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Interactions between ocean acidification and seasonal oxygen depletion in the northern Adriatic

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Since the beginning of the Industrial era, oceanic uptake of CO_2 has resulted in the acidification of the ocean; the pH of ocean surface water has decreased by 0.1 and a further decrease of 0.4 units is expected for the end of the century. These changes have effects on the marine biota, especially on calcifying organisms, like planktonic calcifiers, corals, sea urchins, bivalve mollusks, and then have consequences on the entire trophic chain. The negative impact of ocean acidification could be enhanced in some coastal ecosystems, such as the semi - enclosed shallow northern Adriatic, characterized by the presence of numerous riverine inputs and high variability of its biogeochemical properties. It is also an area with marked anthropogenic pressure, being surrounded by highly industrial regions, in which an acidification process of 0.0025 pH_Tunits/year was previously observed.

The study of the drivers influencing the variability of the CO_2 system and the maintenance of long term series in the northern Adriatic are key issues for understanding the effects of ocean acidification.

Samplings have been performed with a monthly/bimonthly frequency, from December 2014 to January 2017 along a transect from the Po river delta to Croatia (Rovinj). Beside alkalinity and pH_T (total scale), used to define the CO_2 system, salinity, temperature, dissolved oxygen, nutrients, and chlorophyll a were measured.

During the study period strong fluctuations were found: the annual variation of pH_T and pCO_2 reached $\sim$0.56 units and $\sim$618 μatm, respectively; with minima of pH_T (maxima of pCO_2) occurring in autumn and maxima of pH_T (minima of pCO_2) in winter, in proximity of the Po river delta. The ranges were more limited in the eastern oligotrophic waters: up to $\sim$0.29 units and $\sim$249 μatm for pH_T and pCO_2, respectively.

Despite the acidification trend and the seasonal pH decrease, the system never reached the under-saturation state even with the lowest pH_T value (7.828). This was probably due to the freshwater discharges, which increase the ratio alkalinity / total dissolved inorganic carbon and thus the buffering capacity of the system, as demonstrated by the low Revelle factor. Moreover, in the Gulf of Trieste, a time series of the carbonate system has been collected since 2011 on a monthly basis, and an acidification trend has been found. This process can be amplified by other events like the seasonal hypoxia; as in 2015 when in the Gulf quite low pH values ($\sim$7.750) were reached in summer. However, the waters in this area remained always considerably above the carbonate saturation state.

Due to the large seasonal, annual and interannual variability of the CO_2 system it is difficult to highlight the trends over a limited time period and it is vital to obtain long term series to understand the response of shallow systems to the anthropogenic CO_2increase.