

PML

Plymouth Marine
Laboratory

Marine Matters

Towards an integrated forecasting system for pelagic fisheries (WP 3.1.3a)

MyOcean Science Days, Toulouse, 01/02 December 2010

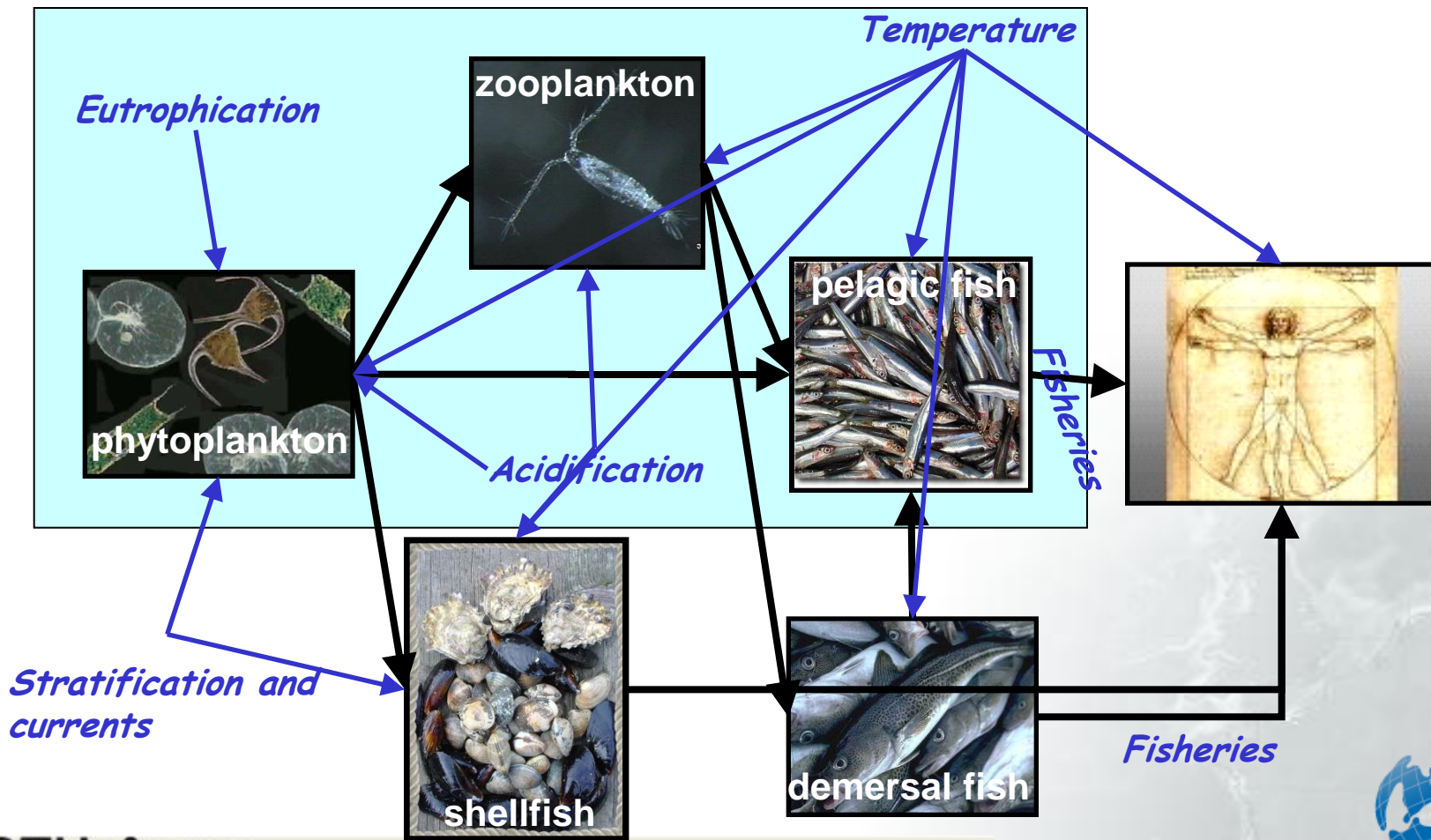
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DTU Aqua

