ESSO

INCOIS

ESSO-INCOIS

ANNUAL REPORT 2014-15

Front Cover

Observations collected from some of our instruments

Ground Station on ESSO-INCOIS campus

Courtesy-Rohith B, Information Services and Ocean Sciences Group (ISG), ESSO-INCOIS

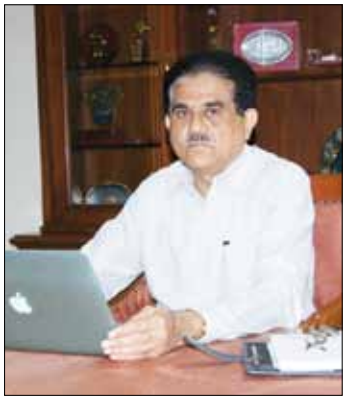
Back Cover

ANNUAL REPORT 2014-15

ESSO-Indian National Centre for Ocean Information Services
(An autonomous body under the Ministry of Earth Sciences, Government of India)
Hyderabad

Contents

From Director's Desk



I am delighted to present you the Annual Report of ESSO-INCOIS for the year 2014-2015. Writing from the Director's desk on ESSO-INCOIS Annual Report is a pleasure and a task that I enjoyed for the past 5 years and looking forward to doing so again. This is because I am consistently pleased to see the fascinating and excellent work being done by a relatively modest number of people with a modest budget. ESSO-INCOIS is not a large organization but we certainly make an impact way above our size.

Over the past one-and-half decade, ESSO-INCOIS has been providing the high quality ocean information and advisory services needed to support decision-making by users that range from ordinary fishermen to higher officials in the Government and Industry. ESSO-INCOIS's core activity is, of course, the ocean information and advisory service to the nation. While the core services like tsunami early warning, potential fishing zone advisory, ocean state forecast, data services, etc. have remained largely unchanged, they have continuously undergone a sea of upgradations by way of increased accuracies, ease of access for users, and timeliness of delivery. Several new services have been designed and operationalised during 2014-15. To mention a few, the day-to-day forecasts on the three dimensional picture of the coastal waters off the west coast of India at a spatial of resolution of 2.25 km, a system for the prediction of storm surge and the extent of inundation, an online oil spill advisory system that predicts the movement of spill, an atlas of potential fishing zones, rapid expansion of ocean database with the addition of biogeochemical data, fine-scale measurements of the upper layers of Bay of Bengal to understand how the freshwater in that layer influences the heat exchange between the ocean and atmosphere that in turn influences the vigour of the monsoon over the Indian subcontinent.

The observing systems deployed and maintained by us, as well as by our collaborators are continuing to provide quality data, as expected. The mooring in the Bay of Bengal that continuously recorded temperature and salinity data at 4, 7, 10, 15, 25, 50, 100 m depths and currents at 5 and 30 m was successfully serviced in December 2014. The data from this mooring would complement the fine scale measurements being made in the Bay of Bengal under the 'Ocean Mixing and Monsoon' programme undertaken in collaboration with several institutions in India and USA. The Automatic Weather Station network on board ships expanded to 21 and the wave rider buoy network around India has expanded to 10. Other observing systems include the Argo profiling floats, ADCP moorings around India and in the Equatorial Indian Ocean, sea level gauges on the east and west coasts of India and Island chains, tsunami buoys in the Bay of Bengal and Arabian Sea, repeated transects of XBT and XCTDs, satellite tracked surface drifters, repeated transects of bio-optical measurements in the coastal waters, etc.

Our efforts in building capabilities in data assimilation in the ocean models adopted for our waters and the efforts in bio-geochemical modeling are showing encouraging results and will fructify in the coming years. Assimilation of in situ as well as satellite-measured data using the newly developed Localized Ensemble Kalman Filter technique will improve the quality of ocean forecasts substantially. Simulation of the biogeochemical variables using the state-of-the art ocean model opens up the possibility of predicting the ecosystem parameters of coastal waters in the near future. Research on the betterment of ocean models for operational activities is also progressing well.

Another important development during the year was that the three major services provided by ESSO-INCOIS, the tsunami early warnings, the ocean state forecasts and the potential fishing zone advisories have been ISO certified. All these operational services received ISO 9000:2008 certification from the Ministry of Communications and Information Technology, Government of India on 29 December 2014. No doubt, the certification recognizes the quality management adopted for the generation and dissemination of these services. ESSO-INCOIS is committed to maintain this quality and retain the certification forever. In the next phase, we are also preparing to obtain the ISO certification for data services, ocean observations, etc.

The International Training Centre for Operational Oceanography (ITCOocean) continued to attract trainees from Indian Ocean Rim countries and African countries. During the year, ITCOocean conducted 8 short term training courses. Two hundred and seventeen trainees from 16 countries attended the training courses. One of the training courses, "Ocean Colour Remote Sensing - Data, Processing and Applications", was co-sponsored by the Ocean Teacher Global Academy of IODE/IOC. IODE/IOC has also designated ITCOocean as the Regional Training Centre (RTC) of Global Ocean Teacher Academy. Further activities of ESSO-INCOIS on capacity development/ manpower development/skill development include student projects and dissertation work. Fifty students carried out their B.Tech./M.Tech./M.Sc. and summer internships under the guidance of our scientists. In addition, 7 of our scientists taught courses on "Ocean-Atmosphere Modeling" and "Ocean Dynamics" for the Master's students of University of Hyderabad.

Realising the importance of the website for the wide dissemination of information, our in-house team carried out a major overhaul of our website in terms of its look and content by adopting new technologies, specially the web GIS and map services. The new website and the Ocean Data Portal has further eased the accessibility to web services. The new website is accessible through a wider range of web browsers and devices, including mobile phones and tablets.

On the infrastructure front, the construction of residential buildings, community hall and the extension of amenity building has been completed and was inaugurated on 26 December 2014 by the Hon'ble Minister for Science & Technology and Earth Sciences, Dr. Harsh Vardhan in the presence of Shri. Y. S. Chowdary, Hon'ble Minister of State for Science & Technology and Earth Sciences.

'Hindi Pakhwara' was celebrated in September 2014 by conducting competitions for ESSO-INCOIS staff and their children and organizing seminars and symposia.

The scientific staff strength remained at 44 as no additional posts have been sanctioned by the government. However, to carry out the tasks envisaged in the projects, 5 project scientists, 4 project assistants and 1 administrative assistant were recruited on contract basis. Two project scientists and 2 project assistants resigned during the year due to permanent employment opportunities elsewhere.

ESSO-INCOIS continued its association with Indian Ocean Global Ocean Observing System (IOGOOS), Regional Co-ordination of Argo Programme, Partnership for Observation of Global Ocean (POGO), Regional Integrated Multi-hazard Early warning System (RIMES) and Intergovernmental Coordination Group (ICG) of Indian Ocean Tsunami and other hazards Warning System (IOTWS) of Intergovernmental Oceanographic Commission (IOC)/UNESCO. ESSO-INCOIS continued hosting the secretariats of IOGOOS, Sustained Indian Ocean Biogeochemistry and Ecosystem Research (SIBER) and Ocean Bio-Informatics System (OBIS). Two projects, one on "Development and Implementation of an Integrated Ocean Information System for the Indian Ocean Countries" and the other on "Implementation of prioritized technical capacity development projects in RIMES for Afro Asian Region" were funded by MoES through ESSO-INCOIS. RIMES executed these projects in Comoros, Mozambique, Seychelles and Sri Lanka under the guidance and technical help from ESSO-INCOIS. In addition, ESSO-INCOIS played an active role in organising the International Symposium to celebrate the 50th Anniversaries of IIOE and National Institute of Oceanography, Goa and also in ensuring the leadership role of India in the second International Indian Ocean Expedition (IIOE-2) coordinated and promoted by IOC, SCOR and IOGOOS.

The Tsunami Early Warning Centre at ESSO-INCOIS was awarded with the CSI-Nihilent e-Governance special jury award under the best project (G2G/G2C) category in 2008-09. I am pleased with the recognition granted as CSI once again chose the Tsunami Early Warning Centre for the CSI-Nihilent award under the sustainability category in 2013-14.

Before concluding, I would like to thank various groups and individuals. First, I would like to thank Dr. Shailesh Nayak for his excellent chairmanship of the Governing Council and his support and guidance to me. Of course, my thanks to the members of Governing Council for all their support and the time they gave so freely: Thank You all. I also would like to thank the Chairs and members of Financial Committee and Research Advisory Committee for their help and advice in conducting the affairs of ESSO-INCOIS. Secondly, I am grateful for the generous support given by my colleagues in Ministry of Earth Science and at other ESSO centres: NIOT, NCAOR, IITM, NCESS, NCMRWF, IMD, CMLRE, and ICMAM.

I would like to end in the customary manner by thanking all ESSO-INCOIS members of staff. You can all feel proud of your achievements, individually and collectively, over the past year, only some of which are reported here. Thank you for your commitment and hard work.

My special thanks to the Editorial Committee of this report under the chairmanship of Francis and its members Hari, Kiran, Praveen, Ajay, Suprit, Nimit, Celsa, Sidhartha and Nisha. Also, my special thanks to Nagaraj and his team mates Shesu, Patanjali , Hari, Padmanabham and Sidhartha who toiled to get the ISO certification for the three services provided by ESSO-INCOIS.

Finally, not only is it a pleasure to write this introduction, I am proud to do so. Contained in this report are some wonderfully exciting examples of our commitment to apply science for the benefit of our Society. I hope, you will enjoy reading them as much as we enjoyed producing them.

Thank you.

Jai Hind.

S. S. C. Shenoi

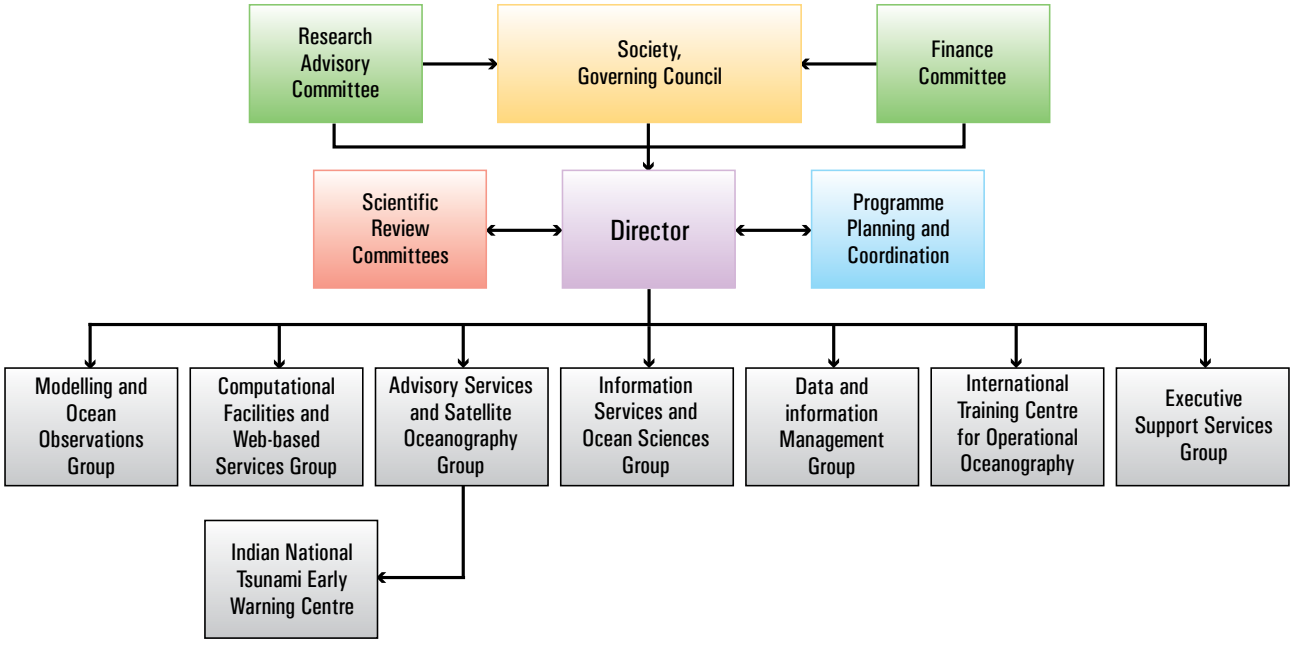
2. ESSO-INCOIS Organizational Structure

ESSO-INCOIS is an autonomous institute under the administrative control of the Ministry of Earth Sciences (MoES), Government of India and a member of the Earth System Science Organization (ESSO), chaired by the Secretary to Government of India for Ministry of Earth Sciences.

ESSO-INCOIS was registered as a society under the Andhra Pradesh (Telengana) Public Societies Registration Act (1350, Falsi), at Hyderabad on 3rd February 1999. The affairs of the Society are managed, administered, directed and controlled, subject to the Bye laws of the Society, by the Governing Council.

2.1 ESSO-INCOIS Society

Secretary, Ministry of Earth Sciences	President
Director, National Remote Sensing Centre, Hyderabad	Vice President
Joint Secretary, Ministry of Earth Sciences	Member
Advisor, Ministry of Earth Sciences	Member
Director, National Institute of Oceanography, Goa	Member
Director, National Institute of Ocean Technology, Chennai	Member
Director, National Centre for Antarctic and Ocean Research, Goa	Member
Director, Indian National Centre for Ocean Information Services	General Secretary



Organisation Structure of ESSO-INCOIS

2.2 ESSO-INCOIS Governing Council

1.	Secretary, Ministry of Earth Sciences, GOI	(Chairman)
2.	Director, National Remote Sensing Centre	(Member)
3.	Director General, India Meteorological Department	(Member)
4.	Financial Advisor, Ministry of Earth Sciences	(Member)
5.	Joint Secretary, Ministry of Earth Sciences	(Member)
6.	Director, National Centre for Antarctica and Ocean Research	(Member)
7.	Dr. S.W.A. Naqvi, Director, National Institute of Oceanography	(Member)
8.	Director, National Institute of Ocean Technology	(Member)
9.	Prof. G.S. Bhatt, Indian Institute of Science	(Member)
10.	Dr. R.R. Rao, Former Scientist 'G', NPOL, Kochi	(Member)
11.	Principal Advisor (S & T), Planning Commission	(Member)
12.	Programme Officer, Ministry of Earth Sciences	(Member)
13.	Director, Indian National Centre for Ocean Information Services	(Member Secretary)

2.3 ESSO-INCOIS Research Advisory Committee

1. Prof. B.N. Goswami, Director, Indian Institute of Tropical Meteorology, Pune, (Chairman)
2. Prof. (Mrs). P. Venkatachalam, Principal Research Scientist, Indian Institute of Technology, Mumbai, (Member)
3. Dr. V.K. Dadhwal, Director, National Remote Sensing Centre, Hyderabad, (Member)
4. Dr. M. Dileep Kumar, Chief Scientist, National Institute of Oceanography, Goa, (Member)
5. Dr. B.K. Saha, Adjunct Professor, School of Oceanographic Studies, Jadavpur University, Kolkata, (Member)
6. Dr. M. Ravichandran, Head, Modelling and Ocean Observations Group, Indian National Centre for Ocean Information Services, Hyderabad, (Member Secretary)

2.4 ESSO-INCOIS Finance Committee

1. Joint Secretary & Financial Advisor, MoES, (Chairman)
2. Additional/Joint Secretary, MoES, (Member)
3. Director, ESSO-INCOIS, (Member)
4. Director/Deputy Secretary (Finance), MoES, (Member)
5. Programme Officer, MoES, (Member)
6. Sri. E. Pattabhi Rama Rao, Scientist, ESSO-INCOIS, (Member Secretary)

2.5 The Mission

To provide ocean data, information and advisory services to society, industry, the government and the scientific community through sustained ocean observations and constant improvements through systematic and focused research in information management and ocean modelling.

The major objectives of ESSO-INCOIS are:

1. To establish, maintain and manage systems for data acquisition, analysis, interpretation and archival for Ocean Information and related services.
2. To undertake, aid, promote, guide and coordinate research in the field of ocean information and related services including satellite oceanography.
3. To carry out surveys and acquire information using satellite technology, ships, buoys, boats or any other platforms to generate information on fisheries, minerals, oil, biology, hydrology, bathymetry, geology, meteorology, coastal zone management and associated resources.
4. To generate and provide data along with value added data products to user communities.
5. To cooperate and collaborate with other national and international institutions in the field of ocean remote sensing, oceanography, atmospheric sciences/meteorology and coastal zone management.
6. To establish Early Warning System for Tsunami and Storm Surges.
7. To support research centres in conducting investigations in specified areas related to oceanic processes, ocean atmospheric interaction, coastal zone information, data synthesis, data analysis and data collection.
8. To organise training programmes, seminars and symposia to advance study and research related to oceanography and technology.
9. To publish and disseminate information, results of research, data products, maps and digital information through all technologically possible methods to users for promoting research and to meet societal needs for improvement of living standards.
10. To provide consultancy services in the fields of ocean information and advisory services.
11. To coordinate with space agencies to ensure continuity, consistency and to obtain state-of -the-art ocean data from satellite observations.
12. To encourage and support governmental and non-governmental agencies/organizations for furthering programmes in the generation and dissemination of ocean information.
13. To undertake other lawful activities as may be necessary, incidental or conducive to the attainment and furtherance of all or any of the above objectives of ESSO-INCOIS.

2.6 Quality Policy

The ESSO-Indian National Centre for Ocean Information Services (ESSO-INCOIS), Earth System Sciences Organization (ESSO), Ministry of Earth Sciences (MoES) is committed to provide the best possible ocean information and advisory services to society, industry, the government and the scientific community through sustained ocean observations and constant improvement through

systematic and focused research. To achieve this, we will continue to align our actions with organizational values & shall ensure our commitment to continually improve our performance with the Quality Management System, by setting and reviewing quality objectives.

3. Highlights during 2014-15

3.1 Early Warning for Storm Surges

A fully automated storm surge forecasting system, using ADCIRC (ADvanced CIRCulation) model, was operationalized for predicting the surge height and the extent of inundation during the landfall of cyclones a few days in advance. Forecasts from this system were found to be quite accurate during the passage of very severe cyclonic storm, Hudhud in October 2014.

3.2 Ocean State Forecasting during severe cyclone Hudhud

ESSO-INCOIS provided very accurate and timely forecasts on the state of the ocean during the passage of cyclone Hudhud (6-14 October 2014). The advisories issued by ESSO-INCOIS, in association with IMD, in the form of joint bulletins has played a significant role in minimizing the loss of life and property.

3.3 High-resolution Operational Ocean Forecast and reanalysis System for the West coast of India

The operationalized HOOFS setup for the west coast of India, is capable of predicting the three dimensional structure of ocean parameters at a very high resolution of 2.25 km x 2.25 km. This setup is the first one in the proposed series of coastal high-resolution forecast systems being developed by ESSO-INCOIS. HOOFS is based on the state-of-the art ocean general circulation model, ROMS and realistic tidal model.

3.4 Experimental setup of the Online Oil Spill Advisory (OOSA) launched

An experimental set up of the Online Oil Spill Advisory System (OOSA) was launched for the benefit of the Indian Coast Guard, port authorities, maritime boards and other agencies involved in clean up measures for oil spills on 12 May 2014 by Vice Admiral Anurag G. Thapliyal, Director General, Indian Coast Gaurd during the 19th NOSDCP meeting held at Chennai.

3.5 PFZ Atlas

An atlas, that was prepared using available PFZ data for all months during 2002 to 2014, was launched during the User Interaction Workshop 2015. The atlas contains analyses based on the

PFZ advisories for a given month. This atlas is a very useful tool to understand variations of PFZs over time and space.

3.6 Ocean Mixing and Monsoon (OMM) Programme

In order to study the turbulent processes in the Bay of Bengal during Monsoon season and to create a reference dataset on the surface fluxes, very fine resolution observations near the surface of the Bay of Bengal were taken as part of the Ocean Mixing and Monsoon programme (OMM), which was undertaken by ESSO-INCOIS with the active participation from sister institutions and collaborations from several US institutes through their ASIRI programme. Last year three dedicated cruises were carried out, two on board ORV Sagar Nidhi and one on board US research vessel RV Roger Revelle. During these cruises, upper ocean data were collected using several state-of-the art instruments like underway CTD (uCTD), microprofiler, Lagrangian float.

3.7 New Website of ESSO-INCOIS and Ocean Data Portal

The website of ESSO-INCOIS has been overhauled using the state-of-the art technology by the ESSO-INCOIS web team. The new website and the ocean data portal was launched on 1 September 2014. The new website has made access to the web services easier. The responsive layout of the website also enables access through a wider range of web browsers and devices, including mobiles and tablets.

