

Indian Ocean
DPM Meeting SIO
24-26 March 2004

Indian Ocean Panel

GOOS (through Indian Ocean GOOS and the Perth Office of the IOC) and CLIVAR have established the Indian Ocean Panel initially charged to develop, coordinate and implement a plan for sustained ocean observations of the Indian Ocean for climate research and ocean state estimation. The Panel will also coordinate research on the role of the Indian Ocean in the climate system with relevance to the African, Asian and Australian Monsoons as well as climate-change processes at higher latitude and in the deep ocean. The Panel met for the first time in Pune, India during February 18-20 under its Chair, Gary Meyers (CSIRO).

The Pune meeting allowed members to voice views on the essential elements of the observing system (OS) and the scientific and operational reasons that the OS is needed. Interactions with the Asian/Australian Monsoon Panel during joint sessions allowed for their reaction and input to the initial direction of the IOP workplan. The Panel reviewed the status of existing observations and their applications. IOP members have undertaken drafting of an Implementation Plan based on an outline and writing assignments agreed at the meeting. The Implementation Plan will represent a consensus on how to develop the OS agreed by representatives from Indian Ocean rim-countries, partners from outside the region, research groups and operational agencies. An informal meeting of IOP will occur at the IOGOOS Second Annual Meeting in Colombo during April 26-29, 2004. It will be used to make progress on IOP activities, particularly on issues that involve interactions with coastal GOOS.

Key outcomes from the Pune meeting, reported in more detail later, are:

- Dr VSN Murty (NIO, Goa) and Dr. McPhaden (NOAA, Seattle) submitted a proposal to India's Department of Ocean Development to deploy three US TAO moorings and an upward ADCP at 80.5E and (1.5N, 0 and 1.5S). The proposed moorings will enhance pilot mooring arrays in the equatorial and north Indian Ocean already established by India and Japan. The proposal asks for time on RV Sagar Kanya during the September-October 2004 cruise. The proposal needs to be approved before 1 June 2004 to allow time for preparations.
- Dr Meyers is discussing with Dr Srivastav (Director General of Meteorology) and Dr Raj (Regional Director at Chennai) about the possibility of getting hourly tide gauge data in near-real time. The potential benefit of storm surge prediction may well outweigh any interest to protect the data for security reasons. The weather data from the Murty/McPhaden TAO moorings will also be relevant to storm surge prediction.
- The Panel reviewed of the status of the present-day OS and, recognizing the objectives of CLIVAR and GOOS, started making plans for its future development.

Terms of Reference:

Preamble: The Indian Ocean plays a key role in climate variability and change and supports a wide range of activities that require sound knowledge of the past and

current state of the ocean and, where practical, forewarning of future conditions. The dominant mode of this variability is on intraseasonal time scales and there is good potential that predictability on these time scales can be exploited for socio-economic benefit. There is also good evidence that inherent predictability in the ocean itself can be exploited to enhance the sustainability of the marine environment and those industries and activities that depend upon the resources of the Indian Ocean. The need for high-quality ocean observations is shared by research (CLIVAR) and ocean applications and services (GOOS) and there is a shared conviction that, together, the ocean community should endeavour to establish the basis for a comprehensive ocean observation network and oversee the staged implementation of a sustainable ocean observing system for the Indian Ocean.

It is therefore agreed that a Panel will be established and supported by CLIVAR and GOOS (through Indian Ocean GOOS and the Perth Office of the IOC) with the following Terms of Reference.

