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Discerning the drivers of inter-annual pCO_2 trends in the Bay of Brest.

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High intra- and inter-annual variability in the carbonate system in temperate coastal ecosystems makes it difficult to discern the anthropogenic carbon dioxide (CO_2) signal in surface waters. A CARIOCA buoy was deployed in the Bay of Brest, a macro-tidal estuary, in 2003 and has collected high-frequency partial pressure of CO_2 (pCO_2) and ancillary data at this site for over a decade, with complementary measurements of dissolved inorganic carbon (CT) and total alkalinity (AT) being taken over the last half decade.

The monthly temperature-normalized pCO_2 anomalies, calculated from climatological averages, over the decade (2003-2012) show a trend of increase of +4.38 μatm yr-1, an approximate two-fold increase of that of the atmospheric pCO_2 increase. However, two patterns emerge from this overall trend; a period of more gradual increase from 2003-2009 (+2.4 μatm yr-1), and an accelerated rate of increase from 2010-2012 (+21 μatm yr-1). A similar pattern is observed in the AT and CT data, which show a half-decade trend of +3.3 μmol kg-1 yr-1 and +3.4 μmol kg-1 yr-1, respectively, however, demonstrate a trend of +17 μmol kg-1 yr-1 and 21 μmol kg-1 yr-1, respectively, from 2010 to 2012. The anomalies during this period are significantly correlated to salinity anomalies (R2=0.67), indicating that they are driven by changes in water mass contributions or end members. Taking the salinity change into account, the changes in AT and CT during this time period account for 85% of the increased pCO_2 trend from 2010 to 2012.

Obtaining an average yearly temperature-normalized pCO_2 anomaly, this value shows a significant correlation (R2=-0.66) with the North Atlantic Oscillation index (NAOI) from 2003 to 2009, however, this relationship breaks down in 2010, a year of exceptionally negative NAOI (-4.64). The increase in salinity indicates that the source of the additional AT and CT is the North Atlantic, which have been shown to be affected by climatic forcing, however, the various time-scales of the processes of water mass formation and water mass transport make it difficult to constrain how this change comes about.