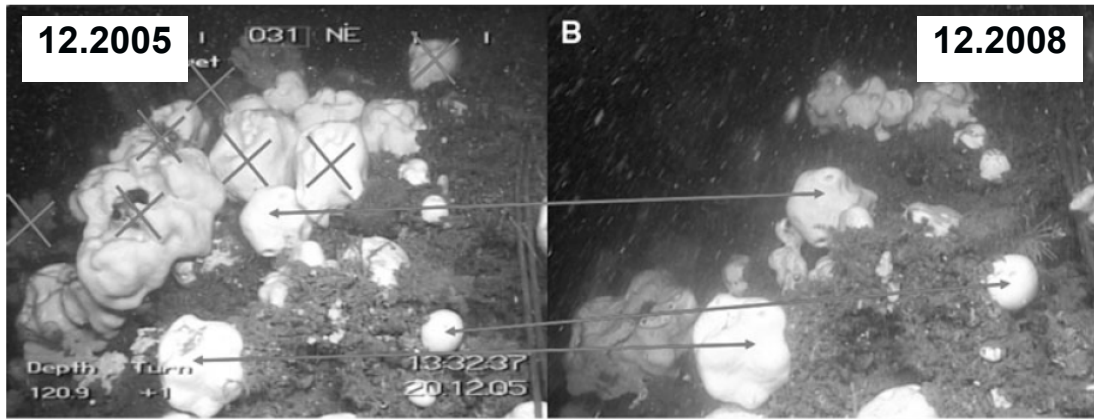
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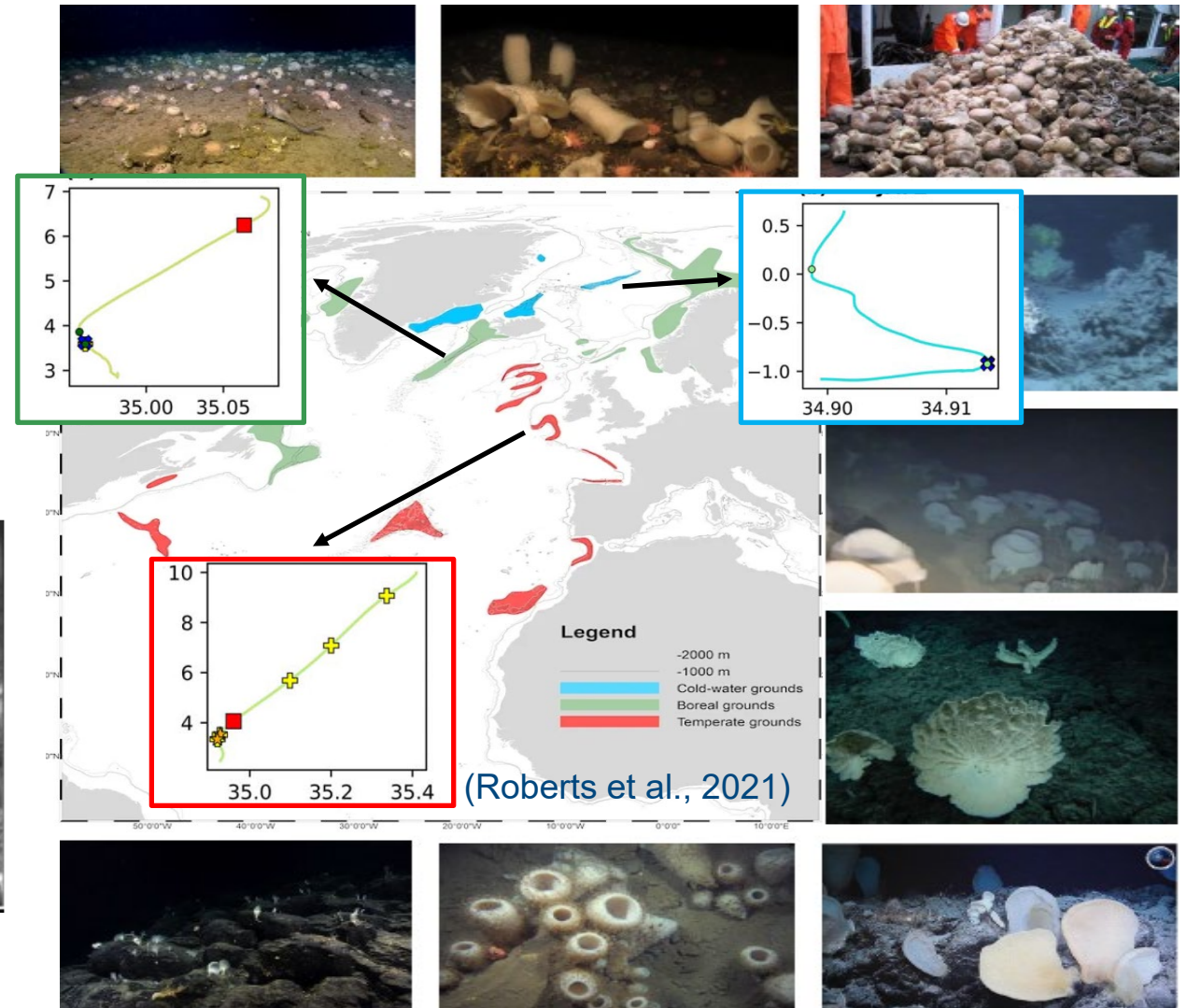
Environmental conditions – key constrains of deep-sea sponge habitat distributions

- Environmental variables: temperature, salinity, concentrations of nutrient (e.g. silicate) and oxygen influences the deep-sea sponge habitats
- Environmental variables are important predictor variables in predictive habitat distribution models.



