



# Partnerships for New GEOSS Applications in the Indian Ocean Region

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DBCX XXIV S&T Workshop  
Capetown, South Africa  
13 December 2008

# Presentation Overview

- Indian Ocean Science Drivers & Societal Applications
- RAMA & IndOOS Implementation
- Partnership Between India's Ministry of Earth Science (MoES) and NOAA
  - Purpose and Objectives
  - Scope of Cooperative Activities
  - RAMA Implementing Arrangement
- Partnership Between Indonesia's Ministry of Marine Affairs and Fisheries, Agency for the Assessment and Application of Technology (BPPT) and NOAA

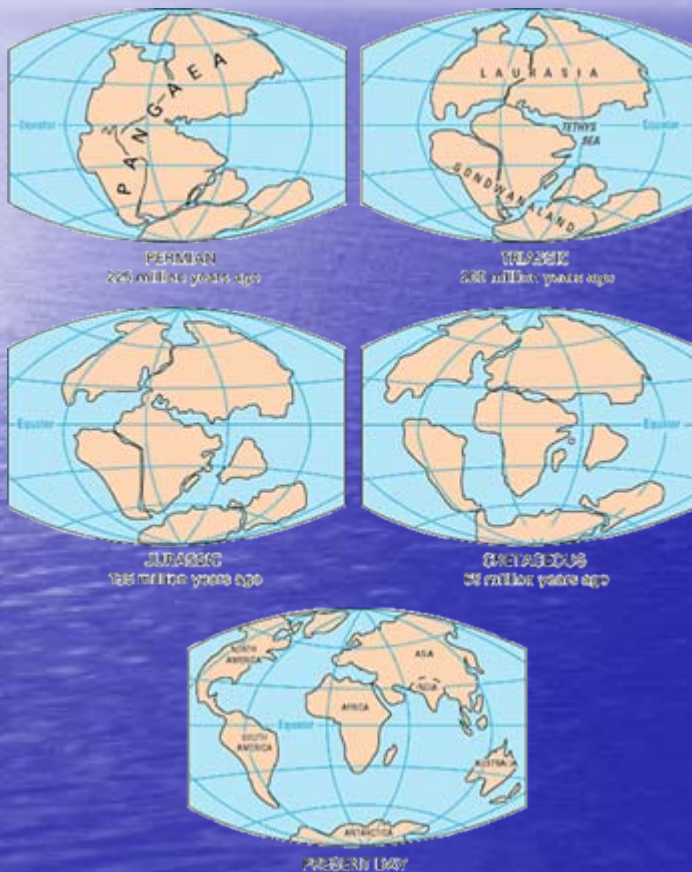
# International Partnerships are Central

*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.

# Partnerships for New GEOSS Applications (*PANGEA*)



- 230M Years ago the Super-continent PANGAEA Existed
- Reunite Met/Ocean Institutes to Increase in-situ Ocean Observations
- Demonstrate Socio-economic Applications of Ocean Data

## PANGEA Promotes the Use of Ocean Observations for Regional Socio-Economic Benefits Through:

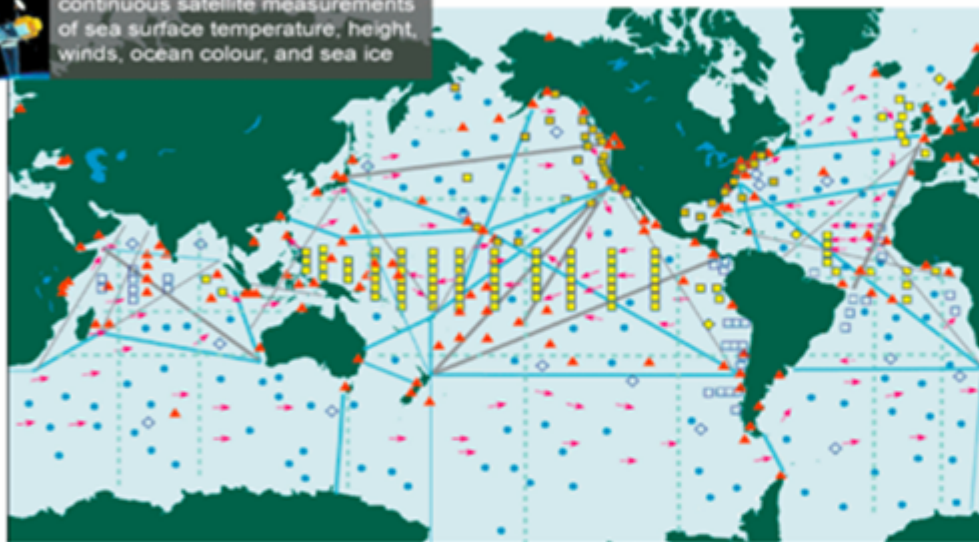
- Sharing required resources such as ship time and training between Partners,
  - Annual and repeatable training workshops conducted in exchange for annual sea days aboard PANGEA partner's ships for deployments and routine maintenance of ocean observations,
  - In-country practical applications training of ocean data provided to large and diverse groups of regional participants, rather than a few selected individuals traveling to a workshop far away,
  - Establishing New sources of ocean observational data by deploying new instruments,
  - Government Officials responsible for making policy and setting budgets are invited to participate in PANGEA workshops,
- 

