

Estimation of ocean biogeochemical parameters in an Earth System Model using the dual one step ahead smoother: a twin experiment

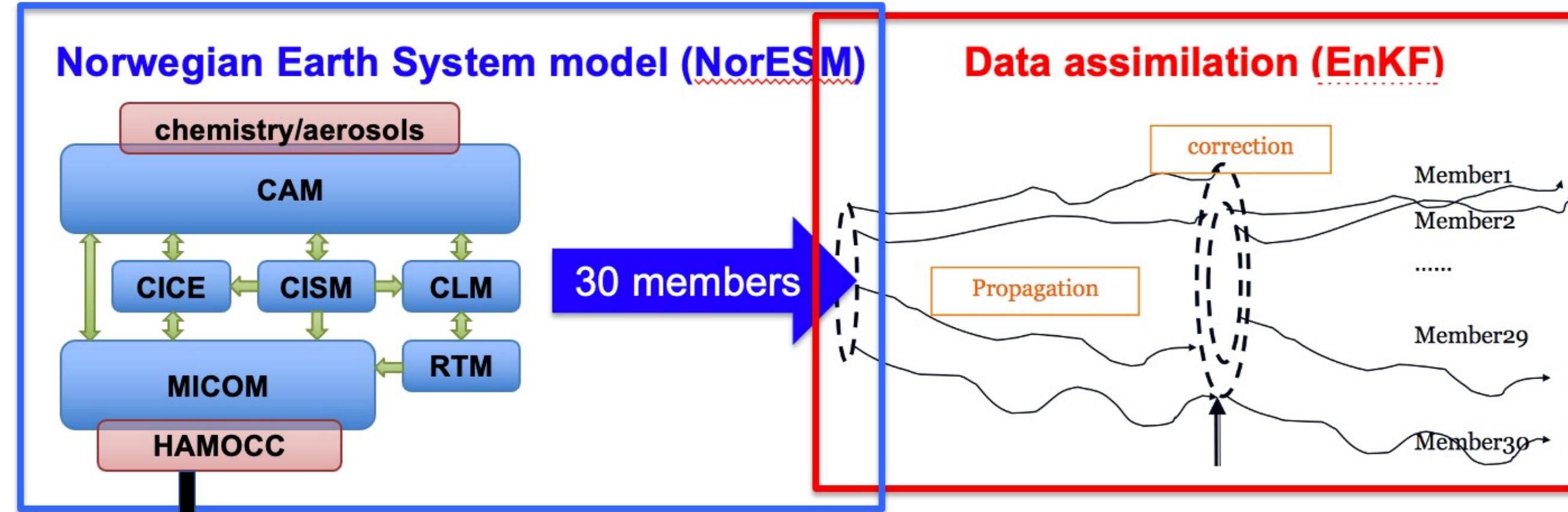


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Norwegian Climate Prediction Model (NorCPM)

