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National Centre for Earth Observation
NATURAL ENVIRONMENT RESEARCH COUNCIL

Listen to the ocean

Multi-platform assimilation of physical and biogeochemical variables on the North-West European Shelf

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OPTIMA
Optical data Modelling and Assimilation

COPERNICUS MARINE ENVIRONMENT MONITORING SERVICE
CMEMS Service Evolution

CAMPUS

AlterEco

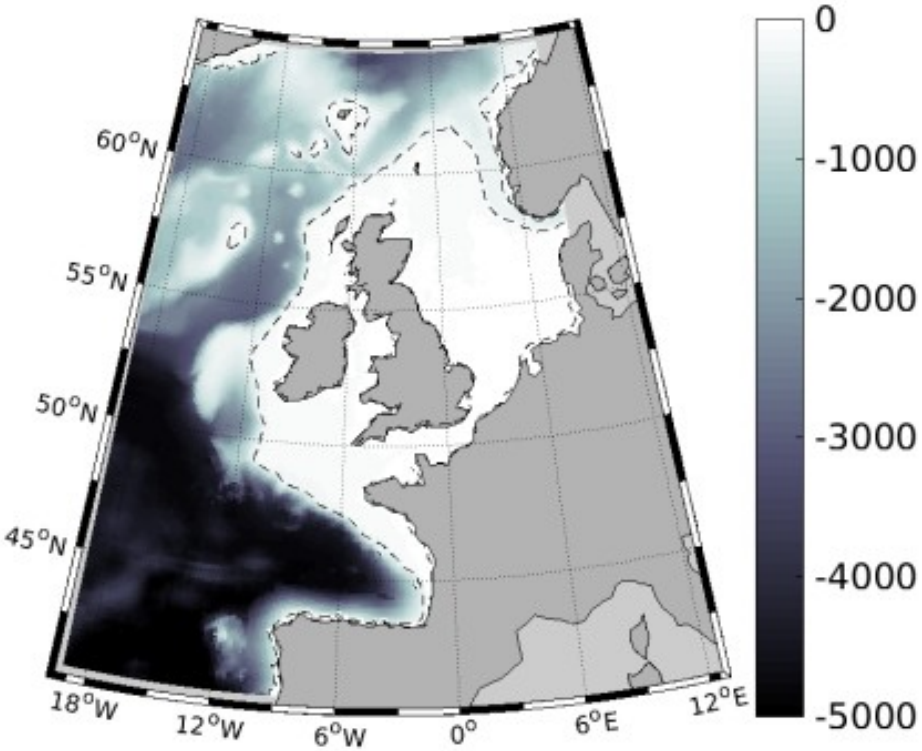
Met Office

UKRI Natural Environment Research Council

24-25 June 2020, NCEO virtual meeting,

North-West European Shelf

Critically important for European economy, food security, carbon cycle (climate change). It is essential to understand the human impact and the imopact of climate change on the ecosystem state.



Progress in observational oceanography

a) Remotely sensed observations: new missions, development of new algorithms: e.g optical absorption by phytoplankton functional types …

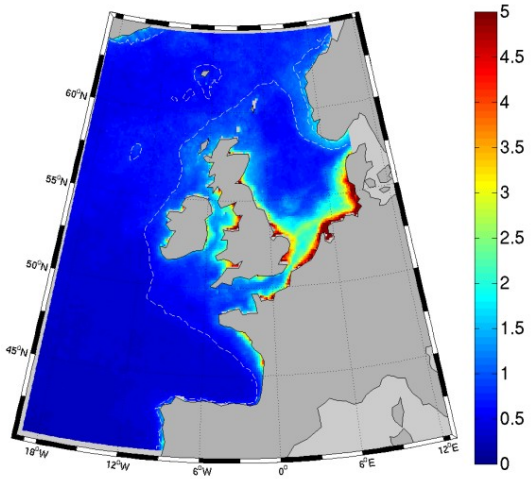
b) New observing platforms: recently deployed Argo float networks and other autonomous vehicles (e.g. gliders) aim at revolutionizing oceanography..

