Hydrodynamic observations in support of Moored Autonomous pCO2 buoy efforts at La Parguera Marine Reserve

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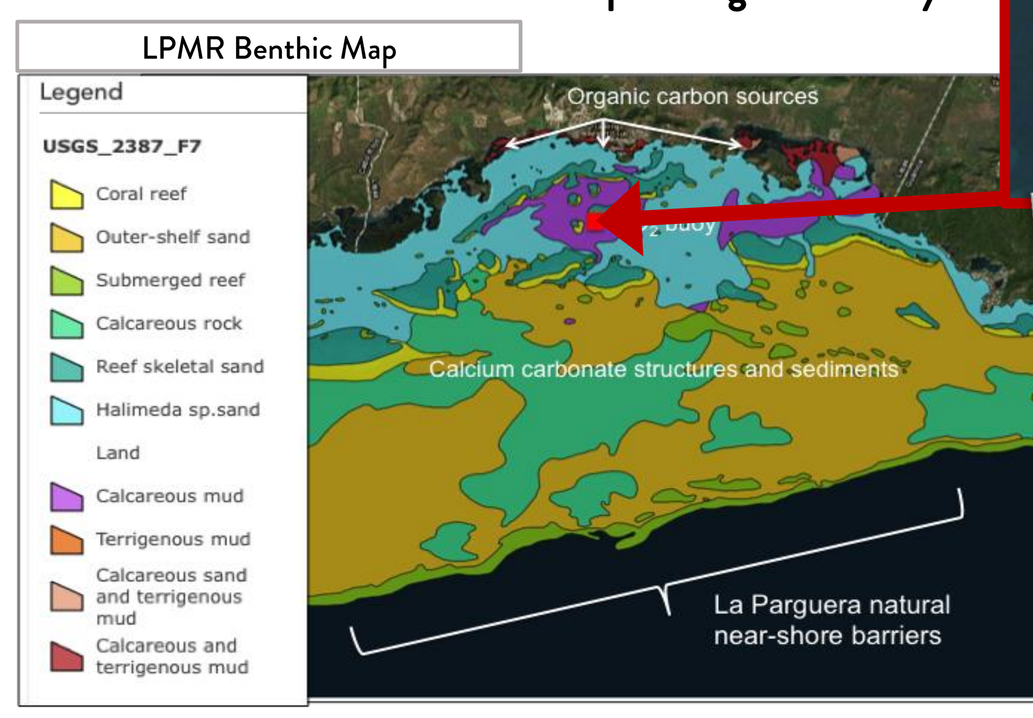
CARICOOS