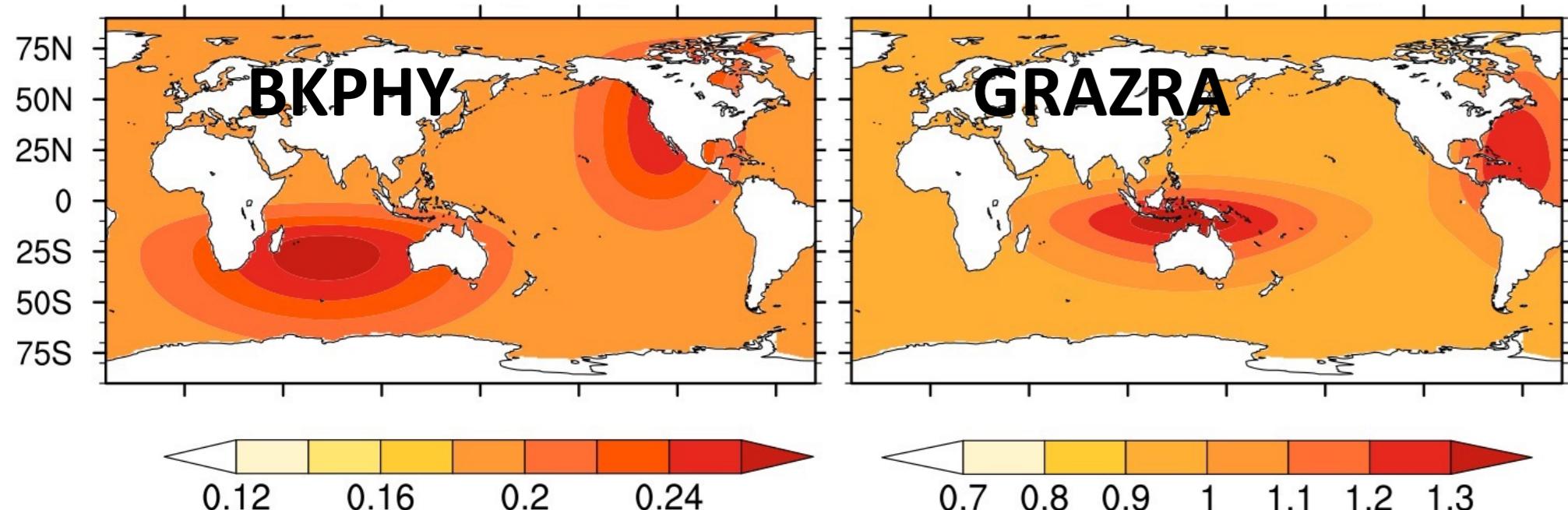


BGC parameters

- (1) Half-saturation constant for nutrient uptake (**BKPHY**)
- (2) Maximum zooplankton grazing rate (**GRAZRA**)
- (3) Phytoplankton exudation rate (**GAMMAP**)
- (4) Sinking speed for particulate organic carbon (**WPOC**)
- (5) Half-saturation constant for silicate uptake (**BKOPAL**)

