



**NOAA**  
GLOBAL OCEAN  
MONITORING & OBSERVING

# Future: Global Ocean Monitoring and Observing Program

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GOMO Community Workshop  
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# Timeline of Programs Supported by GOMO

## PIRATA

PIRATA is a multinational network of ocean buoys that serves as the backbone of the integrated tropical Atlantic observing system.

## Arctic Research

In 1998 the Arctic Research Office was created and in 2006, first Arctic Report Card was released, providing information on the current state Arctic environmental system.

## RAMA

RAMA initiated in the Indian Ocean following deployment of pilot scale arrays by Japan and India. RAMA was designed to study the Indian Ocean's role in monsoons.

## Global Ocean Carbon Network

Long-term network of surface water pCO<sub>2</sub> from moorings (2005), and Ships of Opportunity (SOOP)(2006) were established.

## TPOS

Tropical Pacific Observing System Workshop led to the the TPOS-2020 Project, a multinational observing system designed to measure the surface ocean and atmosphere in the tropical Pacific.

## Ocean Glider

The program started in September 2016 to support active coordination and enhancement of worldwide glider activity.

## Drifters,...

## Sea Level Rise

GLOSS was established by the UNESCO Intergovernmental Oceanographic Commission (IOC) and it currently includes over 90 nations across the globe.

## Argo

Beginnings of the Argo array. A systematic observation of the global ocean.

## Ocean Sites

Worldwide system of long-term, deep water reference stations monitoring the full depth of the ocean, from air-sea interactions down to 5,000 meters.

## Spray Gliders

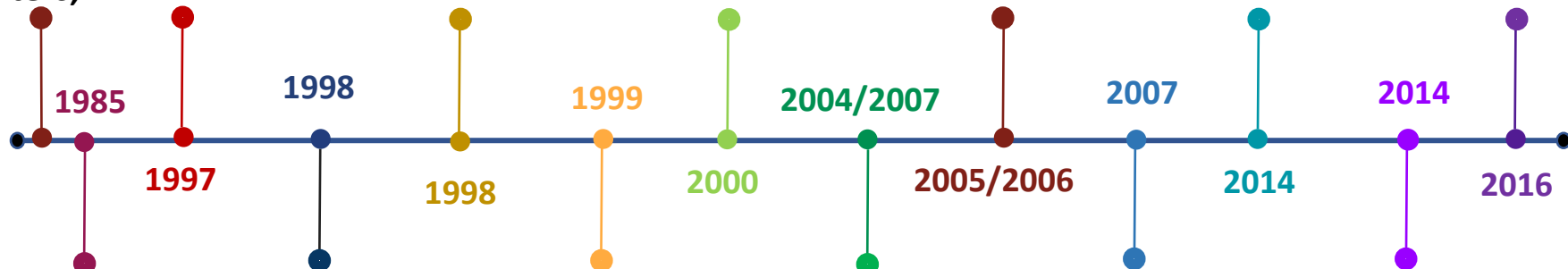
Beginning of efforts with pilot glider lines in the California current in 2004 and with gliders in the Solomon Sea in 2007.

## GO-SHIP

The GO-SHIP (Global Ocean Ship Based Hydrographic Investigations) Panel was established by the IOCCP and CLIVAR. This gave rise to the GO-SHIP Repeat Hydrography Program.

## Sail Drone/UxS

PMEL began a partnership with Saildrone, Inc under a Cooperative Research and Development Agreement. Saildrones are being explored as a tool to provide high quality oceanic and atmospheric observations.



