Ocean acidification in the Belgian coastal zone

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Introduction

The open ocean is a major sink of anthropogenic CO_2, however the accumulation of anthropogenic CO_2 has altered carbonate chemistry in surface waters since pre-industrial times, and is expected to continue to do so in the coming centuries. Ocean acidification of surface waters corresponds to the increase of CO_2 and of H^+, the decrease of pH, of $CO3^{2-}$, and of the saturation state of calcite and aragonite, all related to shifts in thermodynamic equilibria in response to the input of anthropogenic CO_2 from the atmosphere. Changes of saturation state of calcite and aragonite can have negative impacts on marine organisms some of which have an important economic value for tourism (coral reefs) or fisheries (shellfish, …). On the other hand, an increase of CO_2 in seawater can stimulate the photosynthesis of certain autotrophic organisms.

In coastal waters, other factors in addition to the absorption of anthropogenic CO_2 could also affect carbonate chemistry at decadal time scales (Fig. 1). Atmospheric inputs of nitrogen or sulfur could lead to enhanced acidification, while eutrophication could counter to acidification.

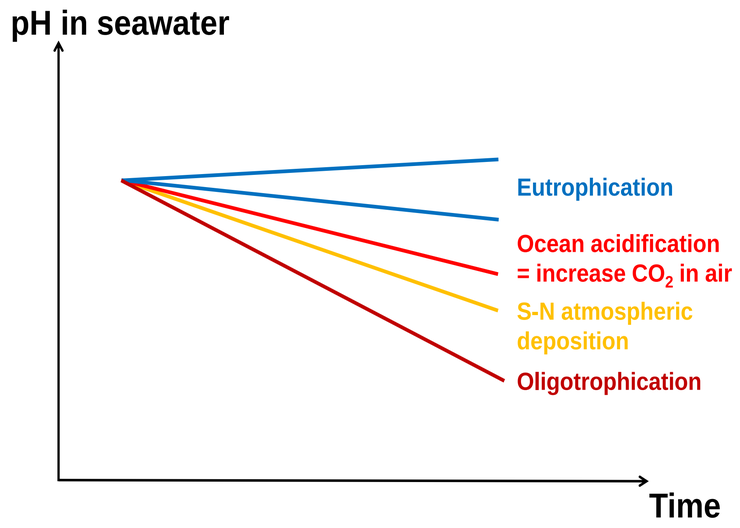

Figure 1: Conceptual frame of the change of pH in oceanic waters, in particular, for coastal waters such as the Belgian Coastal zone.

Datasets

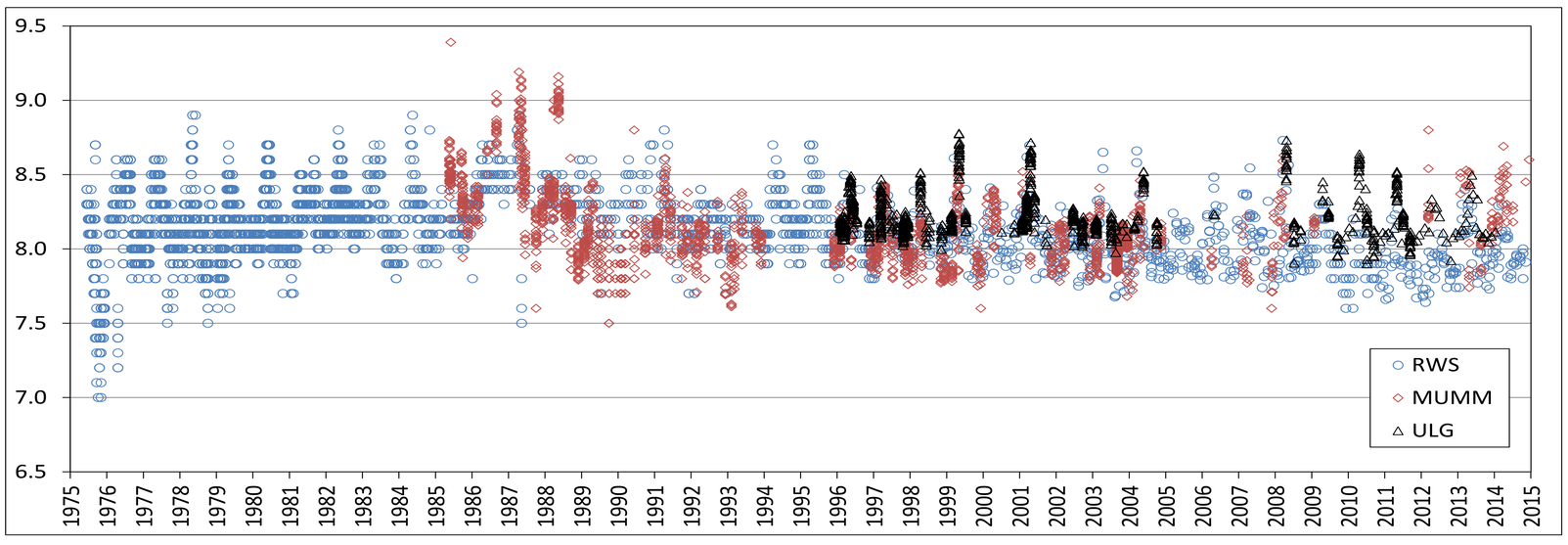

Figure 2: Available pH data records in the Belgian coastal zone as function of time from Rijkswaterstaat (RWS), Royal Belgian Institute of Natural Sciences (RBINS), and University of Liège (ULg). Longest continuous record provided by RWS.

