SYMPOSIUM OP'24 ADVANCING OCEAN PREDICTION SCIENCE FOR SOCIETAL BENEFITS

Developments in operational biogeochemical forecasting at the Met Office

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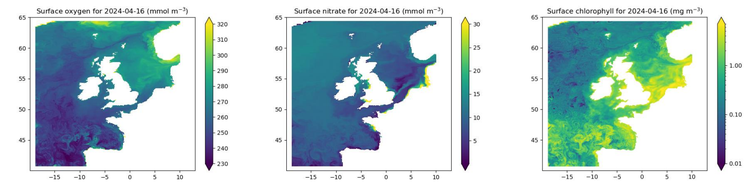


The Met Office provides a daily 5-day forecast and a multi-decadal reanalysis

- Northwest European Shelf Seas, 7km resolution.
- Modelling system: European Regional Seas Ecosystem Model (ERSEM) coupled to the Nucleus for European Modelling of the Ocean (NEMO).
- Assimilation of ocean colour chlorophyll, sea surface temperature, temperature-salinity profiles and sea level anomaly.
- Variables available (daily, depth-resolved): chlorophyll, primary production, phytoplankton biomass, nutrients, oxygen, pH, pCO_2 and light attenuation.
- Product quality documentation is available for both forecast and reanalysis products.


Met Office Marine Data Service

Atlantic- European North West Shelf- Ocean Biogeochemistry Reanalysis

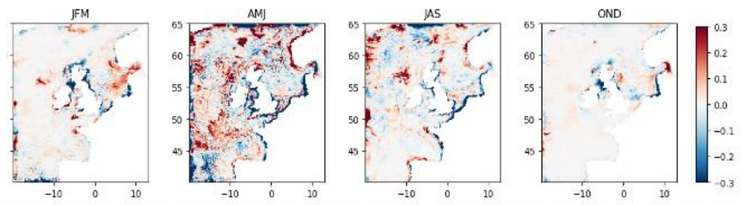
Recent developments

Assimilation of sea level anomaly has been introduced without degrading the biogeochemistry.

The following have been tested and are ready to be implemented in the next system upgrade:

- improved error covariances developed by Alison Fowler at the University of Reading (https://doi.org/10.1002/qj.4408).
- updated satellite-based climatology of the absorption coefficient for detritus and yellow matter, which helps to constrain the absorption of light by sediment and other non-modelled material.
- new output variables: zooplankton, DIC, total alkalinity, N_2O.

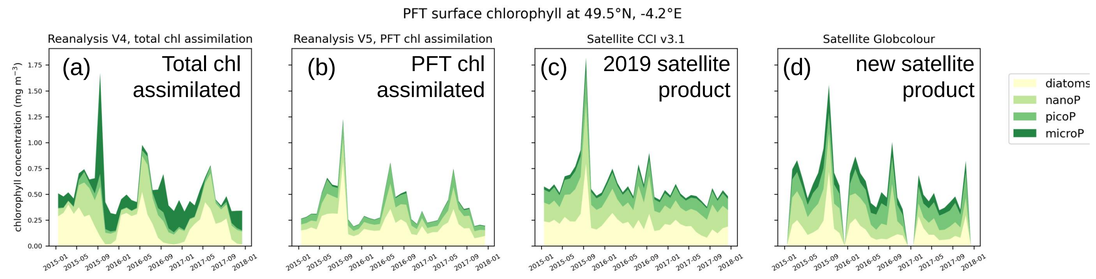
Difference in surface chlorophyll using the new error covariance compared to the standard.



