Topic # I: Improving science through stronger collaborations, facilities and infrastructure.

- **What pressing research questions (regional, topical, modeling, etc) require an improvement in facilities, instrumentation, etc?**
- *Are the lack of facilities, collaborations, etc. a major impediment to existing projects?*
- *Do we anticipate the need for facilities to tackle frontier research?*
- *Do we need to begin strong collaborations for any of these ideas?*
- *Do we need to develop new techniques/instruments for monitoring OA?*
- *What should we be measuring? Especially for biological measurements.*

-Facilities and infrastructure and measurements are dependent on science questions you want to answer:

- Need to look at gene expression levels in experiments, move to the molecular level, maintaining experimental levels of pCO_2.
- Need to quantify both gene expression and physiological responses.
- Measurements in the environment gives a guide for designing experiments.
- Development of micro-sensors for calcification processes.
- Geochemical tools to investigate calcification and responses to perturbations.

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- Rates of change in mesocosm are rapid but are responses realistic?
  - May work for organisms with rapid generation times. Some organisms experience rapid changes in pH in the field on a diel basis.
  - These oscillations in pCO_2 can be reproduced by using CO_2 bubbling system.
  - Not all conditions can be simulated in mesocosm experiments, measurements in the field are needed, despite the lack of control of all variables at least the complexity is present.
  - Need facilities for long-term experiments.

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- Quantify the pools and fluxes of inorganic carbon particles (PIC)
    - How much do biological processes mediate carbonate dissolution?

- Simultaneous measurements of physical, chemical and biological parameters.

- Problems with measuring/calculating TA, need a modeling approach to better parameterize these calculations to inform programs like CO2-SYS.

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• Are there existing facilities, satellite data, datasets, or infrastructure that could be better utilized in the near term, and where is the lack of these resources limiting scientific progress?

• EPA has labs with flowing seawater capabilities available for collaboration.

• HIMB lagoons (wide range of pCO_2) could be used as locations for natural experiments.

• Need for inter-calibration and standardization of new commercial sensors that are coming online.

  • ACT (http://www.act-us.info/) (NOAA) provides this service currently, but this could be expanded to NSF as well.

• Facilities are available to conduct a number of experiments

  • A list of these facilities should be created with POC to aid in collaboration (OCB?).

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• Are there existing facilities, satellite data, datasets, or infrastructure that could be better utilized in the near term, and where is the lack of these resources limiting scientific progress?

• Use existing statewide networks (i.e. coastal labs and LTERs) to deploy a set of standard sensors.

• A Best Practices Guide for OA research does exist, but may need to be updated to address new studies and capabilities. Consistency in experimental design and procedures between labs will be import going forward.

  • What are proper controls for pCO_2 enrichment experiments?

• Maintain existing satellite infrastructure, while expanding capabilities (i.e. salinity).

• Data limits on existing CTDs.

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• Can we organize across facilities, sites, institutions, VOS, etc., to do a better job of monitoring, for example biological as well as biogeochemical changes? e.g., core variables to detect for biological / ecological change?

- *What would these core measurements be?*
- *How would these vary from open ocean sites to coastal sites, etc.?*
- *What instrumentation needs to be developed?*
- *What kind of satellite measurements would be most desirable in the future?*

• Responsibility to provide broad measurements at regional and global scales, ability to describe and detect multiple causes of OA, what kind of biological measurements do we need to match the physical monitoring.

• Is the a set of "basic" biological measurements that can be added to existing OA studies or time series?

- No

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- What things should be measured at specific sites? What is cost effective? Prioritize list of facilities and what the capabilities are. What about DNA sampling? Microbial observatories? Variables will vary with different ecosystems.

- Submit joint (interdisciplinary) proposal to the agencies.

- How will OA affect metal chemistry and how will this affect the biology?

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• What do we need to improve collaborations across agencies, disciplines, international colleagues?

• Need a workshop focused on biological measurements.

• OA research coordination network (T. Klinger's request), support workshops, provides a funding opportunity to continue our efforts (NSF RCNs).

  • BioOce encouraging RCNs in genomics/environmental measurements, evolution/adaptation and climate change (current announcement).

• Another NSF OA Initiative announcement might include an RCN component, opportunity for workshops.

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• What do we need to improve collaborations across agencies, disciplines, international colleagues?

• International efforts to coordinate OA research (UK, France, Germany, S. Africa, Australia, Norway)

  • Program managers from international funding agencies agree on joint submission for international collaborations- this is a difficult task.

• International collaborations (global mooring systems)- develop a set of core sensors for the moorings, ORI sites.

• HOT, BATS as existing resources for collaborations.

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• Building capacity – how to engage and train scientists in diverse fields to work on OA?

• Take students to sea and into labs to gain "hands on" experience.

• Programs to help young scientists network in a multidisciplinary setting (e.g., WHOI OA workshop).

• Friday Harbor Labs undergrad and grad courses, one on OA (5 weeks) in the summer, also an REU site.

• National Estuarine Research Reserve system student programs (2 students per site).

• USGS/USF opportunities, cruise on OA, engage public and students through live feeds on shore, all student levels.

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• Building capacity – how to engage and train scientists in diverse fields to work on OA?

• EPA program, students apply in junior year to spend summer working in EPA lab, OA project is one project, sessions at scientific meetings.

• Course/workshop at Catalina raising forams.

• Hosting of Hollings Fellows at NOAA Fisheries Sandy Hook.

• EPA STAR program.

• Other fields to draw on for students/training? Materials scientists, physical chemists/physics, chemistry of catalysis, biomedical engineering (teeth, bone), genomics/bioinformatics, biophysics (role of skeletons), toxicology.

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• National OA Activities – a National OA Program or a National Program Office?

- What responsibilities should an Office have?
  - Implement the strategic plan of the National Program, convening community to host workshops, updates on research activities, coordination of measurements/support, coordinate education/outreach efforts, data management and website management;
  - Or should these responsibilities be incorporated into OCB?
    - Fill OCB OA committee with strategic partners
  - Or would this fall under IOOS?
    - IOOS provides some support for data management and sensor support, but most support comes from other sources, every agency has separate responsibilities for data management, different levels (federal, state, local) need to be integrated.

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• National OA Activities – a National OA Program or a National Program Office?

- Pros/cons of national program office vs. an office within OCB?
  - A national office would have a Director and Asst. Director with data management personnel,
  - Consortium for Ocean Leadership could handle this,
  - Interagency Working Group would be advisory to a program office

• Some infrastructure already exists to collect and disseminate some kinds of data, currently carbon data are sent to a national repository (CEDIAC?).

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• Participation in International OA Collaboration Activities; i.e. support for an international Coordination Program?

• GEOTRACES as an example (trace metals and isotopes) of forming an international collaboration, facilitate through IOC.

• Proposal to establish an international program to coordinate OA research, overarching goals (education/training, exchanges), hosted by Monaco (perhaps).

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• What role could a bottom-up organization like OCB offer to support this process?

• OCB will be involved whether there is a national office or not.

• Opportunity to expand OCB to incorporate other ecosystems (coastal, intertidal, coral reefs, etc.).

• How would OCB be reorganized? OCB would remain a bottom-up organization to provide services to the community. How do you preserve the traditional services that OCB has provided?