Algal response to ocean acidification masked by natural variability in plankton community structure – a data-model analysis for the European Project on Ocean Acidification (EPOCA)

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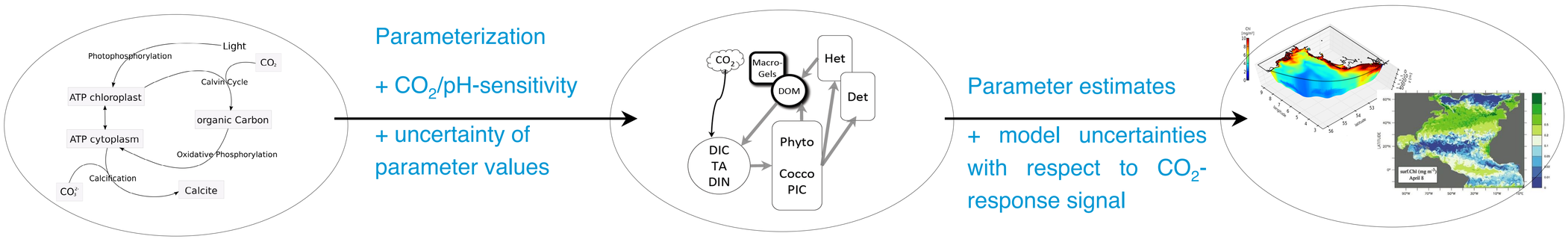
Motivation

A series of mesocosm experiments have been conducted, where enclosed water volumes were disturbed with different carbon dioxide (CO_2) concentrations (e.g. Riebesell et al, 2008), simulating possible future atmospheric CO_2 conditions. The major benefit of mesocosms is to have controlled-, quasi-natural experimental conditions. A mesocosm typically includes a mixture of natural plankton species and thus allows for investigations of CO_2-responses on community level. With a data-model synthesis of mesocosm experiments we aim at improving parameterizations and hope to learn about model uncertainties.

Mesocoms in the Raunefjorden south of Bergen, Norway; picture courtesy GEOMAR, Kiel; http://peece.ifm-geomar.de/images/Comparison).

EPOCA WorkPackage 9: From process studies to ecosystem models



Physiological modelling (laboratory data) → focii on pH-sensitive calcification & pCO_2 dependent growth rates

Ecosystem modelling (mesocosm data) → focus on carbon- & nitrogen uptake

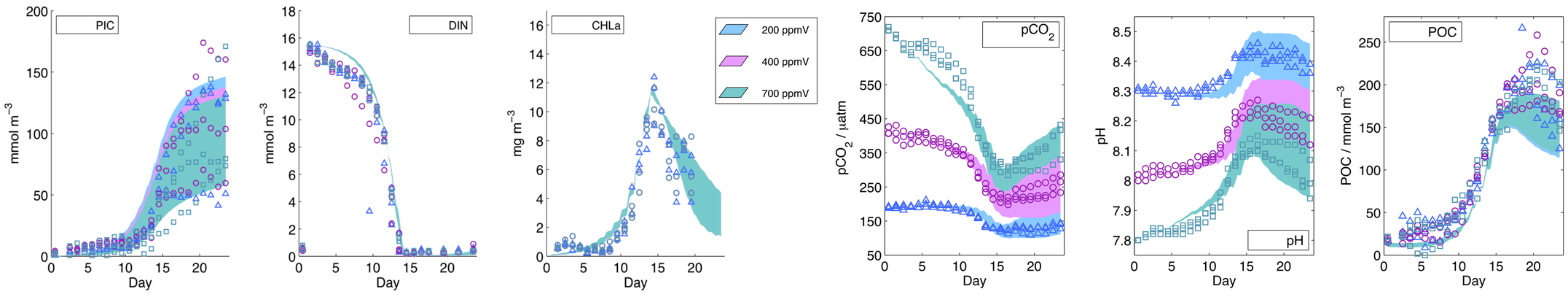
3D-modelling of German Bight (MAECS, HZG) & North Atlantic/ North Sea (at GEOMAR Kiel) (field data) → focus on carbon- & nitrogen fluxes

We first parameterize algal physiological processes and investigate their effects on plankton community level and on biogeochemical cycling. We then specify uncertainties of these model parameterizations and analyse variability in observations. Variability and model uncertainties are related to the strength of a pure pH-response signal (e.g. in calcification). Our results are used to advance the credibility of large-scale, future model projections of ocean acidification effects.

Data-model synthesis of the first Pelagic CO_2 Enrichment Study (PeECE-I) in Bergen

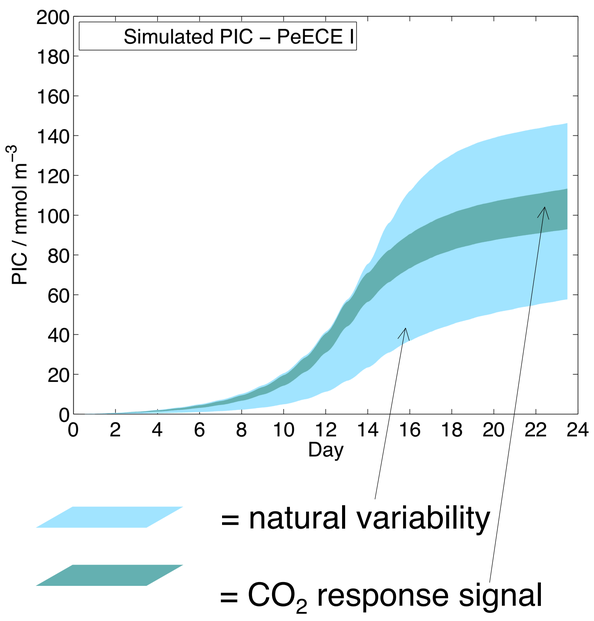
Why data from PeECE-I (Delille et al., 2005; Engel et al., 2005)?
→ well constrained carbonate system, with three mesocosms per treatment (three treatments: low $pCO_2 \approx 200$ µatm; medium $pCO_2 \approx 400$ µatm; high $pCO_2 \approx 700$ µatm)
→ detectable pH/CO_2 response signal in calcification (formation of particulate inorganic carbon, PIC)

Variability (pronounced in PIC) can be explained/simulated with small variations in initial plankton composition, identical for all CO_2-treatments.



PIC: particulate inorganic carbon | DIN: dissolved inorganic nitrogen | CHLa: chlorophyll *a* | pCO_2: partial pressure of carbon dioxide | POC: particulate organic carbon

Model simulations that resolve the observed variability allow us to extract the *pure* ocean acidification effect. This way we specified the CO_2 response signal and can relate it to variations in plankton composition and to model uncertainties. Our data-model analysis recalls that smallest variations in initial conditions (during the filling of the mesocosms) translate into large variability on plankton community level.



Conclusions

→ **variability and uncertainty in model projections are larger than the variational range of the acidification response signal**

→ **variability observed during PeECE-I can be explained with tiny variations in initial plankton composition**

→ **variability on plankton community level must be accounted for in future projections of ocean acidification effects on marine ecosystem dynamics**

References

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