Deep-Sea Research II 118 (2015) 137–141

Contents lists available at ScienceDirect

Deep-Sea Research II

journal homepage: www.elsevier.com/locate/dsr2

Editorial

Ecosystem survey in the Indian Ocean sector of the Southern Ocean – Results from Indian expeditions

1. Introduction

Global processes have significant impact in the Southern Ocean (SO). It is the milieu for the formation of intermediate, deep, bottom and Mode waters, which constitute a major conduit for the exchange of heat and gases between the atmosphere and the oceans. Very few detailed ecosystem surveys have so far been conducted in the Indian Ocean sector of SO. Some of the major investigations carried out in the SO were WOCE (Sokolov and Rintoul, 2002), JGOFS (Priddle et al., 1994), iron fertilization (e.g., Law et al., 2001), distribution and group of organisms such as SOWER surveys (IWC, 1999) or annual krill surveys (Hewitt et al., 2003), meso-scale experiments like RACER (Huntley et al., 1991), and SO-GLOBEC (Hofmann et al., 2004, 2008). The investigations carried out by Marr (1962), Mackintosh (1972) and BIOMASS (Biological Investigations of Marine Antarctic Systems and Stocks) surveys in the early 1980s (El-Sayed, 1994), the BROKE survey of 1996 and 2006 off Antarctica (Nicol et al., 2000; Nicol and Meiners, 2010), and the CCAMLR 2000 survey in the South West Atlantic (Watkins et al., 2004) were primarily discovery investigations to understand the distribution and abundance of Antarctic krill. Based on the results of the 1996 BROKE survey, a conceptual model of the biological–physical interactions in the waters off the Antarctic continent between 80°E and 150°E was made (Nicol, 2006). The BROKE-West survey was carried out in 2006 between January and March to understand the physical and biological environment and krill biomass of the area between 30°E and 80°E. Analyses of the data from this survey indicated that the model proposed based on the 1996 BROKE survey was not suitable for this region. Even though frontal systems do vary in latitudinal position from west to east, the extent of the winter sea ice does not. The productive zone appears to extend in places beyond north of the Southern Boundary of ACC (SB) and this is not strictly associated with the waters of the coastal current (Nicol and Meiners, 2010).

India's research accomplishments in the SO regime underline the significance of improved understanding of the SO processes, biogeochemical cycles, marine productivity and global climate. From 2004 to 2013 seven multi-institutional and multi-disciplinary expeditions were undertaken to the SO, funded and supported by the Ministry of Earth Sciences (MoES, Govt. of India), and a core group has been constituted at the National Centre for Antarctic and Ocean Research (NCAOR) to plan, co-ordinate and organize all the scientific and logistics of the expeditions. The main focus of the SO expeditions (SOE) is to understand the role and response of the SO to regional and global climate variability. Improved understanding of the links between the SO processes and global climate, biogeochemical cycles, air–sea interaction and marine productivity is critical for the society to respond effectively to the challenges of climate change, sea-level rise, ocean acidification and the sustainable use of marine resources. These surveys have been designed in such a way that the inter connection between physical, chemical and biological elements across the Antarctic Circumpolar Current (ACC) is one of the major goals to be achieved. The studies have been further extended so as to understand the carbon sequestration, biogeochemistry, air–sea–ice interaction, aerosols and thermohaline variations in the SO. Some geological surveys have also been carried out for the reconstruction of the paleo-environmental conditions for selected time slices during the last glacial–interglacial cycles to provide perspectives on future climate change.

The papers included in this special issue deals with the various scientific objectives envisaged for the expeditions, based on the wide range of data collected during these voyages. This introductory paper provides an overview of the work carried out during the Indian expeditions and also throws light on our present understanding of this sparsely explored region in the SO.

2. Main focus and objectives

Main Focus: "Role and response of Southern Ocean to the regional and global climate variability"

Objectives identified for main focus

- Interrelationship between physical, chemical and biological elements across ACC and their roles in carbon sequestration and biogeochemistry.
- Air–sea–ice interaction and role of aerosols over the SO.
- Repercussion of heat and mass exchange between subtropical and polar regions.
- Reconstruction of the paleo-environmental conditions for selected time slices during the last glacial–interglacial cycles to provide perspectives on future climate change.
- Generate relevant/critical sea truth and atmospheric data for contributing to global climate data sets for the formulation of climate models to mitigate/regulate climate change.

2.1. Survey outline

The surveys were carried out along two meridional sections, one above the southwest Indian ridge (between 45°E and 48°E) and the

