

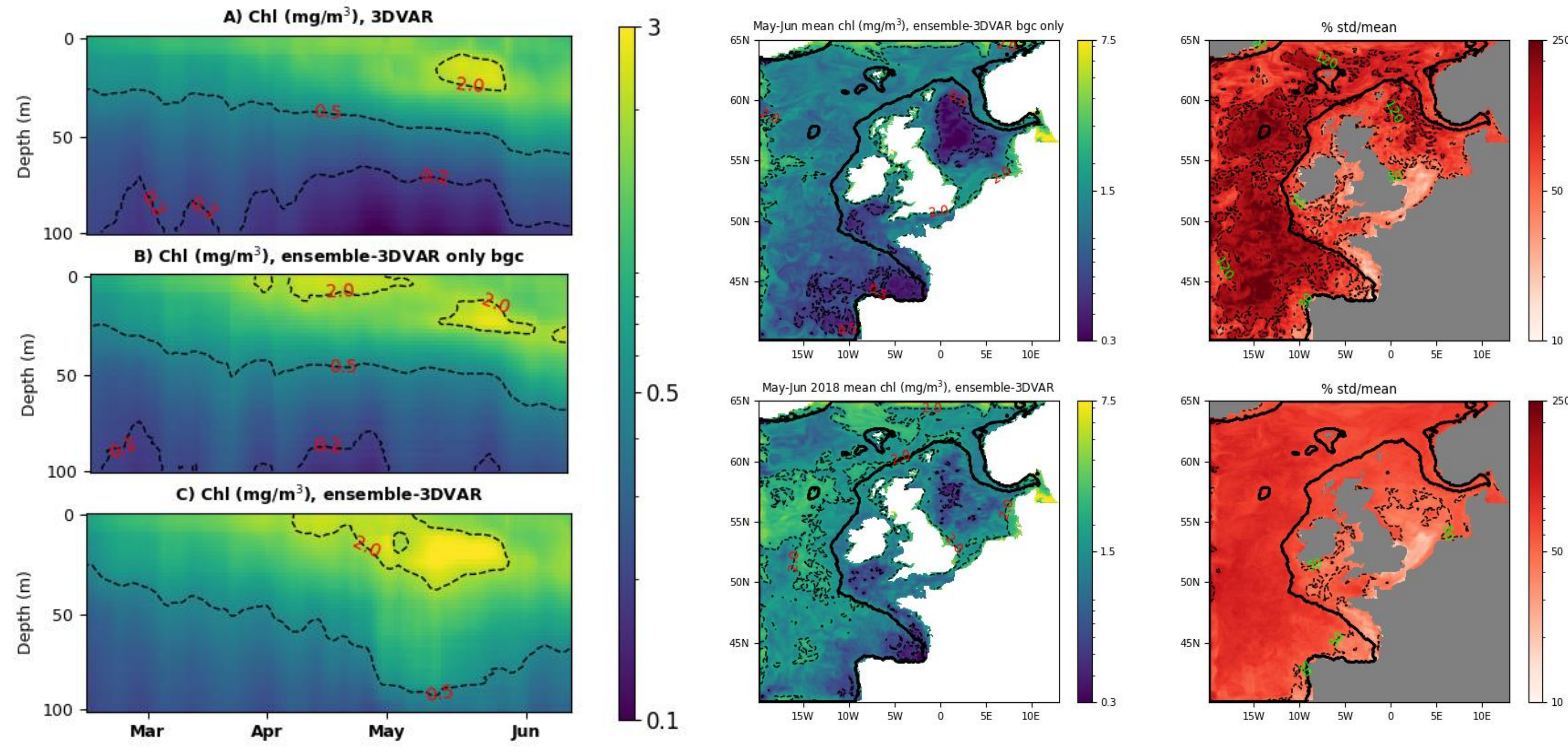
Introducing ensembles to the biogeochemical component of the operational system for the North-West European Shelf