(Guihen et al., 2012)

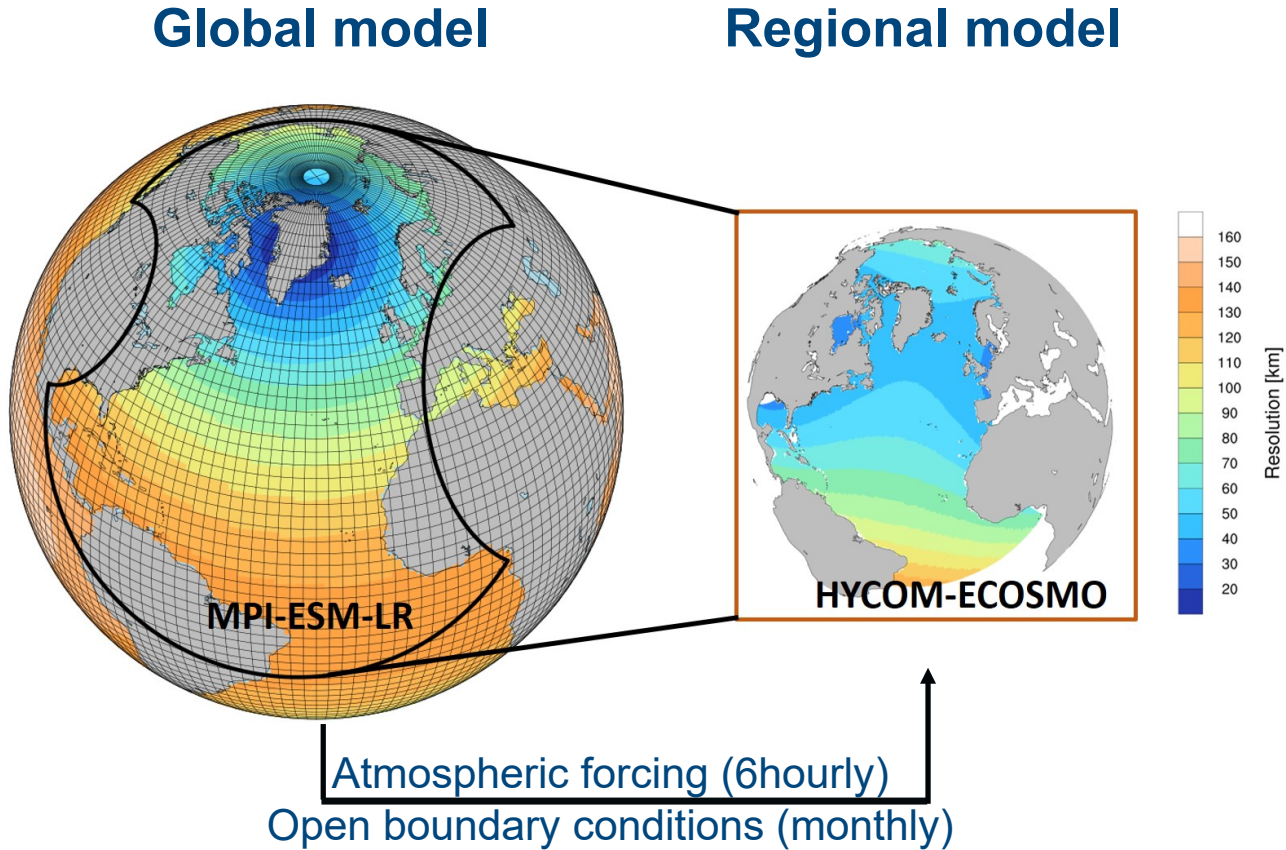
Sponge mortality



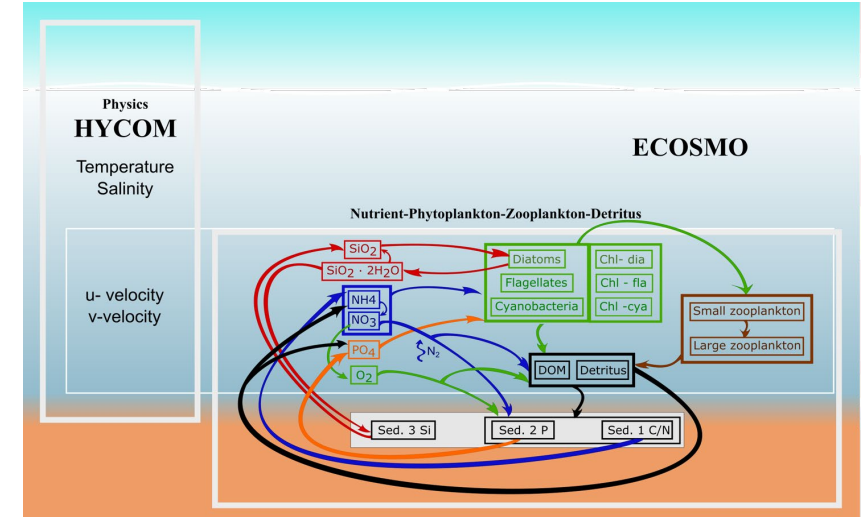
(Roberts et al., 2021)

Rapp, 2016,
SponGES website:
<http://www.deepseasponges.org/>

Downscaling regional decadal prediction system

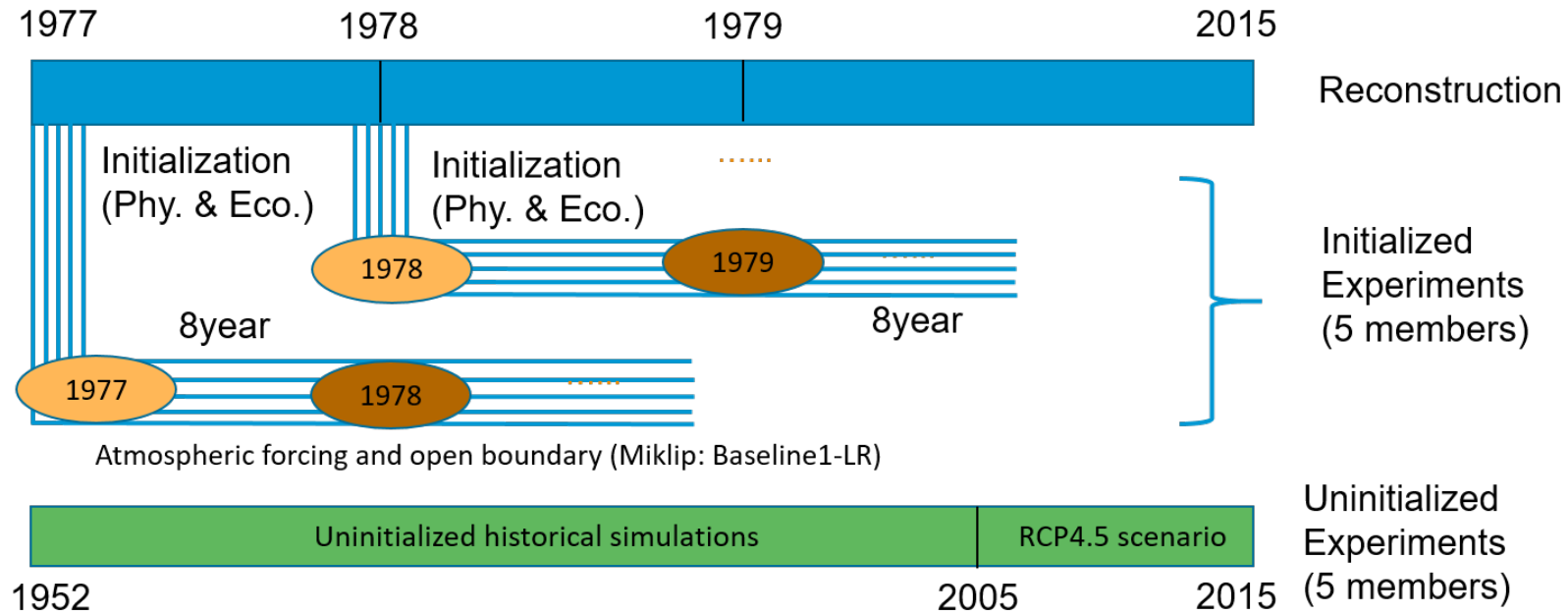


- MPI-ESM-LR: Max Planck Institute Earth System Model with low-resolution configuration (Pohlmann et al. 2013)



- HYCOM: isopycnal levels facilitate good conservation of water-mass and tracer properties in the deep ocean
- ECOSMO: a single layer of sediments allows for processes of settling, resuspension and burial happening at the bottom ocean

Experiment set up



Analysis

Time series of detrended annual mean anomalies

Anomaly correlation coefficient (ACC)

Assess the phase of the variability

Normalized mean absolute error (NMAE).

$$NMAE(x, y) = \frac{\frac{1}{N} \sum_{i=1}^N |x'_i - y'_i|}{\sigma_{y'}}$$

Assess the divergence between mean trajectories

When $NMAE < 1$, the prediction error falls within the variability of the reconstruction and we determine that the prediction is accurate.