# NOAA's FY22-26 Strategic Goals

## 01 BUILD A CLIMATE READY NATION

Building a Climate Ready Nation by establishing NOAA as the primary federal authoritative provider of climate information and services in the whole-of-government response to tackling the climate crisis



## 02 MAKE EQUITY CENTRAL TO NOAA'S MISSION

Integrating equity into our core operations



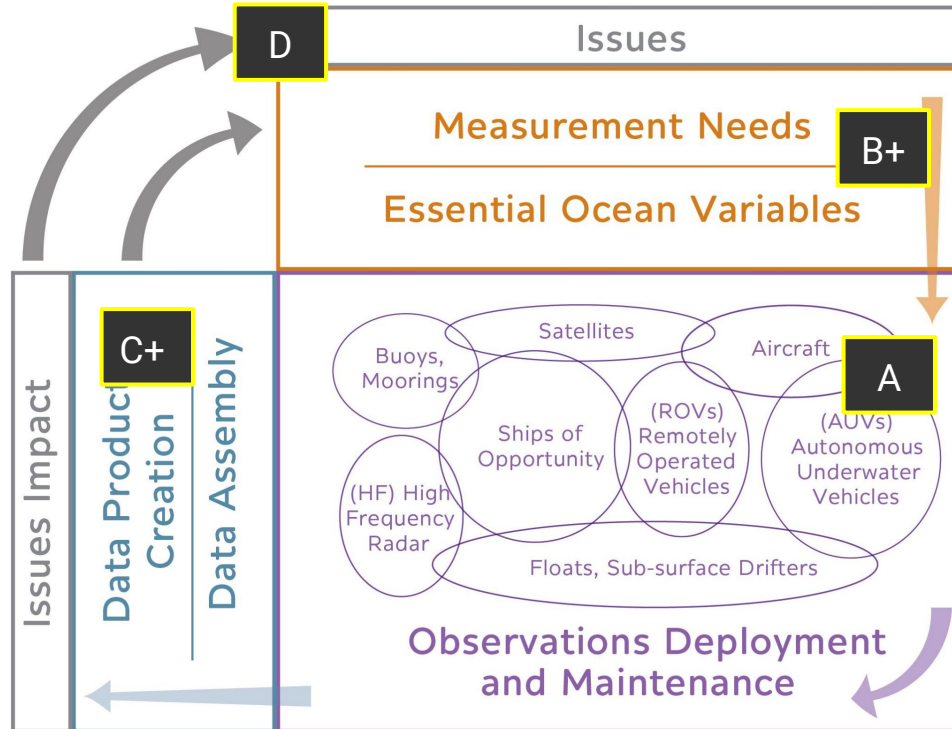
## 03 ACCELERATE GROWTH IN AN INFORMATION-BASED BLUE ECONOMY

Promoting economic development while maintaining environmental stewardship with a focus on advancing the New Blue Economy.

