Ocean Monitoring Breakout

US Underwater Glider Workshop

January 18-19, 2017

Sustained Monitoring Overview:

- **For ocean observing, sustained monitoring is the process of perpetually collecting and analyzing data to determine trends, such as ecosystem health, climate patterns, ocean dynamics, etc.**
- **Purpose of breakout is to assess the scale and potential capability of glider activities**

Event Monitoring Overview:

- **For ocean observing, event monitoring is the process of collecting, analyzing, and signaling event occurrences, such as storms, spills, HABs, etc.**
- **Purpose of breakout is to assess the scale and potential capability of glider activities**

Instructions:

1. **List relevant operational missions and/or scientific objectives**
2. **How can we use existing glider assets more effectively?**
3. **What are the gaps in what we currently do and what are the new capabilities needed to address them?**

Event Monitoring (1/2):

1. **List relevant operational missions and/or scientific objectives**
    a. Storm/Hurricane forecasting
        i. Episodic,
        ii. Isolated,
        iii. Rapid response,
        iv. Strong currents,
        v. Waves
        vi. Seasonal forecasts,
        vii. Improving individual storm intensity forecasts
        viii. Storm surge
        ix. Heat content
        x. Cool wake / productivity response
        xi. Mixing ahead of the eye
        xii. Event is predictable/forecast-able
    b. Disaster response (oil spill, SAR, marine pollutants)
        i. Evolution of oil in the weathering process
        ii. Human health
        iii. Ecosystem response

    iv. Food safety
c. HABs
    i. Cause toxins or hypoxia
    ii. Fish kills
    iii. Human health
    iv. Fishery closures
    v. Ecosystem response
    vi. Mass strandings for marine mammals
    vii. Beach tourism / economic impact
d. Hypoxia
    i. Regions of low oxygen in water column due to strong pycnocline, nutrients, and upwelling
    ii. Seasonal, episodic, and permanent (depending on location)
    iii. Shallower water at times
    iv. Near rivers
    v. Commercial fisheries losses
    vi. Recreational issues
    vii. Fisheries assessment interested in predictions on hypoxia and hypoxic events
e. Ocean Acidification
f. Eutrophication
g. Hydrocarbon seepage
h. Geopolitical incidences / economical (fisherman)
i. Rapid environmental assessment
j. Lake sediment plumes
k. Shelf-break upwelling / frontal dynamics
l. River plume dynamics
m. Deep/dense water formation, mixing, deep convection
n. Meso-, and sub-meso-scale variability
o. Internal waves
p. Sea ice advance/retreat
q. Marine mammal / fisheries migration/detection
    i. regular / seasonal
    ii. intercept choke points
    iii. predictable
    iv. not emergency
    v. variety of species (in mid-Atlantic: everything moving through; whales, stripers, other sport fish)
    vi. tags send a coded message; gliders decode
    vii. effective range is 500 m
    viii. environment changing constantly (in mid-Atlantic)

2. **How can we use existing glider assets more effectively?**
    a. Share data from all existing operating gliders (IOOS Glider DAC)

        i. Enhance data assimilation forecast models
    b. Water space management: integrated command & control (Navy)
    c. Insurance & liability for asset sharing: coordination with regional associations (IOOS)
    d. Sharing knowledge of inventory of excess capacity
        i. Telecommunications line for sharing
    e. Pilots/technician/infrastructure/software for hire
    f. Experience sharing / glider schools (USM model of training)
    g. Leverage regional expert group
    h. Make glider flying easier. Interface glider command & control with optimal path planning or other planning software, improving situational awareness of glider pilots
    i. External vs. internal control; enhancing adaptive sampling & autonomy capability of existing fleet
    j. Dedicate seasonal gliders to areas of interests, deploy gliders with mission specific sensors (Wave, turbulence, ADCP) for rapid response (Hybrid glider for speed)
        i. Utilize operational circulation models to assist with positioning and deployment
        ii. Utilize existing technology to better address and understand seasonal events (oxygen sensors, fluorometers, HFR, operational forecasts)
    k. Enhancing government coordination of mission requirement & funding for event response by glider operators (academic, government, private)

