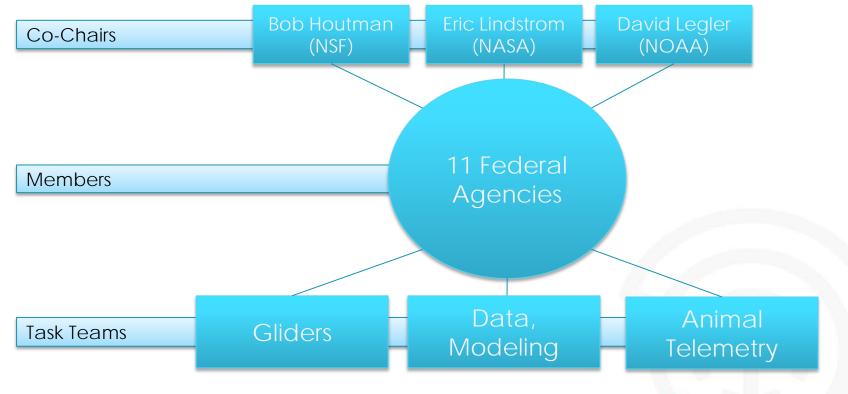
IOOC and IOOS Advisory Committee: Integration Challenges

David Legler, IOOC Co-Chair Wednesday, October 12, 2016



IOOC Overview

The IOOC's mission is to enhance the efficiency of and motivation for multiple-agency contributions to the U.S. Integrated Ocean Observing System (IOOS[®]), for the purposes of societal applications, education, stewardship, and scientific understanding.



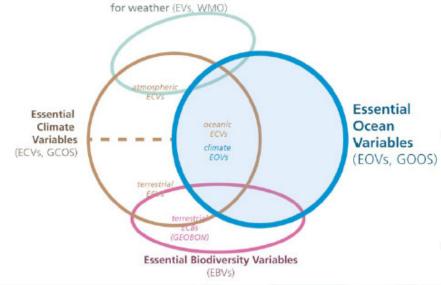


Defining integration:

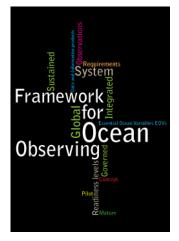
- In-situ and remote
- Global (open ocean) and coastal
- Platform and variable- dependent
- Data access/management (DMAC)

From Oceanobs09:

- Framework for Ocean Observing (FOO)
- Global Ocean Observing System:
- Essential Ocean Variables (EOV)

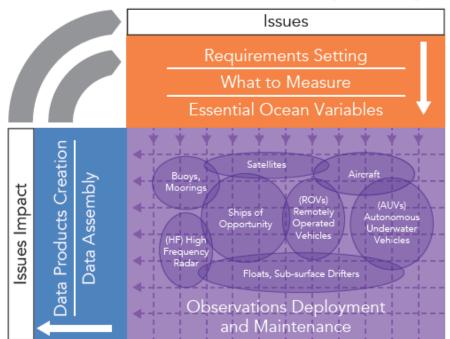


Essential Variables



Framework for Ocean Observing

- 1. Inputs (requirements)
- 2. Processes (observations)
- 3. Outputs (data and products)
- 4. Outcomes (feedback to 1)



Framework for Ocean Observing Process Diagram

Requirements science-driven and informed by societal needs

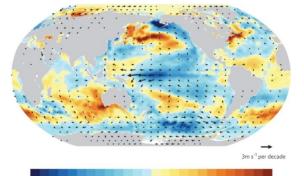
Could this EOV framing encourage integration within IOOS?



Potential Emerging Areas for EOV integration

1. Ocean Temperature/Heat Content (OHC)

- Global: OHC calculated based on all ocean temp data from various networks (Argo, XBT, Moorings, etc)
 - Direct evidence of global warming signals; BAMS State of the Climate Report; future USGCRP Indicator; potential future GCOS indicator; contributor to sea-level
- Regional: emerging evidence of value of regional analyses (e.g. Pacific Anomaly Workshops, GOMOOS, etc)
- 2. Surface Currents
 - Ocean Observations Panel for Climate (OOPC) Variable
 Specification for Surface Currents;
 - HF Radar, moorings, Global drifters
 - Altimeters, etc
 - Routine non-integrated products



Sea surface temperature (shading) from NOAA OISST and surface wind velocity (arrows)



Ocean Temperature/Heat Content

Three different data analyses showing long-term trends of ocean heat content since 1955



IOOS EYES ON THE OCEAN

Ocean Temperature/Heat Content

Difference from average (1021 J)