- Provide scientific and technical oversight for a sustained ocean observing system for the Indian Ocean and Indonesian Throughflow in order to provide ocean observations needed for climate variability research and to underpin operational ocean applications and services relevant to the region, particularly with regard to ocean-state estimation and climate prediction.
- Develop, coordinate and implement a plan for a sustained ocean observing system for the Indian Ocean to
 - (a) meet the common requirement of CLIVAR research themes and regional initiatives, particularly those identified by AAMP and VACS and the CLIVAR modelling panels,
 - (b) satisfy the common requirements of GOOS and its modules, and
 - (c) coordinate implementation activities in collaboration with relevant regional and global bodies and IOGOOS and JCOMM in particular.
- Liaise with relevant research Panels of CLIVAR and implementation Panels of GOOS and JCOMM and provide a focal point for coordination of ocean observing networks in the region. Report to the CLIVAR SSG through its AAMP and to GOOS through the IOC Perth Office.
- In order to make the work of the Panel efficient and effective, it is suggested that agencies currently making relevant observations be invited to assign a focal point for liaison with the Panel and participation in the Panel's activities. CLIVAR will appoint up to five members to represent their interests. Five or more members will be invited to represent operational agencies. Participation in the Panel's activities is open to all agencies planning to contribute to sustained observations. The CLIVAR SSG and the IOC (through the Perth Office) will invite the initial Panel members and select the Chair.

IOP Members:

CLIVAR will appoint up to five members to represent research-interests. Five members will be invited to represent operational agencies.

CLIVAR Representatives

Dr Satish Shetye, National Institute of Oceanography, India

Dr Yukio Masumoto, University of Tokyo, Japan

Dr Peter Hacker, University of Hawaii, USA

Prof Fritz Schott, University of Kiel, Germany

To be named (an expert in air-sea interaction)

Representatives of agencies currently making or planning relevant observations

Indian National Centre for Ocean Information Services, Dr M Ravichandran

Japan Marine Science and Technology Center Dr Yoshifumi Kuroda*

Commonwealth Scientific and Industrial Research Organization Australia, Dr Gary

Meyers

National Oceanic and Atmospheric Administration USA, Dr Michael McPhaden

Laboratoire d'Océanographie Dynamique et Climat France, Dr Robert Molcard

Ministry of Marine Affairs and Fisheries Indonesia, Dr Safri Burhanuddin

Joint members with other CLIVAR Panels

Dr Peter Webster (AAMP)

Dr Jay McCreary (AAMP)

Dr Laban Ogallo (VACS)

CLIVAR Research Issues

CLIVAR will address climate-phenomena that involve circulation and mixed layer dynamics and thermodynamics. The phenomena span spatial scales of ocean-variability ranging from relatively narrow boundary currents and zones of upwelling to basin-scale structure of temperature, salinity, etc. The phenomena include:

- Seasonal monsoon variability
- Intraseasonal oscillation
- Indian Ocean zonal dipole mode
- Decadal warming trends
- Indonesian throughflow
- Shallow overturning cells
- Deep meridional overturning
- Carbon and Biogeochemistry
- Global ocean linkages

Status of Existing Observations

Pilot Mooring Array

Since the last review of mooring activities in 2002:

- agencies in India (INCOIS, NIOT) have established 22 oceanographic and/or meteorological moorings in the Bay of Bengal and Arabian Sea (blue and yellow circles and triangles in Fig. 1).
- NIO has maintained three current meter moorings on the equator (green circles).
- Japan (JAMSTEC, FORSGC) has maintained three Triton and/or ADCP moorings near the equator (red circles).
- The INSTANT Project has established moorings in the major passages of Indonesia (purple triangles) to measure full depth mass, heat and salt transports of the Indonesian Throughflow.

Some of the mooring sites now have a record extending up to four years. Preliminary results show strong intraseasonal variability of currents, as well as longer term seasonal and interannual signals.