3. **What are the gaps in what we currently do and what are the new capabilities needed to address them?**
    a. Assessment of existing glider capabilities, capacity, and data
    b. Onboard decision making ability
    c. Lack of fundamental background data on where events occur
    d. Sensor development and collaboration
    e. Expanding Operational Capabilities: Adaptive sampling capability of gliders
    f. Work force gap
    g. Rapid all weather deployment (aircraft (C-130))
    h. Delivery of time sensitive glider package/sensors to study sites.
    i. Universal backup systems and more effective data sharing: standardized and QA/QCED
    j. Data assimilation: GTS requires very standardized data, how to get new sensor data into models? On ramp onto the IOOS glider DAC. Regional efforts (IOOS) have been very helpful
    k. Knowledge of deployments (collecting what/when/where)
    l. Sharing innovative use of gliders (methods/algorithms), changing mission files on the fly.
    m. Disaster response: Specialize sensors (radioactive sensor, oil-spill sensors, political issue, water space issues

n. Longer loitering capability for gliders in anticipation of episodic events
o. Improving/simplifying glider turnaround (ballasting/recovery/compass calibration)

Sustained Monitoring (1/2):

1. **List relevant operational missions and/or scientific objectives**
    a. California Network (CALCOFI) – PO observations, some ecological/biological
    b. Gulf Stream – FL straits, currents monitoring
    c. New England—Fisheries stock assessment
    d. Solomon Sea – Pacific/Indian Ocean exchange
    e. OOI Initiatives
    f. SECOORA
    g. CariCOOS—tropical cyclone measuring
    h. Eastern Chukchi Sea—Marine mammal monitoring
    i. Coast of Nova Scotia—Marine mammal surveys, biological sensors)
    j. MARACOOS—HABS, Hypoxia
    k. NOAA Caribbean— bioacoustics (reef fish bio hot spots)
    l. Bermuda slocum missions—BATS augment \
    m. GLOS
    n. Northern California

2. **How can we use existing glider assets more effectively?**
    a. Opportunities for teaming, share/coordinate resources
        i. Forums for collaboration—conferences , list serves, operations forecasting
        ii. Operate like UNOLS, NOAA fleet
        iii. Share pilots, deployment/recovery resources
        iv. Interdisciplinary collaboration— more sensors per glider for mission benefit
    b. Creating a business model to make this work—User group
    c. Data and operational guidelines – sharing pathways / QA-QC
    d. Glider user forum for information sharing
    e. Public / Private partnership facilitation at International / National / Regional governance levels (IOOS to RAs)

3. **What are the gaps in what we currently can do and what are the new capabilities needed to address them?**
    a. Better education of glider use / product delivery
    b. Augment sustained systems w/ event monitoring, best practices for such
    c. Better (user/operator/customer) community communication
    d. Prioritize where network needs to expand
    e. Critical mass of personnel based on operation size
    f. Expansion of training for use, collaboration of users
    g. Standardization of additional integration of sensors

User Group Breakout

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User Group Overview:

- **The overarching goal of an Underwater Glider User Group is to establish a forum that encourages sharing and cooperation in the following areas:**
  - **Share experiences related to glider and glider sensor technology**
  - **Communicate the most recent science and monitoring objectives accomplished using gliders**
  - **Share approaches to logistical and operational challenges**
  - **Compare approaches to glider data handling, including quality control, formats, and distribution**
  - **Provide a means for ongoing communication about opportunities and needs for gliders**
  - **Collect, develop, vet and communicate recommendations on best practices to a growing glider community and a developing national glider network.**
  - **Purpose of the breakout is to determine the possible User Group that would be most useful to the underwater glider community.**

Instructions:

1. **Anything to add to the mission above?**
2. **What will the group accomplish?**
3. **What are the activities? (Including scientific contributions)**
4. **How does the user group function (listserv, virtual meetings, in-person meetings?)**

User Group (1-4):

1. **Anything to add to the mission above?**
   a. Collaboration with existing user groups/for a (EGO)
   b. Add language to display the broad regions, inclusivity, and Interaction with international observing community
   c. Commit to data standards and have interoperability
   d. Organizational structure (subgroups, rotating lead)
   e. Interfacing with agency supporters
   f. International connection
   g. Vendor interaction
   h. Cooperation on analysis tools through a forum that can provide co-development
   i. Add language to show that the group provides input and the leaders will provide content for advocacy