# Initial Global Ocean Observing System for Climate

Status against the GCOS Implementation Plan and JCOMM targets

Total *in situ* networks **60%** May 2008

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



**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



**100%** 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%**

58 sites



**48%** Global reference mooring network

29 moorings planned



**79%** Global tropical moored buoy network

119 moorings planned

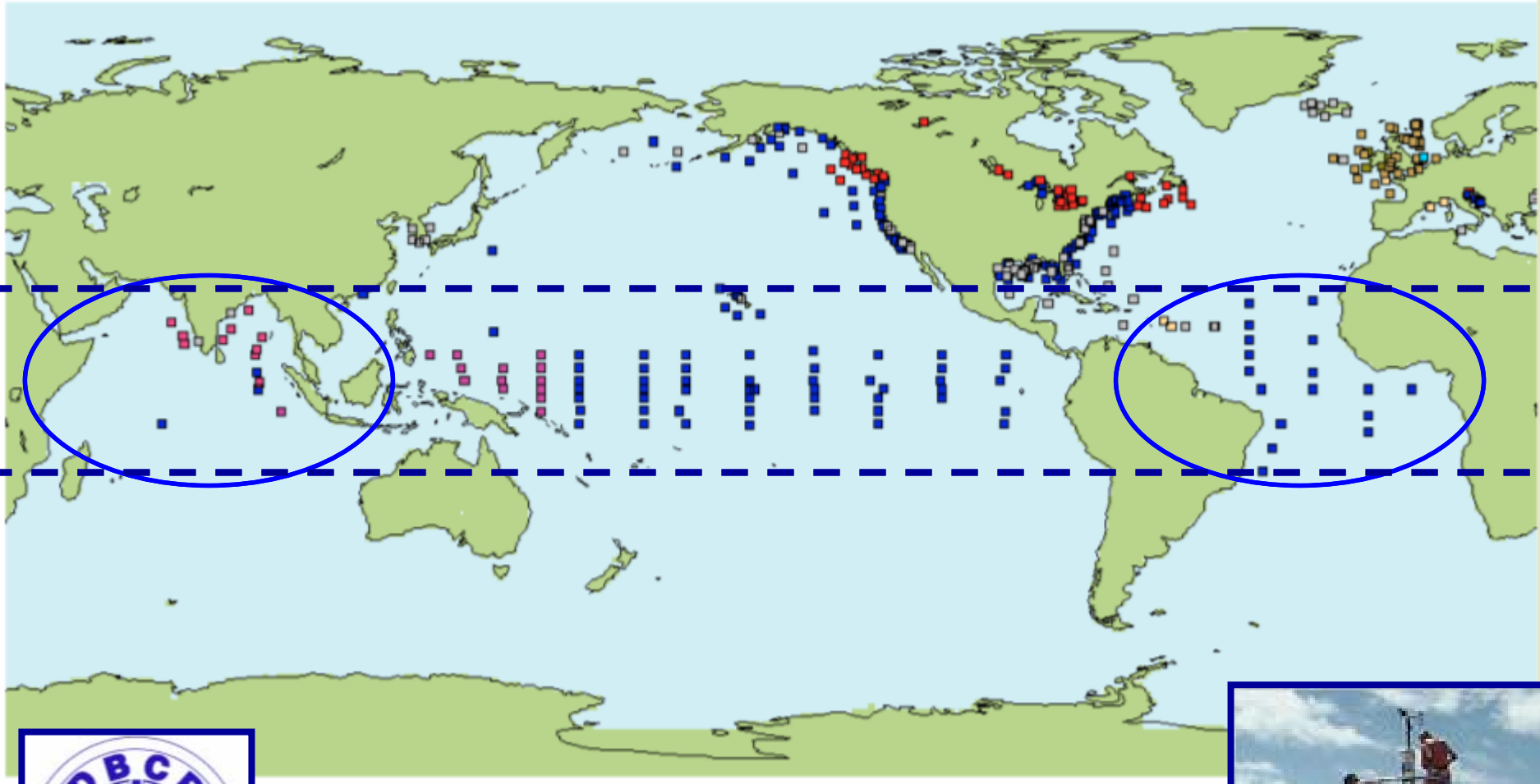


- A total of 7723 *in situ* platforms are maintained globally.
- Of these, 3860 are sponsored by NOAA.

# Tropical Moored Buoys

Date: 03-Oct-2007 00:00:00 to 03-Oct-2007 23:59:59

Platforms Reporting: 419  
Observations: 10714

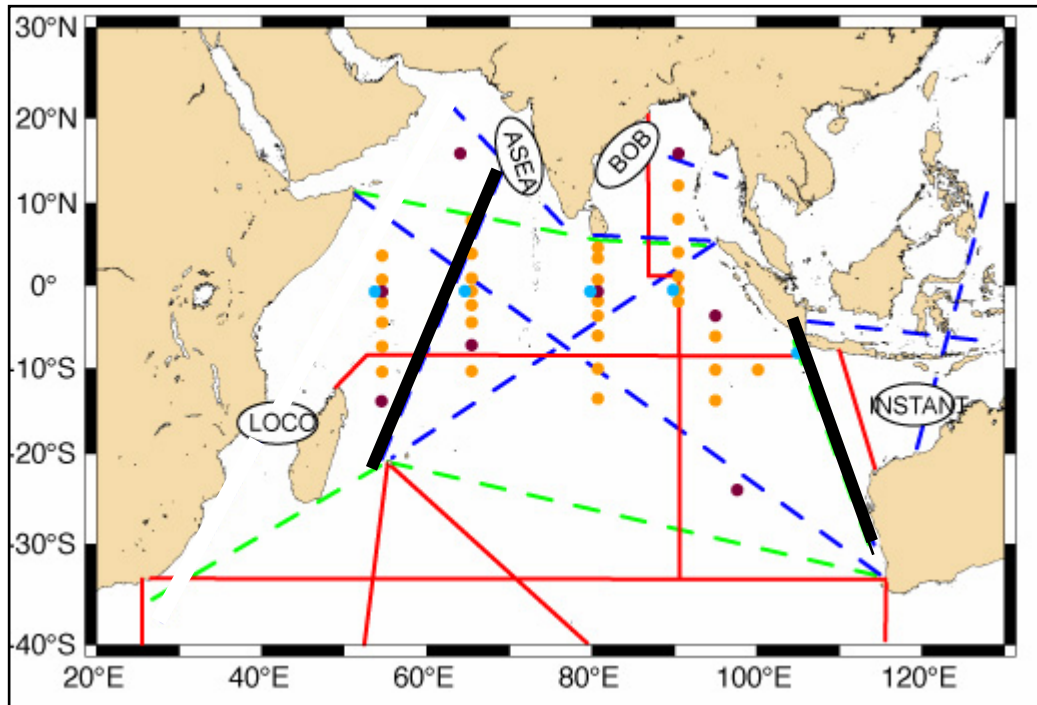


- TAO/TRITON sustained
- PIRATA Extensions implemented
- Indian Ocean RAMA being Implemented





# IOGOOS/CLIVAR Indian Ocean Observing System (IndOOS)



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

Mooring Array

Argo floats  $3^\circ \times 3^\circ$

Drifters  $5^\circ \times 5^\circ$

~20 real-time tide gauges for IOTWS

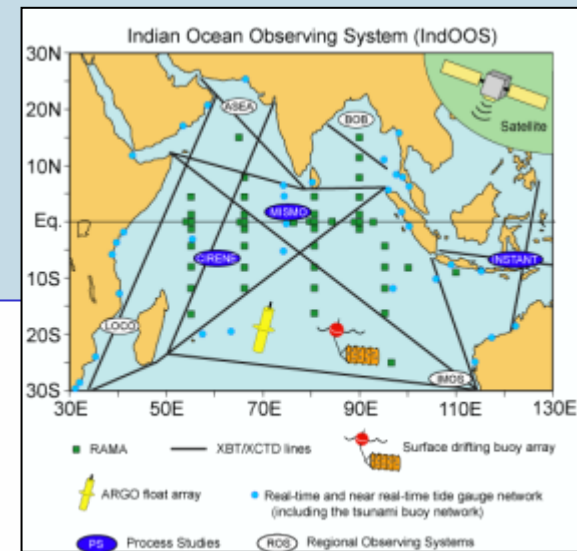
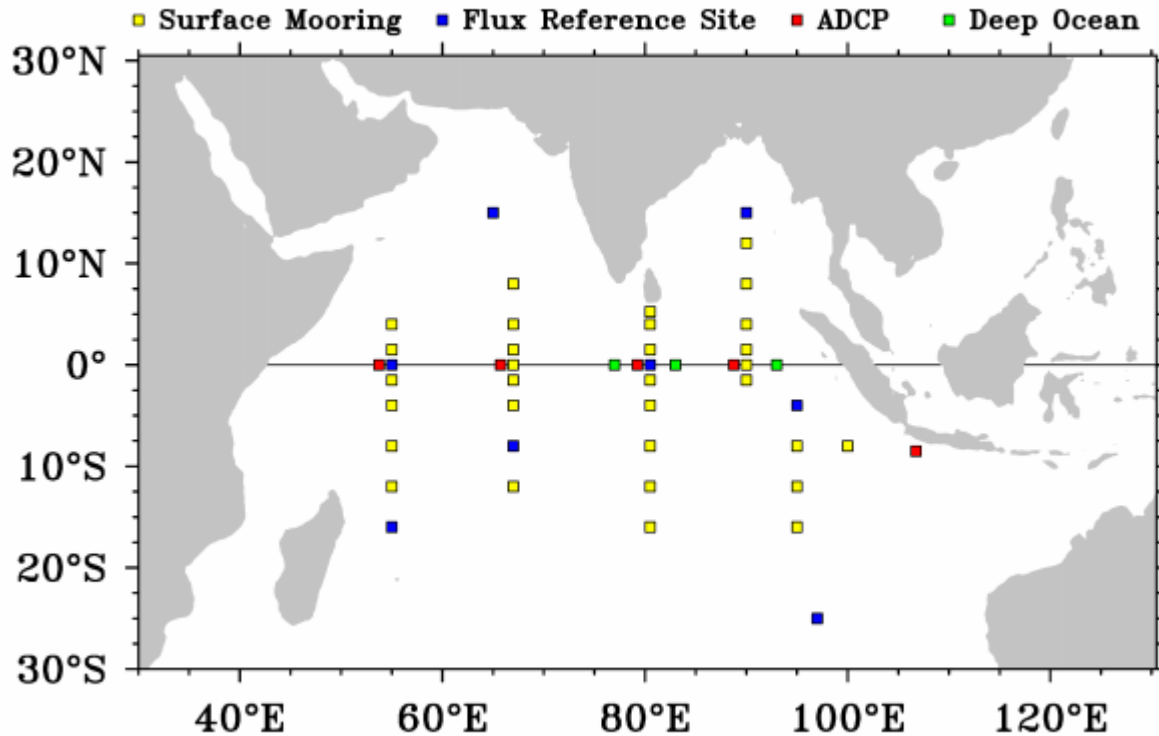
- Carbon/hydro cruise
- High density XBT
- Frequently repeated XBT