3.8 Residential quarters for the staff inaugurated

Hon'ble Union Minister for Science & Technology and Earth Sciences, Dr. Harsh Vardhan inaugurated the recently constructed on-campus staff quarters and multipurpose complex on 26 December 2014 in the presence of Hon'ble minister of state, Dr. Y. S. Chowdary.

3.9 16th Foundation Day on 3 February 2015

The 16th Foundation Day of ESSO-INCOIS was celebrated with an "Open Day" for school and college students which included a detailed tour of the Centre and interaction with staff. The Foundation Day lecture was delivered by Prof. Goverdhan Mehta, National Research Professor, School of Chemistry, University of Hyderabad. Over 833 students from 11 schools and 2 colleges in Hyderabad visited ESSO-INCOIS during the Open Day.

3.10 ESSO-INCOIS received ISO 9000:2008 certification

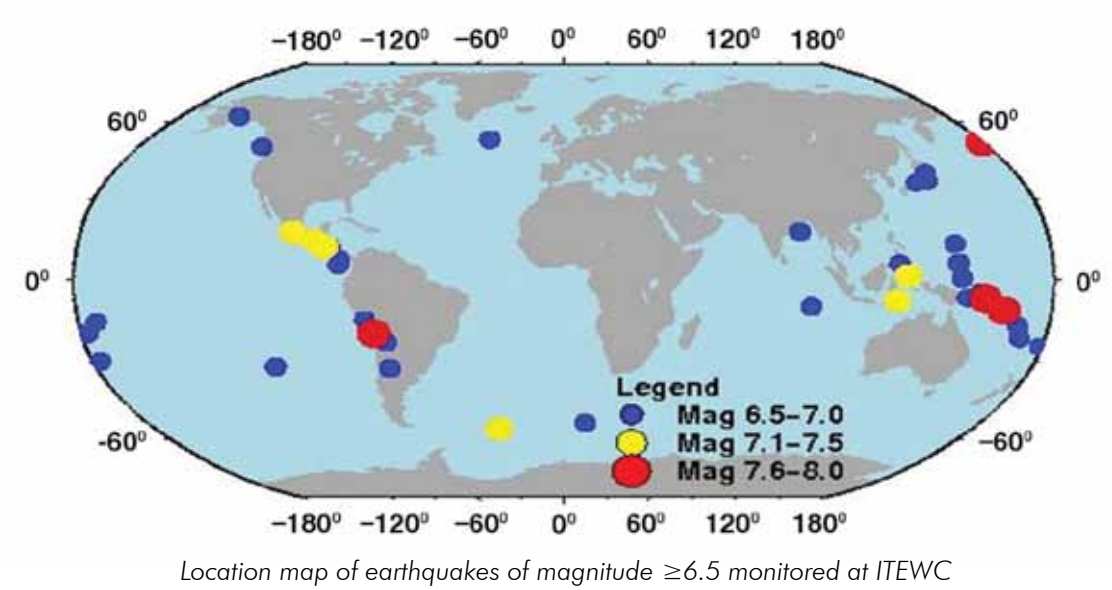
In recognition of the establishment and maintenance of the quality management system for generation and dissemination of the services, which complies with the requirement of ISO certification, ESSO INCOIS received ISO 9000:2008 certification from Ministry of Communications and Information Technology, Government of India on 29 December 2014.

4. Services from ESSO-INCOIS

4.1 Multi-hazard Early Warning System

4.1.1 Tsunami Early Warning

Being the tsunami service provider for the Indian Ocean Rim countries, Indian Tsunami Early Warning Centre (ITEWC) monitored 49 earthquakes of magnitude ≥6.5 during 2014-15 and bulletins have been disseminated to both, National Tsunami Warning Centres (NTWCs) and Tsunami Service Providers (TSP) in the region. Out of 49 earthquakes, only 2 major earthquakes occurred in the Indian Ocean region. There was no tsunami threat in the past one year in the Indian Ocean.



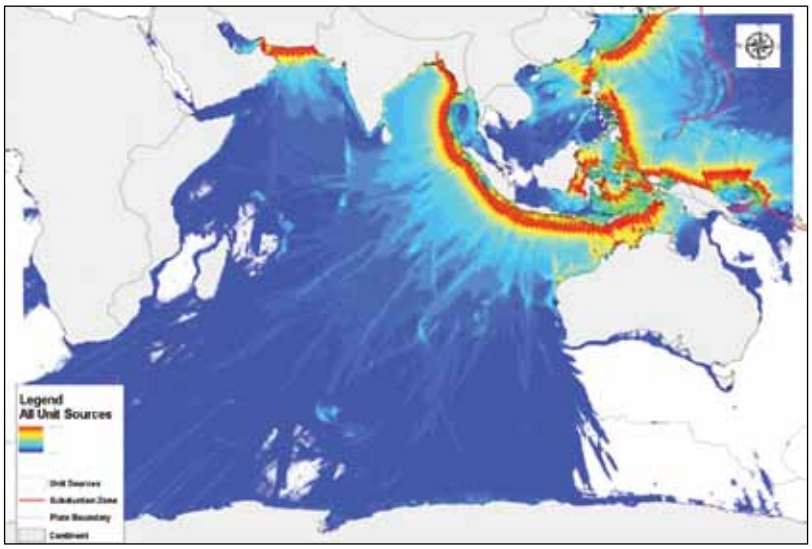
Location map of earthquakes of magnitude ≥6.5 monitored at ITEWC

Table: 4.1 Average performance statistics of ITEWC during April 2014 - March 2015

Sr#	Parameter	Targets	Performance
1	Elapsed time from EQ to initial EQ info issuance (local/distant)	10/15 min	11.2 min
2	Probability of detection of Indian Ocean EQ with Mw ≥6.5	100 %	Achieved
3	Accuracy of hypocentre location	within 30 km	12.45 km
4	Accuracy of hypocentre depth	within 25 km	21.5 km
5	Accuracy of earthquake magnitude (Mw)	0.3	0.22
6	Reliability of RTWP operations (power, computer, communications etc.)	99.5%	Achieved
7	Contact information updated & quarterly communication tests		COMMs test held on 11 June, and 10 December, 2014

4.1.2 Tsunami Modeling

In addition to the two known tsunamigenic sources in the Indian Ocean, scenarios based on the earthquakes in other zones in the region such as Java Sea, Banda Sea, Celebes Sea were also generated for the operational tsunami warning. Seven hundred and forty four (744) unit sources were considered within these zones. The Indian Ocean modeling domain with 2.5 km resolution had been expanded to 30^{0}N-70^{0}S, 10-160^{0}E to also cover the sources in the South China Sea. Simulations up to 25 hours after the occurrence of an event were generated using this model configuration.



Indian ocean subduction zones used for the tsunami modeling

4.1.3 Communication Test (COMMs Test) & Tsunami Mock drill (IOWave14)

a) COMMs Test

Two COMMs tests (on 11 June 2014 and 10 December 2014) were conducted to assess the dissemination process of TSPs to respective NTWCs, validate the dissemination processes for tsunami notification messages with national disaster management contacts, to ascertain the reception of the notification messages by NTWCs and to assess the accessibility of TSP password-protected web sites by NTWCs. During both the tests, ITEWC disseminated notification messages to 23 NTWCs and the other two TSPs (Australia and Indonesia) in the Indian Ocean and also received notification messages from other TSPs.

b) IOWave14 Exercise - Tsunami mock drill

As per ICG/IOTWS recommendations, a tsunami mock drill, 'IOWave-14' was conducted during 9-10 September 2014. ITEWC participated in the drill in capacity of being the NTWC as well as the TSP for the Indian Ocean region. As part of the drill, the warning system was tested based on two scenarios simulated on successive days, one in the eastern Indian Ocean and the other in the Northwest Indian Ocean. First scenario simulated a 9.1M earthquake south of Java, Indonesia

(10.4^{0}S, 112.8^{0}E) during 0530-1730 IST. Second scenario simulated a 9.0 M earthquake in the Makran Trench, south of Iran and Pakistan (24.8^{0}N, 62.2^{0}E) during 1130-2330 IST on next day. ITEWC generated and disseminated 15 tsunami bulletins during each day, targeting national and regional contacts.

ITEWC staff disseminating test bulletins during IOWave14 Exercise

Twenty three countries of the IO region participated in the drill. ITEWC disseminated the bulletins to all NTWCs. Recipients at the national level included control rooms of NDMA, MHA, disaster management offices of coastal state/UTs, National Disaster Response Force, Indian Coast Guard, Indian Navy, Port Authorities, Nuclear Power Stations, etc. Participant agencies took the drill down to different levels, involving field units, local officials, line departments and the public. Authorities carried out village/community level evacuation in Puducherry and Odisha. Last-mile communication systems such as SMS-based alerts and megaphones were used by the local authorities to alert the coastal population.

Table: 4.2 Time taken to notify public in the tsunami mock drill

Activity	**Elapsed Time (in mins)**	
	Odisha	**Puducherry**
Making a decision on public warning (from time of receipt of warning)	10	20
Formulation of public notification (from time of decision)	5	15
Activation of public notification systems (from time of notification formulated)	5	15
Total Time	20	50

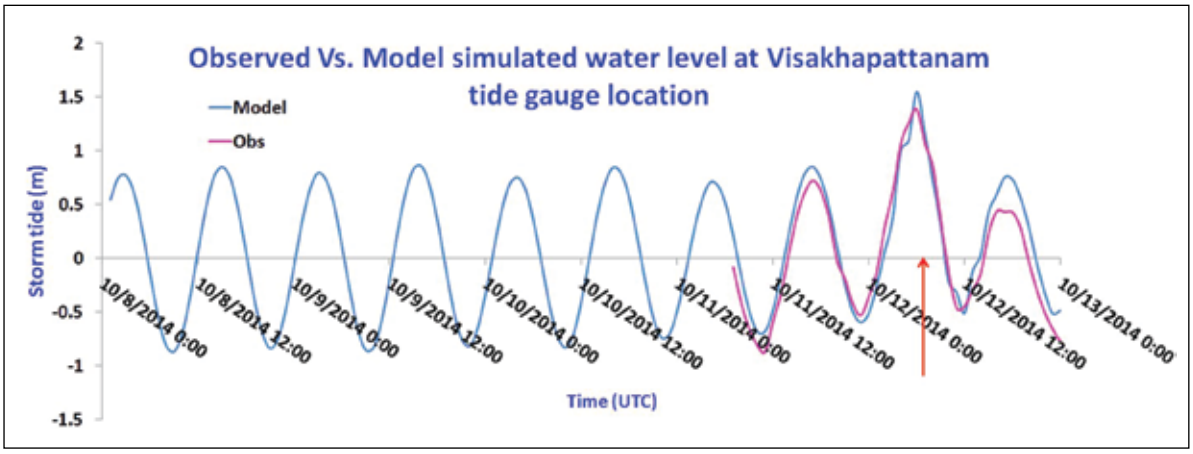
4.1.4 Studies on Paleo-Tsunami

Studies on paleo-tsunamies were conducted through the projects outsourced to principal investigators from six universities/institutes. Core samples collected from Chouldari, Wandoor and Sippighat, Port Blair, South Andaman in the Andaman & Nicobar islands were examined to study paleo tsunamis. The analysis of the cores obtained from Port Blair suggested that there are at

least eight event layers including the 2004 tsunami. The AMS radiocarbon dating from Wandoor revealed two paleo tsunamis dating to 1535±30 yr BP and 2875±35 yr BP. Of these dates, the event around 2875 yr BP correlates well with dates obtained from the cores in Srilanka.

4.1.5 Storm Surges Early Warning

A fully automated storm surge forecasting system, using ADCIRC (ADvanced CIRCulation) model, was operationalized for predicting the surge and the extent of inundation during the occurrence of cyclones. Forecasts from this system were found to be accurate during the passage of very severe cyclonic storm, Hudhud in October 2014.



Model computed surge heights compared with observations for Visakhapatnam

4.1.6 Decision Support System for Storm Surge Early Warning

ESSO-INCOIS has developed an in-house Decision Support System (DSS) for storm surge early warning. It features heterogeneous input data processing, preparing the model inputs and launch of the model on high performance computing facility in real time, assessment, visualization, analysis, warning and dissemination. DSS is developed as a modular tool that complies with the industry standards and uses more than one technology solution to arrive at a decision. Within the DSS, all results are pooled, updated and used in combination with geospatial data sets (including storm surge modeling and risk analysis results) for a detailed assessment of each situation. Such an assessment is useful for the decision makers to evaluate the potential of storm surge, expected wave height along the coast and extent of its inundation.

4.1.7 Portal for Storm Surge Forecasts

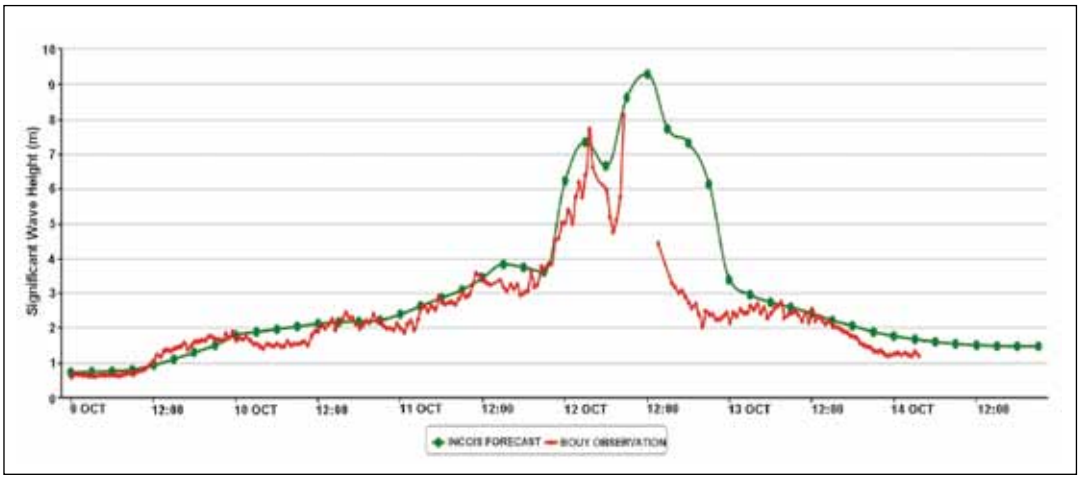
A user-friendly portal for storm surge warning, with text and graphic information, was developed and integrated on the ESSO-INCOIS website (http://www.incois.gov.in/portal/stormsurge) Bulletins were published in real time for testing purpose during VSCS-Phailin in 2013 and the same was made operational during Hudhud cyclone. Additionally, the WebGIS facility is enabled to allow a user to overlay satellite images and cyclone track and assess the threat of storm surge and inundation.

4.2 Ocean State Forecast

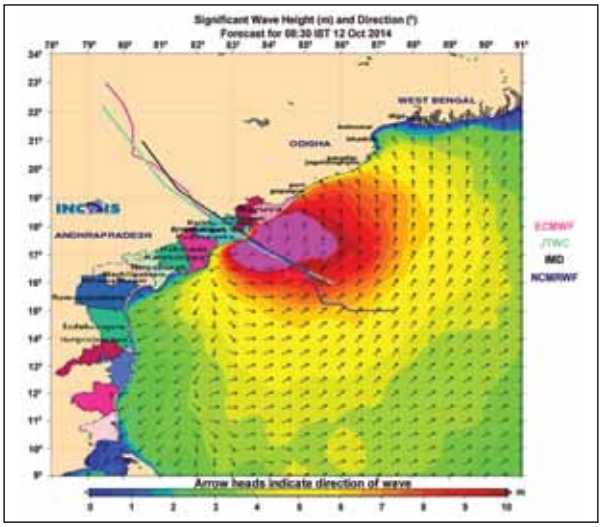
The Ocean State Forecast Services, a critical arm of ESSO-INCOIS, has continued to provide quality forecast and advisory services to a wide spectrum of users which include fishermen, ports and shipping industry, defence, oil and energy exploration agencies, disaster management authorities, etc. Most of the services and products were developed after understanding the requirement of users with the support of focused research and developmental activities, using datasets generated by the observational network and ocean models.

4.2.1 Ocean State Forecasts during severe cyclone Hudhud

The advisories issued by ESSO-INCOIS in association with IMD, in the form of joint bulletins, during the passage of cyclone Hudhud (6-14 October 2014) played a significant role in minimizing the loss of life and property. The wave rider buoys and automatic weather stations deployed off the

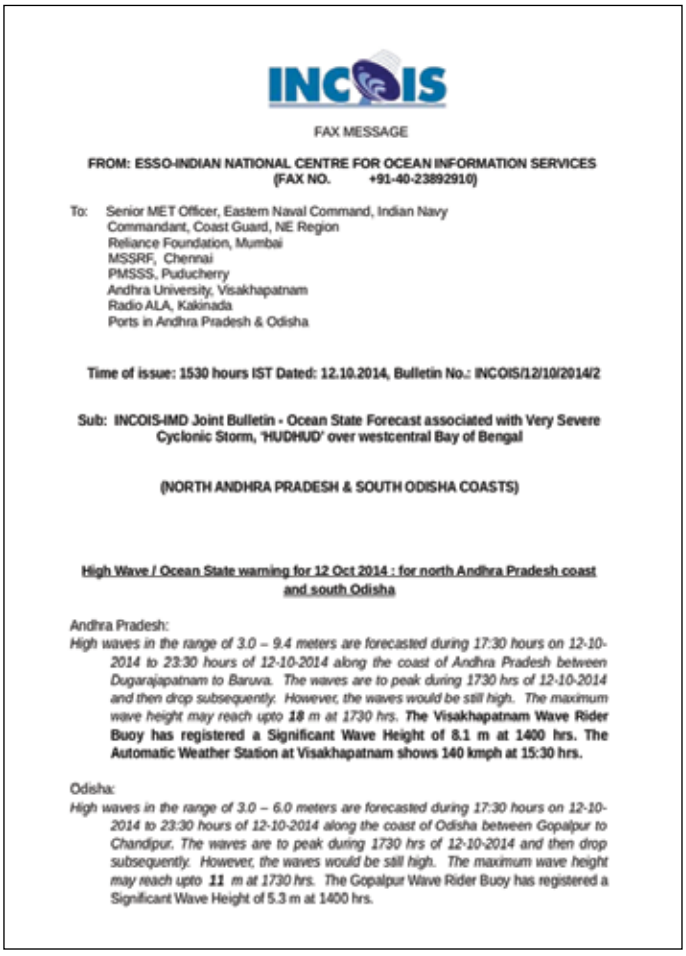


Observed and predicted significant wave heights off Visakhapatnam during the passage of cyclone Hudhud on 12 October 2014



Snapshot of the spatial variation of significant wave height predicted by ESSO-INCOIS. The cyclone tracks predicted by by ESSO-IMD, JTWC, NCMRWF and ECMWF are also shown

coast of Visakhapatnam and Gopalpur by ESSO-INCOIS were very useful in providing real-time marine and meteorological information, which were essential for providing accurate forecasts during the passage of the cyclone. The significant wave height recorded by the wave rider buoy off the coast of Visakhapatnam reached the highest value of 8.1m at 1400 hrs IST, while the forecasted wave height was 8.4m. The automatic weather station on board RV Kaustubh, a research vessel that was stationed in the Visakhapatnam harbour recorded a maximum wind speed of 204 kmph (averaged over 15 minutes).