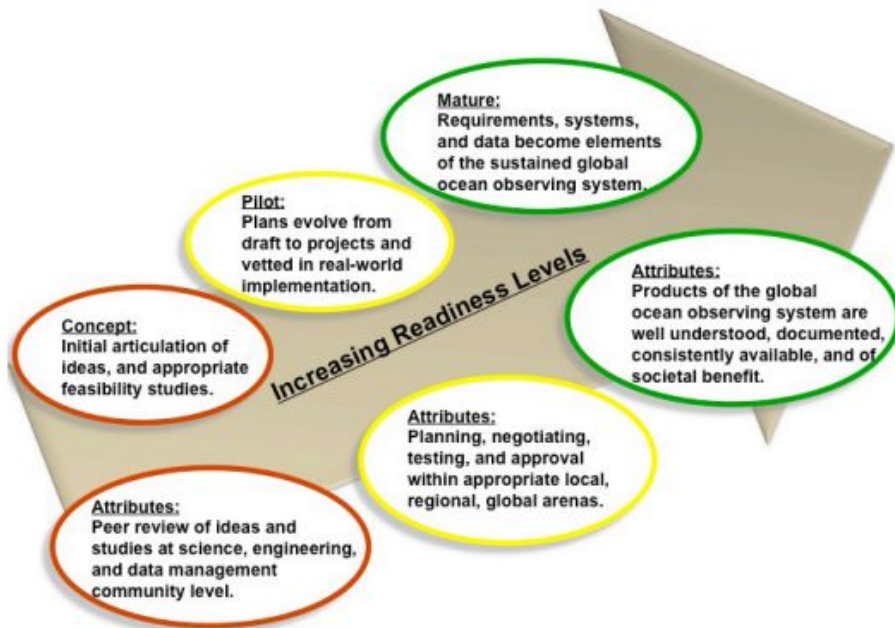


# Framework for Ocean Observing

Framework for Ocean Observing Process Diagram



# Framework for Ocean Observing



## FRAMEWORK PROCESSES BY READINESS LEVELS

Readiness Levels	Requirements Processes	Coordination of Observational Elements	Data Management & Information Products
<b>Mature</b>			
Level 9 "Sustained"	Essential Ocean Variable: <ul style="list-style-type: none"> <li>Adequate sampling specifications</li> <li>Quality specifications</li> </ul>	System in Place: <ul style="list-style-type: none"> <li>Globally</li> <li>Sustained indefinitely</li> <li>Periodic review</li> </ul>	Information Products Routinely Available: <ul style="list-style-type: none"> <li>Product generation standardized</li> <li>User groups routinely consulted</li> </ul>
Level 8 "Mission qualified"	Requirements "Mission Qualified:" <ul style="list-style-type: none"> <li>Longevity/stability</li> <li>Fully scalable</li> </ul>	System "Mission Qualified:" <ul style="list-style-type: none"> <li>Regional implementation</li> <li>Fully scalable</li> <li>Available specifications and documentation</li> </ul>	Data Availability: <ul style="list-style-type: none"> <li>Globally available</li> <li>Evaluation of utility</li> </ul>
Level 7 "Fitness for purpose"	Validation of Requirements: <ul style="list-style-type: none"> <li>Consensus on observation impact</li> <li>Satisfaction of multiple user needs</li> <li>Ongoing international community support</li> </ul>	Fitness-for-Purpose of Observation: <ul style="list-style-type: none"> <li>Full-range of operational environments</li> <li>Meet quality specifications</li> <li>Peer review certified</li> </ul>	Validation of Data Policy <ul style="list-style-type: none"> <li>Management</li> <li>Distribution</li> </ul>
<b>Pilot</b>			
Level 6 "Operational"	Requirement Refined: <ul style="list-style-type: none"> <li>Operational environment</li> <li>Platform and sensor constraints</li> </ul>	Implementation Plans Developed: <ul style="list-style-type: none"> <li>Maintenance schedule</li> <li>Servicing logistics</li> </ul>	Demonstrate: <ul style="list-style-type: none"> <li>System-wide availability</li> <li>System-wide use</li> <li>Interoperability</li> </ul>
Level 5 "Verification"	Sampling Strategy Verified: <ul style="list-style-type: none"> <li>Spatial</li> <li>Temporal</li> </ul>	Establish: <ul style="list-style-type: none"> <li>International commitments and governance</li> <li>Define standardized components</li> </ul>	Verify and Validate Management Practices: <ul style="list-style-type: none"> <li>Draft data policy</li> <li>Archival plan</li> </ul>
Level 4 "Trial"	Measurement Strategy Verified at Sea	Pilot project in an operational environment	Agree to Management Practices: <ul style="list-style-type: none"> <li>Quality control</li> <li>Quality assurance</li> <li>Calibration</li> </ul>



# Needs Improvement

- 1. Integrate along the value chain**
- 2. Establish a data and knowledge ecosystem**
- 3. Apply Framework for Ocean Observing**
- 4. More partnerships**
- 5. GOOS Reform**



