Coordinating Internationally to Observe the Global Ocean for Climate

Second GEOSS Asia-Pacific Symposium

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April 15, 2008
Tokyo, Japan

Critical Themes

- There is a lot more low frequency variability in the ocean than we'd realized and continuous sampling for many decades is needed to get decent estimates of long term trends.
- Interannual to decadal ocean variability is going to affect society much more strongly than climate change over the next few decades. IPCC wants to have a component on decadal projection for AR5…these model runs will depend strongly on ocean initial conditions.
- Satellites simply cannot do the monitoring job of the world's oceans. The need for in situ observations is critical. Much of the critical climate forecasting information comes from the subsurface ocean…carbon, heat, salinity, sea level contributions, overturning circulations…also things the satellites cannot monitor. The same for ecosystem and biogeochemistry variables
- The operational and climate communities have been doing Observing System Sensitivity Experiments (OSSE) work to evaluate the GCOS/UNFCCC/GEO ocean plan and present conclusions are that the plan continues to be the minimum needed, with clear cases to be made for enhancements, Engagement by new Member Nations and closer collaborations.
- One Final key point to keep in mind is that GEOSS is an "end-to-end" concept, meaning that it is not just about data, but the delivery of useful information for meaningful decision making. NOAA is adopting this approach for global ocean observations, as you will see, and we encourage others to consider ways to pursue this.

National Oceanic and Atmospheric Administration

Weather

Watches, warnings, floods, hurricanes, Weather Radio...

Ocean

Coral reefs, tides, currents, buoys, marine sanctuaries, estuaries, diving, spills

Satellites

Real-time imagery, environmental, geostationary and polar satellites

Fisheries

Protecting marine mammals, sea turtles, habitats, statistics, economics, enforcement

Climate

El Niño & La Niña, global warming, drought, climate prediction, archived weather data, paleoclimatology

Research

Environmental labs, air quality, atmospheric processes, climate and human interactions

Coasts

Coastal services & products, Great Lakes, coastal zone management

Charting & Navigation

Nautical & navigational charts, mapping, remote sensing, safe navigation

International Objectives

- Optimize Cost-effective resource sharing for Shiptime, instrumentation, CPU time, etc.
- Enhance Regional Capacity and Training for Socio-economic Benefits
- Eliminate Gaps and Overlap Redundancies
- Coordinate Joint Implementation
- Ensure Free, Open and Timely Access to Data

End User Requirements

- **Climate:**
  - Operational Forecast Centers
  - International Research Programs
  - Major Scientific Assessments

- **System designed to meet climate requirements but also supports:**
  - Weather prediction
  - Global and coastal ocean prediction
  - Marine hazards warning
  - Transportation
  - Marine environment and ecosystem monitoring

- Tide gauge stations
- Drifting Buoys
- Tropical Moored Buoys
- Profiling Floats
- Ships of Opportunity
- Ocean Reference Stations
- Ocean Carbon Networks
- Arctic Observing System
- Dedicated Ship Support
- Data & Assimilation Subsystems
- Management and Product Delivery
- Satellites (managed outside of IOOS)

International Partnerships are Central

A global system by definition crosses international boundaries

NOAA's contributions are managed in cooperation with the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) -- presently 68 nations.

The organizing framework is in place

jcomm
OCEANOGRAPHY & MARINE METEOROLOGY

DBCP WMO – IOC DATA BUOY COOPERATION PANEL

SHIP OBSERVATIONS TEAM JCOMM

GLOBAL SEA LEVEL GLOSS OBSERVING SYSTEM

ARGO

OceanSITES

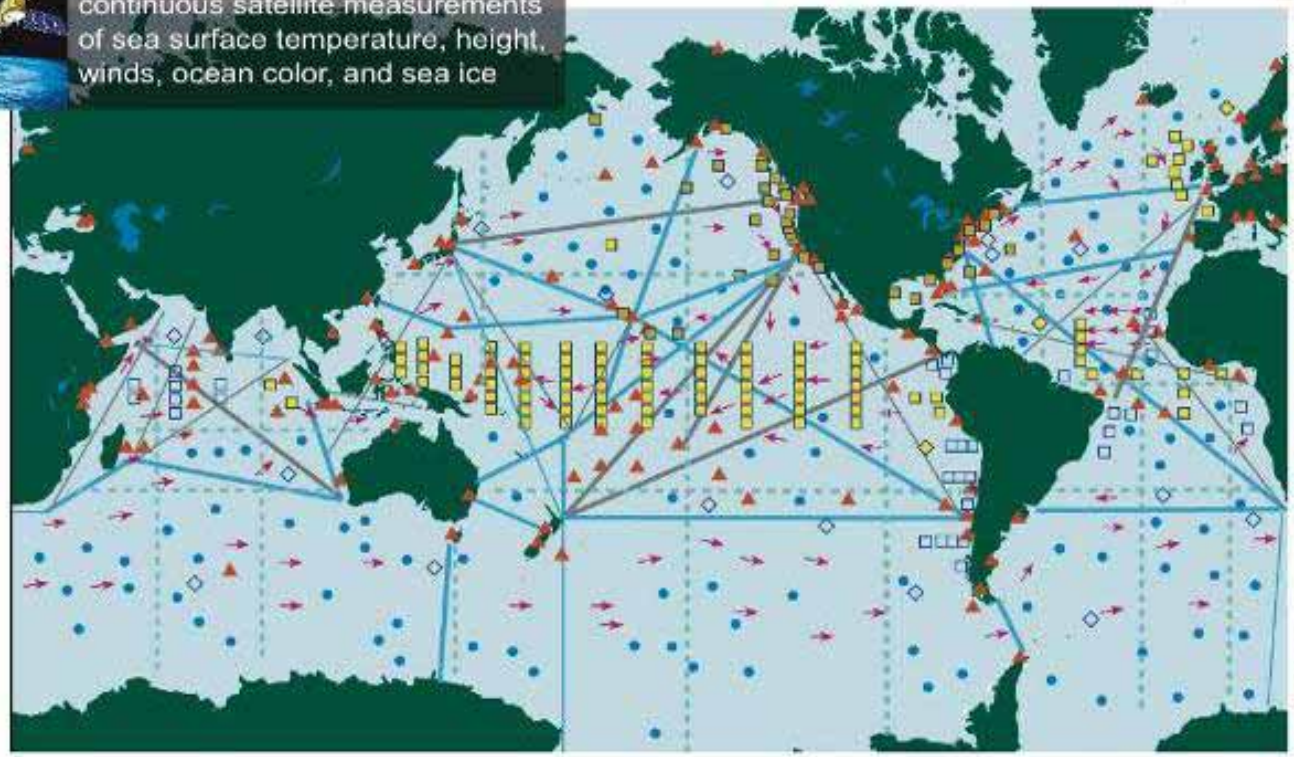
International Ocean Carbon Coordination Project

All Six global *in situ* implementation programs are now linked internationally through WMO/IOC JCOMM coordination

The Open-Ocean component of GOOS

continuous satellite measurements of sea surface temperature, height, winds, ocean color, and sea ice

Total *in situ networks* **59%** August 2007



87% **Surface measurements** from volunteer ships (VOSclim)

200 ships in pilot project

100% Global **drifting surface buoy** array

5° resolution array: 1250 floats

62% **Tide gauge** network (GCOS subset of GLOSS core network)