2. **What will the group accomplish?**
    a. Information/Resource sharing--online forum for questions/experiences/trainings
        i. Address immediate/emergency operations and less immediate needs
        ii. Improve communication between glider groups and modeling groups
        iii. Sharing of prep/piloting resources for smaller groups with limited support
        iv. Share knowledge of logistical support including personnel (technicians & / graduate students)
        v. Share calibration best practices
        vi. Share new scientific breakthroughs
        vii. Act as a publication repository
        viii. Share information on engineering and new sensor integration
        ix. Acts as a repository for deployment and mission information in specific areas
    b. Ease in software exchange
    c. Improved data management—raw through mid-level data; past platform-specific data
        i. Help to develop better data standards-- standardization of file formats (DAC, NCEI)
        ii. Innovative ways to visualize data
        iii. Act as a clearing house for glider operations (JCOMMOPS site)
    d. Creation of coordinated network
        i. Reach out to wider group of experts
    e. Identify ways to find additional end-users for a group's product

3. **What are the activities? (Including scientific contributions)**
    a. Recommend and implement standards (data, e.g.)
    b. Define scientific and community priorities
        i. Webinar series (two way exchange, talk with questions and conversations)
        ii. Creative science challenges
        iii. Facilitate groups to develop proposals
    c. Communicate with agencies
    d. Interact/represent with international communities
    e. Sensor training sessions on appropriate topics, include vendors
    f. Organizes periodic meetings
    g. Sharing contacts, ships, infrastructure
    h. Cooperate on analysis tools
    i. Group should have advocacy to establish minimum core mission, to address economy, jobs, security
    j. Set best practices, technical refresh, regional expertise
    k. Provide trainings for data processing and operators
    l.

4. **How does the user group function (listserv, virtual meetings, in-person meetings?)**
    a. Confederation of members overseen by leadership (rotating co-chairs)
        i. Need to identify size of group
    b. Logistical support (website, online forum, travel)
        i. Need to identify resources
    c. Subgroups, data/operators/users/international/manufacturer
        i. Subgroups
            1. Operators, data analysis, data management
            2. Different types of gliders
            3. Deployment focus
    d. Must have charter
    e. Regular cheap meetings/Virtual meetings or webinars (monthly)

h. Risk assessment / insurance
i. Minimize losses
j. Reduce cost investment
k. Permanent deployment
l. Energy source enhancement

4. **Areas that need sustained monitoring:**
    a. Sustained ecosystem monitoring – IOOS Opportunity
    b. Gulf of Mexico
    c. RESTORE funded project(s)
    d. GCOOS/SECOORA Coordination
    e. Great Lakes
    f. Gulf of ME
    g. Caribbean
    h. Arctic
    i. North Atlantic (AtlantOS project, EU – No funds for sustained ops)

Harmonizing Glider Efforts Breakout

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Operational Reliability Overview:

- **Glider operational reliability measures how dependable the observations are during deployment. Failure occurs due to weaknesses in the design, flaws in the materials, defects from the manufacturing processes, maintenance errors, improper operation, changes in operating concept, etc.**
- **Purpose of breakout is to determine how to implement strategies towards minimizing operational reliability risks**

Data Management Overview:

- **Glider operational reliability measures how dependable the observations are during deployment. Failure occurs due to weaknesses in the design, flaws in the materials, defects from the manufacturing processes, maintenance errors, improper operation, changes in operating concept, etc.**
- **Purpose of breakout is to determine how to implement strategies towards minimizing operational reliability risks**

Interagency Collaboration Overview:

- **Interagency Collaboration among federal agencies, departments, and offices enables many things to be done that no single agency can approach. Ocean scientists, engineers, and decision-makers struggle to synchronize their underwater glider efforts. Enhancing collaboration among U.S. federal agencies can enable powerful new scientific approaches for understanding, predicting, and managing our ocean resources with glider technology.**
- **Purpose of breakout is to determine strategies to advance interagency collaboration, coordination, and cooperation.**

International Collaboration Overview:

- **International Collaboration is essential for optimizing glider activities through fostering engagement with global partners. Overcoming bureaucracies to enable sharing is a major challenge.**
- **Purpose of breakout is to determine how to implement strategies to advance international collaboration, coordination, and cooperation.**

