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SHELF SEA BIOGEOCHEMISTRY
www.uk-ssb.org

Integrative modelling for Shelf Seas Biogeochemistry

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on behalf of WP4

Winchester
5th June 2017

National Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

Cefas

Met Office

Marine Ecosystems Research Programme

Ecosystem Services

1. Described
by ecosystem model

Marine Ecosystem

Components
Habitats
Functional diversity

Processes
Production
Decomposition
Foodwebs
Ecological interactions

2. Emergent properties
of ecosystem model

Intermediate Services

Supporting
Primary production
Nutrient cycling
Oxygen

Regulating
Biological control
Carbon sequestration

3. Informed by
ecosystem model

Final Services

Provisioning
Fish & Shellfish
Seaweed

Regulating
Climate regulation

Cultural
Healthy environment

The overarching scientific goal is to enhance our capacity to assess the physical, chemical and biological controls on biogeochemical cycling and hence to quantify with uncertainties the budgets of C, N, P, Si including their response to climate, natural variability and anthropogenic stress, with a focus on the NW European Shelf.

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Joint vision for SSB and MERP

SHELF SEA BIOGEOCHEMISTRY
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carbon cycle

nutrient cycles

Marine Ecosystems Research Programme

benthic fauna

variable stoichiometry

A traceable and scalable model hierarchy based on size and function

Spatial scales and connectivity

Vertical Mixing

TEP

Size spectra

Biodiversity

Grazing

Advective sediments

Benthic C Chemistry

Linking to higher trophic levels

Generic bacteria

N fixers, N2O, Si, DMS(P)

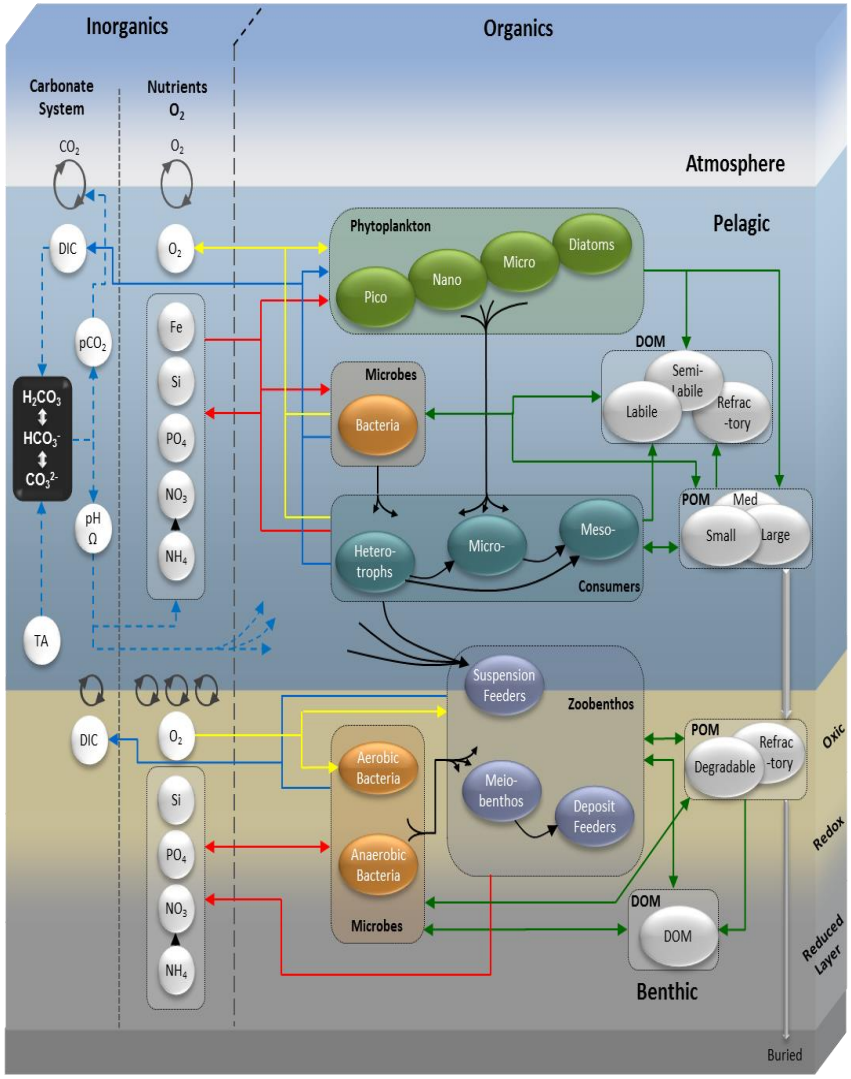
Life history, size and stage structure, meroplankton