170 real-time reporting gauges

81% **XBT** sub-surface temperature section network

51 lines occupied

97% Argo **profiling float** network

3° resolution array: 3000 floats

43% Repeat **hydrography** and **carbon inventory**

Full ocean survey in 10 years

Reference time series 24%

29 sites

48% Global **reference mooring** network

58 moorings planned

74% Global tropical **moored buoy** network

119 moorings planned

GCOS

GOOS

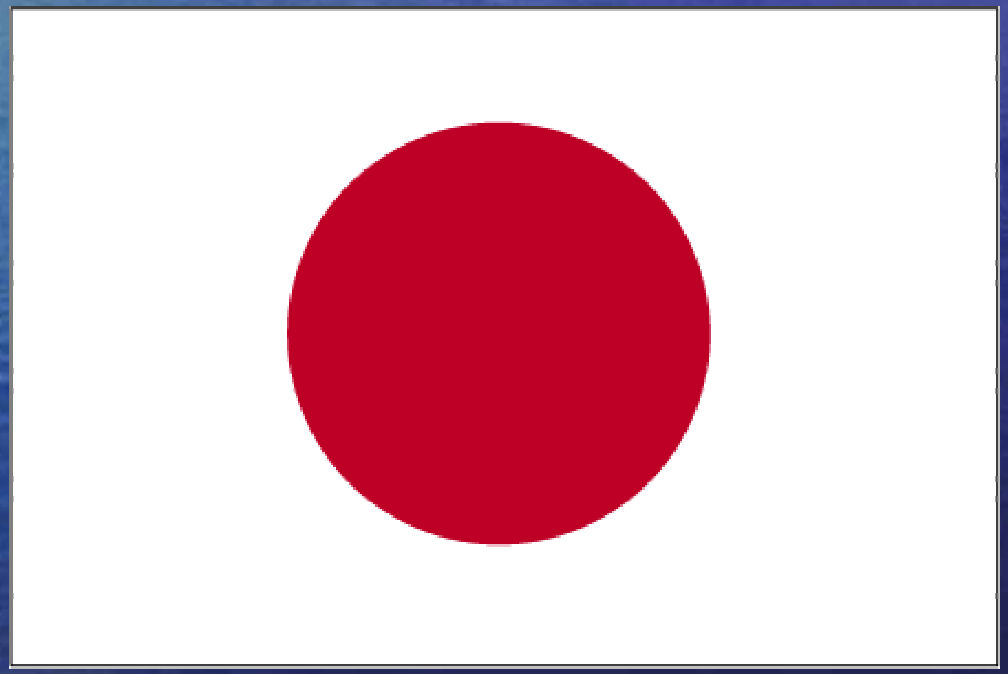
jcomm

OCEANOGRAPHY & MARINE METEOROLOGY

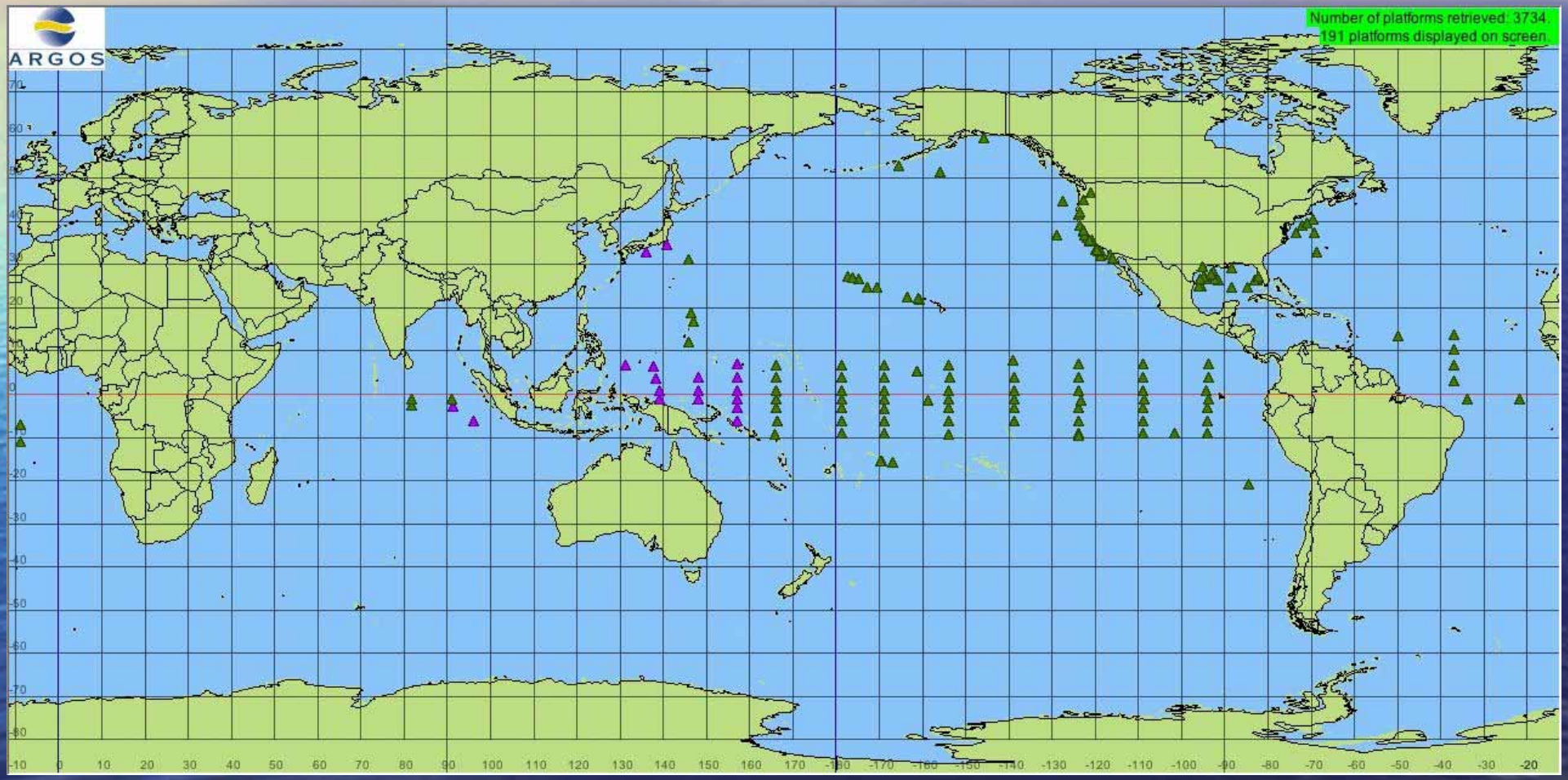
Multi-Year Phased Implementation Plan (NOAA)

3/17/08

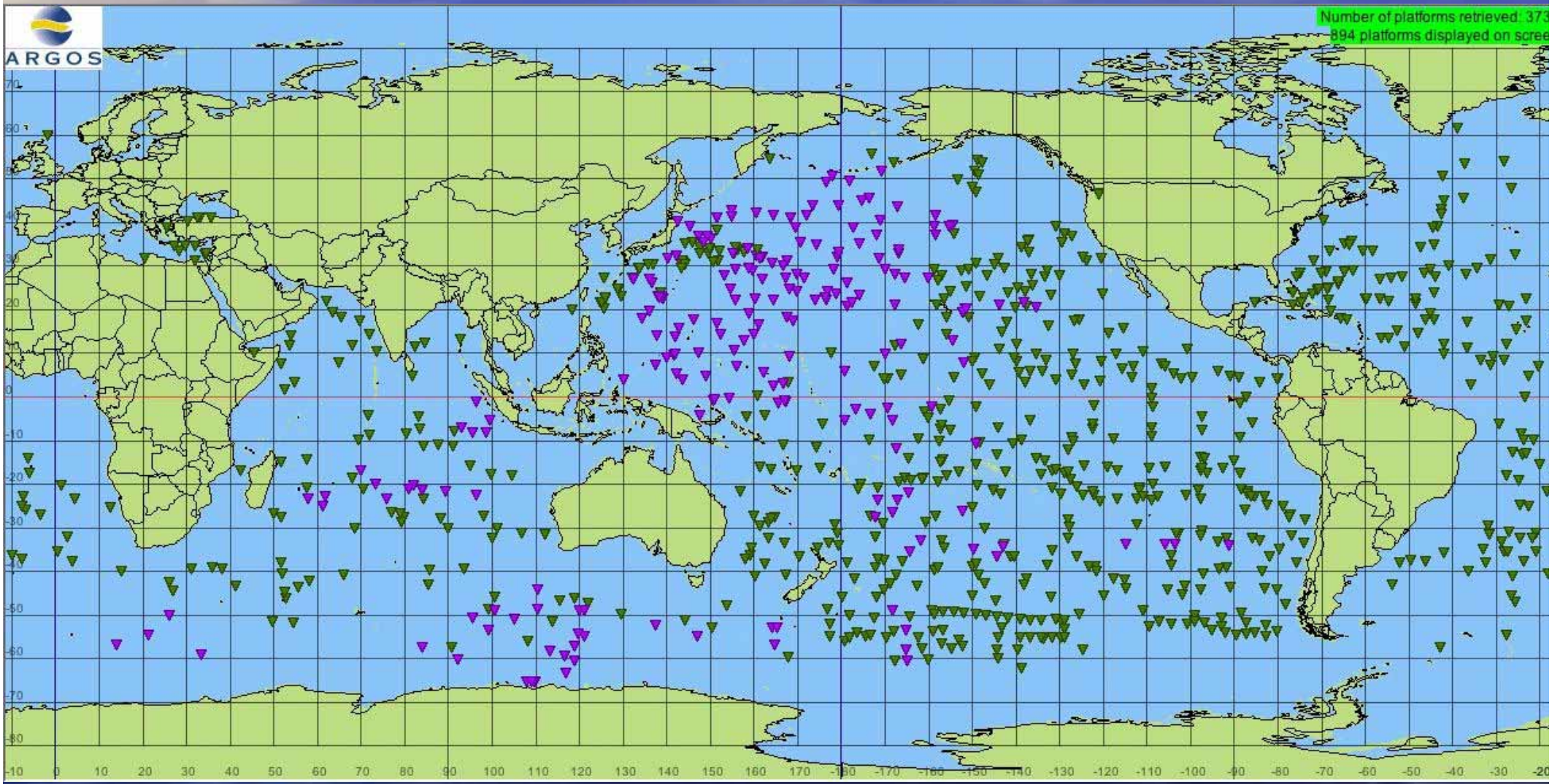
Japan Marine-Earth Science and Technology Center (JAMSTEC) and Institute of Observational Research for Global Change (IORGC)