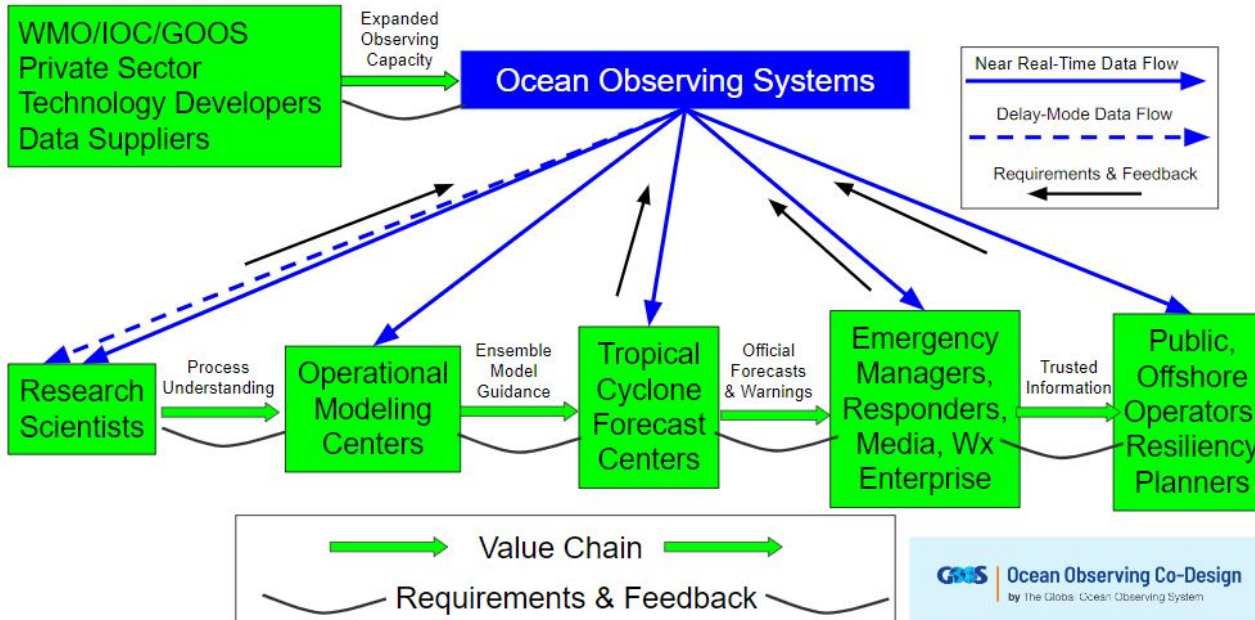
# Needs Improvement - Integration Across Value Chain

## 1. Integration along the value chain

AIMS: Increase role of stakeholders, move towards Ocean Observing Co-Design

### Develop value chain; identify stakeholders

GOOS | Ocean Observing Co-Design  
by The Global Ocean Observing System



Who are the stakeholders?  
Who will provide feedback on observing systems?  
Observing system impact tools?  
Observing system valuations?

8th WMO Workshop on the Impact of Various Observing Systems on Numerical Weather Prediction and Earth System Prediction  
May 27-30, 2024

GOOS | Ocean Observing Co-Design  
by The Global Ocean Observing System



# Needs Improvement - Data

2. Establishing an ecosystem of data and knowledge  
AIMS: Improve access, findability, etc (ie FAIR) of data and products



**F**indable



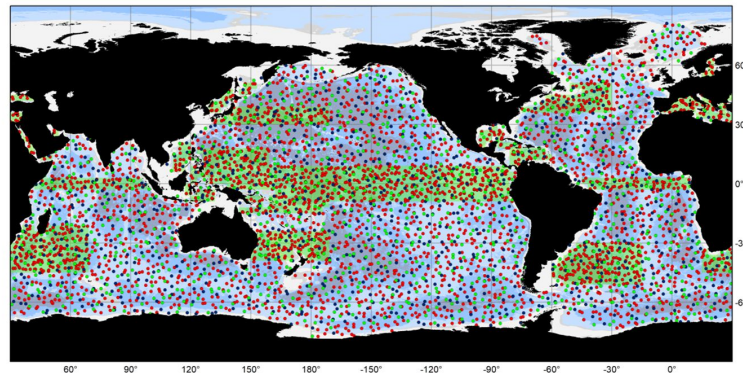
**A**ccessible



**I**nteroperable



**R**eusable





# Needs Improvement - Apply Framework for Ocean Observing

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## 3. Apply Framework for Ocean Observing

