Underwater Glider User Group

UG2 WORKSHOP SEATTLE
SEPTEMBER 20-22, 2022

UG2 Workshop Seattle '22

Final Report

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Table of Contents

Workshop Overview

Basis for the Meeting

The 2022 U.S. Underwater Glider User Group (UG2) workshop was held in Seattle, WA at the University of Washington Botanic Gardens on September 20-22, 2022. The workshop was part of a continued effort to unite the U.S. and international maritime buoyancy glider community and build on the outcomes and action items from the previous two workshops: the 2017 U.S. Underwater Glider Workshop at the Mississippi Infinity Science Center (Stennis Space Center), and the 2019 8th EGO Meeting & International Glider Workshop Meeting at Rutgers University in New Brunswick, NJ. These workshops help strengthen and coordinate underwater glider activities for marine monitoring, services, and scientific research as well as provide an opportunity for collaboration between the U.S. UG2 and the broader international glider community.

Meeting Goals

The overarching goal of the 2022 U.S. UG2 Workshop was to continue to build on an established community that facilitates sharing and coordination of glider missions both in the U.S. and internationally within areas of ocean monitoring, operational reliability, and data management. This meeting was designed to strengthen this collaboration through community dialogue, exchanges of information, sharing of experiences, and development of best practices to support the glider community.

Meeting Objectives

The objectives of the workshop were to:

1. **Harmonize Glider Efforts:** Data management, leveraging partnerships, documenting best practices, collaboration within U.S. and international community;
2. **Share New Developments:** Sensors, gliders, emerging requirements, novel glider applications;
3. **Explore Extreme Operating Environments:** Sea ice, currents, severe weather conditions;
4. **Share/Refine Operational Activities:** Sustained observing, reliability, sampling strategies, ocean modeling impacts (physical and biological), connecting coastal to open ocean biogeochemical observations; and
5. **Ocean Decade and Ocean Obs'XX:** Strategy for the next decade of regional, national, and global ocean observing using glider technologies.

Meeting Components

In order to facilitate these objectives, the workshop offered a mix of oral presentations, breakout groups, poster sessions, and open community dialog through social events. It provided a forum in which scientists, engineers, students and industry members exchanged knowledge and experience on the development of glider technology, the application of gliders in oceanographic research, and the role of gliders in ocean observing systems. It is important to note that after pausing UG2 workshops due to the pandemic, the 2022 Workshop demonstrated the importance of in-person dialogue in addition to a robust agenda.

Oral Presentations: Energetic and captivating speakers submitted abstracts and were invited to educate and inform the community with up-to-date science, practice, and unique case studies. Practitioners representing the full scope of the international glider community – from federal, state, and local agencies, to industry and academia – covered a wide breadth of examples, methodologies, and general uses of gliders.

Working Groups: Focused breakout working groups created opportunities to interact with colleagues and work toward specific outcomes or goals, which included developing a plan for sustained glider observations, fostering regional collaboration, determining standards for biogeochemical (BGC) sensing and data processing, and aligning data management practices.

Poster Presentations: Poster presentations also played a key role in disseminating research, tools, and information. In order to promote networking between participants, the poster sessions coincided with the evening receptions on Tuesday and Wednesday, September 20-21, 2022.

Sponsors

The workshop was primarily funded by the U.S. IOOS Office, but a huge part of the success of the workshop was the additional support and participation of our industry sponsors. The workshop provided dedicated time for industry exhibits and presentations and industry-sponsored social events. The industry sponsors included:

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Working Groups Discussions & Outcomes

The workshop working groups (WG) originally included five focus topics: **Sustained Observing**, **Biogeochemical (BGC) Sensors**, **Collaborative Science**, **Modeling Impacts**, and **Data Management**. Due to interests of attendees, a **Biological Sensors — Acoustics** WG was added after Day 1 of the workshop. The following is a description, goals, and summary of the outcomes of each of these working groups.

Sustained Observing

Lead: Robert Todd, Woods Hole Oceanographic Institution

Building on progress previously made by the OceanGliders Boundary Ocean Observing Network (BOON) effort, this WG discussed plans for sustained, glider-based observing along ocean boundaries. Of particular focus was: forming teams focused on particular regions of interest; identifying scientific and societal drivers and stakeholders for each region; building observing plans for each region; and discussing funding needs and opportunities.

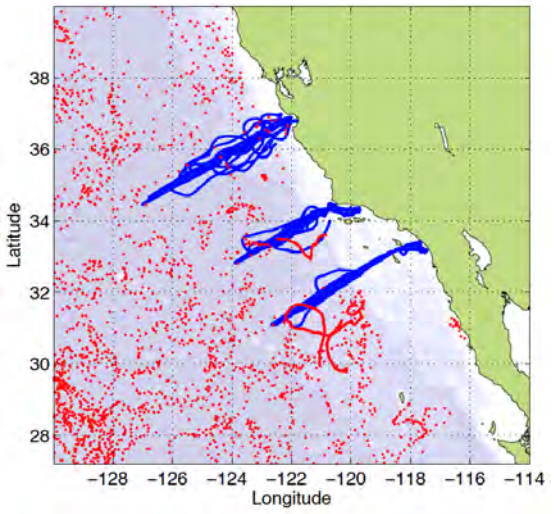
Background

For the Global Ocean Observing System (GOOS), efficiently delivering critical ocean observations – stretching from high to low latitudes, from atmosphere to deep ocean, and from the coast to the open ocean and to areas beyond national jurisdiction – across a growing set of physical, biogeochemical and biological variables, remains the fundamental goal. Underwater gliders are one component of the GOOS with OceanGliders (www.oceangliders.org) being a recognized program within GOOS.

Ocean boundaries are where society experiences most effects of ocean variability. Societally relevant topics include climate, weather, fisheries, pollutants, transportation, and recreation. As an ocean observing platform, underwater gliders are particularly well suited to providing observations in boundary regions, connecting the coastal waters to the deep ocean. Gliders are able to measure essential physical, biogeochemical, and biological parameters with high spatial resolution, which is necessary to resolve the sharp gradients that typify ocean boundary regions. Integrating well with other observing platforms and models, gliders have the potential to be for ocean boundaries what Argo is for the deep ocean.

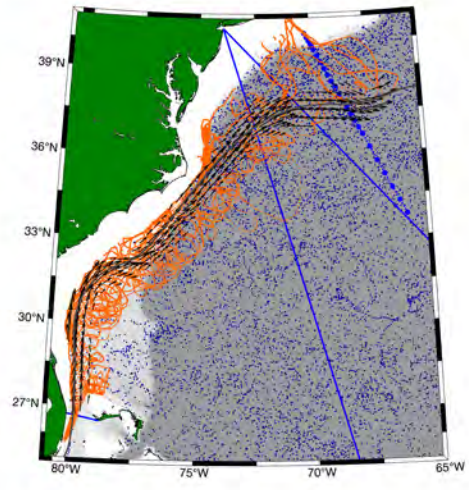
Within OceanGliders, BOON aims to coordinate development of a global network of networks that monitors variability along ocean boundaries. BOON will support regional efforts that respect coastal countries; encourage sustained, year-round operations; help with publishing near-real time and post-processed data to appropriate public repositories; and coordinate with regional modeling efforts. BOON has a stated goal of having 100 sustained gliders operating in boundary regions by 2030.

Glider-based sampling vs Argo sampling



California Current Observation Locations

– Gliders • Argo



Gulf Stream Observation Locations

••• Gliders • Argo ●●●– Other platforms

Figure 1: *Glider-based sampling versus Argo sampling in the California Current System (figure from D. Rudnick) and the Gulf Stream region (figure from R. Todd). High-resolution glider sampling links the coast and/or continental shelf to the deep ocean, which is well sampled by Argo.*

Outcomes

SUSTAINED OBSERVING		
FOCUS AREAS	**CHALLENGES**	**OPPORTUNITIES**
Exclusive economic zones	Must respect coastal states	Opportunity for capacity building
Sustained operations (24hrs/day, 365 days/yr)	Requires substantial equipment and personnel commitment	Opportunity for collaboration between operators
Scope of sampling	Sustained network cannot feasibly do it all. There needs to be a "backbone."	Opportunity for supplementing with additional sampling for process studies
Tracking data use	Difficult to track use data once posted publicly	Opportunity to demonstrate impact of full BOON network of networks
Funding	Will need to come from each coastal state and need operations and recapitalization	Opportunity for international coordination at funding agency level

Goals & Near Term Objectives

SUSTAINED OBSERVING	
GOALS	**OBJECTIVES (1-2 YEARS)**
Reinvigorate BOON	Reach out to the full glider community and (re)build BOON contact list (fall 2022)
Develop plans for each region of interest that can be used to motivate funding	Form groups of interested operators for each region and produce two-page summaries of rationales, drivers, stakeholders, observing plans, and funding needs (early 2023)
Coordinate/Co-Design with other networks (e.g., BGC Argo, OceanSites, shore stations, OceanPredict, and CoastPredict)	Identify key contacts within these networks (end of 2022)
Track BOON observing efforts	Encourage addition of a BOON metadata tag for any glider missions contributing to the BOON mission (end of 2022)
Expand the number of BOON lines and regions occupied	Include new operators and secure additional funding (ongoing)

Biogeochemical (BGC) Sensors

Lead: Yui Takeshita, Monterey Bay Aquarium Research Institute

This working group focused on discussions towards creating an interoperable dataset between Biogeochemical (BGC) Argo and BGC gliders, which will help connect key observations between the open and coastal ocean. Discussions focused on the requirements of such a dataset, the current status of BGC data reporting for gliders, challenges that must be overcome, and strategies for implementation over the next several years.