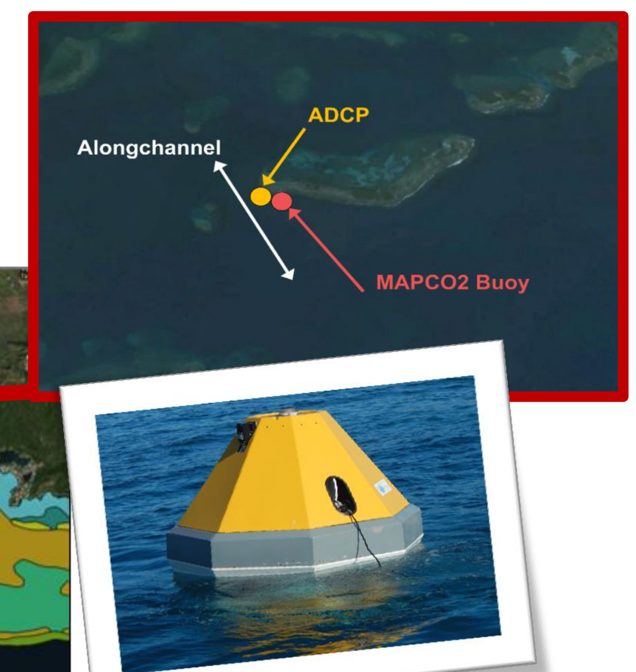
Abstract

Time series of near-reef carbonate chemistry obtained through the National Coral Reef Monitoring Program (NCRMP) at La Parguera Marine Reserve, Puerto Rico exhibit seasonal and diurnal variations modulated by diverse processes including coral community metabolism, thermodynamics and hydrodynamics. While surface CO_2 dynamics have been fairly well characterized with moored pCO_2 measurements, detailed hydrodynamic information resulting from La Parguera's complex morphological, meteorological, and oceanographic processes is currently lacking. This project focuses on a one-month-long hydrodynamic assessment near a fore-reef site located within 100 m of the pCO_2 buoy. Current profiles spanning 12 m of depth were resolved with a bottom-mounted ADCP. Preliminary results show that under no wind conditions, dominant currents are tidally driven and aligned with the reef channel. Depth-averaged currents exhibit diurnal and semidiurnal peaks, not inconsistent with tidal and wind forcing. The analysis also shows that at times surface current direction can differ from near-reef currents by as much as 200 degrees, suggesting a possible mismatch between carbonate chemistry resolved at the surface and that felt by the reef structure. Moreover, buoy measurements are potentially resolving carbonate chemistry from both, oceanic and inshore water masses. Our findings suggest that monitoring and potentially predicting near-reef CO_2 dynamics require interdisciplinary expertise and integrated approaches. This project provides new insights into the effects of tidal and meteorological forcing on the carbonate chemistry of near-reef coral ecosystems.

Study Site

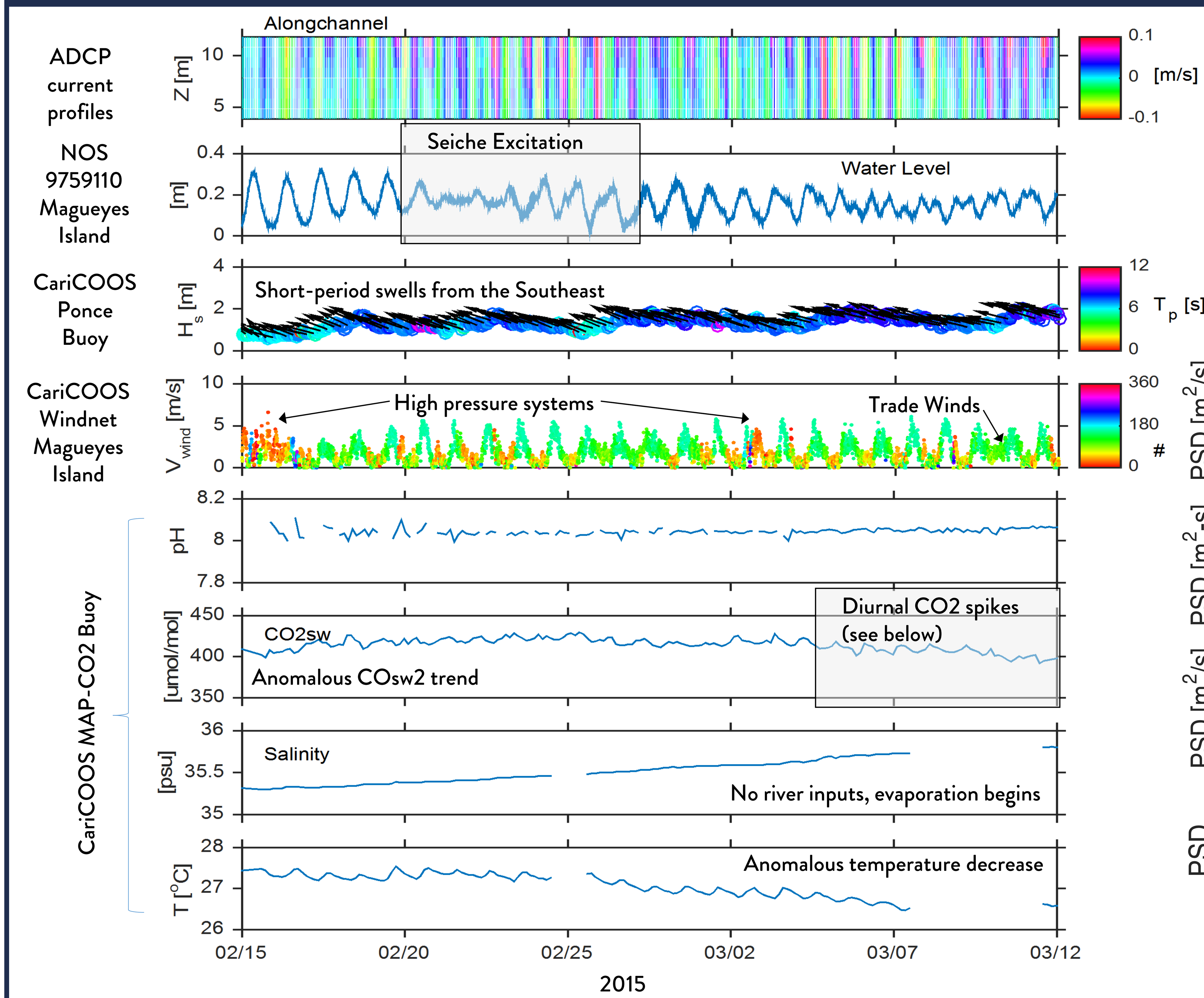
La Parguera Marine Reserve (LPMR)
Mangroves • Sea grasses • Coral reefs
Complex bathymetry leads to **complex hydrodynamics** and even more **complex biogeochemistry.**