Potential Predictive skill ---- Anomaly correlation coefficient (ACC)

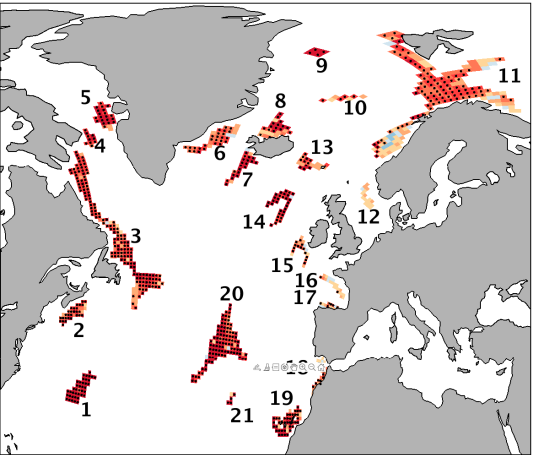
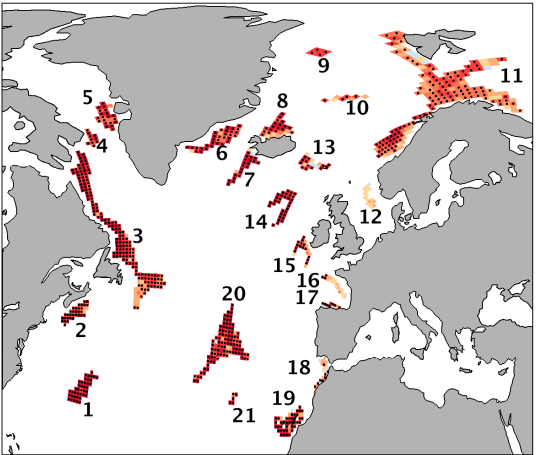
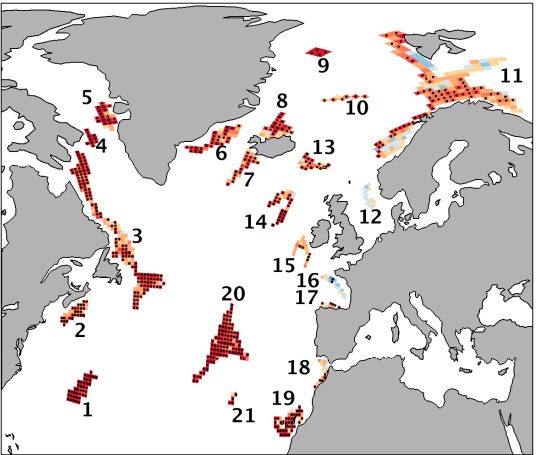
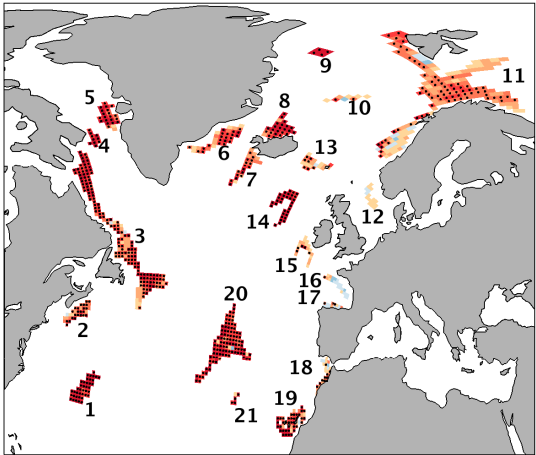
Temperature