Distribution of Operational BCG Argo Floats and Associated Sensors, October 2022
(data distributed within the last 30 days)

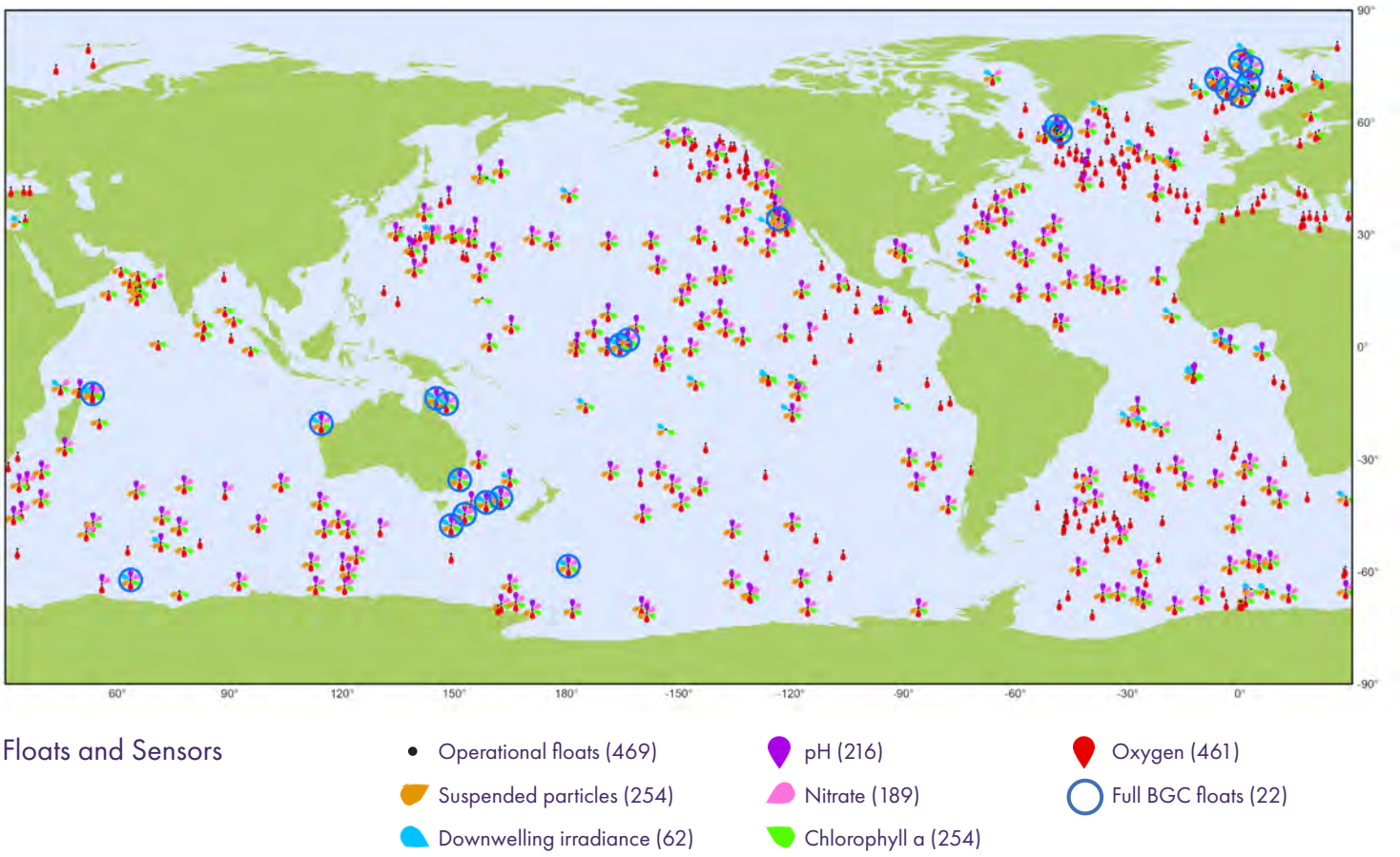


Figure 2: *Current distribution of BGC Argo floats. There are currently 252 floats with at least 4 BGC sensors. Over the next 5 years, 500+ more floats are funded to be deployed by the U.S., and 250+ more floats are planned for deployment by international partners. See Figure 1 for how glider observations can connect the open ocean (Argo) to the coastal ocean (gliders).*

Background

Underwater gliders are well suited to connect measurements from the coastal to open ocean. Biogeochemical (BGC) Argo is a growing network aimed to effectively observe open ocean biogeochemical processes, and now has a suite of six scalable sensors that measure O2, nitrate, pH, Chl fluorescence, optical backscatter, and downwelling irradiance, with standardized methods to calibrate and quality control (QC) these measurements. With a growing suite of BGC sensors for gliders, there is an opportunity to create an interoperable dataset that connects coastal to open ocean biogeochemical observations. However, such a dataset between BGC-Argo and underwater glider networks will require QC protocols with defined uncertainties for various BGC sensors utilized on gliders.

Outcomes

BIOGEOCHEMICAL (BGC) SENSORS	
FOCUS AREAS	**CHALLENGES**
Datasystem	Need standardized data format for BGC glider observations (OG1.0 nearly complete)
	Real-time adjustments for most BGC parameters will need to be implemented for operational uses
	Timely delayed mode QC will need to be conducted
	Cannot mandate this; will be an opt-in system, thus needs regional scientific/operational justification, stakeholders, training, and funding
Sensors	Training to gain expertise on BGC sensors
	Need to further develop some BGC sensors for routine glider operations
Quality control	Training and expertise on QC needed
	Developing QC/adjustment methods for some parameters in coastal waters (can't always adopt Argo methods)
	How will users know which data went through the SOP-QC? Need clear identifiers
	Securing funding for QC

Goals & Near Term Objectives

BIOGEOCHEMICAL (BGC) SENSORS		
GOALS	**OBJECTIVES (1-2 YEARS)**	**OBJECTIVES (3+ YEARS)**
Data needs to have defensible and documented uncertainty estimates for each parameter. Can be higher uncertainty than BGC Argo, but needs to be justified and documented. A centralized data system for glider data with standardized data format with sufficient metadata. Timely delayed mode QC'd BGC glider data for hindcast models and ecosystem assessments. Real-time adjusted BGC glider data for operational model applications.	Wait for OG1.0 official release. Contribute to OceanGlider SOPs: • O2 • Nitrate • Chlorophyll Get sustained glider operators along the West coast of America to report adjusted O2 data in real time to the glider DAC. Work with regional modelers to inform them of upcoming glider data.	Work with BOON to get other regions to report adjusted O2 data to the glider DAC. Continue to develop and refine QC protocols. Challenges: No mandates, need regional push/rationale/ stakeholders, training, and funding.

Biological Sensors — Acoustics

Lead: Christian Reiss

This working group was formed by attendees to have a session on acoustical sensors (passive and active) given the high interest and increased use within the glider community.

The ad-hoc working group on biosensors (acoustics) focused their discussions on creating a framework that:

- Identifies opportunities to demonstrate the utility of acoustic sensors on gliders;
- Discusses current limitations and requirements to acquire high quality data;
- Develops metrics to characterize biological constituents in the water column (e.g. Echometrics) that can be rapidly implemented across within existing active acoustic data sets and how hardware and software can be integrated into existing or new gliders.

Background

The opportunity to collect biological data on ecosystem structure and function using underwater gliders is necessary to monitor ocean health. Acoustic backscatter from Acoustic Doppler Current Profilers (ADCPs), broadband, and/or narrowband scientific echosounders integrated into gliders can provide data stream(s) to develop ocean health indices, as well as information necessary to manage living marine resources. However, the diversity of instruments, the need for instrument calibration, target validation, and the management of large (terabyte) amounts of data collected, requires that glider operators develop analytics and metrics to summarize acoustic data, and data quality standards to ensure compatibility among data streams. While protocols and best practices can be leveraged from other international programs (e.g. ICES acoustic data working group), glider specific challenges remain.

Outcomes

BIOLOGICAL SENSORS — ACOUSTICS	
FOCUS AREAS	**CHALLENGES**
Calibration	Comparability among instruments and programs
System integration	Full description (0 to 1000m) of water column biological properties
Differing scientific goals	Ultimately, developing understanding of predator - prey - human interactions

Goals & Near Term Objectives

BIOLOGICAL SENSORS — ACOUSTICS		
GOALS	**CURRENT STATUS**	**OBJECTIVES (1-2 YEARS)**
Provide biological context to physical processes	Non-standard instruments and collection methods	Increase user community and dissemination of ideas and methods (begin with SLACK channels)
Addition of biological (> chl-a) information to data streams	Non-standard methods for some glider data	Integrate active and passive acoustics (where possible) into some existing monitoring lines (e.g. BOON, CUGN)
Fully integrate biological sensors into existing monitoring		Develop simple metrics for summarizing water column echo data where calibration is not required (perhaps using echometrics) Serve summary data in local ERDAP

Collaborative Science

Lead: Emily Smith, NOAA; Kerri Whilden, Fugro

Background

More can be accomplished if we work together as a community. Diverse backgrounds with complementary goals can lead to innovative solutions.

