NOAA Science Advisory Board Report

Assessment of the "NOAA Ocean and Great Lakes Acidification Research Plan 2020-2029"

December 17, 2019

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Reviewers:

- Dr. Joellen Russell: Chair of the NOAA Science Advisory Board's Climate Working Group, Professor, University of Arizona, Thomas R. Brown Distinguished Chair of Integrative Sciences
- Dr. Irina Marinov: Associate Professor, University of Pennsylvania, Department of Earth and Environmental Science
- Dr. Nancy Williams: Assistant Professor, University of South Florida, College of Marine Science

Summary: The "NOAA Ocean and Great Lakes Acidification Research Plan 2020-2029" carefully and clearly lays out the causes of acidification, the potential impacts of acidification on the scope of human endeavors within NOAA's purview, and a regionally-based assessment of the existing and additionally-needed resources to assess and monitor and mitigate (where possible) or adapt (where mitigation isn't sufficient) to the effects of acidification.

Consistent with the terms of reference laid out in the guiding legislation (the FOARAM Act of 2009), NOAA's mission with respect to acidification (OA, hereafter) has three components:

- Document and predict change via environmental monitoring, analysis and modeling;
- Characterize and predict biological sensitivity of species and ecosystems to; and
- Understand human dimensions and socioeconomic impacts of OA.

NOAA research goals with respect to OA are to:

- Advance OA observing systems, modeling, technologies and data stewardship to improve the understanding and predictive capability of OA trends and processes;
- Enhance understanding and prediction of OA as a stressor co-occurring with other prominent ocean and Great Lakes changes;
- Improve understanding of the biological response and adaptive capacity of ecologically and economically important species, ecosystems and communities; and
- Increase research to understand the vulnerability of communities and stakeholders to OA and to generate useful data that supports adaptation and resilience plans.

This research plan captures NOAA's extraordinary effort to improve the ability to understand, protect, manage, and restore ecosystems that support healthy fisheries, increase opportunities for aquaculture, and balance conservation with tourism and recreation and to promote the health and economy of our people and nation. The Plan will maintain and enhance NOAA's mission, specifically with respect to recently released Blue Economy goals and the objectives outlined in the FOARAM Act of 2009.

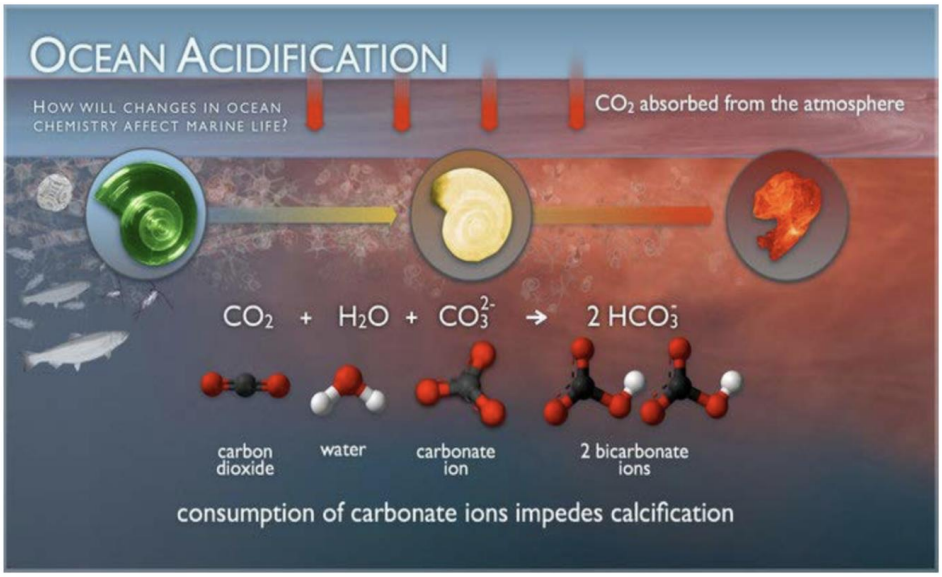

Figure 1: The pH of ocean water decreases (becomes more acidic) when CO_2 is added to it

Overall Assessment

We want to congratulate the authors for drafting a brilliant research plan, and on a terrific job of pulling this together under difficult funding circumstances. The hard work, care and creativity of the authors is evident and they should be commended. It is remarkable that OA research at NOAA spans across five of its six line offices: Ocean and Atmospheric Research (OAR); National Marine Fisheries Service (NMFS); National Ocean Service (NOS); National Environmental, Satellite, and Data Information Service (NESDIS); and Office of Marine and Aviation Operations (OMAO). As such, this document will be significant across NOAA as well as to researchers and stakeholders.