Salinity

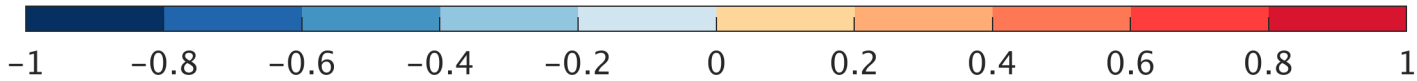
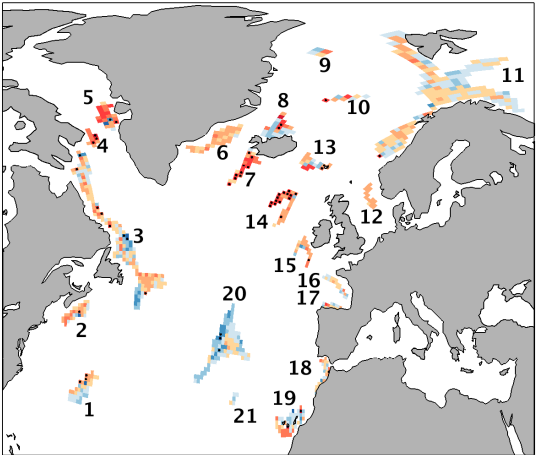
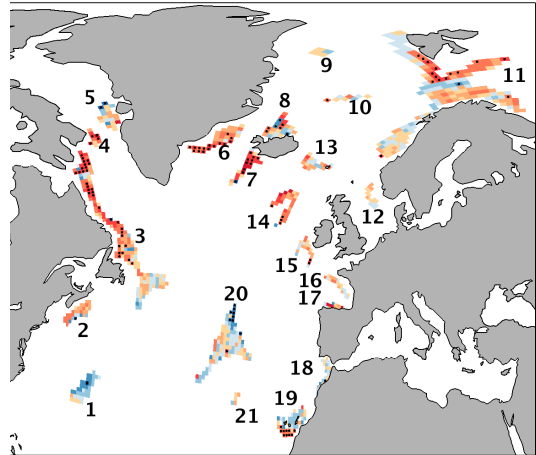
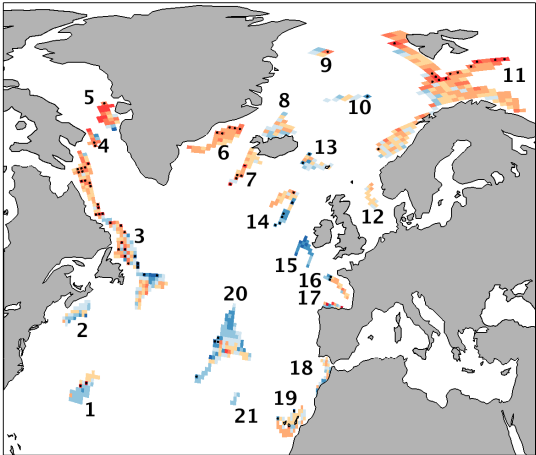
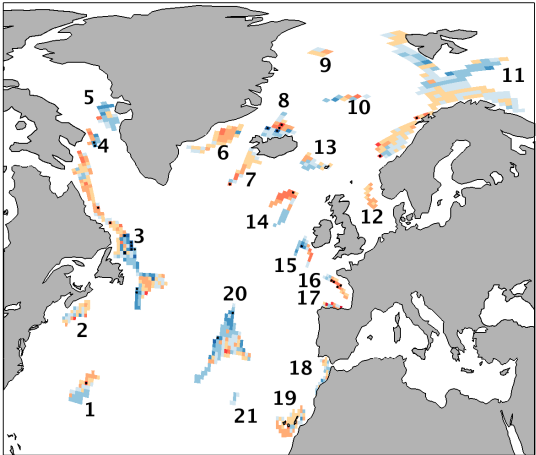
Silicate

Oxygen

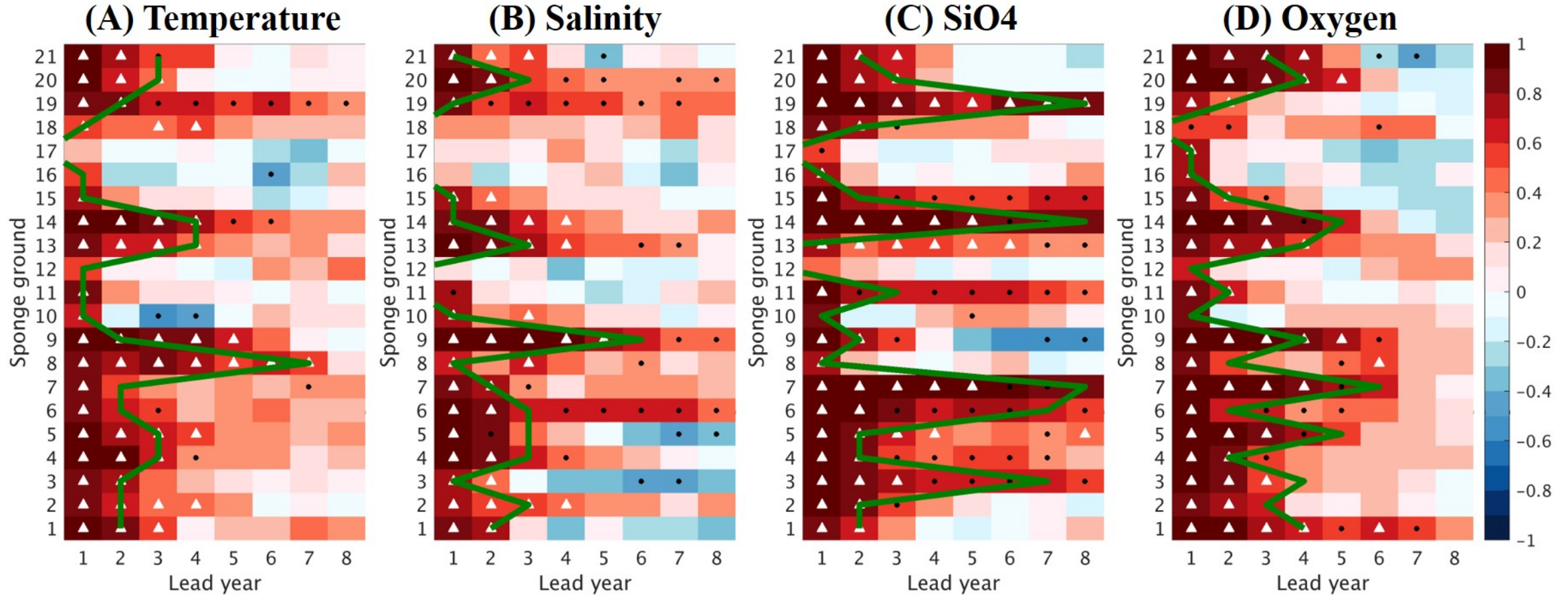
Ini. (LT2) vs. Recons.