This working group allowed an opportunity for individuals and groups with a range of experience and resources to connect by region or technical area of interest.

Targeted topics included:

- Introduction to regional associations and cooperative institutes;
- Examples of ongoing efforts in collaborative science;
- Private/Public partnerships; and
- Suggestions for how UG2 can help foster future collaborations

Outcomes

The following are suggestions from the group to enhance collaboration across the UG2 community:

COLLABORATIVE SCIENCE		
FOCUS AREAS	**GOALS/CHALLENGES**	**NEAR TERM OBJECTIVES**
Practical applications	• How to incorporate a specific sensor? • Adding skill-based webinar topics • Data tools, toolchain, dataset (what people are doing?) • Methods of standard communication across glider missions?	• Using current UG2 Webinars • Use Best Practices Sub-Focus Group • UG2 Slack is a great collaboration tool • Cruise Report Template

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Working Groups Discussions & Outcomes

COLLABORATIVE SCIENCE		
FOCUS AREAS	**GOALS/CHALLENGES**	**NEAR TERM OBJECTIVES**
Training	• How to use sensors to derive bio/phys/chem info from sensors? • What options when you use different sensors? • QC training videos posted on the central site • Failed scenario/use cases videos, learn from the oopsies	• Use the training Sub-Focus Group to establish a UG2 working group for these topics • Use the UG2 Website for applicable training video postings
Webinar topics	• Demo of what is happening in "my" lab (could be done by region) • How frequently are operators calibrating sensors? • These topics could be partially driven by graduate students • Make sure all are permanently archived for reference	• Submit Webinar topics per bi-monthly data calls on UG2 Slack and emails • Webinar topics will be permanently archived in future
Seminars	• More open discussion opportunities vice targeted topic	• Use Training Sub-Focus Group to plan
Miscellaneous	• Offer standard template for mission cruises • Use common metrics across UG2 • Global Map of field work to include "glider ports" • Have metadata standards • Have a UG2 Hotline • Share code to process data	• Stand up a Data Management Working Group • UG2 Slack is essentially a hotline but a review of channels would be useful

Modeling Impacts

Lead: Chris Edwards, University of California Santa Cruz;
Scott Glenn, Rutgers University

This working group focused on documenting these applications and more importantly identifying issues, gaps, and potential opportunities to enhance model applications for societally-relevant needs. Focused discussions included: What glider data is being used in conjunction with ocean models? How are models accessing glider data? How are models using glider data? What are the challenges modelers face in glider data use? How can models inform the glider community? What gaps exist between existing and potential glider data sets and models? What societal needs are being or could be met through model and glider use?

Background

Sampling coastal and deep ocean waters at high spatial and temporal resolution, gliders provide unique subsurface data that can be used for ocean model evaluation and state estimation. Complementing other remote sensing and in situ observations, glider data is presently being used operationally and non-operationally by models in U.S. coastal waters and global ocean basins for physical, biogeochemical and coupled ocean atmosphere applications.

To kick off this working group introductory presentations were given followed by information gathering through targeted questions.

Presentations included:

- Hurricane Gliders – Dr. Scott Glenn
- Challenges to ocean observations for tropical cyclone forecasting – Dr. Avichal Mehra NWS
- 4Dvar Assimilation of Biogeochemical Variables - Dr. Chris Edwards

Outcomes

MODELING IMPACTS	
FOCUSED DISCUSSION TOPICS	**OPPORTUNITIES/CHALLENGES**
What glider data is being used in conjunction with ocean models?	• Opportunity to use gliders for HABs (temp and chlorophyll) • Temperature, salinity, chlorophyll fluorescence (in infancy) assimilated into operational models (T/S) and research (chl) models • Sediment resuspension for model validation (not assimilation) • Glider internal density structure used to project onto model, synthetic profile compared with colocated sea surface elevation (glider and Argo) • Data going into WOD also contributes to accuracy of models by improving climatology • In Great Lakes, O2 data can look at primary production, hypoxia and DO depletion rates • Sound speed profiles (e.g. recent NRL/UW APL experiment on WA shelf) • How are gliders being used to improve vertical projections of altimetry for assimilation?
How are models accessing glider data?	• They should all feed into WOD - raising the issue of time gap • Is there a requirement of metadata that allows it to be usable? Anything that comes onto GTS there is a minimum set of metadata and it is included in the template to upload data • No standardized QC of glider data, but this is needed • What level of flagging should be used? Develop standardized methods for flagging? • Best practice on how to push data to the GTS (help solve political issues with different countries and their requirements) • In Europe the data is pushed to GTS and most data is grabbed from services collecting the data and in situ and modeling/assimilation community - access to potentially more data • Idea brought of "regional glider DACs." Could be replicated in other areas and need to remove political barriers • DAC and GTS need direct interactions with glider operators
How are models using glider data?	• 4Dvar, 3Dvar • Validation • Improving climatologies • Ecosystem models can be coupled to physical models • Coupling with the ARGO network with coastal and open ocean • Closure schemes / mixing schemes (hurricanes mixing and velocities) – minor level of research but not at an operational scale • Model design phase - are targets being thought about (vertical gradients)

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MODELING IMPACTS	
FOCUSED DISCUSSION TOPICS	**OPPORTUNITIES/CHALLENGES**
What are the challenges modelers face in glider data use?	• Independence of assimilated data is an issue, how much data to withhold for independent evaluation? While the ocean is undersampled, it is hard to assimilate all observations that are out there. Some parts of unassimilated observations could be used for validation. • Accuracy, time vertical sampling requirements can be different between model and glider data. • Data assimilative models can work with error as long as it is known and qualified as part of the product. Sensor bias, drift, uncertainty and how it is characterized is generally lacking in data metadata. Need error bars. • Make connections between glider operator, instrument and data analysis and what do modelers need. Can we codesign the data flow? Weigh more observations versus improvements to how data is assimilated.
How can models inform the glider community?	• When the data is rejected. • We don't know if a sensor is broken right away and if those rejection notifications come from the modelers it could be easier to identify. • Possibly a service to send to the owner of floats in the ocean obs system - as soon as you have the unique identifier then you can send this feedback directly back to the owner. Could be a useful feedback loop. • Another service is documenting the service of all the gliders and their assimilation. • Model use cases are a big value. • Help operators in anomaly detection mode. • Fly gliders through model fields to test concepts of operations. • Can we inform models through data and inform data through models? OSSE's are the ultimate expression of this. Formally this is what should be done, but takes time and is expensive. • Observation impact studies that show the impact of each observation on models. • In BGC fields there are areas of enhanced variability, an area where you might want to increase sampling. • Look at forecasts, forecasts are informed by models, identify regions where forecast errors (or uncertainty) are high, ensemble systems to identify regions of large uncertainty. • Models can be used to help piloting, preparation and ballasting.

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MODELING IMPACTS	
FOCUSED DISCUSSION TOPICS	**OPPORTUNITIES/CHALLENGES**

What gaps exist between existing and potential glider data sets and models?	• Measurements are being underutilized (can they get pulled into models - (i.e. depth & velocity?):
	  • Could we put more sensors out in ADCPs and develop an observing system to support the models?
	  • Co-located velocity models.
	  • Turbidity would be an enormous benefit.
	  • The feedback to the community is if data is assimilated what is the effort that needs to be put in to ensure good quality data recorded by gliders.
	  • Gap identified with Data Management WG Day 1 with Kevin O'Brien with data flow and best practices paper to get data uploaded.
	• How to measure uncertainty on observations (precision of the sensor?).
	• A new buffer template includes BGC data; it will go out under the bullet header and do not need a separate header for that data.
	• Applying QARTOD standards (flags) to glider data, especially beyond standard T&S variables. Carrying QC flags through the data flow.
	• Science quality control versus operational level of data?
	• Only part of the glider data is assimilated. We should codesign the optimal sampling strategy.

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MODELING IMPACTS	
FOCUSED DISCUSSION TOPICS	**OPPORTUNITIES/CHALLENGES**
What societal needs are being or could be met through model and glider use?	• Need to get all data to operational forecasts, can withhold data on independent reanalysis studies. • (Hurricane, severe weather, hypoxia identification, and ocean acidification forecasts). • HAB condition detection. • Passive and active bioacoustics, association of organisms with habitat (e.g., right whale habitat for protection), ecosystem services. • Typhoons on other coastlines of the world – low impact of current observations on global models, dependent on models. • Acoustic sound speed models are informed by gliders T and S. • Fisheries applications based on T and S to produce distributions of target species of managed fisheries and bycatch. • Offshore wind development, characterization of fisheries habitat in the context of offshore wind and wave. • Search and rescue (data assimilative ROMS model), pollutants, microplastics, recreational safety. • Marine navigation optimization. • Climate change and climate services, e.g., monitoring choke points (in AMOC), large scale changes. • Integrating glider historical data to look at metabolic balance of Great Lakes (pCO2 changes, pH changes).

Goals and Near Term Objectives

MODELING IMPACTS	
GOALS	**OBJECTIVES**
Having better communication through UG2 for sharing data.	Assure all glider users are aware of impacts of data to models and forecasting and mechanism/pathway for getting data to these models (i.e. DAC).
Encourage operators to provide uncertainty estimates along with values.	

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MODELING IMPACTS	
GOALS	**OBJECTIVES**
QUARTOD flags should be carried through data management flow.	
Co-design: Establish 2-way feedback loop between modelers and glider operators.	Developing a trusted relationship and a formal framework for 2-way feedback.
Product development: NRT and DT Science quality (WOD does this).	
Use common language for variables - common format compliant.	
Communication modeling needs to glider operators (submit data to the DAC), need to work on tools to achieve this. Education outreach.	

