Ocean Data and Information Management – Open Standards and Interoperability

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Indian National Centre for Ocean Informations Services, Hyderabad

The Mission

Provide Ocean Data, Information and Advisory Services to Society, Industry, Government and Scientific Community through Sustained Ocean Observations and Constant improvements through Systematic and Focused Research.
Ocean Observation & Information Services

- Potential Fishing Zone Advisory Services
- Ocean State Forecast Services
- Early Warning for Tsunami and Storm Surges
- Information Bank & Web-based Service
- Contribution to Weather/Monsoon/Climate Forecast
- Value-added Services for Coastal Management

National Infrastructure Network

International Interface

Satellite Oceanography
- Remote Sensing Satellites
- Foreign Satellites

Ocean science and Modeling
- In-situ Observations
  - Argo Profiling Floats
  - Data Buoys
  - Current Meter Arrays
  - XBTs, Tide gauges
  - Sea Truth

International Interface

- Fishing Community
- Coastal States
  - IMD, Navy, NHO, Coast Guards
- Ports and Harbours
- Off-shore and Shipping
- Research Institutions
  - Academia
PFZ Mission

R&D Efforts, Modelling, Technology Development

Operational Generation
(SST, Chlorophyll)
3 per week

Dissemination
Multi lingual Delivery (Map, Text)
Fax, Phone, News Paper, Internet, e-mail, Electronic Display Boards, Radio Broadcast Information Kiosks

Fishing Vessels

Validation Feedback

User Awareness

- Recognised as a matured operational application of satellite remote sensing
- Pursued as part of the ‘Common Minimum Programme’ of the Government of India

Collaboration with SAC, FSI, State Fisheries Departments, Central Fisheries Institutions, Academia, Fisheries Associations, NGO’s, etc
Open Ocean Forecast
The Elements of Early Warning System

- CB, Edu.Trg
  - Historic Data
  - Bathymetry
  - Coastal Topography
  - Coastal Vulnerability

- Warning Centre

- Data Communication (INSAT)

- Coastal Radars, Current Meter Moorings

- Upper Ocean, Surface Met-Ocean Observations

- Tide Gauge Network (Real time)

- A network of Land-based Seismic Stations

- Bottom Pressure Recorders in the Tsunamigenic Zones

- Numerical Modelling
  - Tsunami
  - Storm Surge
Web-based Services

PFZ Advisory Service

Argo Data & Products

Ocean State Forecast

Tsunami Warning System

Chlorophyll Concentration

Sea Surface Temperature

Argo Data & Products

Tsunami Warning System
Need for Ocean Observing System

- Managing Living resources for sustainable use
- Facilitating safe and efficient marine operations
- Detecting and forecasting oceanic components of climate variability
- Mitigation of Natural Hazards
- Preserving marine Ecosystems
- National security
- Strengthening Education and improving knowledge
Indian Ocean Observing System

Key new element—mooring array: ocean obs + meteorology

Argo floats 3°x 3°
Drifters 5°x 5°
~20 real-time tide gauges

- Enhanced XBT lines to monitor Indonesian Throughflow, inflow to western boundary, Java upwelling and 10°S thermocline ridge
- Regional mooring arrays

- Carbon/hydro cruise
- High density XBT
- Frequently repeated XBT

Diagram: Map of the Indian Ocean with lines and dots indicating various observing and monitoring locations.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Accuracy</th>
<th>Resolution</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ocean</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ocean Temperature (Surface and Profiles)</td>
<td>± 0.02°C</td>
<td>0.001°C</td>
<td>0-40°C</td>
</tr>
<tr>
<td>Salinity (Surface and Profiles)</td>
<td>± 0.02 psu</td>
<td>0.002 psu</td>
<td>0-40 psu</td>
</tr>
<tr>
<td>Current Speed &amp; Direction</td>
<td>± 5 cm s⁻¹</td>
<td>0.1 cm</td>
<td>0-250 cm s⁻¹</td>
</tr>
<tr>
<td></td>
<td>± 5°</td>
<td>0.1°s⁻¹</td>
<td>0-359°</td>
</tr>
<tr>
<td>Pressure</td>
<td>±0.25% full scale</td>
<td>0.3 psi</td>
<td>0-1000 psi</td>
</tr>
<tr>
<td><strong>Atmosphere</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air temp</td>
<td>± 0.2°C</td>
<td>0.01°C</td>
<td>0-40°C</td>
</tr>
<tr>
<td>Wind direction</td>
<td>± 5°</td>
<td>1.4°</td>
<td>0-359°</td>
</tr>
<tr>
<td>Wind speed</td>
<td>± 0.3 m s⁻¹ or 3%</td>
<td>0.2 m s⁻¹</td>
<td>0-35 m s⁻¹</td>
</tr>
<tr>
<td>S/W radiation</td>
<td>± 1%</td>
<td>0.4 W m⁻²</td>
<td>0-1600 W m⁻²</td>
</tr>
<tr>
<td>L/W radiation (down-welling)</td>
<td>± 1%</td>
<td>0.1 W m⁻²</td>
<td>0-500 W m⁻²</td>
</tr>
<tr>
<td>Surf Air Pressure</td>
<td>0.1 hPa or 0.01%</td>
<td>0.1 hPa</td>
<td>800-1100 hPa</td>
</tr>
</tbody>
</table>
Ocean Observing Systems – In-situ