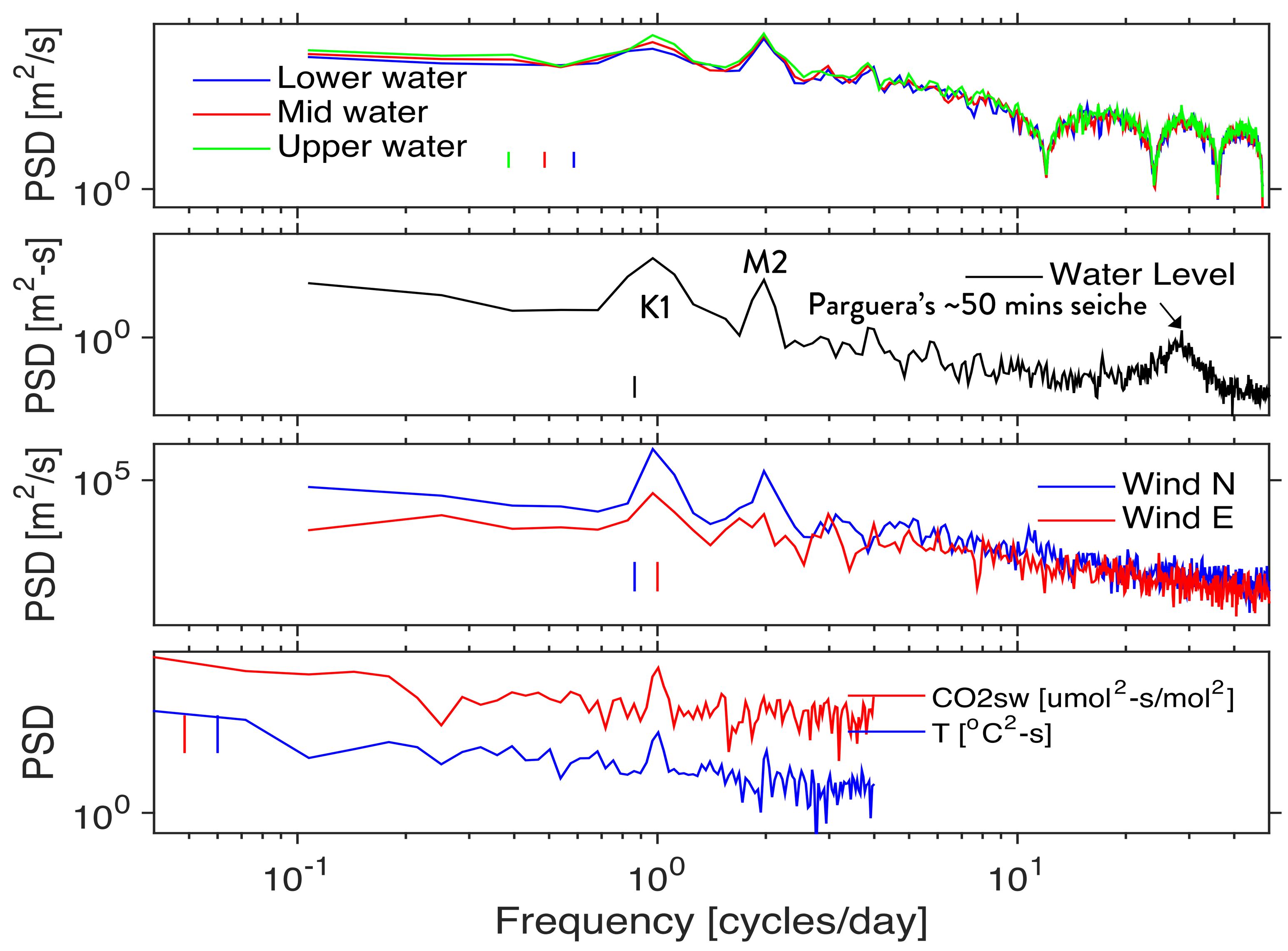
A joint effort between NOAA OAP, NOAA CHMP, NOAA IOOS, NOAA PMEL, UPRM, and UNH.