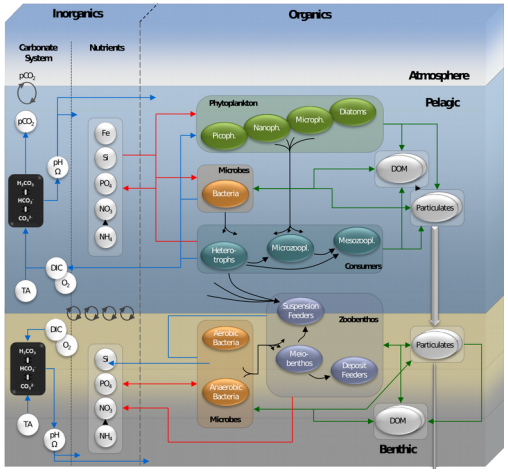
The new data expand both range of observed variables (e.g new algorithms) and regions where observations take place (vertical profiles observed by gliders, Argo)

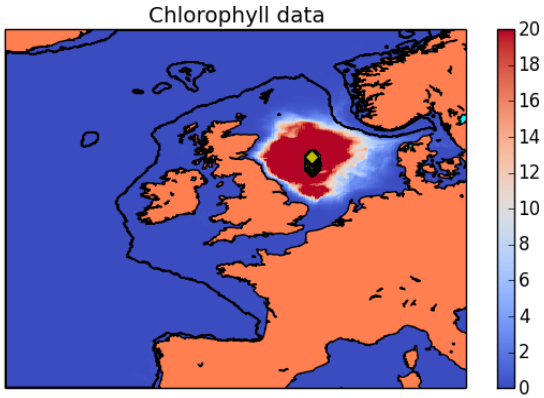
The CAMPUS project aims at establishing an integrated assimilative system to combine models with all different types of multi-platform data. The models and observational systems are expected to work together in order to optimize our understanding of the ecosystem state on the NWE Shelf (e.g. models will navigate gliders into locations of specific interest).

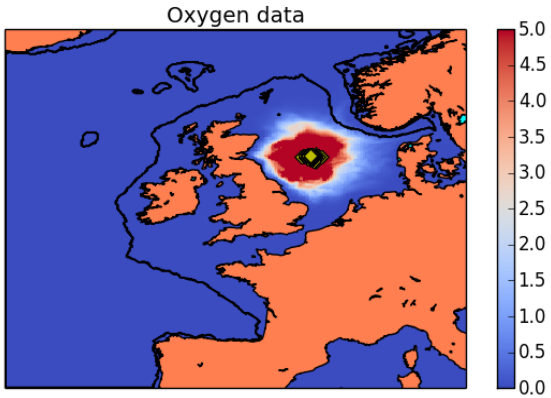
Multi-platform assimilation: conceptual study assimilating satellite Ocean Color and AlterEco glider data for temperature, salinity, chlorophyll and oxygen into NEMO-FABM-ERSEM model.

Period 08/05 – 15/08/2018









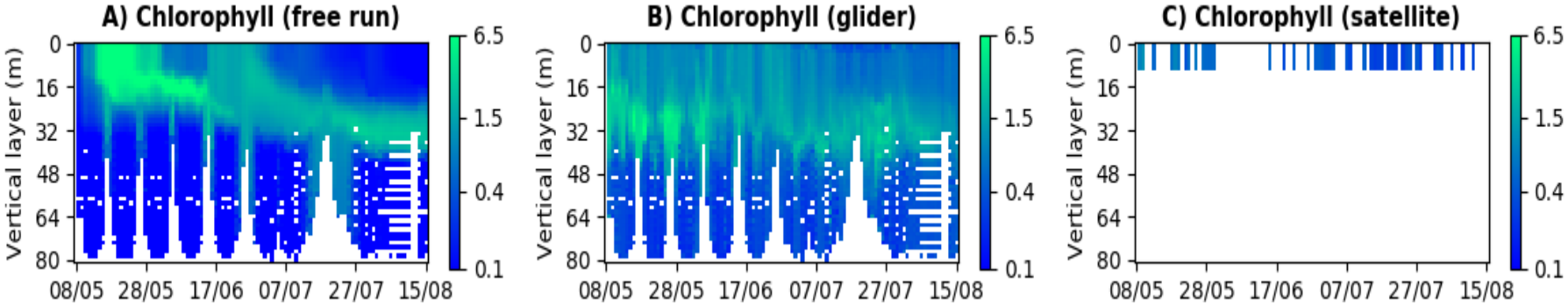
<u>Assimilative system</u>: NEMOVAR, a 3DVar daily assimilation, with the background covariances supplied externally. Reanalysis often converges to observations and tends to be insensitive to the externally supplied uncertainties. The system uses horizontal length-scales parametrized by the Rossby radius and flow-dependent vertical length-scales based on the modelled physics.