- Enhanced XBT lines to monitor Indonesian Throughflow, inflow to western boundary, Java upwelling and  $10^\circ\text{S}$  thermocline ridge
- Regional mooring arrays



# RAMA

## Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction (*RAMA*)



- Plan developed by the International CLIVAR/GOOS Indian Ocean Panel in 2004 as part of “IndOOS”
- Basin scale, upper ocean (~500 m) focus.
- Design supported by numerical model observing system simulation studies.



# International Objectives

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



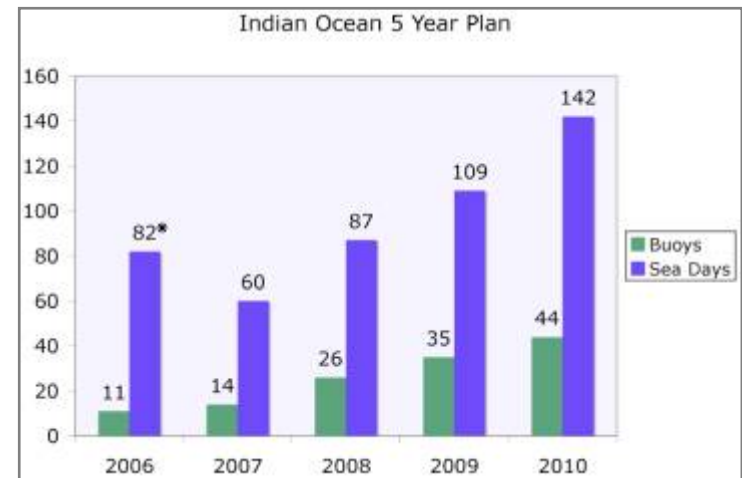


# Challenges: Ship Time



## Requirements:

- $\geq 140$  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**

# *Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction (RAMA)*

✓ *Motivation*

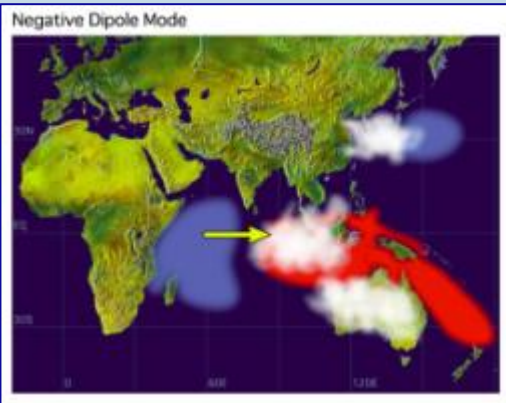
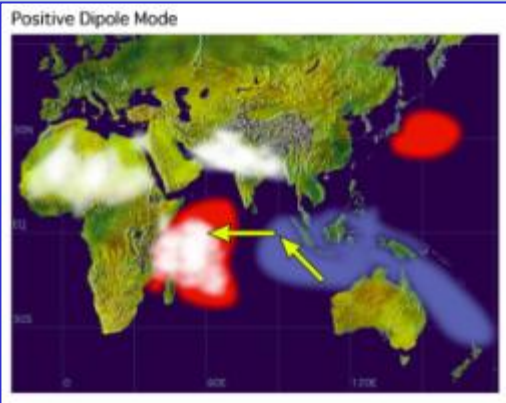
✓ *Design*

✓ *Status*

✓ *Plans*



# *Indian Ocean Climate Science Drivers*



*Indian Ocean Dipole*

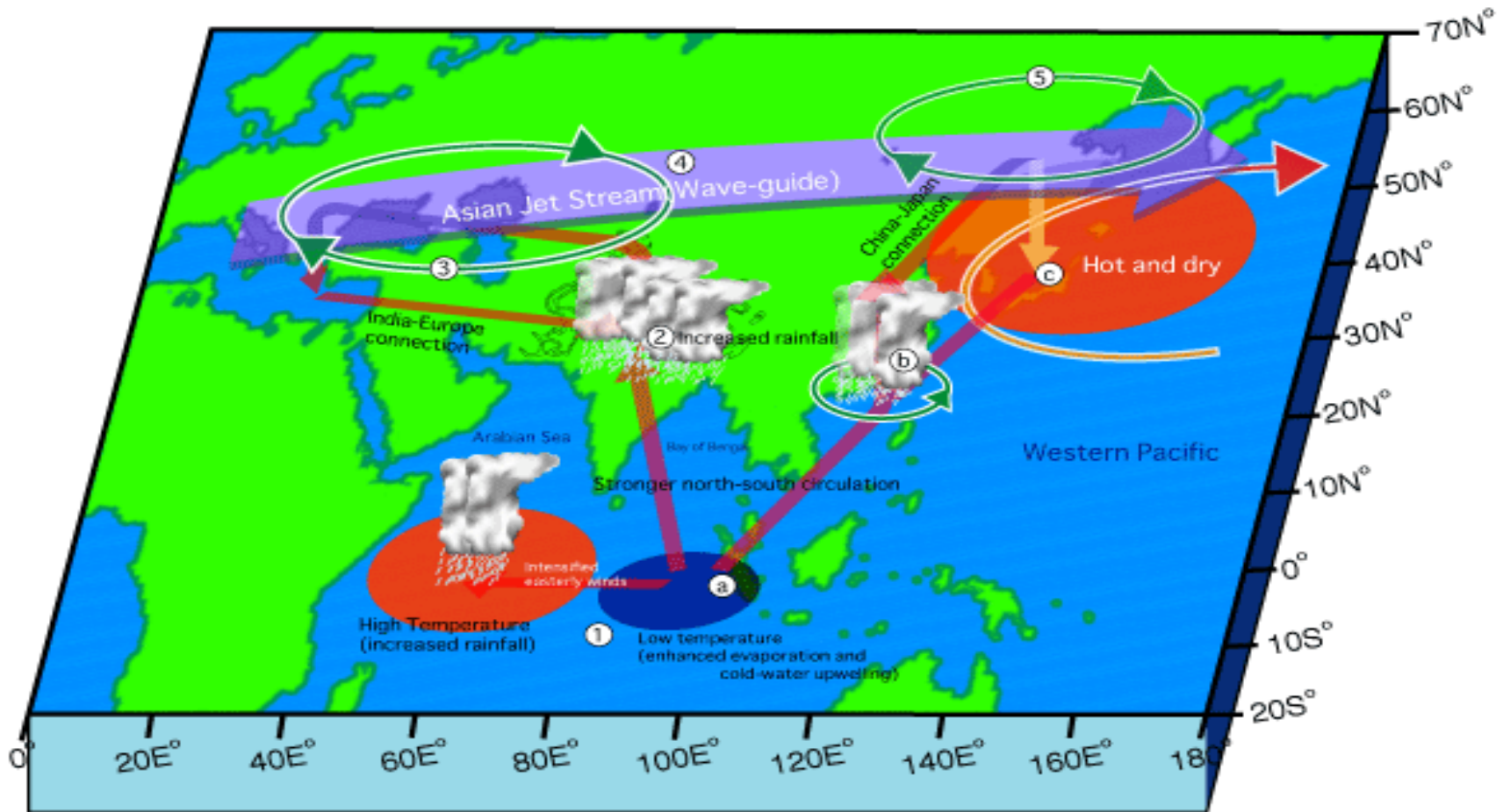
- Seasonal monsoons
- Cyclones and synoptic scale events
- Intraseasonal Madden Julian Oscillation ( $\Rightarrow$  ENSO, west coast US weather, hurricanes)
- Interannual variations: the Indian Ocean Dipole
- Decadal variability
- Warming trends since the 1970s
- Complex ocean circulation
- Poorly understood biogeochemistry