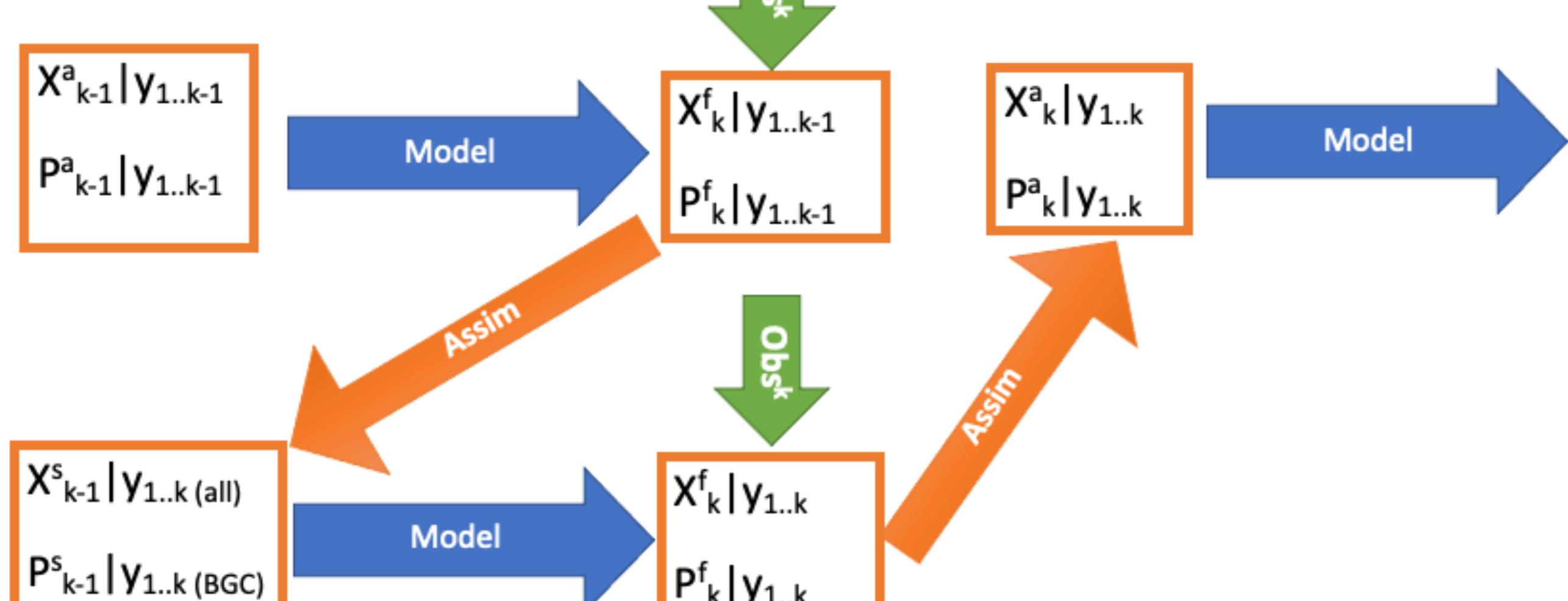
Twin Experiment setup

True Parameters

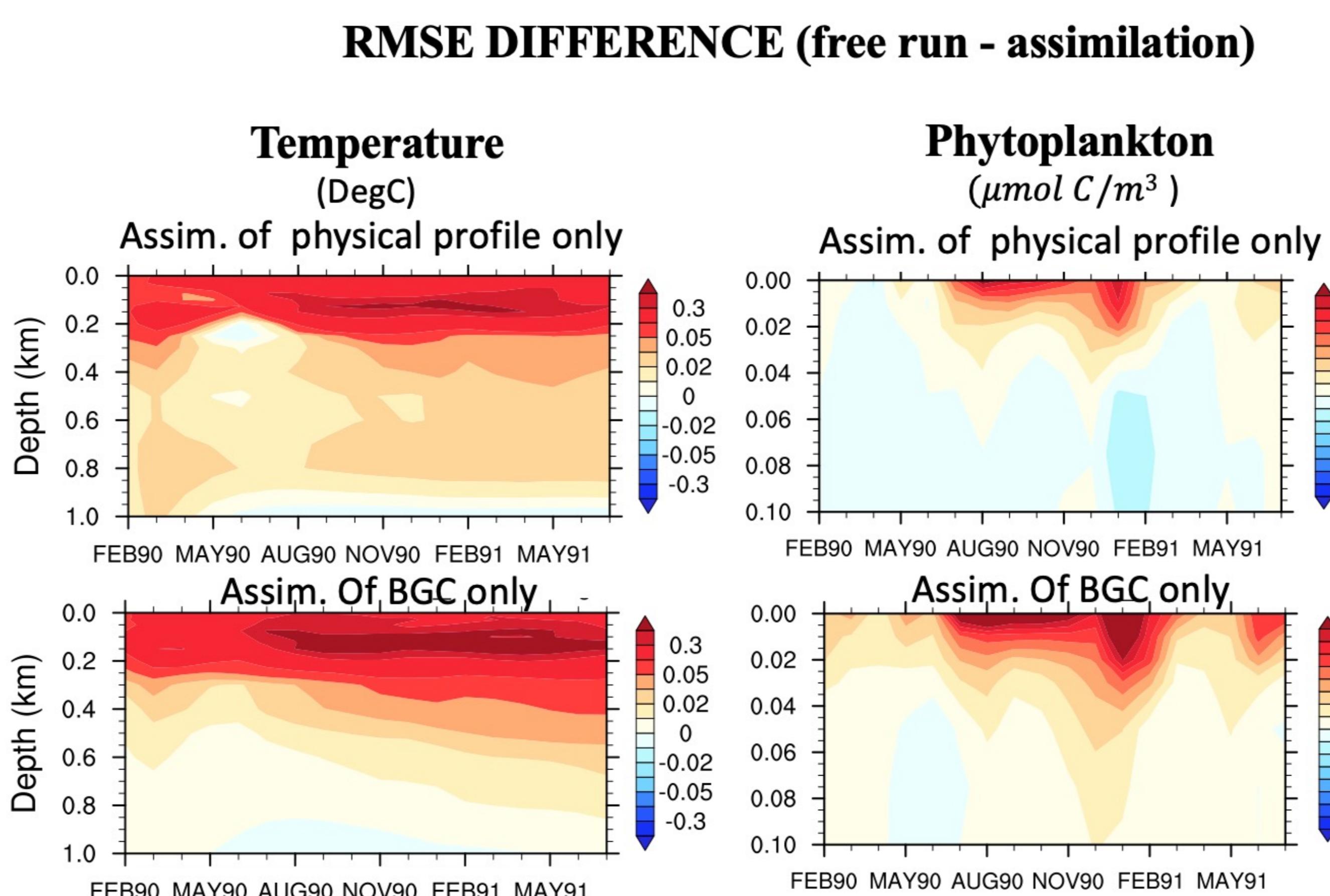


- ❖ First guess/perturbed parameters: Spatially uniform, Ensemble mean = 25% lower than the true value, Ensemble std = 33% of the mean
- ❖ Synthetic observations: Model free run performed with True parameters + additive perturbation
 - (1) Physics time varying + BGC time varying (every 5th grid cell)
 - (2) Physics time varying + BGC climatology (every 5th grid cell)
 - (3) Physics time varying + BGC climatology (every 10th grid cell)