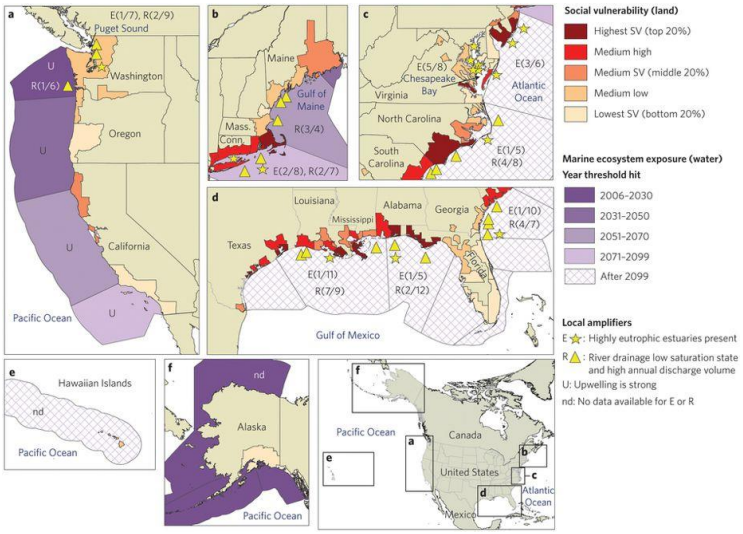

Figure 2: Overall vulnerability of places to ocean acidification. From Ekstrom et al. 2015

Recommendations:

1.0 NOAA-wide Integrated Modeling

Although there is information about NOAA's various OA modeling efforts scattered through out the chapters, we would like to see a more focused and integrated effort across the line offices. NOAA should formally commit to an integrated modeling approach for OA across its line offices and departments. NOAA/GFDL is ready and capable of synthesizing, projecting and predicting OA-related issues numerically, thereby enhancing the abilities of NOAA decision-makers and external stakeholders to rely on the most up-to-date data and assessments. We appreciated the consistent effort throughout the text to integrate the ecological and chemical components of OA and respective science communities. To strengthen this point, linking regional ecosystem models and biogeochemical frameworks should be prioritized so that OA observations can be utilized to their full potential and put into context. Increasing the near-term and longer-term predictive capabilities of NOAA's OA research will enhance NOAA's ability to act quickly in times of crisis and to provide stakeholders with timely information to enhance the economic utility of our national waters and ensure both the public safety.

Recommendation 1: Formally commit to an integrated modeling approach across NOAA line offices.

Recommendation 2: Prioritize the linking of regional ecosystem models and biogeochemical frameworks so that OA observations can be utilized to their full potential.

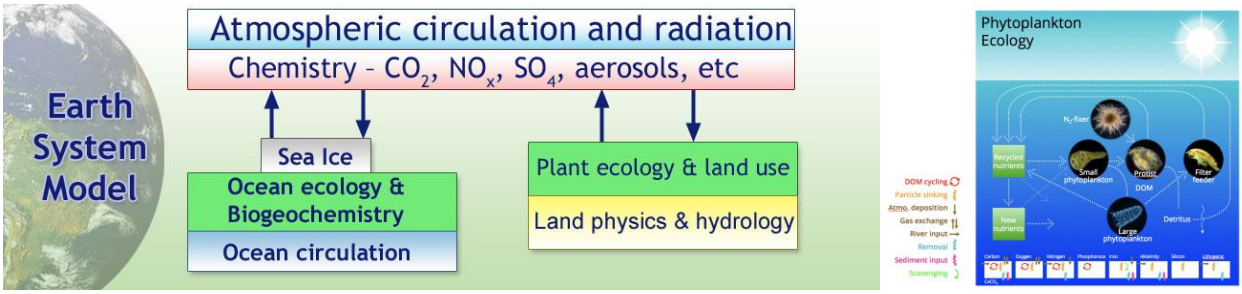

Figure 3: The figure on the left is a schematic showing the main components of an Earth System Model with biogeochemical and ecological components in green [Figure from https://www.gfdl.noaa.gov/earth-system-model/]. To the right is a simplified schematic showing the complex relationships that describe the connection between ocean ecology and ocean biogeochemistry. Simulations of ocean acidification require models of this complexity [Figure adapted from Dunne et al. (2005, 2007)]

2.0 Interactions between Onshore, Nearshore and Offshore Processes

NOAA's OA research plan includes monitoring both the onshore and/or nearshore and offshore connections associated with OA. Aquaculture in particular is expanding in every state: OA in the nearshore waters where aquaculture occurs can be driven by biogeochemistry and freshwater supply, and these regions are often chronically undersampled. In addition, several chapters raise the possibility of interactions between eutrophication and acidification – monitoring the coexistence and coevolution of these processes should be a higher priority.