RESULTS

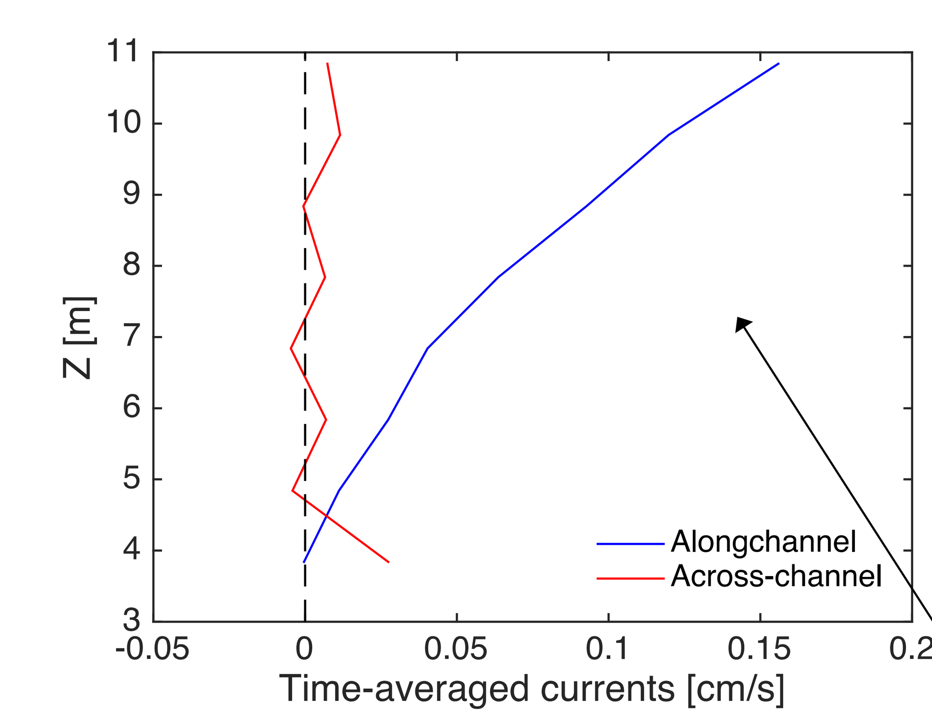


Currents are predominantly directed inshore and are faster in the upper water column. Currents directed offshore often appear during land breeze periods.