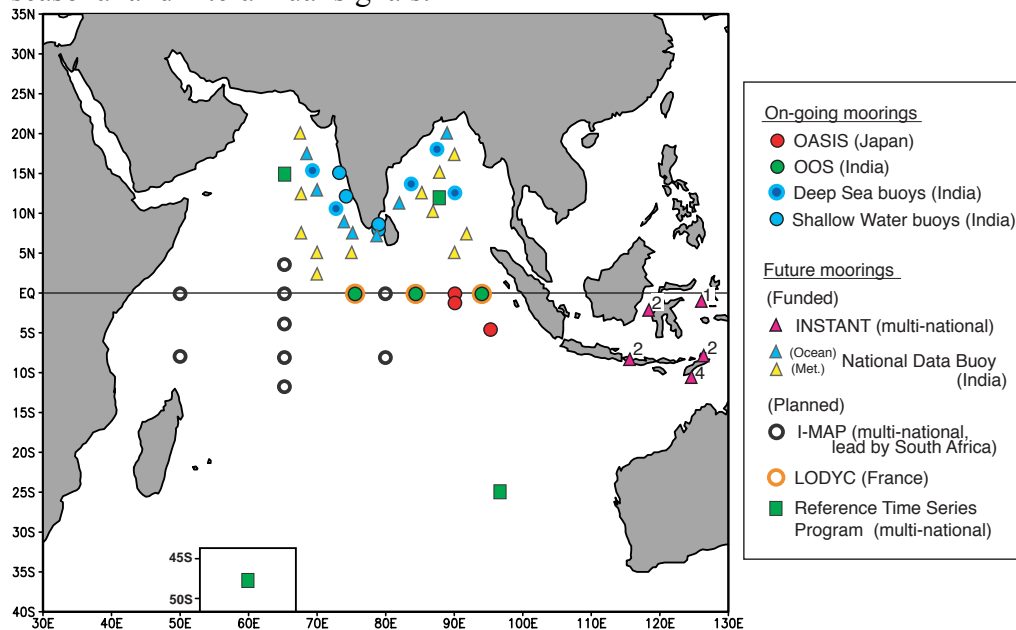


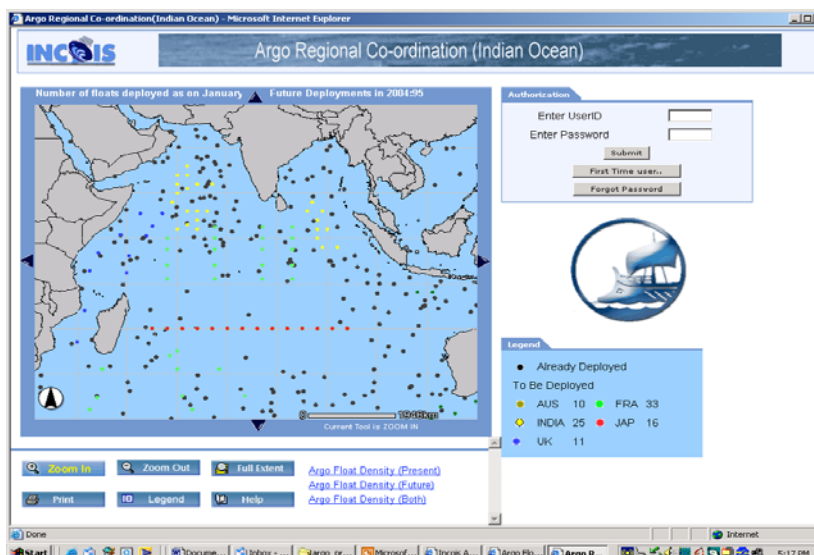
Figure 1: Locations of on-going and planned pilot-moorings at the time of the First Indian Ocean GOOS Conference in November 2002.

An ongoing action of the IOP is design of the future sustained mooring array to provide data for research on

- basin-scale variability with time scales from intraseasonal to interannual
- boundary currents and upwelling zones
- Indonesian throughflow