Recommendation 3: Increase sampling of nearshore waters in sensitive and economically important areas.

Recommendation 4: The co-varying and possibly exacerbating effects of eutrophication and acidification on each other should be studied.

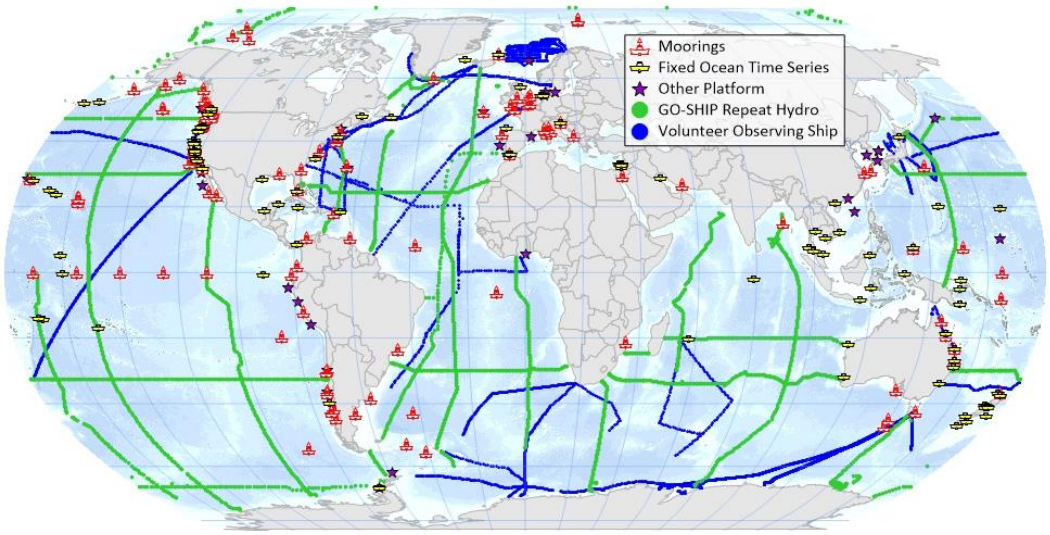

Figure 4: The preset-day Global Ocean Acidification Observing Network

3.0 Data Management and Products

The importance of data management is emphasized in the executive summary, and many of the action items in the various chapters mention stakeholder needs and expectations, but a more centrally-placed, overarching focus on the need to provide useful data products would emphasize the importance that NOAA's OA program places on this objective. In our data-rich world, the FAIR (findable, accessible, interoperable and reusable) standard for data management is essential: NOAA is already a leader in these practices and it can and should continue to set the standards for data generation, storage, management and dissemination. More attention should be paid to the data products that NOAA provides and the stakeholder requirements of those products. Communication with stakeholders on the products and syntheses they need should be a high priority.

Recommendation 5: Highlight centralized access to NOAA's existing data syntheses and products.

Recommendation 6: Highlight and or initiate planned communications with stakeholders on the desired data products and syntheses that would be most useful to those communities.

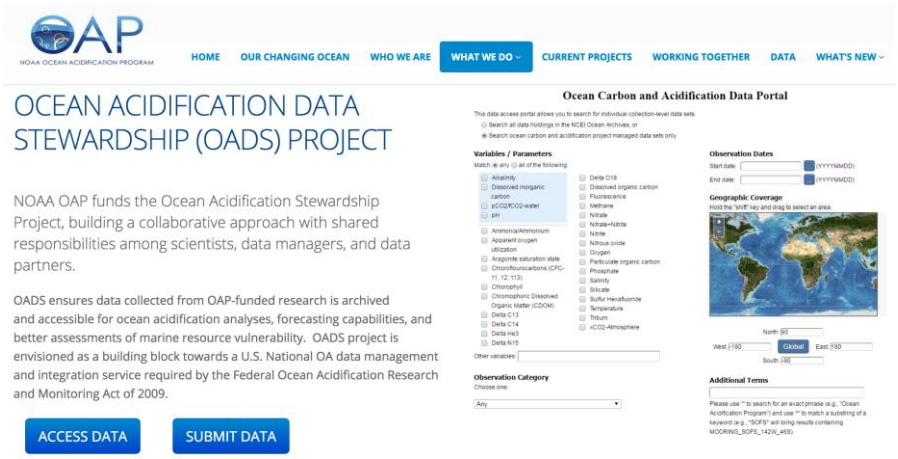

Figure 5: The critical importance of data management, integration and standardization, as well as user accessibility and data product formatting cannot be overstated. From: https://oceanacidification.noaa.gov/WhatWeDo/Data.aspx