Data Management

Lead: Kevin O'Brien, NOAA

Background

This working group focused on current and future data management topics facing the glider community. The topics included:

- A tutorial for finding and using glider data through NCEI and WOD.
- Update on Glider NetCDF OG1.0 format.
- Update on Glider BUFR template development.
- Overview of GOOS Observations Coordination Group data implementation strategy for the GOOS global in situ networks.

Outcomes

DATA MANAGEMENT	
CHALLENGES	**OPPORTUNITIES**

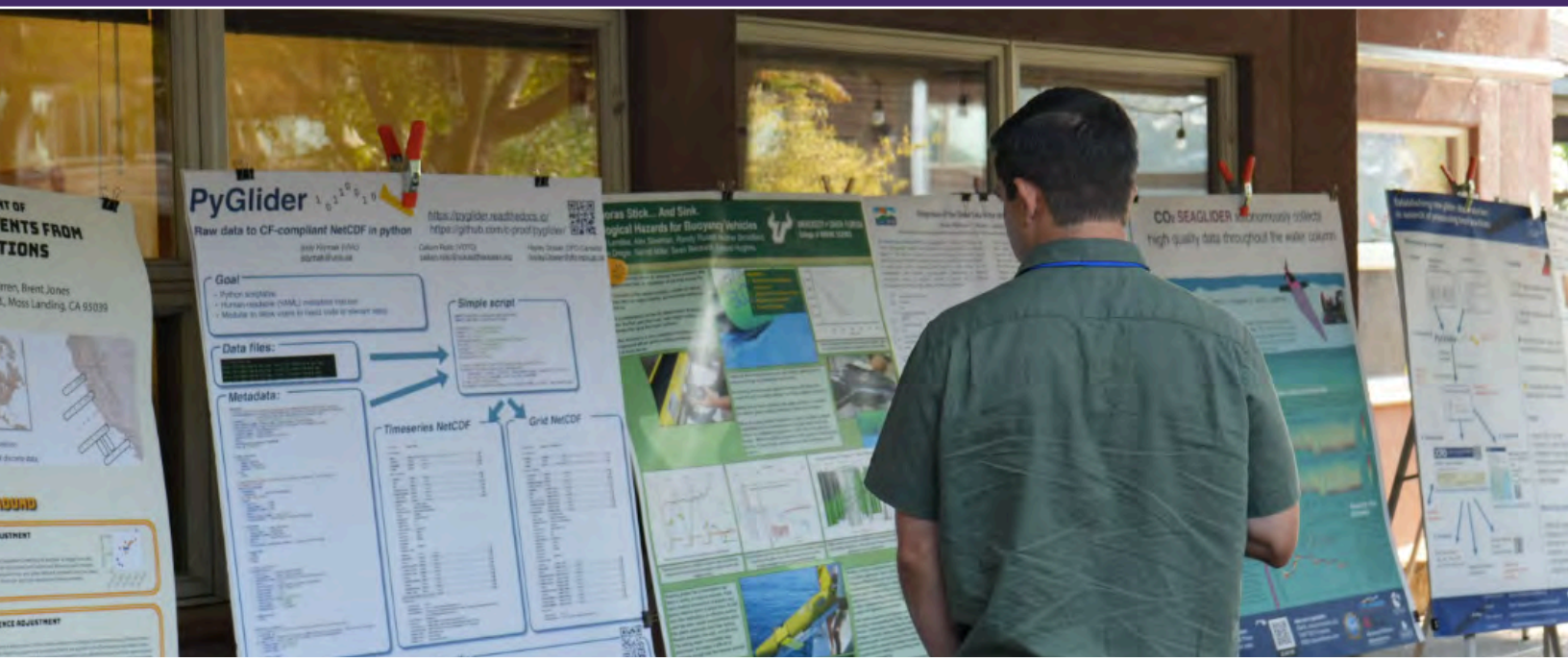
• OG1 NetCDF format not finalized:
  • Format change will mostly affect DACs, not data providers
  • Data providers will need to provide complete/improved metadata	

• Switch from TESAC messages to BUFR messages at DACs • Integrating gliders that aren't currently sending data to GTS (capacity development)	• Provide capacity development to ensure ALL glider data collected is part of the GTS and Glider DACs.
• To have ERDDAP services running at US IOOS, Coriolis and IMOS, and federated under a single focal point (i.e. GOOS OCG ERDDAP?)	• Provide a unified view of real time and delayed mode glider data through Federated/Virtual GDAC • This will make glider data available for efforts such as UN Ocean Decade, WIS 2.0, etc.
• Machine-to-Machine exchange of metadata between DACs and OceanOPS	• Leveraging off some of the m2m metadata exchange currently done with OceanOps.

Goals & Near Term Objectives

DATA MANAGEMENT		
GOALS	**CURRENT STATUS**	**OBJECTIVES (1-2 YEARS)**
Best Quality glider data available in OG1.0 NetCDF format	OG1 NetCDF format is in the final development stages	OG1 and BUFR template finalized and in use
All RT glider data distributed on GTS using TM315012 BUFR template	TM315012 has not yet been approved by WMO/INFCOM. Likely ready for use in Spring 2023	*Most* gliders sending real time data to GTS.
Virtual GDAC using Federated ERDDAP services from distributed DAC ERDDAPs	ERDDAP deployed at 2 of 3 DACs	ERDDAP services running at US IOOS, Coriolis and IMOS, and federated under a single focal point
Machine-to-Machine exchange of metadata between DACs and OceanOPS	Some machine to machine metadata exchange currently with OceanOPS	OceanOPS harvesting metadata from the ERDDAP servers

Poster Topics & Presenters



The following are the posters presented and the POCs for any follow up questions or collaboration.

GLIDER MONITORING/OBSERVATION MISSIONS		
POSTER NAME	**PRESENTER**	**CONTACT**
Investigating Sediment Dynamics Over a Deep Sand Dunes Field Using ADCP-Glider	François Bourbin	Could not attend
Overview of the Long-term Glider Operations at the Ocean Observatories Initiative Coastal Pioneer Array	Peter Brickley	pbrickley@whoi.edu
Eight Years of Caribbean Region and Southwest Tropical Atlantic Underwater Glider Observations in Support of Hurricane Intensity Research and Forecasts	Francis Bringas	Francis.Bringas@noaa.gov
Multi-Year Upper Ocean Dynamics at the OOI Southern Ocean Global Array Using an Array of Autonomous Platforms	Filipa Carvalho	filipa.carvalho@noc.ac.uk
Glider Operations in Atlantic Canada	Richard Davis	richard.davis@dal.ca
Reimagining Glider and Float Mission Logistics - How to Scale the Next Order of Magnitude for Deployments?	Donglai Gong	gong@vims.edu

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Poster Topics & Presenters

GLIDER MONITORING/OBSERVATION MISSIONS

POSTER NAME	PRESENTER	CONTACT
Operations and Explorations of the University of South Florida Glider Operations	Chad Lembke	clembke@usf.edu
Gliders and The Atlantic Carbon Observatory Pilot Program (ACOP)	Nicolai von Oppeln-Bronikowski	nbronikowski@mun.ca
Comparison between Experimental Deployments of a Slocum G3 Glider and a Wirewalker Wave-Powered Profiler on the Florida Shelf	Alfredo Quezada	aq199@nova.edu

GLIDER TOOLS AND BEST PRACTICES

POSTER NAME	PRESENTER	CONTACT
Power Consumption Rates of Slocum Gliders across the SECOORA Glider Fleet - a historical look at over a decade of data	Karen L. Dreger	Karen.Dreger@skio.uga.edu
Field Repair of a Slocum Air Bladder	Jasmin McInerney	jasmin.mcinerney@niwa.co.nz
Best Practices For A New Glider Observatory: Data Management, Sops And Community	Callum Rollo	callum.rollo@voiceoftheocean.org
Evolving Data Tools and Practices for Oculus Glider Data	Margaret Sullivan	peggy.sullivan@noaa.gov

GLIDER DATA MANAGEMENT

POSTER NAME	PRESENTER	CONTACT
Introducing Pyglider To Translate Raw Glider Date To Netcdf	Jody Klymak	jklymak@uvic.ca
Integration of the Glider Data in World Ocean Database	Alexey Mishonov	alexey.mishonov@noaa.gov
Best Practices for a New Glider Observatory: Data Management, Sops And Community	Callum Rollo	callum.rollo@voiceoftheocean.org
Evolving Data Tools and Practices for Oculus Glider Data	Margaret Sullivan	peggy.sullivan@noaa.gov

