

Influence of phytoplankton DOM uptake on the CO₂ pressure in the Gulf of Bothnia/Baltic Sea surface water

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- Problem and aim– What do we want to solve?
- Model development – What did we do?
- Validation of the model – Objective skill metrics
- Evaluation - What did improve, what did we miss?
- Summary and conclusions



Tool:

PROBE-Baltic model – processed based, calculates transient mean profiles in 13 sub-basins.

Problem and aim:

Current modelling efforts in the Baltic Sea can not realistically reproduce the nutrient balance in the Northern Basins. This affects the quality of modelled primary production and thus many biogeochemical rates.

This has serious implications for our endeavour too use models as a tool in understanding the dissolved CO₂ system in these areas, and understand the possible future threats from anthropogenic forcing factors such as eutrophication, acidification and so forth.

Allowing phytoplankton to utilize the labile fraction of the dissolved organic nutrients as a nutrient source.

See how this affects, hopefully improve, the seasonal pCO₂ in especially the Bothnian Bay, but also, the Baltic proper.

Development:

Modelling DOM

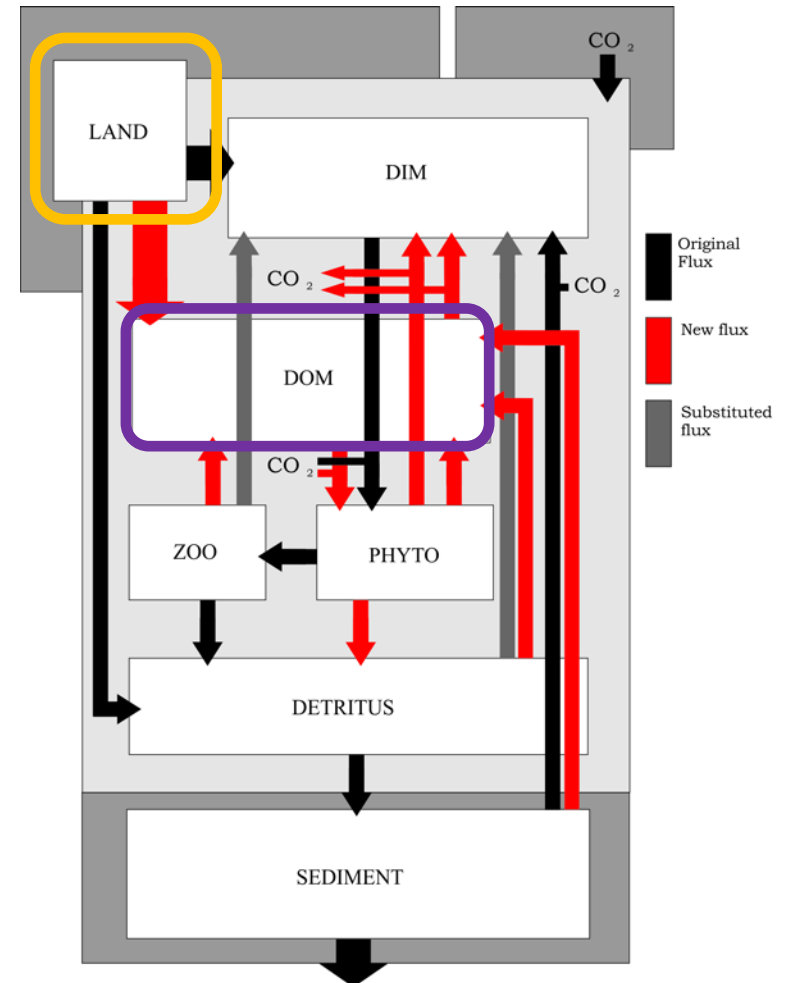
Dissolved organic matter (DOM) is divided into DON, DOP, DOCt, and DOCm.

1. Forcing from land:

DON/DOP - Concentrations of dissolved organic N and P are forced from land with the difference between the total concentrations and inorganic fractions.

DOCt - Concentrations of dissolved organic carbon are taken from CSIM scenario data (Omstedt et al. 2012) and degraded at half the rate of in situ produced marine DOC.

DOCm – Is not forced from land. Entirely produced in situ.