Mixotrophy

Bioturbation

Resuspendable fluff layer

ERSEM: SSB-v0

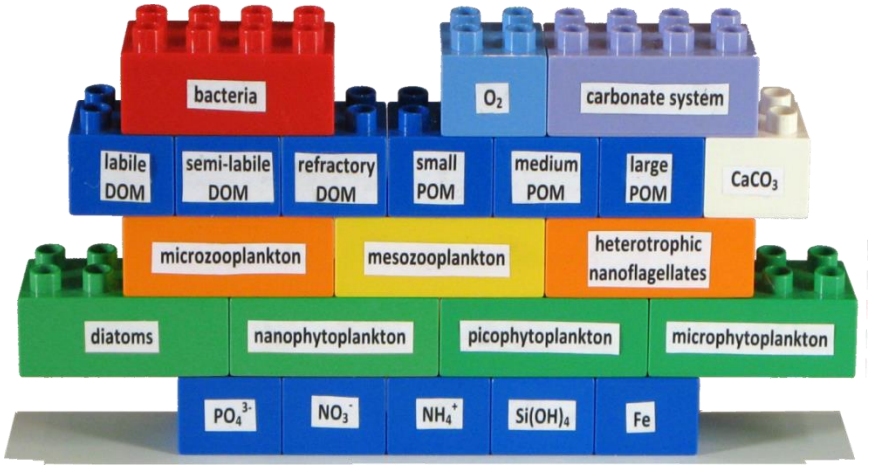


ERSEM v16.06

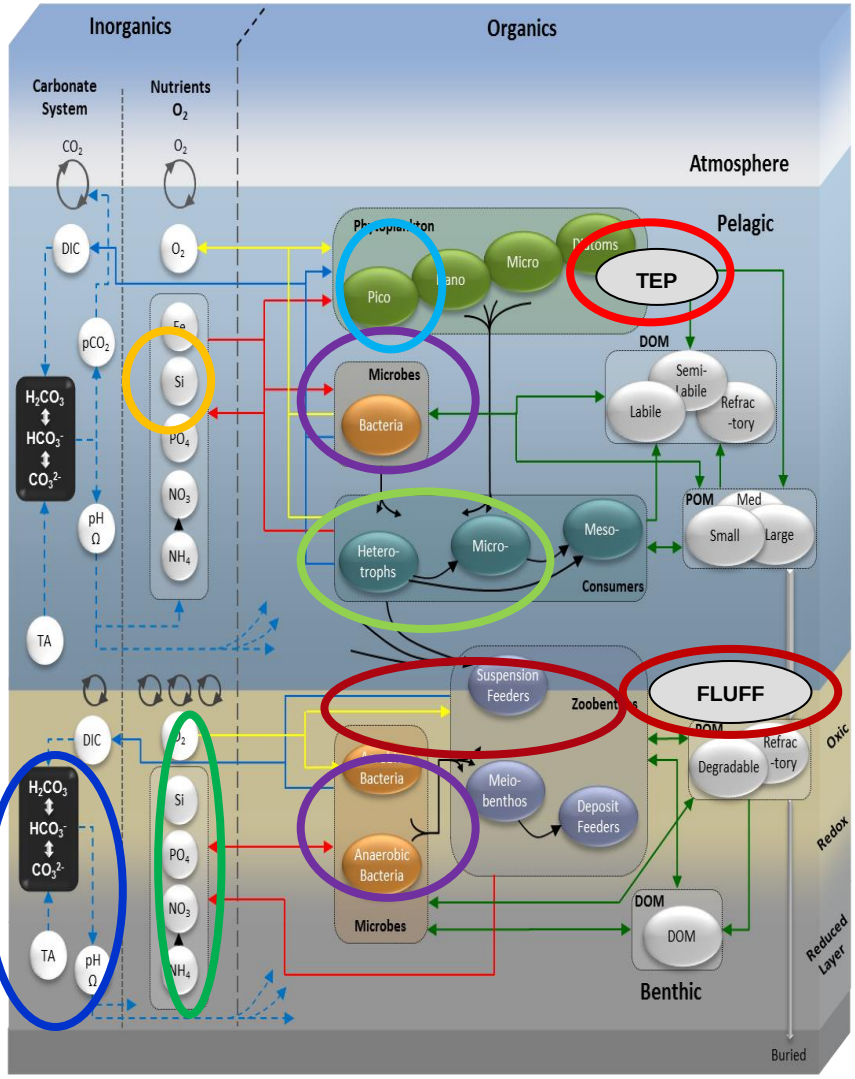
Equivalent to ERSEM v15.06 but in FABM

Allows for flexible configuration

