CARBON ISOTOPES IN THE MEDITERRANEAN SEA

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Abstract
The first basin-wide survey of carbon isotopes in the Mediterranean Sea were from samples collected aboard Meteor cruise 84_3 in 2011. Here we present the delta^{13}C and Delta^{14}C in dissolved inorganic carbon (DIC) data and examine the implications for circulation, ventilation and of anthropogenic CO_2 uptake.

Keywords: Carbon, Vertical profile, Tyrrhenian Sea

The atmospheric stable carbon isotopic composition of CO_2 is changing due to the light carbon in fossil fuels, the Suess effect. The decreasing delta^{13}C signal in DIC can be traced in the ocean and provides an estimate of the anthropogenic CO_2 (Cant) uptake rate. This method is particularly useful since it mimics the slow equilibration time of CO_2 across the air-sea interface and provides an independent and integrated measure of interior ocean Cant storage. This is particularly useful for the Mediterranean Sea since large temporal variability in ventilation renders other Cant inference methods problematic. Those other methods assume steady-state circulation and ventilation. Here we compare the 2011 data [1] to delta^{13}C data from the 1988 and 1990 [2], VICCOMED data. A particularly large ?^{13}C (? ?^{13}C) decrease exists in the Western Mediterranean and Adriatic Seas over this time-period. The Deltadelta ^{13}C values in the Levantine Basin are particularly small, as recently reported by [3] using data near the Israeli coast. The VICCOMED data do not cover the water column below about 2500 meters. In the Mediterranean these waters are generally well ventilated so the full anthropogenic signal could not be estimated. The storage rate of Cant in the upper 2500 meters of Western Mediterranean Sea is in excess of 1 mol C m^2 y^{-1}. This is about twice the global average storage rate, and is likely an underestimate.

We also compare the Delta^{14}C data from 2011 with one profile taken in the Ionian Sea during the GEOSECS project in 1977. Fossil fuel is "dead" with respect to ^{14}C isotopes, so the atmosphere would get lighter with time. The transient signal is, however, dominated by atmospheric ^{14}C input from nuclear bomb tests in the 1960's. In the Ionian Sea we find a remarkable increase of Delta^{14}C throughout the entire water column. This very clear signal of deep ventilation and penetration implies similar Cant distributions through the water column of the Mediterranean Sea.

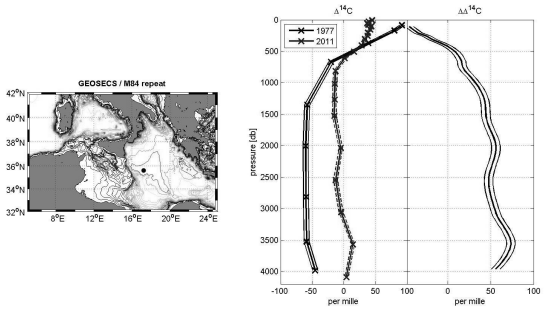

Fig. 1. Repeat measurements of Delta14C in the Ionian Sea; the left panel shows the location of the station, and the right panels show the measurements and the difference over time – narrow lines indicate level of analytical uncertainties.

The surface water Delta^{14}C decrease between 1977 and 2011 parallels the atmospheric decline and illuminates the ventilation signal as the bomb-produced ^{14}C transient moves into the water column.

These carbon isotope data help constrain the uptake and storage of anthropogenic carbon in the Mediterranean Sea. The values are very high due to: 1) high temperature and alkalinity of the deep waters (large buffer factor for Cant uptake), and 2) active deep water formation. While the Cant storage is high everywhere in the Mediterranean Sea, the data indicate significant regional differences.

References
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