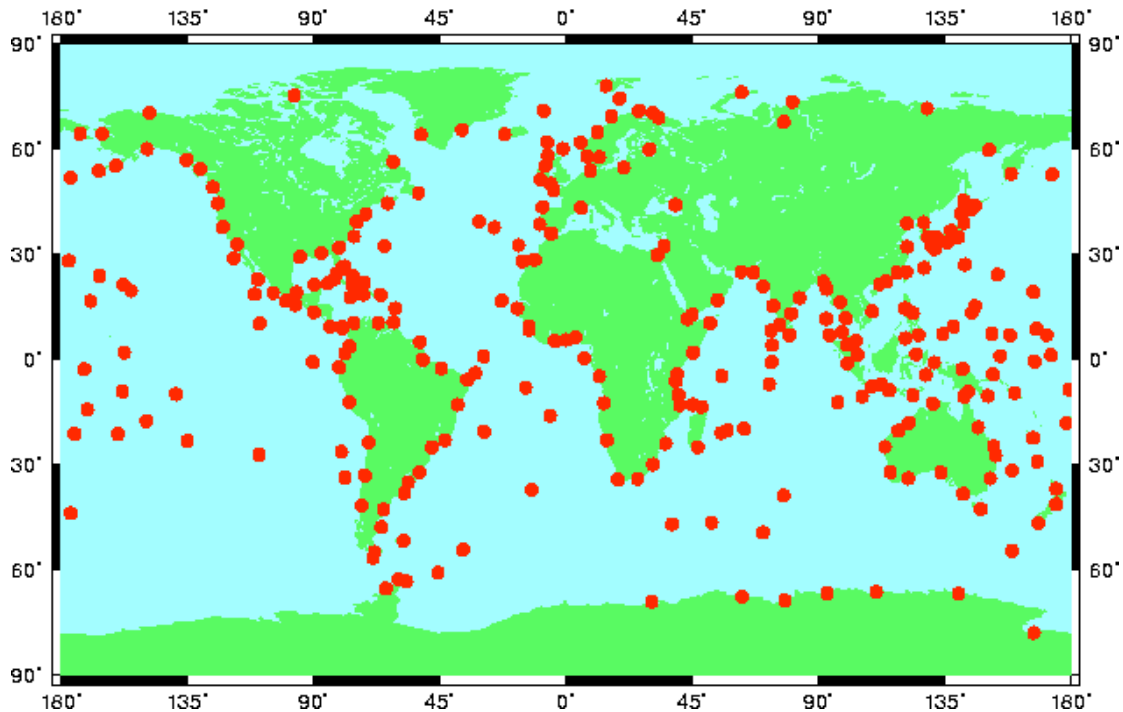
Argo floats

Implementation of Argo has progressed in the past year and is now about 50% complete. An ongoing action of IOP is an assessment of the efficacy of an integrated OS for observing the fast variability of the Indian Ocean using moorings, Argo floats and other observing platforms.



Tide gauge network

GLOSS Core Network defined by GLOSS02



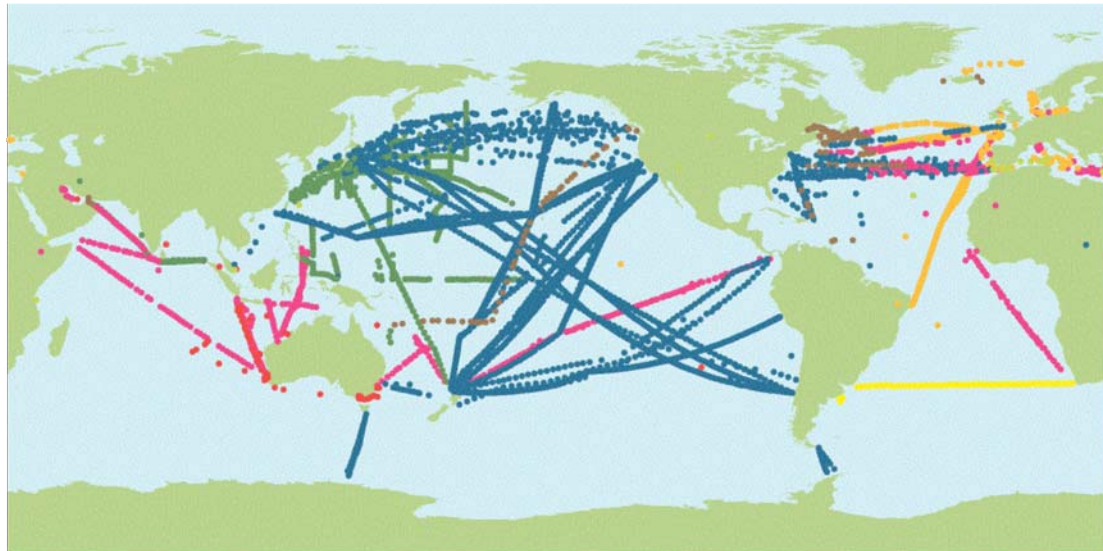
More than 50 Indian Ocean tide gauges have a record of monthly values in the GLOSS sea level archive. Some of the stations are useful for studies of decadal variability and sea level rise. Historical hourly data is not available from most stations and near real time, hourly data is available from only about 10 sites. IOP will correspond with GLOSS to get a better understanding of the possible uses of the historical archive for climate research.