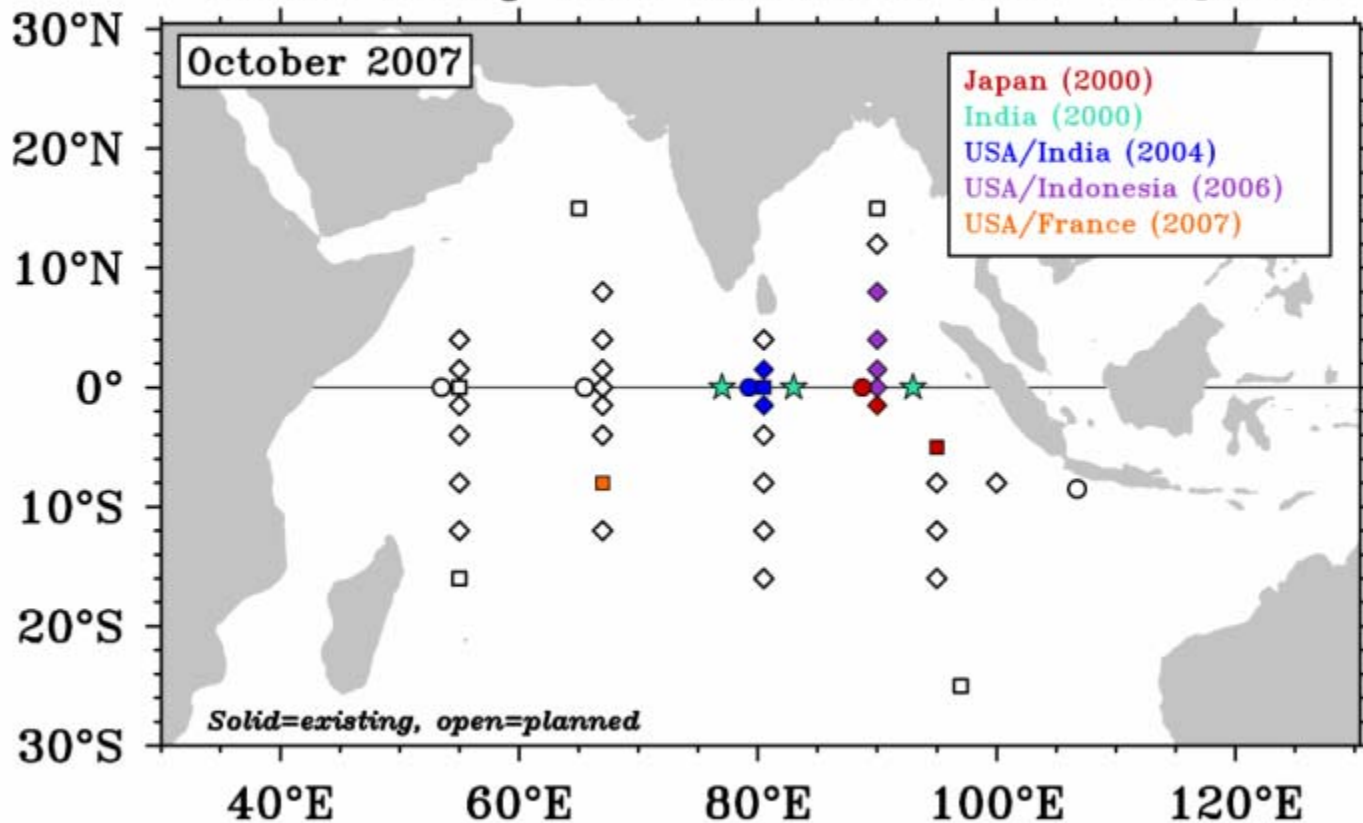
# A Schematic Diagram of the IOD Influence on the Summer Conditions in the Northern Hemisphere

## ダイポールモードとそのテレコネクションの三角関係



# Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction (*RAMA*)