FAX MESSAGE

FROM: ESSO-INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES
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To: Senior MET Officer, Eastern Naval Command, Indian Navy
Commandant, Coast Guard, NE Region
Reliance Foundation, Mumbai
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Andhra University, Visakhapatnam
Radio ALA, Kakinada
Ports in Andhra Pradesh & Odisha

Time of issue: 1530 hours IST Dated: 12.10.2014, Bulletin No.: INCOIS/12/10/2014/2

Sub: INCOIS-IMD Joint Bulletin - Ocean State Forecast associated with Very Severe Cyclonic Storm, 'HUDHUD' over westcentral Bay of Bengal

(NORTH ANDHRA PRADESH & SOUTH ODISHA COASTS)

High Wave / Ocean State warning for 12 Oct 2014 : for north Andhra Pradesh coast and south Odisha

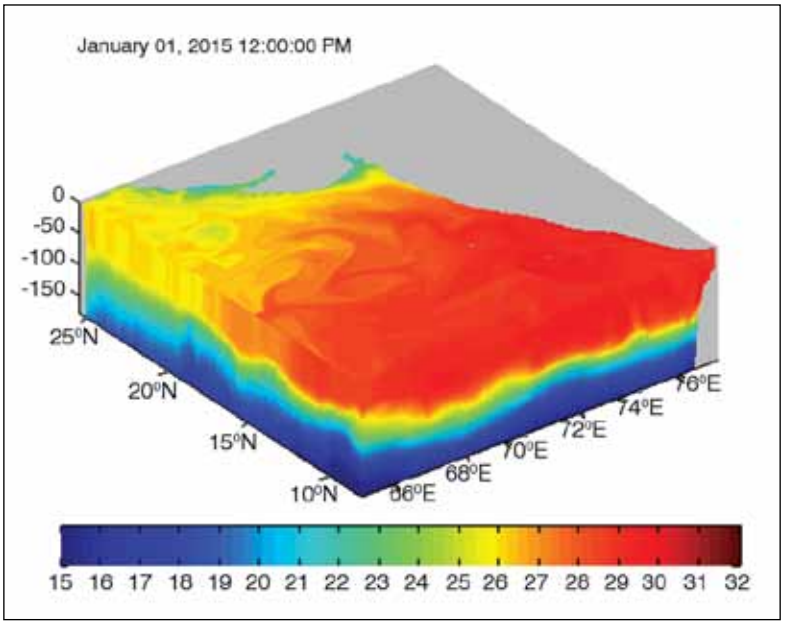
Andhra Pradesh:
*High waves in the range of 3.0 – 9.4 meters are forecasted during 17:30 hours on 12-10-2014 to 23:30 hours of 12-10-2014 along the coast of Andhra Pradesh between Dugarajapatnam to Baruva. The waves are to peak during 1730 hrs of 12-10-2014 and then drop subsequently. However, the waves would be still high. The maximum wave height may reach upto **18** m at 1730 hrs.* **The Visakhapatnam Wave Rider Buoy has registered a Significant Wave Height of 8.1 m at 1400 hrs. The Automatic Weather Station at Visakhapatnam shows 140 kmph at 15:30 hrs.**

Odisha:
*High waves in the range of 3.0 – 6.0 meters are forecasted during 17:30 hours on 12-10-2014 to 23:30 hours of 12-10-2014 along the coast of Odisha between Gopalpur to Chandipur. The waves are to peak during 1730 hrs of 12-10-2014 and then drop subsequently. However, the waves would be still high. The maximum wave height may reach upto **11** m at 1730 hrs.* The Gopalpur Wave Rider Buoy has registered a Significant Wave Height of 5.3 m at 1400 hrs.

ESSO-INCOIS-IMD joint bulletin issued during the landfall of cyclone Hudhud on 12 October 2014

4.2.2 High-resolution Operational Ocean Forecast and reanalysis System (HOOFS) for the west coast of India

HOOFS setup for the west coast of India (65-77.5^{0}E, 8-26^{0}N) is capable of predicting the three dimensional structure of ocean parameters at a very high resolution of 2.25 km x 2.25 km. This setup is the first one of the proposed series of coastal high-resolution forecast systems being developed by ESSO-INCOIS. HOOFS is based on the state-of-the art ocean general circulation model, ROMS, specifically fine tuned for this region. Since the circulation in the west coast, particularly in the northern parts is dominated by tidal forcing, a realistic tide model is incorporated in the HOOFS setup. The forecasts from this system are used for generating several value added products such as forecasts along the ship routes, oil-spill trajectory prediction system etc.



Three dimensional structure of the ocean temperature predicted by the HOOFS setup for the west coast of India for 00:00 hrs of 1 Jan 2015

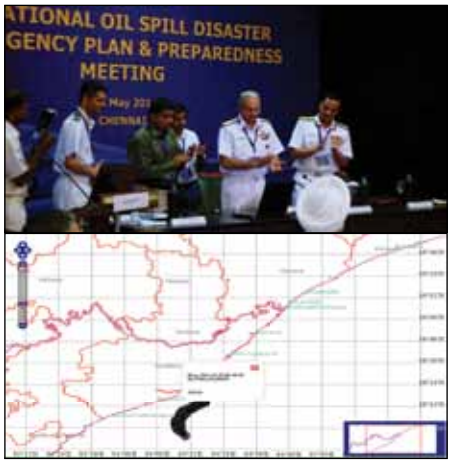
4.2.3 Location-specific OSF systems for Gujarat

The location-specific Ocean State Forecast systems for Okha, Jakhua and Veraval of Gujarat coast was inaugurated on 15 November 2014 at Okha, Gujarat. The system for Okha (along with Jakhua) was inaugurated by the Honourable Minister of Agriculture and Co-operation, Government of Gujarat, Shri. Babubhai Bokhiriya; and the system for Veraval by Honourable MLA of Dwaraka, Shri. Pabubha Virambha Manek. More than 250 fishermen participated in the function. More than 2000 mobile users from Okha, Jakhua and Veraval are daily benefitted by forecast dissemination over SMS.

The inauguration of location-specific Ocean State Forecast systems for Okha, Jakhua and Veraval on 15th November 2014 at Okha, Gujarat

4.2.4 Experimental setup of Online Oil Spill Advisory (OOSA)

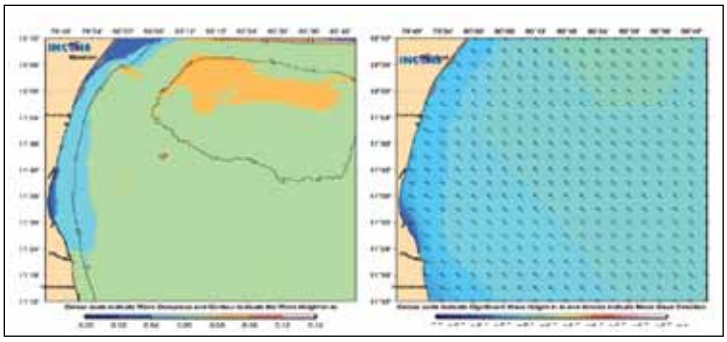
An experimental setup of the Online Oil Spill Advisory System (OOSA) was launched on 12 May 2014 by Vice Admiral Anurag G. Thapliyal, Director General, Indian Coast Guard during the 19th NOSDCP meeting held at Chennai. The OOSA system will provide necessary advisories on the oil-spill trajectory for the benefit of the Indian Coast Guard, port authorities, maritime boards and other agencies involved in clean up measures. The system comprises of an oil spill tracking model, GNOME, and a web interface. OOSA takes the necessary input parameters from the users and provides an advisory based on the track and dispersion details simulated by the GNOME model, forced with surface wind and ocean current forecasts, generated at ESSO-INCOIS. Currently, the experimental setup of the online oil spill advisory system is available only for the coastal waters of India. Several officials from the Indian Coast Guard, Reliance Industries Limited, Oil and Natural Gas Commission, Ports have registered as users.



Operational Oil Spill Advisory service being launched by Vice Admiral Anurag G. Thapliyal Director General, Indian Coast Guard

4.2.5 Wave forecasts using SWAN wave model

Very high resolution (250 x 250 m) wave forecasts for the coast of Puducherry using the SWAN wave model is now being generated and disseminated on operational basis. Three-hourly outputs from the model include wave height & direction, swell height & direction and 'wave steepness'. The forecast is for a lead time up to 3 days.

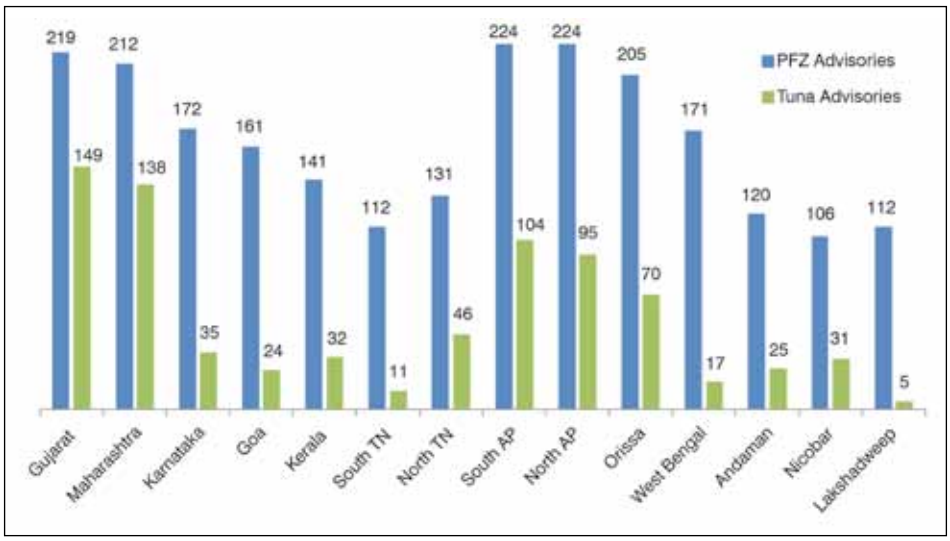


Predicted wave steepness (left) and significant wave height (right) issued by the operational setup based on SWAN wave model for the Puducherry coast for 20:30 hrs on 27 October 2014

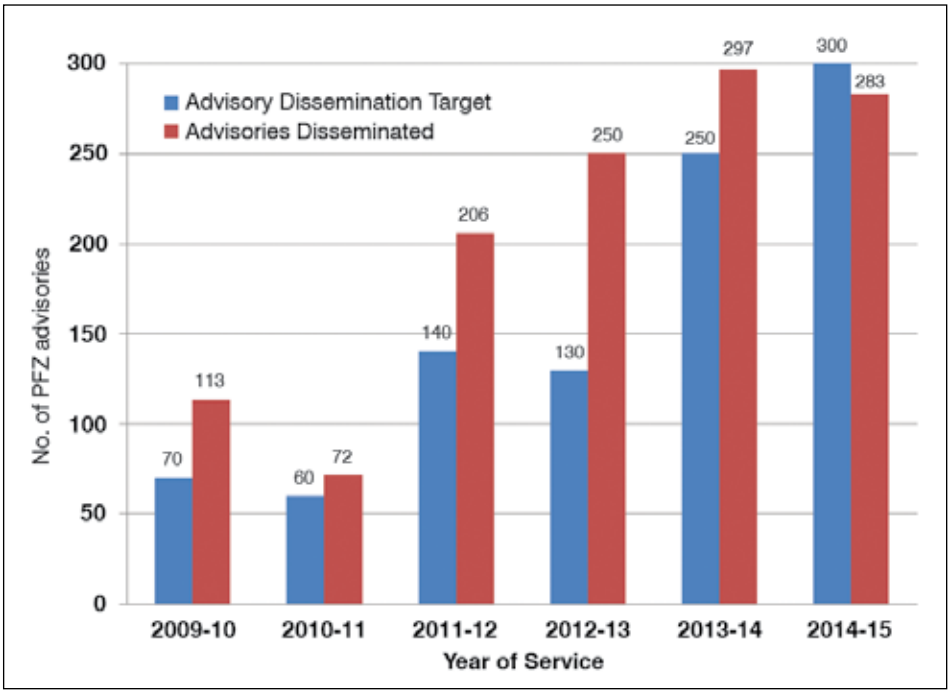
4.3 Marine Fishery Advisory Services

4.3.1 Potential Fishing Zone and Tuna Fishing Advisories

ESSO-INCOIS continued to provide advisories on potential fishing zones and tuna fishing to targeted users in the last year also and ensured that the advisories reached the users on time so that they could effectively make use of them. Two hundred and eighty three multilingual Potential Fishing Zones (PFZ) advisories and 191 species specific advisories for Tuna were issued during 1 April 2014 to 31 March 2015. The advisories were generated and disseminated as smart maps and in text formats on a daily basis, depending on the availability of satellite data. The advisories were not provided during the fishing ban period and during adverse sea state.



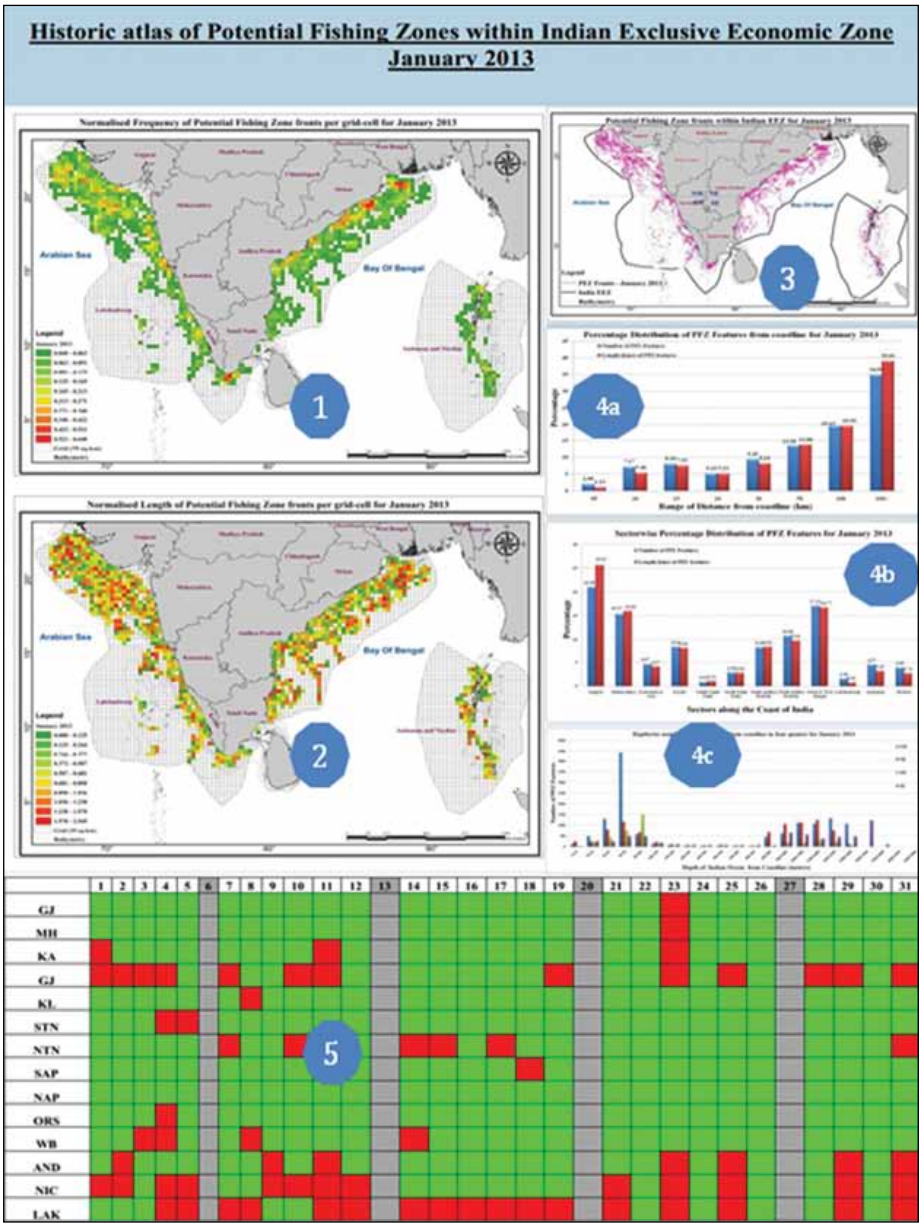
Number of PFZ and Tuna advisories disseminated during April 2014-March 2015 for each sector



Number of PFZ Advisories disseminated against the target

4.3.2 PFZ Atlas

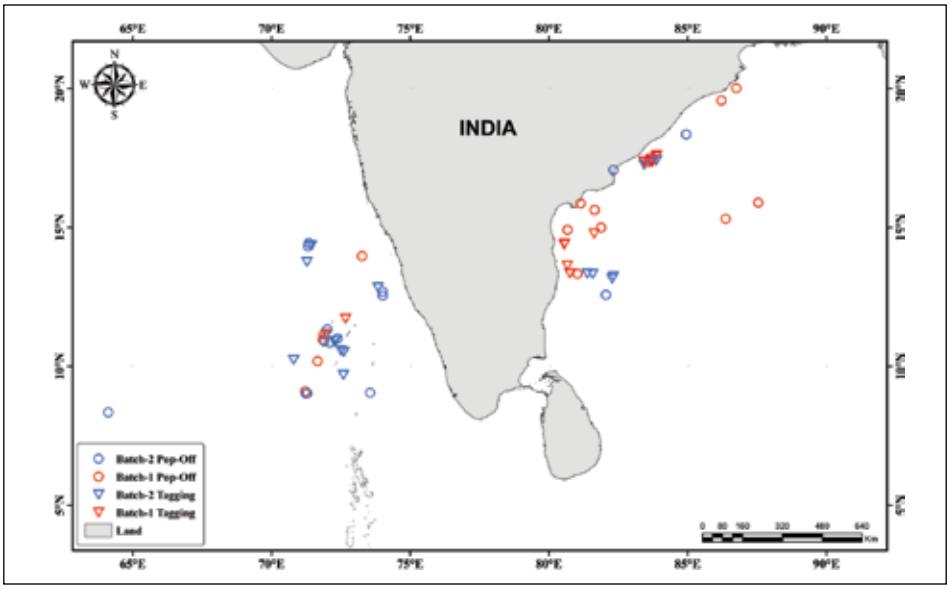
An atlas was prepared using available PFZ data for all the months during 2002 to 2014. The atlas contains analyses based on the PFZ advisories for a given month. The atlas was released during the User Interaction Workshop 2015. This atlas is a very useful tool to understand the variations of the occurrence of PFZ over time and space. This will also serve as a benchmark observation for future modelling efforts to understand the variability of PFZs and generate gap-free products during cloudy days.



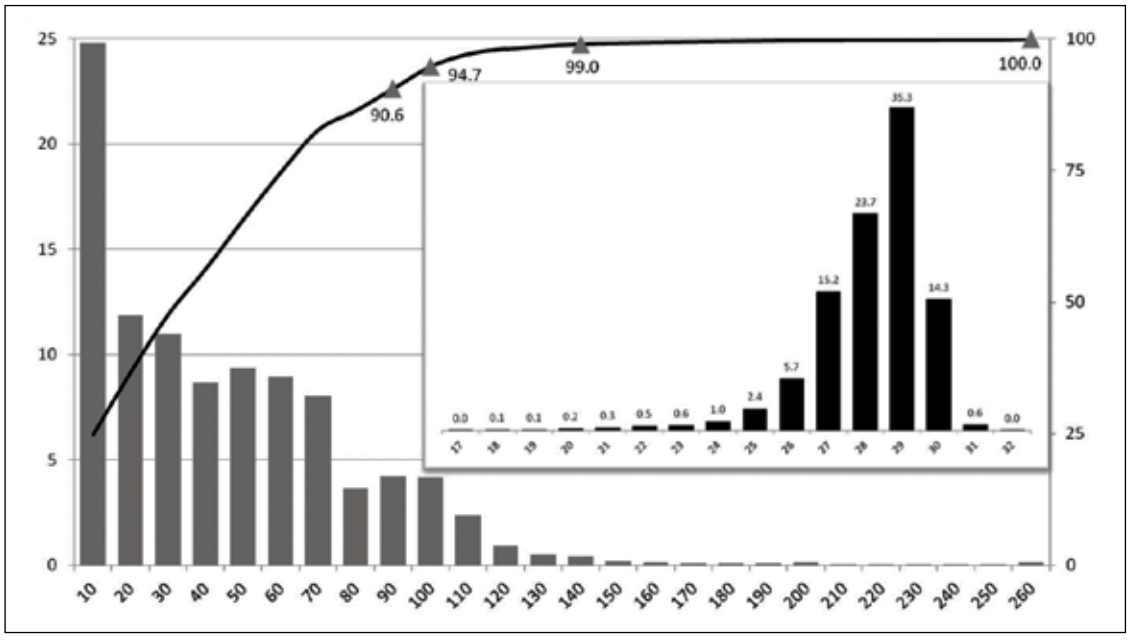
Sample figures from the PFZ Atlas. Numbers denote sections such as 1) spatial distribution of PFZ frequency, 2) spatial distribution of PFZ length, 3) monthly composite of PFZ, 4) monthly distribution of PFZs w.r.t. (a) distance from coast, (b) sector and (c) bathymetry, 5) date-wise availability of PFZ data for each sector during a month

4.3.3 SATTUNA

To improve the species specific advisories for Tuna fish by understanding their ecological preferences, 42 Yellowfin Tuna *(Thunnus albacares)*, were tagged during December 2011-March 2014 under the multi-institutional SATTUNA (Satellite Telemetry studies on migration patterns of Tunas in Indian Seas) project. It was found that Tuna shows affinity toward surface waters and no significant deep diving behaviour was observed. The Tuna mostly inhabited depths ranging between surface and 100 metres. It was also noted that Tuna fish never dived below 350 metres.