Poster Topics & Presenters

GLIDER DATA ANALYSIS

POSTER NAME	PRESENTER	CONTACT
Glider Acoustics in Near Real-Time with Visual Target Validation	Anthony Cossio	anthony.cossio@noaa.gov
Signatures of Biologically Enhanced Turbulent Mixing in the Sargasso Sea using a Rockland Scientific MicroRider and Teledyne Webb Slocum Glider	Jonathan Chapman	jonathan.chapman@bios.edu
Assessment and Improvement of Dissolved Oxygen Measurements Off Oregon and Washington from Ocean Observatories Initiative Gliders	Edward Dever	Edward.Dever@oregonstate.edu
Derived Data Products for the Carbonate System from Ocean Glider Data: Benefits and Challenges	Hayley Dosser	hayley.dosser@dfo-mpo.gc.ca
Sea-Ice, Convection, and Small-Scale Processes in the Labrador Sea Over Two Winters	Eleanor Frajka-Williams	eleanor.frajka@uni-hamburg.de
Development of a Carbon Seaglider for Ocean Acidification Monitoring and Inorganic Carbon Process Studies	Brita Irving	bkirving@alaska.edu
Slocum G3 Glider LADCP Data Comparisons to Bottom Moorings in the Straits of Florida	John A. Kluge	jk1083@nova.edu
Quality Control and Adjustment of Ph Measurements from Spray Glider Observations in the Monterey Bay	Jacqueline Long	jlong@mbari.org
Turbidity Layers Related to Submarine Channels and Sediment Transport Along the Northern Gulf of Mexico Shelf Break	Kevin M Martin	kevin.m.martin@usm.edu
Sustained Environmental Monitoring of the Western Gulf of Mexico with Seagliders	Miguel Tenreiro	tenreiro@cicese.mx
Salinity Effect Revealed by Underwater Glider Observation: The Case of Hurricane Ida	Senam Tsei	senam.tsei@usm.edu
What We Do in the Shadows: Using Glider-Integrated Shadowgraph Cameras for Zooplankton Density Estimates	Jen Walsh	jen.walsh@noaa.gov
Dynamics of Wind, Wave and Water Level During the Storm Season in the Maryland Coastal Bays	Meng Xia	mxia@umes.edu

UG2 Way Ahead

A key focused outcome of the UG2 2022 Workshop was to collect input from the UG2 community to determine the way ahead for UG2. A brief was given on the history of UG2 and what has been accomplished to date to function as a user group. This included:

- Officially establishing UG2 membership currently at 267 members;
- Establishing a UG2 charter;
- Standing up a UG2 Steering Committee (2 year member rotation) - see Figure 3, next page;
- Establishing sub-focus groups (Best Practices, Training, Coordinated Operations, and Industry Engagement) - see Figure 4, next page;
- Standing up a UG2 website: www.underwatergliders.org
- Establishing bi-monthly webinars (industry, science, and operations);
- Establishing a UG2 Slack: https://underwatergli-ciz2530.slack.com.

UG2 Way Ahead

Mission: The Underwater Glider User Group (UG2) is a community-based calition aimed at bolstering scientific collaboration and informatio/resource sharing for glider operator, data users, manufacturers, academia, and government agencies.

UG2 Steering Committee

MEMBERS		1° CATEGORY	LOCATION
Michael Bendzlowicz	CNMOC	Sectoral	Stennis Space Center, MS
Patricia Chardon Maldonado	CariCOOS	Regional	Caribbean
Daniel Hayes	Univ of Cyprus	International	Cyprus
Barb Kirkpatrick	GCOOS	Regional	Gulf of Mexico
Hyun-Sook Kim	NOAA	Stakeholder - User (Ocean Models)	Mid-Atlantic
Chad Kramer	NAVOCEANO	Stakeholder - Operator (Pilot)	Stennis Space Center, MS
Kevin Martin	USM	Technical - Data Manager	Gulf of Mexico
Travis Miles	Rutgers	Regional	Mid-Atlantic
Hank Statscewich	UAF-AOOS	Regional	Alaska
Robert Todd	WHOI	Regional	North Atlantic
Victor Turpin	JCOMMOPS	International	France
Katherine Zaba	UCSD	Regional	West Coast

EXECUTIVE SPONSORS	
Carl Gouldman	Director, NOAA IOOS
Bob Houtman*	Section Head, NSF OCE
Kathleen Bailey	NOAA IOOS
David Legler*	Director, NOAA GOMO

**IOOC Co-Chair*

COORDINATION & STAFF	
Bill Lingsch	UG2 Coordinator
Nick Rome	Staff, Ocean Leadership
Kruti Desai	Staff, Ocean Leadership
Cassie Wilson	Staff, Ocean Leadership

Figure 3.

UG2 Sub-Focus Groups

Training

Lead: Hank Statscewich (Kevin Martin, Patricia Chardon Maldonado)

Identify training requirements, curricula and training gaps

Coordinated Operations

Lead: Robert Todd (Katherine Zaba, Hyun Sook Kim, Mike Bendziowicz)

Improve communication and coordination among operators and users

Industry Engagement

Lead: Katherine Zaba (Hank Statscewich, Patricia Chardon Maldonado, Barb Kirkpatrick)

Engage industry to improve communications, access, customer service

Best Practices

Lead: Kevin Martin (Chad Kramer, Travis Miles, Robert Todd, Dan Hayes)

Coordinate and commuicate best practices and lessons learned across the globe

Figure 4.

Focusing future efforts, to maximize beneficial outcomes to support the UG2 community, is critical given limited resources to implement suggestions. Coincidentally, much of the discussions and suggestions made in the Collaborative Science working group were directed at moving UG2 forward hence these suggestions are captured in the Collaborative Science working group outcomes "Collaborative Science" on page 11.

In addition to the suggestions captured in Collaborative Science, the following were also captured:

- Create an objective to design a STEM outreach product(s) that others can leverage for their local school events. Think SeaPerch, but with buoyancy concepts and gliders.
- Use UG2 as an intermediary to serve as a review committee before new tools are launched.
- Utilize UG2 SG Sub-Focus Groups to spawn off targeted subject working groups.
- Look into possibly having a separate operationally focused workshop apart from science. This could be in between the 18 month larger meetings.
- Define the US UG2 mission vs international glider user group (i.e. Oceanlider, EGO).
- Establish an industry panel that nominates a representative to serve on the Steering Committee.

Appendix A: Working Group Action Items

SUSTAINED OBSERVING		
ACTION ITEM DESCRIPTION	**RESPONSIBLE PERSON(S)**	**EST. COMPLETION DATE**
Rebuild BOON contact list	Robert Todd	Fall 2022
Produce 2-pagers for each boundary region of interest	Regional Teams	Early 2023
Identify contacts at other networks	Robert Todd	End 2022
Encourage BOON metadata tag	Victor Turpin	End 2022

BIOGEOCHEMICAL (BGC) SENSORS		
ACTION ITEM DESCRIPTION	**RESPONSIBLE PERSON(S)**	**EST. COMPLETION DATE**
Contribute to O2 SOP (e.g. SBE63)	Yui, Alice	TBD
Contribute to Chl SOP	Ongoing organized effort across community	TBD
Coordinate with BOON to start O2 RT adjustment, and delayed mode QC along West Coast of America	Yui Takeshita	TBD

BIOLOGICAL SENSORS — ACOUSTICS		
ACTION ITEM DESCRIPTION	**RESPONSIBLE PERSON(S)**	**EST. COMPLETION DATE**
Increase user community and dissemination of ideas and methods (begin with Slack channels)	UG2	TBD
Integrate active and passive acoustics (where possible) into some existing monitoring lines (e.g. BOON; CUGN)	Christian Reiss and others	TBD
Develop simple metrics for summarizing water column echo data where calibration is not required (perhaps using echometrics)	Christian Reiss and others	TBD
Serve summary data in local ERDDAP	Christian Reiss and others	TBD

Appendix A: Working Group Action Items

COLLABORATIVE SCIENCE		
ACTION ITEM DESCRIPTION	**RESPONSIBLE PERSON(S)**	**EST. COMPLETION DATE**
Provide a template for a cruise report for users	Kerri Whilden	TBD
Post training videos	Training Sub-Focus Group	TBD
Share practical applications	UG2	TBD
Comms tools (slack, etc.)	UG2	TBD
Global Map of operations	UG2	TBD
Expert database	UG2	TBD

MODELING IMPACTS		
ACTION ITEM DESCRIPTION	**RESPONSIBLE PERSON(S)**	**EST. COMPLETION DATE**
Having better communication through UG2 for sharing data	UG2 coordinator	TBD
Encourage operators to provide uncertainty estimates along with values	Possibly a modeling working group (WG)	TBD
QARTOD flags should be carried through data management flow	Possibly a modeling WG	TBD
Product development: Non Real Time (NRT) and Delayed Time (DT) science quality (WOD does this)	TBD	TBD
Codesign: Establish feedback loop between modelers and glider operators	Travis Miles	TBD
Use common language for variables - common format compliant	TBD	TBD

(Continued on next page)

Appendix A: Working Group Action Items

MODELING IMPACTS		
ACTION ITEM DESCRIPTION	**RESPONSIBLE PERSON(S)**	**EST. COMPLETION DATE**
Communicate modeling needs to glider operators (submit data to the DAC), need to work on tools to achieve this • Education outreach • Common format	TBD	TBD
Communication feed / marketing campaign to make sure people understand common format compliant, standardized units - NOAA working on communications piece on the importance • DAC service helping new glider users • Error bars • Encouraging users to send data to DMAC • NRT and DT science quality (could be done by versioning) both are archived	TBD	TBD

DATA MANAGEMENT		
ACTION ITEM DESCRIPTION	**RESPONSIBLE PERSON(S)**	**EST. COMPLETION DATE**
Finalize and implement OG1.0 format and TM315012 BUFR template	OceanGliders team/ Kevin O'Brien	TBD
Implement ERDDAP services at DACs	Kevin O'Brien	TBD
Implement m2m metadata harvesting from OceanOPS	Victor Turpin	TBD