In the frame of WP5 in the BELSPO project "4 decades of Belgian marine monitoring" (4Demon), we compiled available historical datasets of pH in the Belgian coastal zone.

The dataset spans from 1970 to 2015, and totals > 8,800 values.

Three main contributors to the datasets are :

1. Rijkswaterstaat (RWS)
2. Royal Belgian Institute of Natural Sciences (RBINS)
3. University of Liège (ULg).

Results and Main Conclusions

A direct comparison of the 3 datasets is not possible since the data were obtained at different dates and locations, but for some periods data is available simultaneously from the 3 main records (Fig. 3).

This shows that the data from the 3 main records are comparable numerically. Reassuringly, the datasets also show a seasonal variation that is consistent with the know biological cycles: increase of pH in spring and summer resulting from primary production, decrease of pH in fall and winter with a dominance of respiration over primary production.

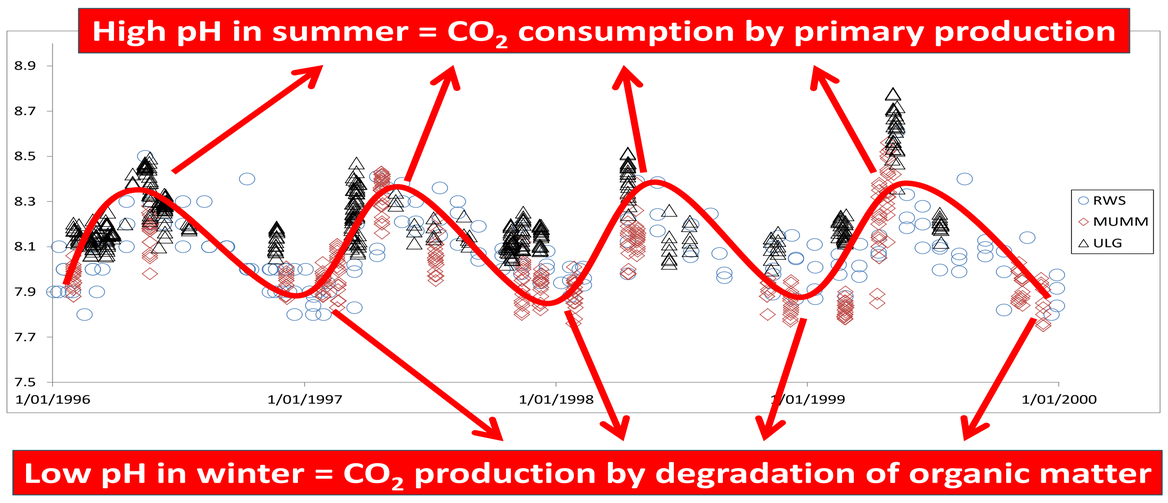

Figure 3: sub-set from 1996 to 2000 of pH data records in the Belgian coastal zone as function of time from Rijkswaterstaat (RWS), Royal Belgian Institute of Natural Sciences (RBINS), and University of Liège (ULg).

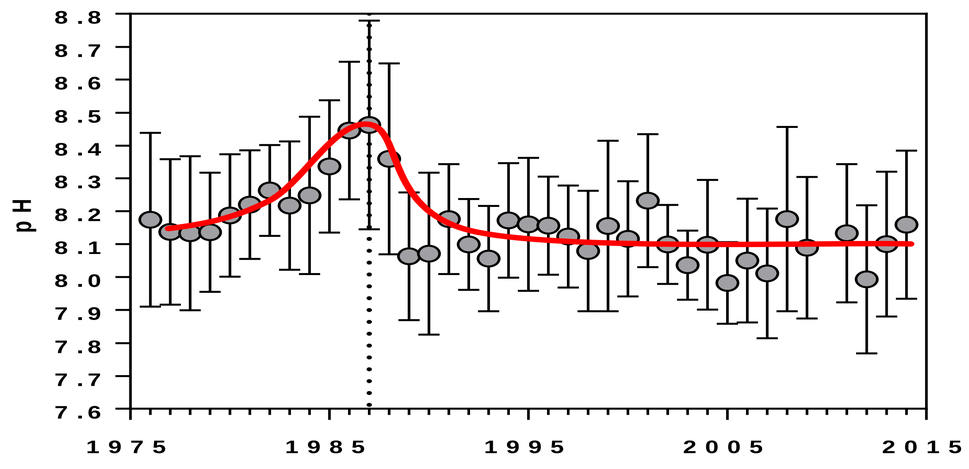

Figure 4: Annual averages of pH in the Belgian coastal zone

In order to remove seasonal effects and emphasize long term trends, data were averaged annually (Fig. 4). The emerging pattern from the annual means is an increase of pH from the early 1970's to the mid 1980's, and then a decrease on-wards.

This pattern could be related to changes in primary production related to eutrophication and nutrient reduction policies, in response to European legislation (reduction of phosphate emissions to rivers and coastal zones implemented from the mid 1980's onwards).

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