Modeling pH changes in coastal seas: why are there regional differences?

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Introduction
Ocean acidification, the lowering in pH driven by the absorption of anthropogenic atmospheric CO$_2$ is a major problem for present-day oceans. Measurements for the open ocean reveal a decrease in pH of 0.0013-0.0020 unit/yr; however, the few available long-term data sets of coastal regions [1-3] show variable trends, which in some cases exceed the open ocean decrease in pH by one order of magnitude. The differences with the open-ocean rate and among data sets suggest that processes other than enhanced CO$_2$ uptake alone can lead to coastal acidification.

Research questions
- What is the relative importance of physical and biogeochemical processes responsible for acidification in coastal seas?
- How can we explain variability between the southern North Sea, Baltic Sea, northwestern Mediterranean Sea and South China Sea?

Regional variability
At present, atmospheric deposition contributes most significantly to total acidification in the North Sea (13-29%) and least in the NW Mediterranean Sea (1.7-3.4%) (Fig. 2). Assuming no changes in input, this contribution will increase during the 21st century (17-41% in the North Sea in 2100) due to a decrease in the seas’ buffering capacities.

Effect of different processes on pH
By modeling pH explicitly we can show that production and respiration dominate proton cycling (Fig. 3). The increase in cycling intensity with time is due to a 60% decrease in buffering capacity during the 21st century.

Main conclusions
- Atmospheric deposition of sulfur and nitrogen enhances acidification of coastal seas by further decreasing their buffering capacities, especially in the southern North Sea
- Regional differences are a result of both differing atmospheric deposition and production rates and varying buffering capacities
- Production and respiration account for the majority of proton cycling. Hence, disturbing their balance has the most profound effect on pH

References