Development:

Modelling DOM

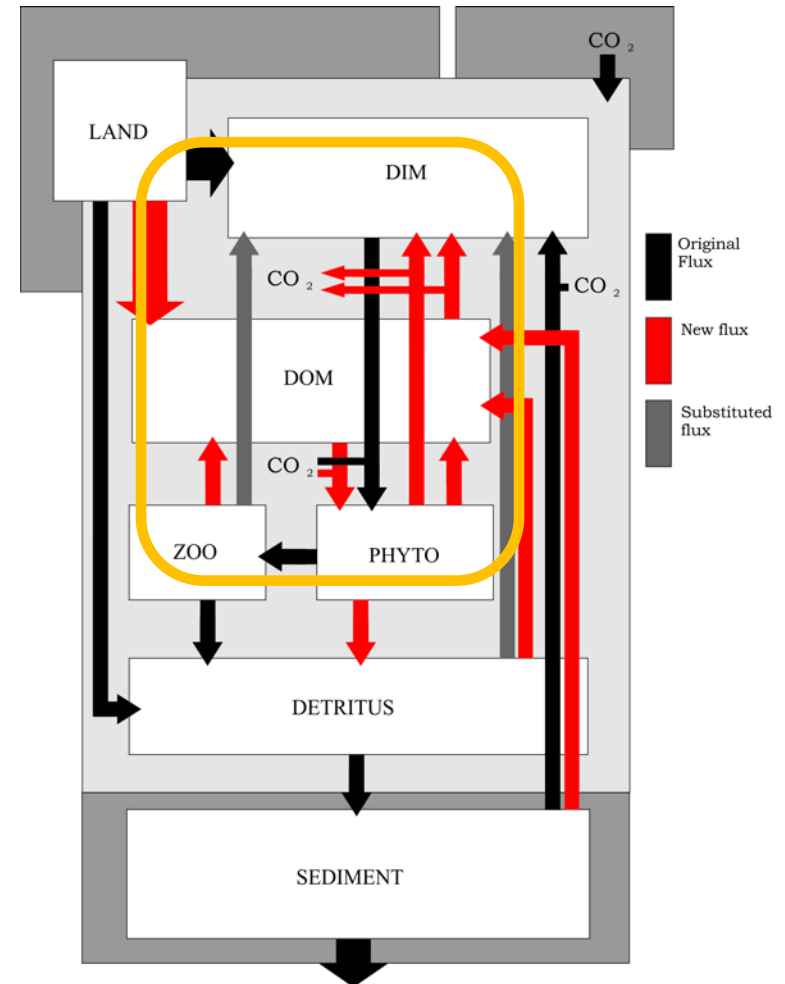
2. Biogeochemical sources:

The DON and DOP pools are added to from river transported nutrients, but also from plankton excretion and decay of POM in sediment and detritus.

The DON and DOP pools are degraded into inorganic nutrient, but the labile fractions are also used to sustain the primary production.

This enables effective recycling of matter within the euphotic zone. Before, this re-use was parameterized.

DOCt and DOCm are also degradable, but phytoplankton carbon uptake is always from DIC.