National Institute of Aquatic Resources

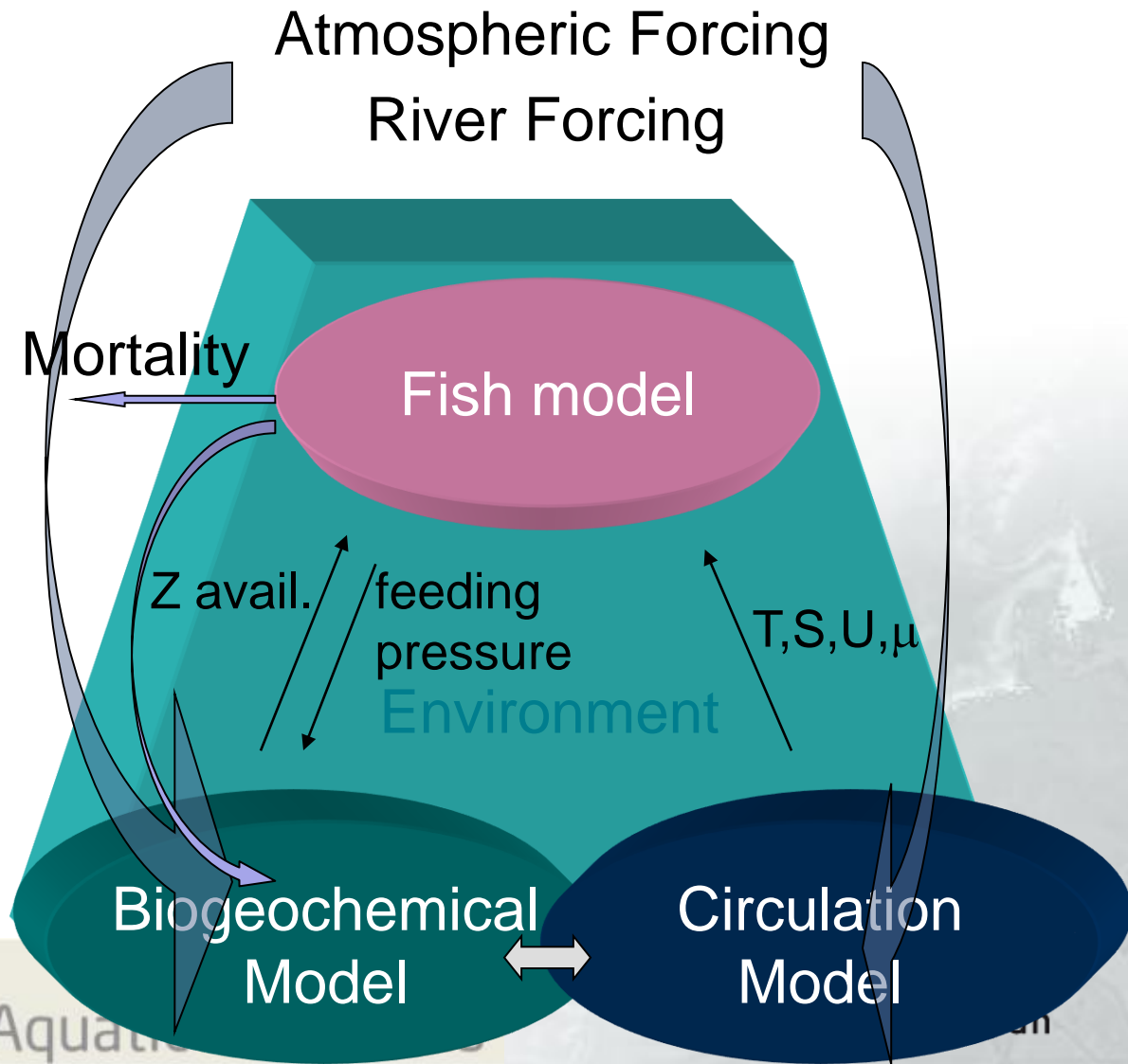


Marine ecosystem change: a multiple driver problem



Coupled System

- Zooplankton biomass -> food availability.
- Feedback through predation pressure.
- Interpolations from biogeochemical model to locations of fish-model.
- Synchronise time stepping.
- Parallelisation: establish processes for fish model running in parallel with biogeochemical model.



Coupling models for biogeochemical dynamics with fish-population models

- Biogeochemical models resolve ecosystem up to zooplankton level.
- Fish models' lower trophic boundary at prey availability.
- Problem: Lagrangian vs. Eulerian description.

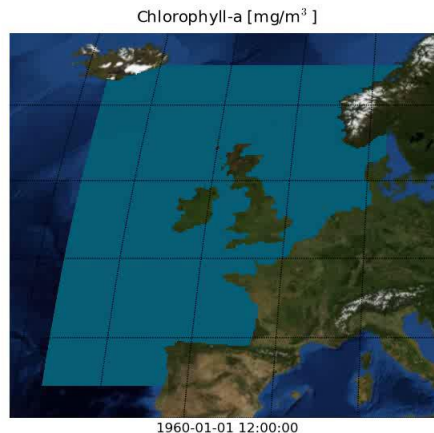
The Atlantic Margin Model

POLCOMS

- 3D baroclinic model
- FTCS differencing
- Time splitting
- Piecewise-parabolic advection
- Mellor-Yamada turbulence closure

ERSEM

- Carbon based
- Functional group approach
- Resolves microbial loop and POM/DOM dynamics
- Includes benthic system
- Explicit decoupled cycling of C, N, P, Si and Chl.

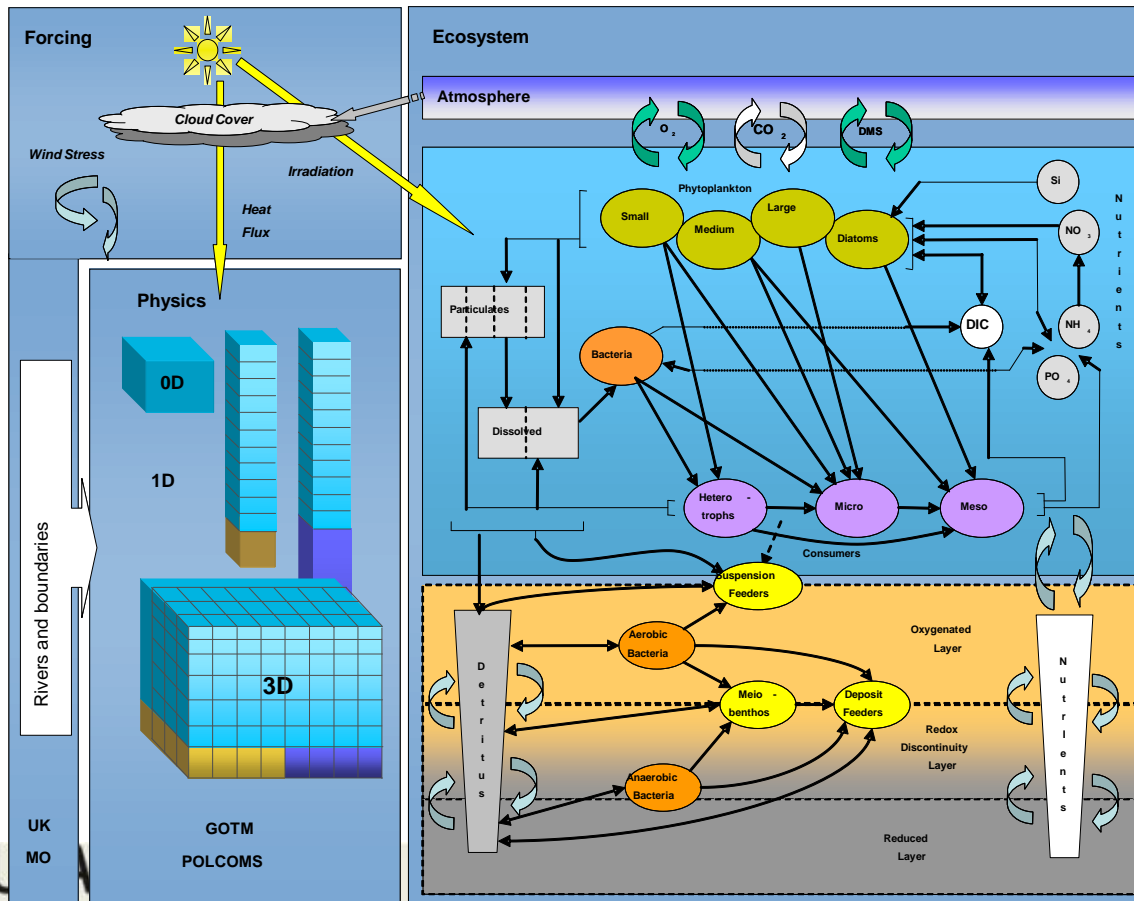


- 1.8 Mill. Grid points
- Resolution: ~12km
- Runtime ~30'-1h/month on 64 nodes
- Research version of MyOcean v0