US and Japan Tropical Moored Buoys

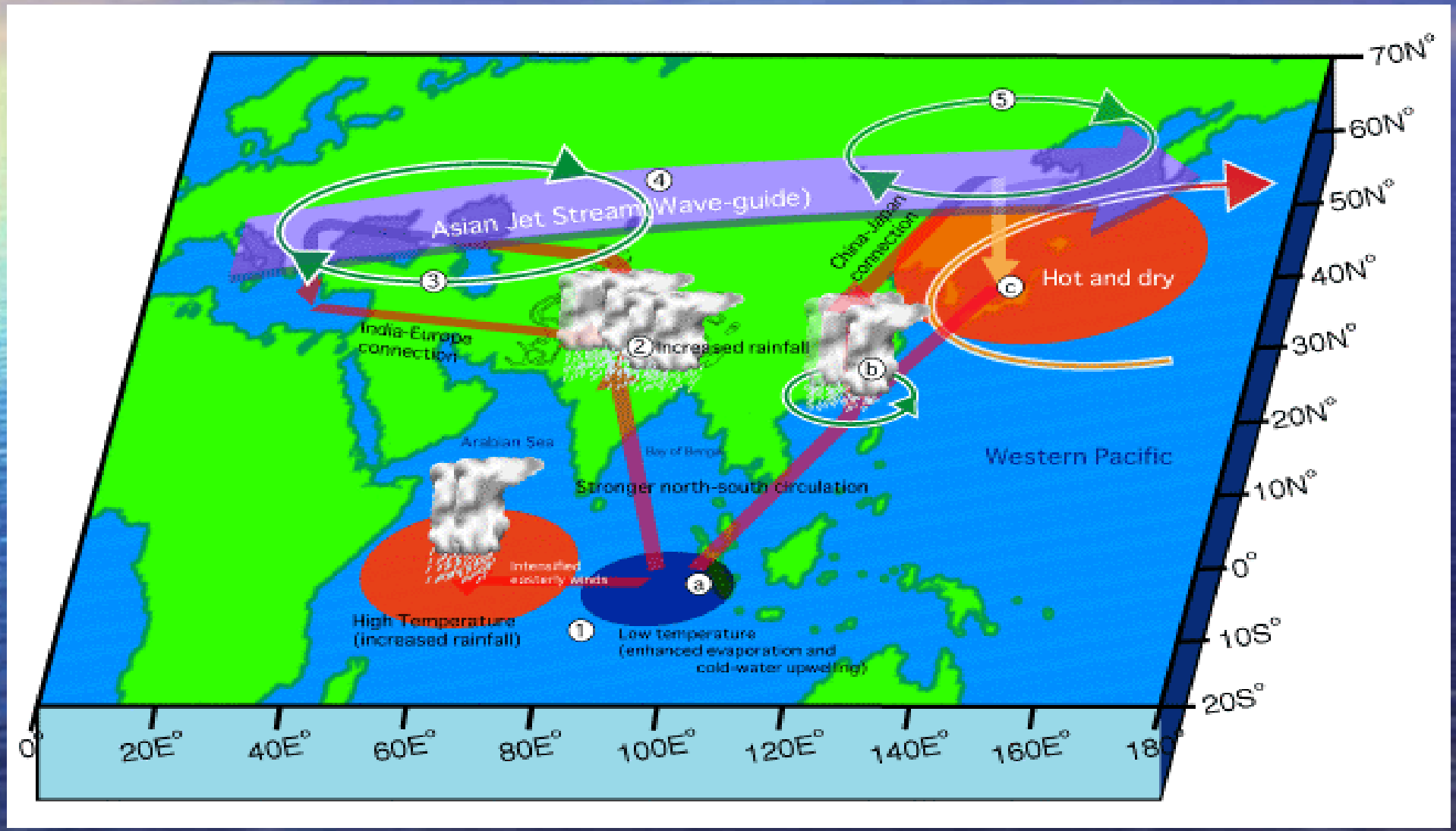


US Japan Argo Deployments

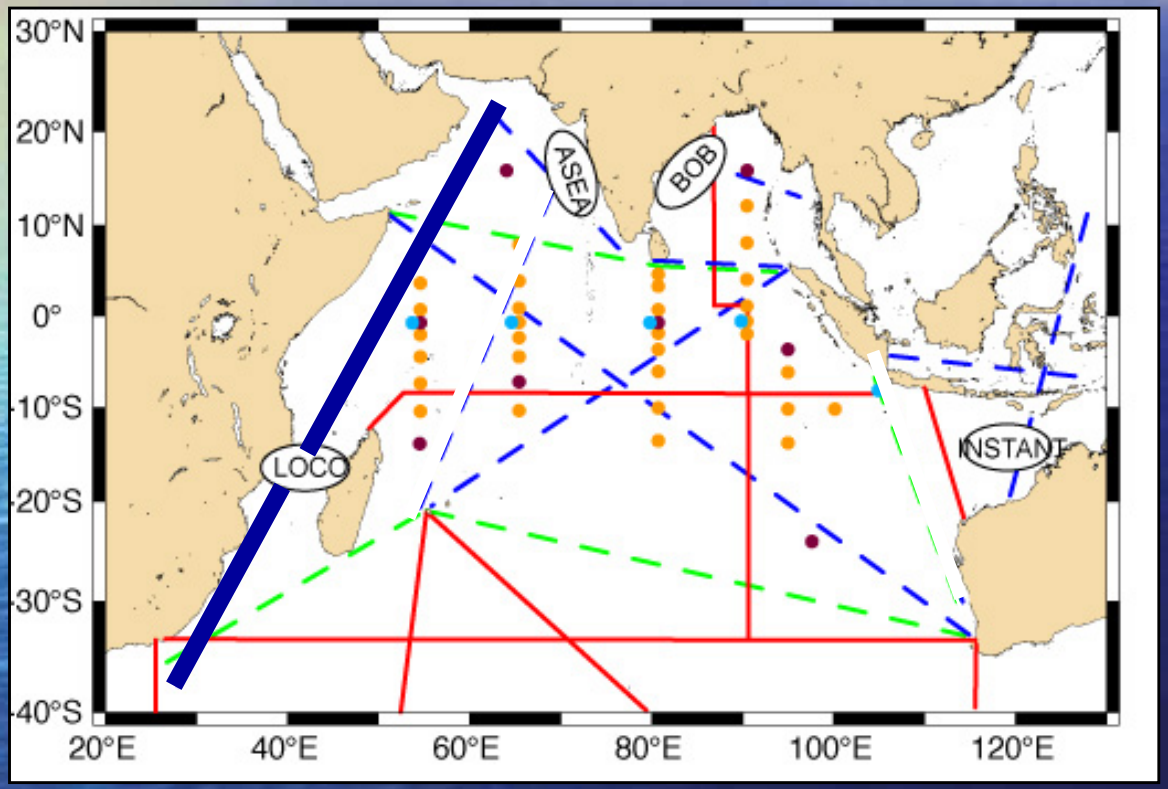


A Schematic Diagram of the IOD Influence on the Summer Conditions in the Northern Hemisphere

ダイポールモードとそのテレコネクションの三角関係



IOGOOS/CLIVAR Indian Ocean Observing System (IndOOS)



Emphasis on ocean, but will provide surface met data as well

Mooring Array

Argo floats 3°x 3°
Drifters 5°x 5°

~20 real-time tide gauges for IOTWS

Carbon/hydro cruise

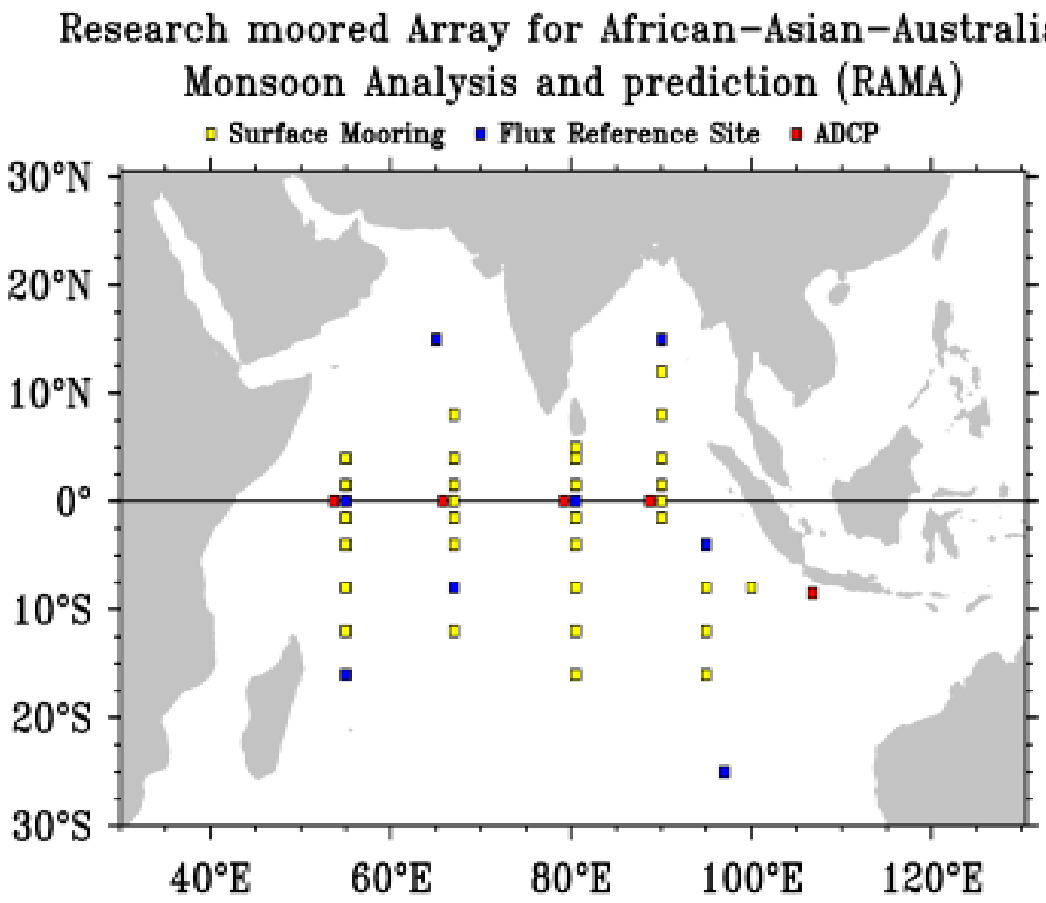
High density XBT

Frequently repeated XBT

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

Regional mooring arrays

Strategy for Indian Ocean Moored Buoy Array



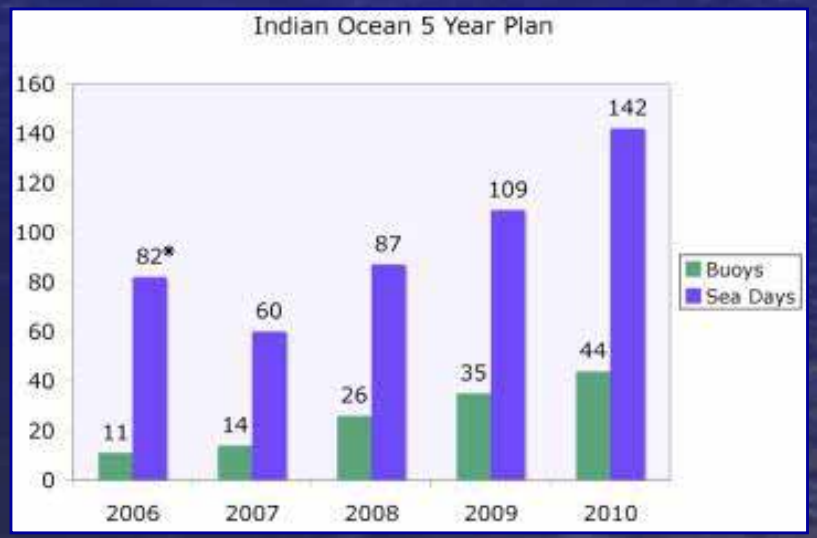
- Basin scale, tropical upper ocean (500 m) focus.
- Arabian Sea, Bay of Bengal, Eq. Waveguide, Thermocline ridge (5°-10°S), subtropical subduction, Java upwelling.
- Does not sample western boundary currents, ITF, coastal zones.
- Design supported by numerical model observing system studies.

