

Author note:

We thank all referees for their insightful and constructive comments on our manuscript “A high-resolution synthesis dataset for multistressor analyses along the U.S. West Coast.” We appreciate the opportunity to incorporate and respond to these thoughtful comments and improve our manuscript. Below, we discuss the comments from Reviewer 1. We have included all original comments, with our response to each point raised bulleted below.

Rev 1

This manuscript is a well-written description of a data compilation/synthesis effort for the California Current System (CCS). The main value added over existing data products is: 1) the inclusion of nearshore data sets that are missing in many of the larger-scale data compilation/QC products, and 2) the inclusion of data sets that explicitly address CCS temperature and O₂ data along with the carbonate chemistry data that are the focus of the larger-scale data products I'll discuss further below. I think these two things make this data compilation a valuable contribution that will advance the state of coastal multi-stressor work in the CCS after the paper's weaker points are adequately addressed. However, I am a bit challenged by several aspects of the paper and data set in their current form.

Major concerns:

For starters, modelers and other scientists doing ocean acidification-related coastal analyses would likely still be best advised to use the existing Surface Ocean CO₂ Atlas (SOCAT.info, see Dorothee Bakker et al. 2016 ref in ESSD) and Coastal Ocean Data Analysis Product for North America (CODAP-NA, see Li-Qing Jiang et al. 2021 ref in ESSD), which have compiled all global surface ocean CO₂ data and coastal carbonate system data for North America, respectively. In my view, both of these projects provided a more rigorous secondary QC of the data, or at least a more detailed description of the secondary QC processes, while also providing the other benefits of the MOCHA data effort (consistent formatting and data treatment, etc.).

- We appreciate this reminder to highlight SOCAT and CODAP-NA, as both are admirable data compilations. SOCAT and CODAP-NA are exceptional products for oceanic geochemists and modelers, but neither product is ideal for nearshore-focused carbonate chemistry and hypoxia work. SOCAT provides surface CO₂ data and includes many nearshore records, but lacks deeper records and other carbonate-system parameters (e.g., TA, DIC, and pH). For nearshore

work focused on synoptic cruise observations, CODAP-NA is an excellent resource with high-quality data, but it excludes many coastal records such as moorings and shore observations. We feel there is a need for a synthesis product that combines the consistent formatting and organization of SOCAT and CODAP-NA with the data inclusivity of regional databases such as that maintained by CenCOOS, allowing coastal researchers to examine cruise and sensor observations in tandem. We have added language to the fourth paragraph of our introduction (lines 92-111) highlighting the strengths of SOCAT and CODAP-NA while clarifying the value we see in bringing sensor and cruise datasets together.

This makes me wonder who the envisioned target end user group is for the MOCHA data products beyond scientists. To be clear, I can certainly see broad utility for the data, as amassed here, for the added nearshore data and T and O2 data.

- We envision this dataset being of particular interest to coastal scientists working on or supporting policy- and management-relevant research questions. We have added the following to the fifth paragraph of the introduction to clarify this (lines 128-134): “We anticipate that this synthesis product will be broadly useful to OAH-focused investigative teams and particularly impactful for coastal scientists investigating policy- and management-relevant projects, such as investigating spatiotemporal variation in marine climate risk from OAH events and warming, evaluating the efficacy and completeness of CCS monitoring efforts, linking oceanographic conditions to coastal social or socio-economic considerations across large geographic ranges (e.g., Ward et al., 2022), evaluating spatial management zones such as aquaculture sites and marine protected areas (e.g., Hamilton et al., 2023), and pursuing other questions of interest to coastal communities.”

But if the end users are not scientists and capable with programming, I do think it might be useful to provide some additional data products that would be easy to create and archive at NCEI and much more accessible to less technically savvy end users. I say this because I was unable to open the nearly 3 GB data file in Excel on my computer. I was able to open it in R, but it was still very slow and cumbersome to use there.

- The size of the dataset is a challenge and certainly limits its utility to non-scientists. We agree with your concerns and, to that end, we have been collaborating with the Central and Northern California Ocean Observing System (CeNCOOS) to

incorporate the data into their web based portal. Additionally, we are posting the aggregated daily dataset to NCEI in accordance with your suggestion below.

