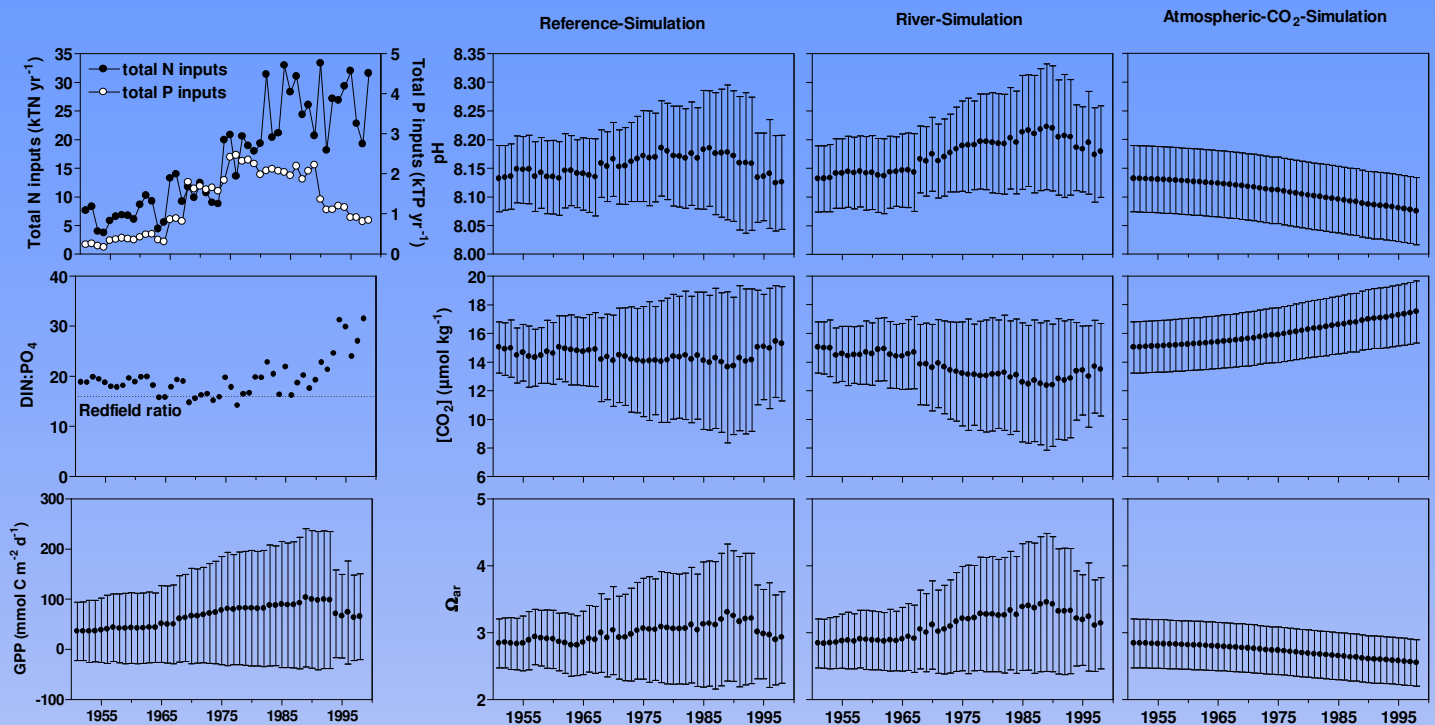


Carbonate chemistry in the coastal zone responds more strongly to eutrophication than to ocean acidification

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The accumulation of anthropogenic CO₂ in the ocean has altered carbonate chemistry in surface waters since pre-industrial times and is expected to continue to do so in the coming centuries. Changes in carbonate chemistry can modify the rates and fates of marine primary production and calcification. These modifications can in turn lead to feed-backs on increasing atmospheric CO₂.

We used the RIVERSTRAHLER-MIRO-CO₂ (R-MIRO-CO₂) coupled model (Gypens et al. 2009) to investigate the decadal changes of seawater carbonate chemistry variables related to the increase of atmospheric CO₂ and of nutrient delivery in the highly eutrophied Belgian coastal zone (BCZ) over the period from 1951 to 1998.

From 1951 to 1998, two periods can be distinguished in terms of river inputs of N and P, quality of nutrient enrichment defined by winter-time ratio of dissolved inorganic nitrogen to phosphate (DIN:PO₄), gross primary production (GPP), and carbonate chemistry variables (pH, [CO₂] and saturation state of aragonite (Ω_{ar})).

From 1951 to 1990, the river nutrient inputs increased and the winter-time DIN:PO₄ ratios remained close to phytoplankton requirements (Redfield ratio = 16:1) leading to an increase of GPP. Consequently pH and Ω_{ar} increased and [CO₂] decreased. From 1990 to 1998, the decrease of the total P river inputs (mainly due to removal of polyphosphates from washing powders), led to winter-time DIN:PO₄ ratios above the Redfield ratio, and to a P limitation and decline of GPP. Consequently, pH and Ω_{ar} decreased and [CO₂] increased.

Sensitivity analysis shows that decadal changes in water temperature and wind speed had little impact on the simulated decadal changes in carbonate chemistry variables. The comparison of the River-Simulation (all forcings kept constant except river loads) and the Atmospheric-CO₂-Simulation (all forcings kept constant except increasing atmospheric CO₂) shows that most of simulated decadal changes in carbonate chemistry variables are related to the increase of nutrient loads. Hence, the effect of eutrophication on carbon cycling can counter the effect of ocean acidification on the carbonate chemistry of surface waters. However, after 1990, the pH and Ω_{ar} decreased faster and [CO₂] increased faster than expected from ocean acidification. This highlights that changes in river nutrient delivery loads due to management regulation policies can modify carbon cycling in the coastal zone, and lead transiently to stronger changes in carbonate chemistry than ocean acidification.