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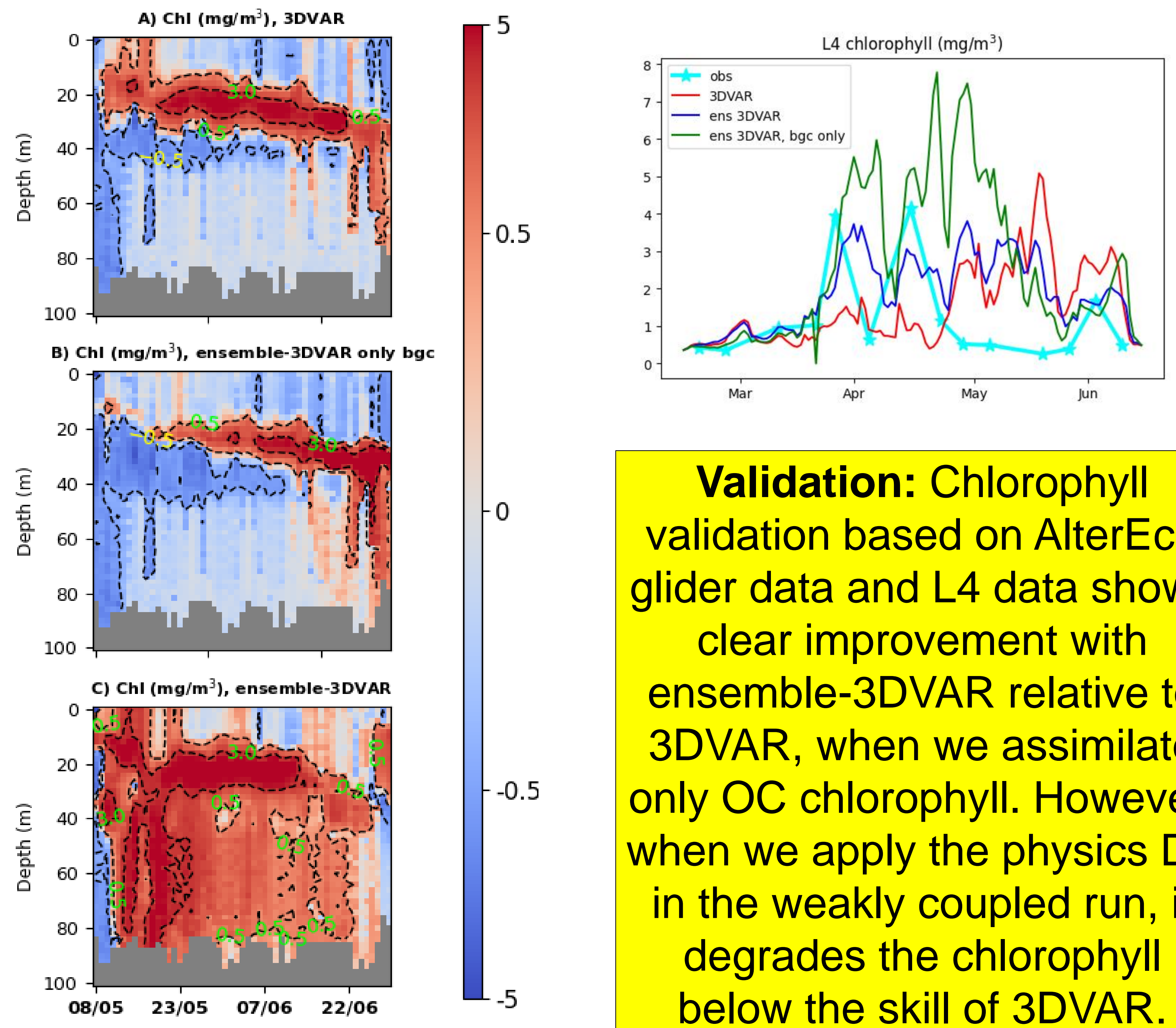
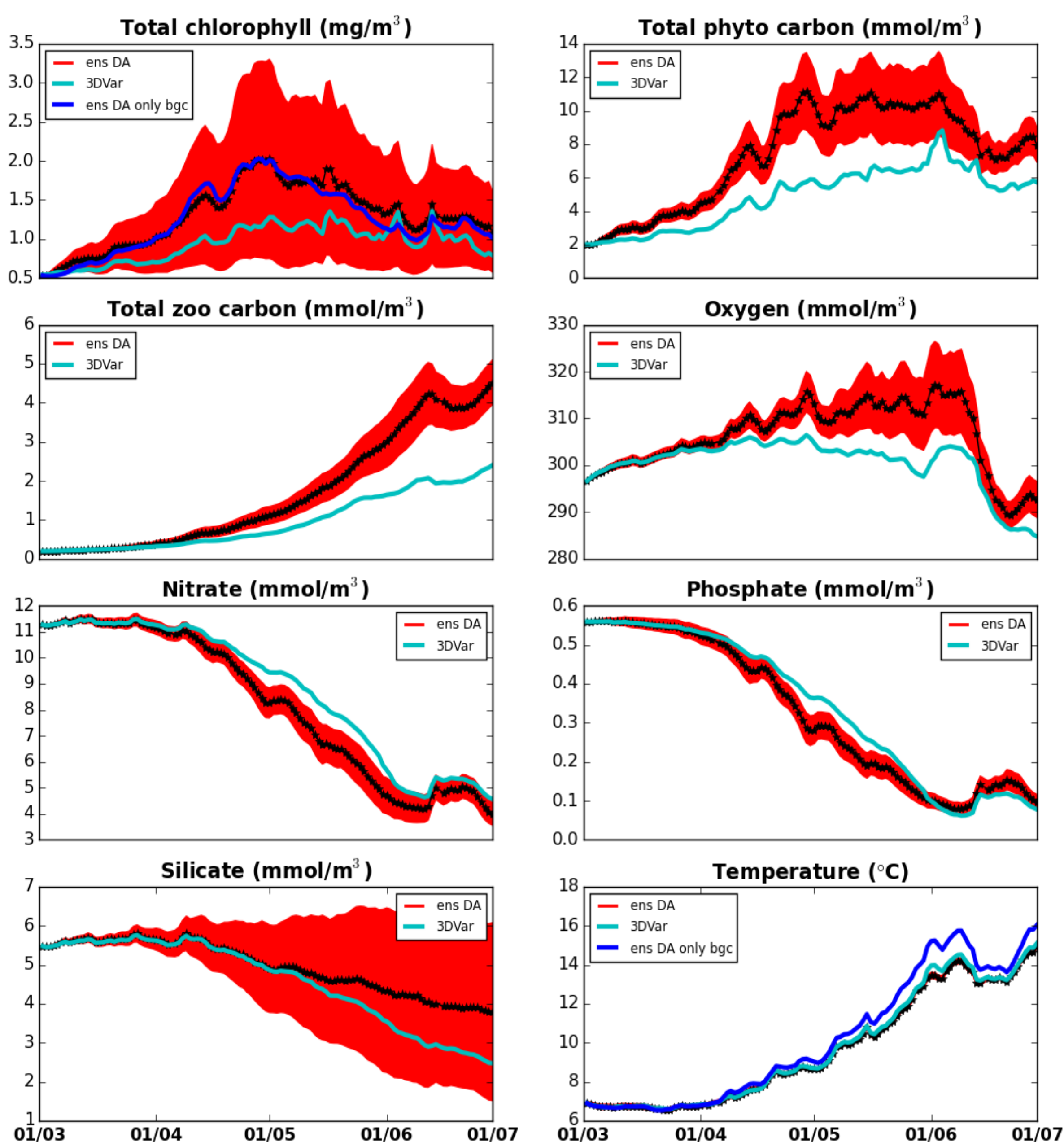
Summary: Based on parameter sensitivity analysis and perturbations, we have developed biogeochemical ensembles within the Met Office R&D version of the operational system for North-West European Shelf (NWES). We have used these ensembles within the newly developed hybrid ensemble-3DVAR DA system and we demonstrate that the ensemble-3DVAR could, at least in some situations, outperform the existing 3DVAR.