SOCAT and CODAP-NA provide a useful model for one way I'd imagine you might subset this data product: 1) one product including observations that reflect the surface conditions (where I would likely use 10-25 m as the depth cutoff, rather than 50 m as they used for their TA-S analysis), and 2) another smaller subset of observations that were depth-resolved and included a broader range of parameters (nutrients, chl, etc.). This would eliminate the need for millions of empty/"NA" entries, that I presume slow down operations with the data set in R (and make it inoperable in Excel [in my experience]). Further, the authors provided this massive data compilation, and the code they used to create the greatly reduced data summary, around which much of the discussion was written. I would suggest also directly providing this summary data product (along with the surface and full water column data subsets) via the NCEI webpage where the original data set is logged.

- We appreciate the suggestions for some more user-friendly data compilations. We have uploaded our daily summary dataset to NCEI as suggested (aggregated_daily_dataset.csv). At 1.2 million rows, this aggregated dataset is still slightly too large for easy handling in Excel, but it is much easier to work with than the full dataset. While we appreciate the suggestion for additional gridded surface and depth-resolved data products à la SOCAT and CODAP-NA, summarizing the MOCHA dataset over a spatiotemporal grid would require significant interpretive decisions that are better handled by individual science teams. For example, if a given spatial area contains several autonomous sensors from different projects with different protocols along with data from one or more cruise stations, how should the data be aggregated and combined? The correct protocol in this case depends on the project and question asked and is beyond the scope of this paper.

I do also think that the authors need to discuss this data product in relation to the SOCAT and CODAP-NA data products and how they are related and pros/cons of each. This comment got long, so to recap, what I'd like to see addressed here are: 1) providing alternate data products to facilitate accessibility for various end users, including possibly splitting out surface and depth-resolved data product subsets and providing the data summary directly; 2) put this data product into the context of existing high-quality data products like SOCAT and CODAP-NA.

- Please see our detailed response to this suggestion in the section above.

Second, as a person whose livelihood comes from producing data sets such as those included here, it was disappointing to not see reference to data providers and original data set DOIs (for those that have them) in Table 1 in the main paper. Yes, this information is in the very similar metadata file at NCEI, but in my experience, no one reads the metadata, so the major amount of work data providers do is not going to be appreciated/cited/acknowledged. It is important for the on-going funding and ability to do observations that data producers are able to find and report papers that rely on their data for subsequent publications. On a related note, I completely agree with the authors that there is a significant need for not just continued observational coverage, but expanded observational coverage, particularly for the carbonate system, in a future world with accelerating rates of change, marine carbon dioxide removal, etc., etc. To that end, it is critical that data creators get fair acknowledgement of their products.

- We completely agree, and apologize that our misunderstanding of what could be included in the References section meant that we did not include dataset citations or DOIs in Table 1. We have since added those following an excellent example from Sutton et al., 2019 (<https://doi.org/10.5194/essd-11-421-2019>). Table 1 and the References section now both include full citations for each dataset. Now that the datasets listed can be identified by their citations, we have also shortened their titles and improved the overall readability of Table 1.

Consequently, it would be ideal to see all of the data sets appear as citations in the main article of this paper. I also encourage the authors to consider including a “fair data use statement” in their data availability section regarding the data product. They can see the SOCAT statement here:

https://socat.info/wp-content/uploads/2023/06/2023_SOCATv2023_Data_Use_Statement.pdf. And the GLODAP statement here (GLODAP is the open ocean data product that CODAP-NA was modeled after): <https://glodap.info/index.php/fair-data-use-statement/>

- A fair data use statement is an excellent suggestion. We have added one just after our Data Availability section requesting that users fully credit constituent datasets and reach out to original PIs, as appropriate (lines 640 to 646) .

To recap, 1) it would be nice to see better inclusion of main data provider information and DOIs in Table 1, along with citations for all data sets in the main manuscript if

possible; 2) I encourage the authors to consider adding a “fair data use statement” that would encourage end users to cite both the MOCHA paper/data set AND authors of any major subset of the data used for follow on publications and information products, as appropriate, to help support the long-term stability of observational programs.