AIMS: Encourage integration of systems, increase transparency, prioritize

- Further develop and apply EOV concepts
- Identify measures of pilot and mature sustained observing activities
- Standardize/define terms such as pilot, mature/sustained, etc
- Embrace pilot to sustained continuum, and introduce appropriate GOMO management changes, support mechanisms, and decision-points
- Develop assessment/evaluation measures for pilot activities (eg new technologies)
- Develop open best practices for observing decision-making (eg EOVs, requirements, etc)
- Determine an initial **Global Ocean Basic Observing System (GOBOS)**



# Needs Improvement - More partnerships

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## 4. Encourage and support more partnerships

AIMS: Increase number of contributing technologies, partners, solutions, and stakeholders



- NWS, NOS, NESDIS
- National and international partners

# Needs Improvement - GOOS Reform

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## 5. Undertake GOOS Reform AIMS: Improve the influence and relevance of GOOS

- Increase sponsor participation and guidance
- Encourage cross-GOOS integration
- Embrace a new era of co-designed observing systems
- Consider organizational realignment
- What is the vision for a more permanent ocean observing system; and how will it be operated?



# The future is ours to write...

2030: The global ocean carbon and global ocean health monitoring system nails it! US scientists discover limits of ocean sequestration.

2030: GOMOs initial Arctic ocean and marine environment observing system improves regional weather/climate forecasts ocean's support of life in the thawing north

2030: GOMO and Jeff Bezos announce a new center of ocean observing technology development.

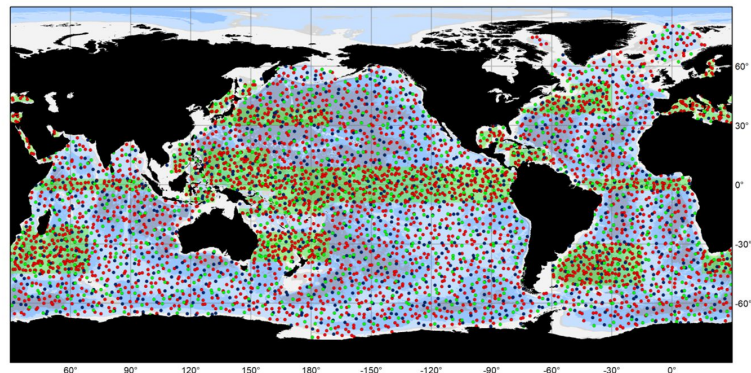
2030: NOAA, WMO, the IOC, and 7 other countries announce the start of the sustained Global Ocean Observing System for climate and marine services - new center established in NOAA



Extra slides

# GOMO of the future - biogeochemistry and biology

- Focus beyond physical variables: Biogeochemistry, ocean carbon, ocean oxygen, healthy ocean, and global metrics of biological variables

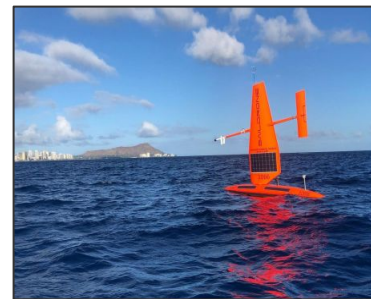


Argo

- Core Floats, 2500
- Deep Floats, 1200
- BGC Floats, 1000
- Target density doubled



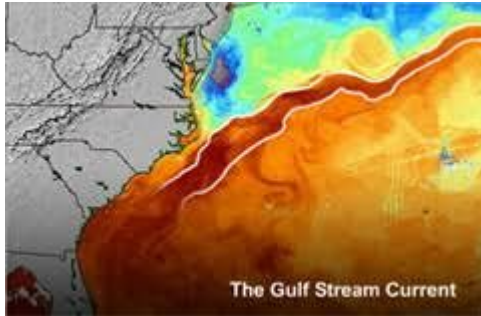
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2030: The US (NOAA, NSF, NASA) is the leading developer of the global ocean carbon and global ocean health monitoring system