Designed by the CLIVAR/GOOS Indian Ocean Panel
http://eprints.soton.ac.uk/20357/01/IOP_Impl_Plan.pdf

Challenges: Ship Time

Requirements:

- ≥ 140 days per year to maintain full array
- Must be available routinely and with regularity
- Assumes 1-year mooring design lifetime and annual servicing cruises

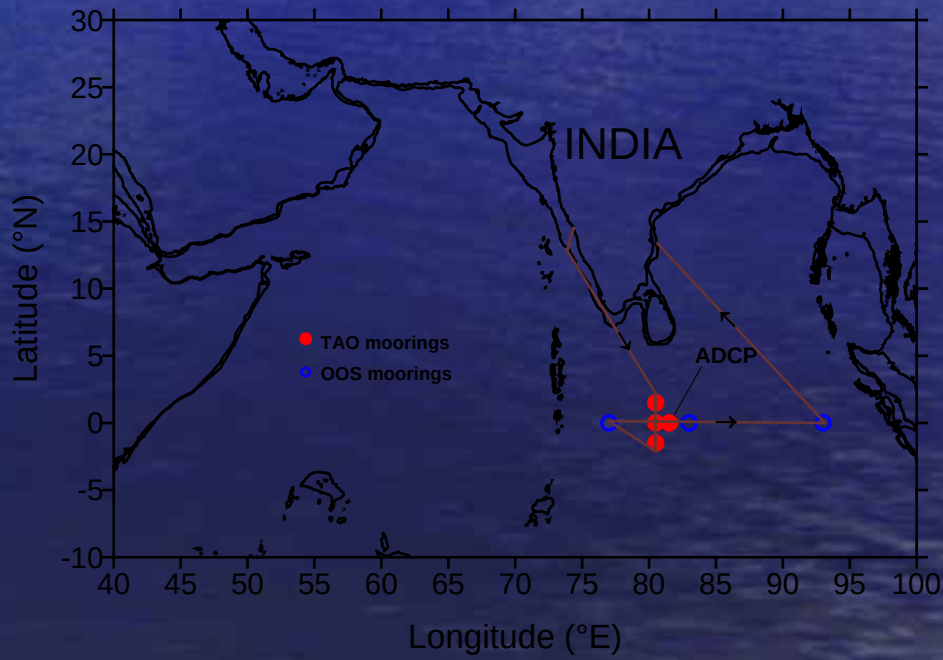


***Actual sea days in 2006: involves more than just mooring work**

India's Ministry of Earth Sciences (MoES)

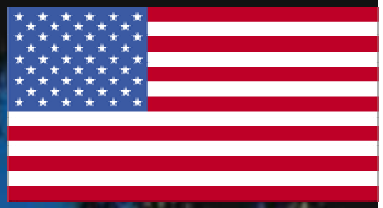
RV Sagar Kanya Cruise
October-November 2004, 2006, 2007

- National Institute for Oceanography (NIO) and NOAA-PMEL
- 3 ATLAS & 1 ADCP Mooring 1.5°S, 0°, 1.5°N along 80.5°E
- ATLAS enhanced with current meters, salinity, rainfall, SW; in addition, LW & atmospheric pressure on central mooring
- Expect to continue and expand with Indian (NIO, NIOT, DOD/NCAOR, etc) and other institutions.



Proposed locations of the PMEL TAO and ADCP moorings (red dots) along with the existing Indian OOS mooring locations (blue open circles). Also proposed are the hydrographic stations between 2°N and 2°S at 0.5° interval along 80.5°E.

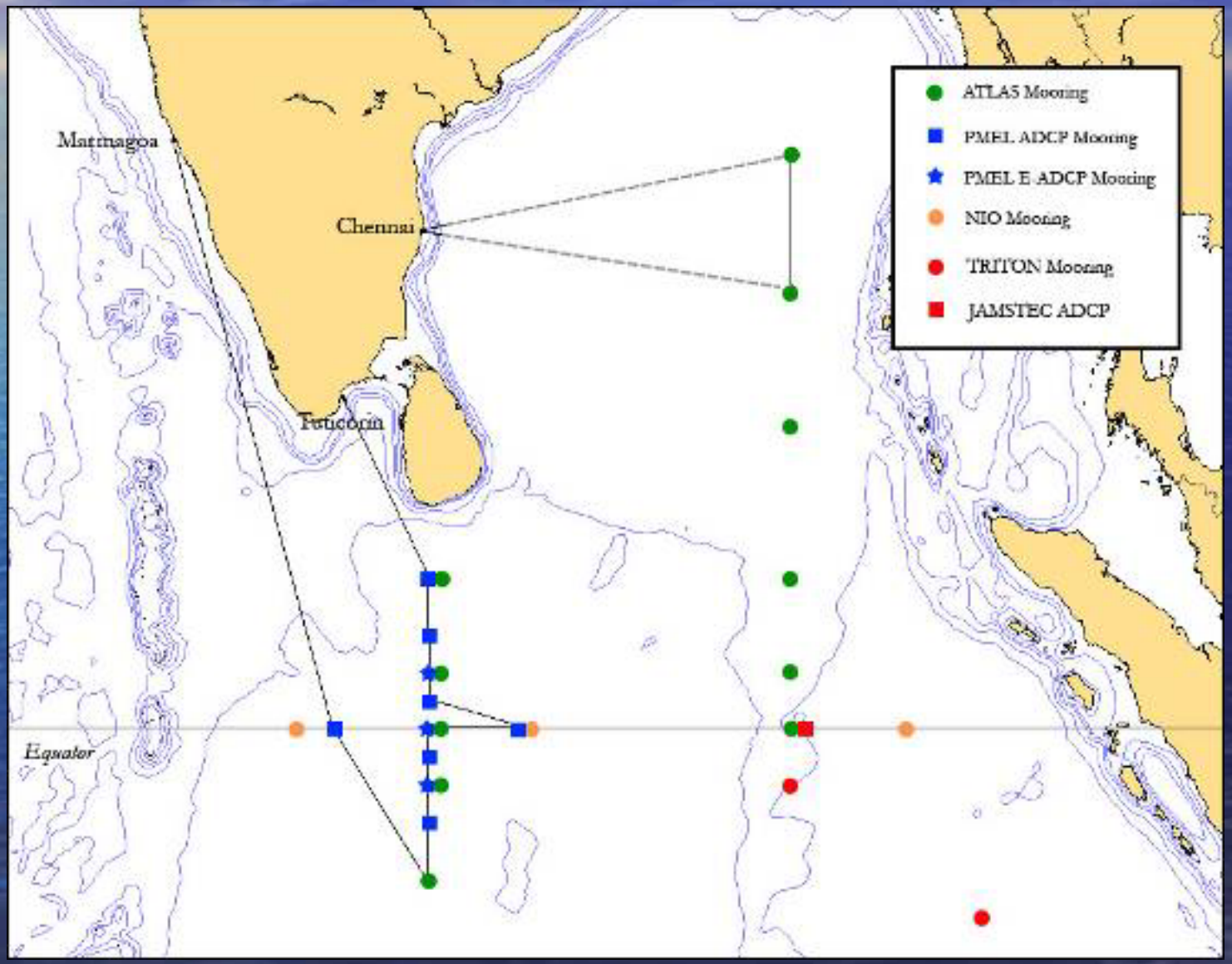
Goa India, Western Indian Ocean Workshop



Overview Of MoES-NOAA Partnership for Earth Observations and Earth Sciences

- Based on Science Drivers & Societal Applications
- Broad Memorandum of Understanding (MOU)
  - Purpose and Objectives
  - Scope of Cooperative Activities
- RAMA Implementing Arrangement (IA)
  - Responsibilities
  - Principals

Deployment Plan with Ministry of Earth Sciences for 2008

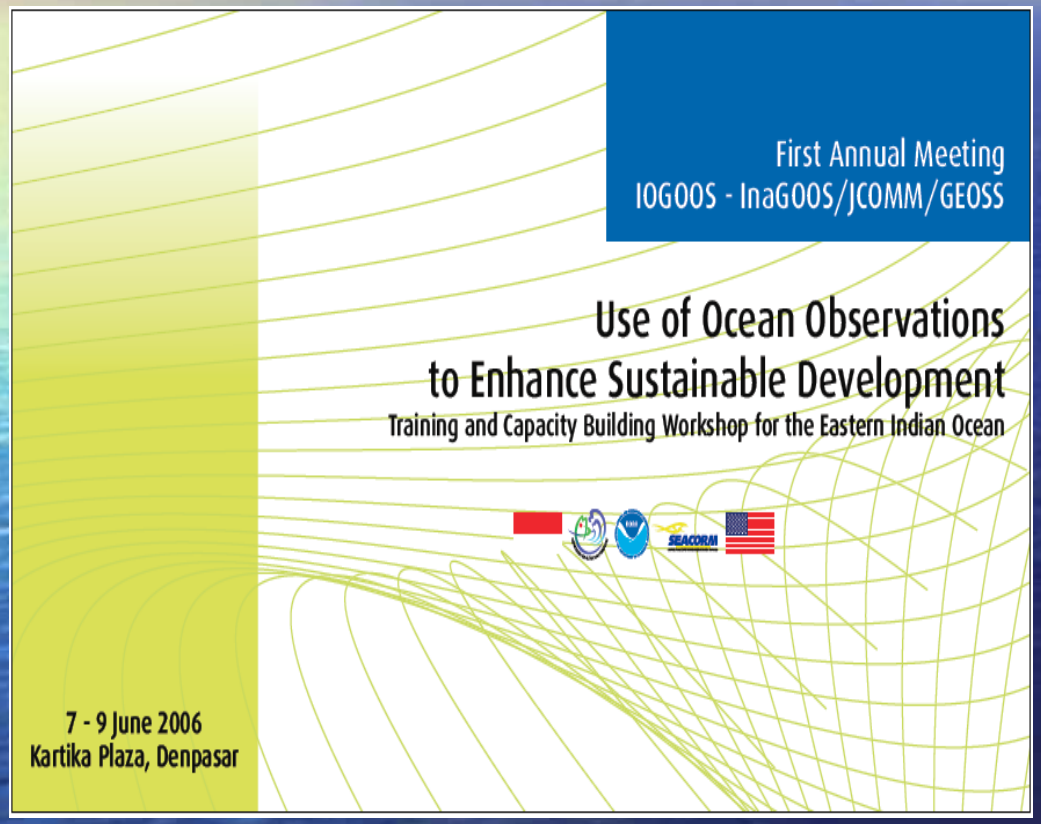


Indonesia's Ministry of Marine and Fisheries (DKP) and Agency for Assessment and Application of Technology (BPPT)