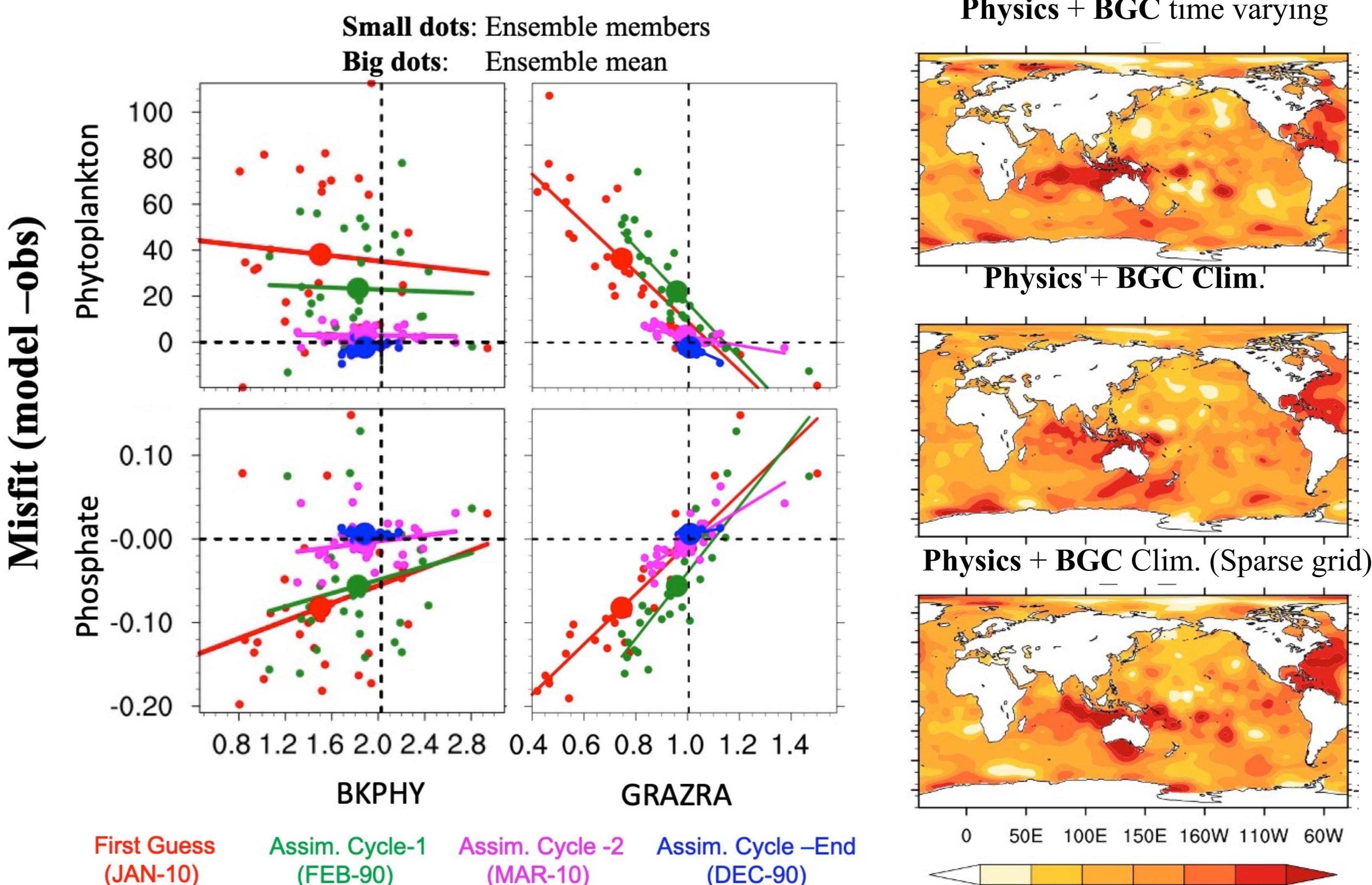
Dual one step ahead smoother (DOSA) scheme