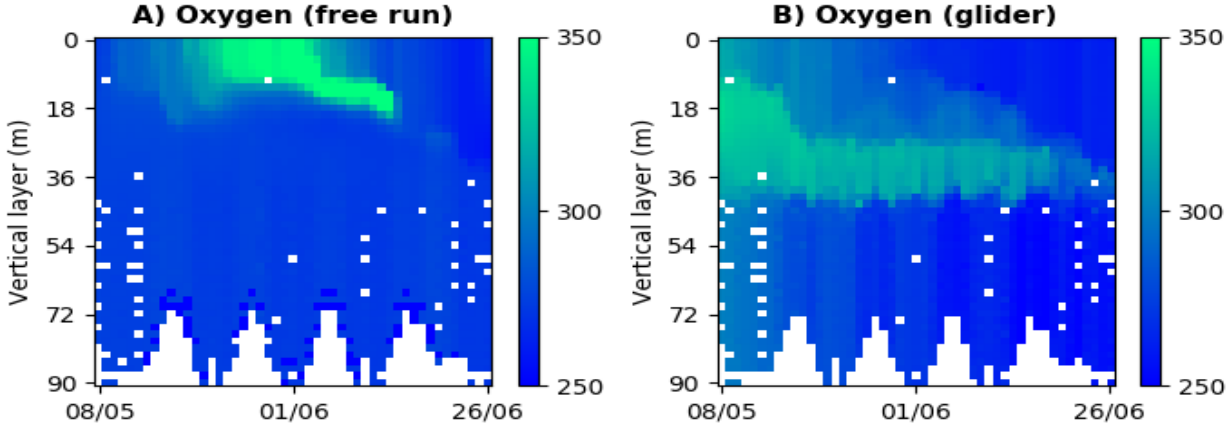
Assimilated variables:

<u>Chlorophyll:</u> an essential proxy for the primary productivity and marine life

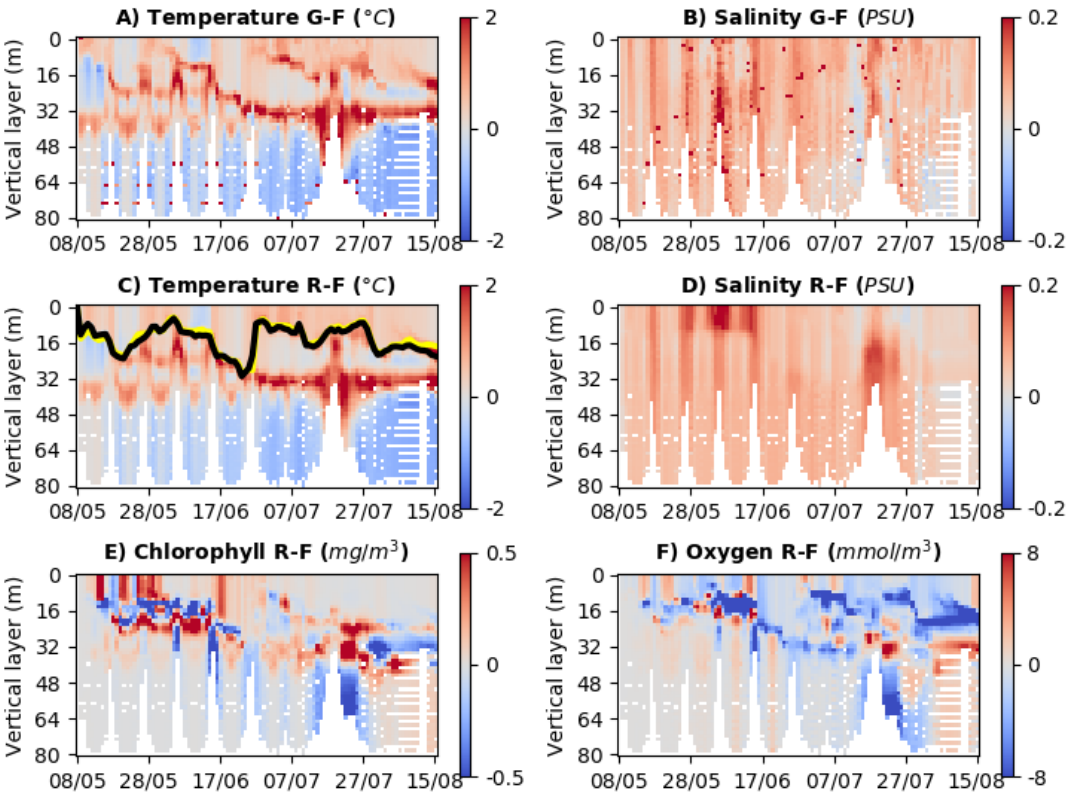
<u>Oxygen:</u> an important variable to monitor events of hypoxia, which can have disastrous effect on marine life