APEC Ocean Ministerial MEETING (AOMM-2) Bali, Indonesia September 2005

- 20 APEC Ocean Ministers Met in Kuta Bali
- “Our Coast, Our Ocean... an Action Plan for Sustainability”
- “Bali Action Plan”
- DKP-NOAA Ministerial Bilateral Discussions
- NOAA-DKP Letter of Intent Signed

Bali Indonesia PANGEA Workshop June 2006

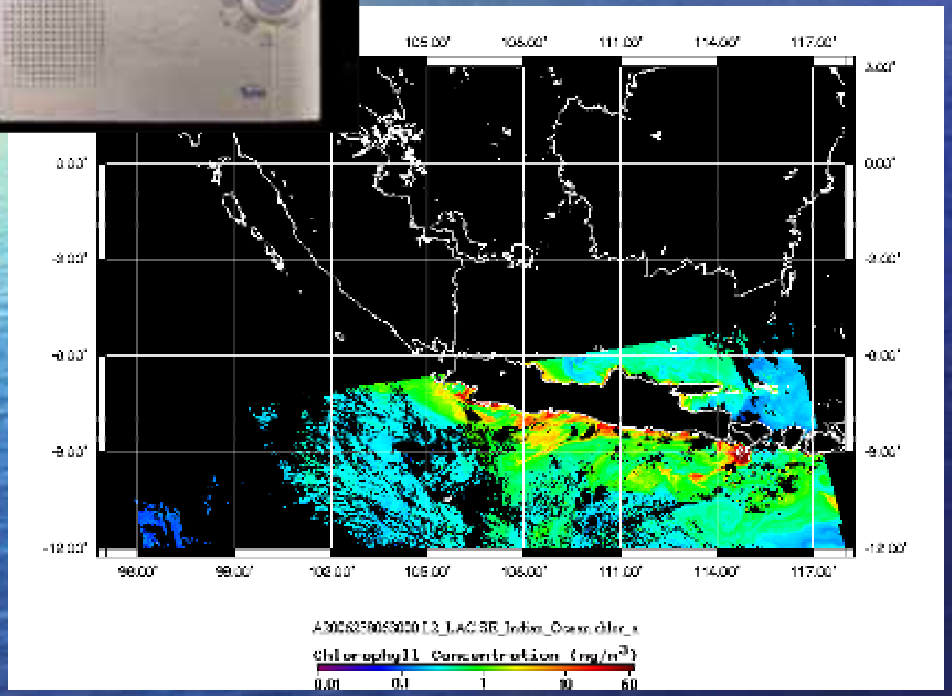


Bandung Indonesia September 2006

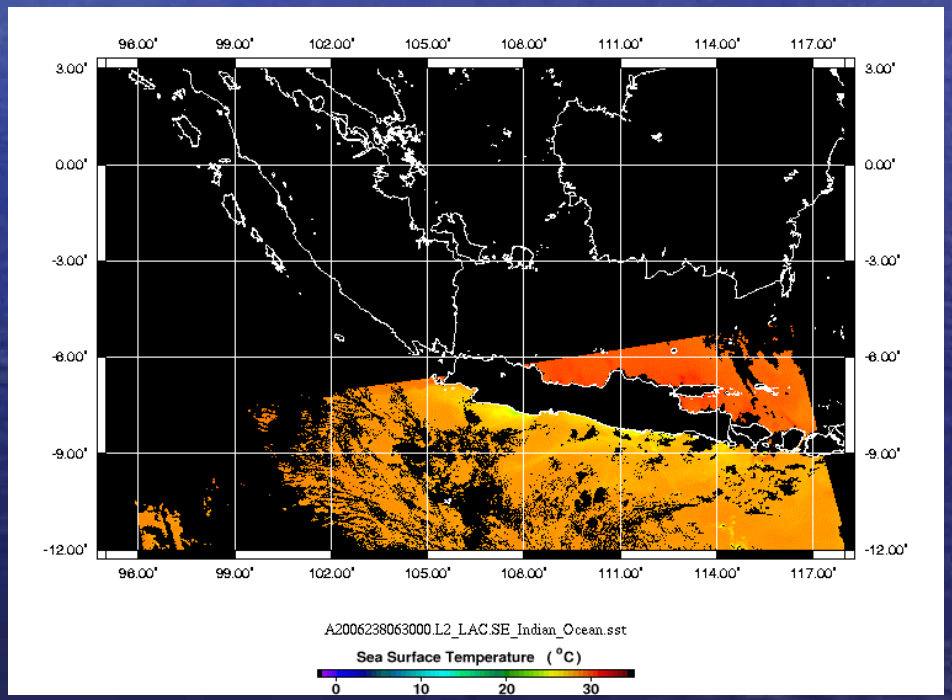
- Fisheries Applications of Ocean Data
- Modeling and Assimilation
- Bandung Institute of Technology