• Forcing

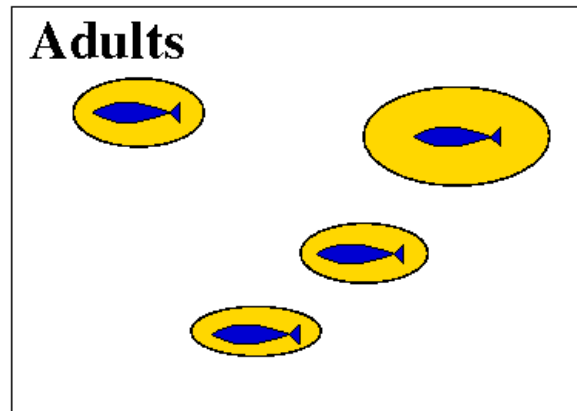
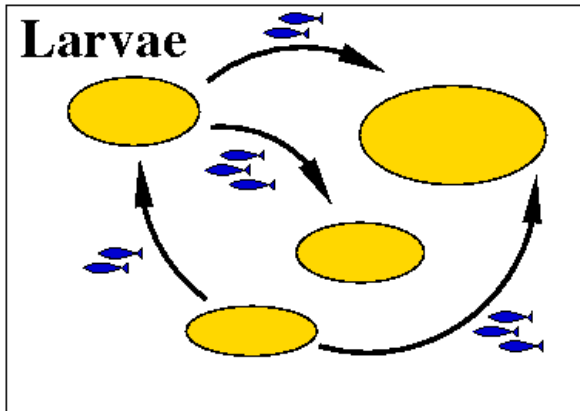
- Atmosphere: ERA40 extended
- Open ocean: ORCA reanalysis (ESSC)
- Rivers: CEH+Global river discharge database
- SPM and POM adsorption relaxed to climatology

Lower Trophic Level Model: ERSEM (PML version)



- Carbon based process model
- Functional group approach
- Resolves microbial loop and POM/DOM dynamics
- Complex suite of nutrients
- Includes benthic system
- Explicit decoupled cycling of C, N, P, Si and Chl.
- Iron dynamics optional