# GOMO of the future - global to coastal oceans

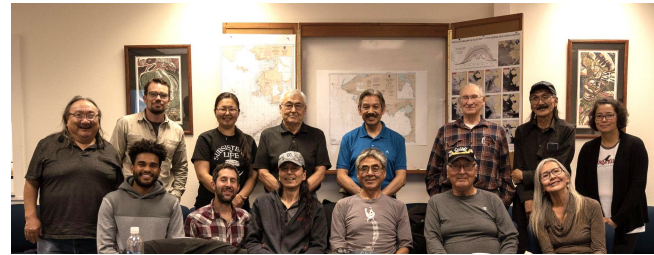
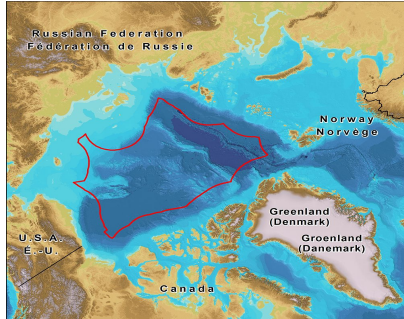
- Connect global oceans to coastal seas through research to understand and consider these interactions as they relate to societally relevant needs (products and services), e.g. sea level rise, marine ecosystems, ocean circulation, ocean carbon uptake/mCDR, etc



**2030: GOMO and NOS research highlights the roles of global oceans in coastal environments, coastal communities, and addressing national ocean-dependent economies**

# GOMO of the future - Arctic Observing

- Develop and codify an initial Arctic ocean and marine environment observing system to track and help predict future changes of the thawing Arctic system



**2030: GOMOs initial Arctic ocean and marine environment observing system documents extent of ocean warming and the ocean's support of life in the thawing north**



# GOMO of the future - partnerships and DEIA

- The GOOS/MTS Ocean Dialogues highlight a number of actionable recommendations to grow the ocean observing marketplace.
- More partnerships are desired in the international arena - the US/GOMO needs to be pro-active in developing and nurturing the ocean observing/services agreements with other countries and actors
- The future of the ocean sciences relies on recruiting and engaging a more diverse community of marine scientists, technicians, and experts

**2030: GOMO and POGO announce the 3rd class of Ocean Observing Fellows at its annual Indonesian Marine Sciences symposium.**

**2028: GOMO announces new partnership with Marine Odyssey, to purchase and deploy 1000 Argo floats over the next 3 years.**

**2030: NOAA announces a Young Ocean Engineers event at its new Marine Citizen Science test site near Miami.**

# GOMO of the future - Global Ocean Observing System

- Over the past 30 years, GOMO and NOAA have led the demonstrated how to develop elements of an in-situ global ocean observing system. Over the next 5 years, the focus will be on Co-Design, integration, and developing plans and infrastructure for a more permanent ocean observing system.



**2030: NOAA, WMO, the IOC, and 5 other countries announce the start of the operational Global Ocean Observing System for climate and marine services - new center established in NOAA**

# Points to make...slides not yet decided

## What is GOMO?

- 1) People and community and observing practices and systems we/NOAA created with our partners
- 2) International leaders in development of a global ocean observing system for global climate, operational services, and healthy oceans
- 3) Developers of the next-gen observing capabilities and systems for
  - a) global ocean carbonate system;
  - b) Extreme events
  - c) Environmental prediction of regional and global weather/climate (eg Tropical Oceans, California Current, Atlantic)
- 4) Leaders of Arctic marine research in marine ecosystems and sea-ice prediction

## What do we want you to know?

1. Dependencies on ships (OMAO and charters)
2. Challenging fiscal environment: sustain amidst inflation
3. Review impacts on the future of GOMO
4. Willingness to change HOW and what we support
5. So many partnering opportunities: private sector, more international partners,
6. We need help of OAR to elevate our messages and opportunities

## What do we want it to be?

1. GOMO data and products are widely recognized and supported across NOAA and around the world
2. GOMO is the recognized developer of the global ocean carbon and ocean health monitoring system
3. GOMOs initial Arctic ocean and marine environment observing system documents changes in the thawing north
4. GOMO initiates new global marine life studies
5. Research highlights the roles of global oceans in coastal environments, coastal communities, and addressing national ocean-dependent economies
6. GOMO helps the nation accept that the global ocean is important in most (all?) NOAA missions: climate, weather, coasts, and fisheries