Appendix A: Working Group Action Items

UG2		
ACTION ITEM DESCRIPTION	**RESPONSIBLE PERSON(S)**	**EST. COMPLETION DATE**
Reengage sub-focus group leads to determine way ahead	UG2 Coordinator	January 2023
Determine next UG2 Workshop dates	UG2 Coordinator	February 2023
Determine feasibility/interest in a separate Operations Workshop	UG2 Coordinator	February 2023
New Steering Group Nominees	UG2 Coordinator	March 2023
Stand Up Industry Panel	UG2 Coordinator	January 2023

Appendix B: UG2 Workshop Agenda

Agenda, Day 1: September 20

07:30 Registration, Coffee & Continental Breakfast

08:30 Day 1 Opening (Bill Lingsch, UG2)

- **Welcome to PNW** (Jan Newton, Northwest Association of Networked Ocean Observing Systems)
- **UG2 SC Welcome** (Carl Gouldman, U.S. Integrated Ocean Observing System, National Oceanic and Atmospheric Administration)
- **UG2 Overview** (Bill Lingsch)
- **OceanGliders Intro** (Brad de Young, Memorial University of Newfoundland)
- **Outcomes of Previous Workshops** (Scott Glenn, Rutgers University)
- **Overview of Goals for this Workshop** /Robert Todd, Woods Hole Oceanographic Institution)
- **Logistics** (Nick Rome, Consortium for Ocean Leadership)

09:30 Science Talks: Sustained Obs, Facilitator: Emily Smith, NOAA

- **Heather Tabisola** (University of Washington): *A NOAA Transition Project and the Operational Hurdles of a New Glider Program*
- **Olle Petersson** (Voices of the Ocean Foundation): *Voice of the Ocean Observatories: Lessons from Continuous Glider Occupations of Multiple Observatory Sites in the Baltic Sea*
- **Alice Ren** (Woods Hole Oceanographic Institution): *The Annual Cycle of Dissolved Oxygen in the California Current System from Glider Observations*
- **Christian Reiss** (National Oceanic and Atmospheric Administration, Antarctic Ecosystem Research Division): *REFOCUS - Reimagining Ecosystem and Fisheries Observations by Combining Two UxS Fleets*
- **Robert Todd** (Woods Hole Oceanographic Institution): *Eddy Fluxes and Shelf-Deep Ocean Exchange Near Cape Hatteras*

10:45 Break

11:00 Science Talks: BGC and Ecological Sensors, Facilitator: Robert Todd, Woods Hole Oceanographic Institution

- **Dan Hayes** (Cyprus Subsea Consulting and Services Ltd): *Integration of Sensors with Gliders: New Advances for Carbon Dioxide, Methane, Optical Imaging, and Sonar Imaging*
- **Yui Takeshita** (Monterey Bay Aquarium Research Institute): *Estimating Gross Primary Production and its Relationship to Light from Diel Measurements of Oxygen and pH from Underwater Gliders*
- **John Horne** (University of Washington): *Adding Echosounders and Acoustic Brains to Characterize Water Column Biomass Distributions*
- **Selene Fregosi** (Ocean Associates, Inc.): *Advancing Remote Marine Mammal Stock Assessment with Passive Acoustic Gliders*
- **Dave Mellinger** (Oregon State University): *Real-Time Detection of High-Frequency Marine Mammals with Passive Acoustic Gliders*

Agenda, Day 1: September 20

12:15 Lunch

- Early Career Mentorship Luncheon - Part 1: Federal and Academic Jobs
- Knowledge Sharing Groups

13:45 Working Groups

- **WG 1:** Sustained Observing (Lead: Robert Todd)
- **WG 2:** BGC Sensors (Lead: Yui Takeshita)
- **WG 3:** Collaborative Science (Lead: Emily Smith and Kerri Whilden)
- **WG 4:** Modeling Impacts (Maximizing Impact of Glider Data) (Lead: Chris Edwards and Scott Glenn)
- **WG 5:** Data Management (Lead: Kevin O'Brien)
  - Tutorial: How to Find Archived Glider Data at NCEI (Matt Grossi, NOAA NCEI)

15:30 Break

15:45 Science Talks: Modeling, Facilitator: Yui Takeshita, Monterey Bay Aquarium Research Institute

- **Chris Edwards** (University of California Santa Cruz): *Assimilating Glider Data in Physical and Biogeochemical Regional Ocean Models*
- **Avichal Mehra** (National Oceanic and Atmospheric Administration, National Weather Service): *Use of Ocean Observations for Operational Ocean and Hurricane Forecast Systems at NWS/NCEP*
- **Doug Wilson** (University of the Virgin Islands): *Gliders, Climatology, and Ocean Models – What We Can Learn About the NE Caribbean by Increasing Upper Ocean Observation Density*
- **Victor Turpin** (OceanOPS, World Meteorological Organization): *Leveraging the Multi-system Glider Data Assimilation Experiments Within EuroSea to the International Level*

16:45 Break

17:00 Vendor Presentation and Community Feedback, Facilitator: Emily Smith, NOAA

- **RBR** (Greg Johnson): *RBR sensor Development for Gliders and AUVs: A Fully-Integrated Approach*
- **MRV** (Kasia Zaba): Spray2: *Next-Generation Underwater Glider*
- **Ocean Sonics** (Manuel Morgan): *Ocean Listening for Gliders*
- **Community Questions**

18:00 Sponsored Cocktail Hour with Posters and Vendor Booths

19:30 Adjourn

Agenda, Day 2: September 21

07:30 Coffee & Continental Breakfast

08:30 Welcome (David Legler, National Oceanic and Atmospheric Administration)

- Day 1 Recap & Day 2 Setup (Kathleen Bailey, U.S. IOOS)

09:00 Science Talks: Collaborative, Facilitator: Kevin Martin, University of Southern Mississippi

- **Dan Rudnick** (Scripps Institution of Oceanography): A Four-Dimensional Survey of the Almeria-Oran Front by Underwater Gliders: Tracers and Circulation
- **Nikolaos Zarokanellos** (Balearic Islands Coastal Observing and Forecasting System): Glider Survey Reveals the Mesoscale and Submesoscale Dynamics in the Balearic Sea.
- **Yixi Zheng** (University of East Anglia): Multi-Disciplinary Glider Mission in the Amundsen Sea, Antarctica
- **Nolan Pearce** (Trent University): Primary Production in the Great Lakes Measured from Autonomous Underwater Vehicles
- **Catherine Edwards** (Skidaway Institute of Oceanography - University of Georgia): Integrating Diverse Uncrewed Systems Platforms into the GANDALF Piloting Portal
- **Adam Comeau** (Ocean Tracking Network): Coordination to Monitor the North Atlantic Spring Bloom

10:30 Break

10:45 Science Talks: Misc, Facilitator: Mike Crowley, Rutgers University

- **Lina Eyouni** (The Red Sea Development Company, King Abdullah University of Science and Technology): Summertime Stratification and Inflow into the Northern Red Sea Using High Resolution Glider and Remote Sensing Observations
- **Alexandre Heumann** (University of Toulon): Real-Time and Continuous Monitoring of Magmatic Fluid Emissions in the Mayotte Sea Using a SeaExplorer Glider
- **Joe Gradone** (Rutgers University): Slocum Glider ADP Based Observations of Caribbean Through-Flow and Their Implications for Global Climate
- **Justin Shapiro** (University of Washington Applied Physics Laboratory): Backseat Sensing on TWR Slocum G2/G3
- **Atle Lohrmann** (Hefring Engineering): Glider Development à la iPhone

12:15 Lunch

- Early Career Mentorship Luncheon - Part 2: Industry Jobs
- Knowledge Sharing Groups

Agenda, Day 2: September 21

13:45 Working Groups

- **WG 1:** Sustained Observing (Lead: Robert Todd)
- **WG 2:** BGC Sensors (Lead: Yui Takeshita)
- **WG 3:** Collaborative Science (Lead: Emily Smith and Kerri Whilden)
- **WG 4:** Modeling Impacts (Maximizing Impact of Glider Data) (Lead: Chris Edwards and Scott Glenn)

15:30 Break

15:45 Science Talks: Best Practices, Facilitator: Kathleen Bailey, U.S. IOOS

- **Mathieu Dever** (RBR Global): *Using the RBRlegato3: Standard Operating Procedures from Field Operations to Data Processing*
- **Victor Turpin** (OceanOPS, World Meteorological Organization): *Progress Towards OceanGliders Best Practices and Standards*
- **Hank Statscewich** (University of Alaska Fairbanks): *What's in Your Glider Toolkit? Essentials for Ensuring Reliable Slocum Glider Deployments*
- **Matt Grossi** (National Oceanic and Atmospheric Administration, National Centers for Environmental Information): *From Good to Great: Strengthening the FAIRness of Underwater Glider Data Through Community Metadata Implementation*

16:45 Break

17:00 Vendor Presentation and Community Questions, Facilitator: Kevin Martin, University of Southern Mississippi

- **Sea-Bird Scientific** (Jochen Klinke and Eric Rehm): *What Lies Beneath: Underwater Glider Technology & Innovation*
- **Teledyne** (Clayton Jones): *Celebrating our History and Looking to the Future of Slocum Gliders*
- **Community questions**

18:00 Sponsored Cocktail Hour with Posters and Vendor Booths

19:30 Adjourn

Appendix C: Workshop Presentations

Tuesday, 9/20

View Tuesday's presentations

Christopher Edwards
Assimilating Glider Data in Physical and Biogeochemical Regional Ocean Models