Instructions:

1. **List requirements and/or opportunities**
2. **What are some of the challenges in achieving these opportunities?**
3. **Provide recommendations/next steps**

Operational Reliability:

1. **List requirements and/or opportunities**
   a. **Causes for Failure**
      i. Inexperienced people/lack of available prep time/rush
      ii. Time between deployments
      iii. Deployment team separate from prep team, not focused solely on glider work
      iv. Biofouling or biological impact (shark, remora)
      v. Leaks
      vi. Sensor failure (eg. ctd pump, or a pressure leak)
      vii. Buoyancy (fresh water lens)
      viii. Length of deployment (up to a year difficult, biology happens)
      ix. 90 day cutoff (battery)
      x. Damage in shipping
      xi. Environment challenges (currents)
      xii. Weather
      xiii. Deployment impact (ship hits glider)
      xiv. Loss of steering
      xv. Buoyancy pump
      xvi. Air bladder
      xvii. Ship strike
      xviii. Underwater hazards (crab traps, fishing gear, wrecks)
      xix. Fishermen (pick up)
      xx. New technology impacts time for prep and success rate
      xxi. Software bug
      xxii. Altimeter
      xxiii. Connector issues after significant use
   b. **Opportunities**
      i. Resource pools (local expertise)
      ii. Training courses
      iii. Test early (vendors)
      iv. Guaranteed instrument tests prior to deployment and as new sensors come online (env testing).
      v. Set up standard preparation procedures (users & providers)
      vi. Detailed feedback to glider producers to improve process
         1. Root cause analysis (RCA)
         2. Detailed record keeping by users

2. **What are some of the challenges in achieving these opportunities?**
   a. **Funding/Resouces**
      i. Dedicated personnel
      ii. Training
      iii. Testing
      iv. Technology refresh

v. Configuration management

b. Centralized feedback org does not exist (user groups)

3. **Provide recommendations/next steps**
   a. 1-3 year goals
      i. Formalized testing procedures
      ii. Procedures/preparation working group (workshops, webex, forum)
      iii. Helium leak testers
      iv. Improved software (data vis and piloting)
   b. 4-10 year goals
      i. Current technology needs to become more like commercial
         1. It will never be like operating a r/c car
      ii. Improved power/batteries
      iii. Biofouling improvements (including remora)
         1. Chlorine generation
         2. Snails on a tether
      iv. Improved sensor calibrations
      v. Minimized sensor drift
      vi. sensor/soareft redundancy where available
      vii. Configuration management – shared database of what sensors are used, how calibrated, etc
         1. Cross agency collaboration

Data Management:

1. **List requirements and/or opportunities**
   a. Managing metadata, calibration coefficients, etc.
   b. Ability to integrate different datasets
   c. All data available in same format (automation of conversation to netcdf)
   d. CF compliant data at current standards
   e. CF data need to be converted from cdf to profiles
   f. QAQC– including agency requirements for QAPPs
   g. Archive raw data (time series, delayed mode, real-time)
   h. Create a group of representatives to figure out current state of data management

2. **What are some of the challenges in achieving these opportunities?**
   a. Entry into system for new users/learning curve for building and querying netcdf files
   b. Lack of resources for small shops
   c. Reliance on third party (ERDAP) adds layer of complexity
   d. Inconsistency in metadata between groups
   e. Time/money for personnel at each group to prep data
   f. Inconsistent QAQC
   g. Lack of automation to get files into needed formats (not provided by manufacturer)

h. All gliders output data in different formats
i. Standards change
j. High configurability of gliders means there are sensor data with no standard name, and regularly new types of data
k. Archiving raw data- ownership
l. Coordinating communication between the range of user groups
m. Central location for housing information

