



Forum for Operational
Oceanography

Observing Systems – research and operational

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Observing Systems – outline of talk

Emphasis will be on near-real-time observing systems given our focus on operational oceanography...

- Operational observing systems (*in situ*)
 - Bureau of Meteorology (BOM), other Australian Government agencies, States, Industry, international dependencies
- Integrated Marine Observing System (IMOS)
 - research infrastructure, sustained observing, open data access
- Earth Observation from Space (EOS)
- Opportunities
 - and Threats

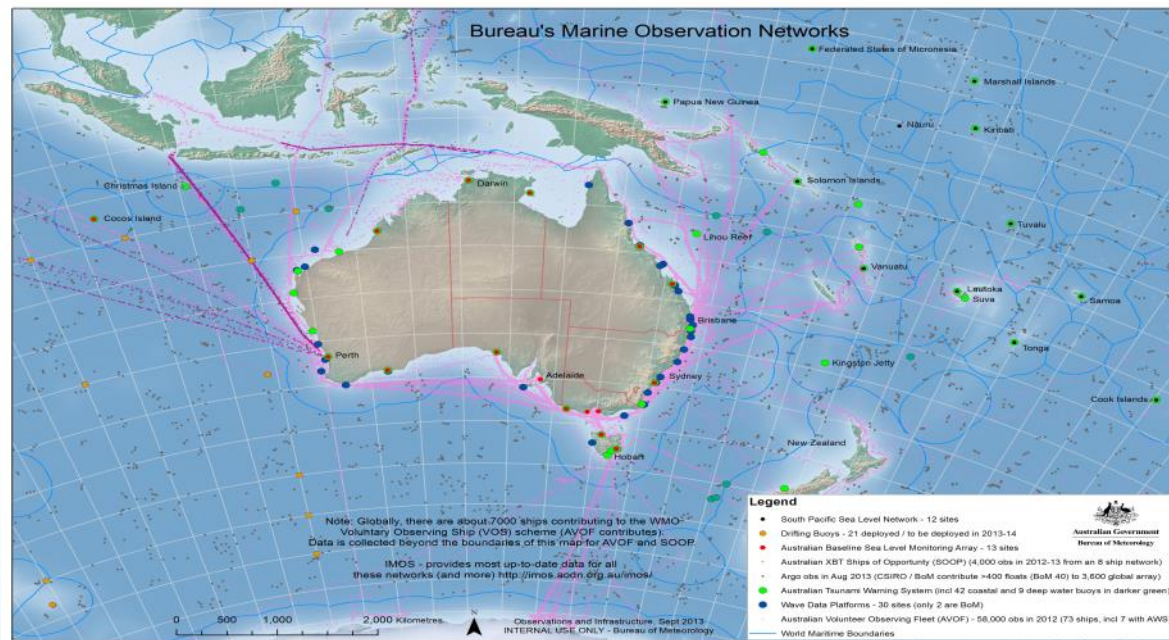


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Operational observing systems

- Marine observation networks used by BOM

- Sea level gauges
- Bathythermographs
- Drifting buoys
- Wave buoys
- Profiling floats
- Tsunameters
- Volunteer Ships



* Marine data being provided in real-time to the Global Telecommunication System (GTS) and the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM)



Operational observing systems

- Marine observation networks used by BOM

- BOM as a long history of working with Australian and foreign owned merchant, research, passenger and private vessels through the AVOF and XBT programs
 - proving difficult to recruit and retain commercial vessels (currently 60-70% of target)
- Wave Buoys and Tide Gauges are largely operated by States and Industry (e.g. Ports)
 - 'third party' data used by BOM to provide services
- Argo is funded from research budgets
 - IMOS (55%) with co-investment by CSIRO, ACE CRC...
 - Significant international leverage



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Operational observing systems (continued)

- Australian Maritime Safety Authority (AMSA)
 - Automatic Identification System (AIS)
 - Aids to Navigation system (AtoN)
 - Under Keel Clearance Management (UKMC) system in Torres Strait
 - Oil spill monitoring and surveillance
- Royal Australian Navy (RAN)
 - National responsibility for hydrography
 - Provision of metocean services to the defence services
- Geoscience Australia
 - Acquisition of underpinning bathymetry and sediment data
- State and Territory Governments
 - Contribution to Tide Gauge and Wave Buoy networks noted above
 - Undertake a wide range of other biophysical observing/monitoring programs to meet their legislative and policy requirements
 - Currently no obvious mechanism for national coordination