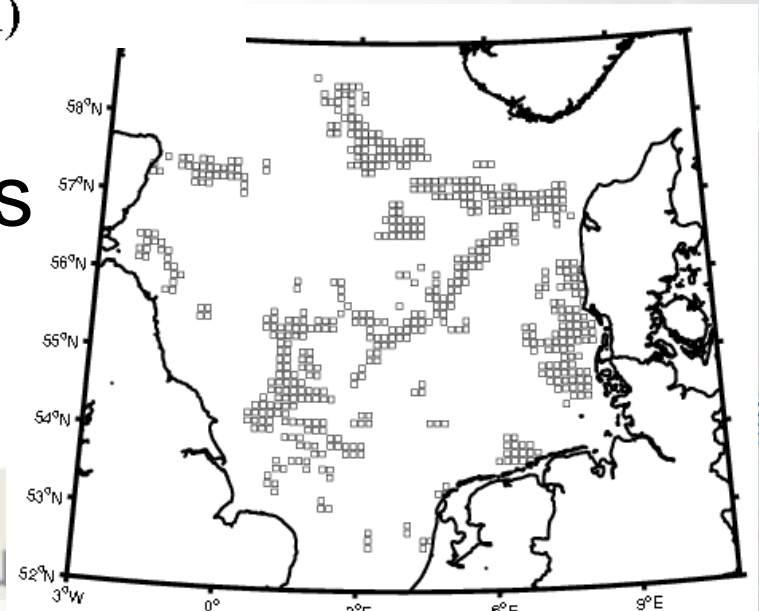
Sandeel life cycle modelling



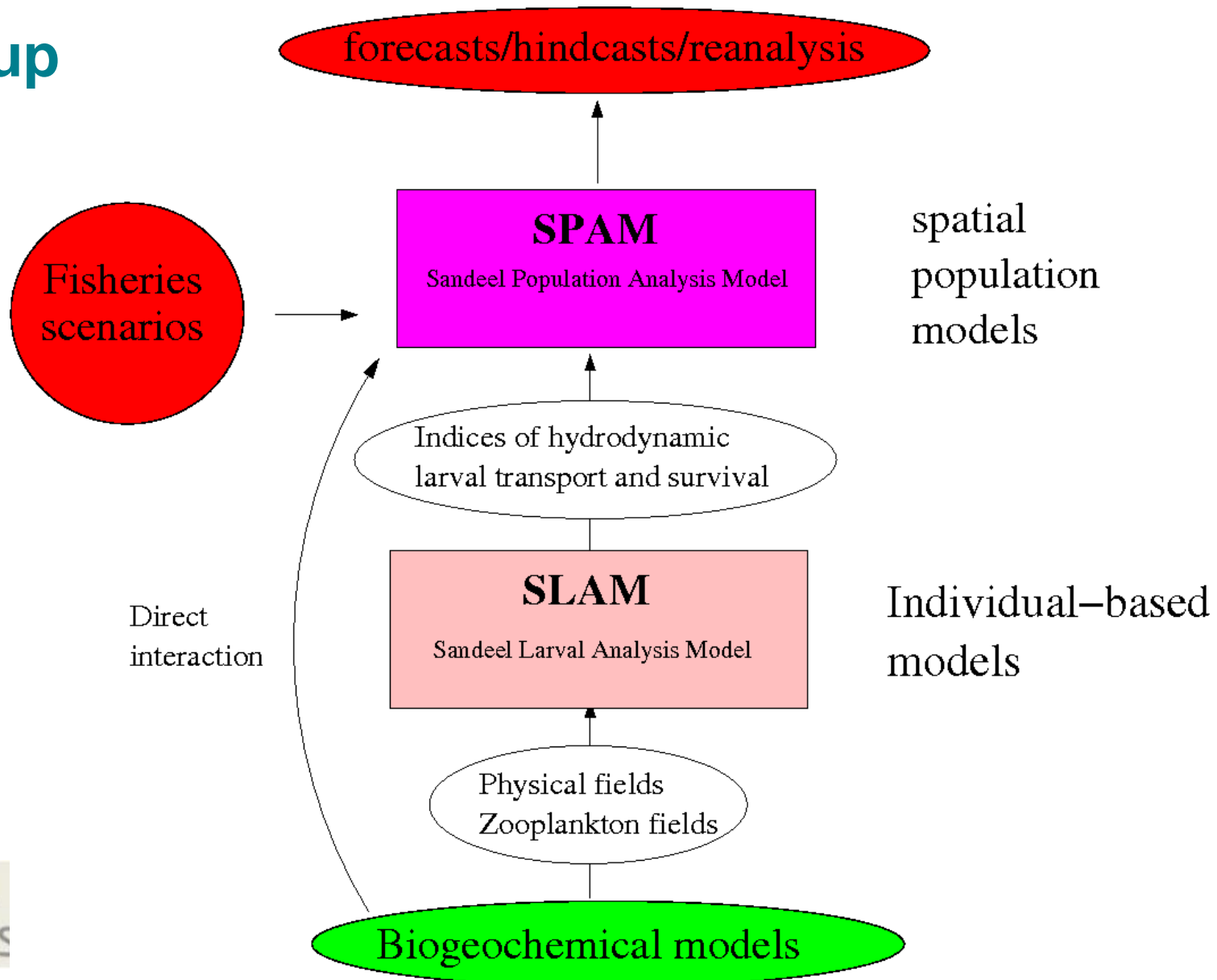
**Individual-based models
(SLAM)**

**spatial population models
(SPAM)**

**Sandeel habitats
mapped**

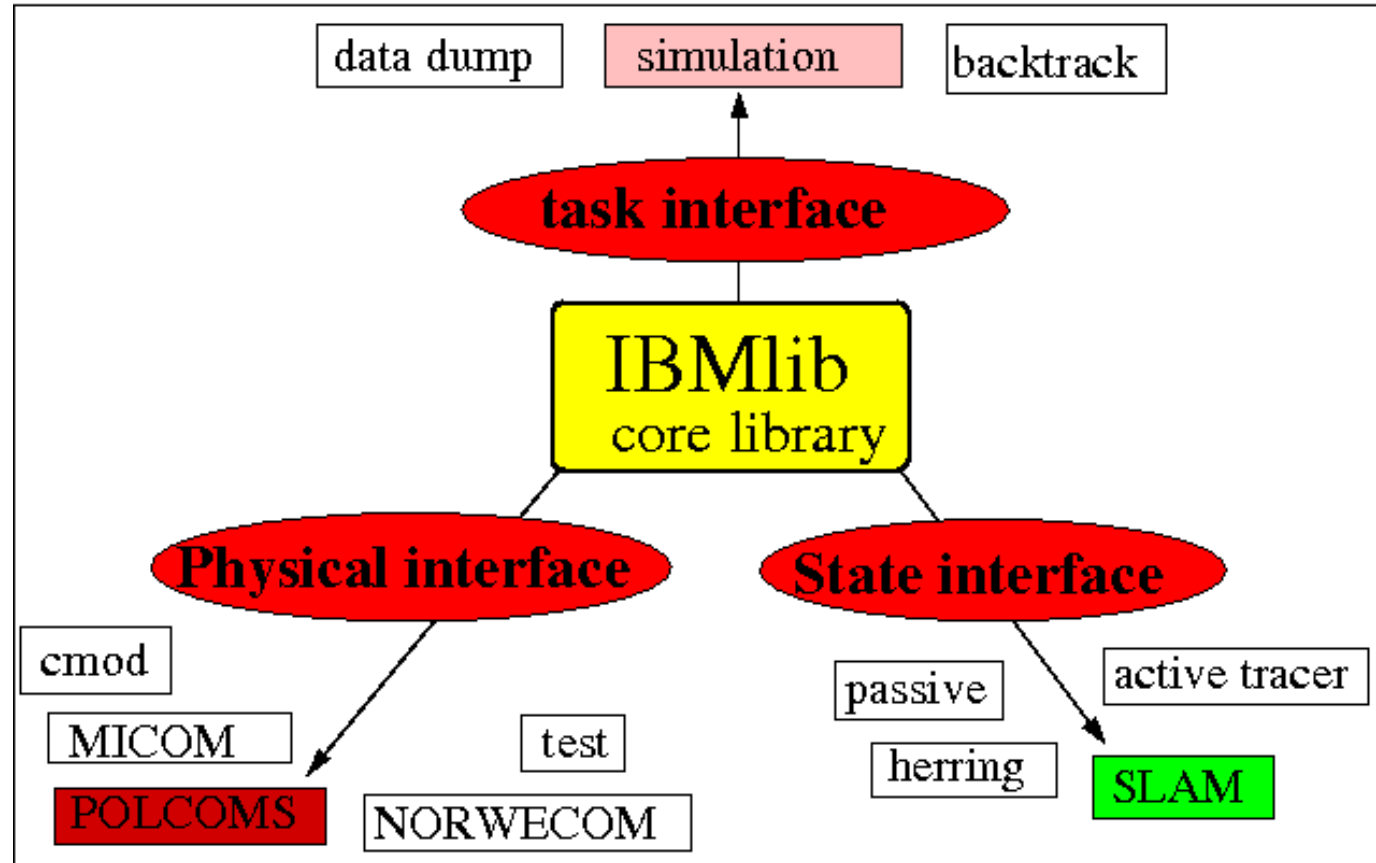


Model setup



Individual-based model

- SLAM is based on generic toolbox IBMlib

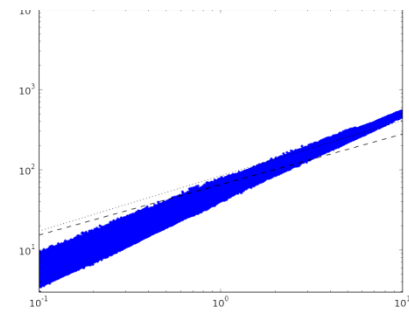
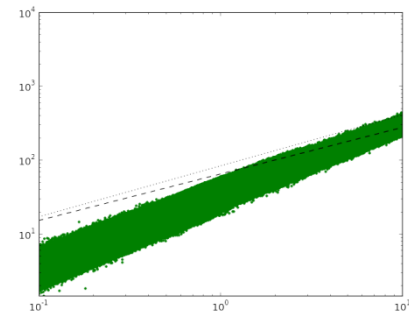
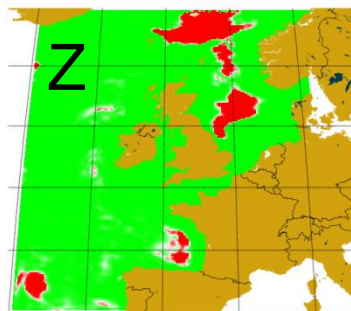
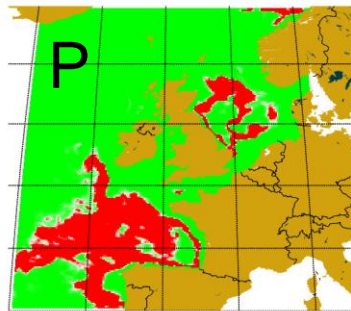


ERSEM parameterisation – improving emerging properties

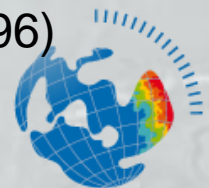