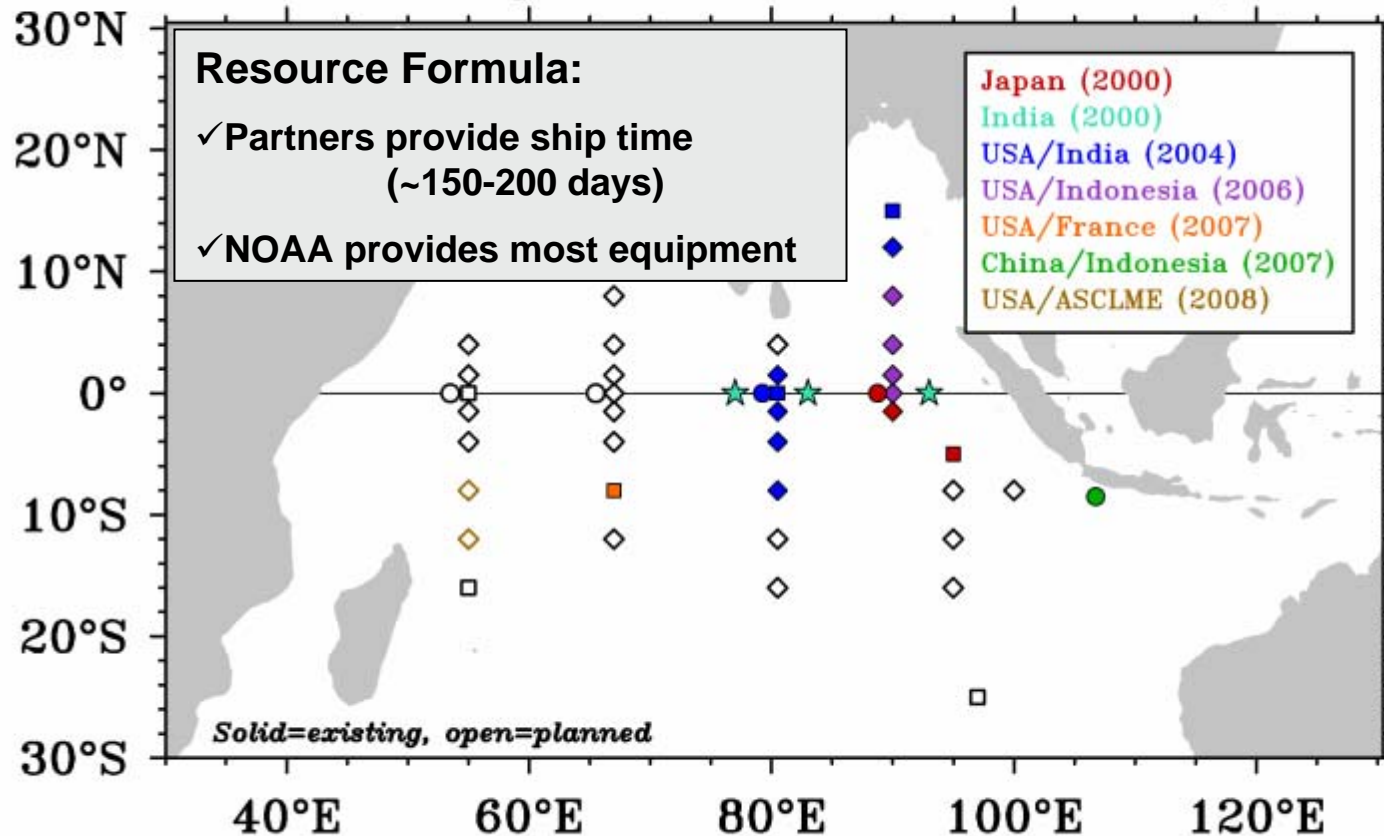
◆ Surface Mooring    ■ Flux Reference Site    ● ADCP    ★ Deep Ocean



# RAMA: Present Status

## Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction (*RAMA*)

◆ Surface Mooring   ■ Flux Reference Site   ● ADCP   ★ Deep Ocean

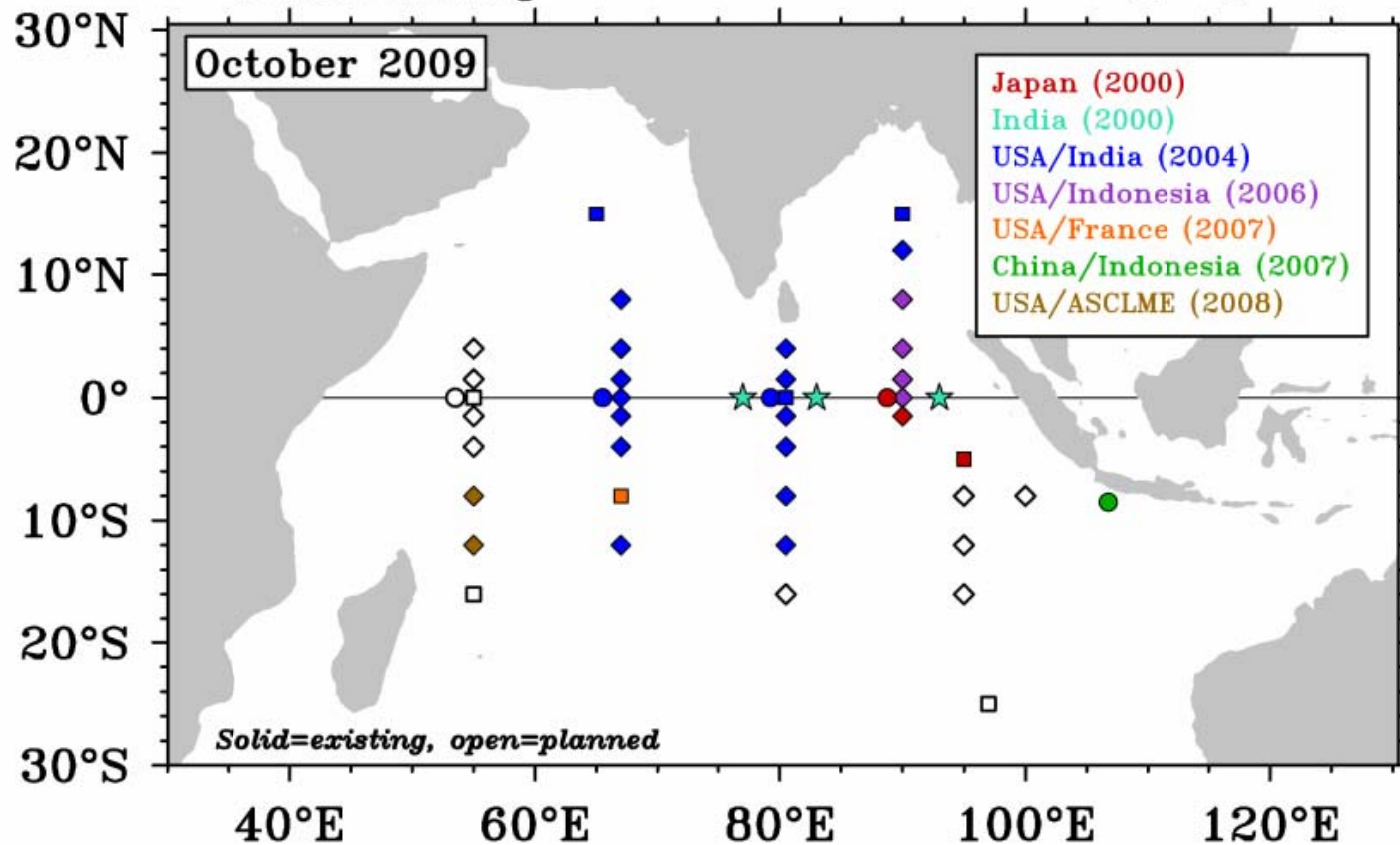


47% of sites occupied by end of 2008 (22 of 46)



# Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction (*RAMA*)

◆ Surface Mooring   ■ Flux Reference Site   ● ADCP   ★ Deep Ocean



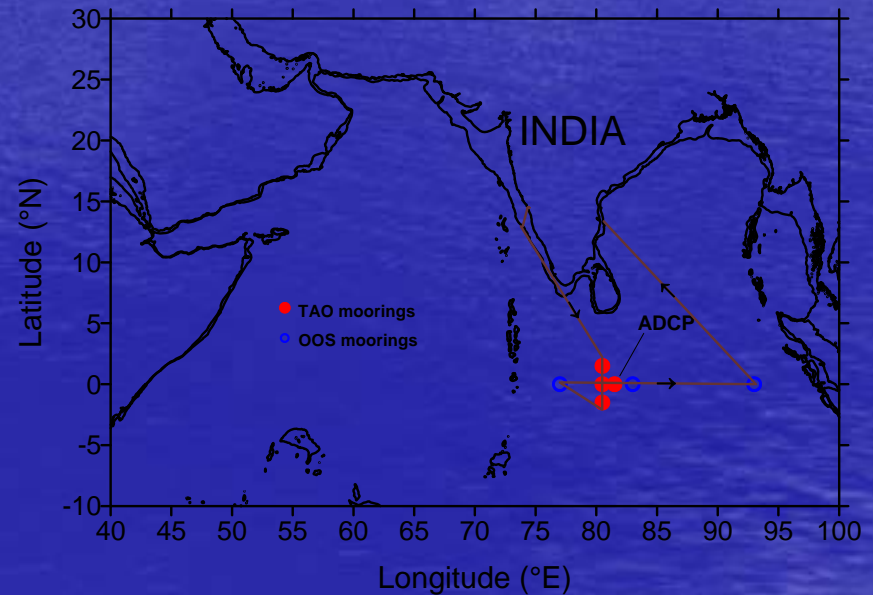


***India (MoES) and the U.S. (NOAA)***

# RV Sagar Kanya Cruise

## October-November 2004, 2006

- 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.