Model vs glider: Model has a late and intense Spring bloom in May that severely degrades the model skill



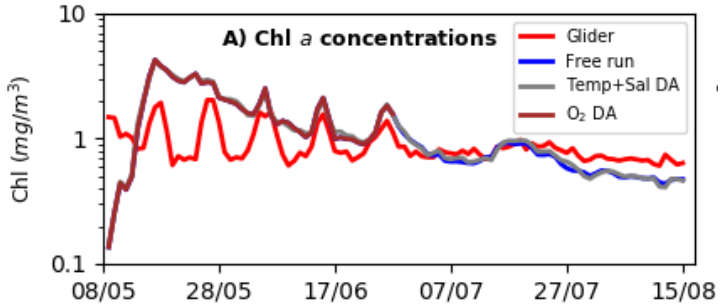


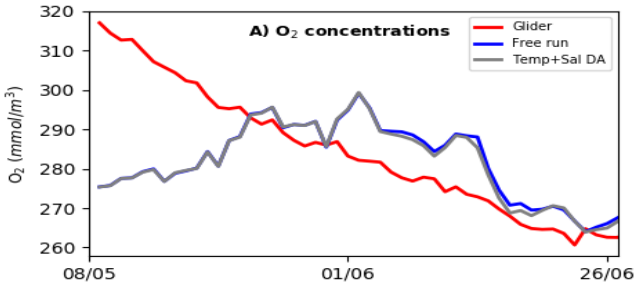
Impact of physical assimilation (temperature + salinity) on the biogeochemical model performance



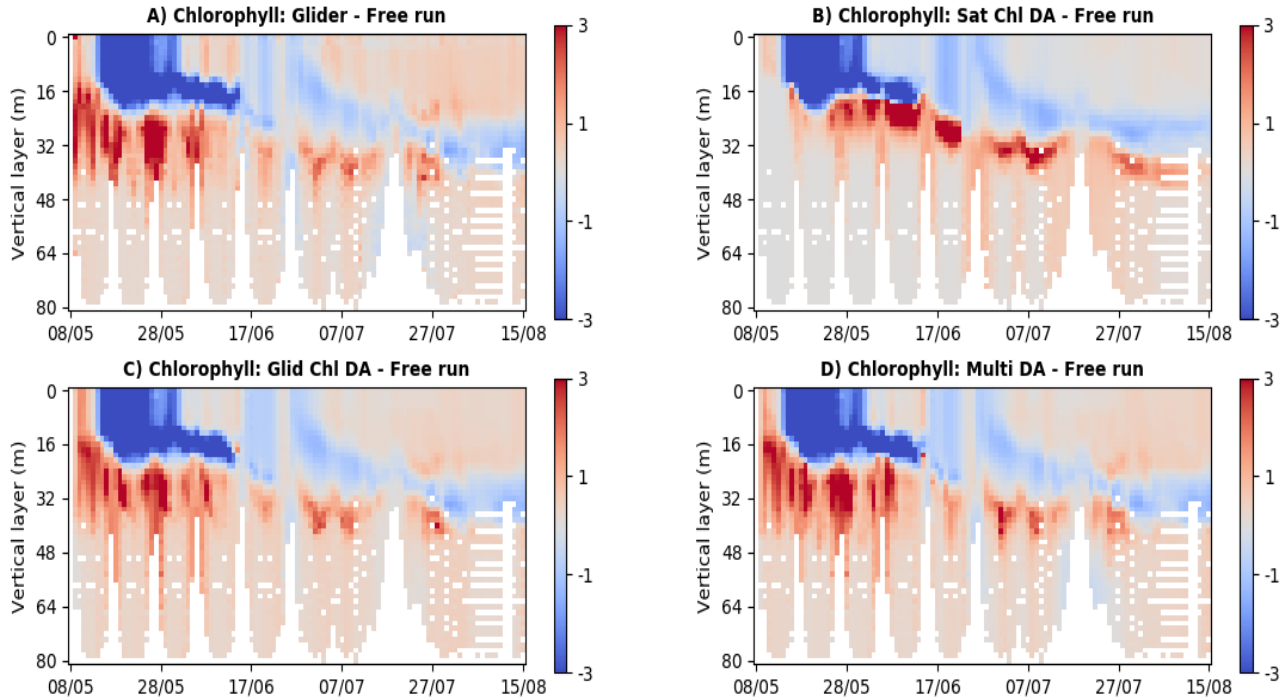
Important lesson:

Physical data assimilation (temperature and salinity) has a neglibile impact on the model late bloom, since the model bloom dominantly depends on the model atmospheric forcing and the forcing is unaffected by the assimilation of temperature and salinity.



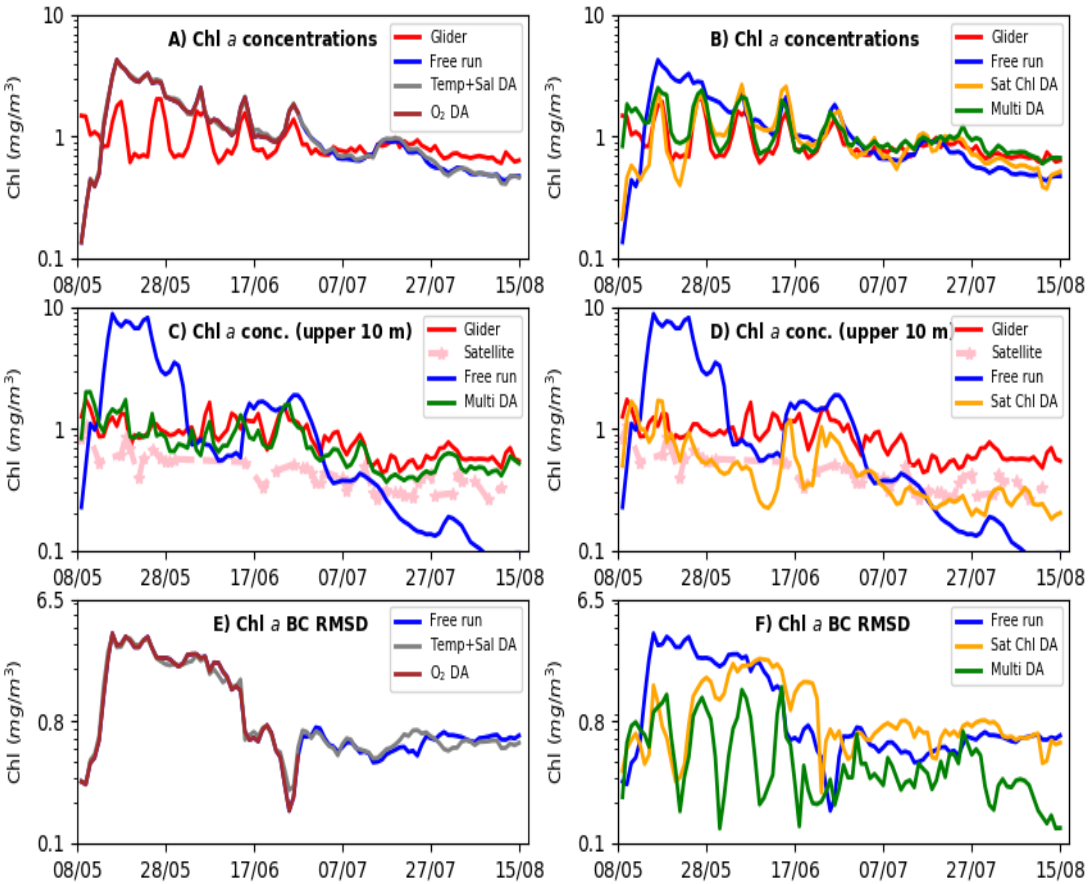


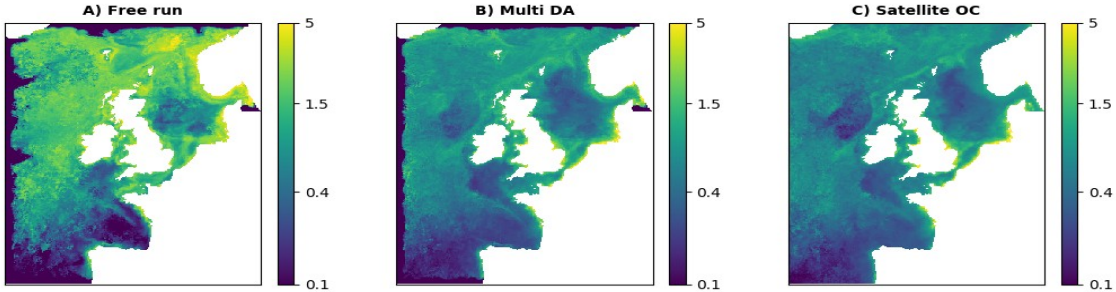
The impact of different components of multi-platform assimilative system on the simulated chlorophyll