120

80

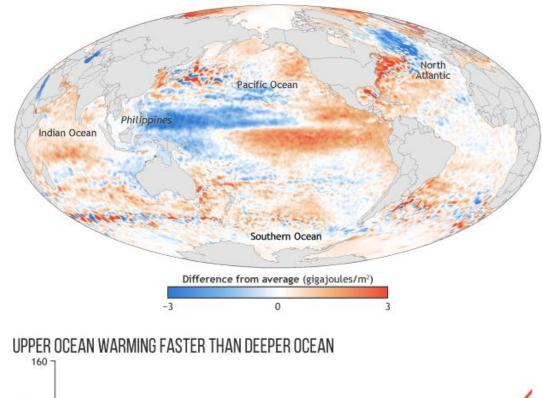
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1990

1995

UPPER OCEAN HEAT CONTENT HITS RECORD HIGH IN 2015



2000

Heat energy in the top 2,300 feet (700 meters, or slightly less than half a mile) of the ocean in 2015 relative to a 1993–2015 average (collected from in situ ocean temperature and sea level data from satellites)

Heat content in the upper 2,300 feet (700 meters) of the ocean (orange) and the deeper ocean (2,300–6,500 feet, gray) relative to a 1993 baseline

2005 2010 2015 NOAA Climate.gov, adapted from State of the Climate 2015

1993 baseline

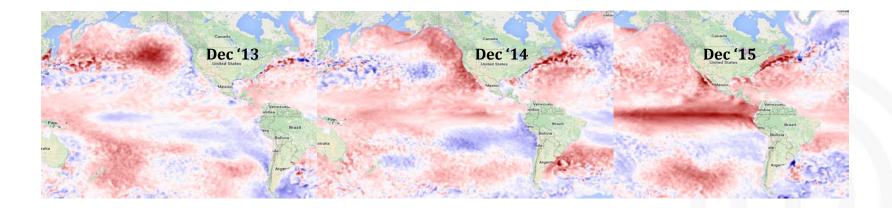
(0-700m)

deep ocean (700-2000m)

Ocean Temperature/Heat Content

Pacific Anomalies Workshop

- The unusual ocean weather and climate patterns observed during 2014 across the North Pacific basin, earning the nickname the "blob", persisted into 2016 and were accompanied by a strong El Niño during 2015-2016.
- The extreme conditions in physical and biogeochemical parameters appeared to impact the pelagic ecosystem, including fisheries.





Integrated requirements for temperature/ocean heat content?

 Informed by existing global ocean info and recent PAWS workshops

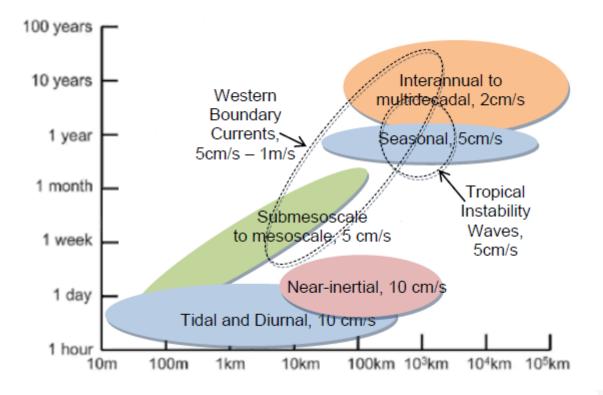
Data assembly

- Databases exist to assemble subsurface temperature data. Not sure how integrative they are of coastal info
- Data and Model Products
- Some global products exist and are routinely updated....
- Many models: not clear which are most suitable...



Surface current capacity

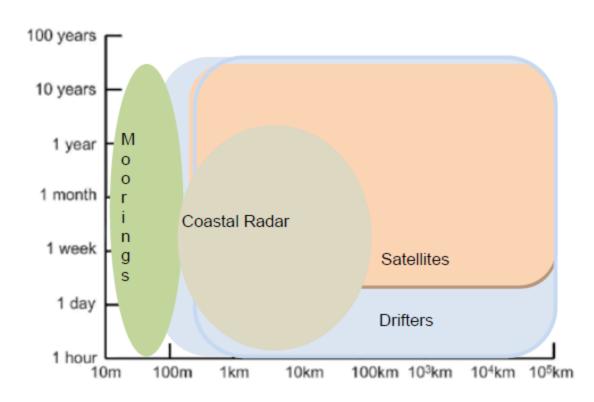
• Scales of surface current velocity phenomena addressed with indications of the magnitude of the signal to capture.





Surface Currents

Surface current networks





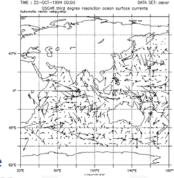


Figure 2. Draw in the well resolved observation scales of the component networks. If these scales are highly dependent on location or time, separate ovals could be drawn to capture this variability (e.g., one for the North Atlantic Ocean, and another for the Southern Ocean). If the capability changes greatly in recent times or will change in the near future (i.e., within five years), provide examples from two times.