The TA-S analysis was not fully described or discussed. It was unclear why they would have used the upper 50 m rather than a smaller part of the upper water column, as other authors have done. Maybe they determined this experimentally, but how they arrived at this decision should at least be described. However, if one is expecting to discern the influence of freshwater, this should likely be a shallower depth range. Further, there were some really strange results—e.g., offshore of SF Bay mouth—that were not discussed adequately. Also, these results were not placed in the context of other publications by Andrea Fassbender (and references therein) or Kitack Lee.

- We appreciate this reviewer’s (and Reviewer 3’s) questions about these data, as we had also been puzzled by them. In light of these questions, we went back to the raw, original titrator files and realized there was a years-old issue with quality control on some autotitrator runs associated with CRMs that had not run well. In total, these autotitrator quality control issues impacted a subset of three of the author team-provided datasets in the MOCHA compilation. All of the impacted total alkalinity measurements and their associated samples have now been entirely removed from the uploaded dataset and the figures and led us to substantively rewrite this section (new text in lines 485-515). The remaining variability in coastal total alkalinity comes from samples that have been thoroughly examined. This variability is in line with previous investigations, plausible given riverine inputs and potential organic alkalinity contributions, limited to within 2 km of shore, and no longer shows San Francisco Bay as an anomalous region. We have removed the previous Figure 7 and Table 3 with a revised Figure 7 showing regional surface (< 25 m depth, as suggested) TA-S relationships for coastal (< 2 km from shore) and offshore (2-100 km from shore) zones. We have also placed these observations in context with Fassbender et al. (2017) and others.

Along these lines, and because of the importance of salinity data to the carbonate system (as reflected by the TA-S work discussed just above), I will note that mention of salinity felt a bit inconsistent throughout (e.g. one place it was noted that DO and pH data were not included if they did not have accompanying temperature data, but it left me wondering—what about salinity data (lines 135-136)?

- We evaluated pH data from ISFET and spectrophotometric sensors that were not accompanied by salinity measurements on a case-by-case basis. Where high-quality pH data passed all other QC checks (e.g., diver-accessed bottom sensors used in Donham et al., 2023 and coastal monitoring by the OMEGAS program, e.g., Chan et al, 2017), we retained the pH data. This detail has been added to our Methods section (lines 174-176).

Also on line 298 where T and DO are mentioned as having the widest coverage—presumably also S? I ask because low S events associated with flooding may also be associated with coastal multistressor events (e.g., potential importance in kicking off HAB events).

- Thank you for the suggestion; the links between low salinity and HAB events represents an application of our dataset that we hadn't fully appreciated. We have added text to clarify how the amount and spatiotemporal coverage of salinity data compares to the figures shown, as salinity observation density hews closely to dissolved oxygen observations in both spatial and temporal coverage (lines 386-387).

Finally, the “detailed metadata” file referred to in the text at NCEI I think is the one actually called “SubmissionForm_carbon_v1_428.xlsx” and is NOT the one called “MOCHA_dataset_metadata_table.csv”. This is confusing and should be clarified by either adding the name of the actual file intended to be referenced here the main text (probably in parentheses) or by asking NCEI to rename the file at NCEI to “detailed metadata...” (or whatever the final name used in the manuscript is).

- This is an excellent point. We actually intended the “detailed metadata” to point toward the MOCHA_dataset_metadata_table.csv. All references to “metadata” in the text have now been clarified to refer explicitly to either the “dataset metadata” (MOCHA_dataset_metadata_table_v2.csv) or the “parameter metadata” (SubmissionForm_carbon_v1_428.xlsx). The following sentence has also been

added to our Data Availability section: "The downloadable content includes the full MOCHA dataset available as a text file, the daily summarized dataset discussed extensively above available as a text file (aggregated_daily_dataset.csv), standard NCEI accession parameter metadata which provides an overview for each variable included in the text files ("SubmissionForm_carbon_v1_428.xlsx"), and a bespoke dataset metadata table describing each included dataset with citations and links to reference papers (MOCHA_dataset_metadata_table_v2.csv)."

Less major concerns:

On a positive note: I do like the simple data QC flagging routine they used. If a major portion of end users are non-technical, this will greatly facilitate the uptake and correct use of this data product. That said, another benefit of directly providing the data summary product, beyond its vastly smaller file size is that it only includes the "reliable" data. So non-technical users should definitely be steered toward that sub-product.

- Thank you, we appreciate this point. While the QARTOD flags are more detailed, the variety of data sources and previously applied QA/QC practices we worked with in this synthesis pointed toward applying a simpler system.