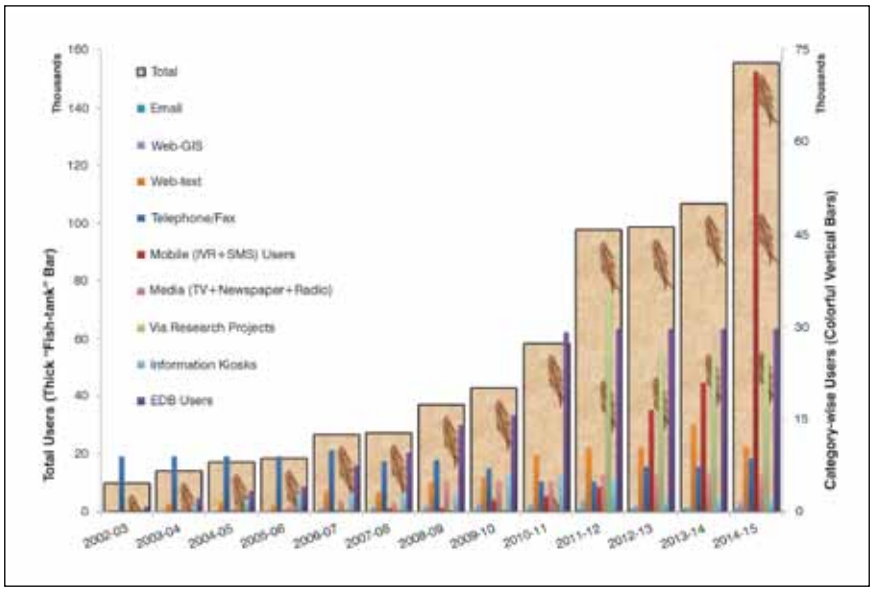
Locations of Yellowfin Tuna tagged and where they popped-up for batch-1 (with pressure and temperature sensors) and batch-2 (with pressure, temperature and light sensors.) PSATs



Percentage of Yellowfin Tuna found at different depths. X-axis: depth in metres

4.3.4 MFAS Services User base

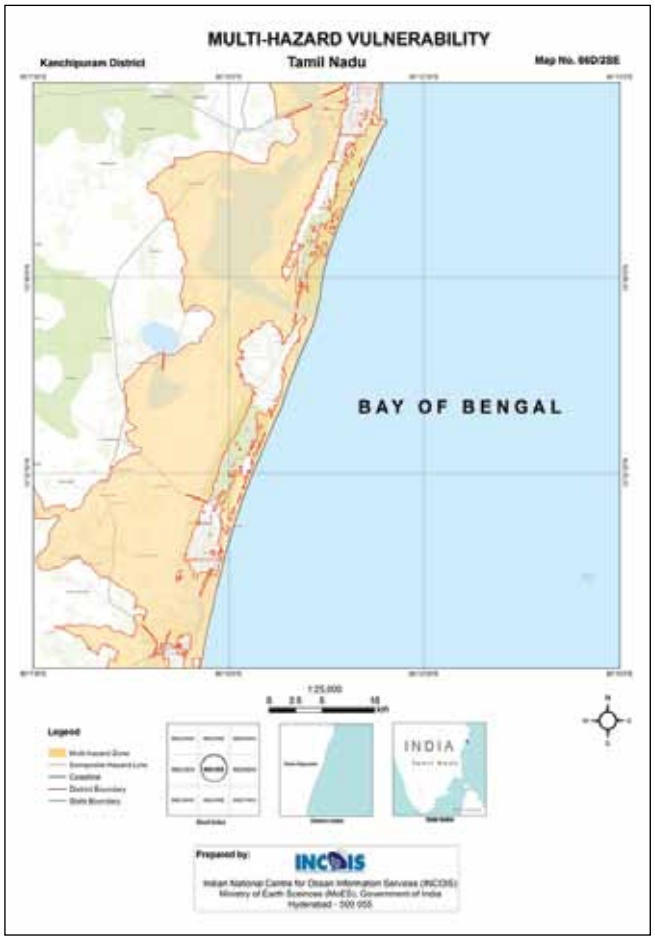
User base of MFAS services continued to grow during 2014-15. The partner NGOs expanded their reach in Kerala with a seasonal calendar of fish availability as well as a helpline in Malayalam. Recognizing the potential of mobile phones as a mode to reach out to the end users, ESSO-INCOIS started multilingual SMS service with PFZ advisories. An Android app to fetch the PFZ advisory on mobile phones was also developed and launched (beta version) during the User Interaction Workshop 2015.



Graph depicting the growth of the PFZ users availing different modes of communication

4.4 Coastal MHVM (Multi-Hazard Vulnerability Mapping)

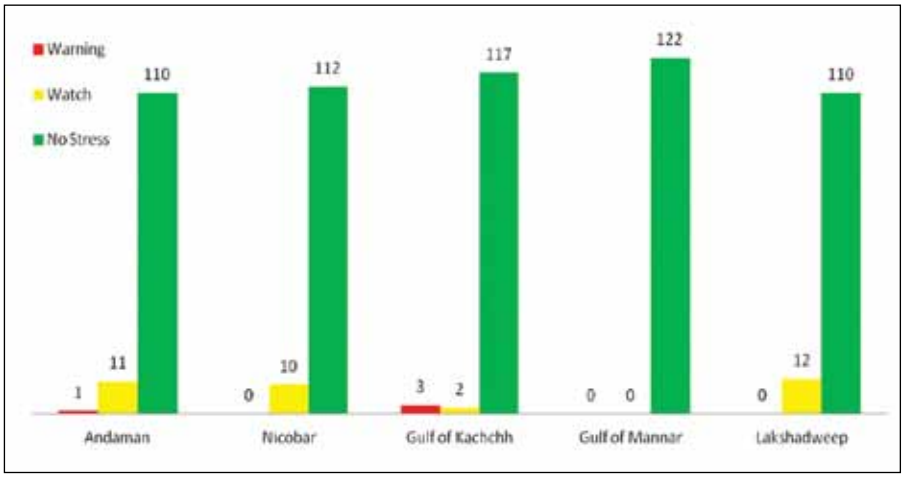
ESSO-INCOIS has taken up the Multi-Hazard Vulnerability Mapping (MHVM) project with an objective to identify the regions which are most vulnerable to process line changes in the sea level and shoreline due to several reasons. The vulnerability along the entire coastal belt of the country was carried out using the parameters such as sea level trend, shoreline change rate, contours, extreme water level and the return periods. Coastal topography at 0.5 m contour interval was generated from ALTM and Cartosat-1 DTM data. Sea level trend was calculated from tide gauge data and shoreline change rate was calculated using satellite imagery. The extreme sea level was computed for a return period of 100 years. Cumulative distribution function (CDF) of extreme water/sea levels and their return periods for all the tide gauge locations were calculated. These maps form a useful baseline information for the disaster management. High vulnerable areas were identified from MHVM for the coastal stretch between Kochi and Paradeep. 3D GIS mapping on 1:10000 scale will be carried out in these selected vulnerable areas. In the first phase, coastal regions in Pondicherry, Cuddalore and Machilipatnam were surveyed. The development of visualization and analysis system for this 2D/3D geospatial data (3DVAS) has already been initiated.



Sample map of MHVM Atlas

4.4.1 Coral Bleaching Alert System

Satellite based Coral Bleaching Alerts were provided as advisories on the hotspots, degree of heating weeks and the variation of SST anomalies on bi-weekly basis. Coral Bleach Warnings were issued for Andaman and Gulf of Kachchh regions and Coral Bleach Watches were issued for Lakshadweep and Nicobar. No warning or watch was issued for Gulf of Mannar. The advisories were disseminated through web service.



Numbers of Coral bleaching advisories issued during 2014-15

4.5 Data Services

Being the National Oceanographic Data Centre (NODC) as designated by International Oceanographic Data Exchange (IODE) of the Intergovernmental Oceanographic Commission, ESSO-INCOIS sustained and strengthened the data reception, processing and quality control of meteorological and oceanographic data from a wide variety of observing systems, including Argo floats, moored buoys, drifting buoys, wave rider buoys, tide gauges, wave height meters, ship mounted autonomous weather stations and HF radars. Datasets were regularly disseminated to various operational agencies in the country through email/web-site/FTP in near-real time.

In order to manage heterogeneous data efficiently, ESSO-INCOIS improved the process chains for the data received from INSAT and moored buoys deployed by ESSO-NIOT. The data centre also obtained and archived in situ data from various ocean observing systems such as XBT/XCTD, meteorological observations from NODPAC, OMNI buoys and from the CTCZ programme in delayed mode. Notable additions are the biogeochemical and physical data obtained from various cruises conducted by CMLRE (FORV Sagar Sampada) and the data from equatorial current meter moorings deployed and maintained by NIO. Processing of physical, chemical and biological

Programme (Institute)	**Parameters**	**Period of Observation**	**No. of Platforms / Stations Reported**	**Status**
XBT, XCTD (CSIR-NIO)	T Profiles	Apr 2014 – Mar 2015	60 profiles	Updated in the database
	T & S Profiles	Apr 2014 – Mar 2015	32 profiles	
Met Observations along Ship track (NODPAC)	Surface met parameters	Jan 2013 – Dec 2014	6257 records	Archived
RAMA buoys (PMEL)	Met-Ocean parameters	Apr 2014 – Mar 2015	19 buoys	Updated in the database
Ship-mounted AWS (ESSO-INCOIS)	Met parameters	Apr 2014 – Mar 2015	19 stations	Updated in the database
Wave rider buoys (ESSO-INCOIS)	Wave parameters	Apr 2014 – Mar 2015	10 buoys	Updated in the database
Wave Height Meter (ESSO-INCOIS)	Wave Parameters	Apr 2014 – Mar 2015	1 station	Updated in the database
Equatorial Current Meter Mooring (CSIR-NIO)	Currents	2000 – 2013	Archived	
CTCZ	Met-Ocean	Monsoon 2013	Archived	
Hydrographic data from FORV Sagar Sampada (ESSO-CMLRE)	Physical and Biogeochemical	Cr. No. 201 to Cr. No. 320	Archived	

oceanographic data received from ICMAM for the period 2002-2007 was initiated. Details of the data received are summarized above.

4.5.1 Ocean Remote sensing data products

Remote sensing data from various sensors on board Oceansat-2 as well as data from NOAA, MetOp and MODIS series of satellites were received in real time at the ESSO-INCOIS ground station. Data were processed and made available for in-house operational activities as well as for other operational agencies in the country. In addition, data from past missions by India (Oceansat-1) and other countries are also archived as detailed below.

Sensor/satellite	Parameters	Period
NOAA AVHRR	Sea Surface Temperature, Fog, Brightness temp's, Cloud Top Temperatures and Normalized Difference Vegetation Index (NDVI)	2005–Till date
MODIS (Terra and Aqua)	Sea surface temperature and chlorophyll (Several other atmospheric and ocean parameters can also be generated using the radiance data obtained from this sensor)	2005–Till date
OCM (Oceansat-2)	Chlorophyll-a, Total Suspended Sediments, Diffuse Attenuation Coefficient (Kd490) and Aerosol Optical Depth (AOD) over Ocean	2011–Till date
Altimeter (TOPEX)	Wave height, sea level, sea ice	1996–2007
TMI (TRMM-TMI)	SST, rainfall, wind speed	1997–2007
QuikSCAT	Wind vector	1998–2007
SeaWiFS	Chlorophyll	1997–2005

4.5.2 Other data products and activities:

Area of Interest (AoI) based product dissemination system: Our Data centre initiated an AoI-based product dissemination system to provide real-time satellite data for cruise operations. Image file size is kept minimum to facilitate transmission and reception at research vessels. These products were provided to CSIR-NIO during their cruise in April, 2014 and February, 2015 and to OMM cruise during 22 August - 8 September, 2014.

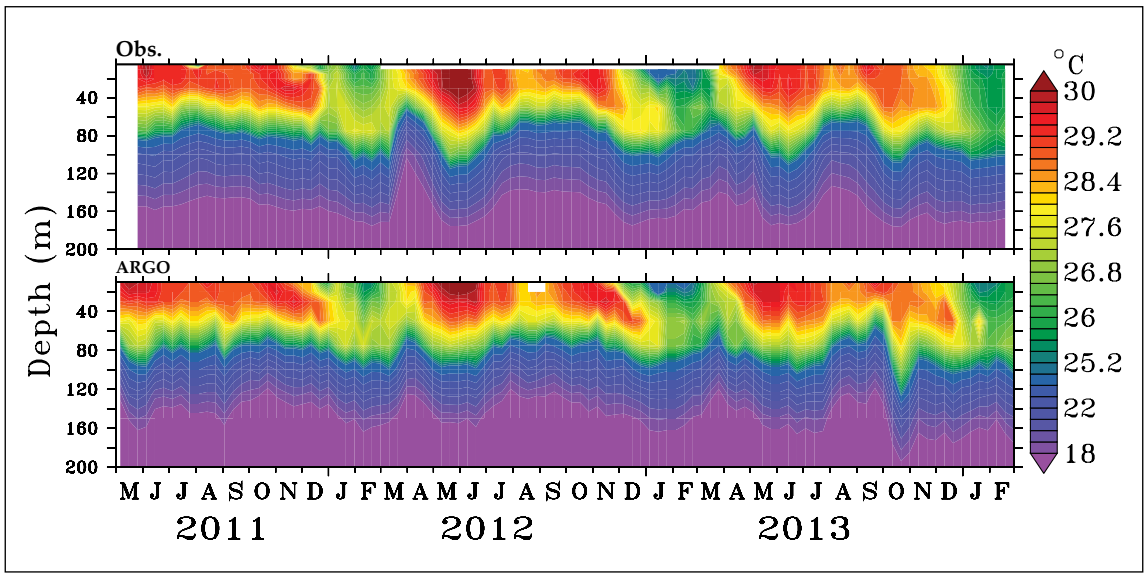
CMLRE cruise data: ESSO-CMLRE has been regularly conducting research cruises to make observations on bio-geo-chemical and physical properties of the ocean for the past several years.

ESSO-INCOIS obtained the data collected through 139 cruises on board FORV Sagar Sampada. Raw data were processed and preliminary quality checks were applied. ESSO-INCOIS data centre had also obtained 45 physical records of earlier cruises (Cruise No: 1 – 45) from FORV Sagar Sampada. Details of the data archived so far are as follows.

Data	Observations	Cruises	Time Period
Zoo plankton	1170 Profiles	165 – 302 (60)	1998 – 2012
Phytoplankton	260 Observations	262 – 314 (16)	2009 – 2013
Water Quality	2076 Observations	165 – 304 (78)	2008 – 2012
Primary Productivity	499 Observations	166 – 314 (42)	1998 – 2013
CTD	3390 Profiles	165 – 325 (104)	1998 – 2014

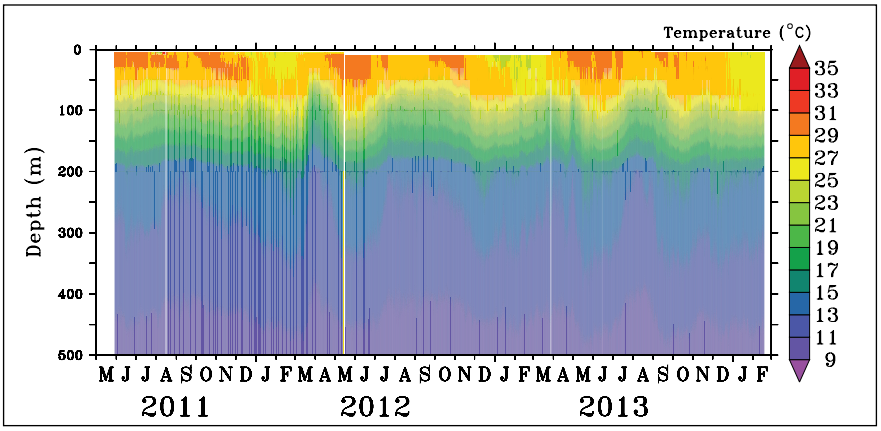
Argo data products: Data products from Argo floats (since 2004) were generated and validated with the data from RAMA and OMNI buoys. These products (temperature and salinity) provide Argo derived data on regular grids, and offer various statistical estimates and error analysis. The products are available on ESSO-INCOIS Live Access Server. Argo products are made available via FTP, both at the Argo-UCSD and ESSO-INCOIS websites, from where registered users can download the data.

OMNI buoy data: ESSO-INCOIS data centre continued to archive meteorological and upper ocean data obtained in real time and delayed-mode from OMNI buoys, which were deployed and maintained by ESSO-NIOT. Real-time data, after standardized quality control

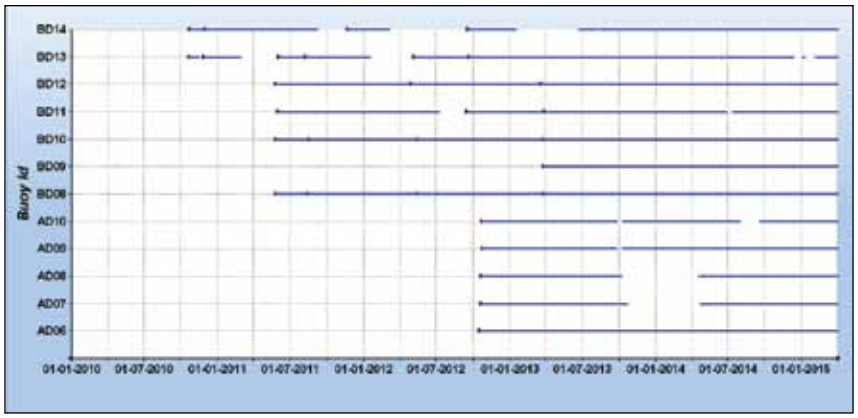


Temperature data from OMNI (BD08; top panel) and ARGO (bottom panel) extracted at the same location (18° 10′ N and 89° 40′ E)

checks, go into the database for archival, distribution and visualization. Data visualization and meta data information were made available through the ESSO-INCOIS data portal. Delayed mode quality control was applied to the data obtained directly from the sensors during servicing and redeployment and made available offline in scientific analysis-friendly NetCDF format form October 2010 onwards.

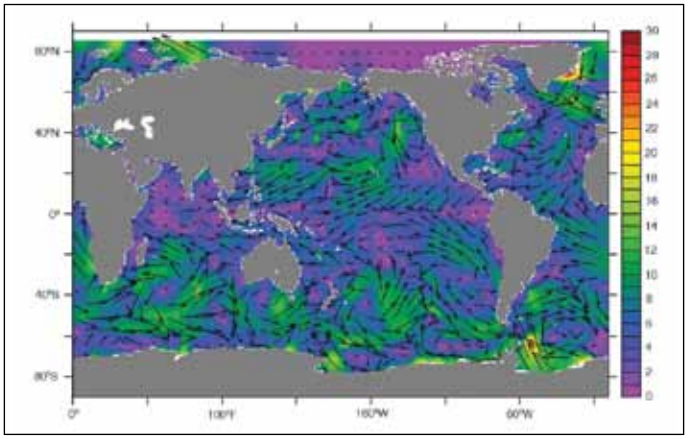


High-resolution temperature (°C) profile data obtained from the BD08 at 18° 10'N, 89° 40'E



Data-availability diagram from the OMNI Buoys

Global wind data product: Composite ocean wind fields from OSCAT were generated at different resolutions viz. 0.5, 0.25 and 1.0 degrees. The gridded product was validated with available in situ data from OMNI and RAMA buoys.



Ocean wind field (wind speed in ms^{-1}) using data from OSCAT

CTD data processing tool: A desktop-based GUI tool was developed using MATLAB, for the processing and quality control of CTD data collected during various research cruises. The tool includes an automated process chain for building database for CTD metadata which contain the details of data delivery mechanisms, file format and file naming conventions as well as parameter descriptions and general data set information.