Revised parameter set to improve ecosystem functioning

T-test

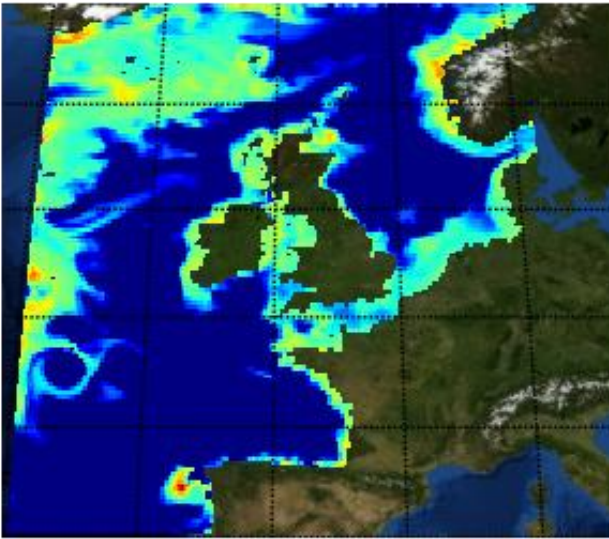
Are the 2 sets statistically separable



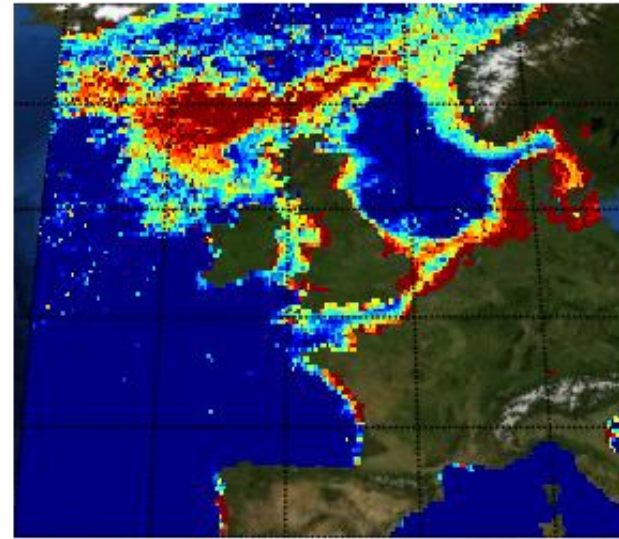
C to Chl ratios of the model compared to published data regressions (Sathyendranath et al. 2009 & Buck et al. 1996)



Model skill



Model



SeaWiFS

Model skill spatially resolved (wavelets)

Method:

Transform model and satellite data into cut-off based binary maps.

Aggregate signal pixel-wise to decompose spatial scales

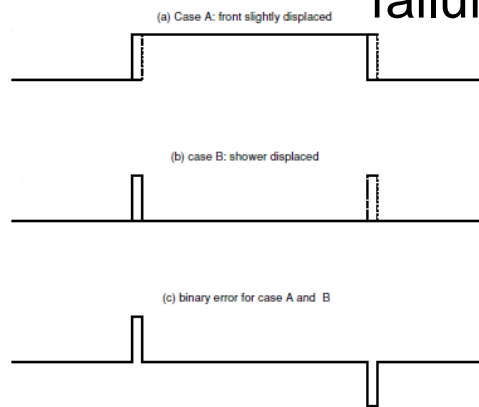
Analyse for each scale, e.g. through metrics

Skill-coefficient used (Casati e al. 2004):