Selene Fregosi
Advancing Remote Marine Mammal Stock Assessment with Passive Acoustic Gliders

Scott Glenn
Outcomes of Previous Workshops

Daniel Hayes
Integration of Sensors with Gliders: New Advances for Carbon Dioxide, Methane, Optical Imaging, and Sonar Imaging

John Horne
Adding Echosounders and Acoustic Brains to Characterize Water Column Biomass Distributions

Greg Johnson
RBR Sensor Development for Gliders and AUVs: A Fully-Integrated Approach

Avichal Mehra
Use of Ocean Observations for Operational Ocean and Hurricane Forecast Systems at NWS/NCEP

David Mellinger
Real-Time Detection of High-Frequency Marine Mammals with Passive Acoustic Gliders

Manuel Morgan
Ocean Listening for Gliders

Olle Petersson
Voice of the Ocean Observatories: Lessons from Continuous Glider Occupations of Multiple Observatory Sites in the Baltic Sea

Christian Reiss
REFOCUS - Reimagining Ecosystem and Fisheries Observations by Combining Two UxS Fleets

Heather Tabisola
A NOAA Transition Project and the Operational Hurdles of a New Glider Program

Yui Takeshita
Estimating Gross Primary Production and its Relationship to Light from Diel Measurements of Oxygen and pH from Underwater Gliders

Robert Todd
Eddy Fluxes and Shelf-Deep Ocean Exchange Near Cape Hatteras

Victor Turpin
Leveraging the Multi-system Glider Data Assimilation Experiments Within EuroSea to the International Level

Doug Wilson
Gliders, Climatology, and Ocean Models – What We Can Learn About the NE Caribbean by Increasing Upper Ocean Observation Density

Katherine Zaba
Spray2: Next-Generation Underwater Glider

Wednesday, 9/21

View Wednesday's presentations

Adam Comeau
Coordination to Monitor the North Atlantic Spring Bloom

Mathieu Dever
Using the RBRlegato3: Standard Operating Procedures from Field Operations to Data Processing

Catherine Edwards
Integrating Diverse Uncrewed Systems Platforms into the GANDALF Piloting Portal

Joe Gradone
Slocum Glider ADP Based Observations of Caribbean Through-Flow and Their Implications for Global Climate

Matt Grossi
From Good to Great: Strengthening the FAIRness of Underwater Glider Data Through Community Metadata Implementation

Alexandre Heumann
Real-Time and Continuous Monitoring of Magmatic Fluid Emissions in the Mayotte Sea Using a SeaExplorer Glider

Clayton Jones
Celebrating our History and Looking to the Future of Slocum Gliders

Atle Lohrmann
Glider Development à la iPhone

Nolan Pearce
Primary Production in the Great Lakes Measured from Autonomous Underwater Vehicles

Eric Rehm
What Lies Beneath: Underwater Glider Technology & Innovation

Dan Rudnick
A Four-Dimensional Survey of the Almeria-Oran Front by Underwater Gliders: Tracers and Circulation

Justin Shapiro
Backseat Sensing on TWR Slocum G2/G3

Hank Statscewich
What's in Your Glider Toolkit? Essentials for Ensuring Reliable Slocum Glider Deployments

Victor Turpin
Progress Towards OceanGliders Best Practices and Standards

Nikolaos Zarokanellos
Glider Survey Reveals the Mesoscale and Submesoscale Dynamics in the Balearic Sea

Yixi Zheng
Multi-Disciplinary Glider Mission in the Amundsen Sea, Antarctica

Thursday, 9/22

View Thursday's presentation

Bill Lingsch
Discussion on Role of UG2 and Activities for the Community

Appendix D: List of Attendees

David Aragon
Rutgers University, dkaragon@marine.rutgers.edu

Kathleen Bailey
NOAA/NOS/U.S. IOOS, kathleen.bailey@noaa.gov

Carlos Barerra
PLOCAN, carlos.barrera@plocan.eu

Shaun Bell
NOAA/PMEL, shaun.bell@noaa.gov

Lindsey Biondo
Sea-Bird Scientific, lbiondo@seabird.com

François Bourrin
CEFREM - CNRS, fbourrin@univ-perp.fr

Charles Branham
Sea-Bird Scientific, cbranham@seabird.com

Peter Brickley
Woods Hole Oceanographic Institution, pbrickley@whoi.edu

Francis Bringas
NOAA/AOML, Francis.Bringas@noaa.gov

Steve Brodet
Kongsberg Underwater Technology, LLC, steve.brodet@km.kongsberg.com

Eugene Burger
NOAA/OAR/PMEL, eugene.burger@noaa.gov

Cailin Burmaster
Open Ocean Robotics, cailinburmaster@gmail.com

Roxanne Carini
NANOOS, rjcarini@uw.edu

Daryl Carlson
Sea-Bird Scientific, dcarlson@seabird.com

Filipa Carvalho
National Oceanography Centre, filipa.carvalho@noc.ac.uk

Rob Cermak
UAF, jrcermakiii@alaska.edu

Jonathan Chapman
Bermuda Institute of Ocean Sciences, jonathan.chapman@bios.edu

Natalie Coleman
WA Department of Ecology, natalie.coleman@ecy.wa.gov

Michael Coleman
Navoceano, michael.j.coleman164.civ@us.navy.mil

Adam Comeau
Ocean Tracking Network, adam.comeau@dal.ca

Jeff Condiotty
Kongsberg Underwater Technology, Jeff.condiotty@km.kongsberg.com

Anthony Cossio
NOAA, anthony.cossio@noaa.gov

Michael Crowley
Rutgers University, crowley@rutgers.edu

Robert Currier
Texas A&M/GCOOS, robertdcurrier@gmail.com

Beth Curry
MRV Systems, bcurry@mrvsys.com

Richard Davis
Ocean Frontier Institute, Dalhousie University, richard.davis@dal.ca

Eric De Tretaigne
ALSEAMAR, edetretaigne@alseamar-alcen.com

Patrick Deane
Woods Hole Oceanographic Inst., pdeane@whoi.edu

Massitan beny Dembele
WASCAL, dembelemassitanbeny@gmail.com

Kruti Desai
Consortium for Ocean Leadership, kdesai@oceanleadership.org

Mathieu Dever
RBR, mathieu.dever@rbr-global.com

Edward Dever
Oregon State University, Edward.Dever@oregonstate.edu

Brad DeYoung
Memorial University, bdeyoung@mun.ca

Hayley Dosser
Fisheries and Oceans Canada, hayley.dosser@dfo-mpo.gc.ca

Karen Dreger
Skidaway Institute of Oceanography, University of Georgia, Karen.Dreger@skio.uga.edu

Masha Edmondson
COL, medmondson@oceanleadership.org

Appendix D: List of Attendees

Catherine Edwards
Skidaway Institute of Oceanography, University of Georgia, catherine.edwards@skio.uga.edu

Chris Edwards
UCSC, cedwards@ucsc.edu

Rob Ellison
Sea-Bird Scientific, rellison@seabird.com

Zachary Erickson
NOAA/PMEL, zachary.k.erickson@noaa.gov

Charlie Eriksen
University of Washington, eriksen@uw.edu

Lina Eyouni
The Red Sea Development Company. King Abdullah University of Science and Technology (KAUST), lina.eyouni@kaust.edu.sa

Andrea Fassbender
NOAA PMEL, andrea.j.fassbender@noaa.gov

Estel Font
University of Gothenburg, Department of Marine Science

Eleanor Frajka-Williams
Universität Hamburg, eleanor.frajka@uni-hamburg.de

Selene Fregosi
Ocean Associates, Inc contracted to NOAA PIFSC and Oregon State University, selene.fregosi@gmail.com

Hartmut Frenzel
University of Washington/NOAA-PMEL, hartmut.frenzel@noaa.gov

Erica Fruh
NOAA OMAO UXS Operations Center, erica.fruh@noaa.gov

Jordan Gates
Sea-Bird Scientific, jgates@seabird.com

Scott Glenn
Rutgers University, glenn@marine.rutgers.edu

Jason Gobat
University of Washington, jgobat@uw.edu

Judah Goldberg
Rockland Scientific, judah@rocklandscientific.com

Donglai Gong
Virginia Institute of Marine Science - William & Mary, gong@vims.edu

Cordielyn Goodrich
Teledyne Webb Research, cordielyn.goodrich@teledyne.com

Carl Gouldman
IOOS Office, carl.gouldman@noaa.gov

Joe Gradone
Rutgers University, jgradone@marine.rutgers.edu

Matt Grossi
NOAA NCEI, matt.grossi@noaa.gov

Daniel Hayes
Cyprus Subsea Consulting and Services C.S.C.S. Ltd, hayesdan@cyprus-subsea.com

Alexandre Heumann
Université de Toulon, AHEUMANN@alseamar-alcen.com

Philip Hoffman
NOAA Ocean Exploration, philip.hoffman@noaa.gov

Patrick Hogan
NOAA/NCEI, patrick.hogan@noaa.gov

John Horne
University of Washington, jhorne@uw.edu

Micah Horwith
Washington State Department of Ecology, micah.horwith@ecy.wa.gov

Clara Hulburt
Teledyne Marine, clara.hulburt@teledyne.com

Brita Irving
University of Alaska Fairbanks, bkirving@alaska.edu

Vince Jelsema
Sea-Bird Scientific, vjelsema@seabird.com

Greg Johnson
RBR, greg.johnson@rbr-global.com

Becky Johnston
Hefring Engineering, becky.johnston@hefring.com

Clayton Jones
Senior Director of Technology, Teledyne Marine, cjones@teledyne.com

