The Global Ocean Observing System (GOOS) and the U.S. Integrated Ocean Observing System

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Meeting of GCOOS Parties
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Outline

• Global Ocean Observing System

• U.S. Integrated Ocean Observing System
  - The Political Environment
  - The IOOS Architecture
  - The Global Module
  - The Coastal Module
  - The Current Status

• Engaging The Private Sector
Global Ocean Observing System
Global Ocean Observing System (GOOS)

- GOOS is an end-to-end system of observations, data management, and production and delivery of products/services.

- GOOS is being coordinated by United Nation agencies with the participation of some 100 ocean nations.

The GOOS Modules

The Global Ocean Observing System (GOOS) has been designed and is being implemented in two modules:

- **The global module** is designed to monitor, predict, and understand marine surface conditions and climate variability/change; and

- **The coastal module** is designed to sustain healthy marine ecosystems, ensure human health, promote safe and efficient marine transportation, enhance national security, and predict and mitigate against coastal hazards.
U.S. Integrated Ocean Observing System
Integrated Ocean Observing System (IOOS)

An End–to–End System that Routinely Provides Data & Information Specified by

Groups that Use, Depend on, Manage or Study Oceans & Coasts

(1) Analysis, Modeling

(2) Data Management & Communications

(3) Observing In Situ & Remote Sensing

GOOS

End To End
Integrated End – to – End System
Rapid Access to Diverse Data from Many Sources

Observations → Data Telemetry → Data Management & Communications → Modeling & Analysis → Products & Services

Satellites
Aircraft
Fixed Platforms
Ships
Drifters & Floats
AUVs

Metadata standards
Data discovery
Data Management
Data transport
Online browse
Data archival

Maritime Navigational Services
Search & Rescue
Coastal Flooding & Erosion
Beach Closures
Water Management
Nutrient Management
Fisheries Management
Political Background
1998 U.S. Congress Called for an Integrated Ocean Observing System (IOOS)

Provide Data/Info Required for More Rapid Detection & Timely Prediction of State Changes

- Improve the safety & efficiency of marine operations
- Improve homeland security
- Mitigate effects of natural hazards more effectively
- Improve predictions of climate change & their effects
- Minimize public health risks
- Protect & restore healthy ecosystems in coastal environments more effectively
- Sustain living marine resources

1 System, 7 Goals
Ocean.US

- **Established in 2000**
- **Executive Committee (EXCOM)**
- **Functions & Responsibilities**
  - Prepare & maintain IOOS Development Plans
  - Coordinate interagency implementation
- **Past, Present & Future Directors**
  - Past: David Martin, Eric Lindstrom
  - Current: Tom Malone
  - Future: Mary Altalo (Early 2006)
2004 U.S. Commission on Ocean Policy

- Implement an Integrated Ocean Observing System (IOOS)
  - Make more effective use of existing resources
  - Enhance operational capabilities over time to address all 7 societal goals
- Implement Ecosystem-Based Approaches to Managing
  - Natural resources &
  - Water quality
- Strengthen Regional Approach
  - Locally relevant, nationally coordinated
President’s Ocean Action Plan

- **Enhance Ocean Leadership & Coordination**
  - Establish ocean governance structure

- **Establish an IOOS as part of the GEOSS**

- **Optimize & Harmonize Use & Conservation of**
  - Ocean, Coastal, & Great Lakes Resources

- **Manage Coasts & their Watersheds**

- **Establish strong partnerships among stakeholders**
Ecosystem-Based, Adaptive Management

- **Rapid & Repeated Detection of changes**
  - over a broad spectrum of time-space scales
- **Timely Predictions of such changes**

Tune the flow of environmental data & information to the Time scales on which decisions should be made

WE DO NOT HAVE THIS CAPABILITY TODAY
Why?