- Tide Gauges
  - SOI/NIOT
- Current Meter Mooring Arrays
  - NIO/INCOIS
- XBT Lines
  - NIO/INCOIS
- Drifters
  - NIO/INCOIS
- Moored Buoys
  - NIOT
- Floats
  - INCOIS/NIOT
  - NCAOR/CMLRE
- A Fleet of Research Vessels
Distribution of Observation Platforms

- Argo Floats
- Drifting buoys
- Current Meters
- Moored buoys
- XBT Surveys
Early Warning System for Tsunami and Storm Surges

Observational Network

Seismic Network

Network of 17 Seismic stations with Central Receiving Stations at IMD Delhi and INCOIS, Hyderabad for monitoring the seismic activity

Bottom Pressure Recorders

Network of 12 Deep Ocean Assessment and Reporting Systems (DOARS) for detection of Tsunami Waves

Tide Guages

Network of 50 Tide Gauges for monitoring the progress of Tsunami Waves

Complementary Observations

- 5 Coastal Radars
- 2 Current Meter Moorings
- 26 Surface Drifters
- 2 XBT Lines
- Surface, Met-Ocean observing platforms
- Observations from other Systems on Internet
Value added Products on INCOIS Website

Objectively analyzed product

Time Series Plots of Individual floats

- SST
- SSS
- Salinity
- Temp

Heat Content up to 300 mts + 1E-08 (J/m2)

Depth of 20 Deg Isotherm (mts)

Mixed Layer Depth (mts)

Sea Surface Salinity (PSU)

Sea Surface Temperature (Deg C)

December 2004
Ocean Observations through Satellites

- Sea Surface Temperature (SST)
- Ocean Colour
- Coastal Process
- Wind Speed
- Wave Ht.
- Sea Level
- Surface Wind Vector
- Sediment
- Wave Spectrum
- SST
- Sea Ice Extent
- Sea Ice Elevation
- Scatterometer
- SAR
- IRS-P4 OCM, MSMR
- Megha Tropiques
- Oceansat-2
- TRMM
- IRS P5/P6
- INSAT Series
- TOPEX
- Jason
- ERS
- Radarsat
- NOAA (AVHRR)
- IRS-1C/D
- NOAA (AVHRR)
Data Source

In-Situ Data
- Argo Floats
- Moored Buoys
- Drifting Buoys
- XBT
- Current Meter Arrays
- DOARS
- Tide Gauges
- Coastal Radars
- Seismic Network

Remote Sensing Data
- NOAA
- MODIS Tera/Aqua
- OCM
- TRMM
- Quikscat
- SeaWifs
- Altimeter
Data Source

Model Outputs, Reanalysis Data, Climatology Atlas

OSF
SODA
JEDAC
NCEP
CMAP

Topographic Maps
Nellore-Machipatnam
1:25,000 Scale

CRZ Maps
Land Use (1:25,000), Aqua Culture and Wet lands (1:50,000)

CRZ Land Use Maps
Gujarat Coast
(1:25,000 Scale)
## Data Flow

### ~ 2.6 TB/Year

<table>
<thead>
<tr>
<th>Platform</th>
<th>Instrument</th>
<th>Annual Volume</th>
<th>Data Vol. Per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-Situ</td>
<td>Argo</td>
<td>1 GB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>XBT</td>
<td>1 GB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Moored Buoy</td>
<td>10 GB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Drifting Buos</td>
<td>1 GB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Current Meter Moorings</td>
<td>1 GB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tide Gauges</td>
<td>2 GB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HF Radars</td>
<td>100 GB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bottom Pressure Recorders</td>
<td>1 GB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Seismic Data</td>
<td>500 GB</td>
<td></td>
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<tr>
<td>Satellite</td>
<td>NOAA</td>
<td>300 GB</td>
<td>1900 GB</td>
</tr>
<tr>
<td></td>
<td>MODIS Tera/Aqua</td>
<td>1000 GB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>OCM/Oceansat-1</td>
<td>200 GB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TRMM</td>
<td>100 GB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quikscat</td>
<td>100 GB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SeaWifs</td>
<td>100 GB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Altimeter</td>
<td>100 GB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Model Outputs, Reanalysys Data</td>
<td>100 GB</td>
<td>100 GB</td>
</tr>
<tr>
<td></td>
<td>Geospatial Data</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Bathymetry</td>
<td>1 GB</td>
<td>1 GB</td>
</tr>
<tr>
<td></td>
<td>Topography</td>
<td>1 GB</td>
<td>1 GB</td>
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<tr>
<td></td>
<td>Digital Atlas</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Atlases of various parameters</td>
<td>1 GB</td>
<td>1 GB</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>2620 GB</td>
</tr>
</tbody>
</table>
Managing Databases