Satellite surface chlorophyll assimilation does a surprisingly good job in improving the vertical chlorophyll profiles. This can be explained by a relatively straightforward chlorophyll dynamics. The best performing system component is the glider chlorophyll assimilation, which plays a dominant role in the multiplatform assimilative system.

Chlorophyll validation:





Summary:

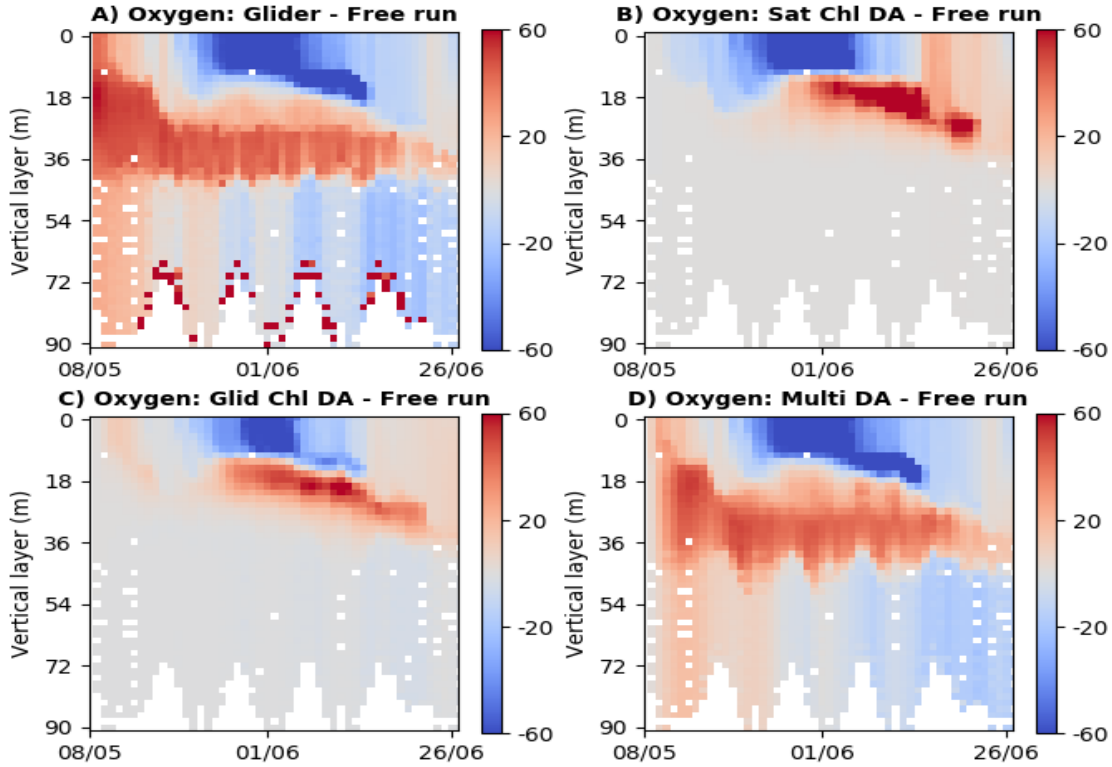
1. Physical assimilation and oxygen assimilation have no impact on the model skill to represent chlorophyll.