Used in the 2 SSB modelling workshops



ERSEM: SSB-v1 & v2



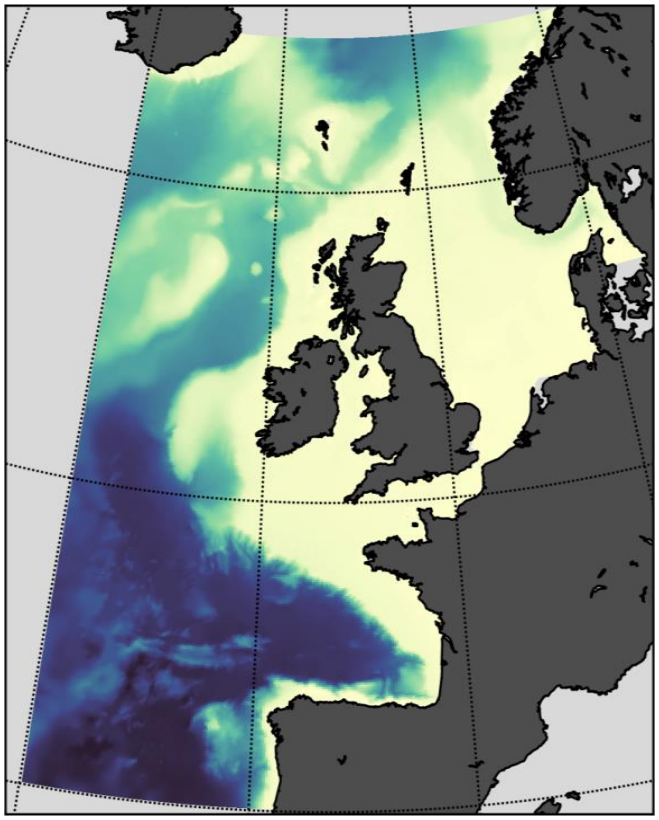
Major updates: V1

- TEP
- SMP
- Pelagic Si remin.
- Fluff layer
- Benthic carbonate

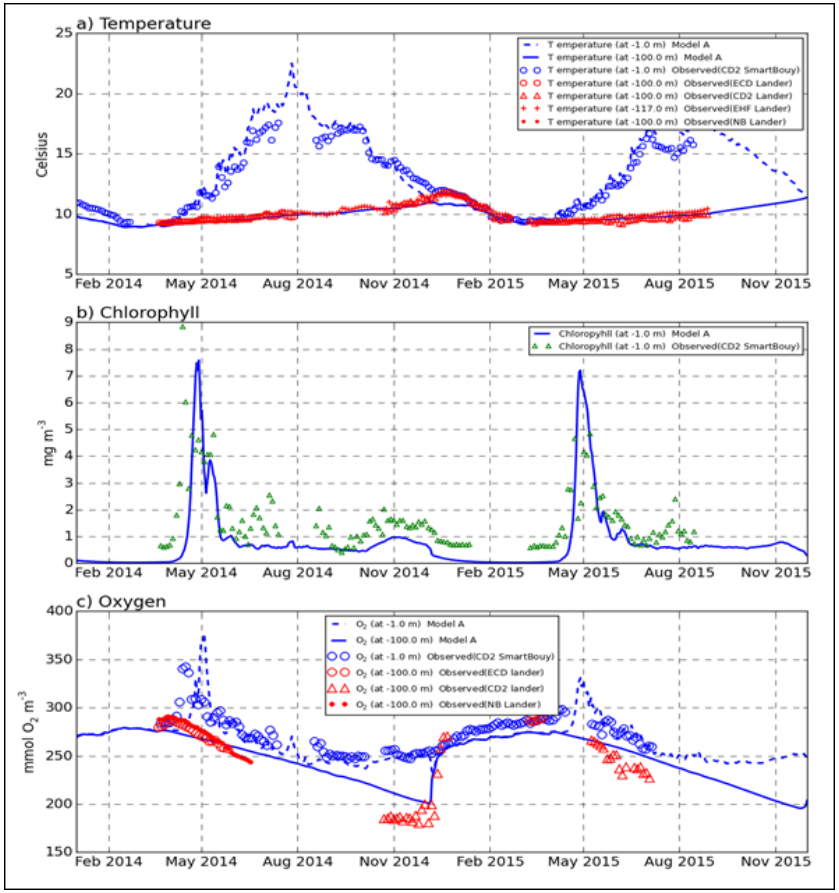