Uninit. vs. Recons.



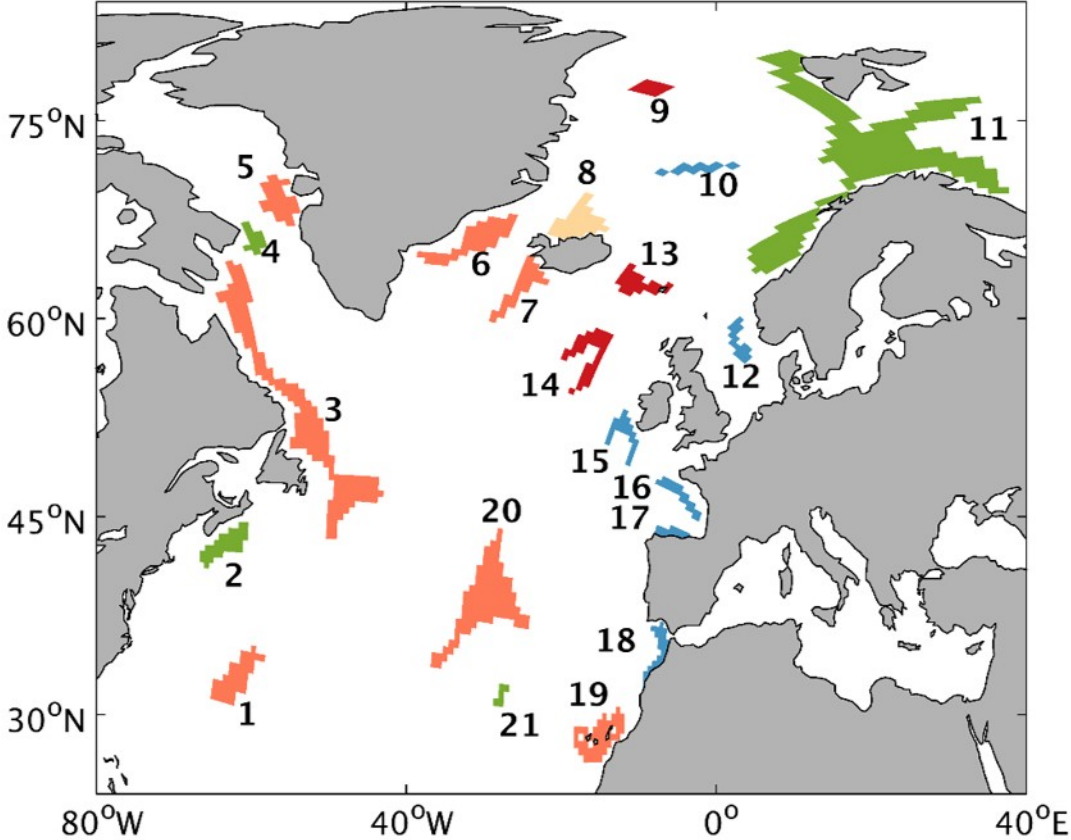
Potential predictability horizon ---- ACC



- ▲ *Init. > uninit.*
- *Init. significant but **not** > uninit.*
- *Maximum year of predictability*