An ongoing action of IOP is discussion of the availability of near real time tide gauge data with responsible bodies in the Bay of Bengal region. Real time data is useful for mitigating the impacts of climate (e.g. extreme events, storm surge) as well as maintaining a high quality, sustained network. Develop of a pilot real-time network around the Bay of Bengal will be coordinated with the MILAC Project (Johannes Guddall).

XBT Network

The XBT network established by TOGA and WOCE has been taken over as a global, operational activity by JCOMM and is implemented by SOOPIP. The excellent work of several people in JCOMM and SOOPIP (including Rick Bailey and Steve Cook, the former and present SOOPIP Chairmen, and Etienne Charpentier of JCOMM OPS) needs to be recognized. They have established a tracking system for XBT lines that assesses implementation of the GOOS XBT strategy, as recommended by the UOT review (Melbourne 1999; see the OceanObs99 book by Neville Smith and Chet Koblinsky). The GOOS strategy calls for a shift from so called “broadcast sampling” to “line sampling”. In the future Argo floats will provide the broadcast data set. High

density (HDX) and Frequently Repeated (FRX) lines provide detailed, accurate information on currents and seasonal to interannual structure.



SOOP semestrial survey, January-June 2003

(MFSP Data not included here)

- | | | |
|--------------------|-------------------------|-----------------------|
| ● AMMC (Melbourne) | ● KNHC (Washington) | ● SABM (Buenos Aires) |
| ● CWOW (Montreal) | ● KWBC (Washington-NWS) | ● SBBR (Brasilia) |
| ● EDZW (Offenbach) | ● LFPW (Toulouse) | |
| ● EGRR (Bracknell) | ● RJTD (Tokyo) | |

Note: GTS data source is not necessarily related to country in charge of the programme

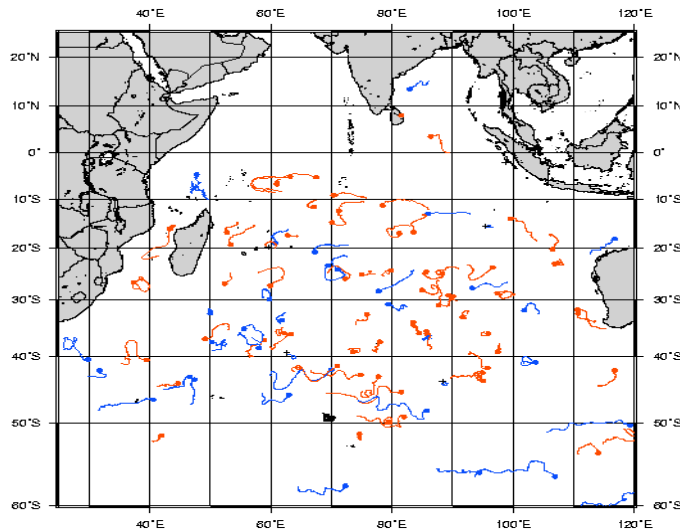
According to the JCOMM OPS assessment for Jan-Jun 2003:

- FRX lines IX1, IX9(north of 5N) and IX10(east of 78E) are well sampled
- FRX lines IX10(west of 78E), IX12, IX22 and PX2 are sampled but not well
- HDX line IX28 is well sampled
- The remaining FRX and HDX lines (IX2, 6, 7, 8) are not sampled according to this review.