RANET Infrastructure Development Workshop Bali September 2007

Chlorophyll

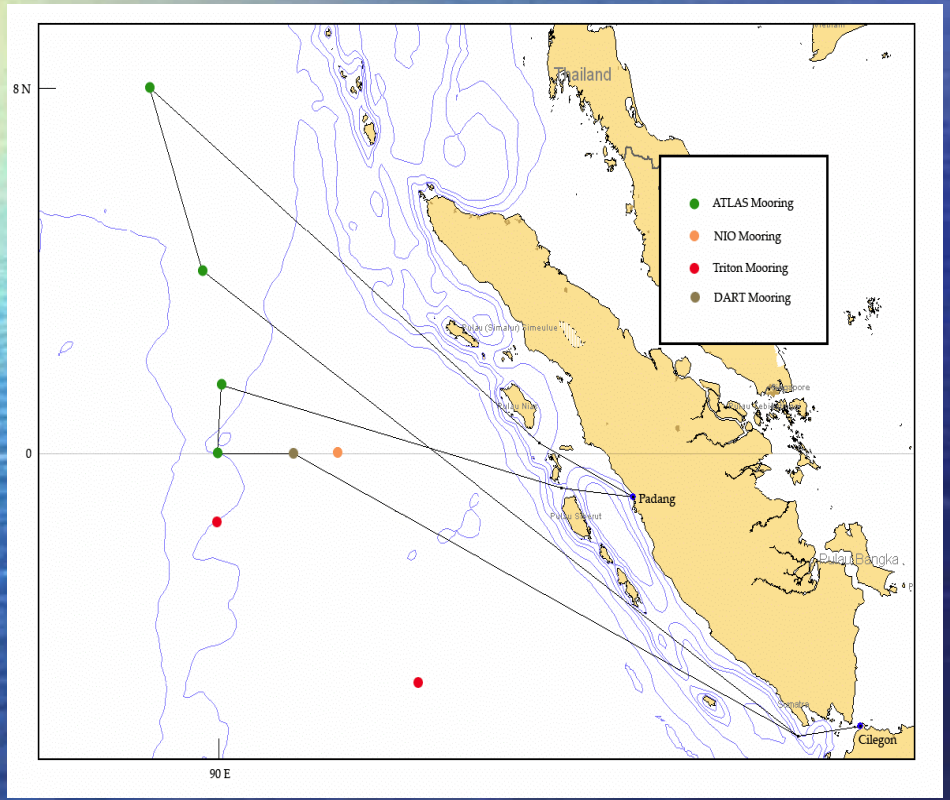


Sea Surface Temperature

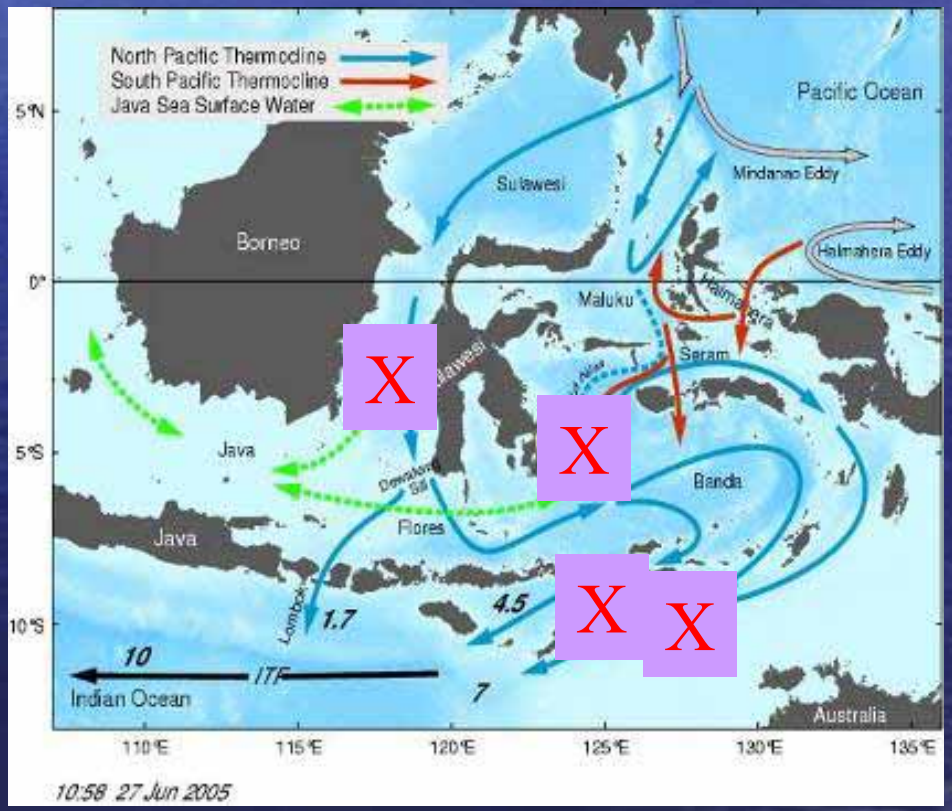


NOAA's 2008 Investment in Regional Ocean Observations

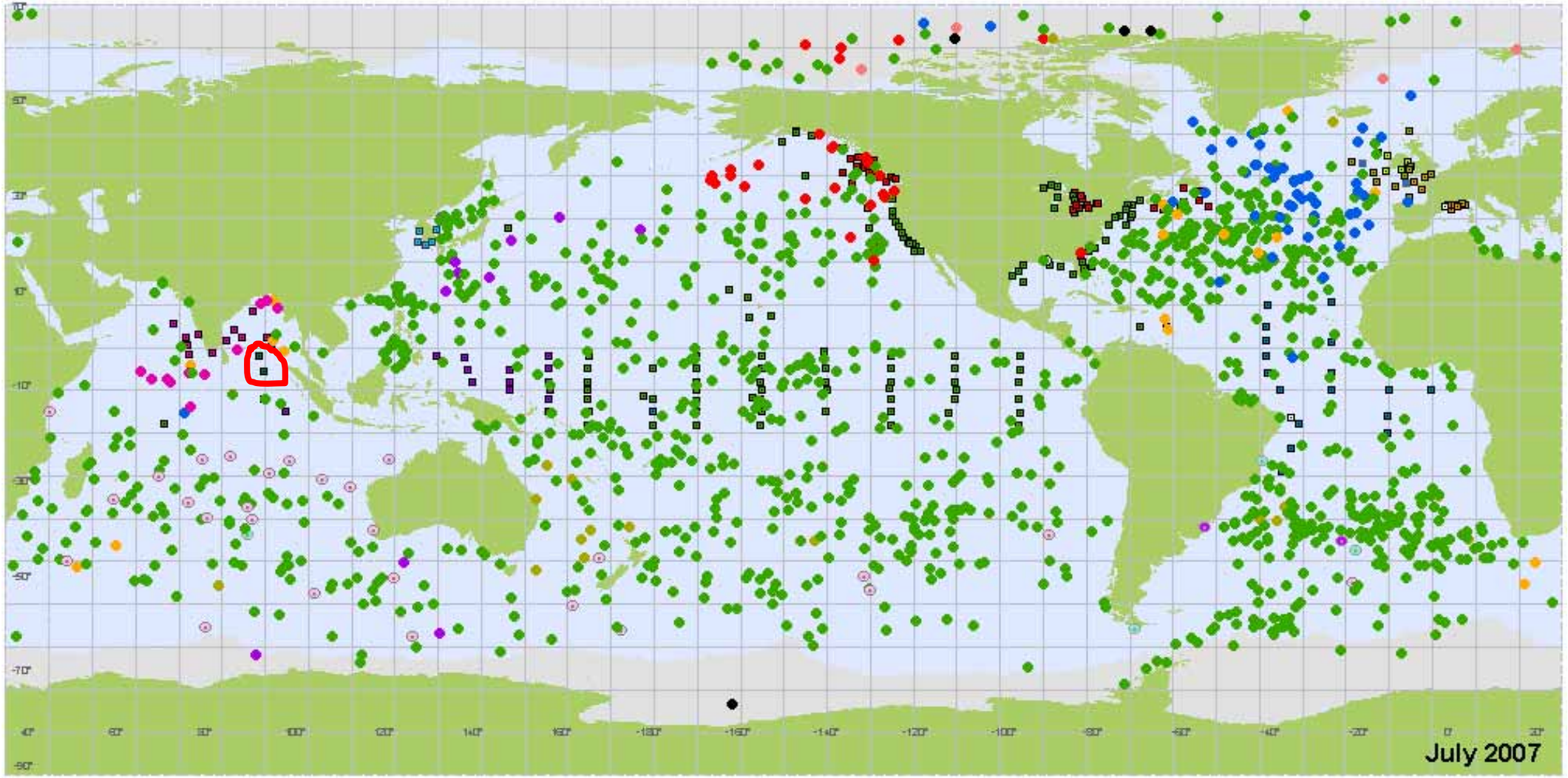
ATLAS Climate & DART Tsunami Moorings



Indonesian Throughflow Monitoring



US / Indonesia Moorings on JCOMMOPS WebSite

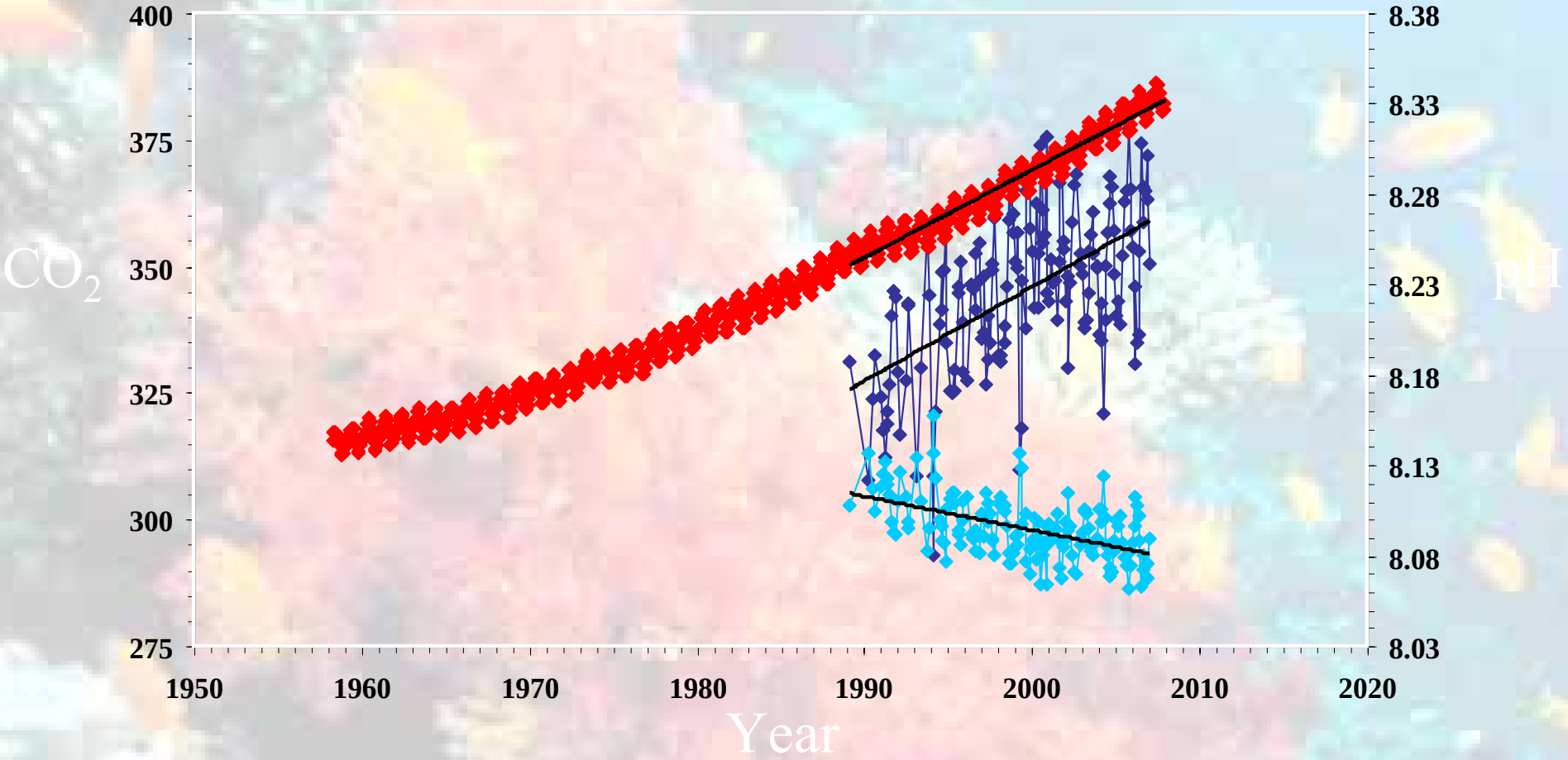


South Africa Weather Service

- Broached Partnership During IOP-4 in Pretoria April 2007
- Scoping Workshop November 2007

Ocean Acidification

Since the beginning of the industrial age, the pH and CO_2 chemistry of the oceans (ocean acidification) have been changing because of the uptake of anthropogenic CO_2 by the oceans. These changes in pH and carbonate chemistry may have serious impacts on open ocean and coastal marine ecosystems.

