Indian Ocean GO-SHIP: IIOE-2 planning

April 7, 2014 (GO-SHIP Executive Group)

Introduction

Global hydrographic surveys, including the Indian Ocean, have been carried out approximately every decade since the 1960s through research programs such as IIOE, GEOSECS, WOCE / JGOFS, and CLIVAR. In 2009 the Global Ocean Ship-based Hydrographic Program (GO-SHIP) was established as part of the Global Ocean Observing System under the WCRP to provide international coordination and scientific oversight of the decadal global ocean survey.

GO-SHIP aims to develop a globally coordinated network of sustained hydrographic sections as part of the global ocean/climate observing system including physical oceanography, the carbon cycle, marine biogeochemistry and ecosystems. GO-SHIP provides approximately decadal resolution of the changes in inventories of heat, freshwater, carbon, oxygen, nutrients and transient tracers, covering the ocean basins from coast to coast and full depth (top to bottom) ,with global measurements of the highest required accuracy to detect these changes.

GO-SHIP Observation Strategy

GO-SHIP Reference Sections (figure 1) are full-depth repeat hydrographic sections that are coast-to-coast or coast-to-ice, along specific lines with small modifications as necessary for territorial waters, ice coverage, etc. Two types of surveys comprise the GO-SHIP scientific objectives: (1) decadal surveys and (2) a sub-set of the decadal survey lines sampled at high frequency (repeats every 2-5 years). Station sampling along the section is nominally 30 nautical miles (nm) for physical measurements and 60 nm (or better) for carbon and tracer measurements.

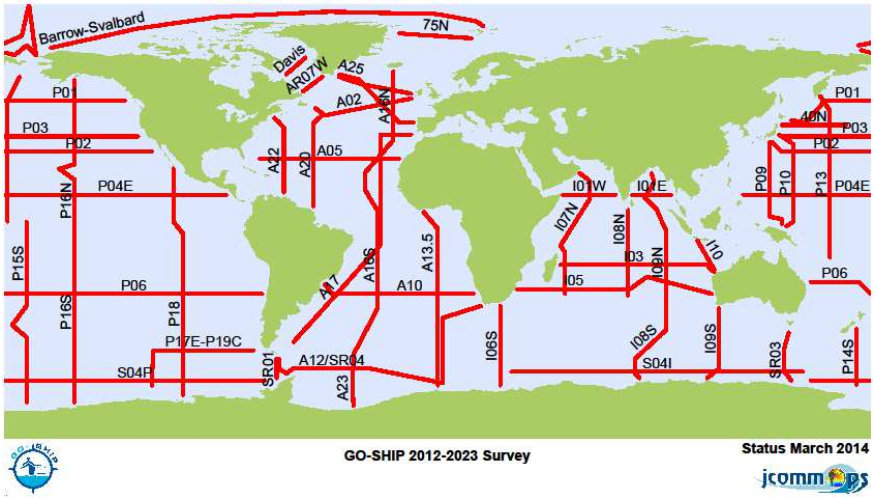

Figure 1 Global GO-SHIP sections as of March 2014. See www.go-ship.org for more information

Level 1 data are of highest priority. GO-SHIP recommends that level 1 data should be collect at least once per decade on all sections. Sections occupied at higher frequencies (yearly, biennial) do not need to undertake all level 1 measurement on all re-occupations.

Level 1 data:

- CTD pressure, temperature, salinity (calculated from conductivity, temperature and pressure)
- CTD oxygen (sensor)
- Bottle salinity
- Nutrients by standard auto analyzer (NO_3/NO_2, PO_4, SiO_3)
- Dissolved oxygenDissolved inorganic carbon (DIC)*
- Total Alkalinity (TAlk)*
- pH*
  *(note any two of the above carbon related observations)
- Chlorofluorocarbons (CFC-11, -12) and SF_6
- Surface underway system (T, S, pCO_2)
- ADCP shipboard
- ADCP lowered
- Underway navigation and bathymetry
- Meteorological data.

Level 2 data are highly desirable. GO-SHIP recommends that level 2 should be collected when possible.

Level 2 data:

- Discrete pCO_2
- ^{14}C (by AMS)
- CCl_4
- $\partial^{13}C$ of DIC
- Dissolved organic carbon
- Dissolved organic nitrogen
- Fe/trace metals
- CTD Transmissometer
- Surface underway system (nutrients, O_2, Chl, skin temperature).

Level 3 data are ancillary measurements are done according to opportunity and space available. They should not significantly interfere with Level 1 or 2 data collection, and may be regional or specific to an individual cruise.

The GO-SHIP data policy for its basic parameter set is stringent and geared towards rapid, open dissemination, with a clear structure for all data to undergo quality control, and to be sent to and available from recognized data centers. A summary of the data types and data management structures can be found on the GO-SHIP website (www.go-ship.org). (Links to national programs can be found on the GO-SHIP website.)