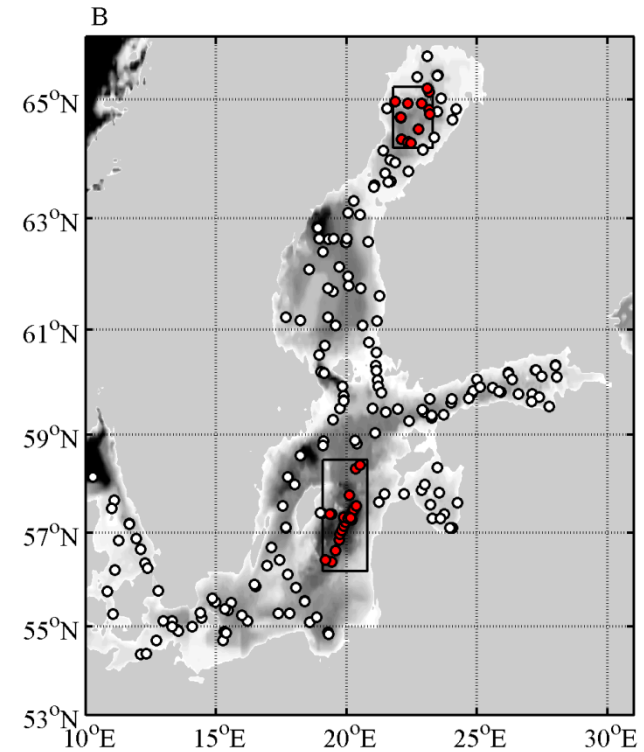
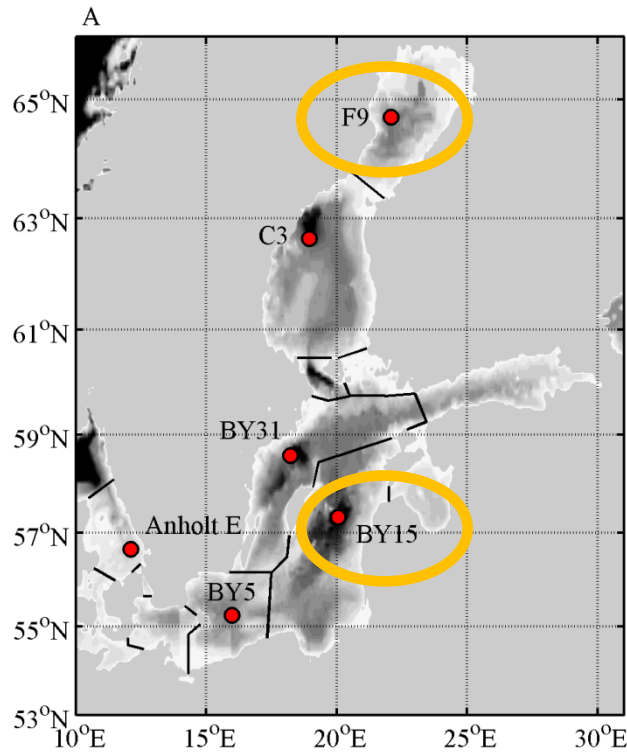


Validation data

Where and what

Data is acquired from SMHI and cruises performed during the Baltic-C project.

The SMHI data (6 stations) is used to validate the model, while data measured during the Baltic-C project is used to put the monitoring data in context.



F9 and BY15 are also used for detailed studies.

Model skill:

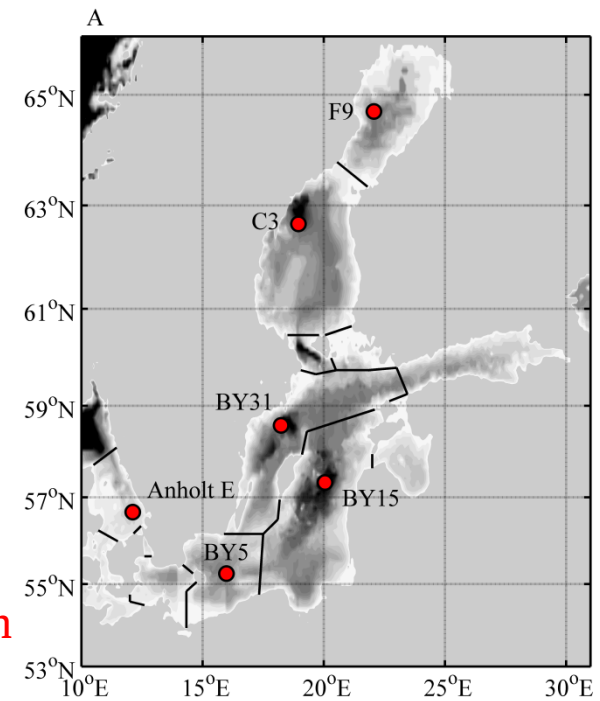
Mean profiles and seasonal variation

Period: 2000-2012

Where: In 6 of the 13 sub-basins.

What: Mean depth profiles and mean seasonal variation of 8-9 key physical and biogeochemical variables.

How: Dimensionless skill metrics. The **mean of a cost function (C)** gives an indication of how well the level is modelled, and the **correlation coefficient (r)** gives an indication of how well the shape of a distribution is modelled.