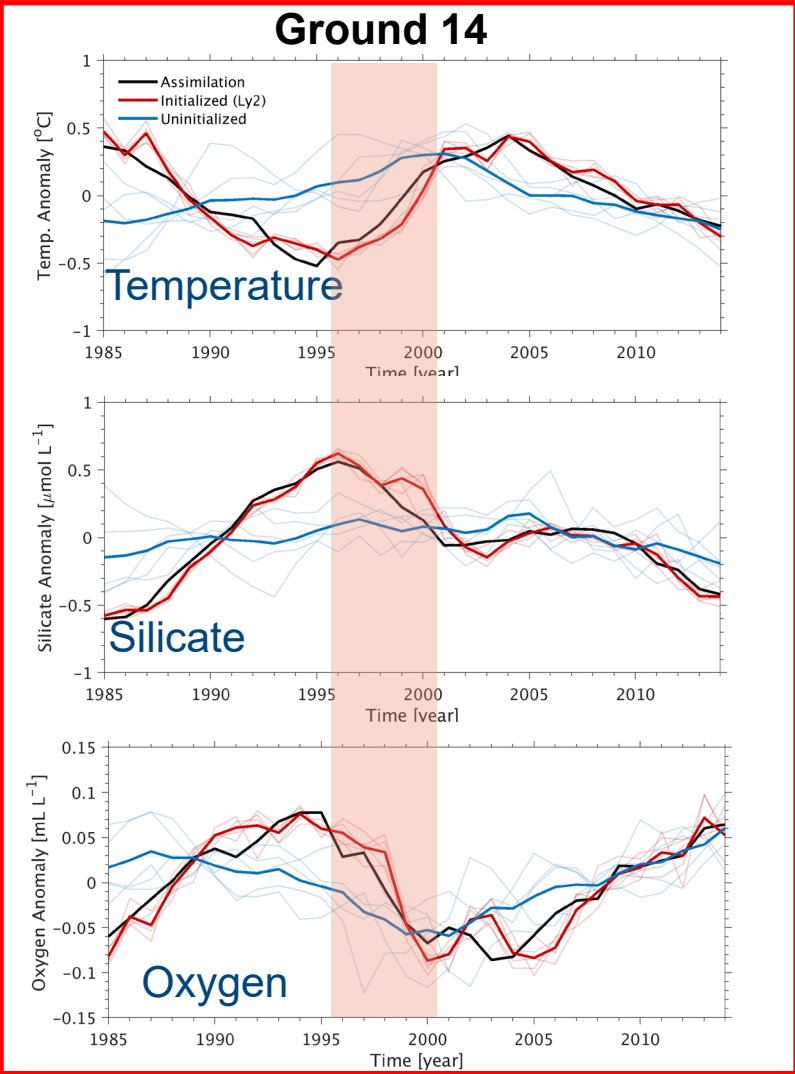
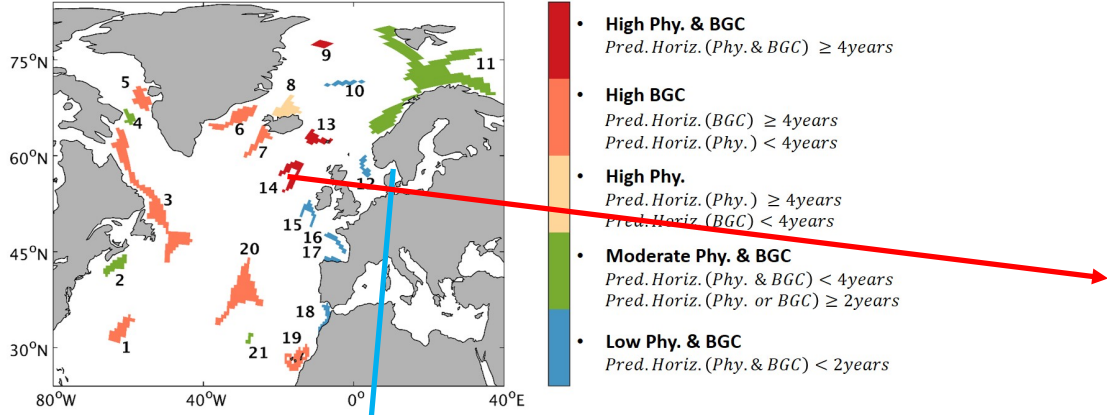
1. Remarkable spatial difference
2. BGC > Phy.

Five categories of predictability



- **High Phy. & BGC**
Pred. Horiz. (Phy. & BGC) \geq 4years
- **High BGC**
*Pred. Horiz. (BGC) \geq 4years
Pred. Horiz. (Phy.) $<$ 4years*
- **High Phy.**
*Pred. Horiz. (Phy.) \geq 4years
Pred. Horiz. (BGC) $<$ 4years*
- **Moderate Phy. & BGC**
*Pred. Horiz. (Phy. & BGC) $<$ 4years
Pred. Horiz. (Phy. or BGC) \geq 2years*
- **Low Phy. & BGC**
Pred. Horiz. (Phy. & BGC) $<$ 2years

Five categories of predictability – Applicability?



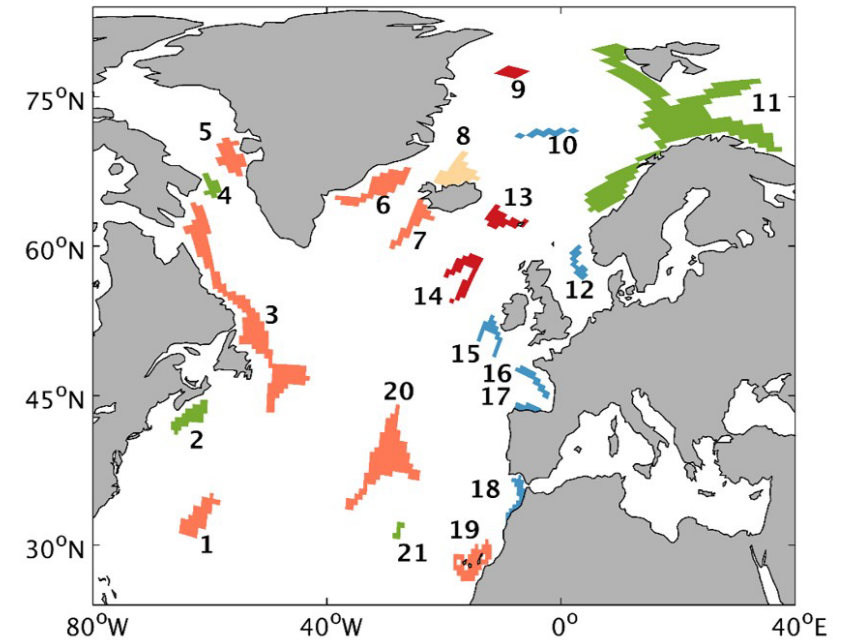
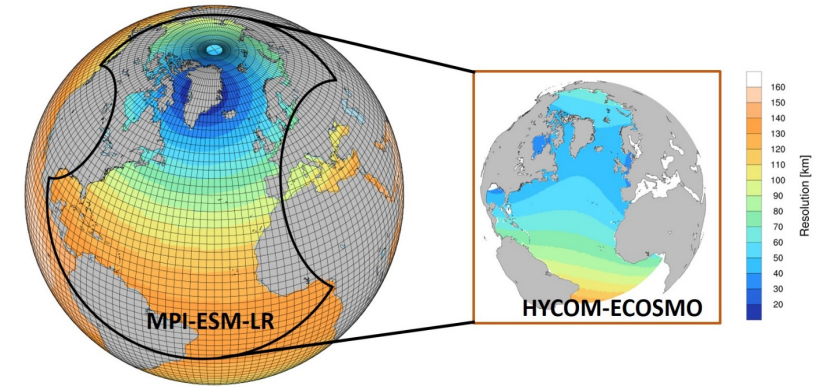
Multi-stressors?