Australian Government
Australian Maritime Safety Authority



Australian Government
Geoscience Australia



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Operational observing systems (continued)

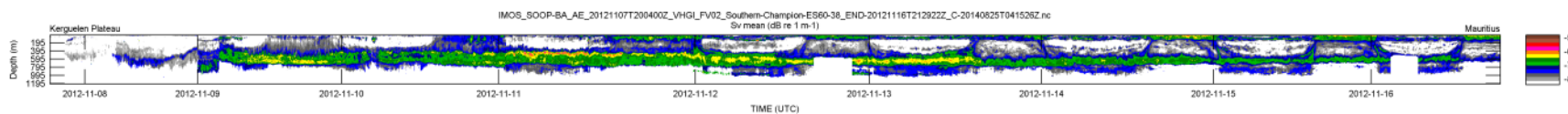
- Marine Industries draw on observations from Government Agencies, and contract Service Providers and R&D Providers to deliver additional observations as required to support their operations
- Industry contributes to observing systems through 'ship of opportunity' programs
- Leading companies within the Fishing Industry are playing an increasingly important role in observing
 - e.g. Austral Fisheries provision of 'bio-acoustic' data
- Greater access to industry observations is seen as an opportunity by R&D Providers and Government Agencies...



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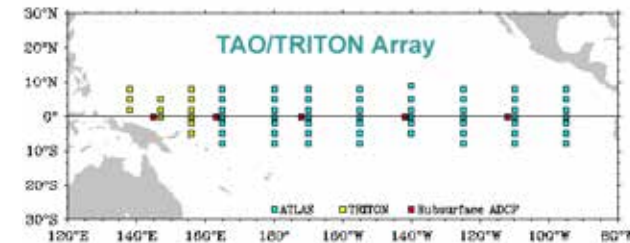
FACILITY 2: Enhanced Measurements
from Ships of Opportunity (SOOP)



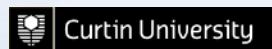
Operational observing systems (continued)

Reliance on international observing systems...

- An interesting example is the moored buoy array in the Tropical Pacific
 - the 'TAO/TRITON' array
 - tracking El Nino/La Nina
 - started 1984, completed (70 moorings) by 1994
- Pressures in both the US (NOAA) and Japan (JAMSTEC) led to significant decline in data returns from mid-2012 to late 2014
- Spawned a new international project to redesign the Tropical Pacific Observing System (TPOS 2020)
- TAO/TRITON data relied on by BLUElink OceanMAPS etc.



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Integrated Marine Observing System (IMOS)

- IMOS is a
 - national
 - collaborative
 - research infrastructure
 - funded by Australian Government



NCRIS
National Research
Infrastructure for Australia
An Australian Government Initiative

- It provides the means for multiple institutions to undertake systematic and sustained observing of the marine environment
- Making all of the data openly available for research and other purposes

