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Towards better understanding of carbon and oxygen biogeochemical rates in the Red Sea

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Abstract

The Red Sea is one of the warmest and saltiest seas in the world, with surface water temperatures of 26–30°C and salinities of 36–41. The sea gains heat in the south and loses heat in the north and this gives a large-scale thermohaline circulation pattern with a northward surface flow and a southward flow at sill depth. At smaller spatial scales, along-coastal currents and upwelling occur.

Here we summarise the main results from two studies that are parts of a PhD-study. We demonstrate how multi-spatial scale circulation and biological processes influence rates of: air-sea flux of carbon dioxide (CO2), oxygen utilization (OU), and removal of total alkalinity by calcification and sedimentation, i.e., alkalinity utilization (AU).

In the first study, based on cruise data collected in the Red Sea in 2011 and 1982 (Aegaeo and MEROU cruises, respectively), we combine depth profiles of tracer-based water mass ages, AU, and OU to derive the first-ever basin-wide, long time integrated utilization rates of alkalinity (AUR) and oxygen (OUR). Results reveal that the large-scale circulation impacts the water masse ages and OU

while remineralization of organic matter and calcification also influences in depth variations of OU and AU. The highest rates for OUR and AUR occur in the surface water followed by a swift attenuation of the rates towards zero for AUR and ~5 μmol kg^{-1} for OUR at 500 m depth.

In the second study, new carbon and hydrography data from the Sudanese coastal Red Sea were used to investigate seasonal dynamics of sea surface partial pressure of CO_2 (pCO_2) and air–sea CO_2 exchange. The results show that seasonal pCO_2 change was primarily driven by temperature changes while along-coast advection, upwelling of CO_2-rich deep water, and uptake of atmospheric CO_2 also contributed to changes in dissolved inorganic carbon and total alkalinity. Furthermore, based on a compilation of historical and our new data, the region seems to have transformed from being a source of CO_2 to the atmosphere throughout the year to becoming a sink of CO_2 during parts of the year.