Integrated requirements for surface velocity?

- Needs to be developed
- Data assembly
- Unclear what capabilities could be exploited...
 Data Products
- Who are the users?
- What products are needed most and would require integration?



Regional:

- NANOOS
- CeNCOOS
- University of Washington
- Georgia Institute of Technology
- NOAA Southwest Fisheries
 Science Center
- PaclOOS
- AOOS
- Oregon State University
- Scripps Institution of Oceanography
- DFO Canada
- Farallon Institute
- SCCOOS

National:

- IOOS Program Office
- NOAA Climate Obs Division
- EPA
- NSF
- NASA
- ???
- Global:
 - Global Ocean Observing System
 - Global Climate Observing System
 - Ocean Obs Panel for Climate
 - WMO/IOC JCOMM



• Areas/EOVs:

Ocean Temperature/Heat Content Surface Currents Others?

 Potential activities (integrate users and information providers): Integrated product development/pilot activities Task teams (coordination mechanism...several topics/issues) Sharing technologies/knowledge



- To what extent could EOV and FOO framework help to advance integration of observing activities and delivery of useful information?
 - Which EOVs (if not temperature and currents)?
 - Which facets of integration?
 - Motivation/desired outcomes of such activities (use of integrated information)?
- If not EOV/FOO and these EOVs, what strategies would the IOOS AC advise the IOOC to support to encourage integration?





