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Distribution of anthropogenic CO2 and acidification levels in the Eastern Mediterranean Sea – Comparison of two approaches

Evangelia Krasakopoulou (1), Ekaterini Souvermezoglou (1), and Catherine Goyet (2)

(1) Institute of Oceanography, Hellenic Centre for Marine Research, 19013, Anavyssos, Greece, (2) Universite de Perpignan, Via Domitia, 52 avenue Paul Alduy, 66860 Perpignan, France

The Mediterranean Sea plays an active role in the sequestration of atmospheric CO2 because of: 1) its high total alkalinity, 2) its deep waters short residence time and 3) the basin's general circulation features. The Mediterranean Sea is one of the few places in the world ocean where deep water mass formation takes place, i.e. the Gulf of Lions in the western basin and the Adriatic and Aegean Seas in the eastern basin. The Eastern Mediterranean is the formation area of the dominant water mass of the Mediterranean basin, the Levantine Intermediate Water (LIW) that is subsequently exported to the North Atlantic through the Strait of Gibraltar. Although its considerable influence on the global ocean circulation, little is known about the carbon chemistry of the Mediterranean Sea.
Over the last decade, several national and international programs were designed to provide both knowledge and reference for further investigation on the inorganic carbon system in the region. Using data acquired during the cruises of the FP6 SESAME-IP project in the different compartments of the Eastern Mediterranean Sea (Aegean, Ionian and Levantine Seas), the distributions of CT and AT are described and the observed differences are discussed. For instance, the distributions of these two parameters showed that the Aegean Sea deep waters hold the highest CT and AT values, reaching 2340 and 2670 micromol/kg respectively. Nevertheless important differences exist between the North and the South Aegean Seas.
Furthermore this study compares two different data-based approaches for estimating the concentration of anthropogenic CO2 (Cant) that has been accumulated since the pre-industrial era: the so-called preformed inorganic nutrient method and the TrOCA approach. Based upon the Cant estimates, the level of acidification is also quantified. Despite the different methodologies used, similar results are obtained. They show that large amounts of anthropogenic CO2 have already invaded the Mediterranean Sea even within the deepest water masses. The accumulation of Cant causes a significant reduction in pH of the Mediterranean water masses since the beginning of the industrial era, but at different levels depending on their origin and history. However, the calcite and aragonite saturation state of the Eastern Mediterranean Sea is high throughout the water column, hence carbonate dissolution seems unlikely. Nevertheless the observed decrease in pH may have both direct and indirect impacts on microbial nutrient cycling and carbon fixation, which may, in turn, fundamentally alter the current biogeochemical cycles in the Mediterranean Sea. The observed decreasing pH will probably increase its oligotrophic nature and the degree of phosphorus limitation and could, therefore, contribute to reduced productivity and carbon export. The new field measurements of the carbonate system properties together with observational and experimental data that will be collected within the frame of the FP7 MedSeA project will elucidate these issues.