2. Assimilation of satellite ocean color improves also vertical chlorophyll profiles.

3. Chlorophyll glider DA outperforms any other component near the glider locations.

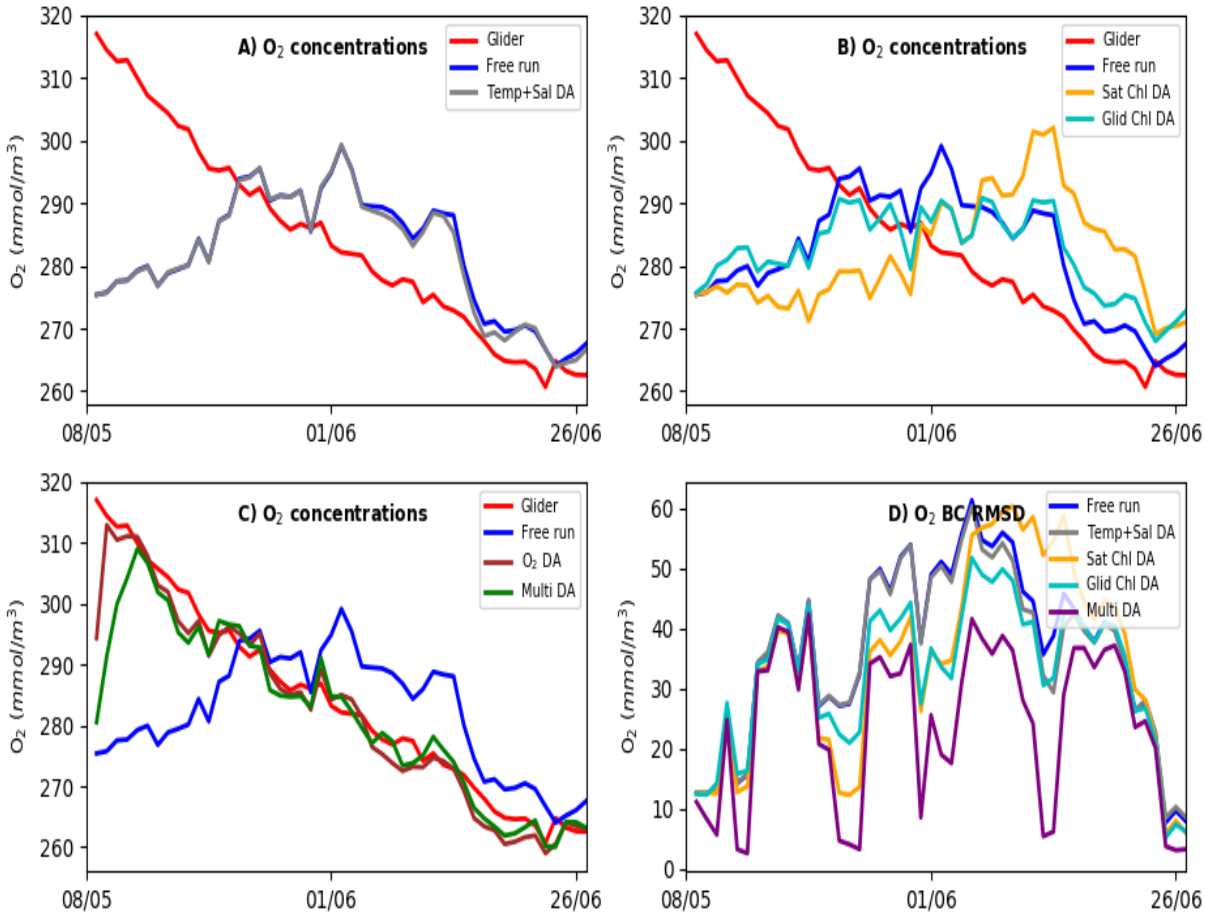
4. Multi-platform assimilation optimally combines the advantages of all its components. It performs comparably to its best component near the glider locations and also improves chlorophyll away from the glider locations.

The impact of different components of multi-platform assimilative system on the simulated oxygen



Since phytoplankton bloom (photosynthesis) is a key factor in the model skill to represent oxygen, both ocean color and glider chlorophyll assimilation have positive impact on the modelled oxygen. Similarly to chlorophyll, the best performing system component is the glider oxygen assimilation, which plays a dominant role in the multiplatform assimilative system.