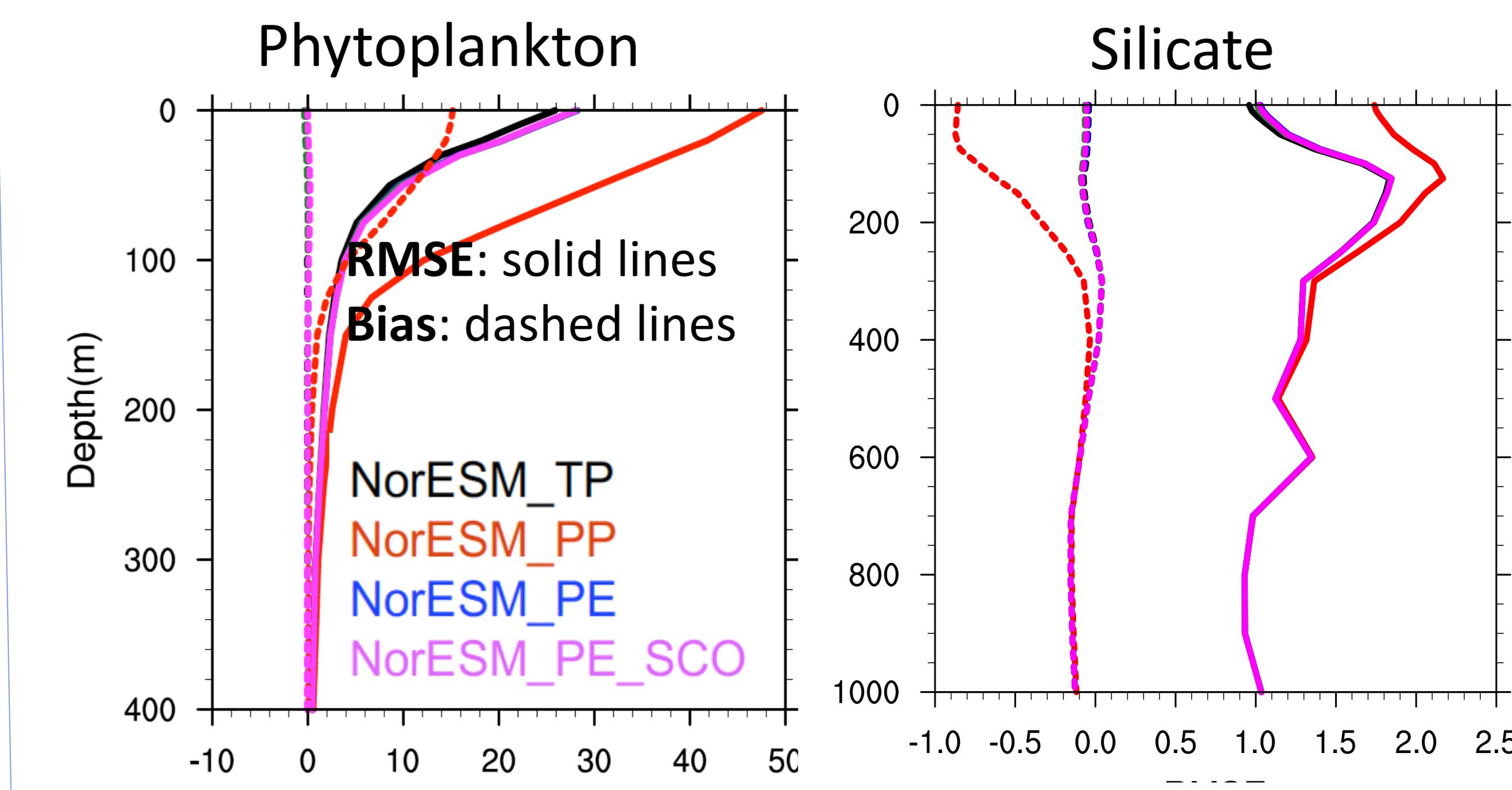
Can ocean obs constrain BGC and vice versa ?