# India Ministry of Earth Sciences – NOAA Science Colloquium



- 15 Member USA Delegation
- CPO, OAR, NESDIS, PMEL, GFDL, ESTH ESRL, NCEP/CPC, NWS
- International Research Institute for Climate and Society (IRI)



# A Broad Portfolio of Implementing Agreements Are Underway



1. *Collaboration towards Development of the IndOOS Moored Buoy Array for Improving Weather and Monsoon Forecasts 1 July 2007 to 31 June 2012: PMEL - INCOIS*
2. *South Asian Regional Reanalysis (SARR): U MD - NCMRWF*
3. *Climate Monitoring and Prediction System for the South Asian Region: NCC - CPC*
4. *Climate Model and Ocean Assimilation Analyses for the Indian Ocean Region: NCC - GFDL*
5. *Preparation for SST Retrievals from INSAT-3D: NESDIS - IMD*
6. *Collaboration on GreenHouse Gas Monitoring: NOAA Earth System Research Laboratory (ESRL) - IMD*

# Signing MoES-NOAA Implementing Agreements





# MoES – NOAA RAMA Implementing Arrangement (IA)



- NOAA agrees to:
  - Provide all mooring instrumentation and hardware for the deployment of NOAA subsurface ADCP and surface ATLAS moorings,
  - Provide training of MoES personnel in mooring deployment and recovery onboard MoES Research Vessel,
  - Provide data processing and quality control,
  - Display and disseminate data telemetered in real-time data from surface moorings on a public web site. The data will be made available to INCOIS in near real time,
  - Provide delayed-mode data to research partners within 6 months of mooring recovery,



# MoES – NOAA RAMA Implementing Arrangement

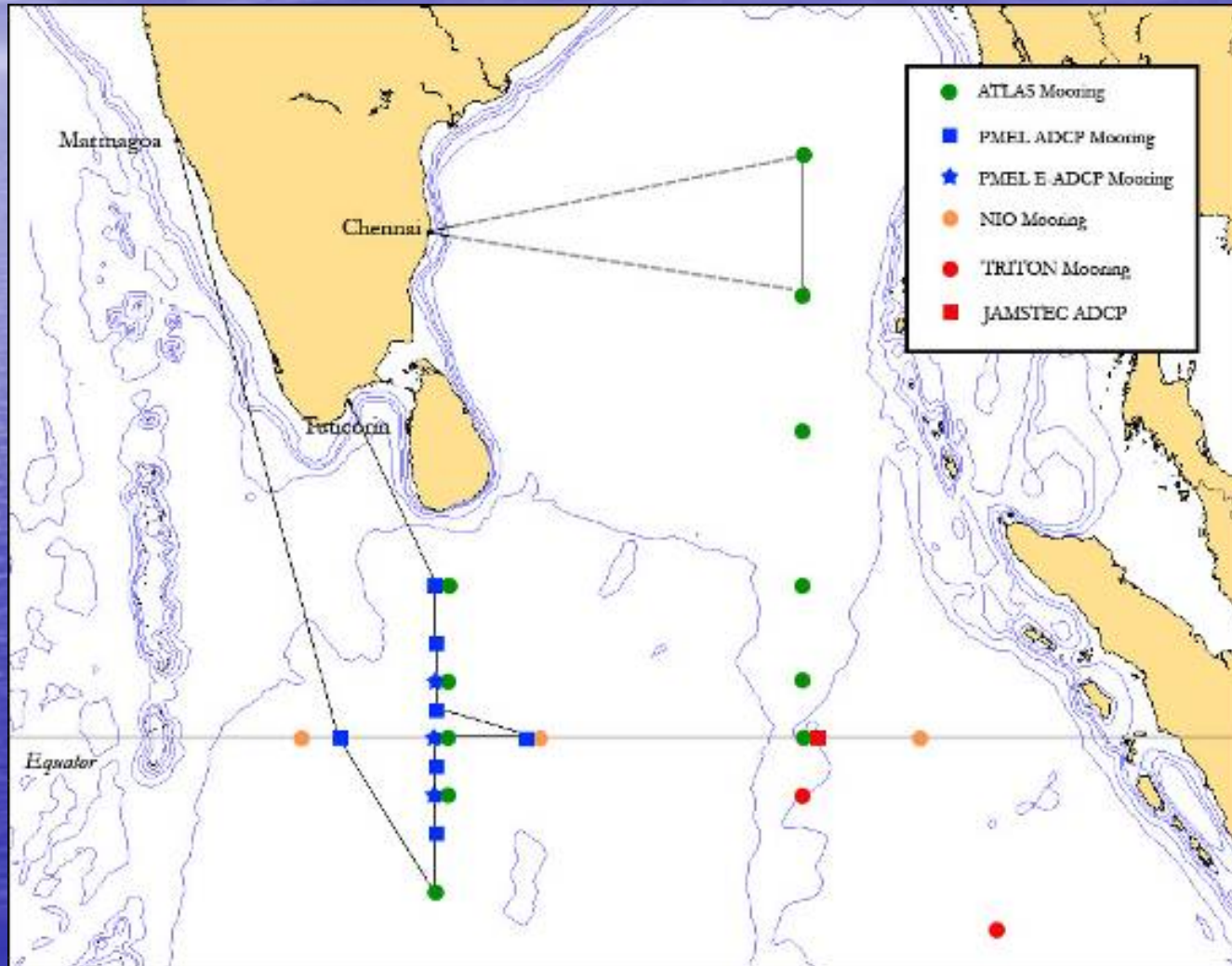
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- Ministry of Earth Sciences agrees to:
  - Provide 60 Days at Sea per year on a research vessel equipped to deploy, recover and repair deep ocean (up to 6000 m) surface and subsurface moorings.
  - Conduct detailed bathymetric surveys at mooring sites before deployments,
  - Provide ship personnel for technical and deck support during mooring operations,
  - Provide high quality meteorological (wind speed and direction, air temperature, relative humidity, rainfall, short and long wave radiation, and barometric pressure) and oceanographic (CTD to 1000 m) measurements from the research vessel when near the mooring sites,