Physical		Nutrients					Dissolved CO ₂ system	
Temperature	Salinity	Total Nitrogen	DIN	Total Phosphorous	DIP	Oxygen	Total alkalinity	pH or the partial pressure of CO ₂
T	S	N _T	DIN	P _T	DIP	O ₂	A _T	pH/pCO ₂

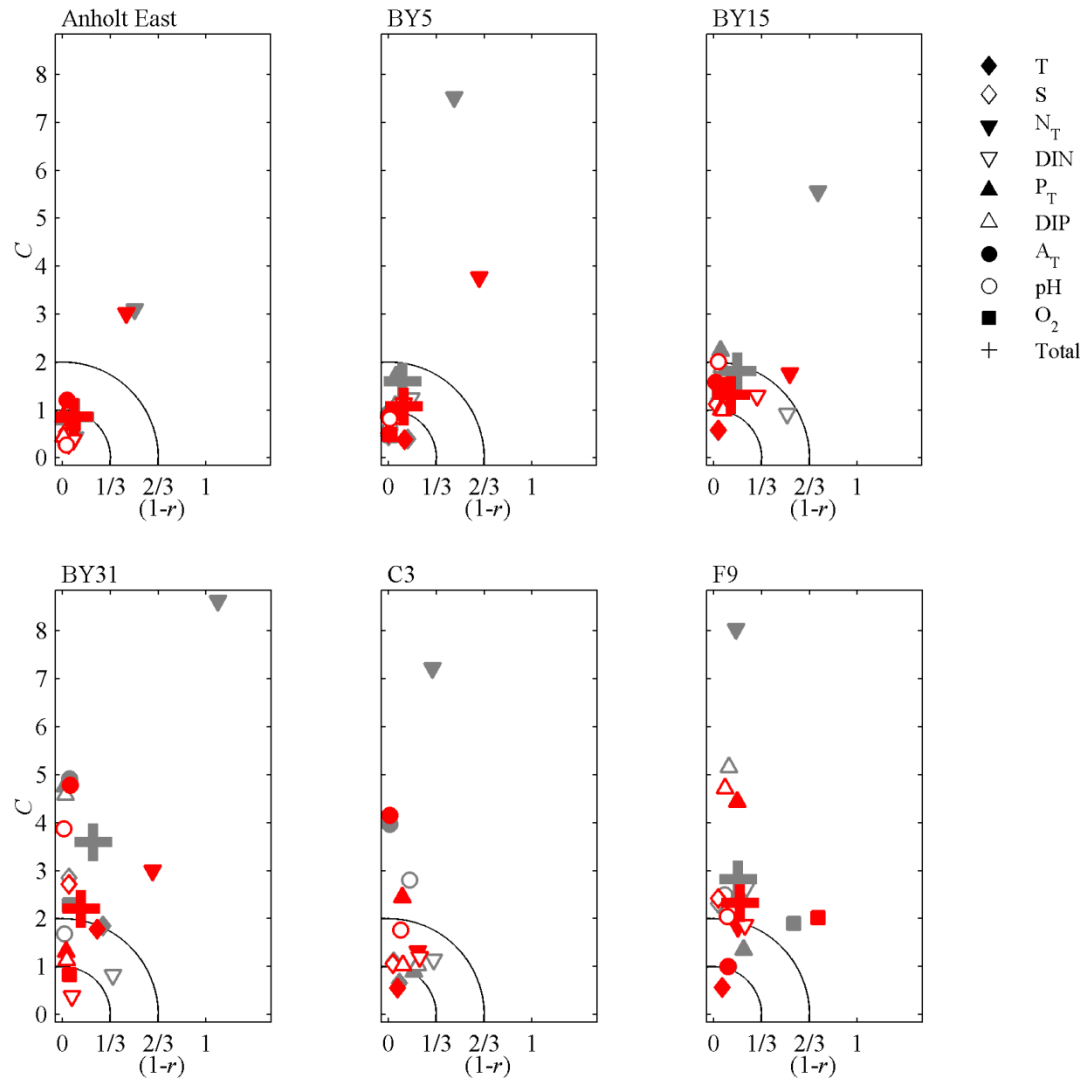
Model skill:

Mean profiles

- maintained or improved

Inner field = Good
Middle field = Acceptable
Outer field = Not good enough

At station C3 no measured oxygen profile was available, so no total quality could be calculated.