(Guihen et al., 2012)

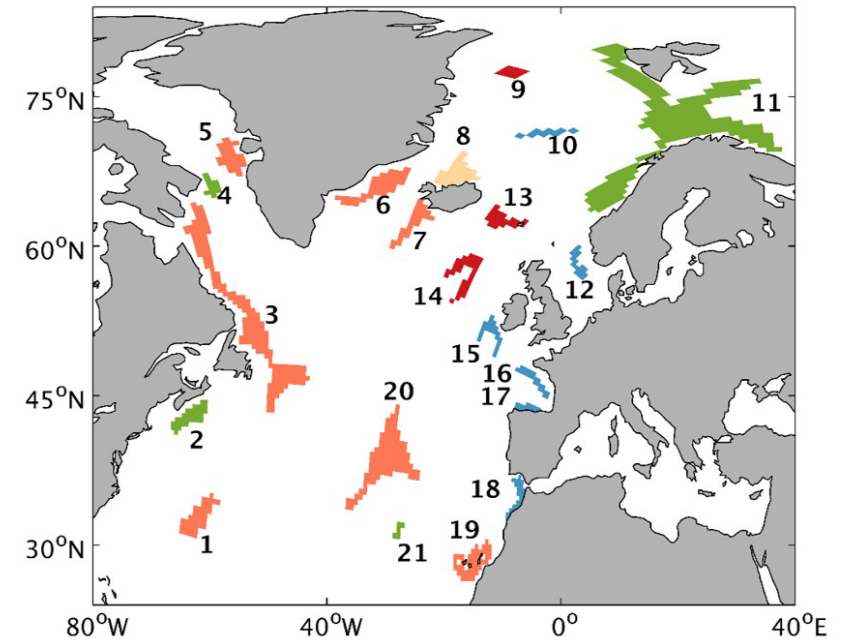
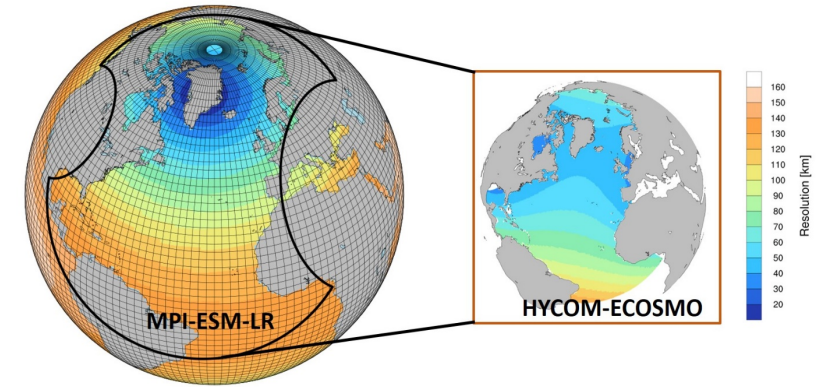
Summary

- A **dynamical downscaling** system is applied in the decadal prediction of deep-sea environmental properties at the sponge grounds.
- The predictability is subject to distinct regional differences:
 - high predictability** → ocean overturning structures (e.g. AMOC) that are regulated by large-scale climate variability such as the NAO or with the persistence of sea ice;
 - low predictability** → influence of the atmosphere or the Mediterranean outflow.
- Predictability: **biogeochemical** fields > **physical** fields.
- Predictability is significantly **improved by initialization** in areas with weak air-sea coupling and areas free from the influence of Mediterranean outflow.
- **The prediction system can be used as an important part of an integrated approach towards the preservation and sustainable exploitation of the North Atlantic sponge habitats.**



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Thanks!