Ocean pCO₂ Variability and Drivers at the US Atlantic Coastal Pioneer Array

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Introduction
- The ocean plays an important role in the global carbon cycle by taking up and releasing significant amounts of CO₂ each year.
- Characterizing oceanic and atmospheric CO₂ exchange is therefore vital for studying climate change and ocean acidification, but the magnitude, sign, and drivers of this flux vary seasonally and spatially.
- Past studies have characterized the Northwest Atlantic as a sink driven by biological and thermal factors (Fennel et al. 2019, Lauderdale et al. 2016, and Takahashi et al. 2002).
- The objective of this research is to characterize local seasonal and interannual cycles of pCO₂ exchange and its drivers, the spatial and temporal variation, and to identify the extent to which the northern US Atlantic continental shelf is a net carbon source or sink.

Method
- This study takes data from three surface moorings (Inshore, Central, and Offshore) along the Atlantic coastal shelf within the Ocean Observatories Initiative Pioneer Array from 2016 and 2017.
- Telemetered data is collected from pCO₂, meteorological, and fluorometer instruments.
- OOI flagged data and outliers outside of 3 standard deviations were removed from the dataset before averaging and plotting.

Calculations
- pCO₂ Flux Calculation
  \[ \text{flux} = k \times T \times \text{pCO₂} \]
  where \( k \) = gas transfer velocity and \( T \) = salinity coefficient
- Takahashi Decomposition Calculation
  \[ \text{pCO₂} = \text{pCO₂}_{\text{calculated}} - \text{pCO₂}_{\text{observed}} \]
  where \( \text{pCO₂}_{\text{calculated}} \) = temperature and dissolved inorganic carbon
  \[ \text{pCO₂}_{\text{observed}} = \text{pCO₂}_{\text{expected}} - \text{pCO₂}_{\text{inferred}} \]
  where \( \text{pCO₂}_{\text{expected}} \) = temperature and dissolved inorganic carbon
  \( \text{pCO₂}_{\text{inferred}} \) = temperature and dissolved inorganic carbon

Summary and Conclusions
- The Northwest Atlantic acts annually as a strong sink for atmospheric carbon, only acting as a minor source in the late summer; the annual average flux is -0.85 to -1.6 mol m⁻² yr⁻¹ from across the three moorings and two years.
- pCO₂ flux varied by as much as 12 mmol m⁻² d⁻¹ between stations and 7 mmol m⁻² d⁻¹ between years. Generalization of this dataset to other locations and time periods may hide distinct cycles or variation.
- Preliminary regression plots that show correlation between pCO₂ and sea surface temperatures, and chlorophyll are further supported by Takahashi decomposition plots which show that pCO₂ variation is highly temperature driven, and somewhat dampened by opposing biological effects.
- This study gives new insight into variation in flux and pCO₂ between stations and years, along with reporting annual flux values and relative contributions of different drivers that are in line with previous studies.
- Long term data collection and further quality control through the Ocean Observatories Initiative will allow research to progress on the effects of climate change and ocean acidification in this area.

References:

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