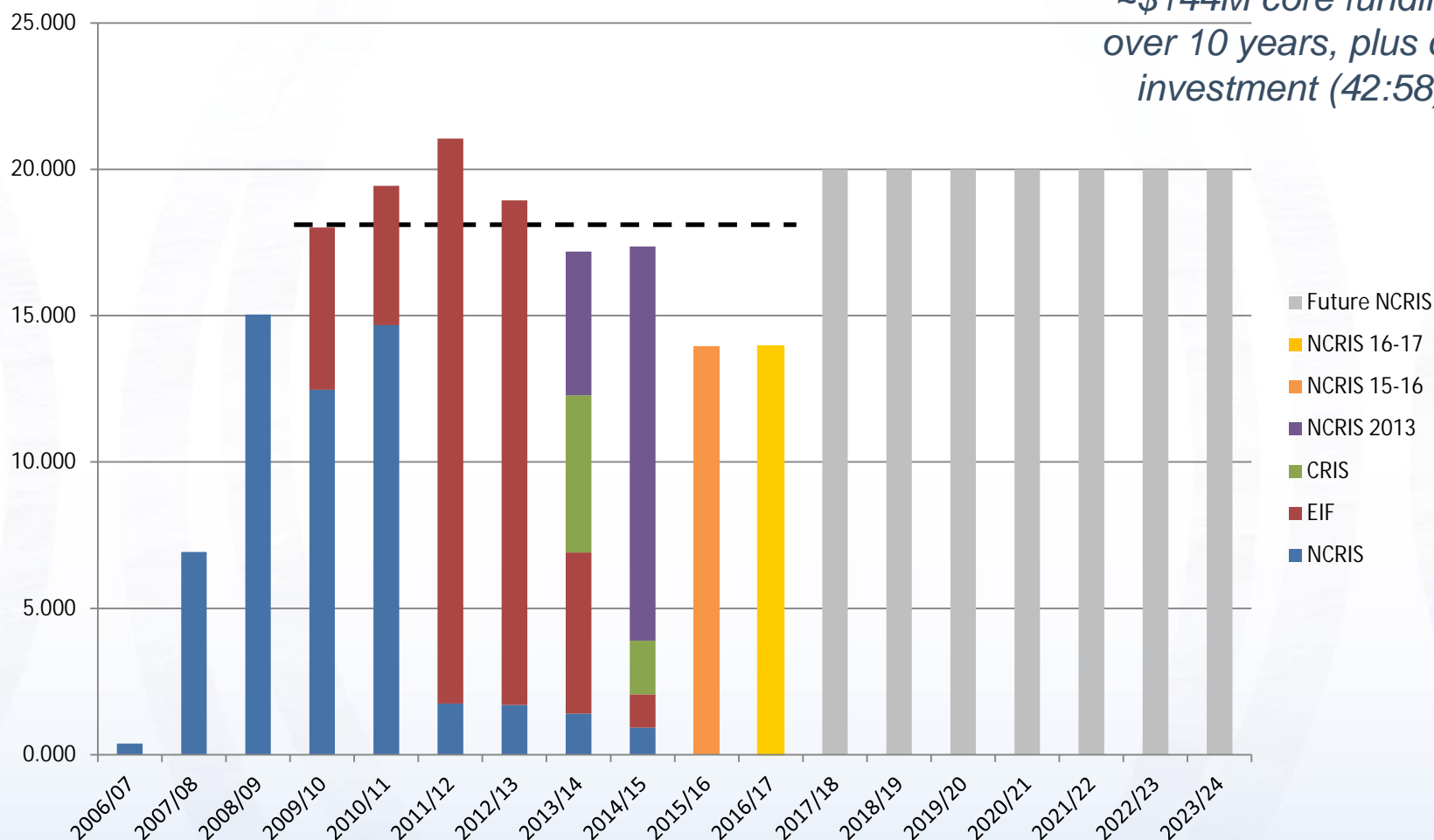


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IMOS – a ‘big deal’ for Australian marine science

*~\$144M core funding
over 10 years, plus co-
investment (42:58)*



1. Argo Floats
2. Ships of Opportunity
3. Deepwater Moorings
4. Ocean Glider Fleet
5. Autonomous Underwater Vehicles
6. National Mooring Network
7. Ocean Radar Network
8. Animal Tagging and Monitoring Network
9. Wireless Sensor Network
10. Satellite Remote Sensing



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IMOS as an observing system has...

1. Brought 'new', near-real-time observing technologies to Australia, at scale e.g.

- Ocean Gliders

- 27 platforms, 171 deployments
- 418,000 profiles, 146 million measurements
- Step change increase in sub-surface, biophysical profiles available for Australian shelf/coastal seas (NRT, DMQC)
- New discoveries, significant learning...

- Ocean Radar

- 12 stations, paired at 6 sites, in 4 States
- Surface currents (NRT and DMQC)
 - Ongoing investigation into utility for waves, and winds
- Recognised as a contribution to an emerging global high-frequency radar program



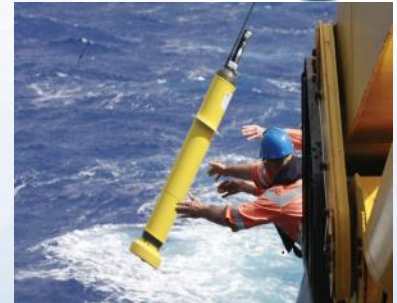
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IMOS as an observing system has...