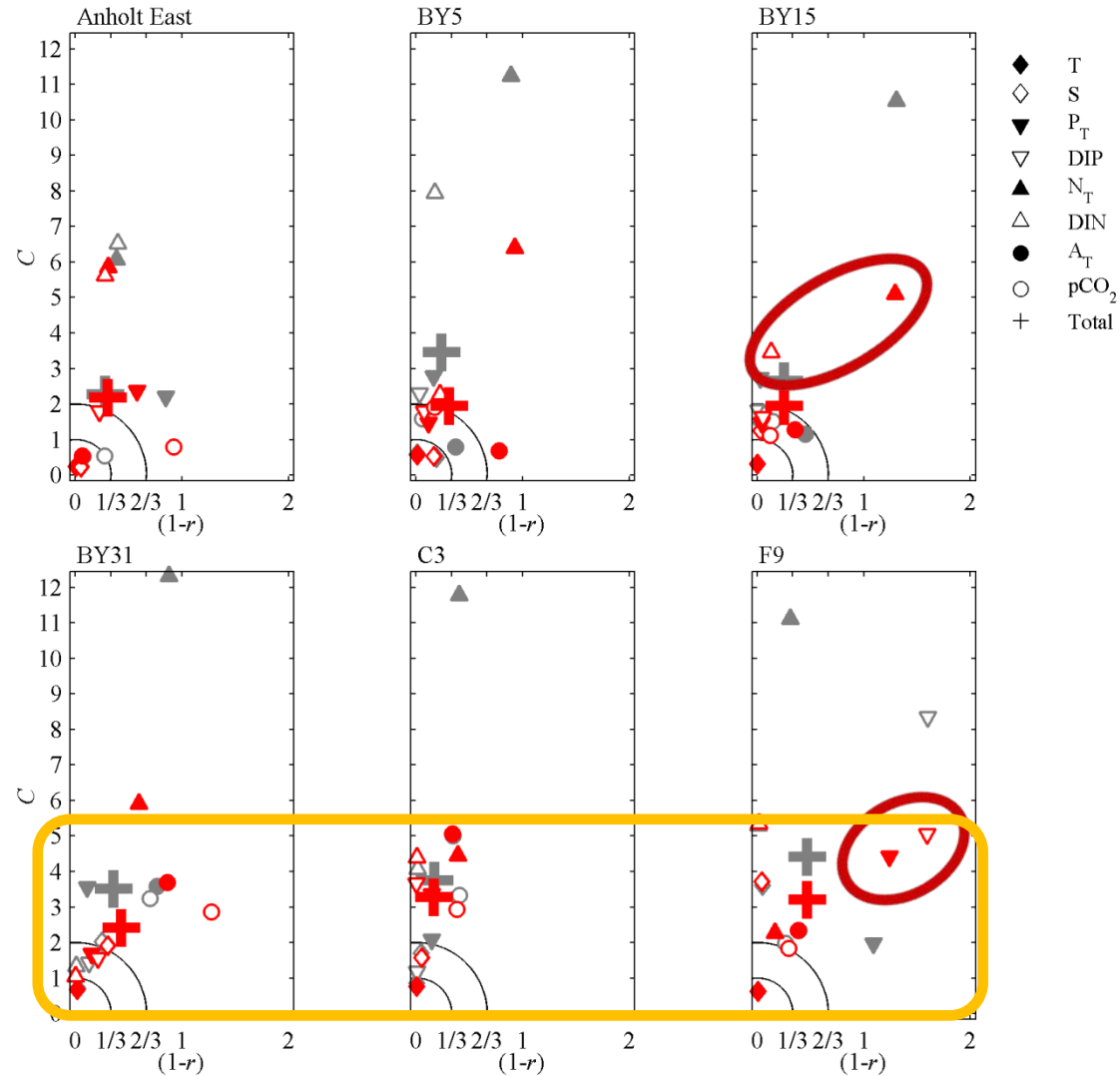
Red=new Grey=old

Model skill:

Seasonal variation

- maintained or improved

Inner field = Good
 Middle field = Acceptable
 Outer field = Not good enough



... but still not fully acceptable.

