Interannual variability in the inorganic carbon system at the Gulf of Alaska Ecosystem Observatory

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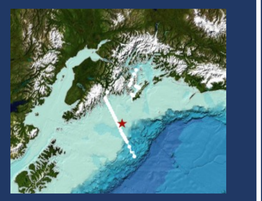
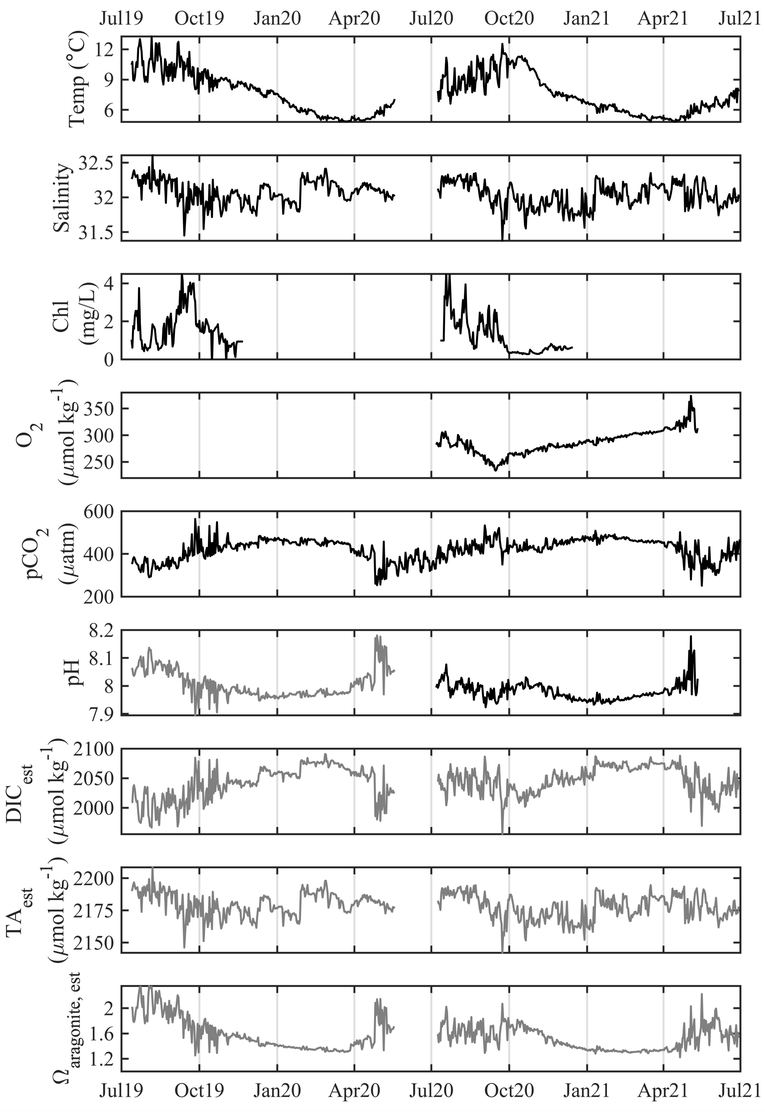
UAF UNIVERSITY OF ALASKA FAIRBANKS