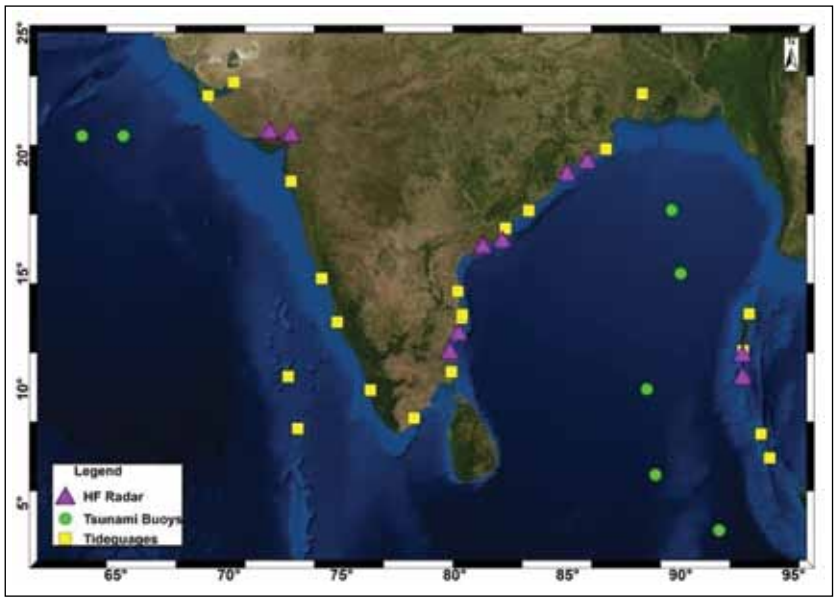
Preparation of Marine Meteorological Atlas: ESSO-INCOIS initiated the processes to develop an atlas of marine meteorological parameters based on the data obtained from IMD for the period 1961-2012. Information used for this atlas include the data collected through Voluntary Observing Ships (VOS) on dry bulb temperature (DBT), dew point temperature (DPT), sea surface temperature (SST), air pressure and wind speed, wave parameters, cloud parameters and prevailing weather conditions. After quality checks as per standardized Minimum Quality Control guidelines set by the Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM), data were gridded using optimal interpolation method at 1-degree resolution and gaps were filled by DIVA (Data-Interpolating Variational Analysis) interpolation.

5. Ocean Observations

Gathering information on the state of the ocean is one of the key requirements for providing quality ocean services. ESSO-INCOIS has taken the lead in many of the national ocean observation programmes and partnered with international agencies, which resulted in the establishment of many ocean observation systems in the Indian Ocean. Real-time data from these observation platforms are widely used in providing ocean forecasts, validating the predictions and unravelling the answers to several science questions. In 2014-2015, ESSO-INCOIS continued its efforts to collect several critical marine parameters by deploying and maintaining many observation platforms in the Indian Ocean.

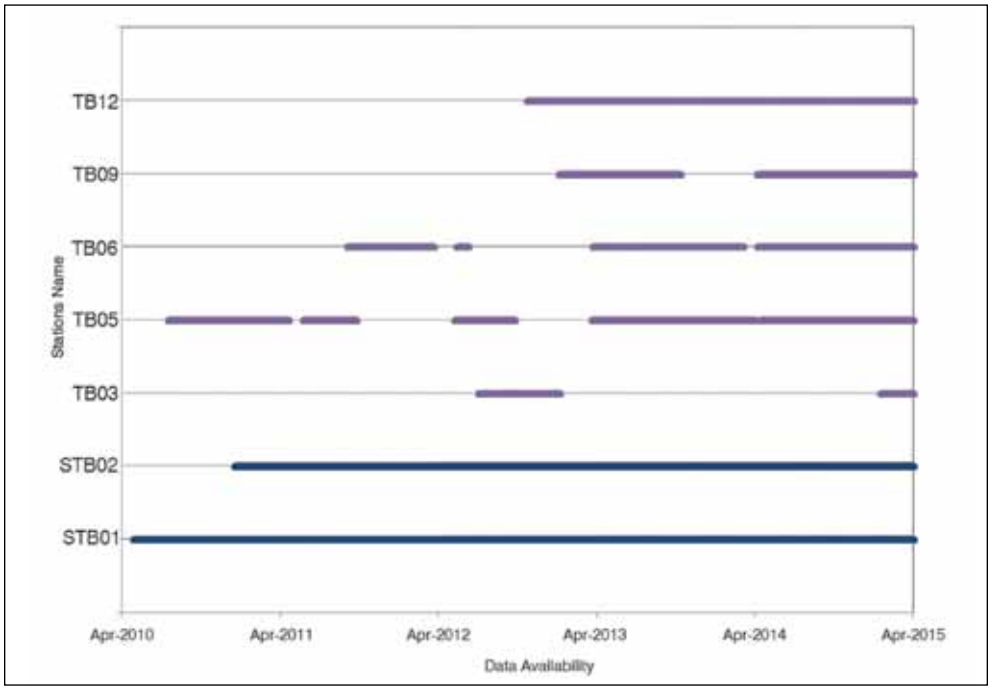
5.1. Tsunami Buoys

ESSO-INCOIS maintained a network of 7 tsunami buoys which were already deployed close to the tsunamigenic source regions in the Arabian Sea and Bay of Bengal in collaboration with ESSO-National Institute of Ocean Technology (ESSO-NIOT, Chennai), and through a contract with Science Applications International Corp (SAIC, USA). These high precision buoys are capable of detecting even very minor water level changes (from 1 cm) at water depths up to 6 km. The data from these buoys are transmitted in real time to the Indian Tsunami Early Warning System (ITEWS) at ESSO-INCOIS through satellite communication. In addition to these buoys, real-time data from around 50 tsunami buoys operated by other countries in the Indian and Pacific Oceans are also received at ITEWS and the data made available on the ITEWC website.



Locations of the ITEWS Sea level network (Tsunami buoys, Tide gauges & HF Radars)

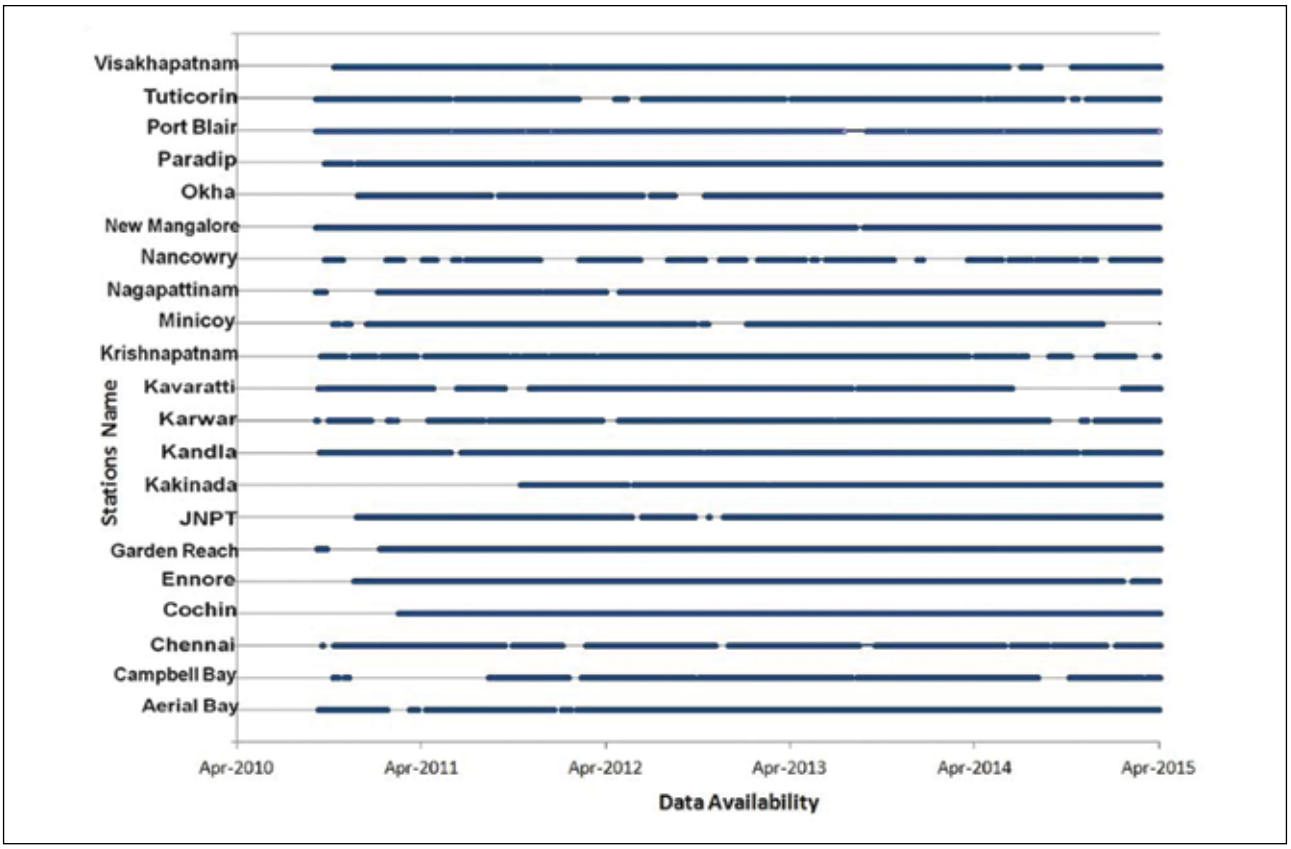
Retrieval and redeployment of the SAIC Tsunami Buoy (STB02) in the Arabian Sea



Data availability from the tsunami buoys since April 2010 till March 2015
(Blue: INCOIS SAIC Tsunami Buoys; Purple: NIOT tsunami buoys)

5.2. Tide gauges

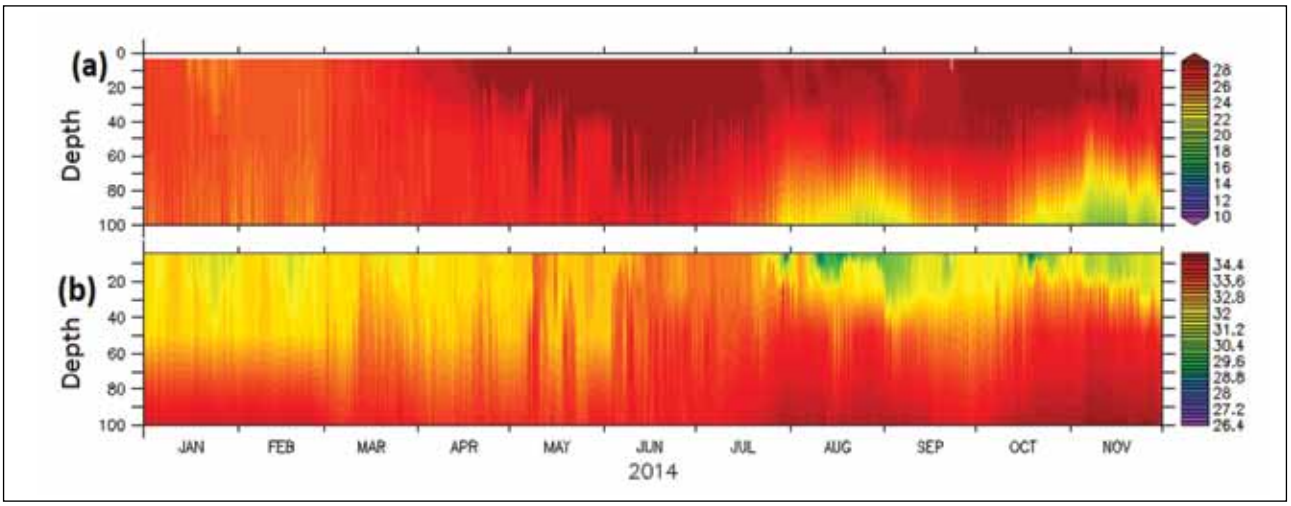
In collaboration with Survey of India, ESSO-INCOIS has maintained a network of 21 state-of-the-art tide gauges along the Indian coast which provided real time data to ESSO-INCOIS through INSAT and GPRS communication facilities. In addition, ESSO-INCOIS also received data from around 300 international tide gauges in near- real time through the IOC-Sea level monitoring website. It was proposed to expand the tide gauge network by establishing RADAR based tide gauges at 10 more locations. Site surveys in 7 locations have been completed.



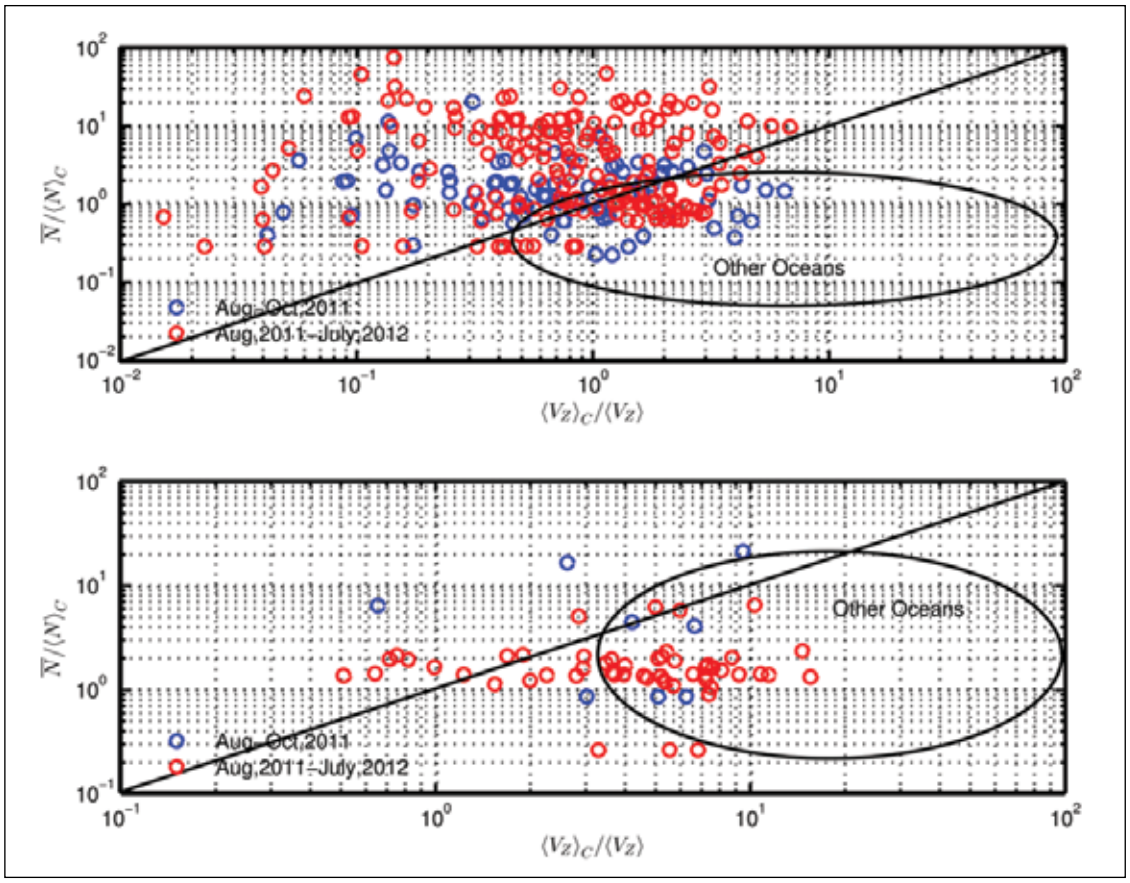
Data availability from the Tide gauge network during April 2010-March 2015

5.3. Bay of Bengal mooring

The fourth phase of the Bay of Bengal mooring at 18^{0}N, 89.5^{0}E was successfully retrieved in November 2014 during the cruise on board Sagar Nidhi. Time series data of temperature and salinity at 4, 7, 10, 15, 25, 50, 100 m depths and currents at 5 and 30m were obtained for the period November 2013 to December 2014.



Temperature and salinity time series from the fourth deployment of the Bay of Bengal

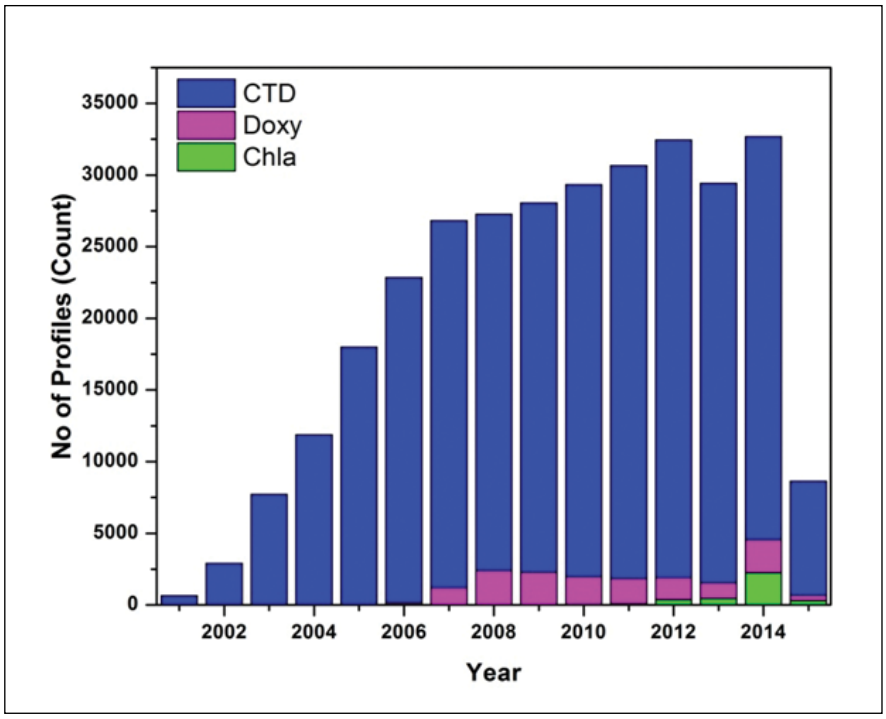


Normalized shear vs normalized stratification during unstable conditions at 10m (top panel) and 15m (bottom panel) at the Bay of Bengal mooring

Data from the Bay of Bengal mooring was used to study the flow stability characteristics in the upper surface layers of the northern Bay of Bengal. Observations suggest that buoyancy frequency variation near the mixed layer base has a significant role in mixing and pycnocline deepening. Analysis in terms of reduced shear as well as normalized shear show that stratification is the driving variable across all seasons and more so during the winter and spring season. Unstable perturbations can arise from higher than average shear or lower than average buoyancy. It is found specifically for the Bay of Bengal that lower than average buoyancy frequencies are more likely to drive the flow perturbations.

5.4. Argo floats

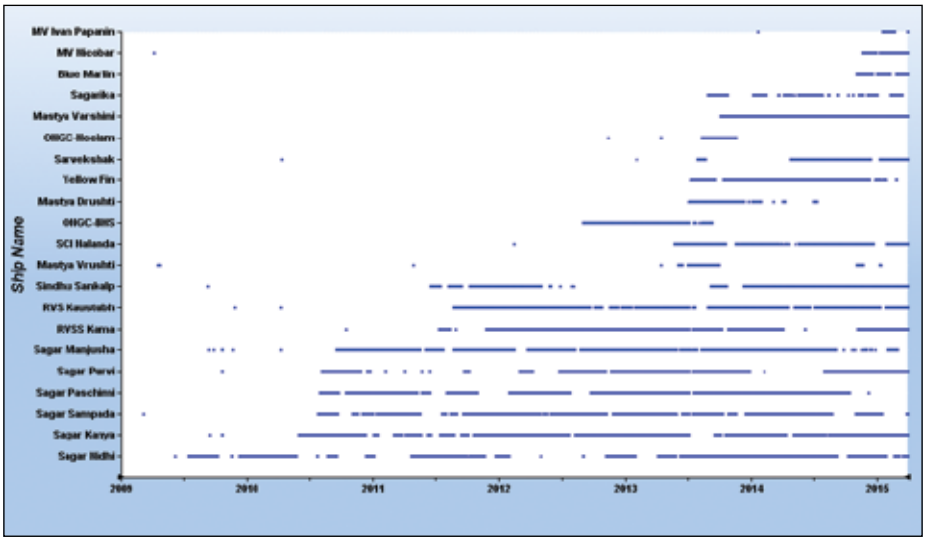
India continued to contribute to global efforts in the Argo floats programme by deploying 50 Argo floats (33 Apex, USA and 17 NKE, France) during the period from 1 April 2014 to 31 March 2015 in the Indian Ocean. Thus the total Indian contribution to the Argo programme increased to 368, of which 132 were active and transmitted data in real time. Of the 50 deployments during the last year, nine were bio-Argos deployed in the tropical basin and 2 were ice detecting Argos; these were deployed in the Southern Ocean. The Indian involvement in the Argo programme resulted in obtaining 4691 temperature and salinity, 968 Chlorophyll and 1019 dissolved oxygen profiles during the last one-year period.