3. **Provide recommendations/next steps**
   a. Establish minimum metadata, etc. standard (1-3 year)
   b. Coordinate with EGO and IMOS to develop a unified system (a la ARGO) or improve compatibility – bring together representatives from all 3 groups to work on this (EGO building a team), can also improve QC; include manufacturers in these discussions (1-3 year)
   c. Centralize data management and formatting within the regions (1-3, after initial meeting)
   d. IOOS should develop set recommendations for manufacturers (1-3, after initial meeting)
   e. Recommendation to manufacturers to provide capability to convert data into netcf when they get to shore (Establish minimum requirements to be implemented now, and wish list of further capabilities
   f. Training at the universities (ongoing, coordinate with pilot training programs)
   g. Quantify value of standardized formats – who's using the data? How? Etc.
   h. DOI for each deployment to track use of data (developing this at EGO and OOI, publications are starting to require this)
   i. Include QAQC plan into funding requests
   j. Discussion on archiving raw data and relation to ownership
   k. Data management team –road map, develop standards, implementation, training
   l. Side meetings at major conferences –AGU, Oceans Sciences, etc.
   m. Webinars
   n. Increased support for national glider DAC

Interagency Collaboration:

1. **List requirements and/or opportunities**
   a. Agencies must see value in collaboration
   b. Agencies have mission requirements that gliders can support (e.g., hypoxia, env. monitoring)
   c. Agencies should discuss/ID common areas, aligned goals, exchange mechanisms to examine overlaps, gap areas over a larger glider community

2. **What are some of the challenges in achieving these opportunities?**
   a. Lack of formal agreements in place, long time scales can hinder development
   b. Need high level statement of importance, need for gliders, their contribution to larger issues, quantify impact

c. Making data available, usable, standardized, increase demand, find new users
d. Intra-agency collaboration, communication can improve

3. **Provide recommendations/next steps**
   a. Initial step: stronger agency engagement through user group to identify existing agreements to facilitate asset/expertise sharing, share agency strategic vision, then tailor glider agreements (as needed)
   b. User group driven – grassroots efforts to develop topic areas identified by user group
   c. Review existing agreements, future needs to support collaborations
   d. Representatives to NOPP, other program meetings to share user group needs
   e. Evaluate non-federal opportunities
   f. Formal group
   g. Identify common topics for interagency collaborations. Self-organized task teams with 2+ agencies -> commitment for chair, limited funding to move forward
   h. Biological task team (mainstream observations)
   i. Engagement by all IOOC agencies at regional level
   j. IOOC could support structure, commit funding based on glider user group activity
   k. Strategic planning required
   l. Find ways for money to come together (e.g., NOPP). IOOC as "seed funding" for long term development
   m. Data management requirements, sharing policies
   n. Priority: well-developed glider DAC that operates across agencies
   o. Technology testbed (e.g., Gulf range) as opportunity
   p. Regular communication facilitates, is required for effective leveraging
   q. ID level of commitment in sharing: data of different types, resources, support and have agreements in place
   r. Gliderpalooza as example of past interagency success
   s. Identify forum/mechanism: share logistics, new methods at higher level, but where is repository of information? Grassroots sharing can be most effective, realistic.
   t. Identify formal body to integrate strategic planning, 3/5/10 year plans, weave together by topic (e.g., gliders)

International Collaboration:

1. **List requirements and/or opportunities/challenges**
   a. International best practices
   b. Data sharing, data access
   c. Access to national EEZs
   d. Technology transfer
   e. Collectively addressing science challenges

2. **Provide recommendations/next steps**
   a. Collaborate with International OceanGliders group
   b. Recognize group as the forum for international coordination

    i. ACTION: Pierre to distribute to workshop attendees further information on OG
c. Engage in joint planning of global science challenges for boundary currents, storms, ocean processes, and data management (standards)
    i. ACTION: Distribute information on these activities and additional US participation.
    ii. ACTION: Nominate US participation in future OG activities.
    iii. ACTION: Encourage OG to engage in intergovernmental discussions about access and permission issues.
d. Glider deployment awareness
    i. ACTION: Work with OG and others to improve access to deployment plans and current glider missions.
e. Permissions and access
    i. ACTION: Operators should establish collaborations in countries to encourage access to foreign EEZs and sharing of data
    ii. ACTION: Review IOOS and NOAA international agreements to cover access issues and data sharing for broader US glider community. Share agreements as appropriate as templates for future agreements. Ensure gliders are a part of existing agreements.
    iii. ACTION: Explore potential role of NGOs in enabling collaborative project (scientific and capacity development) with other countries (First step: Collect case studies and target NGO that can help.)