IOP recognized that a number of lines in the Indian Ocean are sampled but do not appear in the JCOMM OPS assessment because the data are not submitted to the GTS, and in some cases are not submitted in delayed mode until years have passed. IOP will discuss data availability with XBT operators. IOP recommended a high level review of the XBT network (probably to be carried out by OOPC) to provide an overview of the implementation of the line sampling plan.

Drifter network

The drifters are <50% implemented. IOP recommended contacting IBPIO to discuss how the panels can work together to make more resources available.



Data management issues

1. *What are your requirements for real-time and delayed-mode (define your time scales) management of ocean data?*

Regional Centre for Indian Ocean Data Management

In December 2003 the IOGOOS Workshop on Data Management suggested that IOGOOS Secretariat (which is operated by INCOIS, Hyderabad, India) be the Regional coordinator for Ocean data and Information Management in the Region. INCOIS has been asked to submit a proposal to establish a Regional Data Archive, or coordinate a distributed data facility. INCOIS is willing to take up this responsibility for the region.

- **Recommendation: CLIVAR data management coordinate its development with the activity at INCOIS.**

Historical data archive (T/S at least)

CSIRO Marine Research and Asia Pacific Data Research Center with support from NOAA are carefully quality controlling and flagging all the available T(z) data for the Indian Ocean through December, 1999 using the published qc methods developed by the WOCE UOT DAC's. We found that the WODB2001 can be substantially improved. Similar work is needed for the S(z) data and the other oceans.

- **Recommendation: Careful (WOCE level) quality control of the whole T/S data set for the global ocean**

Near real time XBT line analysis

Most of the XBT line data is sent to the GTS in near real time, including a decimated representation of the HDX lines. A near real time (say monthly) analysis of present thermal structure compared to the historical record could be useful.

- **Recommendation: Explore the usefulness and feasibility of a near real time XBT line analysis**

Argo data

Carefully controlled (near real time and delayed mode) Argo data is required as quickly as possible for ocean state estimation. This is probably being addressed by IAST, but needs to be reviewed at the SIO Data meeting.

Mooring and current meter data

A number of mooring sites have been recently occupied by several agencies (INCOIS, NIOT, NIO, JAMSTEC, FORSGC and various research groups). Establishing a sustained mooring array in the Indian Ocean is a key element of the Indian Ocean OS. The past and future data will have to be managed in a unified, consistent manner, even though the data will be collected by a variety of agencies. In addition to multiple agencies, data within and near some EEZ's are not made generally available due to a perceived threat to national security. The availability of the mooring data is essential for CLIVAR Indian Ocean research.

- **Recommendation: CLIVAR promote and implement an effective data management system for the Indian Ocean mooring array, working in cooperation with the key regional agencies.**

Near real time, hourly tide gauge data

We don't know yet if it will be possible to establish a near real time tide gauge network, to support storm surge prediction. CLIVAR needs to follow the ongoing discussions and become engaged as progress is made.

2. What data streams are most important? What types of data quality information are of value?

From the perspective of developing the sustained OS the mooring array is most important. The intraseasonal time-scale is the building block of the monsoons, and a major factor in seasonal to interannual variability. It also has huge, socio-economic impact on Indian Ocean nations. Without the mooring array, little progress will be made in improving predictability at intraseasonal and seasonal time scales.

Never-the-less, all the data-types mentioned above are important and should include data quality indicators that make it easy for a researcher to use the data set without becoming an expert in that type of data.

3. How much of the data you depend on comes from non-CLIVAR funded activities?

Possibly some of the Argo data is CLIVAR funded. Very little of the other sustained observations come from CLIVAR funded activity.

4. To what extent are your data management needs being/not being met, and what are your highest priorities for enhancements or changes to the data management system ?"

Highest priorities are management of Argo data and the past and future mooring data.