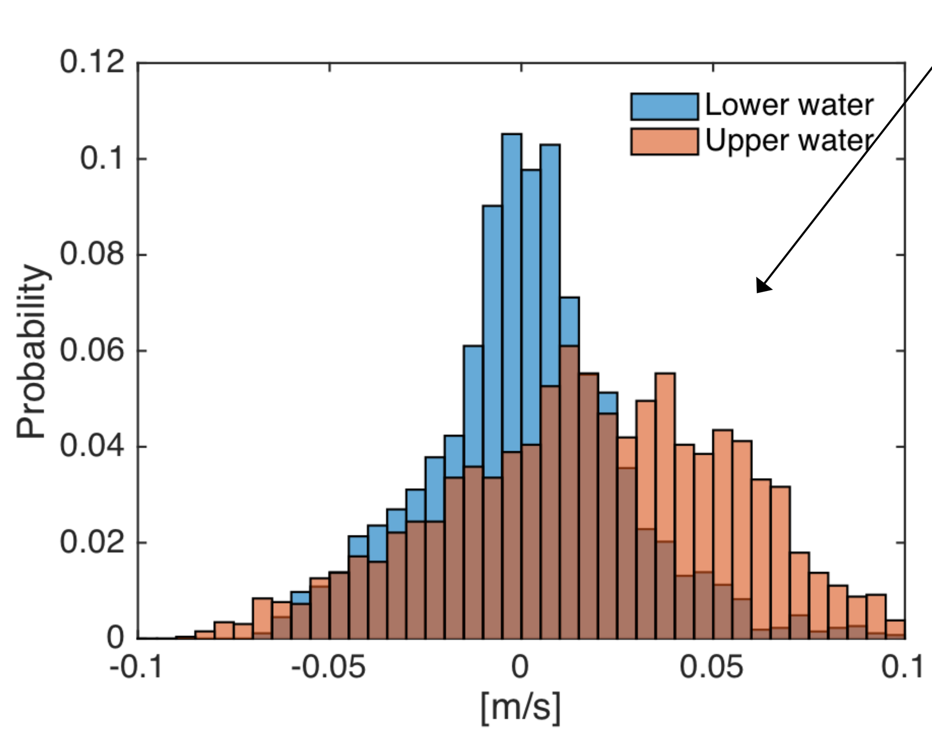
Cycles per day (Diurnal = 1, Semidiurnal = 2)		
Currents	Diurnal	Semidiurnal
Water levels	Diurnal	Semidiurnal
Wind (land-sea breeze)	Diurnal	Semidiurnal
Temperature (cooling & warming)	Diurnal	
CO_2 (metabolic processes)	Diurnal	



