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Biogeochemical Response to Ocean Alkalinity Enhancement from varying Alkalinity Sources

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Negative CO_2 emission technologies such as ocean alkalinity enhancement (OAE), in tandem with emissions reduction is necessary to keep the climate system below a critical tipping point. While the biogeochemical consequences of OAE are poorly constrained, field deployment is rapidly accelerating in the commercial sector, leaving questions of ecosystem impact in the wake. In this study we conduct alkalinity perturbation experiments using concentrations and timescales consistent with a ship-based deployment – near field, far field, and long term (figure) – to capture the resultant impact to the carbon and carbonate pools. We quantify shifts in dissolved/particulate inorganic (DIC, PIC) and organic (DOC, POC) carbon after the addition of three alkalinity sources – NaOH, CaO, and $NaHCO_3$ + $CaCl_2$ (to simulate dissolved limestone). In the near field experiments, we show how the threshold for spontaneous precipitation of PIC post alkalinity addition changes based on the type of alkalinity used for OAE. We find precipitation occurs at Omega_aragonite = 30 for NaOH, 8 for CaO, and 8 for $NaHCO_3$ + $CaCl_2$ addition. In the far field, we explore changes in PIC and POC production after a ~500 µmol/kg alkalinity perturbation in 6L of surface ocean water that is incubated for 0-4 days. These microcosms are either exposed to a natural light-dark cycle or are completely isolated from the light. We discover that the likelihood of PIC formation depends on the strength of the alkalinity source and the potential surface area for nucleation (i.e. ambient PIC concentration). We will also present preliminary results from the Ocean Alkalinity Enhancement Pelagic Impact Intercomparison Project (OAE PIIP), which requires monitoring of a wider range of standardized biogeochemical parameters over a 20-day incubation. This is a global project led by L. Bach (U. Tasmania) that will expand our understanding of OAE impact on particles to changes in phytoplankton size classes, nutrients, and microbial diversity. Primarily, this synthesis provides threshold guidelines to negate carbonate (PIC) formation, which will help identify regions suitable for OAE scale up but also contributes to a comprehensive assessment of the ecosystem response to OAE within surface ocean waters in the Los Angeles region.