# Deployment Plan with Ministry of Earth Sciences for 2008

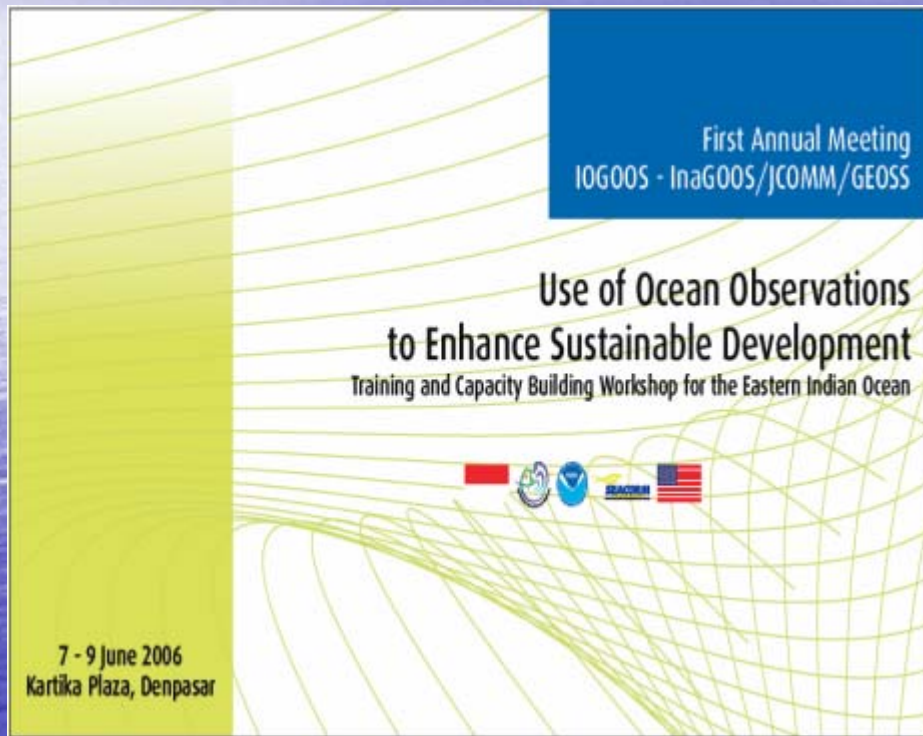


# Indonesia's Ministry of Marine and Fisheries (DKP) and Agency for Assessment and Application of Technology (BPPT)



# Bali Indonesia PANGEA Workshop

## June 2006



# Bandung Indonesia September 2006

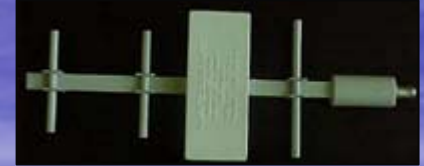
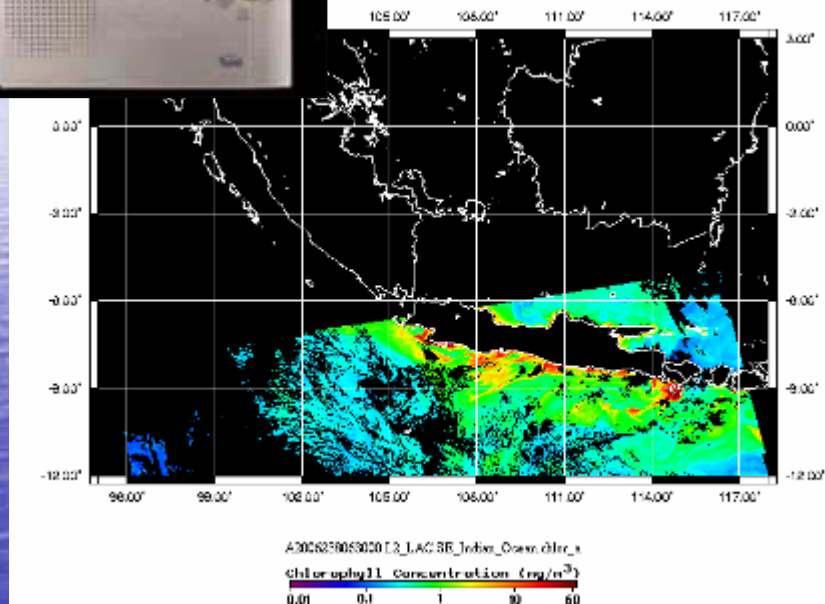


- Fisheries Applications of Ocean Data
- Modeling and Assimilation
- Bandung Institute of Technology

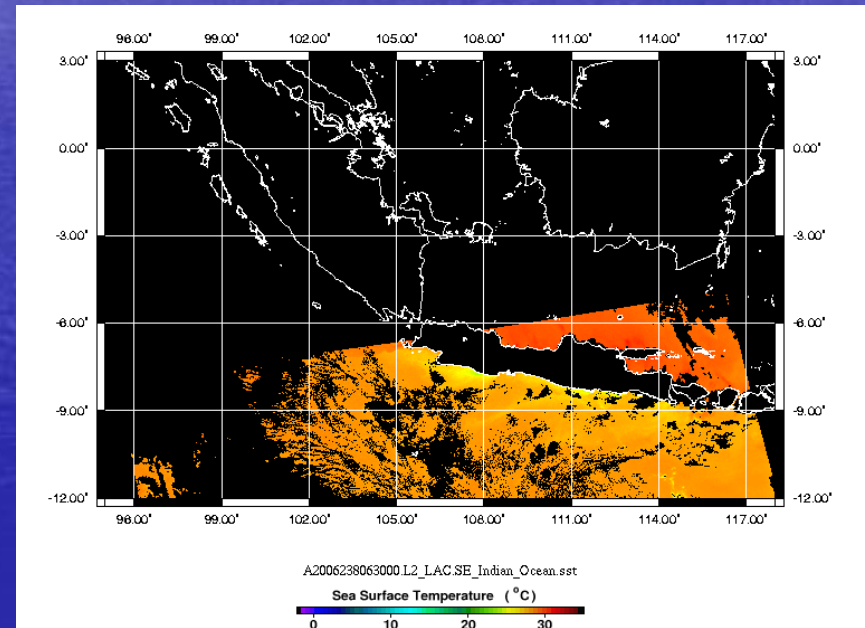
# RANET Infrastructure Development Workshop Bali September 2007



Chlorophyll



Sea Surface Temperature



# Education Task Team Overview

## Researching options for Indonesians to study in U.S.

### Objectives

- Indonesian students studying at U.S. Universities (2008)
- U.S. students studying in Indonesia (2009 or 2010)

### NOAA Approach

- NOAA is identifying partners and options
- Identifying existing options
- Will present findings, options, suggestions at RANET and Education Capacity Building Workshop in Bali (August 27-31, 2007)

### Possible DKP Approach

- Identify Indonesian University partners to help *groom* students
- Academic requirements/prerequisites; selecting students; funding
- Identify an office to coordinate with NOAA and Universities (GRE, TOEFL, etc)
- Present findings at the workshop in Bali—August 27-31, 2007