Dominant Currents



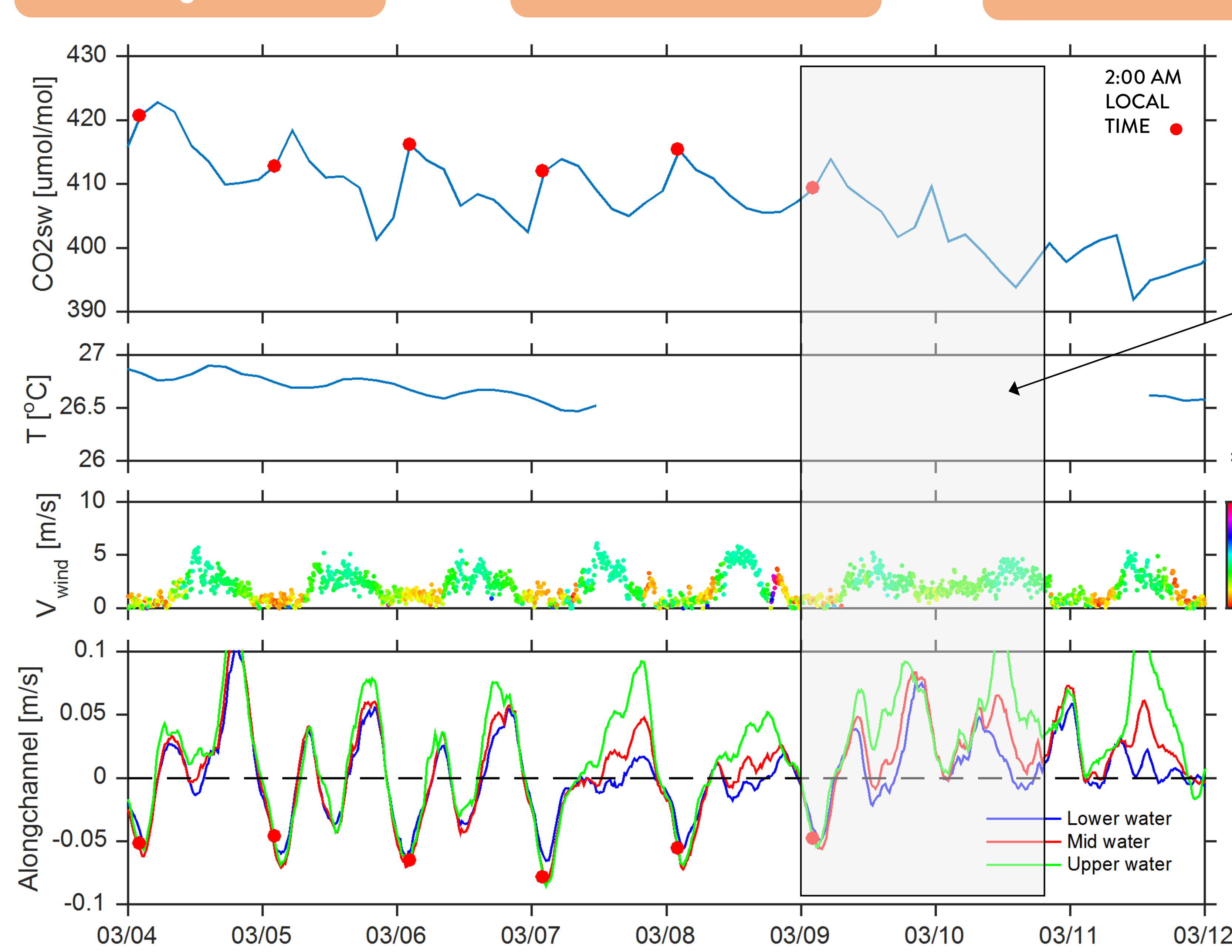
The MAPCO2 buoy is predominantly seeing shelf waters.



Diurnal spikes in CO2

Phenomenological Model for diurnal spikes in CO_2

Land breeze → Respiration mangroves/ sea grasses + Offshore-directed currents = Spike in CO_2



No land breeze → No Flushing → No apparent spike in CO_2

Correlation Tests		
Variables	ρ	P-value
Upper water - CO_2	.26	<.001
Upper water - Temperature	.14	.04

Summary & Future Work

As one of the first efforts looking to provide a hydrodynamic context to LPMR's carbonate chemistry observations, our analysis reveals the following:

- On average, Parguera's MAPCO2 buoy is predominantly seeing shelf waters.
- The alternate case (inshore waters flushing through the channel offshore) corresponds to land breeze periods. This added to mangroves/seagrasses respiration results in a clear diurnal spike in CO2sw.
- Seiche excitation may be responsible for an anomalous CO2sw trend, probably because of induced mixing.
- The history of water masses may be a crucial factor to further the understanding of LPMR's complex biogeochemistry.

FUTURE (ONGOING) WORK:

- CO2 spatial mapping at LPMR to further understand carbonate chemistry over different benthic habitats.
- Observational campaign with Increased temporal and vertical resolution sampling.
- LPMR hydrodynamic model.

Acknowledgements

This work was supported by NOAA IOOS (Grant #NA11NOS0120035), NOAA Ocean Acidification Program and the NOAA Coral Health and Monitoring Program. The authors are grateful to J. Capella and J. González for insightful comments about the Caribbean tides and seiche events, and appreciate the extensive help provided by UPRM's CAOSE, NOAA PMEL, and UNH OPAL teams.