Enhanced OA observing by citizen science initiatives and land-based measurement strategies in coastal Alaska

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Key Points: (1) Citizen scientists extended data coverage across region; (2) Seasonally-modified agreement between village and global datasets; (3) Commitment to project is key to resolving trends, i.e. seasonal cycles; (4) APSH BoL data consistent with other winter data records - data are applicable beyond the hatchery itself with APSH tracking environmental conditions and OA

Introduction:

Ocean acidification (OA) monitoring has been ongoing at the Alutiiq Pride Shellfish Hatchery (APSH) in Seward, Alaska since October 2013. A Burke-o-Lator (BoL) pCO_2/TCO_2 analyzer is used to near continuously determine seawater CO_2 content in water drawn into the hatchery as well as in discrete seawater samples collected by tribal citizen science groups and other research partners operating around Kenai Peninsula and Prince William Sound. This analysis aims to assess the value-added by such citizen science initiatives and land-based measurement strategies in assessing OA compared with larger-scale oceanographic efforts (*i.e.* research vessel (R/V) surveys and oceanographic moorings). While data from large-scale oceanographic work is essential for developing our understanding of OA in Alaska, the addition of citizen science initiatives and land-based measurement strategies allows for increased coverage in dynamic coastal settings that may otherwise remain unresolved.

Burke-o-Lator pCO_2/TCO_2 Analyzer:

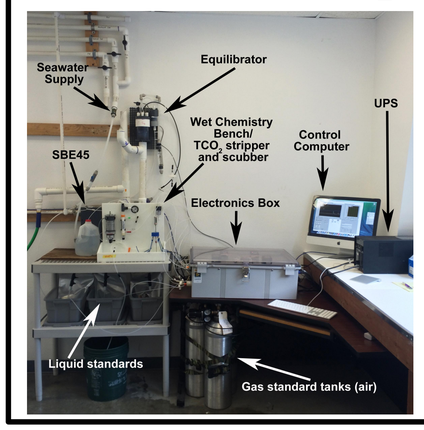

Photo 1: Components of the BoL at APSH. Seawater is drawn into APSH from an intake at 75 m depth in Resurrection Bay adjacent to the hatchery. The CO_2 partial pressure (pCO_2) measurement is made on carrier gas equilibrated with the seawater CO_2 content and analyzed using a non-dispersive infrared (NDIR) sensor (LI-COR LI840A). Total dissolved CO_2 (TCO_2) measurements, made only on discrete samples, are done by acidification and subsequent stripping of evolved CO_2 followed by NDIR analysis.

Citizen Science Contributions:

Photo 2: Seldovia citizen scientist. Photo by Michael Opheim the environmental coordinator for Seldovia Village Tribe.

Table 1: Number of samples provided by village/partner as well as time and geographical coverage and sampling method.

Citizen Science Group	# Good Samples Collected	Time Coverage	Latitude [Deg_N]	Longitude [Deg_W]	Sampling Notes
Seldovia Village Tribe (SVT)	73 (75 Total)	12/15 - 06/17	59.44	151.71	Bucket grab
National Parks Service (NPS) - Aialik Bay Cruises	68 (73 Total)	06/17 - 08/17	59.64 - 59.94	149.52 - 149.84	Niskin bottle
Prince William Sound Science Center (PWSSC)	7 (7 Total)	04/16 - 08/16	60.61 - 60.62	146.73 - 147.20	Niskin bottle
Kachemak Bay National Estuarine Research Reserve (KBNERR)	109 (134 Total)	11/15 - 02/17	59.51 - 59.60	151.35 - 151.65	Bucket grab
Valdez	27 (38 Total)	11/15 - 09/16	61.09 - 61.13	146.13 - 146.36	Bucket grab
Nanwalek	21 (22 Total)	04/15 - 09/15	59.36	151.92	Bucket grab

Total Alkalinity/Salinity Relationship:

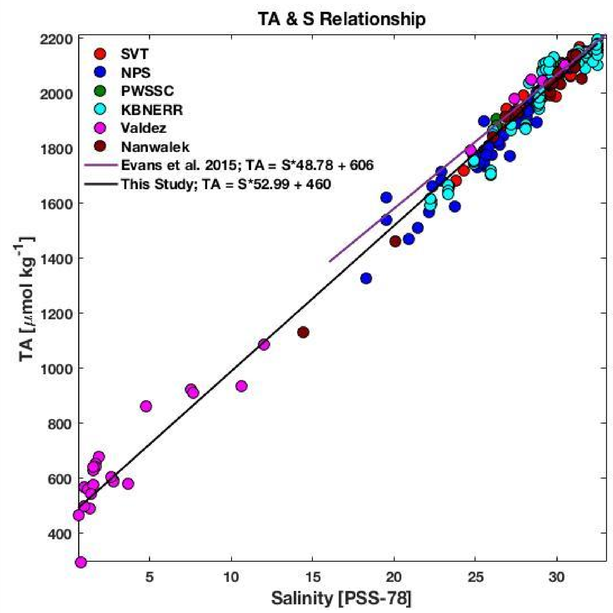

Figure 1: Total alkalinity (TA) versus salinity relationship constructed using data generated by citizen science groups (Table 1). Also shown is the TA-S relationship from Evans et al., 2015 developed using larger-scale oceanographic data collected in the northern Gulf of Alaska (magenta line). The updated TA-S relationship is similar to that of Evans et al., but spans the full range of salinity.

R/V Survey (SOCATv5) Comparison:

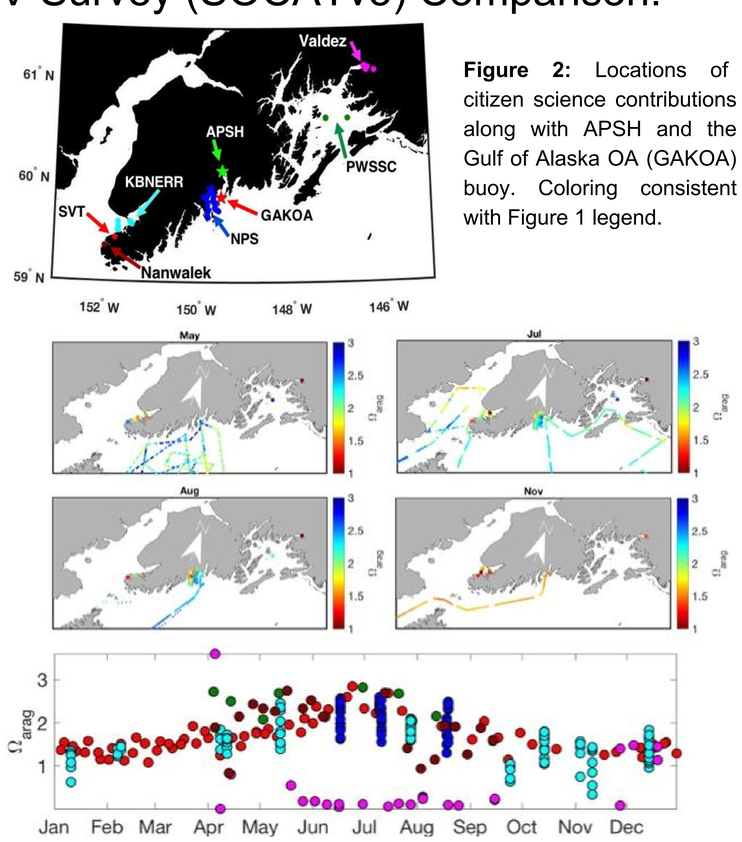

Figure 2: Locations of citizen science contributions along with APSH and the Gulf of Alaska OA (GAKOA) buoy. Coloring consistent with Figure 1 legend.