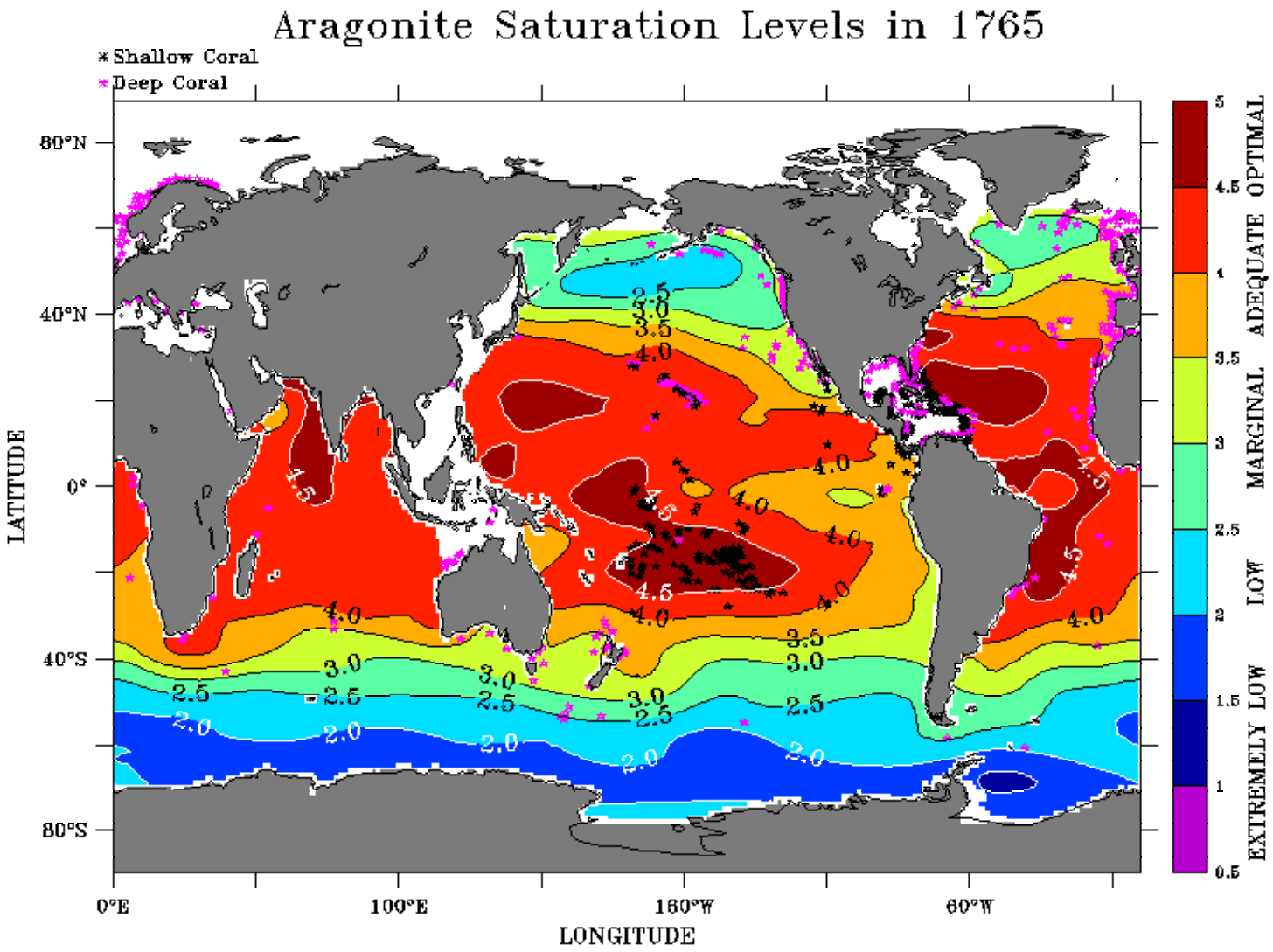


Predictions of Ocean Acidification and the effects on coral reef calcification

Coral Reef calcification

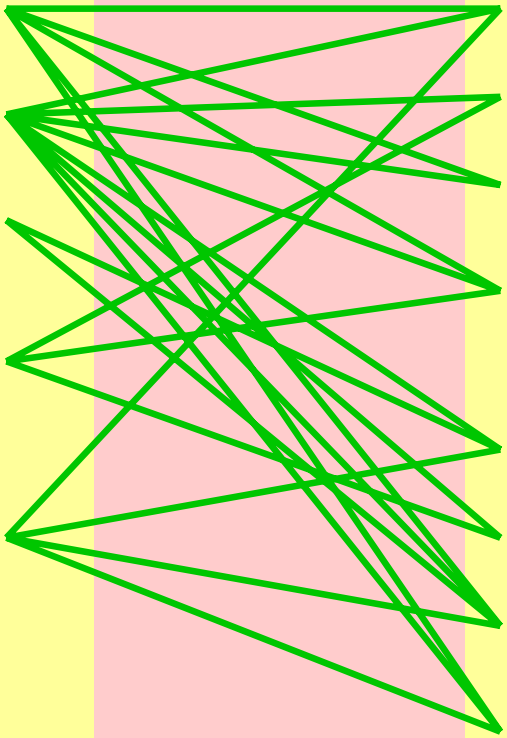
- 1765 **Adequate**
- 2000 **Marginal**
- 2100 **Low**

Calcification rates in the tropics may decrease by 30% over the next century

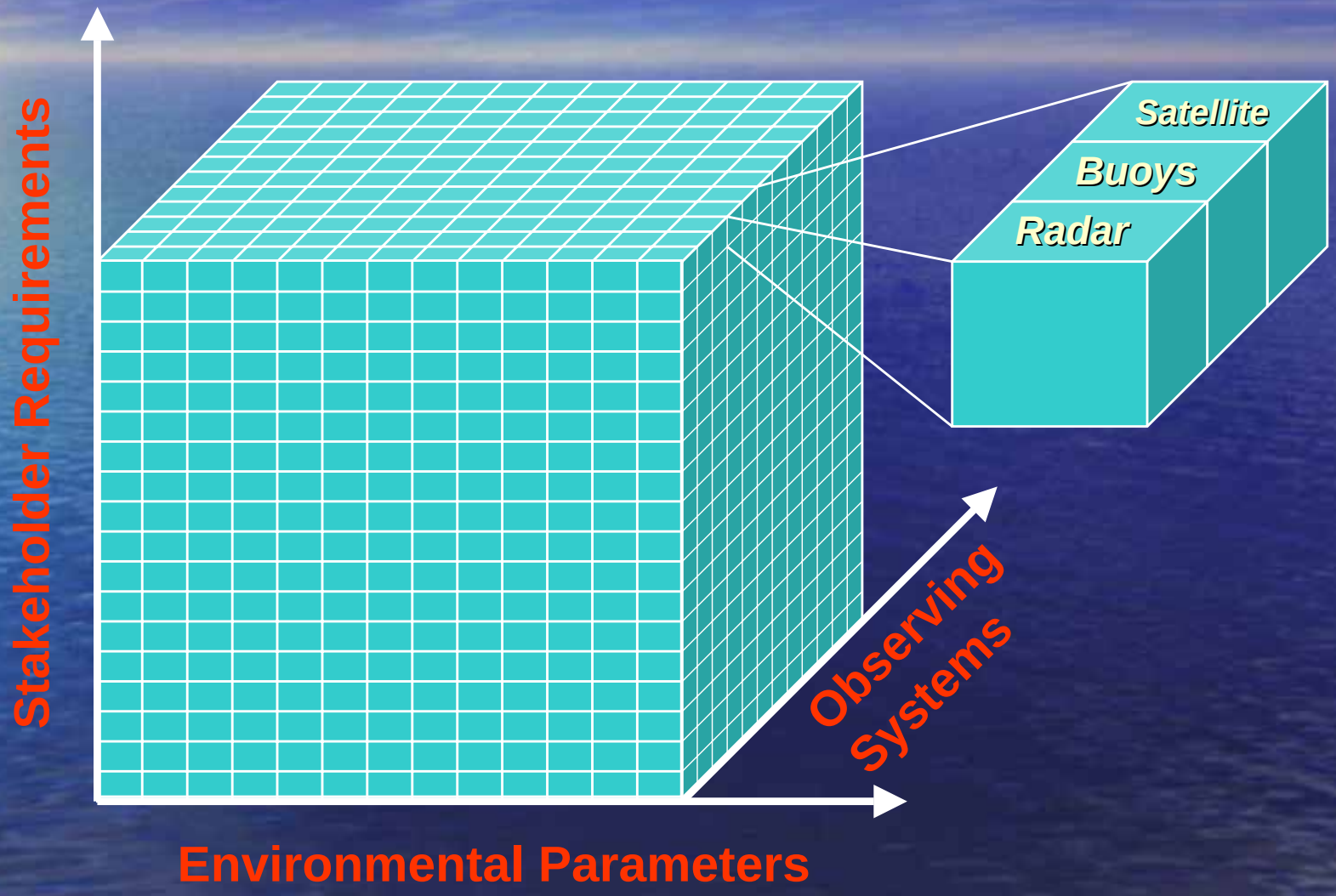


Observing System Challenges

NOAA Missions	Programs & Services (10's)	Observing Systems (~100)	Observing Parameters (100's)
❖ Monitoring & Prediction ❖ Stewardship	❖ Weather ❖ Climate ❖ Charting ❖ Fisheries Mgmt ❖ Homeland Security ❖ …		❖ Precipitation ❖ Ocean Salinity ❖ Solar Radiation ❖ Sea Surface Temperature ❖ Sea Height ❖ Stock Assessment ❖ Shoreline ❖ Aerosols ❖ …