- **Cultural divides**
  - Engaging both data providers & users in design, implementation, operation & improvement of IOOS

- **Inefficient, ineffective data management**
  - Data lost or not accessible
  - Time required to acquire, process & analyze data of known quality

- **Under sampling in time, space & ecological complexity**
  - Inputs to coastal ecosystems poorly quantified
  - Lack of long term, high resolution time series
  - Lack of synoptic measurements of physical, chemical & biological properties & processes

- **Lack of capacity for rapid data acquisition & analysis**
  - Remote & Autonomous *in situ* sensing & real time telemetry of geological, biological & chemical properties
  - Operational models for assimilating & analyzing data with speed & skill
The IOOS Architecture
The Integrated Ocean Observing System

- End – to – End
- Multi – Disciplinary
- Multi – Scale
U.S. IOOS
Multi – Scale Hierarchy of Observations

Global Ocean Climate Component
GOOS/GCOS

Coastal Ocean Component

Regional Observing Systems

National Backbone

Low
Resolution
High

H Ist
NW
GoA

C Cal
S Cal

GLs
NE
MAB
SE
GoM
Carrib

S Cal

Mex
GoA
C Cal
H Ist

NE
Inter – Disciplinary
Coastal Phenomena of Interest

Globally ubiquitous, Local Expressions of Large Scale Changes

Climate, Marine Ops, Natural Hazards
- Surface currents, waves
- Sea level, Temperature, Salinity
- Coastal flooding & erosion

Public Health Risks
- Seafood contamination
- Waterborne pathogens

Ecosystem Health & LMRs
- Loss of habitat, Biodiversity
- Nutrient pollution, Anoxia
- HABs, Invasive species
- Mass mortalities
- Chemical contamination
- Declines in living resources
- Aquaculture production
The Global Module
Global Component of the Observing Subsystem
Integrate Remote & In Situ Sensing
An International Collaboration
Implementation Plan for the Global Observing System for Climate in support of the U.N. Framework Convention for Climate Change

• Recommended for implementation by the Tenth Conference of Parties in Buenos Aires in December 2004

• Integration of satellite and in situ observations collected by operational and research groups to be synthesized into information products.
The ocean component of this observing system is developed with broad objectives

- Monitoring and detection of climate change
- Seasonal-to-interannual climate prediction
- Marine and weather forecasts
- Short-range ocean forecasts
- Understanding decadal variations
- Support of scientific research
- Routine ocean state estimation
Key Actions

• Full implementation of the surface and subsurface observing networks
• Designate and support national Agents for Implementation and establish research-operational partnerships
• Timely, free, unrestricted data exchange and comprehensive data management procedures
• International standards for metadata for Essential Climate Variables
• Develop more cost effective two-way communication technologies
• Develop integrated global climate product needs
Coordination and Oversight of the global Ocean Component is by the WMO-IOC Joint Technical Commission for Oceanography and Marine Meteorology
**Multi-year Phased Implementation Plan**

- **Tide Gauges**
  - 2000: 51
  - 2001: 56
  - 2002: 67
  - 2003: 67
  - 2004: 69
  - 2005: 79
  - 2006: 91
  - 2007: 106
  - 2008: 126
  - 2009: 148
  - 2010: 170

- **Surface Drifting Buoys**
  - 2000: 807
  - 2001: 671
  - 2002: 779
  - 2003: 787
  - 2004: 975
  - 2005: 1250
  - 2006: 1250
  - 2007: 1250
  - 2008: 1250
  - 2009: 1250
  - 2010: 1250

- **Tropical Moored Buoys**
  - 2000: 77
  - 2001: 77
  - 2002: 79
  - 2003: 79
  - 2004: 79
  - 2005: 84
  - 2006: 87
  - 2007: 97
  - 2008: 104
  - 2009: 115
  - 2010: 119

- **Ships of Opportunity**
  - 2000: 23
  - 2001: 24
  - 2002: 26
  - 2003: 26
  - 2004: 27
  - 2005: 28
  - 2006: 34
  - 2007: 45
  - 2008: 51
  - 2009: 51
  - 2010: 51