Model: two-way coupled NEMO-FABM-ERSEM for AMM7 configuration
30 member ensemble, based on:

- existing 10 member ERA5 atmospheric forcing ensemble
- perturbations of assimilated observations
- perturbations of 6 most sensitive ERSEM parameters. The parameter sensitivity was determined in 1D, relative to a selected range of target indicators (e.g netPP, oxygen, nutrients, POC). From the 6 parameters, 4 are for PFTs and 2 for bacteria. All were perturbed by up to 30%.



Although within 3DVAR system there is typically little difference in chlorophyll between the weakly coupled assimilation of physical data (SST, EN4 T&S) + OC chlorophyll, and the assimilation of (only) OC chlorophyll, it turns out there are major differences within the ensemble-3DVAR. This might be due to insufficient spread in the physical part of the ensemble and spurious correlations in temperature. Although this has overall little impact on temperature reanalysis, it might still introduce spurious vertical mixing: there is much larger sub-surface chlorophyll in the weakly coupled DA run.



Validation: Chlorophyll validation based on AlterEco glider data and L4 data shows clear improvement with ensemble-3DVAR relative to 3DVAR, when we assimilate only OC chlorophyll. However, when we apply the physics DA in the weakly coupled run, it degrades the chlorophyll below the skill of 3DVAR.

Model error by comparing it to AlterEco glider at the central North Sea.

The 4 month simulation demonstrating the difference between ensemble-3DVAR and 3DVAR. The values are surface averages through NWES.

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