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Application of stable carbon isotopes in long term mesocosm studies for carbon cycle investigation

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Carbon dioxide (CO_2) is an effective greenhouse gas. The Oceans absorb ca. 30% of the anthropogenic CO_2 emissions and thereby partly attenuate deleterious climate effects. A consequence of the oceanic CO_2 uptake is a decreased seawater pH and planktonic community shifts. The quantification of the anthropogenic perturbation was investigated through stable carbon isotope analysis in three "long term" mesocosm experiments (Sweden 2013, Gran Canaria 2014, Norway 2015) which reproduced near natural ecosystem conditions under both controlled and modified future CO_2 level (up to 2000 ppm) scenarios. Parallel measurements of the stable isotope composition of dissolved inorganic carbon (δ13CDIC) dissolved organic carbon (δ13CDOC) and particulate carbon (δ13CTPC) both from the mesocosms water column and sediment traps showed similar trends in all the three experiments. A CO_2 response was noticeable in the isotopic dataset, but increased CO_2 levels had only a subtle effect on the concentrations of the dissolved and particulate organic carbon pool. Distinctive δ13C signatures of the particulate carbon pool both in the water column and the sediments were detectable for the different CO_2 treatments and they were strongly correlated with the δ13CDIC signatures but not with the δ13CDOC pool. The validity of the isotopic data was verified by cross-analyses of multiple substances of known isotopic signatures on a GasBench, Elemental Analyser (EA) and on an in-house TOC-IRMS setup for the analysis of δ13CDIC, δ13CTPC and δ13CDOC, respectively. Results from these mesocosm experiments proved the stable carbon isotope approach to be an effective tool for quantifying the uptake and carbon transfer among the various compartments of the marine carbon system.