$$SS = 1 - \frac{MSE}{2f(1-f)}$$

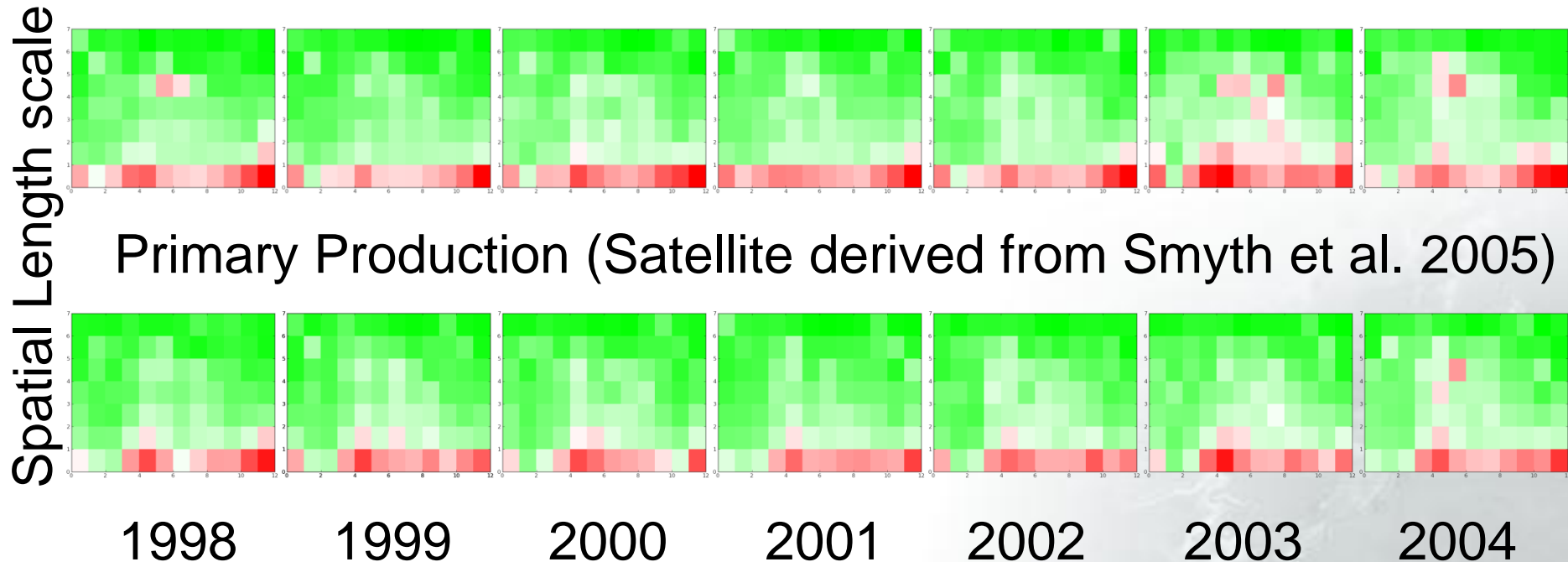
f: fraction of “True” pixels

Avoids overstressing of small displacements of large features vs. failures in predicting small scale features



Model skill spatially resolved (wavelets)

Chlorophyll-a



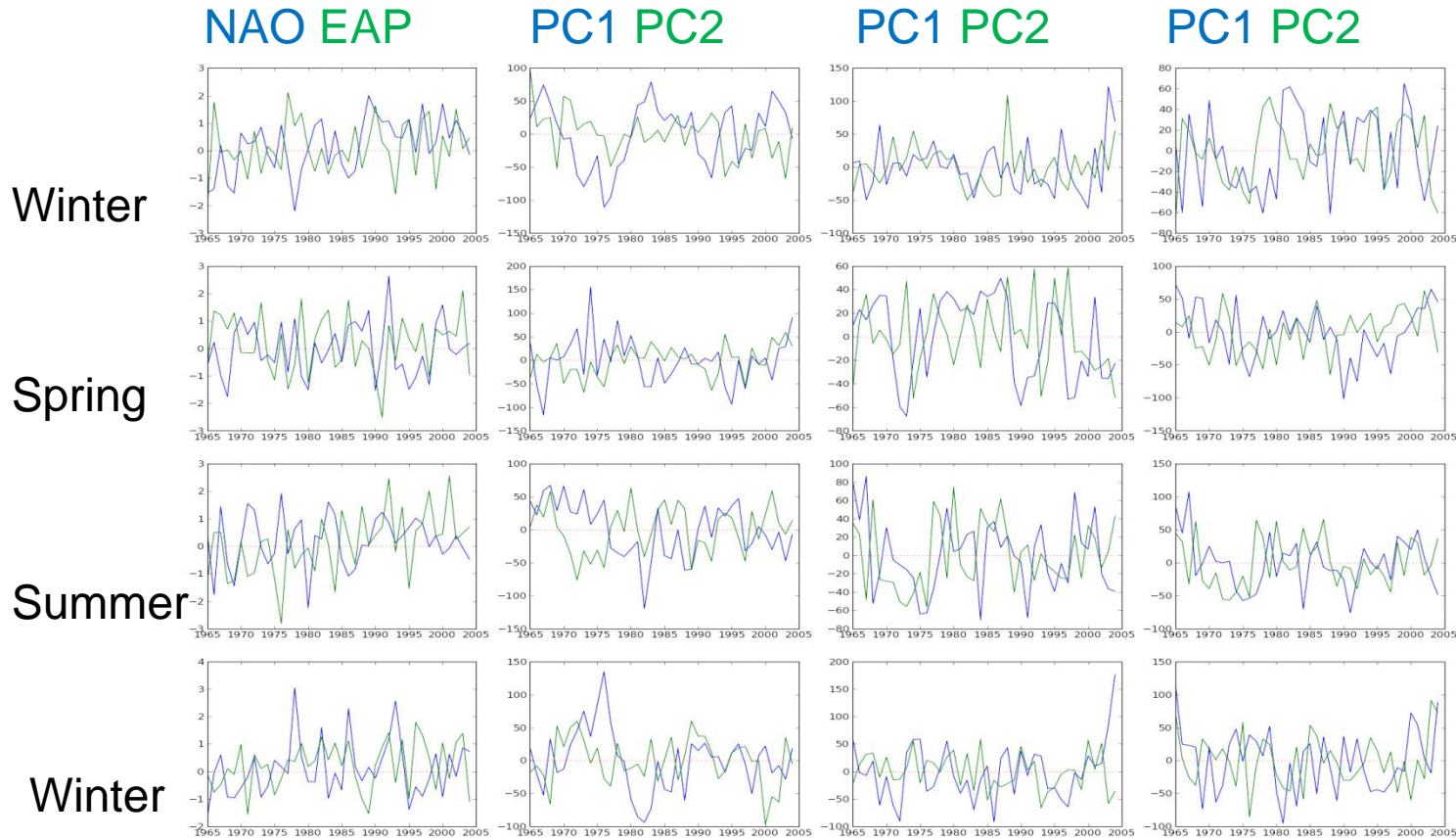
Primary Production (Satellite derived from Smyth et al. 2005)

Cutoff: IQR

How does the climate signal propagate through the ecosystem?

Identification of major pathways.