2. Matured 'pilot-scale', research activities into sustained observing programs e.g.

- Satellite tagging of marine mammals
 - NRT data from poorly sampled regions (Southern Ocean)
 - High impact science, including citable datasets...
 - 213,000 profiles, 3.5 million measurements
 - Strong bio-physical integration
- Argo Australia
 - Transition from an institutional research project to highly valued national research infrastructure with global reach
 - Global Argo 'at design', key role played by Australia in the Southern Hemisphere
 - Well-positioned to exploit new Bio-Argo and Deep Argo developments
 - 290,000 profiles, 99 million measurements

MACQUARIE
UNIVERSITY

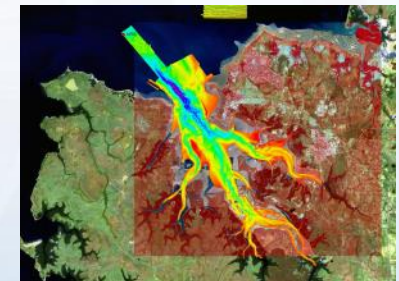
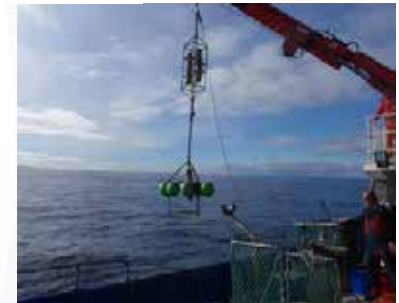
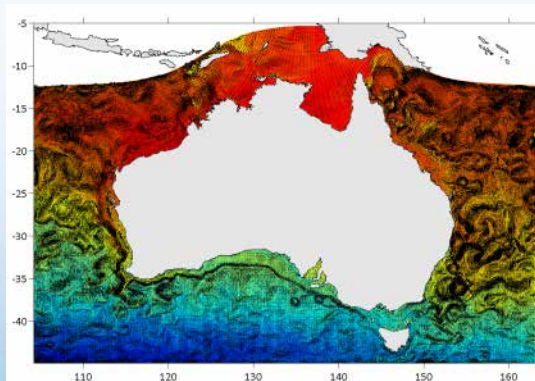


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IMOS as an observing system has...

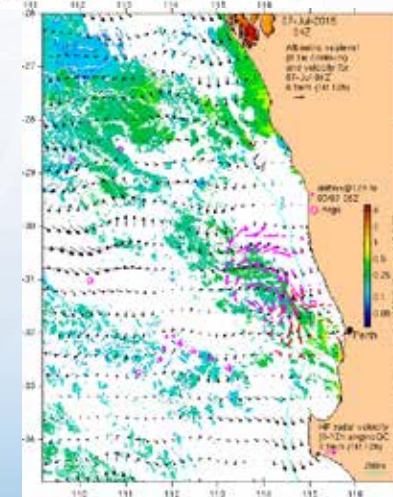
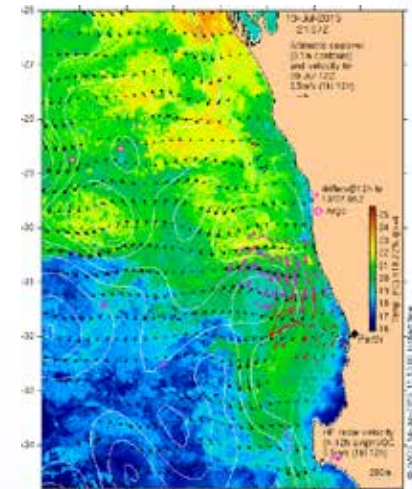
3. Provided a national 'backbone' for sustained (vs stop-start, project-by-project observing) e.g.

- National Mooring Network
 - 7 National Reference Stations
 - 4 of 7 delivering NRT data
 - Partnership with AIMS and Darwin Port Corporation in Darwin Harbour demonstrates to utility of this infrastructure in an operational context
- Regional shelf mooring arrays
 - QLD, NSW, SA, WA
 - Have been fundamental in supporting development of regional modelling capability (especially ROMS/Universities)
 - Data assimilation the next step, NRT data requirements?