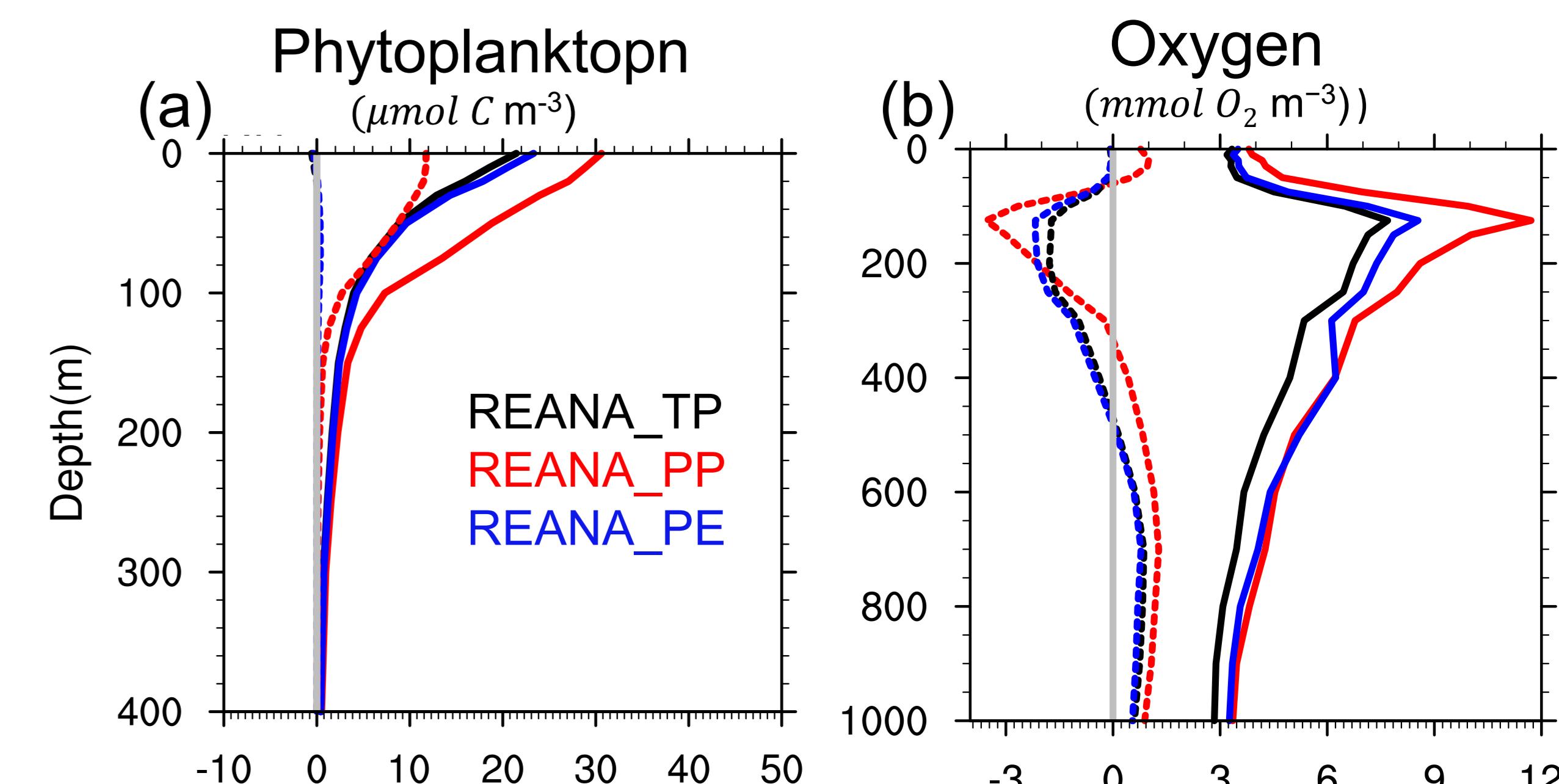
Online parameter estimation



Model ensemble run with estimated parameters



Reanalysis with estimated parameters



- The method converges quickly (less than a year) and largely reduces the errors in the BGC parameters.
- The estimated parameters perform nearly as well as that of true parameter values.
- This study demonstrates the applicability of the approach for tuning the system in a real framework.

References:

- Gharamti, M., Tjiputra, J., Bethke, I., Samuelsen, A., Skjelvan, I., Bentsen, M., et al. (2017). Ensemble data assimilation for ocean biogeochemical state and parameter estimation at different sites. *Ocean Modelling* 112, 65–89.
- Counillon, F., Bethke, I., Keenlyside, N., Bentsen, M., Bertino, L., and Zheng, F. (2014). Seasonal-to decadal predictions with the ensemble kalman filter and the norwegian earth system model: a twin experiment. *Tellus A: Dynamic Meteorology and Oceanography* 66, 21074.