GO-SHIP: Indian Ocean

GO-SHIP has a number of lines in the Indian Ocean that are part of the global decadal survey. A number of these lines have national commitment for occupation during the IIOE-2 timeframe (Table 1). Collaboration between GO-SHIP and IIOE-2 provides a unique opportunity for (1) addition of measurement (level 3) to the GO-SHIP observation suite and (2) leveraging national support to complete the Indian Ocean survey.

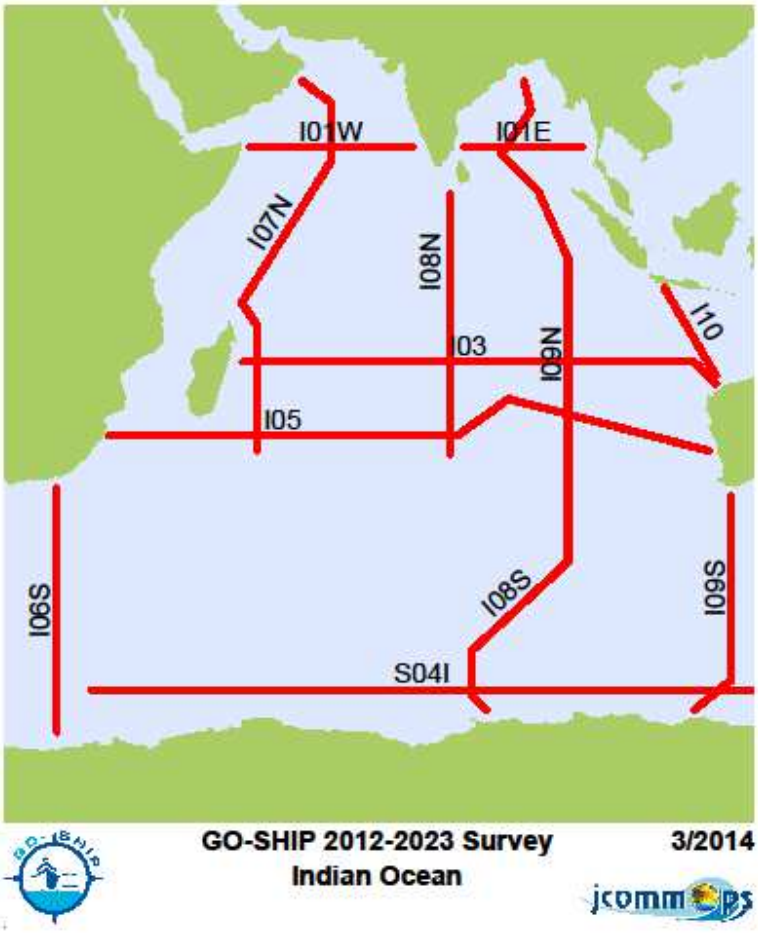

Figure 2 GO-SHIP section that will be part of the IIOE-2. Some sections have national commitments (see table 1).

Table 1. GO-SHIP sections to be occupied during IIOE-2.

GO-SHIP section	Nominal location	Year	Country
I08S	95°E south of 32°S	2015-2016	U.S.A.
I09N	95°E north of 32°S	2015-2016	U.S.A.
I01E	10°N Bay of Bengal	2016	U.S.A.
I09S	115°E	2017	Australia
I05	32°S	2018	U.S.A.
I06S	30°E	2019	U.S.A.
I08N	90°E north of 32°S	2015 or 2018	Japan/India
I07N	60°E	No commitment (due to security reasons)	See ^
I10/IR06	Java to NW Australia (110^{o}E)	2015 or 2018	Japan
I03	20^{o}S Australia to Madagascar	No commitment	See #
S04I	62^{o}S	No commitment	
I01W	10°N Arabian Sea	No commitment	

^ Although not in the USA planning, they will do the section if international security warnings are removed.

Under discussion between Indian partners and UK IIOE2.

Summary

GO-SHIP is an integral component of the IIOE-2 project, providing high quality, comprehensive sampling of the Indian Ocean along dedicated repeated hydrographic lines. It will provide the fourth comprehensive high-quality survey after GEOECS, WOCE/WHP, and CLIVAR CO2/GO-SHIP from which the anthropogenic climate change signals into the deep and intermediate ocean can be quantified. Working with the IIOE-2, GO-SHIP suggests we define a list of ancillary measurements that can be included in the Indian Ocean. These ancillary measurements may include improved biological sampling including bio-optical and water samples, and nutrients dynamics focuses on the large denitrification signal in the Northern Indian Ocean.

Any proposed additional data collection that adds ship-time to GO-SHIP voyages should be agreed upon no later than 18 months in advance of a voyages in order to work with national funding agencies to gain the additional ship time and/or support for the technical groups to participate on the voyage.