Gulf of Alaska Ecosystem Observatory 59.0°N, -148.7°W

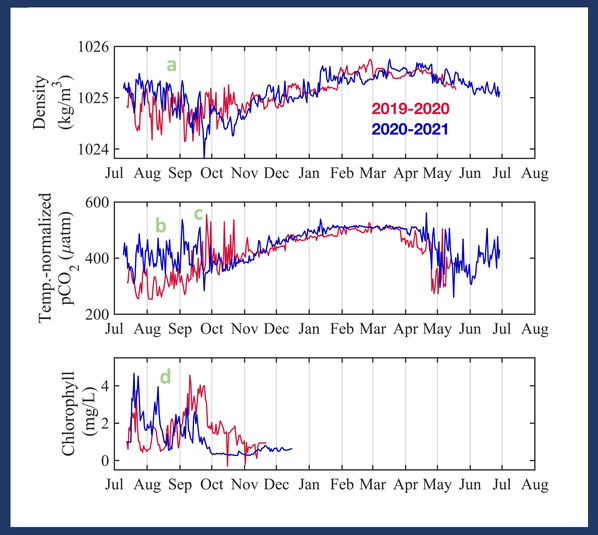


- Physical and biogeochemical sensor measurements available at 25m
- Total alkalinity (TA) is estimated using a salinity-TA algorithm derived from hydrographic measurements. Additional carbonate chemistry parameters (where noted) are calculated using TA_{est} and measured pCO_2
- All parameters are interpolated to pCO_2 measurement frequency (24h).

Two year-long mooring deployments:



Do interannual variations in mixing/water column stability and primary production influence when and to what extent high pCO_2 conditions form?



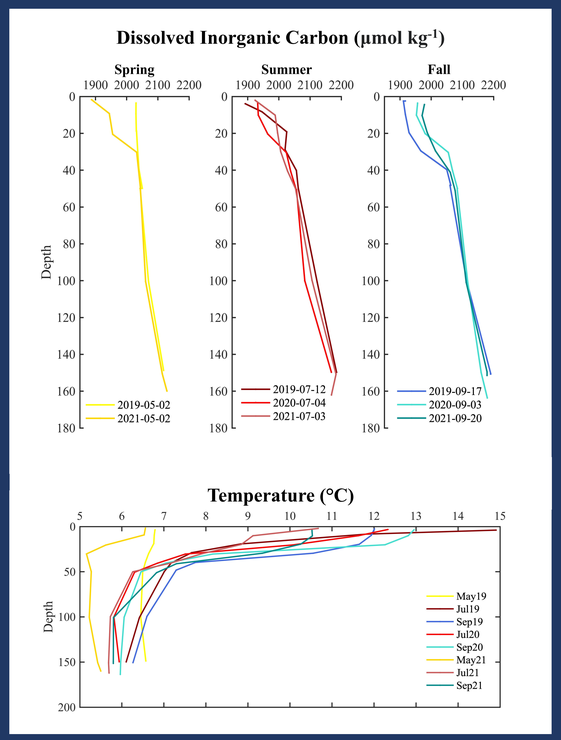
a) Lower density in summer 2019: The marine heat wave may have increased stable stratification.

b) pCO_2 is lower during summer 2019. Decreased mixing and/or stronger stratification may have caused photosynthetically lowered pCO_2 to persist. Chlorophyll was lower in summer 2019 than summer 2020, so higher production may not explain the lower pCO_2 .

c) The pCO_2 yearly maxima in fall 2019 and 2020 is due to mixing from the seasonal onset of storms. The increase is greater in 2019 compared to 2020. The pCO_2 "spikes" are accompanied by increases in density, indicating storm mixing. Decreased mixing throughout summer 2019 may have caused a greater accumulation of inorganic carbon at depth, causing a stronger "spike". Alternatively, since the onset of the 2019 "spike" occurs later, perhaps more carbon has accumulated at depth.

d) In 2019, a fall bloom exceeded the summer chlorophyll. 2020 summer chlorophyll was higher than 2019, and there was a smaller fall bloom. Primary production does not seem to be the primary driver of interannual variation in pCO_2 at 25m, which mirrors density (mixing) more than chlorophyll.

Hydrographic data at nearby station GAK5 gives full water column context



Spring

- Dissolved inorganic carbon (DIC) is the same at depth in 2019 and 2021, indicating a "reset" of conditions from thorough winter storm mixing .

Summer

- 2019 DIC integrated over the water column is higher
  - Is there less carbon in particulate form due to decreased production during the 2019 heat wave? Could higher temperatures in 2019 cause increased remineralization & higher DIC?

Fall

- 2019 DIC is higher at depth, and lower at the surface compared to 2020. This may explain the higher pCO_2 fall "spike" in 2019.
- **Did decreased mixing and/or increased temperatures during summer 2019 cause an increased accumulation of inorganic carbon at depth?**
- **Could spring through fall mixing create or ameliorate potentially harmful conditions at depth?**

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