Global Ocean Monitoring and Observing
NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION

NOAA-MoES *Collaboration*
in building ocean observations in the Indian Ocean

M. Ravichandran,

Secretary to Govt. of India

Ministry of Earth Sciences (MoES)

New Delhi, India

IndOOS: Indian Ocean Observing System (Basic scale Observing Systems)

- Science Drivers
  - *Monsoon (Asia, Africa and Australia)*
  - *MJO: Main mode of atmospheric intraseasonal variability develop in the Indian Ocean*
  - *Biogeochemical impacts! Oxygen Minimum Zone*
  - *Indian Ocean Dipole: Strong driver of regional climate variability*
  - *Fastest warming Ocean!*
  - *Long term Sea level trend*

Indian Ocean Observing System (IndOOS)
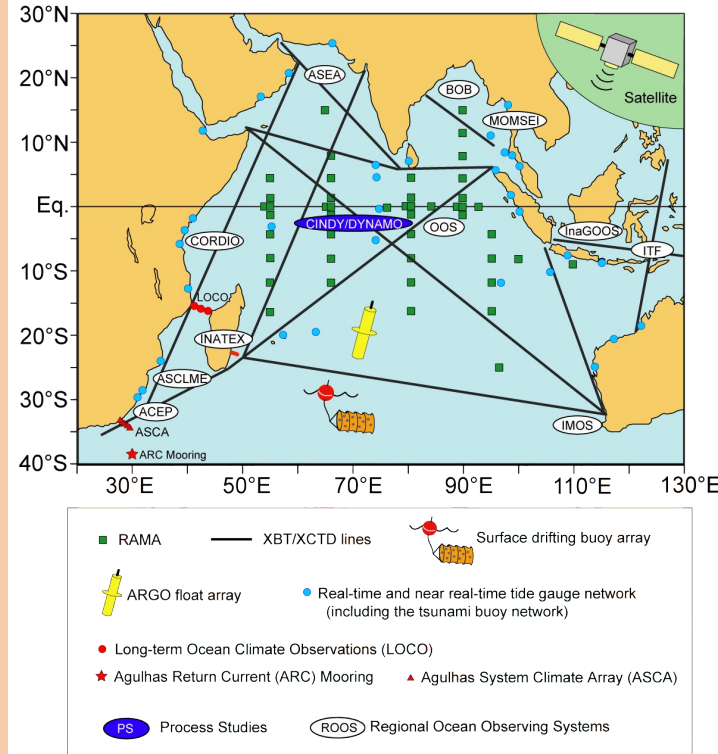
IndOOS: backbone for various Ocean related services

Ecosystem Services

- Marine Fishery Advisory Services
- Harmful Algal Bloom Information
- Coral Bleaching Alerts
- Coastal Water Quality Nowcast and Forecast

Early Warning Services

- Tsunami Early Warning
- Storm Surge Early Warning
- Ocean State Forecast
- Oil Spill Trajectory
- Marine Search and Rescue

Weather and Climate

- Monsoon forecast
- Tropical cyclone forecast
- Monitor and forecast IOD, MISO and teleconnection of ENSO and AZM
- Trend in physical parameters
- Trend in ecosystem parameters

NOAA-MoES Collaboration

- NOAA and MoES singed on MOU in the year 2008 with various Implementation Agreement

- Indian Ocean is data void region before this MoU

- After this collaboration, Indian Ocean has populated with various in-situ observations, especially RAMA moorings, Argo profiling floats and drifters

- These Observations facilitated India to build dynamical prediction of Monsoon at various time scales

- On August 9, 2021, signed an updated partnership agreement that marks more than 12 years of partnership between these nations in the name of ocean and atmospheric observations for improved weather and climate prediction.

RAMA-OMNI

- Initiated in 2004, the [Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction](#) (RAMA) was designed to study the Indian Ocean's role in monsoons, improve monsoon forecasts, and to better study the historically data-sparse Indian Ocean. The first RAMA buoys were deployed by NOAA in 2004, with the most recent moorings deployed in the Arabian Sea in 2019. MoES has extended operational support to the RAMA array since the earliest deployments. RAMA buoys collect data on a range of atmospheric and oceanic variables, including ocean temperature, salinity, currents, wind, sea level air pressure and humidity. Data collected within RAMA has been extensively used globally and in collaborations between NOAA and MoES scientists to understand the thermohaline structure in the Bay of Bengal, and to validate satellite products and ocean-climate-weather models.

- The [Ocean Moored Buoys in the Northern Indian Ocean](#) (OMNI) array was initially deployed in 2012, and MoES [announced](#) in 2018 that data from the open ocean elements of the OMNI array would be open access and shared freely among researchers to help improve the accuracy of forecasts.

- The renewed partnership and joint data portal will significantly benefit the U.S., Indian, and global community working in ocean and climate science, forecasting, and disaster preparedness, especially as we enter the [UN Decade of Ocean Science for Sustainable Development](#) and look for new ways to address the [climate crisis](#).

INCOIS, IITM, NIOT, NCCR, CMLRE, NCPOR, NCMRWF, IMD.

IISc, NIO, SAC, IIT-D, IIT-M, IIT-Bhu, Univ. Allahabad

EKAMSAT project is aimed to improve the quality of monsoon forecasts issued by IMD and operational ocean forecast services issued by INCOIS by understanding the specific physical processes in based on focused observations in the Arabain Sea and incorporating them in the numerical models.

U. Mass., WHOI, UW, Scripps Institute Oregon State Univ. NOAA-PMEL

1. What processes govern the surface evaporation and physical processes associated with entrainment at the top of the atmospheric mixed layer over the Arabian Sea?

2. How does the Arabian Sea attain high SST during the pre-monsoon months?

3. What controls the barrier Layer formation in the South-eastern Arabian Sea?

4. At what rate, locations, and times does the mixing influence the upper ocean structure in the Arabian Sea?

5. What processes exchange salinity between the evaporative Arabian Sea and the much fresher Bay of Bengal?

6. Are recurring algal blooms (Noctiluca and Diatom), during winter monsoon in northern Arabian Sea, is leading to intensification and expansion of OMZ?

7. Does the interplay between penetrative radiant flux, nutrient stoichiometry and mixed layer dynamics control the bloom in the northern Arabian Sea?

8. What are major factors controlling acidification of the Arabian Sea?

Thank you