Red=new Grey=old

Evaluation:

Seasonal variation

Remaining problems:

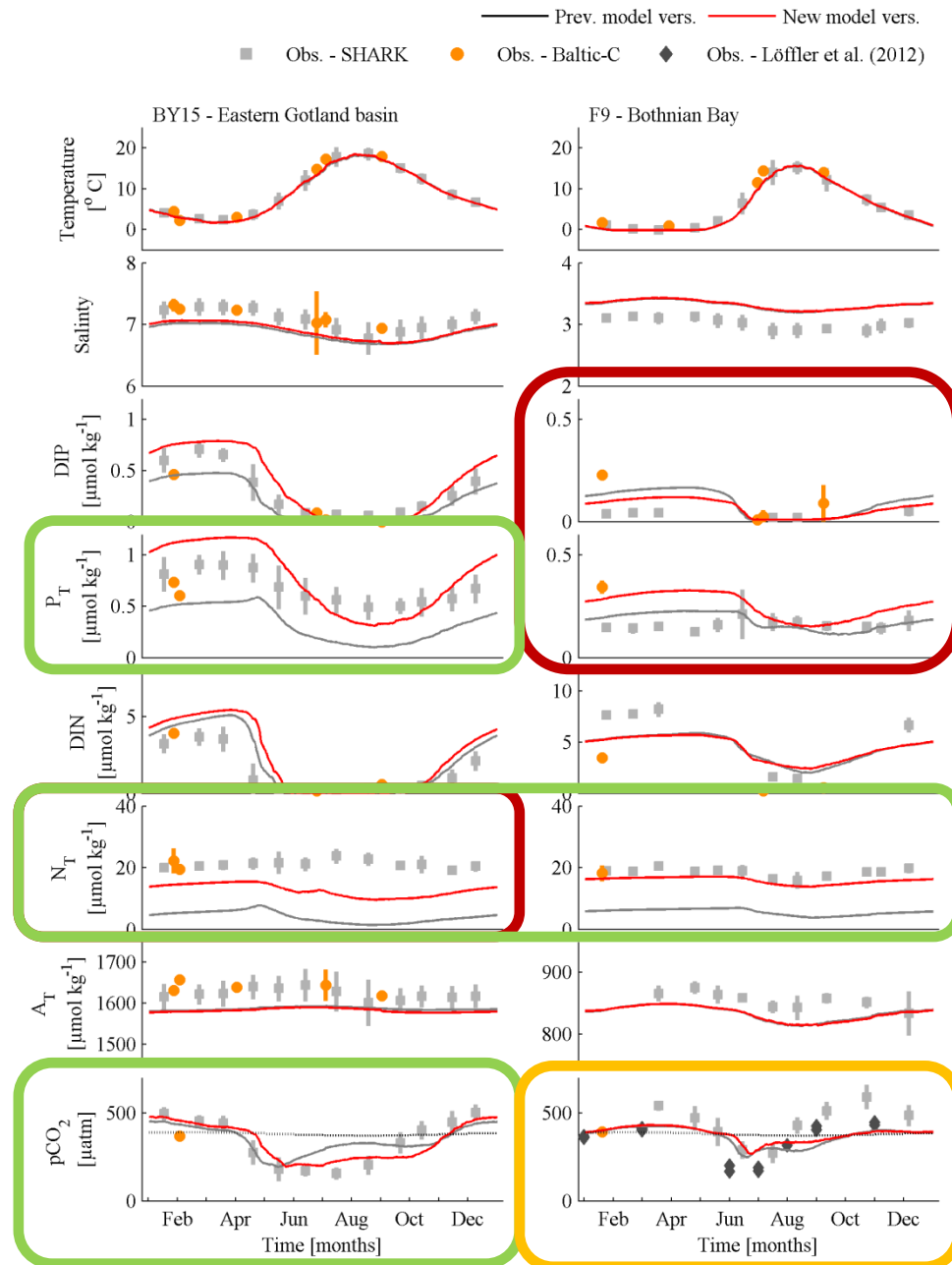
- Observations indicate increased N_T at BY15 during summer, while the model gives a decrease.
- Phosphorous dynamics in the Bothnian Bay are still lacking. But also, the observational data-sets do not agree.

Main improvements:

- Much better levels for total nutrient concentrations.
- Better seasonal CO_2 drawdown in BY15.