Assimilation of Plankton Functional Type chlorophyll has been implemented in the reanalysis

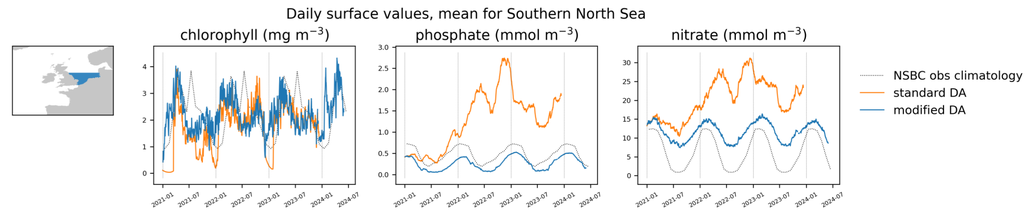
This gives a different community structure, more in line with satellite observations – but satellite observations vary.

The figure shows surface chlorophyll separated by PFT for a point south of Plymouth, as modelled in two versions of the Met Office reanalysis which assimilated (a) total chlorophyll and (b) PFT chlorophyll. The assimilated data came from (c) the ocean colour CCI v3.1 dataset; (d) a more recent Globcolour product shows a different distribution of PFTs.



Problem: nutrient accumulation in shallow seas

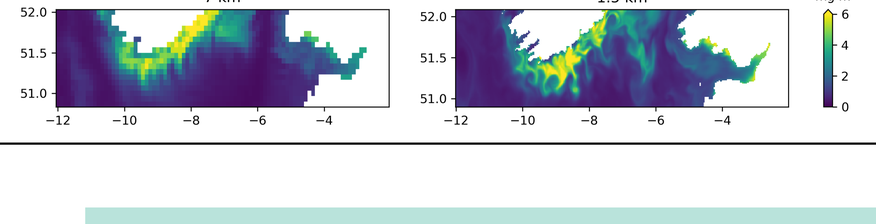
- We saw a rise in dissolved inorganic nitrate and phosphate in the southern North Sea and Irish Sea during 2022 and 2023.
- Our assimilation scheme updates plankton nitrogen and phosphorus as well as chlorophyll; over time this leads to in-water nutrients increasing.
- We have switched to updating only chlorophyll in waters less than 60 m deep; in the longer term we are seeking a better balancing scheme.



For the future: higher resolution

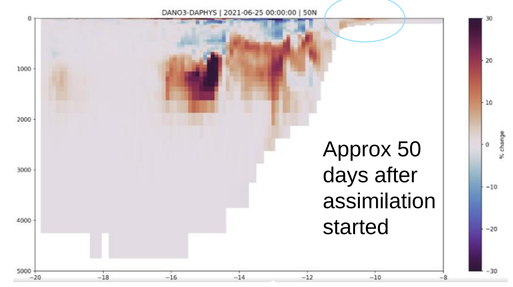
A physics-only model runs operationally at 1.5 km resolution. Adding biogeochemistry to this is computationally demanding, but we have completed multi-month test runs with and without data assimilation. Further work will explore options such as:

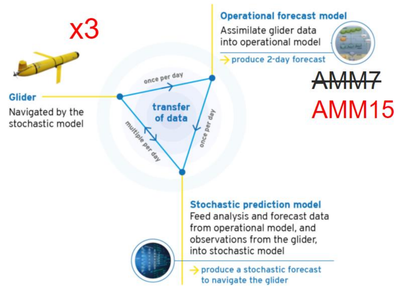
- More test runs following a computer upgrade later this year.
- Creating forecasts by advection, without BGC processes.
- A simpler version of ERSEM.
- Slower time-stepping for biogeochemistry than physics.
- Use of machine learning approaches to speed up forecasting.



For the future: assimilation of in situ data

Tests show that assimilation of BGC-Argo data affects cross-shelf transport of nitrate. The figure shows % change in nitrate when assimilating data from a float near the shelf break at 50 N.





This summer we participated in a demonstration digital twin mission led by PML. Glider data was assimilated and our forecasts used to influence the gliders' route.

The system builds on an earlier experiment described in Ford et al. (2022) https://doi.org/10.3389/fmars.2022.1067174

We are always interested to hear from users and potential users of our products. We would welcome any feedback from meeting attendees about the usefulness of our products and what you would like to see in future.

Met Office

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