- **Argo Floats**
  - 2000: 20
  - 2001: 31
  - 2002: 544
  - 2003: 923
  - 2004: 1572
  - 2005: 2300
  - 2006: 3000
  - 2007: 3000
  - 2008: 3000
  - 2009: 3000
  - 2010: 3000

- **Reference Stations**
  - 2000: 15
  - 2001: 29
  - 2002: 35
  - 2003: 37
  - 2004: 41
  - 2005: 42
  - 2006: 49
  - 2007: 54
  - 2008: 60
  - 2009: 78
  - 2010: 89

- **Arctic System**
  - 2000: 29
  - 2001: 29
  - 2002: 30
  - 2003: 30
  - 2004: 31
  - 2005: 34
  - 2006: 37
  - 2007: 54
  - 2008: 64
  - 2009: 78
  - 2010: 85

- **Ocean Carbon Network**
  - 2000: 0
  - 2001: 0
  - 2002: 1
  - 2003: 24
  - 2004: 24
  - 2005: 27
  - 2006: 27
  - 2007: 29
  - 2008: 31
  - 2009: 31
  - 2010: 31

- **Dedicated Ship Time**
  - 2000: 340
  - 2001: 370
  - 2002: 497
  - 2003: 497
  - 2004: 497
  - 2005: 531
  - 2006: 640
  - 2007: 730
  - 2008: 830
  - 2009: 830

- **System Evaluation**
  - 2000: 0
  - 2001: 1
  - 2002: 1
  - 2003: 2
  - 2004: 3
  - 2005: 7
  - 2006: 8
  - 2007: 9
  - 2008: 9
  - 2009: 9
  - 2010: 9

- **Total System**
  - 2000: 30
  - 2001: 34
  - 2002: 40
  - 2003: 45
  - 2004: 48
  - 2005: 53
  - 2006: 55
  - 2007: 66
  - 2008: 77
  - 2009: 88
  - 2010: 100

**System % Complete**

- Real-time Stations
- Initial GCOS Subset
- Number of buoys
- Number of moorings
- High resolution and frequently repeated lines occupied
- Number of floats
- Number of observatories, flux, and ocean transport stations
- Ice buoys, drifting and Moored stations
- Repeat Sections Committed, One inventory per 10 years
- Days at sea (NOAA contribution)
- Product evaluation and feedback loops implemented (NOAA contribution)
DBC P status by country, February 2005 (data buoys reporting on)

Drifting buoys: 908
Moored buoys: 184

- AUSTRALIA (28)
- CANADA (7, 19)
- INDIA (1, 10)
- NETHERLANDS (2)
- SOUTH AFRICA (10)
- MOORINGS

- BRAZIL (2)
- FRANCE (30, 6)
- IRELAND (2, 2)
- NEW ZEALAND (10)
- UNITED KINGDOM (30, 7)
- BRAZIL/FRANCE/USA (8)
- GERMANY (11)
- JAPAN (6, 15)
- NORWAY (8)
- UNITED STATES (763, 115)
- UNKNOWN
Challenge: Extending the tropical moored buoy network across the Indian Ocean

CLIVAR/GOOS Initial Indian Ocean moored array design
- Japan - 2 existing TRITON sites
- India-USA deployed 4 ATLAS moorings

November 2004

67% complete
Arroyo Network, as of February 2005

- Australia (44)
- Canada (80)
- China (13)
- European Union (36)
- France (106)
- Germany (80)
- India (39)
- Ireland (1)
- Japan (279)
- Korea (55)
- Mauritius (2)
- Netherlands (3)
- New Zealand (5)
- Norway (9)
- Russia (4)
- Spain (9)
- United Kingdom
- United States (81)

1671 Active Floats

56% complete
GLOSS Status, October 2004

- **Category 0**: Real-time stations (69 stations received at UHSLC).
- **Category 1**: "Operational" stations for which the latest data is 2000 or later (185 stations).
- **Category 2**: "Probably operational" stations for which the latest data is within the period 1990-1999 (10 stations).
- **Category 3**: "Historical" stations for which the latest data is earlier than 1990 (27 stations).
- **Category 4**: Stations for which no PSMSL data exist (25 stations).
The Coastal Module
Coastal Component