It would be nice to use the recommended/best practices column headers recommended by Jiang et al. 2022.

- We found those headers and dataset structure to be less appropriate given the mixed nature of our data sources (cruises, shore samples, autonomous sensors, etc.), whereas the Jiang et al., (2022) headers are very well tailored toward either discrete cruise data or moorings. We have uploaded code to our Github repository to convert our column headers and dataset into a format more compatible with Jiang et al.'s recommendations, for those who would prefer ("reformat_toward_NCEI_standard.R").

--Along similar lines, Jiang et al. 2022 recommend using different carbonate system coefficients and would be worth a look for future use. I do not believe there would be a noticeable difference in your results, so am not necessarily suggesting you re-do anything here, because you don't submit or show the calculated parameters.

- Since the inclusion of calculated carbonate system parameters did not meaningfully change our figures or paper conclusions, we have entirely removed unmeasured pH values from our paper, so this suggestion is moot but well-taken. As there are no longer any calculated parameters in our figures, we also have removed section 2.6 (Additional Carbonate System Calculations).

Jiang et al 2022 also point out that units of $\mu\text{mol}/\text{kg}$ refer to “substance content” rather than “concentrations,” which are in $\mu\text{mol}/\text{L}$ units. This should be corrected in the “Submission form_carbon_v1_428.xlsx” at NCEI and in the text as well.

- This has been fixed throughout and at NCEI. Thank you.

In Table 1, is #68 a gridded data set? I got that impression, and if so, I'd argue it's not appropriate to include here. The language should be clarified around this.

- Thank you for noticing this apparent error. Dataset 68 is actually composed of the CTD casts used to create the “gridded dataset” referenced in the title. We have fixed the title and description of this dataset to make it clear that we are using the CTD cast data that Risien et al. (2022) then used to create their gridded data product.

--It would be useful to state more decisively in the early text that the data were limited to within US border. It's alluded to a few times, but because I happen to know that some of the data sets span the Canadian and/or Mexican border, as does the CCS, I didn't initially catch it. Easy enough to justify.

- This has been added to both our Introduction and early in the Methods section (lines 118 and 158).

I don't believe they mentioned which pH scale they used in the text, although it is in the “Submission form” file. Please add to the text, and for any original files that used a different pH scale, whether/how they converted to the same scale.

- We have clarified that we are using the total pH scale in our methods section. Surprisingly, no pH scale conversions were required during this compilation. Along the same lines of this comment, though, we have added details about converting pH measurements to in-situ conditions when necessary to our Methods section (lines 209-212).

In Table 1, ship names should be italicized and 2s in CO₂ or O₂ should be subscripted.

- This has been fixed.

--Finally, as noted previously, I completely agree with the authors about the importance of the coastal multi-stressor observations, and particularly carbonate system observations, needing to be sustained or expanded rather than contracted, but there was an incorrect statement in the conclusions section regarding the NOAA West Coast Ocean Acidification (WCOA) cruises. Unfortunately it's also mislabeled on the NCEI WCOA web page here:

<https://www.ncei.noaa.gov/access/ocean-carbon-acidification-data-system/oceans/Coastal/WCOA.html>

Specifically the 2017 cruise was not a WCOA cruise. Rather it was a collaborative effort led by NOAA HABs scientists and an added cruise-of-opportunity for OA sampling. I think they also sampled OR on that cruise, but I haven't looked at the data for a long time so the authors should double check this (the title said PNW, so I assume Oregon was included). However, NOAA did have another full US West Coast OA cruise in 2021. It was delayed from 2020 due to COVID. Thus, please edit that sentence to not state that WCOA cruises have contracted.

- We appreciate the correction and tip toward the 2021 WCOA cruise. We have updated the title of dataset 41 to "NOAA Northwest Pacific harmful algal bloom program cruise SH1709" in Table 1. We have also updated our discussion of synoptic oceanographic cruises to note that there has been a WCOA cruise since 2021 (line 609).

Minor concerns:

- Unless otherwise noted, all following suggestions have been fully incorporated.

--The DOI in the abstract doesn't go to the data set.

- The DOI seems to be correct, but we have re-checked this.

--Figure 1—why are the a and b panels smaller than c? It lends some confusion when all could be the same size and fit nicely across the page.

