EGU2020-8875
https://doi.org/10.5194/egusphere-egu2020-8875
EGU General Assembly 2020

Carbon and nutrient cycling between estuarine and adjacent coastal waters

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Seasonal and annual nitrate and phosphate loads were determined from FerryBox measurements to investigate the high seasonal and inter-annual variability of carbon and nutrient exchange between the Elbe estuary and North Sea. At the inner continental shelf, high biological activity is driven by riverine nutrient inputs, which can contribute to the net carbon dioxide (CO_2) uptake. It is possible that in tidal systems this newly formed phytoplankton is transported back into the estuary over the flood tide, and this organic matter can be remineralized in the intertidal region. At present, the influence of this tidally driven mechanism on the nutrient exports and primary production in the coastal zone is not fully characterized, hence carbon sources and sinks at the estuary-coastal boundary may not be well accounted for.

The coupling between nutrient inputs from the Elbe estuary to adjacent coastal waters and the subsequent biological activity are now being investigated with a high-frequency dataset provided by a FerryBox situated at the mouth of the estuary. The FerryBox continuously measures physical and biogeochemical parameters every 10 to 60 minutes. Prelimary seasonal and nutrient (nitrate and phosphate) loads from the Elbe estuary to the coastal waters were calculated with FerryBox data between 2014 and 2017. The nutrient loads exhibited high seasonal and inter-annual variability. For example, in summer 2014 nitrate loads reached 100 x 10^7 mol yr^{-1} whereas, in summer 2017 nitrate loads were 50 x 10^7 mol yr^{-1}, which cannot be explained by river discharge alone. Such changes in nutrient loads are likely to influence primary production rates in the adjacent coastal waters and impact CO_2 uptake and therefore carbon cycling.

Time-series analysis is employed to determine patterns in oxygen changes in relation to photosynthesis and respiration, along with nutrient fluctuations, between 2014 and 2017. Salinity is used to differentiate between the coastal and estuarine end members, with low and high salinity representing flood tide (estuarine waters) and ebb tide (coastal waters), respectively. Changes in dissolved oxygen concentrations are used to estimate primary production (P) and community respiration (R) rates in the water column. The P/R ratio provides the ability to classify the community into autotrophic and heterotrophic systems. Results of this analysis will show the role of varying nutrient loads in supporting primary production in the coastal waters, along with estimating net ecosystem metabolism, and therefore give us a better understanding of nutrient and carbon cycling.

How to cite: Rewrie, L., Voynova, Y., Brix, H., and Baschek, B.: Carbon and nutrient cycling between estuarine and adjacent coastal waters , EGU General Assembly 2020, Online, 4–8 May 2020, EGU2020-8875, https://doi.org/10.5194/egusphere-egu2020-8875, 2020