Major updates: v2

- Generic Prokaryote
- N fixers/N20
- Benthic redox
- Macro faunal predators

Model Hindcast and Validation



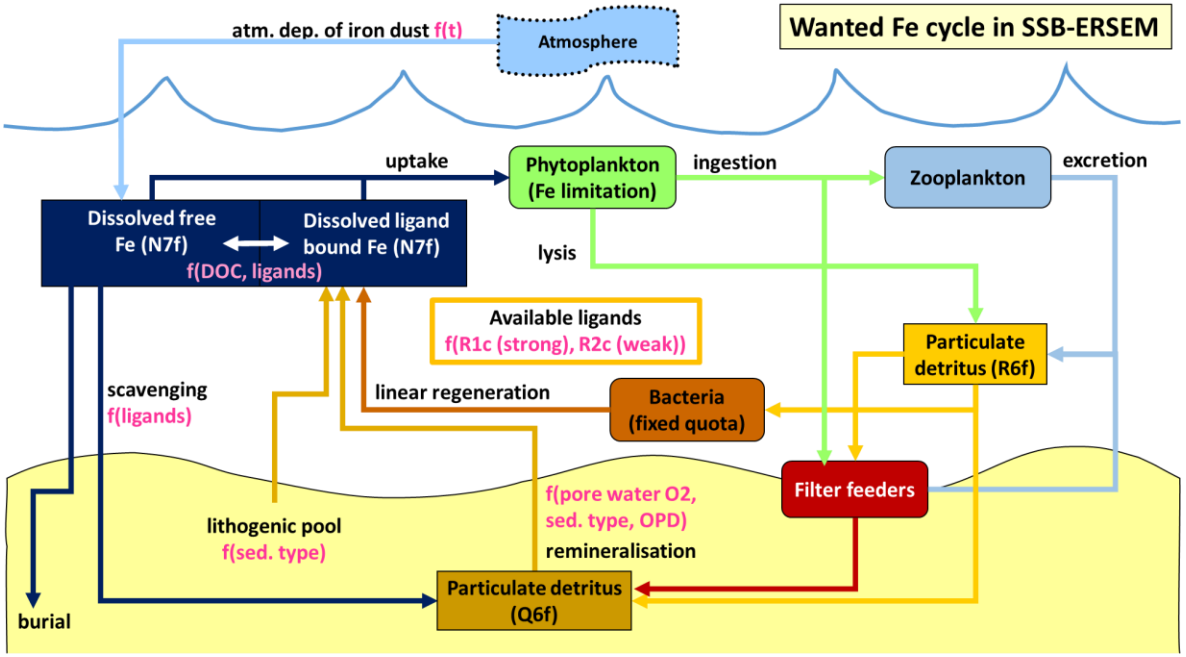
Model Validation at Celtic Deep.