Earth Observation from Space (EOS)

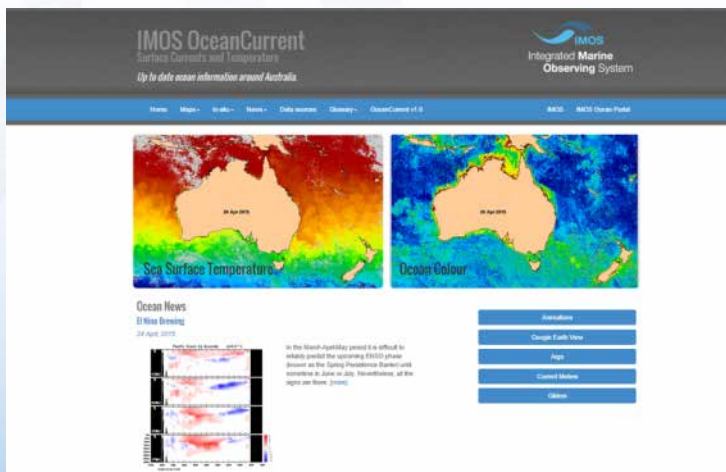
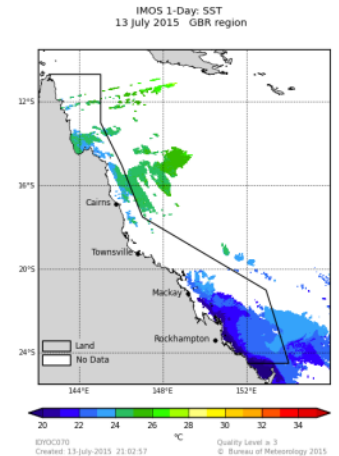
- Australia has no domestic satellite capability, so we are totally reliant on international collaboration for EOS
 - from NOAA, NASA, ESA, JMA etc.
- Operationally we have a key reliance on access to:
 - Sea Surface Temperature (SST)
 - Altimetry/Ocean Surface Topography (OST), and
 - Ocean Colour (OC)
- This requires attention to and investment in
 - National reception, communications and spectrum;
 - Data processing, analysis and delivery; and
 - In situ calibration and validation
- Involves BOM, CSIRO, GA, States and Universities
 - no clear operational oceanography mandate
- IMOS is trying to coordinate reception/data/cal-val investments in the research domain



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Earth Observation from Space (EOS)

- There is increasing use of satellite observations to deliver operational oceanography services and products in Australia e.g.
- ReefTemp
- eReefs Marine Water Quality Dashboard
- IMOS *OceanCurrent*



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Earth Observation from Space (EOS)

- BOM, GA and CSIRO have been leading an effort to develop a National Earth Observation from Space Implementation Plan, covering reception/data/cal-val
- Something like this must proceed as Australia needs to be positioned to
 - (a) exploit next-generation satellite data streams, and
 - (b) mitigate reliance on data from satellites being decommissioned
- Examples of short/medium/long term opportunities:
 - Sea surface salinity from the NASA *Aquarius* mission
 - Non-met applications from the JMA *Himawari* geostationary satellite mission
 - Various applications of ESA's *Sentinel* missions etc.



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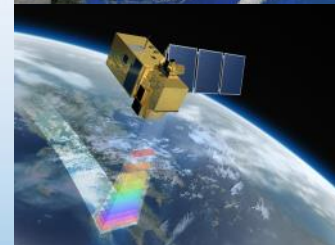
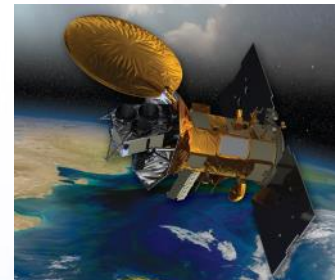
Australian Government