4.0 Metrics of Success

Metrics for assessing the success of NOAA's OA research plan should be included in the plan. The research plan would be significantly stronger if there were metrics by which NOAA, Congress and the public could assess:

- The execution of the research plan (did we accomplish what we set out to)
- The excellence of the outcomes (these are all of the amazing products and services we provided)
- The total contribution of the plan in dollars to the Blue Economy

Putting a dollar value on usefulness of NOAA's OA research and products to the nation and the economy would specifically highlight the importance and effectiveness of NOAA contribution to commerce and the safety and the livelihoods of stakeholders and the public in U.S. waters.

Recommendation 7: Include metrics by which NOAA can quantify the success of its OA research and outreach.

Recommendation 8: Quantify the economic benefit of NOAA's OA research and products to the Blue Economy.

5.0 Further minor comments and suggestions are included in the spreadsheet in Appendix A.

Appendix A

2020 NOAA Ocean and Great Lakes Research Plan
Review and Comment System
NOAA EXTERNAL REVIEW October 28-November 15, 2019

Instructions: For each comment, please select the Comment Type, Chapter Title, and Paige and Line numbers, as required. Note, for drop down selections in columns A and B, you may copy/paste or drag to populate subsequent cells, if applicable (to save time).

Comment Type	Chapter Title	Figure/ Table Number	Start Page Number	Start Line Number	End Page Number	End Line Number	Comment
Text Region	Introduction		10	326	11	339	As datasets grow larger and more diverse, this is more important than ever and the OAP has done a great job with data management, stewardship, and archival
Text Region	Introduction		10	326	11	339	There should be continued support for OA data management
Text Region	Introduction	Figure 4					Says "Placeholder figure"
Text Region	National Chapter		13	440	13	446	The OA Information exchange portal is a great forum for increasing communications across the different stakeholders and support for this effort should be increased
Text Region	National Chapter		16	478	16	495	The authors point out the lack of coverage for in situ observations in the Great lakes. This seems a natural place to focus more funding in future efforts
Text Region	National Chapter		16	478	16	495	New technologies for in situ observing are maturing and should be included as part of NOAA's ocean observing system
Text Region	National Chapter		16	497	16	509	The international GOA-ON is playing an integral role in planning and developing the global OA observing system which helps the NOAA OA program achieve its goals
Text Region	National Chapter		17	515	17	521	Linking regional ecosystem models and biogeochemical frameworks should be prioritized so that OA observations can be both utilized to their full potential and put into context
Text Region	National Chapter		18	572	18	573	I understand the need for OA information for national OA reports or those involved with commercial fisheries, but it is unclear why the "general public" would need

							information about their local OA conditions
Text Region	National Chapter		18	554	18	573	These Actions are all in line with furthering NOAA OAPs environmental monitoring goals
Text Region	National Chapter		20	646	20	647	Should also prioritize studying regions where there are longer historical physical/chemical datasets so that results can be put into context, as stated in previous paragraphs
Text Region	National Chapter		20	646	20	671	"'Omics" are discussed in the previous paragraphs as a new sampling strategy that can provide large amounts of information with relatively low effort, yet 'omics is not explicitly included in any of the Actions
Text Region	National Chapter		20	657	20	671	Focusing in more on ecologically and economically important species is a good strategic move
Text Region	SE and Gulf of Mexico		88	2935	88	2939	This is the only place in the entire research plan where "physics" is mentioned. The links between the physical circulation and the biogeochemistry/ecology are important for acidification, especially with respect to seasonal, interannual and decadal variations in surface stratification, or upwelling strength
Text Region	Open Ocean		24	796	24	796	Ideally, each of the specific subsections should have model-development goals and connect OA with the bigger climate science efforts
Text Region	Introduction		11	342	11	363	Numerical modeling for prediction is mentioned with regard to "Environmental Monitoring," but MOM6 from GFDL and earth system prediction, have progressed sufficiently for reliable subseasonal to seasonal to decadal prediction (S2S2D). As such, modeling capabilities and a push for a more integrated modeling strategy across NOAAs lines is likely warranted