See AMM7 hindcast: validation and major biogeochemical dynamics (WP4) *Yuri Artioli et al and* ERSEM model comparisons with SSB observations: benthic oxygen dynamics (WP4, WP2 & WP1) *John Aldridge et al*

Progress Towards Addressing Hypothesis

H1: *The post bloom flux of particulate material into the benthos drives the release of Fe back into the pelagic system during the summer and hence the export of Fe off the shelf (WP3)*



See Update on iron modelling (WP4 & WP3*) Sonja van Leeuwen et al*

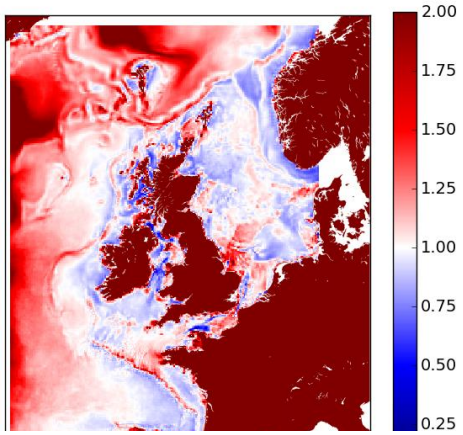
With respect to progressing this work, we have:

- Joint workshop with WP3
- Pooled WP3 Fe data to help with validating the model
- Tested existing Fe phytoplankton parameters against available data – some of these will need updating, since they are not appropriate for shelf sea taxa
- Performed simple runs using the old Fe model at L4 (JC) and at the WP3 sampling sites (SVL)
- Implemented an improved parameterisation of scavenging (LP), but n ot yet tested in 1D .

Progress Towards Addressing Hypothesis

H2: *The shelf sea carbon pump is driven by an imbalance between C:N or C:P in inflowing and outflowing waters. I.e. the shelf sea carbon pump arises not because shelf seas are highly productive (which is not necessarily true at a shelf scale), but because they have internal mechanisms that generate this imbalance (WP1, 2, 5).*

We have the simulation ready to explore this (hindcast v0), Analysis of C:N fluxes to start summer 17. of the C:N fluxes before the meeting, See AMM7 hindcast: validation and major biogeochemical dynamics (WP4) *Yuri Artioli et al*

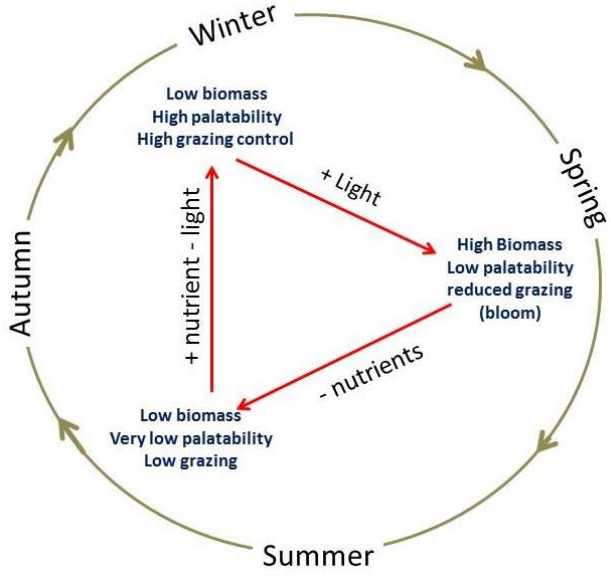


N uptake from phyto/ local sources
(blue=source provide more N than needed by phyto;
red=phyto need external sources of N, ie. advection)