Year-wise distribution of temperature-salinity (blue), Dissolved Oxygen (pink) and Chlorophyll (green) profiles obtained using Argo floats in the Indian Ocean

5.5. Automated Weather Stations (AWS)

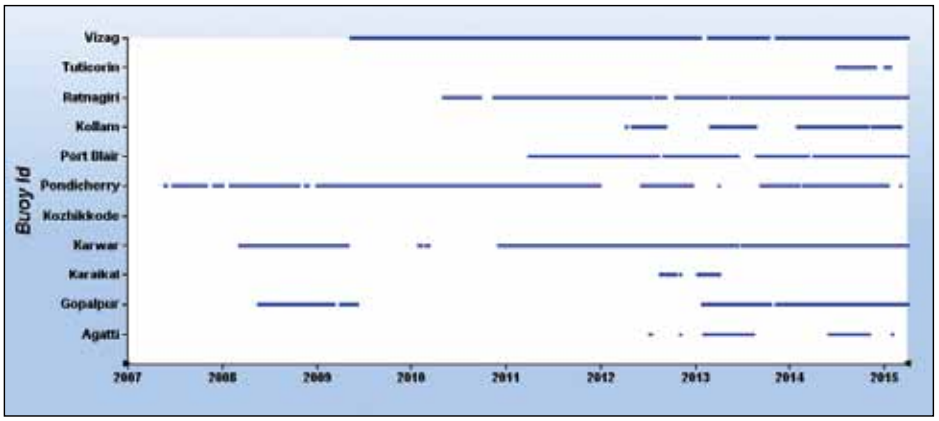
Last year, ESSO-INCOIS deployed 2 more AWSs onboard M. V. Nicobar and M. V. Blue Marlin. Currently, 20 AWSs are active. In order to provide information about the data availability, calibration updates and communication between vessel owners, system integrators and ESSO-INCOIS, a web portal was developed and is being updated periodically.



Availability of data from the automated weather stations installed on board ships

5.6. Wave Rider Buoys

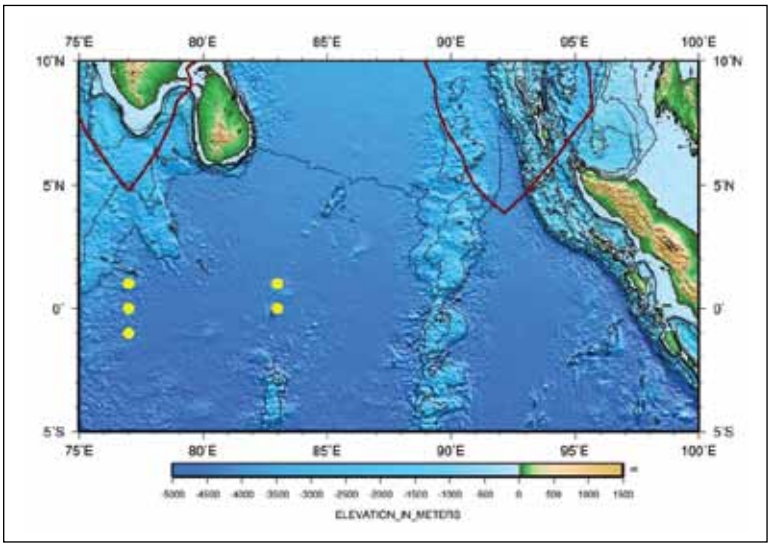
ESSO-INCOIS deployed a new wave rider buoy in July 2014 off Tuticorin to measure the wave parameters in Gulf of Mannar and for the validation of wave forecasts. With this deployment, the total number of active wave rider buoys increased to 10. A web portal was developed for better inventory management of wave rider buoys and interactions with partner agencies in the project.



Availability of data from the wave rider buoys network established by ESSO-INCOIS

5.7. ADCP current meter mooring in the Equatorial Indian Ocean

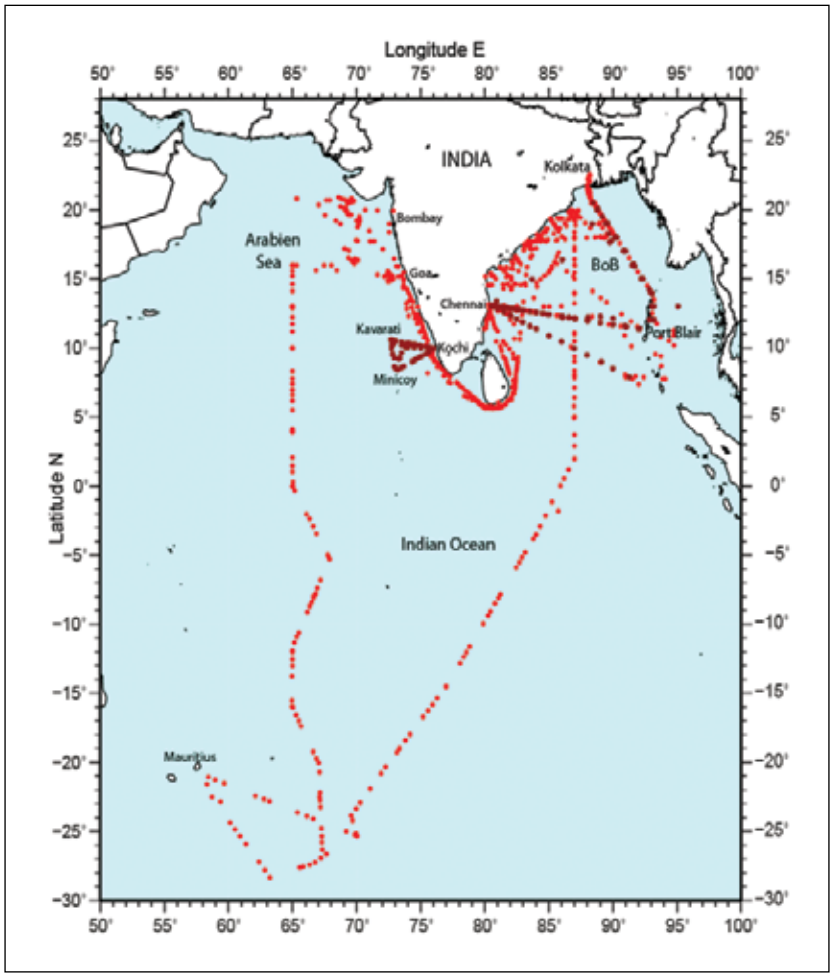
In order to measure ocean currents, CSIR-National Institute of Oceanography, with funding from ESSO-INCOIS had earlier deployed 7 deep-sea moorings near the equatorial Indian Ocean. Three of these moorings at 1^0N, 93^0E; Eq., 93^0E and 1^0S, 93^0E were successfully recovered last year. Utilizing these instruments, an additional deep-sea mooring was deployed at 1^0N, 83^0E. The other four deep-sea moorings at 1^0N, 77^0E; Eq., 77^0E; 1^0S, 77^0E and Eq., 83^0E continued to be operational. At present, there are 5 active deep-sea current meter moorings in the Equatorial Indian Ocean.



Locations of the Equatorial current meter moorings are represented by the yellow dots

5.8. XBT transects

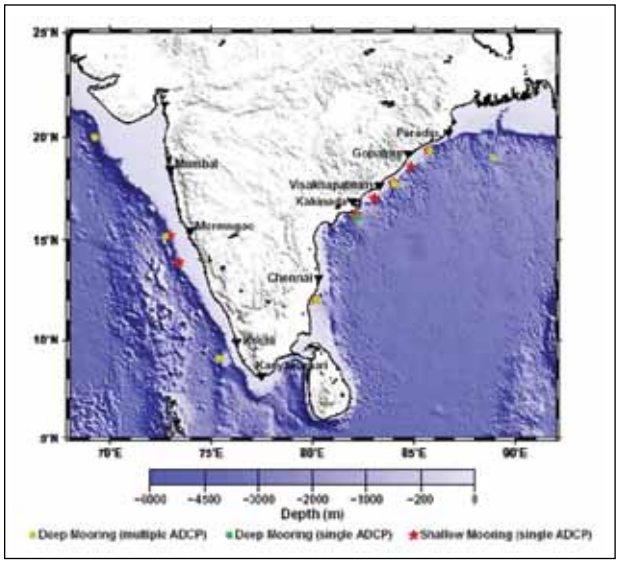
CSIR-NIO continued the XBT programme with funding from ESSO-INCOIS and collected 166, 1286 and 134 XBT/XCTD profiles from Arabian Sea, Bay of Bengal and Southern Indian Ocean respectively during 2014-15. All XBT/XCTD data were processed, quality controlled following international standards and archived at ESSO-INCOIS. Unprocessed data are received at ESSO-INCOIS in near-real time through email for operational use.



Temperature/Salinity data density along XBT transects during 2014-15 in the Indian Ocean under INCOIS supported programme

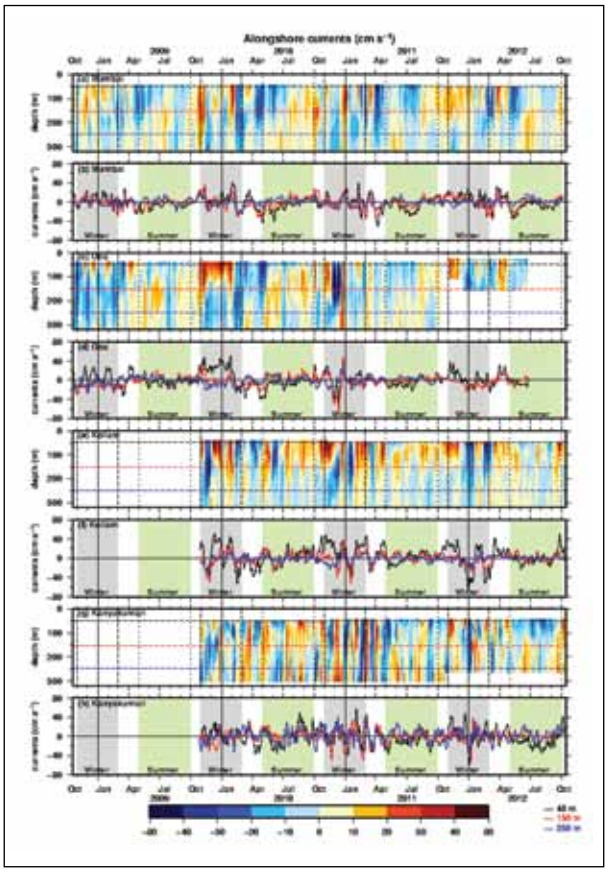
5.9. Coastal ADCP network

With funding from ESSO-INCOIS, CSIR-NIO maintained 16 ADCPs which record the vertical profile of currents in the coastal waters of India. In the past one-year period. CSIR-NIO carried out fifteen operations, which included 9 recovery and 6 deployments off the west coast of India. At present 16 moorings are active, which include 1 pair and 3 individual ADCPs off the west coast of India and 4 pairs and 3 individual ADCPs off the east coast of India. The data obtained from these ADCPs provide very good insight on the variability of subsurface currents on the shelf and slope of Indian coast. In addition, the data from these ADCPs are routinely used for validating the simulations by Ocean General Circulation Models used for operational services.



Current status of coastal ADCP mooring. (Green circle-Deep mooring single ADCP; red star-shallow single ADCP and yellow circle-Deep mooring multiple ADCP)

Analysis of data from these moorings shows a spectrum of current variability that is being presented for the first time. There is variability over time scales ranging from a few days to months. Over time, it is expected that this data will throw light on the interannual variability as well, but the data record is not yet long enough for this analysis. These ADCP data, which describe facets of the West India Coastal Current (WICC) and East India Coastal Current (EICC) that could not be described earlier, are expected to provide a similar fillip to theoretical studies of intraseasonal variability at CSIR-NIO.



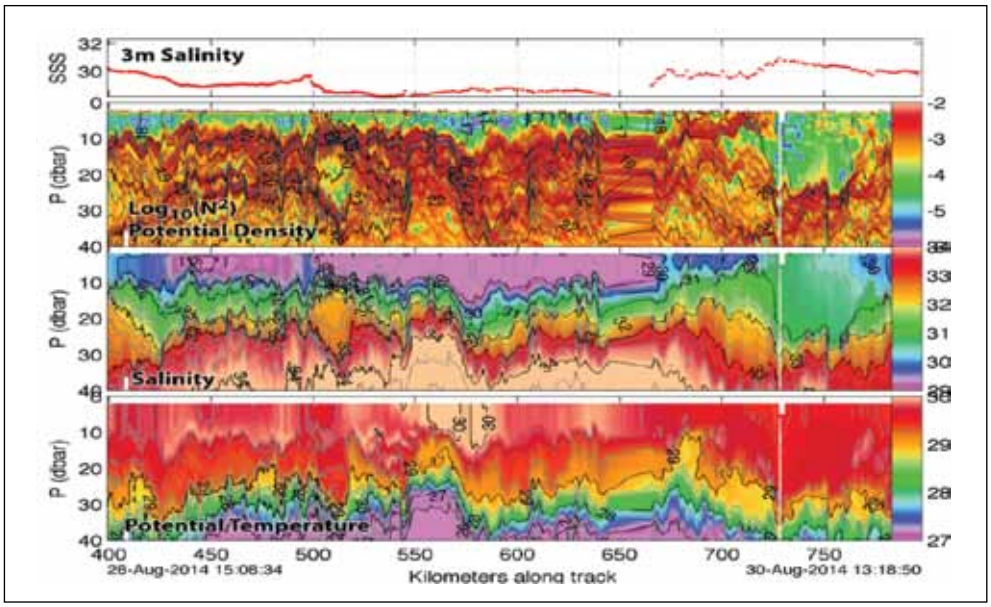
Panels (a), (c), (e), and (g) show the 5-day low-passed alongshore WICC (cm/s) as a function of depth. Blue shade implies equatorward (eastward) flow and red shade poleward (westward) flow at Kollam, Goa, and Mumbai (Kanyakumari); The dotted and dashed vertical lines are drawn to delineate summer and winter monsoons, respectively. The dashed horizontal lines mark 48 m (black), 150 m (red), and 250 m (blue) water depth. Panels (b), (c), (f), and (h) show corresponding line plots for currents at 48 m (black), 150 m (red), and 250 m (blue).

5.10. Ocean Mixing and Monsoon (OMM) Programme

In order to study the turbulent processes in the Bay of Bengal during Monsoon season and to create a reference dataset on the surface fluxes, very fine resolution observations near the surface of Bay of Bengal were taken as part of the Ocean Mixing and Monsoon programme (OMM), which was undertaken by ESSO-INCOIS with the active participation from sister institutions and collaborations from several US institutes through their ASIRI programme. Three dedicated cruises were carried out during the last year, two on board ORV Sagar Nidhi and one on board US research ship RV Roger Revelle. Several unique instruments like underway CTD (uCTD), microprofiler, Lagrangian float etc were used for the survey of upper ocean. First, fine-scale (order of 1km horizontal resolution) upper ocean observations were obtained from the Bay of Bengal with uCTD and Acoustic Doppler Current Profiler (ADCP). During August-September 2014, Sagar Nidhi cruise covered a total distance of 1790 km and obtained 1894 profiles of temperature and salinity upto 90-100 m depth using uCTD with a vertical resolution of 1m and horizontal resolution of 0.5-1.5 km.

List of instruments operated and number of profiles obtained during ORV Sagar Nidhi cruise in the Bay of Bengal during August-September, 2014 (OMM cruise) is given below.

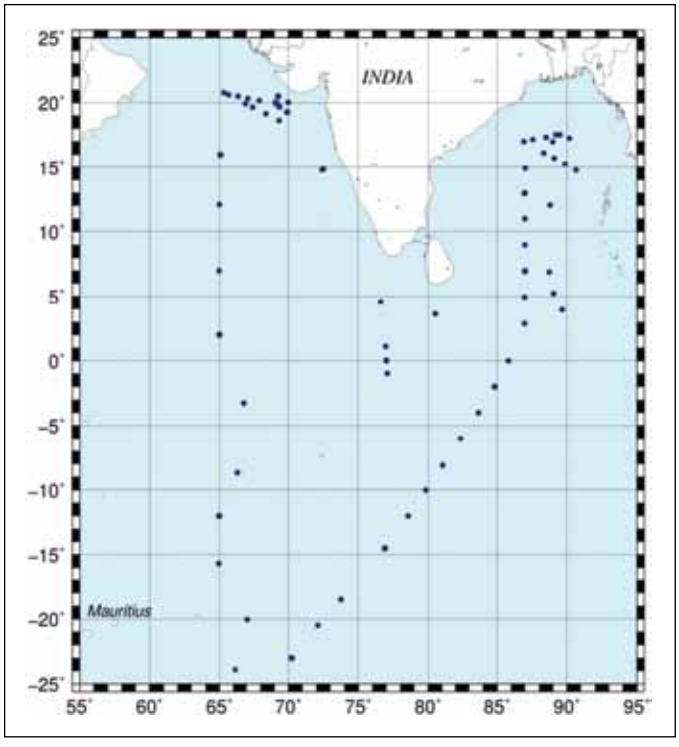
S. No.	List of Instruments	Total no. of profiles	
		Launched / Taken	Successful
1	uCTD	1918	1894
2	Microprofiler	36	36
3	Radiometer	35	35
4	Radiosonde	29	23
5	High Volume Sampler	12	12
6	IOP	8	8
7	FRRF	7	7
8	Ship CTD	7	7
9	Water sample	7	7
10	XBT	8	7
11	XCTD	6	6
12	Drifters	7	7
13	Salinity Drifters	1	1
14	Lagrangian Float	7	3



Data collected along the track of OMM cruise onboard ORV Sagar Nidhi in Bay of Bengal during August-September, 2014. First panel: Salinity (at 3 m depth); Second panal: Brunt - Vaisala frequency and potential density contour; Third panel: Salinity and Fourth panel: Potential temperature

5.11. Indian Ocean drifting buoy programme

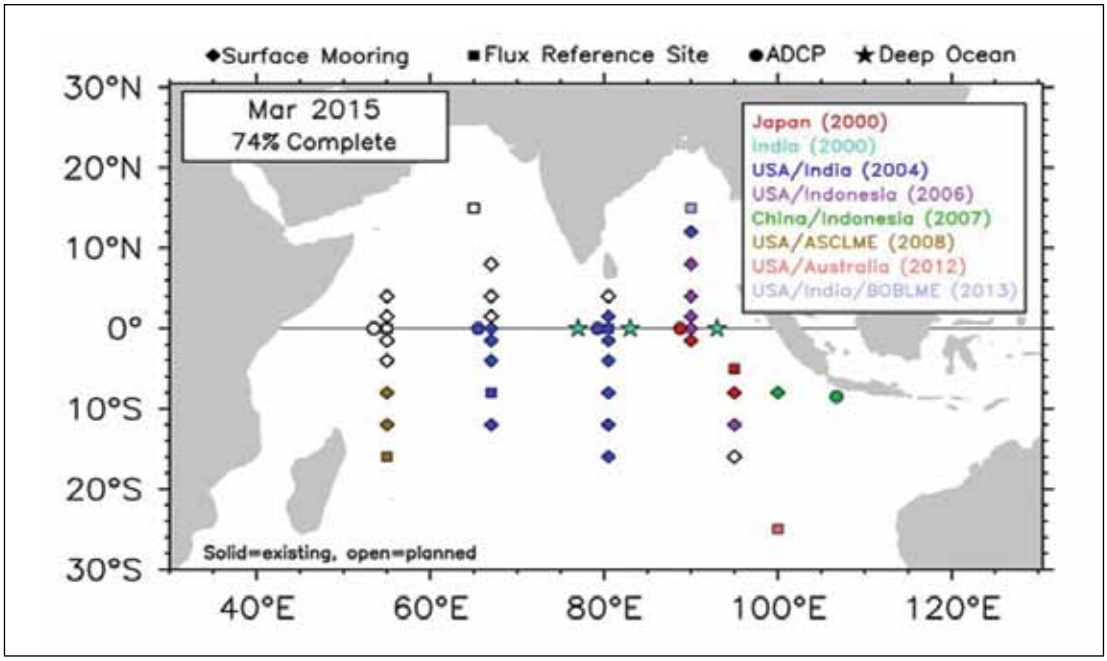
Satellite tracked drifting buoys are one of the cost-effective methods to continuously observe upper ocean currents and other met-ocean variables. CSIR-NIO has been implementing this project with funding from ESSO-INCOIS. During last one year, 53 drifters were deployed in the Bay of Bengal, Arabian Sea and Equatorial Indian Ocean.