Bureau of Meteorology



Australian Government

Geoscience Australia



Opportunities

- and Threats

- Our Bureau of Meteorology has developed a Marine Strategy (2014-19) that sets out a greater role in operational oceanography
 - Currently no additional funding for an enhanced 'marine mission'
- IMOS has operated for a decade and has proved that national collaboration in marine observing can be done
 - Ongoing funding for IMOS remains fragile
- Internationally, the trend is towards sustained and experimental observing (i.e. away from research vs operations)
 - Australia needs to keep up
- New sensors/autonomous platforms and next-generation satellite missions provide great opportunities for operational oceanography in Australia
 - Competition amongst players will see us under-achieve as a nation
- Industry can potentially play a larger role in observing systems
 - Open access to data may be an issue



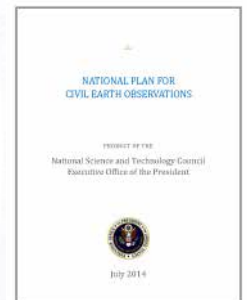
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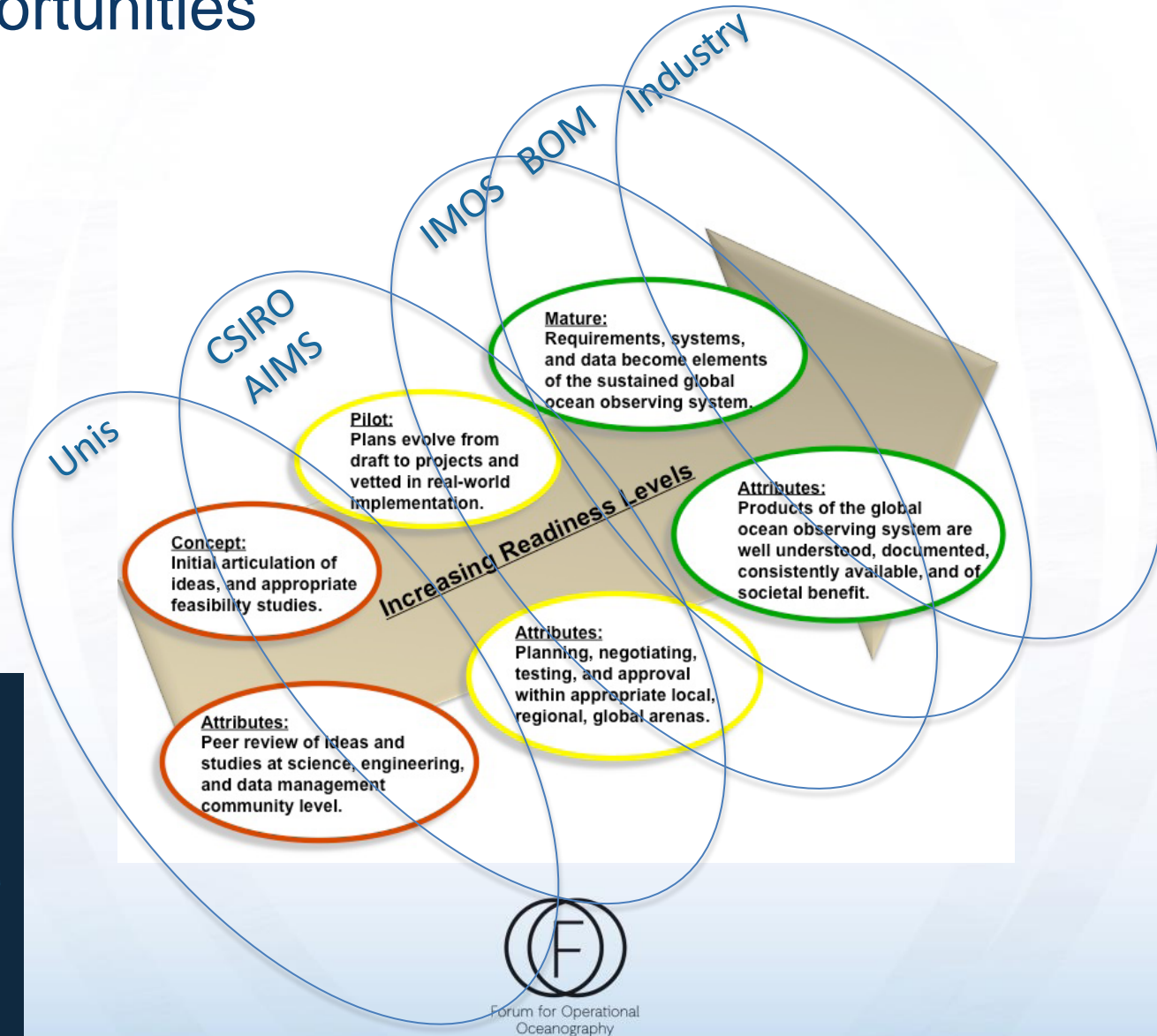
Marine Strategy 2014-2019