Figure 3: A global surface water dataset from R/V's has only data for 4 months around Kenai Peninsula. Aragonite saturation states (Ω_{arag}) computed from these data and citizen science initiatives show contrasting conditions except during late autumn (November). The time series panel demonstrates differences between citizen science contributions, with samples from the Seldovia Village Tribe being the most temporally resolved. Coloring consistent with Figure 1 legend.

GAKOA Buoy Comparison:

Photo 3: GAKOA buoy at the mouth of Resurrection Bay tracking surface conditions.

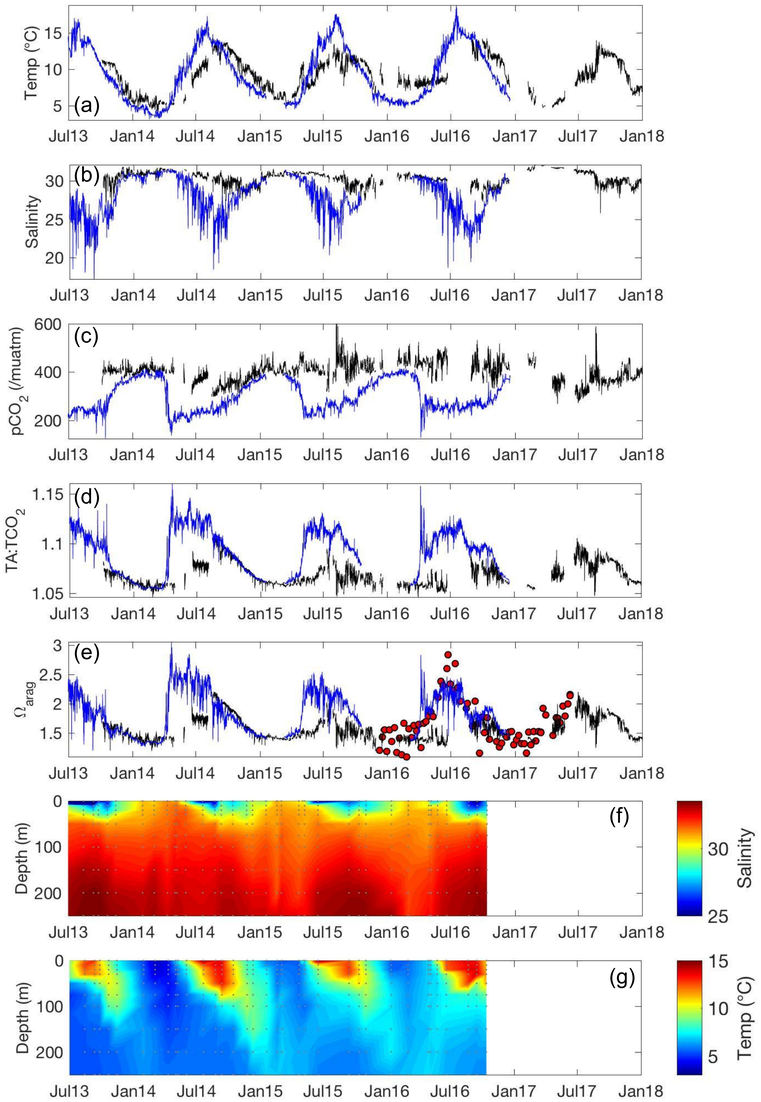

Figure 4: Time series of APSH BoL (black) and GAKOA (blue) data (panels a-e). Salinity, pCO_2, $TA:TCO_2$, and Ω_{arag} data are consistent between both platform records during the winter months, but not in summer months when surface waters are impacted by high primary productivity. Seldovia Ω_{arag} data are consistent with these trends as well (panel e; red dots). Panels f and g show water column data from a station adjacent to GAKOA (GAK1). Seasonal temperature penetration drives APSH BoL record variability, which would otherwise consist of perpetual winter conditions.

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