Drifter deployment locations during 2014-15

5.12. RAMA observation network

RAMA moored buoy network was designed and implemented to enhance monsoon research and forecasting in the historically data sparse Indian Ocean region. As per the MoU between MoES/ ESSO-INCOIS and NOAA/PMEL, 25 RAMA operations at 15 sites were carried out last year through two cruises which included deployment, recovery and repair of ATLAS, TFLEX and ADCP moorings. At present, 34 out of the 46 (74%) RAMA sites have been covered. In addition, 14 CTD casts were carried out during the course of the cruise to service the RAMA buoys.



Present status of the RAMA programme

Data availability map for sea surface temperature from RAMA buoys

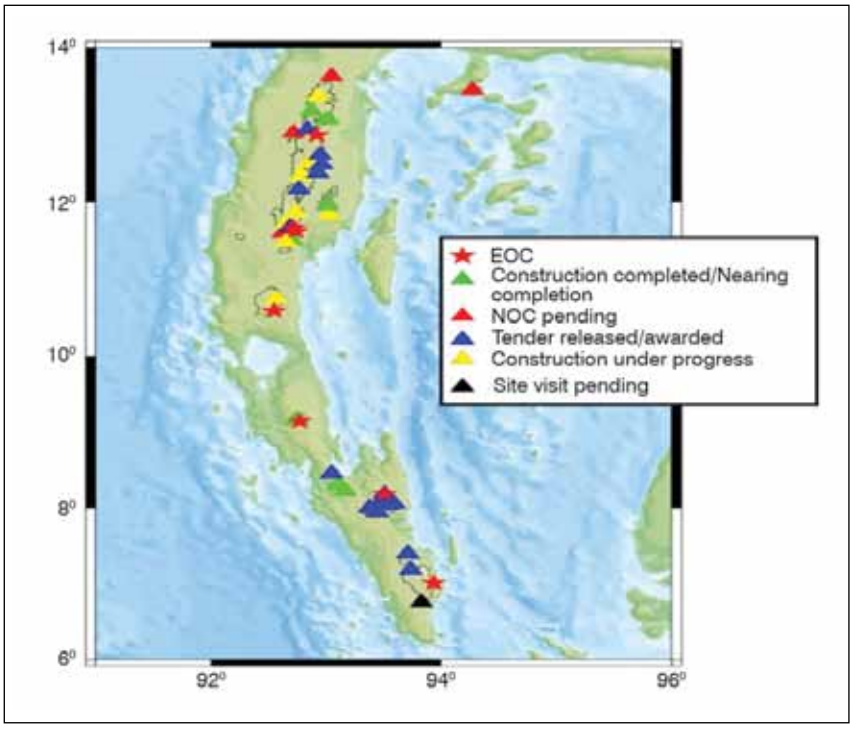
5.13. Network of communication systems

a) Establishment of the Indian Seismic and GNSS Network (ISGN)

In order to monitor the seismic activity in India, a network of seismic and GNSS stations called Indian Seismic and GNSS network (ISGN) was established under the aegis of MoES, New Delhi, with ESSO-INCOIS and IMD acting as the Central Receiving Stations (CRSs). Real-time connectivity was provided through VSAT to various ISGN stations, and data were received in real time at the CRSs. Data from 127 stations were received at ESSO-INCOIS and IMD. The seismic data were received from 100 stations through VSAT (53 stations) and terrestrial MPLS link (47 stations). The GNSS data were received from 27 stations through VSAT. The historical data that were collected from regional centres were archived at both data centres. The seismic as well as GNSS near real-time data are available through www.isgn.gov.in. Data from selected stations are openly available to all users for operational use, but data from remaining stations are available on request as per the data policy. Fifty-three users registered on ISGN web portal by March 2015.

b) Establishment of GNSS & Strong Motion network in A&N Islands

ESSO-INCOIS has continued with the two-phase planned installation process of co-located Strong Motion sensors, GPS receivers and Meteorological sensors with real-time VSAT connectivity at 35 locations in Andaman & Nicobar (A&N) Islands. The site selection committee visited A & N Islands and completed site surveys at 34 locations on the feasibility for installation of sensors. Accordingly, M/s Nanometrics has completed noise surveys at 30 locations. NOCs were obtained for 31 locations and the construction work at all these 31 locations was initiated by APWD Andaman and is under progress.



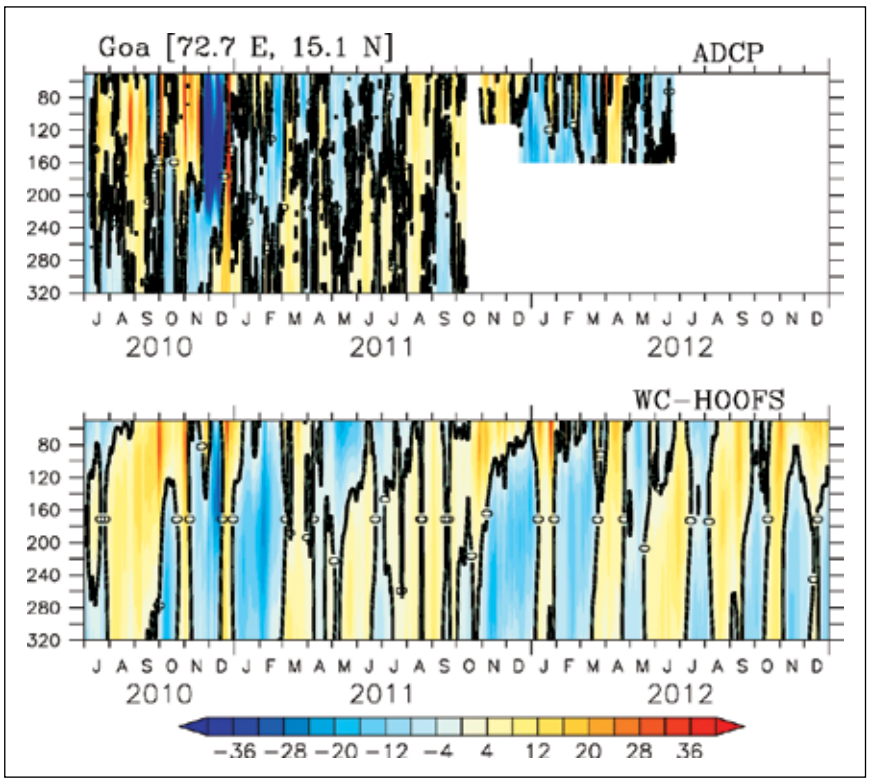
The status of co-located GNSS & SMA network in Andaman & Nicobar Islands

6. Ocean Modeling and Data Assimilation

Successful prediction of the ocean features depends heavily on the accuracy of the simulations/ forecasts by numerical models. ESSO-INCOIS has been striving to improve the quality of the ocean models used for predictions through the initiative, "High resolution Operational Ocean Forecast and reanalysis System (HOOFS)", which is being implemented in a phased manner.

6.1 Coastal Circulation Model

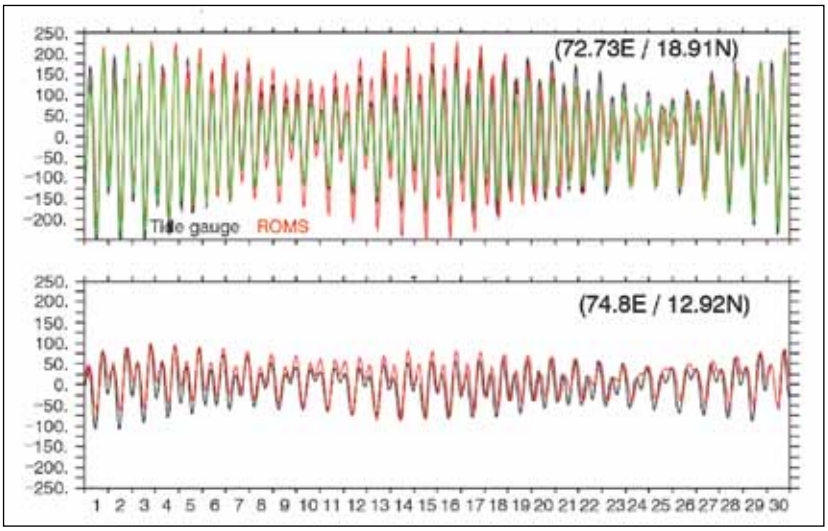
In order to build better forecasting capability in the coastal waters of the country, a series of high resolution coastal setups have been planned under the HOOFS project. As a first step, the HOOFS setup for the west coast of India (65-78^{0}E and 8-26^{0}N) which was configured at a very high spatial resolution (1/48^0 X 1/48^0) using the Regional Ocean Modeling System (ROMS) was made operational at ESSO-INCOIS. It was found that this setup not only provides accurate prediction of sea surface parameters like temperature, sea surface height anomaly, currents, etc., but also accurate forecasts for subsurface layers.



Alongshore component of currents (cm s^{-1}) off the coast of Goa (72.7^{0}E, 15.1^{0}N) simulated by ROMS setup with a horizontal resolutions of 1/48 x 1/48 degrees is compared with the ADCP observation

As, it is well known that in the coastal waters, the ocean currents and the sea level are mostly dominated by tides, the module to incorporate tidal effects on circulation was added to the operational setup of HOOFS for the west coast of India. This state-of-the art tidal module is capable of simulating accurate tidal amplitude and tidal currents. It was forced

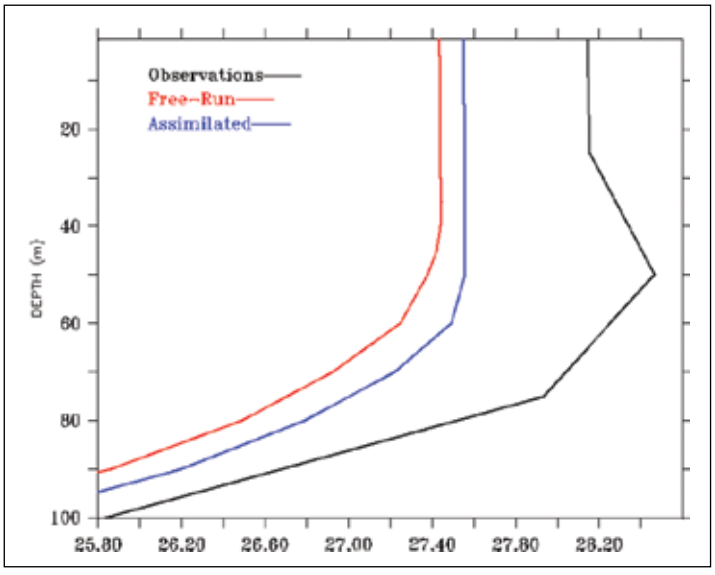
at the open southern and western boundaries using OSU TOPEX/Posidon Global Inverse Solution, TPXOv7. Ten tidal constituents (viz. M_2, S_2, N_2, K_2, K_1, O_1, P_1, Q_1, Mf, and Mm) were incorporated in this setup.



Amplitude of tidal elevation (cm) near Mumbai (top) and Mangalore (bottom)

6.2 Data Assimilation in ROMS

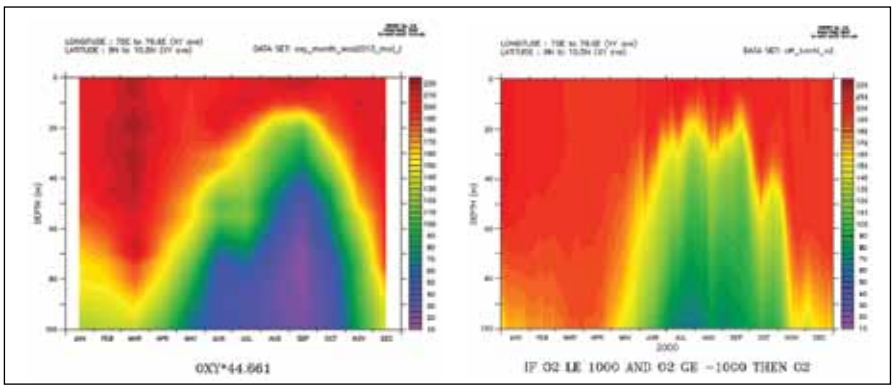
Using a classical Ensemble Kalman Filter, gridded weakly mean sea-surface height (SSH) and daily mean sea surface temperature (SST) were assimilated in the basin-wide setup of Regional Ocean Modeling System (ROMS). The initial ensemble was generated using the growing modes technique that involves perturbing a reference model state along the dominant modes of the system. The total error variance of the model state after assimilation reduced considerably compared to the non-assimilated run. It was also found that the assimilated model is able to reproduce the spatio-temporal variabilities more realistically. Further analysis showed that the assimilation also improved the vertical profile of temperature.



Vertical profile of temperature before and after assimilation is compared with the observation at 90^{0}E, 1.5^{0}S

6.3 Marine Ecosystem Modelling

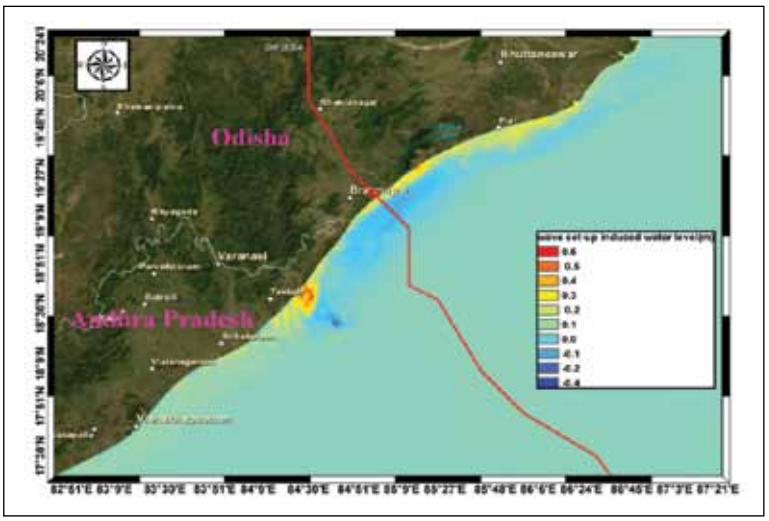
The biogeochemical module based on the Fennel Ecosystem Model was coupled with the basin-scale setup of ROMS. Comparison of model simulated chlorophyll-a with satellite based observation showed that the model could capture the variability of sea surface chlorophyll distribution in space and time. The model could reproduce two distinct growth periods of phytoplankton, bloom, one in summer during the South West Monsoon (SWM), the other in winter during the North East Monsoon (NEM). Analysis of the patterns of empirical orthogonal functions showed that there is significant improvement in SST due to biological feedback at different coastal locations. The characteristics of oxygen minimum zones (OMZs) in the Arabian Sea, at the intermediate-depth layers featuring low oxygen saturations, were also simulated with good accuracy by the model.



Depth-time section of the dissolved oxygen simulated by the model (right) is compared with WOA2009 climatology (left) for the region averaged over 75^{0}E-76.6^{0}E, 09^{0}N-10.5^{0}N. The presence of the coastal hypoxia off-the Kochi is clearly seen

6.4 Wave-hydrodynamic modelling

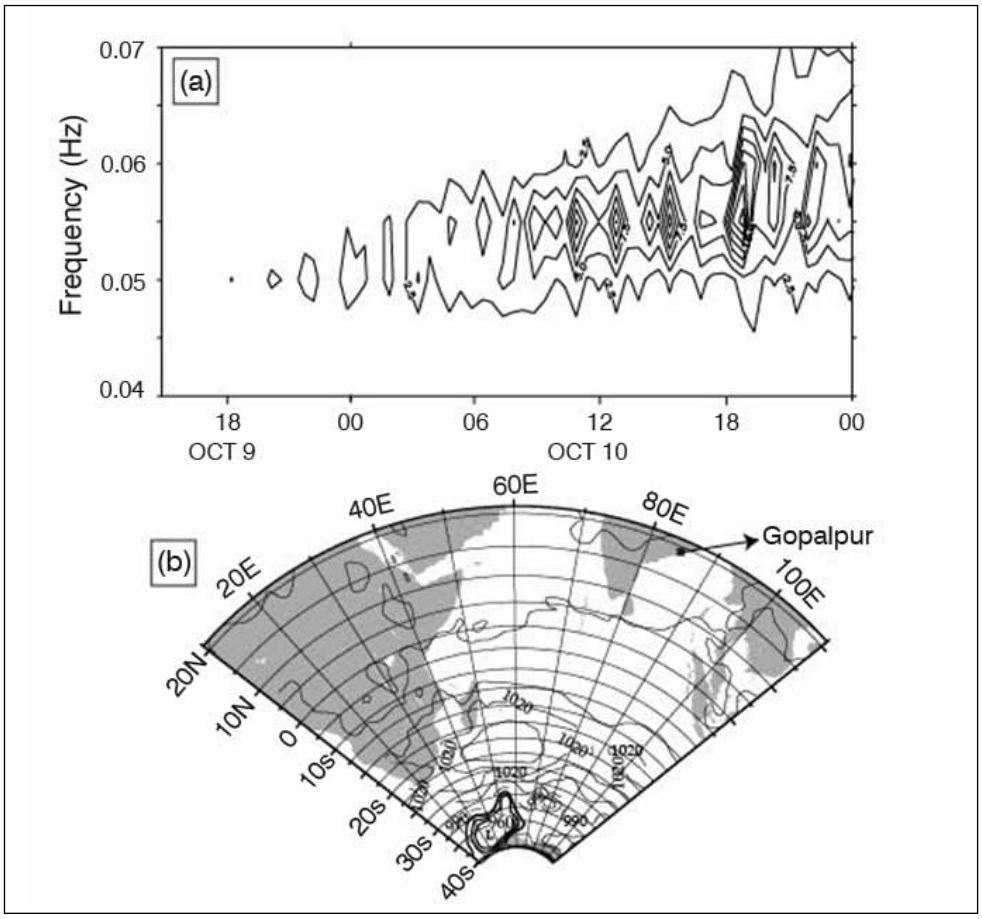
In order to incorporate the effect of radiation stress on the coastal water levels and inundation, particularly during the passage of cyclones, a coupled setup of SWAN and ADCIRC has been configured. Experiments proved to have good simulation results for cyclone 'PHAILIN'.



Spatial distribution of Wave induced Setup (in m) associated with the cyclone 'Phailin'

6.5 Analysis of Wave Spectra

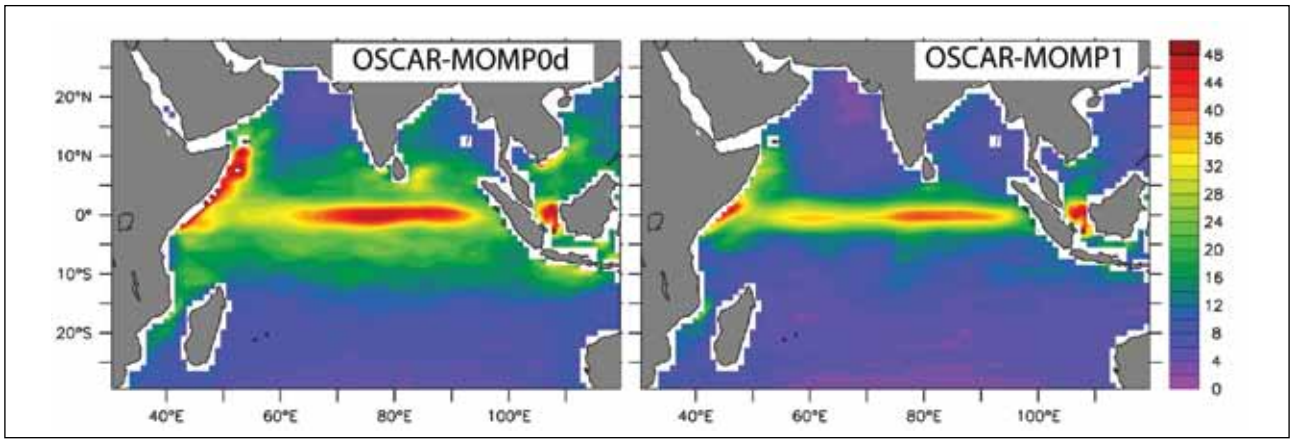
The wave rider buoy off Gopalpur recorded very high waves 2-3 days before the landfall of cyclone Phailin, which occurred during 8-14 October 2013. Analysis of the wave energy spectra for this station showed that the total wave before the landfall of the cyclone was dominated by a very low-frequency swell component. Base on the 'Ridge analysis', it was estimated that the source of this swell was not the Phailin cyclone, but was in the southern ocean (around 50^0S, 44^0E) and its origin time was around 12 UTC on 3 October, 2013.