PCA scores



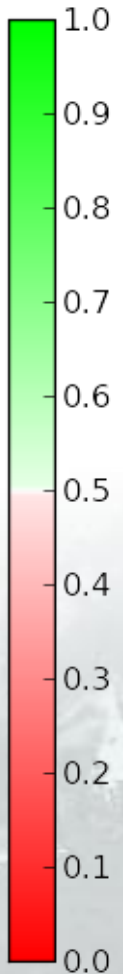
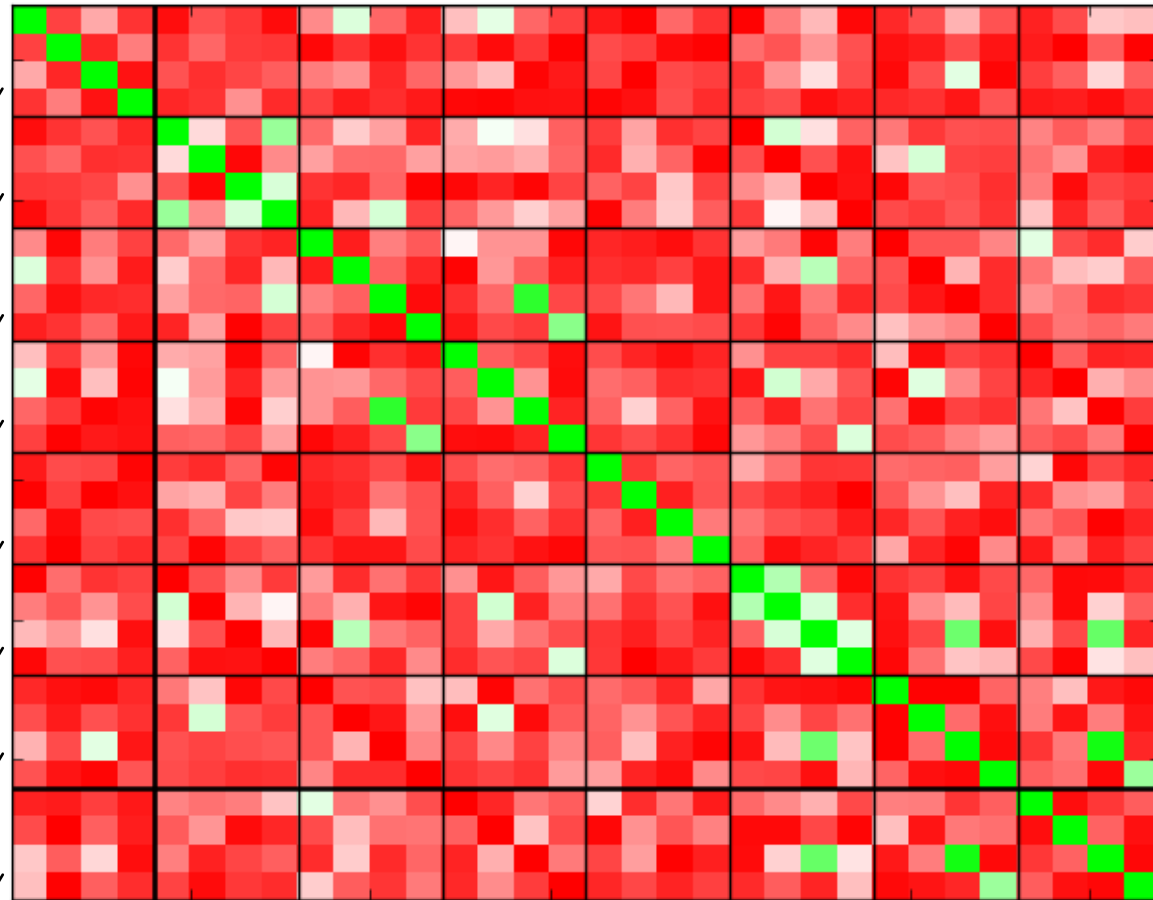
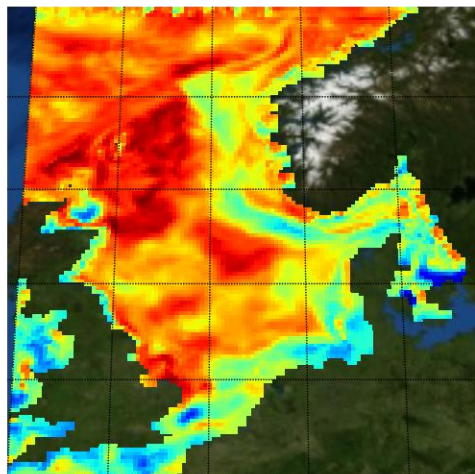
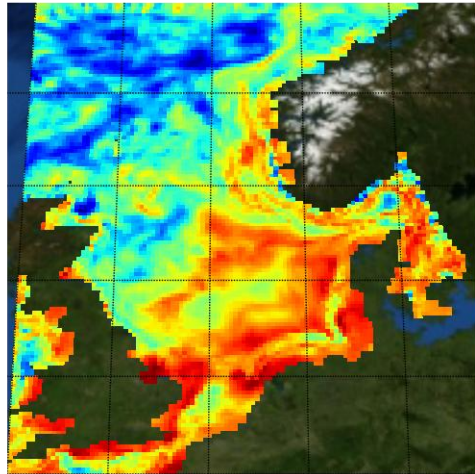
NAO and EAP from NOAA CPC



How does the climate signal propagate through the ecosystem?

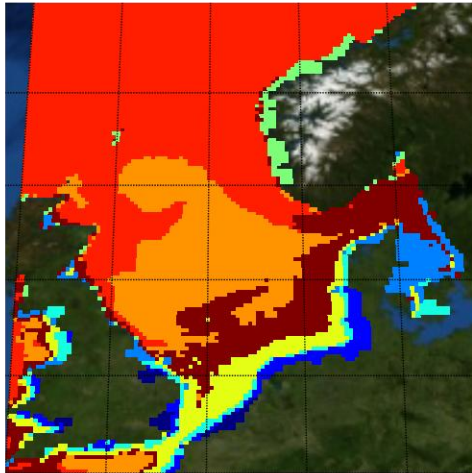
Identification of major pathways.