Regional COOSs
- Regional Associations Responsible
- Involve private & public sectors
- Inform Federal Agencies of user needs
- Enhance the backbone based on user needs
- Incorporate sub-regional systems

National Backbone
- Federal Agencies Responsible
- EEZ & Great Lakes
- Core variables required by regions & Federal Agencies
- Network of sentinel & reference stations
- Standards/Protocols

Regional Associations Responsible
- Involve private & public sectors
- Inform Federal Agencies of user needs
- Enhance the backbone based on user needs
- Incorporate sub-regional systems
11 Groups Funded to Establish Regional Associations (RAs)
Coastal Backbone
Core Variables

• Geophysical
  ➢ Sea surface meteorological variables
  ➢ Land–Sea Stream flows
  ➢ Sea level
  ➢ Surface waves, currents
  ➢ Ice distribution
  ➢ Temperature, Salinity
  ➢ Bathymetry

• Biophysical
  ➢ Optical properties
  ➢ Benthic habitats

• Chemical
  ➢ pCO₂
  ➢ Dissolved inorganic nutrients
  ➢ Contaminants
  ➢ Dissolved oxygen

• Biological
  ➢ Fish species, abundance
  ➢ Zooplankton species, abundance
  ➢ Phytoplankton species, biomass (ocean color)
  ➢ Waterborne pathogens
National Backbone
Initial Operational Observing Subsystem
EEZ, Great Lakes

• Remote Sensing
  ➢ POES & GOES (NOAA)

• In Situ Sensing
  ➢ Stream gauge program (USGS)
  ➢ Tide gauge network (NOAA, USGS)
  ➢ Buoy programs (NOAA, Navy)
  ➢ Wave gauge programs (NOAA, Navy, USACE)
  ➢ Hydrographic surveys (NOAA, USGS)
  ➢ Habitat surveys & assessments (NOAA, EPA)
  ➢ Fish stock assessments (NOAA, USGS)
  ➢ Protected resources surveys (NOAA)
Coastal Component
High Priority Research & Pilot Projects

• Surface current mapping
  - Product: real–time surface current maps
  - HF–radar, remote & in situ sensing
  - Data assimilation–numerical modeling

• Space–based remote sensing
  - Improve chl algorithms for ocean color
  - Increase spatial, temporal, & spectral resolution
  - Sea surface salinity

• Aircraft remote sensing of near shore environments
  - LIDAR

• Coupled physical–water quality/ecosystem models
  - Ecosystem – Based Management

• Glider development for *in situ* sensors

• *In situ* sensors for core variables
  - Chemical & biological
The Current Status
Summary: Current Status

• 1st Annual IOOS Development Plan
  - Global ocean–climate component being implemented
  - Initial backbone in place
  - Sub-regional coastal ocean observing systems funded
  - DMAC Plan completed

• Regional groups funded to
  - Form Regional Associations
  - Engage User Groups: Public & Private Sectors
  - Establish RCOOSs

• Government support
  - Current Funding: ~ $125 M
  - Executive order
  - Legislation in Congress to Authorize Additional Funding
Engaging the Private Sector
Engaging Private Sectors in IOOS Development

• Two convergent, interdependent approaches
  
  **Regional**: Focus on involving private sectors, NGOs, and state agencies early in the development of RCOOSs
  - Regional Associations – Establish & Maintain User Forums
  - Conduct Regional Workshops, e.g., Houston 2004

  **National**: Focus on serving data & information to attract the interest of private sectors & stimulate product development
  - Industry Days
  - Annual IOOS Implementation Conference to formulate & update the IOOS Development Plan
Thank You

• http://ioc.unesco.org/goos/

• http://ocean.us/

• http://www.gcoos.org