H3: *Autotroph community structure and resource availability significantly influence the stoichiometry of organic matter through increasing C:N:P:Si ratios under nutrient depleted conditions and hence the redox conditions of the benthic system. (WP1, 2, 3).*

See Phytoplankton stoichiometry: the (missing) link between grazing and recalcitrant DOM production (WP4) *Luca Polimene*

Analysis of the hindcast planned for autumn 2017.



(Polimene 2016)

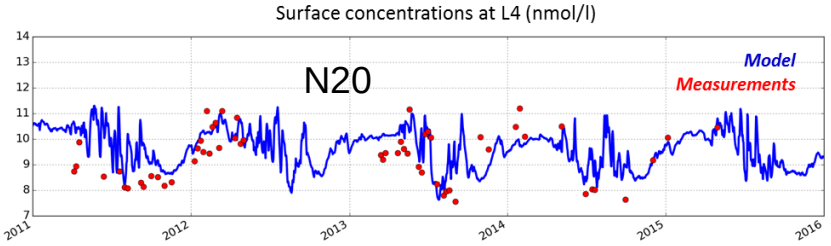
Progress Towards Addressing Hypothesis

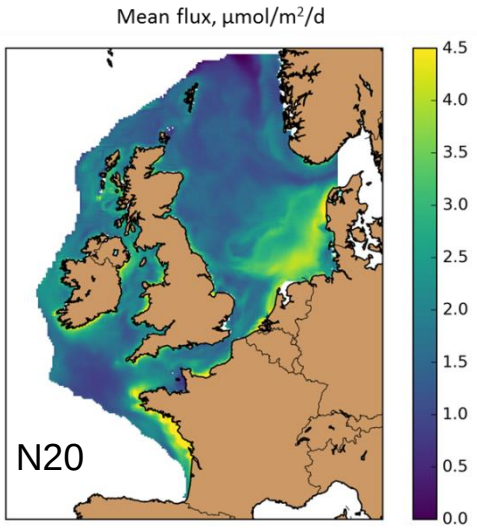
H4: *Calcification (both benthic and pelagic) exerts a significant impact on the shelf seas inorganic carbon budget. (WP5).*

Analysis of the hindcast planned for autumn 2017.

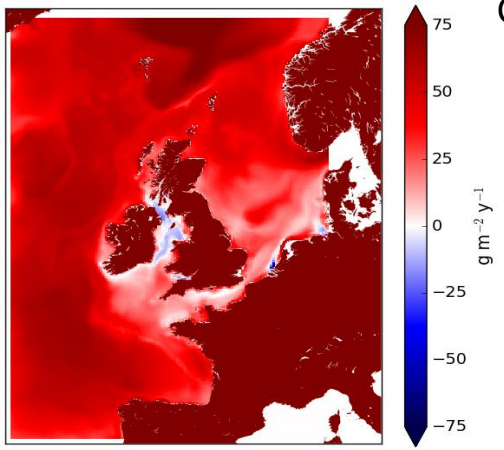
H5: *UK shelf seas are a source of N2O and a sink for CO2. (WP1, 5)*

See: Modelling shelf-wide air-sea fluxes of N_2O (WP4) *Gennadi Lessin*
Spatial distribution and carbon flux budgets in the hindcast runs (WP4)
Tiago Silva et al