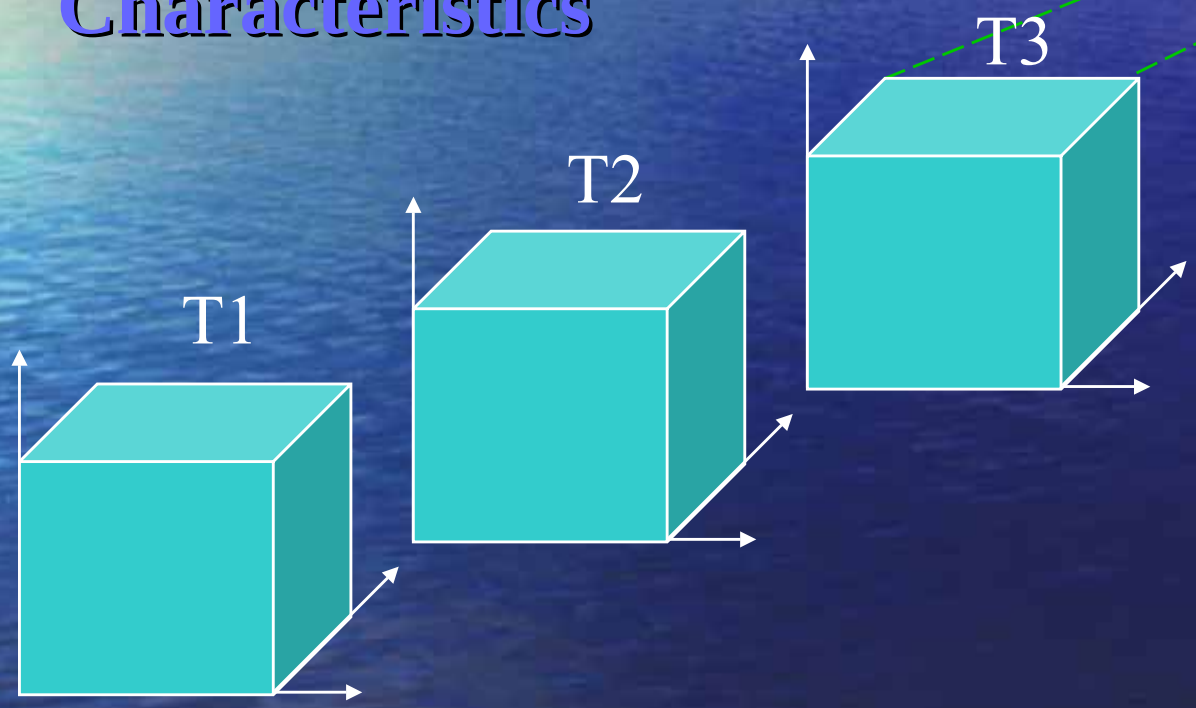


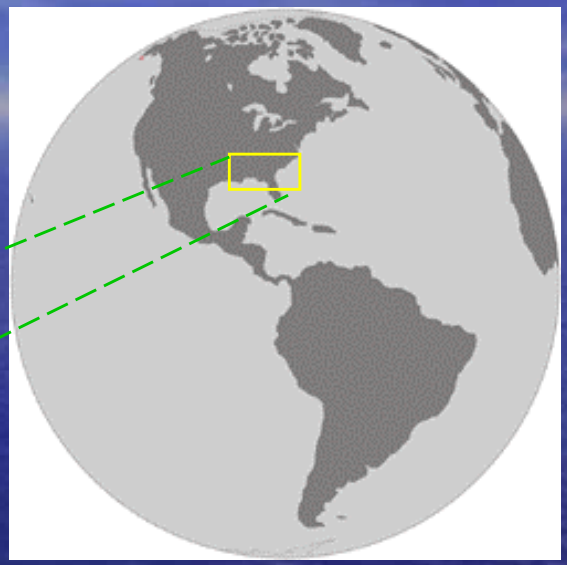
Multiple Dimensions of the Problem



Temporal & Geospatial Complexity

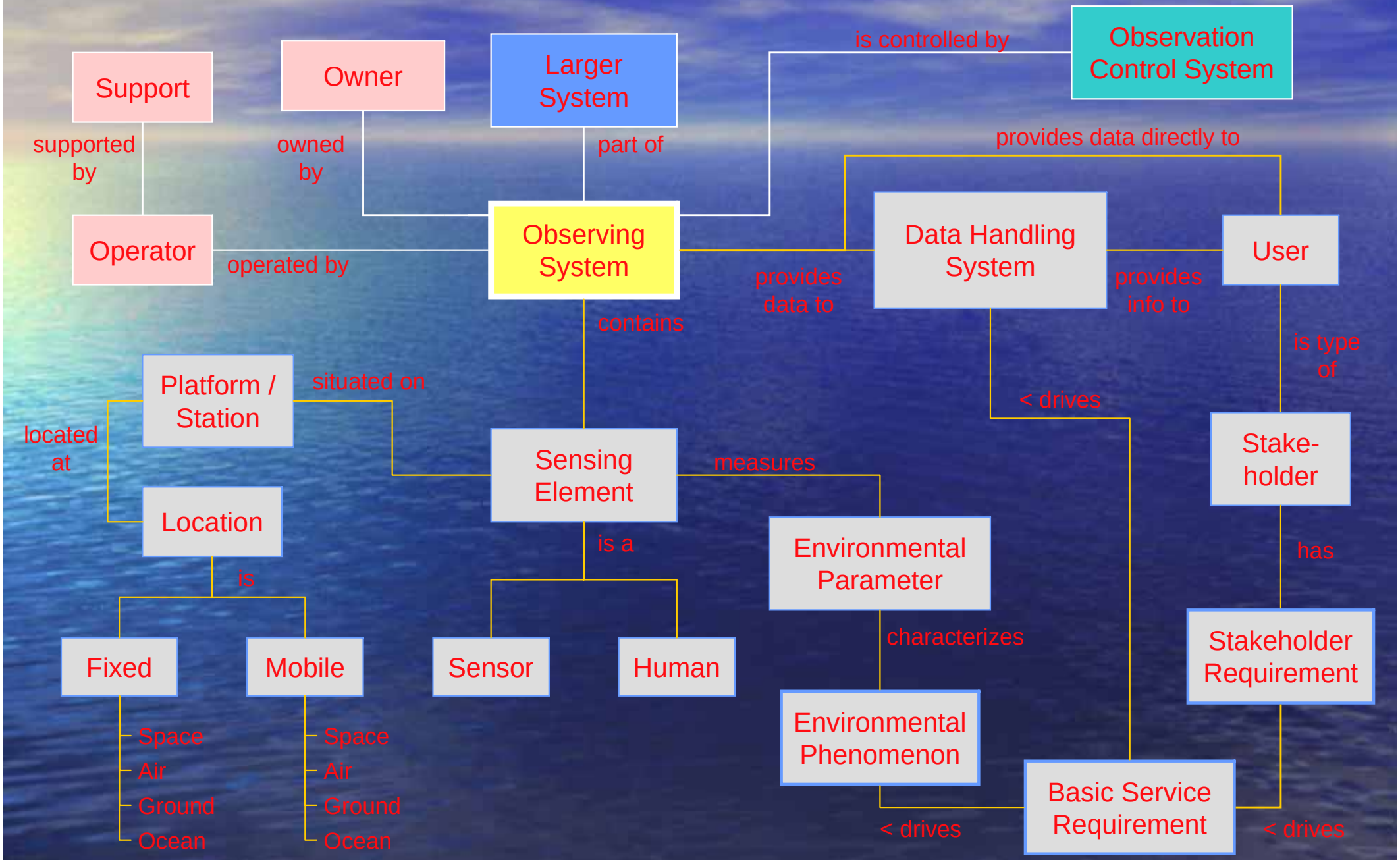
Temporal Characteristics





Geospatial Characteristics

The NOSA Conceptual Framework

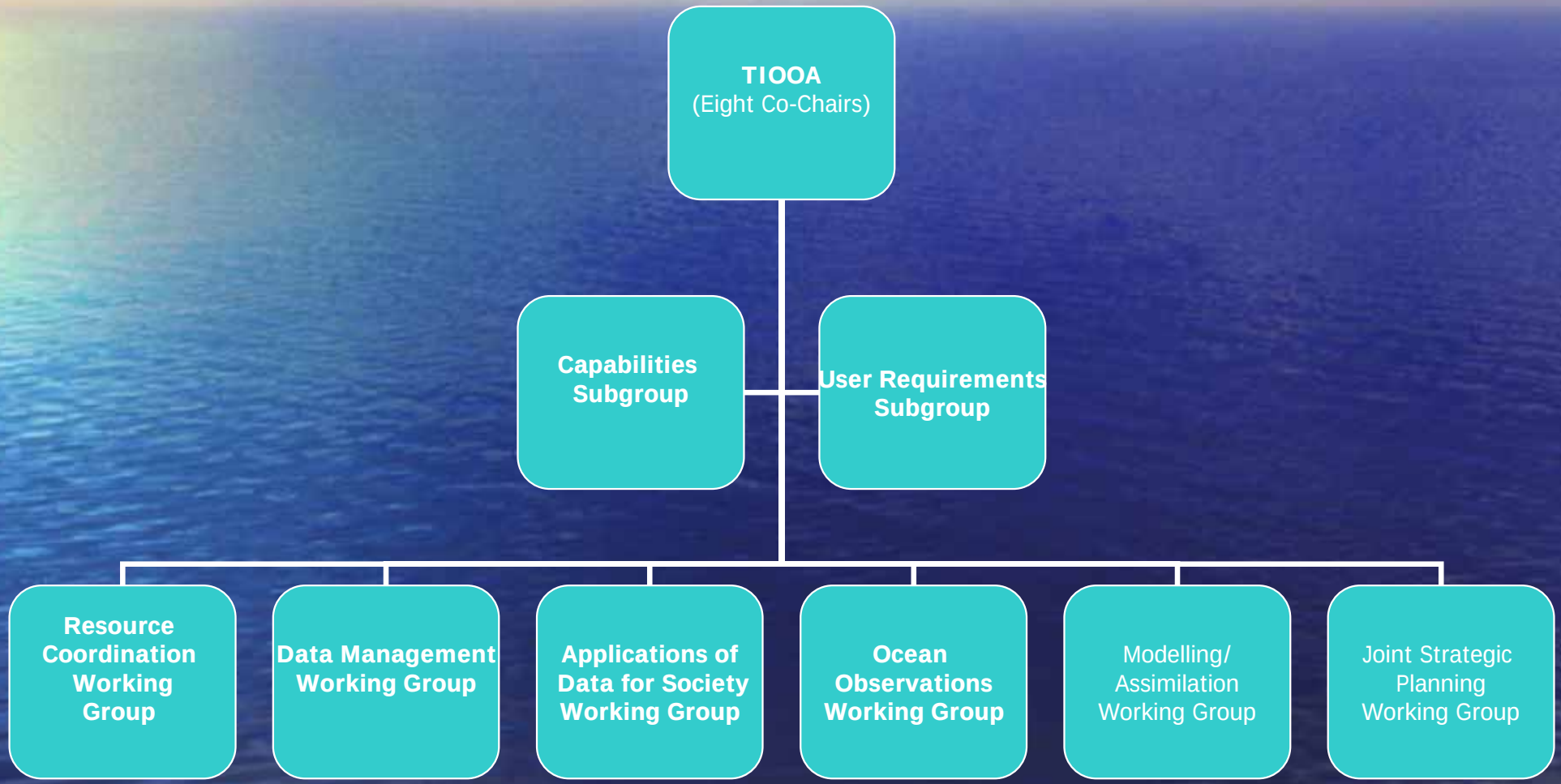


Prospectus: Enhanced Planning and Coordination of Ocean Observations are Needed for GEOSS Asia-Pacific Region

- Jointly Coordinate National Plans
- Assess User Requirements
- Assess Capabilities & Resources
- Coordinate Applications, Assimilation and Modelling
- Coordinate and Share Resources

“

“Pacific-Indian Ocean Observations for Applications”



Concluding Remarks

- Sustainable capacity building fosters both an increase in observations while developing the socio-economic applications of the data

- We have been successful in incorporating end-to-end observational data and information into GEOSS. Still, the observation data being collected today is just a fraction of what could be available through data sharing, collaboration, and leveraging each others' investments. We need to have vision.

Concluding Remarks

- The ocean/meteorological community is already the ambassador for enhanced integrated observing programs to save lives, protect property, and support sustainable development. We must now reach beyond our existing networks to health, tourism, agriculture and other ministries as ambassadors for achieving results for society across economic sectors and national boundaries.

- No one country can achieve GEO benefits alone. Thus, we ask that you reach out within your own country and with other countries to become participants in GEO.

Thank You

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