Oxygen validation:



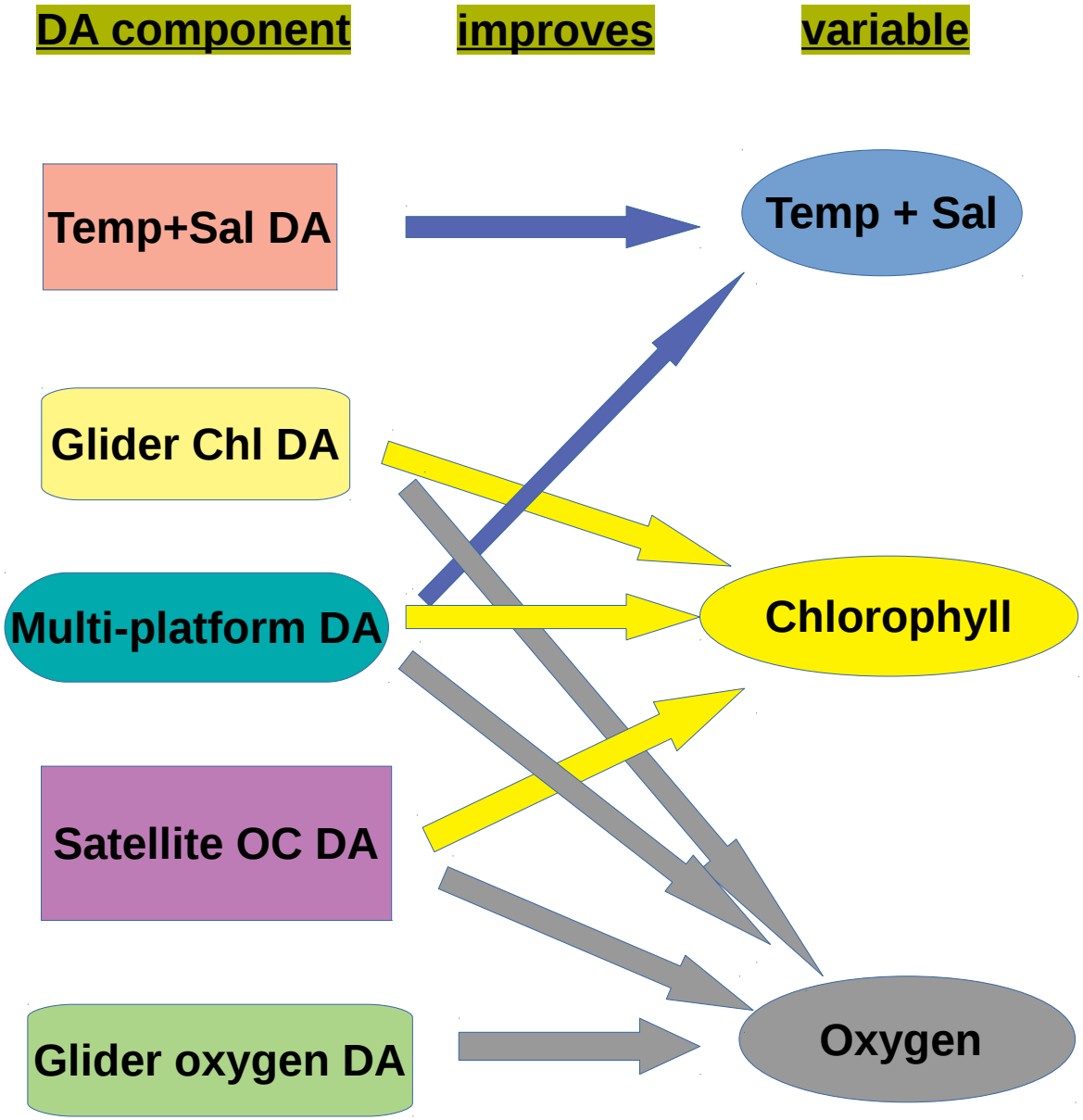
Summary:

1. Physical assimilation has no impact on the model skill to represent chlorophyll.

2. Assimilation of satellite ocean color and glider chlorophyll has a potential to improve oxygen profiles.

3. Oxygen glider DA outperforms any other component near the glider locations and its skill is inherited by the multi-platform assimilative system.

Conclusions and future work



In the future we would like to add more arrows into the diagram by using a two-way physical-biogeochemical coupled model and potentially a strongly coupled physical – biogeochemical DA. This could provide arrows both from the physical DA to biogeochemistry and also the other way round.