Thank You

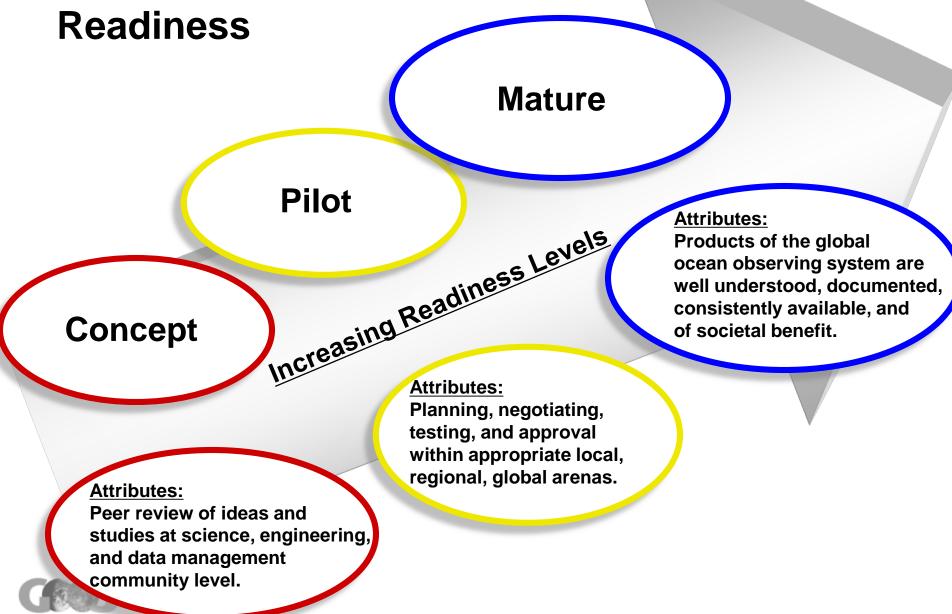


Extra Slides





Towards sustained system: requirements, observations, data management

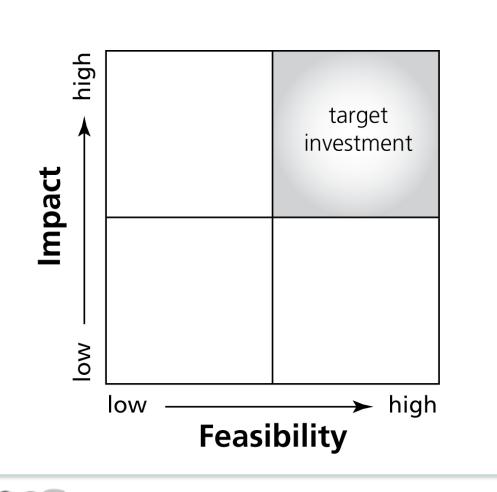


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Framework for Oce	ean Observing		OBSERVATIONS	
REQUIREMENT	S			
Themes	Societal Benefit	Scientific Issue / Application	Essential Ocean Varia	ble Observing element
		, , , ppilodelott	Surface current	cicilient
			SST	
			current	
			Sea level	
			SSS	HF radar surface drifters
			temperature	hopical moored arrays
			salinity	96 Virtual constellation
		/////	Nitrous oxide	JSS actellite missions
		// 184	Transient tracers	RETE and TSGs
		Heat transport	Sea state	dige gauges
		Sea level monitorin	9 Sea ice	profiling floats
		 Decadal predictabil 		Volunteer Observing Ships
Climate Real-time Services Ocean health	Climate services	Upwelling systems	carbonate system	
	Mitigation of elimate cha	Non-GO2 greenhou	Non-CO2 greenhouse gas cycles Macro Nutrients	repeat hydrography
	Adaptation to climate ch Tsunami-risk mitigation	Ocean acidification		Gilders (subsurface)
	Efficient maritime econd	omy Changes in ocean o	carbon contemplankton	Sea state satellite missions
	Carbon-storage	Inundation early wa		moared time series
	Human-bealth	Ocean forecastin	spended particulates	
	Coastal protection	Weather forecast	solved Organic Matter	Sea ice satellite missions - sea ice drifters -
	Food security	Ocean productivity	Zooplankton	Ships of Opportunity
	Tourism/cultural		Chlorophyll	Ship-based timeseries
	Clean waters	Ocean dead zonep Water quality		n color radiometry constellation
	Coastal livelihoods Biodiversity	Ecosystem services	W Look Contraction	zooplankton surveys
	BIOUVELAILY	La Human impact	Salt-marsh area Irge marine vertebrates Harmful Algal Blooms	multiple elements
		Biodiversity and hal	Mangrove area	Mangrove surveys
		Biodiversity and hal	bitats Coral cover	Coral reef surveys

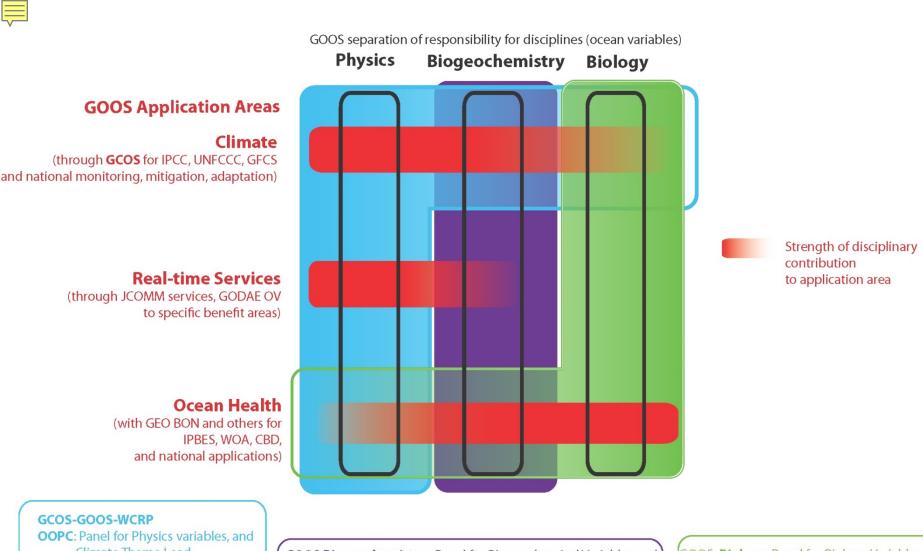
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Driven by requirements, negotiated with feasibility **Essential Ocean Variables**



- We cannot measure everything, nor do we need to
- basis for including new elements of the system, for expressing requirements at a high level
- Driven by requirements, negotiated with feasibility
- Allows for innovation in the observing system over time



Climate Theme Lead RT Services Theme Lead. Ocean Health Theme Support



GOOS **Biogeochemistry**: Panel for Biogeochemical Variables and Climate Theme Support Ocean Health Theme Support GOOS **Biology**: Panel for Biology Variables, and Ocean Health Theme Lead Climate Theme Support





EOVs and readiness level

CONCEPT PILOT MATURE

- Physics
- •Sea State
- •Ocean surface vector stress
- •Sea Ice
- •Sea level
- •SST
- •Subsurface temperature
- •Surface currents
- Subsurface currentsSSS
- •Subsurface salinity

Biogeochemistry

- •Oxygen
- Inorganic macro nutrients
- •Carbonate system
- •Transient tracers
- Suspended particulates
- •Nitrous oxide
- •Carbon isotope (13C)
- •Dissolved organic carbon

Biology and Ecosystems

- Phytoplankton biomass and productivity
- HAB incidence
- Zooplankton diversity
- Fish abundance and distribution
- Apex predator abundance and distribution
- Live coral cover
- Seagrass cover
- Mangrove cover
- Microalgal canopy cover