http://dx.doi.org/10.1016/j.dsr2.2015.07.001

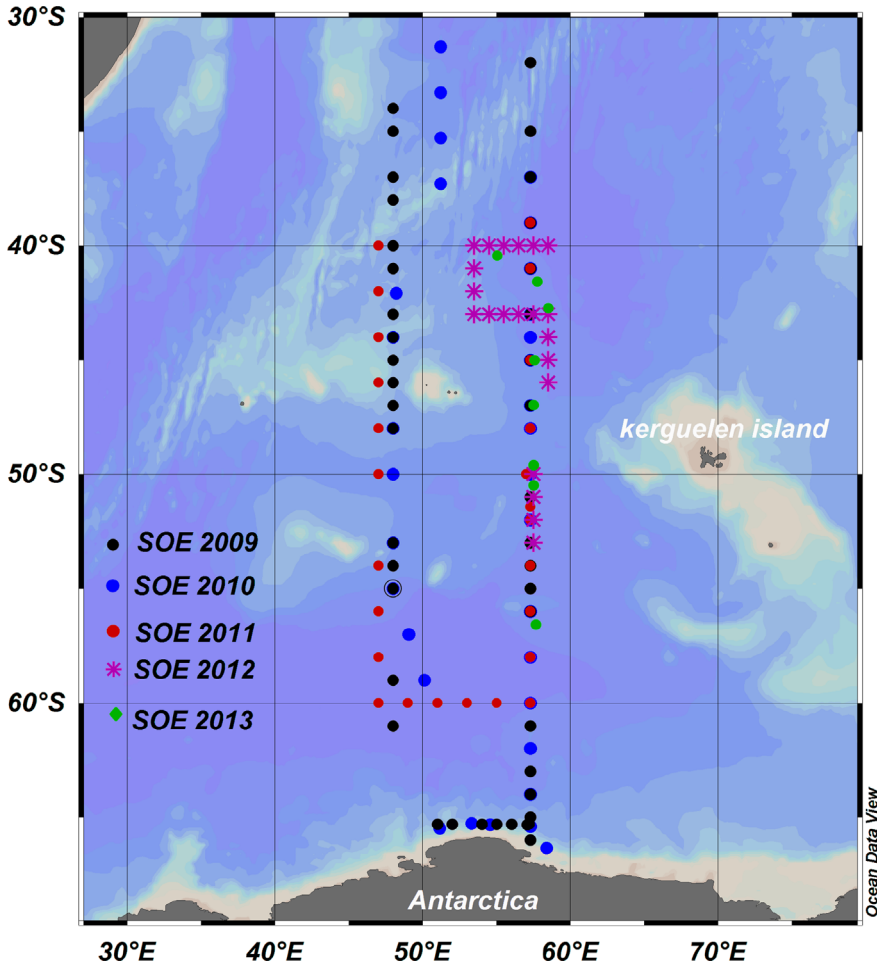

Fig. 1. Indian Ocean sector of Southern Ocean: multidisciplinary station locations from which data and samples were used for interpretation of results submitted for this special issue.

other above a relatively flat bottom (57°30′E). The observations were carried out as far south as 67°S to understand the hydrodynamics and biogeochemistry of the ecosystem, and for this the atmospheric, physical, chemical and biological parameters were measured. The observations were mainly concentrated between the subtropical (40°S) and coastal waters of Antarctica. Data and samples were collected during the austral summer (January–February) onboard ORV Sagar Kanya in 2004, Akademic Boris Petrov (ABP) in 2006 and 2009 and ORV Sagar Nidhi, in 2010, 2011, 2012 and 2013 (Since most of the studies included in this issue are based on the expeditions from 2009 to 2013, the details of the expeditions carried out in 2004 and 2006 are not included in this editorial). The multidisciplinary station locations pertinent to the publications included in this issue are portrayed in Fig. 1. In the entire cruise track the depth of the ocean varied between 100 and 5900 m, depending on the bottom topography due to the Southwest Indian ridge and Crozet plateau.

2.1.1. SOE 2009

The expedition was launched from Mauritius on 12 February 2009 onboard vessel I/B Akademik Boris Petrov. During this survey, Aerosol Optical Depth and Automatic weather station (AWS: wind speed, wind direction, air temperature, atmospheric pressure and humidity) measurements were made along the entire cruise track. CTD profiles, sea-water samples at different depths, CO_2 samples and air samples were collected from various locations along 57°30′E and 48°E to analyze various parameters such as DO, pH, nutrients, phytoplankton, chlorophyll etc. A Multiple Plankton Net (MPN) was operated to collect zooplankton samples from the upper 200 m water column, and a Bongo net was hauled to collect zooplankton samples from the surface water.

2.1.2. SOE 2010

This expedition was launched on 12 January 2010 from Marmugoa Port, Goa. Multi-disciplinary observations were carried out from 39°S to the coastal waters of Antarctica (66°30′S) along 57°30′E. Near the coastal waters of Antarctica observations were made at four stations along ~65°27′S latitude between 57° 30′E and 53°28′E. Further the measurements were continued along a track between 65°27′S 53°28′E and 55°S 48°E and along 48°E up to 40°S. Continuous observations for atmospheric parameters were made in the entire cruise track.

Physical (sea-surface temperature and salinity using Thermosalinograph, temperature and salinity profiles using CTD and XCTD/XBT), chemical (dissolved oxygen, pH, nutrients etc.) and biological parameters (bacteria, phytoplankton) were collected along the entire cruise track. Zooplankton and benthic samples were also collected. Observations were made with prime importance to the frontal regions.

2.1.3. SOE 2011

The scientific team set sail to the SO from Port Luis, Mauritius, onboard ORV Sagar Nidhi on 24 January 2011. The observations started from 37°S and two meridional sections along 57°30′E and 47°E were covered during this expedition. Atmospheric, physical,