- Spatial Databases
  - Local, national, regional/global,

- Spatial Image Analysis:

- Digital Mapping: Automated and semi-automated approaches, change detection, data fusion, data integration

- Applications: Modeling, information systems for resource management and disaster management

- Services: Web GIS, Location-based
<table>
<thead>
<tr>
<th>Marine Data Centres</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>India Meteorological Dept., New Delhi</strong></td>
</tr>
<tr>
<td><strong>Geological Survey of India, Kolkata</strong></td>
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<tr>
<td><strong>Survey of India, Dehradun</strong></td>
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<tr>
<td><strong>National Institute of Oceanography, Goa</strong></td>
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<tr>
<td><strong>Naval Hydrographic Office, Dehradun</strong></td>
</tr>
<tr>
<td><strong>Fishery Survey of India, Mumbai</strong></td>
</tr>
<tr>
<td><strong>K.D. Malaviya Inst. Of Petroleum Exploration, Dehradun</strong></td>
</tr>
<tr>
<td><strong>National Remote Sensing Agency, Hyderabad</strong></td>
</tr>
</tbody>
</table>
Current Responsibilities

- National Oceanographic Data Centre
- National and Regional Argo Data Centre
- Regional Centre for Indian Ocean (IOGOOS)
- Each of this program has a definite set of standards and protocols
- Compatibility with IOC, WMO, GCOS, GEOSS
- Data Exchange: IODE guidelines
Argo Data Center

- National Argo data center
  Acquisition of Argo data from CLS ARGOS/INCOIS antenna, processing, real-time QC, dissemination to GDAC and INCOIS website

- Regional Argo data center
  - Acquisition of Argo data from GDAC other than Indian floats, real-time QC and made available at INCOIS web based services
  - Preparation of Indian ocean hydrology
  - Delayed mode Quality control
  - Value added products

Regional (Atlantic – CORIOLIS, Indian – INCOIS, Pacific – AOML and Southern – BODC)
Data Base Organisation

- Interoperability
- Open, easy access and discovery
- Reliable, sustained, efficient operations
- Open design and standards process
- Preservation of data and products
Meta Data

MEDI Meta Data Base
Software developed by IOC used for Meta Data Base generation (ISO 19115)

- Data set: Name, Custodian, Jurisdiction
- Data Description: Abstract, Search Words, Geographic Extent Name and Polygon
- Data Currency: Beginning and Ending Dates
- Data Status: Progress, Update Frequency
- Data Quality: Positional Accuracy, Attribute Accuracy, Consistency, Completeness
- Data Access: Stored Data Format, Available Format Type, Access Content
- Contact Information: Person, Organisation, Address, WWW, E-mail, Phone
- Data Content: Equipment, Parameter Description, Sampling Intensity, Sampling Method, etc.
- Program Information: Name, Coordinator, Organisation, Platform
- Public Information: Document Reference, Online Link
- Monitoring: Parent Organisation, Principal Organisation, Funding Organisation, Objectives, Clients
OGC Ocean Interoperable Experiment

The Ocean IE will focus on these areas:

- Web Services for Interoperable Ocean Science.
- OGC WMS and WFS access to ocean data, focusing on SOAP bindings.
- Application of the OGC Service Oriented Architecture (SOA) for Web Services to Ocean-observing applications.
- Sensor Web Enablement (SWE) in particular Observations & Measurements and Sensor ML.
- Sensor Observation Service for raw observations.
- GML application schema for Ocean data.
- Semantic interoperability using RDF-based ontologies.
- Application of semantic services to Catalog Services for the Web as related to use in an Interoperable Ocean Service.
Where we stand....

- Open standards and interoperability are being widely used for the land based GIS applications. They should be ecoming integral part of Ocean Data and Information Management e.g. British Oceanographic Data Centre

- About 100 Live Access Servers [build on Open Source Project for a Network Data Access Protocol (OPeNDAP)], around serving marine community with data services with common data formats. We have developed a LAS for Argo Data services and also providing Web-based services. Our meta data base generation adopts the ISO 19115 standards

- Marine XML project was initiated by the IODE based on the models of OGC on standards development.

- Ocean Science Interoperability Initiative (web services, ocean-observing applications, access to ocean data, sensor observation service, ..........by OGC is timely necessity.
Thank You....