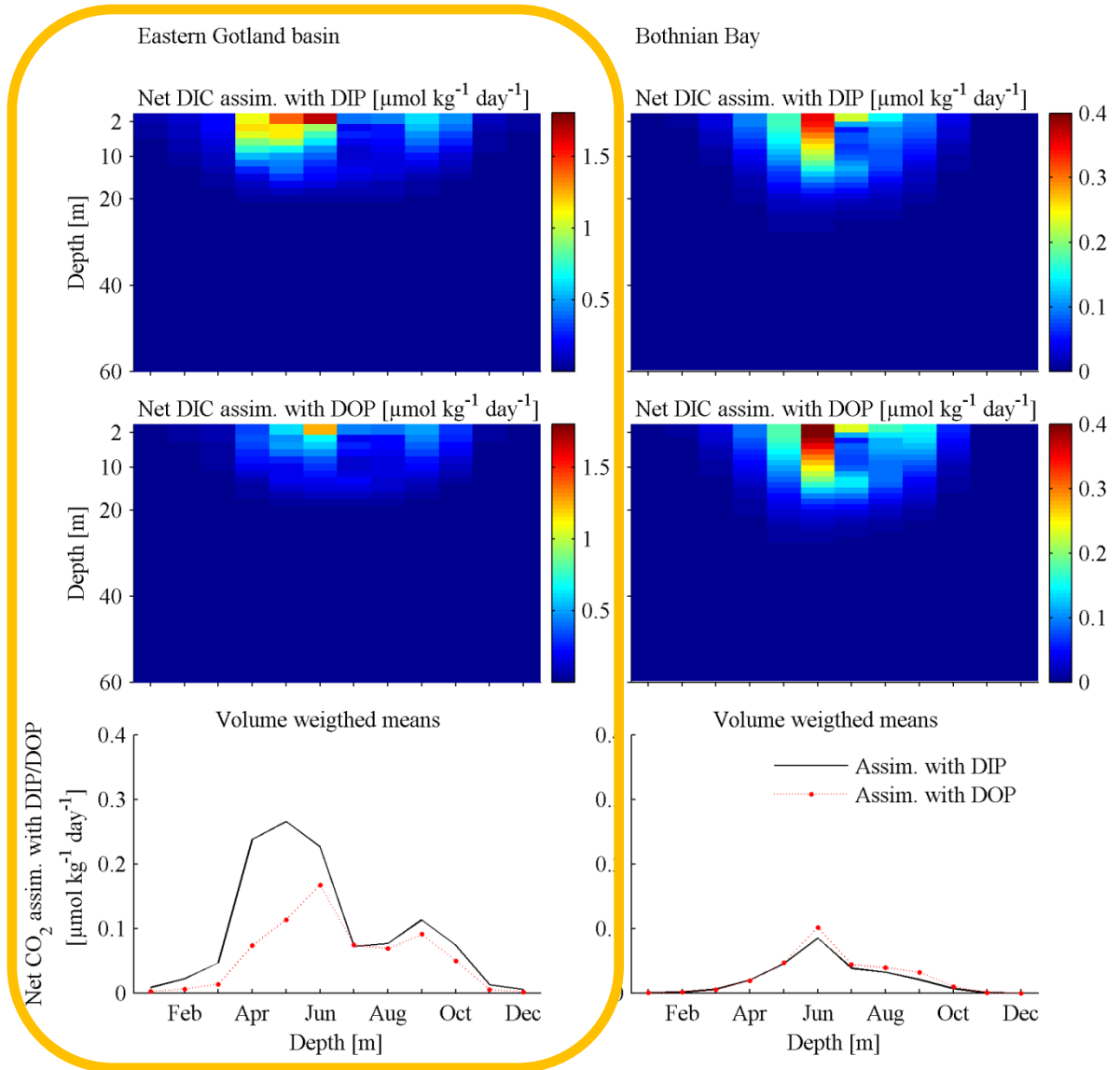
Also comment:

- pCO_2 during winter in F9 – Observational data-sets do not agree.



Evaluation: CO₂ assimilation

- In the model CO₂ is mainly assimilated with inorganic phosphorous in the Eastern Gotland basin, except during summer when the use of org. and inorg. phosphorous is equal.
- In the Bothnian Bay the use of org. and inorg. forms of phosphorous is equal all through the season.



Summary and conclusions

- Attempt to model the Northern Baltic Sea basins better with regard to CO_2 draw down and nutrient balance, by allowing phytoplankton to utilize dissolved organic nutrients.
- Adding dissolved organic C, N and P to an existing model system.
- Validation with objective skill metrics showed maintained or improved model skill for both profiles and seasonal surface variation.
- Still uncertainties regarding the phosphorus dynamics in the Bothnian Bay.
- Better total nutrient content in the model, and better seasonal cycle of pCO_2 in the Eastern Gotland basin.

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Thank you for your attention!
Questions?