- This figure has been updated and all maps are now on the same scale.

--I don't think "carbonate system" needs to be hyphenated. I am familiar with how this works with adjectives vs nouns, but it is not used consistently throughout the manuscript in any case. Also, there was at least one place where one might hyphenate dissolved oxygen where carbonate system was hyphenated (e.g., line 119).

- We have eliminated all hyphens in "carbonate system" throughout the manuscript. Thank you.

--L. 123—specifies data collected *before* 2020 but there are at least two places in the dataset metadata table that say either 2020 or 2021.

- These typos have been corrected at NCEI.

--dataset ID 2 in Table 1 and in the Excel metadata table—There's a space before the text that makes a gap appear in the excel file.

--dataset 5 in Excel file—Greeley is misspelled

--Table 1 dataset 25—should be to 2020 not "present"

--dataset 41—didn't this also include Oregon? (It says Pacific NW)

--dataset 52—La Push is two words

--dataset 68—again, the words "gridded" and "monthly climatologies" make me think this data set may not be right for inclusion in MOCHA

- Please see our more detailed comment about this above. This language and the title of this dataset have been clarified to reflect that we used CTD cast data.

--Lines 224-226—It might be useful to differentiate between the # of samples dropped as questionable data vs. those dropped due to daily averaging, because this sentence gives the impression that there were more 3s than there were.

- This point has been clarified. We now explicitly note that the reduction in data quantity is not a result of unreliable data, but simply a result of collapsing high resolution sensor datasets into daily summaries (lines 289-290).

--line 232—I'm not sure that "high-quality" was defined anywhere. Uncertainties definitely were not adequately spelled out across the data sets, and I'm almost certain the

uncertainties would have varied across the 71 distinct data sets used. This information doesn't seem to be in either the submission form or the metadata file on NCEI.

- We have replaced "high-quality" as a term with "plausible and reliable" data, versus data that is "unreliable". We have further clarified in our Quality Control section (2.4) that our "plausible and reliable" data may warrant additional QC depending on the investigator's needs. The uncertainty of datasets does vary significantly throughout this compilation and, in many cases, was not available to us with the published data. Our intent was to clear the compiled data of all unreliable observations, but we can not assert that all the "plausible and reliable" data meets an objective accuracy or precision standard.

--I encountered some confusion between "handheld" sensor measurements vs. those collected "by hand" (hand collected—line 155)—maybe making the latter not use "hand" would prevent others' confusion when thinking back to what earlier categories of observations and instruments were.

- Excellent point. We have changed the sampling scheme "intertidal/subtidal hand collected" to be "intertidal/subtidal discrete collection".

--L. 162—TA is not "extrapolated" from S measurements—please reword

--Throughout—the word "data" always gets a "plural" verb tense

--Table 2: missing value in reliability column for calculated pH

- There is now no calculated pH data in the paper so this row has been removed.

--Lines 296-297—Please indicate on the figure where Pt Arena, CA, and central OR are for readers' convenience. It could just be asterisks along the axes or similar.

--Line 312—Should say July through September (it's correct in the figure caption, but the caption doesn't include May, which it should).

--I liked the discussion of the co-occurrence of stressful DO and pH conditions—I have been looking at similar occurrence statistics myself. And I agree with the conclusion about this pointing to a need for expanded CO₂ system observations. It may be useful in this discussion to give DO results in alternate units also (mg/L and mL/L) for our colleagues and end users who use different units.

--Figures 5 and 6 (and elsewhere)—again, should be DO content rather than concentration

--Line 382 and Table 3 caption—the p values do not agree.

--Table 3—again, the offshore relationship with the r squared of 0 seems to require further explanation than given. Specifically, while I would buy that the effect of urban runoff could be strong outside SF Bay, none of the #s in the offshore box make any sense—they are all SO different from all other boxes, including the nearshore SF Bay one, that it makes me wonder if there was an error in the analysis or a typo.

- Please see our detailed response to this observation in the section above. Table 3 has now been entirely replaced by the new Figure 7 and the conclusions therein are much more compatible with anticipated offshore vs. onshore TA-S relationships.

--Lines 418-421—Really seems like the authors are not aware of the wealth of surface CO2 data in SOCAT. This is one of the places where SOCAT might be drawn into the discussion.