# High-Level NOAA-DKP-BPPT Signing Ceremony Jakarta September 2007



# Indonesian Colleagues Visit NOAA NDBC June 2008





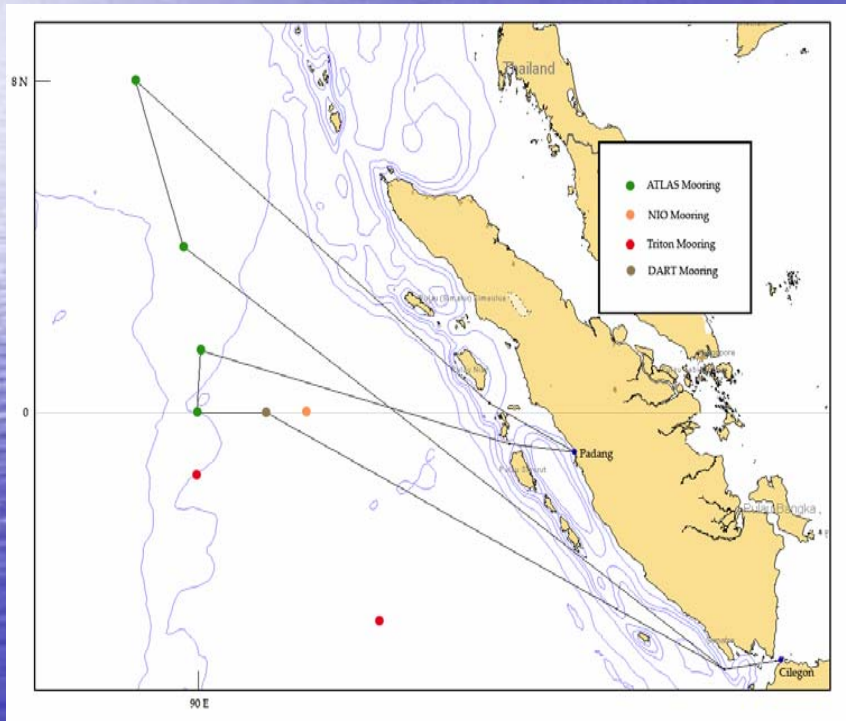
# 4<sup>th</sup> NOAA – Indonesia Ocean Observations Capacity Building Workshop August 2008

- Providing content on the RANET system
- Ocean Observation Applications
- Dissemination of Ocean Observing System Data
- Importance of real time data for decision makers, such as port managers and fisheries resource managers
- Evaluation to assess Stakeholder needs

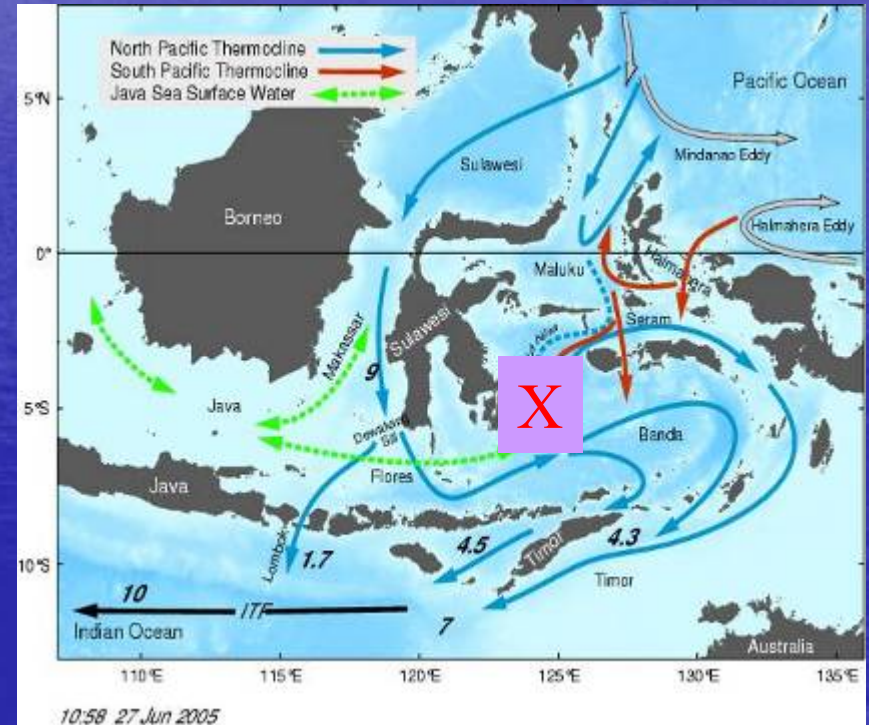


# NOAA's Investment in Eastern Indian Ocean Observations

ATLAS Climate & DART Tsunami Moorings



Indonesian Throughflow Monitoring



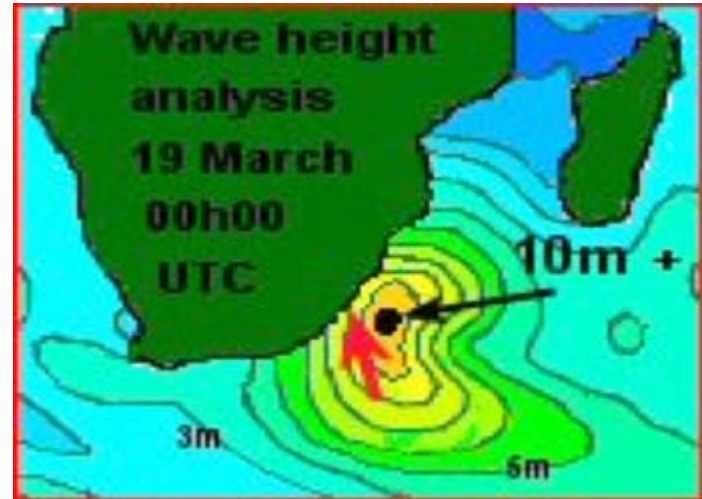
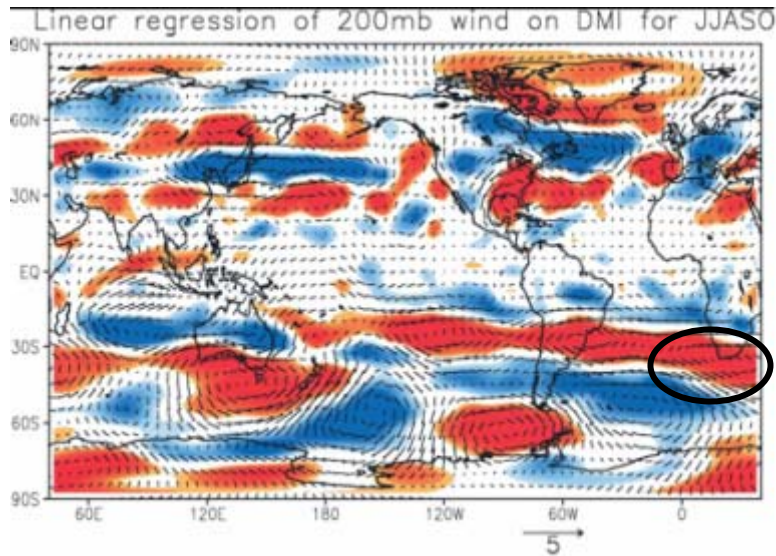
# South Africa Weather Service

- Broached Partnership During IOP-4 Hosted by SAWS in Pretoria April 2007
- U.S. - South Africa S&T Meeting Washington, DC February 2008
- DBCP-24, Capetown



# Indian Ocean Dipole

## Potential Impacts to South Africa



- An important feature which may influence storm tracks in the southern hemisphere is the Indian Ocean Dipole (IOD).
- Saji and Yamagata (2003) utilized the Dipole Mode Index (DMI) to demonstrate the impacts of the IOD on the subtropical jetstream;
- Since changes in the intensity and location of the subtropical jet likely influences the location of South African stormtracks, it is proposed to utilize the DMI in assessments of Storm Tracks and Intensities in South Africa.

# Summary

- Sustainable Capacity Building develops both an increase in observations while increasing the demand from socio-economic applications of their data
- The Indian Ocean is advancing nicely in the Central and Eastern Regions, the West remains a Challenge
- Clarity and Unity Make Great Things Happen!

# Thank You!



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