Air –Sea Fluxes

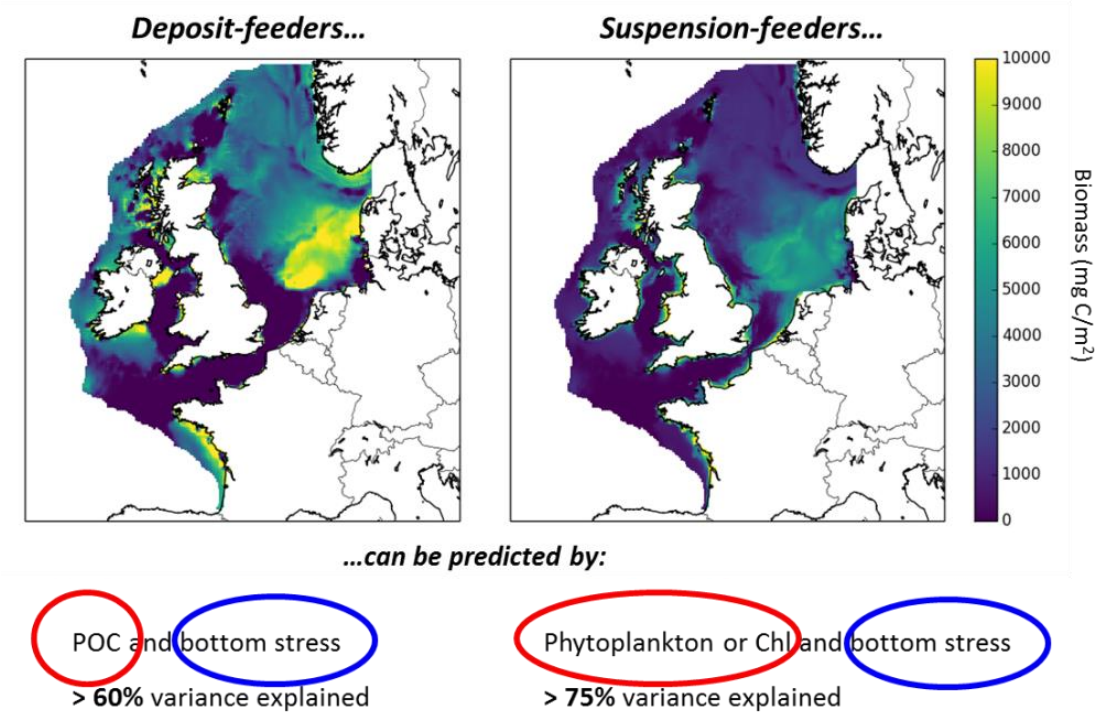


Progress Towards Addressing Hypothesis

H8: *Shelf scale biogeochemical budgets are sensitive to changes in physical processes (e.g. resuspension, advection though sediments, waves) acting at the benthic pelagic interface. (WP2).*

A first look the model including flow through permeable sediments doesn't big differences. Present parameterisations don't consider all the possible effects of pore water flow, so may be preliminary to draw any conclusions.

Further analysis underway



Progress Towards Addressing Hypothesis

H9: *Shelf seas biogeochemical budgets are sensitive to changes in benthic community structure and activity mediated by anthropogenic disturbance (e.g. trawling). (WP2)*

See poster by Artioli: Modelling impact of bottom trawling on carbon cycling*

***H10**: SSB ERSEM-NEMO has seasonal scale forecast skill (up to 6 months ahead).*

Code is in place to extract forcing fields from the GloSea5 seasonal forecast system to drive the NEMO-ERSEM NWS model. Next step is to extract initial conditions from the T3 historical NEMO-ERSEM run. Once these are ready a selection of case study years (high/mid/low production) will be run and skill examined for physical (Met O) and BGC (PML) variables.

A paper (Tinker et al.) on drivers of interannual variability in physical variables on the NW Shelf, based on analysis of the NWS reanalysis, is in advanced draft.