Burton Jones
KAUST, burton.jones@kaust.edu.sa

Andrew Jones
KAUST, jonesyjones0912@gmail.com

John Kerfoot
Rutgers University, johnkerfoot@gmail.com

Billy Kessler
NOAA/Pacific Marine Environmental Laboratory, william.s.kessler@noaa.gov

Appendix D: List of Attendees

Youcef Khamallah
ENSSMAL, khamallahyoucef@gmail.com

Barbara Kirkpatrick
GCOOS/TAMU, barb.kirkpatrick@gcoos.org

Jochen Klinke
Sea-Bird Scientific, jklinke@seabird.com

John Kluge
Nova Southeastern University, jk1083@nova.edu

Jody Klymak
University of Victoria, jklymak@uvic.ca

Chad Kramer
NAVOCEANO, chad.kramer3.civ@us.navy.mil

Christopher Krembs
Washington State Depatment of Ecology, ckre461@ecy.wa.gov

Gerhard Kuska
MARACOOS/IOOS Association, kuska@maracoos.org

Kenneth Larrieu
UC Davis, kglarrieu@ucdavis.edu

David Legler
NOAA, david.legler@noaa.gov

Chad Lembke
University of South Florida, clembke@usf.edu

xiang ling
CEOTR/OFI, xiang.ling@dal.ca

William Lingsch
UG2, bill.lingsch@noaa.gov

Atle Lohrmann
Hefring Engineering, atle.lohrmann@hefring.com

Jacki Long
MBARI, jlong@mbari.org

Chris Mackenzie
Hakai Institute/CPROOF, chris.mackenzie@hakai.org

Kevin Martin
University of Southern Mississippi, kevin.m.martin@usm.edu

Kim Martini
Martini Oceanographic, dr.kim.martini@gmail.com

Jasmin McInerney
NIWA, jasmin.mcinerney@niwa.co.nz

Avichal Mehra
NOAA\NWS\NCEP\EMC, Avichal.Mehra@noaa.gov

Dave Mellinger
NOAA Pacific Marine Environmental Lab and Oregon State University, david.k.mellinger@noaa.gov

Alberto Mestas-Nunez
University of Texas at San Antonio, alberto.mestas@utsa.edu

Travis Miles
Rutgers University, tnmiles@marine.rutgers.edu

Garrett Miller
University of South Florida CMS, millerg1@usf.edu

Russ Miller
University of Michigan CIGLR, rusmil@umich.edu

Robert Millsap
Industry Professional, rmillsap@wassoc.com

Albert Miralles
SOCIB, amiralles@socib.es

Alexey Mishonov
University of Maryland/NCEI, alexey.mishonov@noaa.gov

Don Moretti
RPS Group, donald.moretti@rpsgroup.com

Manuel Morgan
Ocean Sonics Ltd., manuel.morgan@oceansonics.com

Daniel Nelson
RBR Ltd, daniel.nelson.@rbr-global.com

Jan Newton
University of Washington & NANOOS, janewton@uw.edu

Emery Nolasco
Aqua Satellite, emerinciana.n@gmail.com

Addie Norgaard
University of Alaska Fairbanks International Arctic Research Center, anorgaard2@alaska.edu

Kevin O'Brien
UW/CICOES, NOAA/PMEL, GOOS OCG, kevin.m.o'brien@noaa.gov

Lenka O'Connor Sraj
Monterey Bay Aquarium Research Institute, lenka@mbari.org

Sage Osborne
CICOES/PMEL, joshua.osborne@noaa.gov

Stuart Pearce
Oregon State University/Ocean Observatories Initiative, stuart.pearce@oregonstate.edu

Nolan Pearce
Trent University, nolanpearce@trentu.ca

James Pegg
Fisheries and Oceans Canada & C-PROOF, james.pegg@dfo-mpo.gc.ca

Appendix D: List of Attendees

Olle Petersson
Voice of the Ocean Foundation, olle.petersson@voiceoftheocean.org

Dawn Petraitis
NOAA/NWS/National Data Buoy Center, dawn.petraitis@noaa.gov

Luis Pomales Velázquez
University of Rhode Island | Graduate School of Oceanography, luispomales@uri.edu

Evan Price
Nortek, evan.price@nortekgroup.com

Alfredo Quezada
Halmos College of Arts and Sciences at Nova Southeastern University, aq199@nova.edu

Shea Quinn
Teledyne Webb Research, shea.quinn@teledyne.com

Pablo Quiroga
Alseamar

Grant Rawson
NOAA/AOML/PHOD, grant.rawson@noaa.gov

Eric Rehm
Sea-Bird Scientific, erehm@seabird.com

Christian Reiss
NOAA - Antarctic Ecosystem Research Division, christian.reiss@noaa.gov

Alice Ren
Woods Hole Oceanographic Institution, alice.ren@whoi.edu

Eric Rignot
UC Irvine, erignot@uci.edu

Ulises Rivero
NOAA/AOML, ulises.rivero@noaa.gov

Callum Rollo
Voice of the Ocean foundation, callum.rollo@voiceoftheocean.org

Nick Rome
Consortium for Ocean Leadership, nrome@oceanleadership.org

Melissa Rossi
Teledyne Marine, melissa.rossi@teledyne.com

Dan Rudnick
Scripps Institution of Oceanography, drudnick@ucsd.edu

Julianne Ruffner
Department of Ecology, jruf461@ecy.wa.gov

Angel Ruiz-Angulo
University of Iceland, angel@hi.is

Christopher Rushing
NAVO, christopher.rushing@navy.mil

Saraswathy Sabu
Indian National Centre for Ocean Information Services(INCOIS), saraswathy.s@incois.gov.in

Christian Sarason
Immersion Science, cpsarason@gmail.com

Max Schlereth
Williamson & Associates, mschlereth@wassoc.com

Shannon Searing
Teledyne Marine, shannon.searing@teledyne.com

Charles Seaton
Columbia River Inter-Tribal Fish Commission, cseaton@critfc.org

Jennifer Sevadjian
UC San Diego, jpsevadjian@ucsd.edu

Parth Shah
NIWC Pacific, parth.m.shah.civ@us.navy.mil

Justin Shapiro
APL/UW, jshapi@uw.edu

Margaret Sinsky
Aqua Satellite, Inc., margaret@aquasatellite.com

Ana Sirviente
Great Lakes Observing System (GLOS), ana@glos.org

Emily Smith
NOAA/GOMO, emily.a.smith@noaa.gov

Fritz Stahr
MRV Systems, LLC, stahr@mrvsys.com

Fritz Stahr
University of Washington, stahr@uw.edu

Hank Statscewich
University of Alaska Fairbanks, hank.stats@alaska.edu

Margaret Sullivan
Univ. of Washington, CICOES and NOAA/PMEL, peggy.sullivan@noaa.gov

Heather Tabisola
University of Washington/NOAA PMEL (CICOES), heather.tabisola@noaa.gov

Yui Takeshita
MBARI, yui@mbari.org

Anneke ten Doeschate
Rockland Scientific, anneke@rocklandscientific.com

Miguel Tenreiro
CICESE, tenreiro@cicese.mx

Appendix D: List of Attendees

Pierre Testor
CNRS

Joaquín Tintoré
SOCIB and IMEDEA (CSIC-UIB), jtintore@socib.es

Robert Todd
WHOI, rtodd@whoi.edu

Jim Todd
NOAA/OAR/GOMO, james.todd@noaa.gov

Mark Traganza
Civilian, mark.e.traganza.civ@us.navy.mil

Romain Tricarico
Rockland Scientific, romain@rocklandscientific.com

Senam Tsei
University of Southern Mississippi, senam.tsei@usm.edu

Victor Turpin
Oceanops, vturpin@ocean-ops.org

Eduardo Vaz
RBR, eduardo.vaz@rbr-global.com

Nicolai von Oppeln-Bronikowski
Memorial University, nbronikowski@mun.ca

Nicolai von Oppeln-Bronikowski
Memorial University, nbronikowski@mun.ca

Nicole Waite
Rutgers University, waite@marine.rutgers.edu

Jen Walsh
NOAA/SWFSC, jen.walsh@noaa.gov

Kerri Whilden
Fugro, k.whilden@fugro.com

Doug Wilson
University of the Virgin Islands, doug.wilson@uvi.edu

Wendy Wilz
NAVOCEANO, wendy.w.wilz.civ@us.navy.mil

Rachel Wold
UW/APL, NANOOS, rwold@uw.edu

Mitchell Wolf
Ocean Networks Canada, mkwolf@oceannetworks.ca

Samuel Woodman
NOAA SWFSC Antarctic Ecosystem Research Division, sam.woodman@noaa.gov

Meng Xia
Professor, University of Maryland Eastern Shore, mxia@umes.edu

Matthew Yanagi
USN, mattyanagi@yahoo.com

Katherine Zaba
MRV Systems, LLC, kzaba@mrvsys.com

Nikolaos Zarokanellos
SOCIB, nzarokanellos@socib.es

Yixi Zheng
University of East Anglia, Yixi.Zheng@uea.ac.uk

Andy Ziegwied
Ocean Aero, andy.ziegwied@oceanaero.com

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