Integrated **Marine**
Observing System



Opportunities



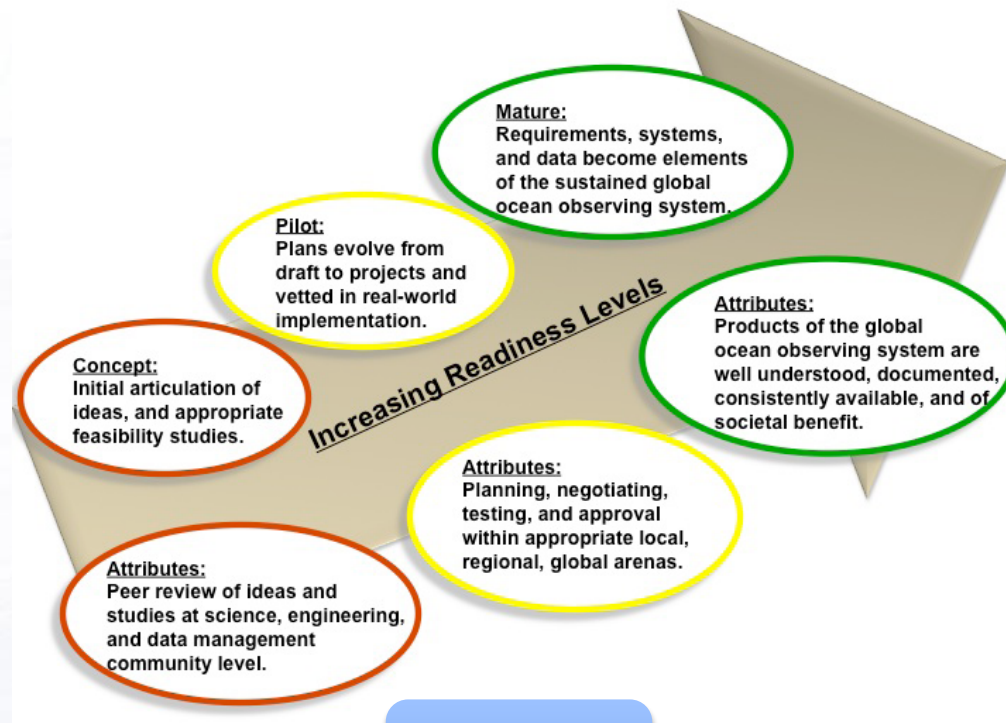
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Sustained
Global for
Observing
Ocean

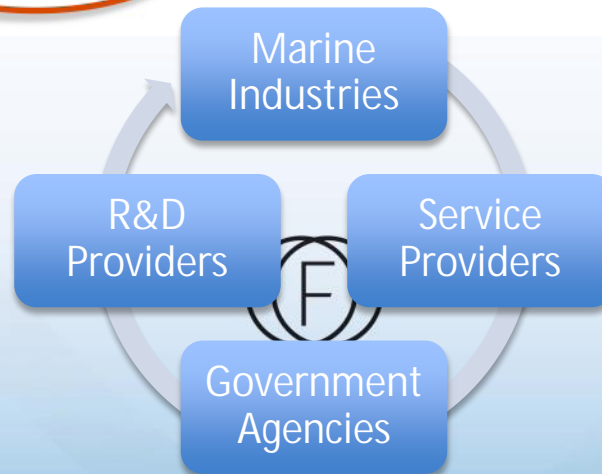
Requirements
System
Integrated
Observations
Data and Information products
Essential Ocean Variables EOVS
Governed
Readiness levels
Pilot
Mature

Framework for
Observing
Global for
Ocean

Opportunities



Sustained
observing for
many users



Thank you

For discussion...



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