Score correlation matrix

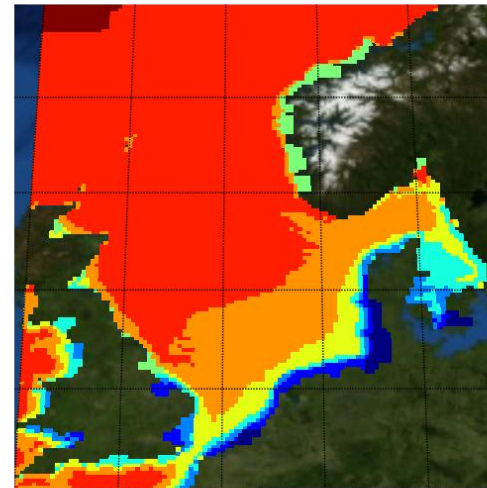


Classification based on ERSEM results

Self Organising Maps – non-supervised neural network algorithm

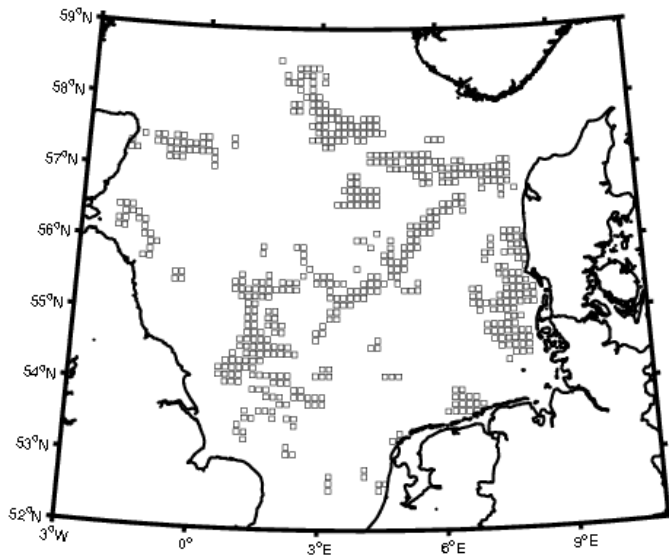


Phytoplankton

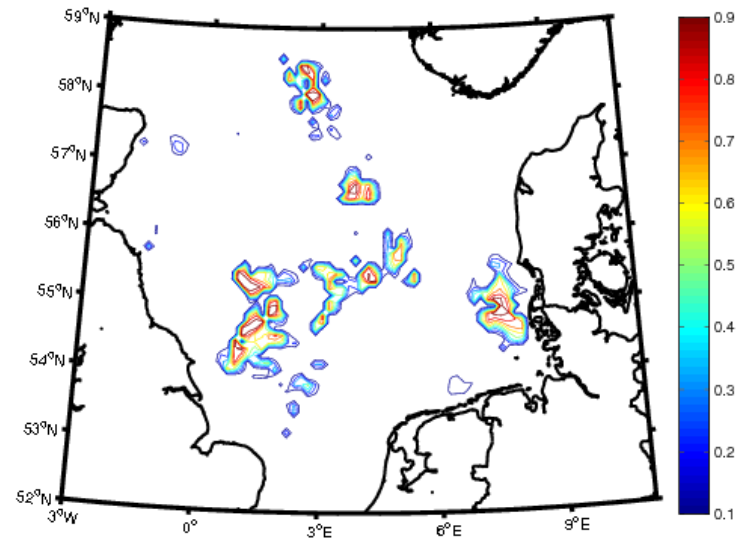


Zooplankton

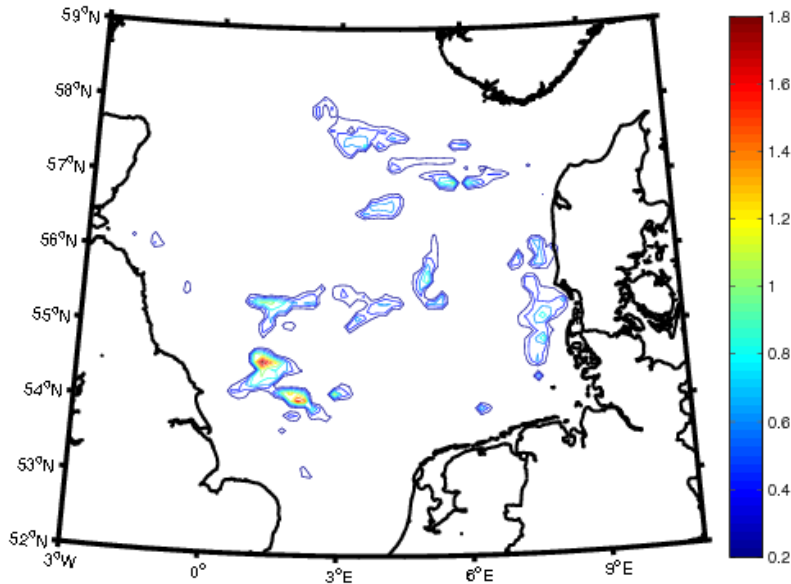
Results of coupled POLCOM-ERSEM-SLAM run (2004)



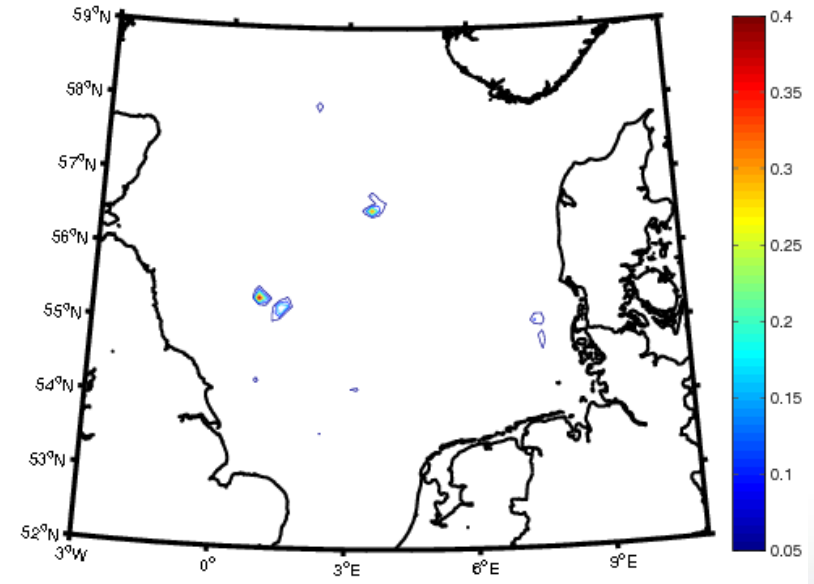
Mapped habitats



Hydrodynamic transport success for larvae



Transport sink index



Transport retention

- Framework build for fish stock forecasts:
POLCOMS/ERSEM → SLAM ↔ SPAM
- Spatial advice on maximal fishing pressure possible
- Optimal design of fisheries management areas