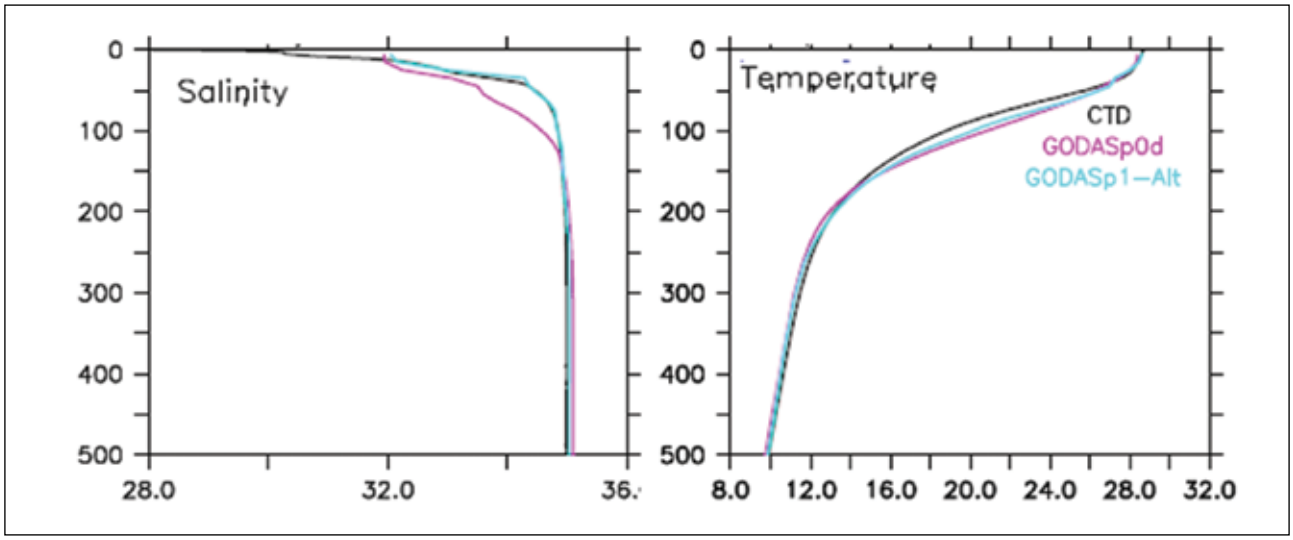
Frequency-time diagram showing the variation with time of the wave energy (m^2 Hz^{-1}) in different frequencies (top) and the history of significant wave height and peak wave direction before the landfall of cyclone Phailin

6.6 Global Ocean Analysis products from INCOIS-GODAS and efforts to improve the system

ESSO-INCOIS initiated upgradation of the ocean general circulation model being used in INCOIS-GODAS from MOM4p0d to MOM4p1 to incorporate the assimilation of the sea level anomaly data from satellite altimeters. In an experimental setup, altimeter data from Topex 1 and 2 and Jason 1 and 2 were assimilated in addition to the temperature and salinity profiles. Experimental hindcast for the period 2003-2012 was carried out and the preliminary analysis suggest significant improvements in SST simulations over the north Indian Ocean and currents in the equatorial regions compared to the previous versions of the GODAS setup.



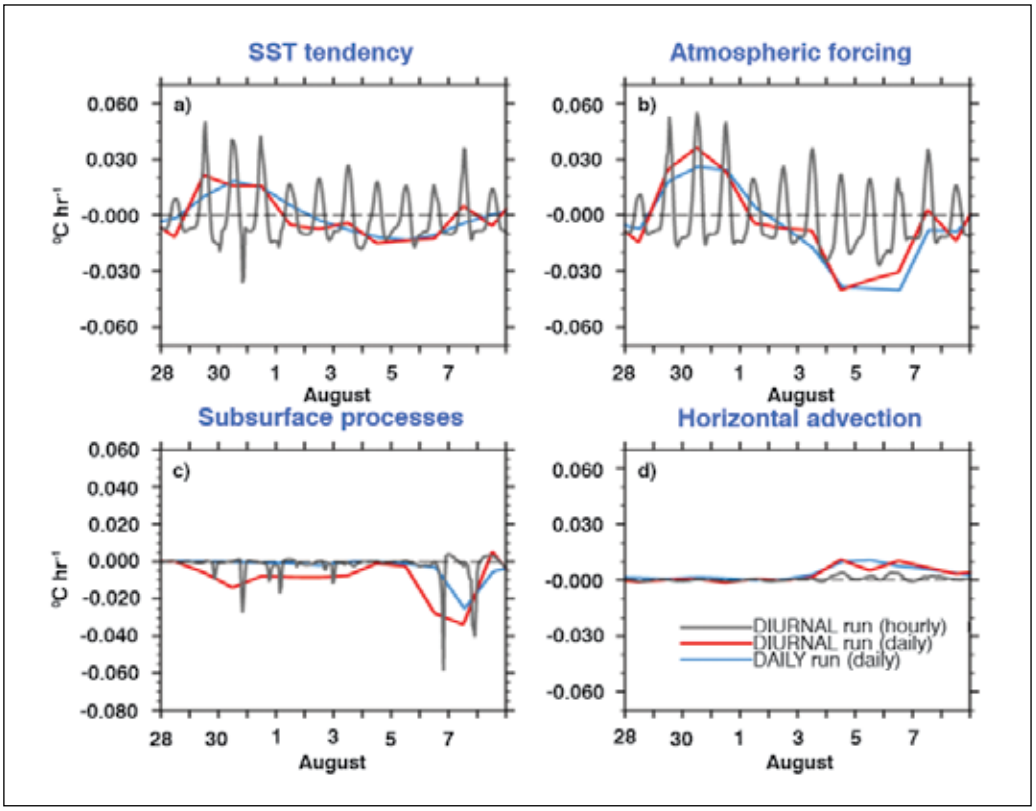
Root Mean Square Error (cm s^{-1}) of the zonal current at 15m depth simulated by GODAS based on MOMp0d (left) and MOMp1 (right)



Temperature and Salinity comparison from GODAS MOM4p0d and MOM4p1 with CTD observation over north Bay of Bengal at 89°E, 19°N averaged for the period 22 July to 6 August 2009

6.7 Influence of Diurnal cycle of Atmospheric Forcing on the SST variation

Experiments using an Ocean General Circulation Model (OGCM) for the summer monsoon of the year 2007 showed that incorporation of the diurnal cycle in the model atmospheric forcings improved the SST simulation both at intraseasonal and shorter time scales in the Bay of Bengal (BoB). The increase in mixed layer heat gain from insolation with diurnal atmospheric forcing, mainly due to the shoaling of the daytime mixed layer increased the sea surface warming in the intraseasonal time-scale. Amplified intraseasonal cooling was dominantly controlled by the strengthening of subsurface processes owing to the nocturnal deepening of the mixed layer.



Time series of (a) SST tendency, (b) atmospheric forcing, (c) subsurface processes, and (d) horizontal advection in the northern bay for a single SST-ISV event (N3) from DIURNAL run (gray curve), daily average from DIURNAL run (red curve), and daily average from DAILY run (blue curve). Atmospheric forcing is the sum of shortwave, longwave, sensible, and latent heat fluxes. Subsurface processes include vertical advection, diffusion, and convective entrainment. Daily averages are plotted as 5 times their actual values. Colour codes are shown at the bottom right plot. From Thushara and Vinayachandran (2014)

7. SATellite Coastal and Oceanographic REsearch (SATCORE) programme

7.1 Time Series stations

Twelve time-series stations were established for the measurement of bio-optical and physico-chemical parameters including those defined as essential (such as chlorophyll-a concentration, total suspended matter concentration, nutrients, dissolved oxygen, aerosol optical thickness, meteorological parameters, apparent optical properties and inherent optical properties of phytoplankton, detritus and coloured dissolved organic matter) under SATCORE sampling strategy. These were equipped with Spectrophotometer, Integrating Sphere, Sun photometer, Fluorometer, Weighing Balance, Automatic Weather Station and Vacuum Filtration Unit.

During 2009-14, 3151 stations have been sampled of which 311 stations were sampled during 2014-15.

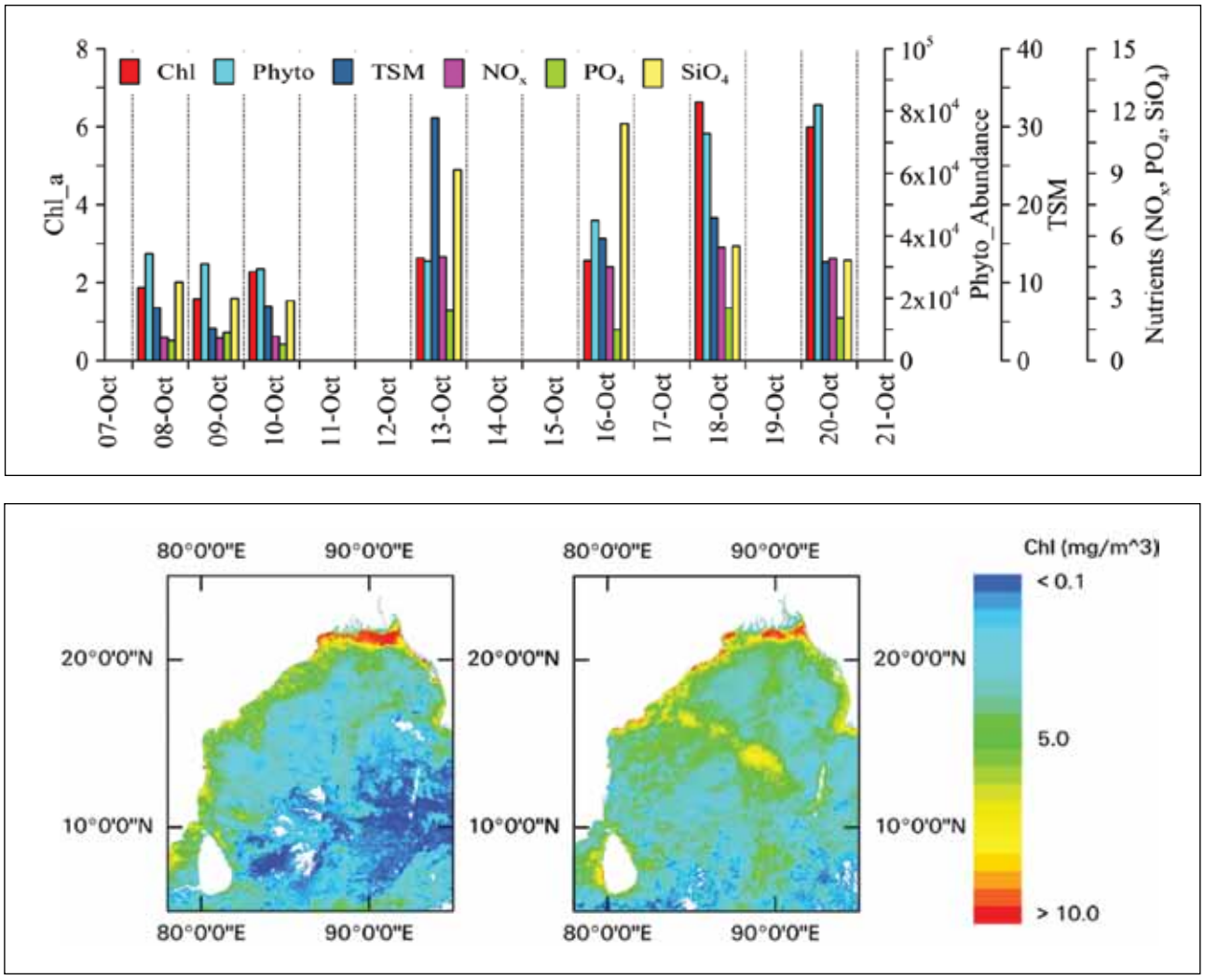
	Chl-a	TSM	CDOM	IOP	AOP	AOT	Nutrients	Phyto	pH	DO	Salinity	Water Temp
Okha	31	901	16	25		23	29					892
Goa-1	93	68	91		93	45					68	68
Goa-2	1021	1059	612	74	288			184	1059	1059	1059	1038
Mangalore	896	782			45		466				58	58
Kochi	1077	966	710	644	80		3538	294	988	599	743	604
Parangipettai	2172	93					4364	870	868	868	868	868
Vizag-1	68	340	66		78	24		81				
Vizag-2	1536	875	1529		18		8092	598	1632	1548	1280	1318
Gopalpur	1033	966	508	30	3		5264	3	31	31	31	31
Total	7927	6050	3532	773	605	93	21753	2030	4578	4105	4107	4877

Parameter-wise data statistics measured at different time series locations (2008-14)

7.2 Biological implications of cyclone "Hudhud" in coastal waters

Analysis of biogeochemical parameters in active influence zone of the cyclone Hudhud showed higher abundance of total phytoplankton (81.97x104 cells L^{-1}) after the occurrence of cyclone compared to its concentration before the cyclone (34.20x104cells L^{-1}). During the pre-Hudhud phase, diatoms were observed as the most dominant group (70%-79%) of phytoplankton wherein,

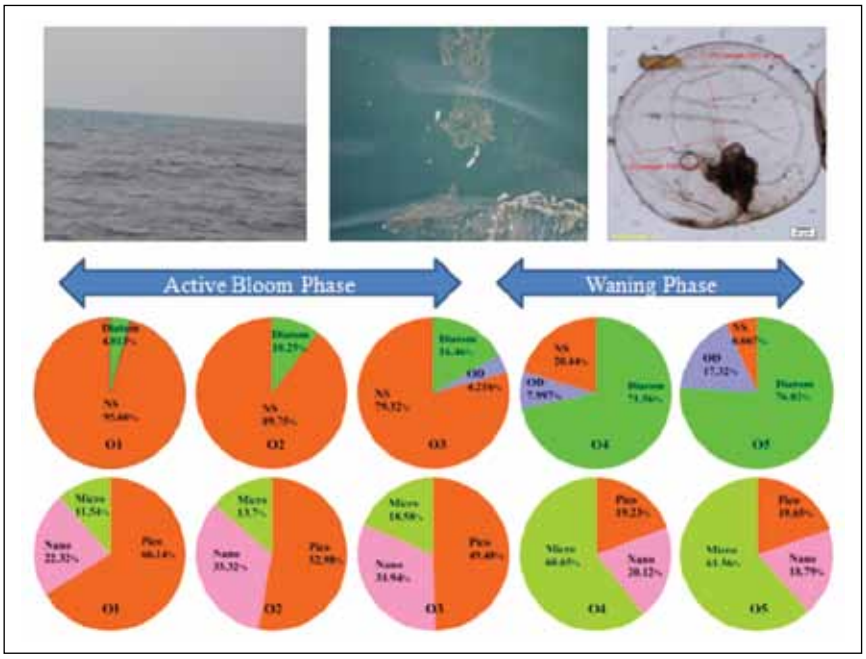
Asterionellopsis glacialis shared a sheer abundance. Post-Hudhud, a shift in species dominance was noticed with predominance of *Thallassiothriox longissima*. Pre-Hudhud, nitrogenous nutrients NO_x were observed at a concentration of ~1 µmol/l which increased fourfold subsequent to the passage of the cyclone. Similar to NO_x, a twofold increase in PO_4 concentration was recorded. There was a significant increase in Chl-a from pre- (1.58 to 2.28 mg/m^3) to post- (2.57 to 6.62 mg/m^3) cyclone phase. This increase was linear with the same for nutrients. The increase in Chl-a concentration post-Hudhud was due to the combined effect of nutrient entrainment from river influx and the mixing that resulted from the cyclone. Level-2 (L2) data of Ocean Colour Monitor-2 (OCM-2) revealed a significant increment in Chl-a concentration along the track of cyclone subsequent to its passage in Bay of Bengal. Apart from this, coastal waters in its vicinity was also observed with enhanced Chl-a.



Average distribution of chl-a (mg/m^3), phytoplankton abundance (cells/l), TSM (mg/l), NO_x (µmol/l), PO_4 (µmol/l) and SiO_4 (µmol/l) during pre and post phases of Hudhud (First row); Composite images of Chl-a generated from level-2C OCM-2 data for the period of pre (left panel) and post- Hudhud (right panel) (Second row)

7.3 Consequences of "red tide" on water quality

A bloom of *Noctiluca scintillans* (NS) was observed in a coastal region of the north western Bay of Bengal during April, 2014, resulting in brown to dull red discolouration of surface waters. The peak cell density observed was 3.3 x 10^5cells-l^{-1} with waters dominated by NS. Nutrient depletion in these waters is believed to have caused this. Increased concentrations of ammonia during the latter phase of the NS bloom were indicative of active grazing and nutrient regeneration. Two toxigenic dinoflagellate species, *Gonyaulux spp.* and *Alexandrium spp.*, were present during the bloom period, albeit in low numbers. Dissolved oxygen concentrations in subsurface waters decreased to near hypoxia conditions (alarmingly low) and anecdotal information from local fishermen suggests that fish were avoiding the area. Picoplankton contributed 66% of the total phytoplankton (chlorophyll) biomass during the early stage of the NS bloom but declined sharply in the waning phase, probably to grazing of NS. Microplankton, dominated by diatoms succeeded during the declining phase.

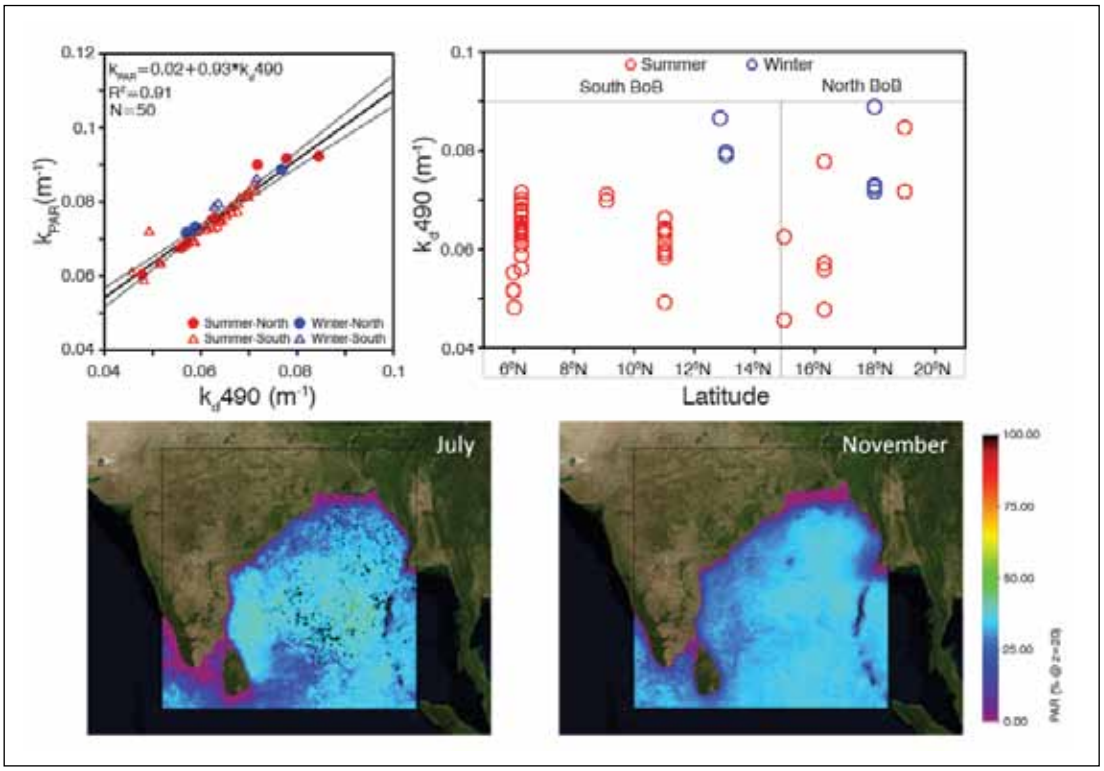


Discolouration of water with floating bloom and under-microscope photographs of Noctiluca scintillans (First row); Contribution to total phytoplankton abundance by diatoms, NS: Noctiluca scintillans and OD: Other Dinoflagellates during different observation days of the bloom (Second row); Contribution to total Chlorophyll-a by picoplankton, nanoplankton and microplankton (Third row)

7.4 Empirical model to estimate subsurface light flux using ocean colour satellite data

An empirical model was derived by relating the observed values of downwelling diffuse attenuation coefficient at 490nm (k_d490) and photosynthetically active radiation (k_{PAR}) in the Bay of Bengal. This empirical model was applied to satellite (MODIS-Aqua) derived k_d490 to compute k_{PAR}. Using MODIS-aqua derived PAR and modelled k_{PAR}, light flux were computed at 20m depth during summer (July) and winter (November) monsoon. The results showed that around 25 to 40% of the

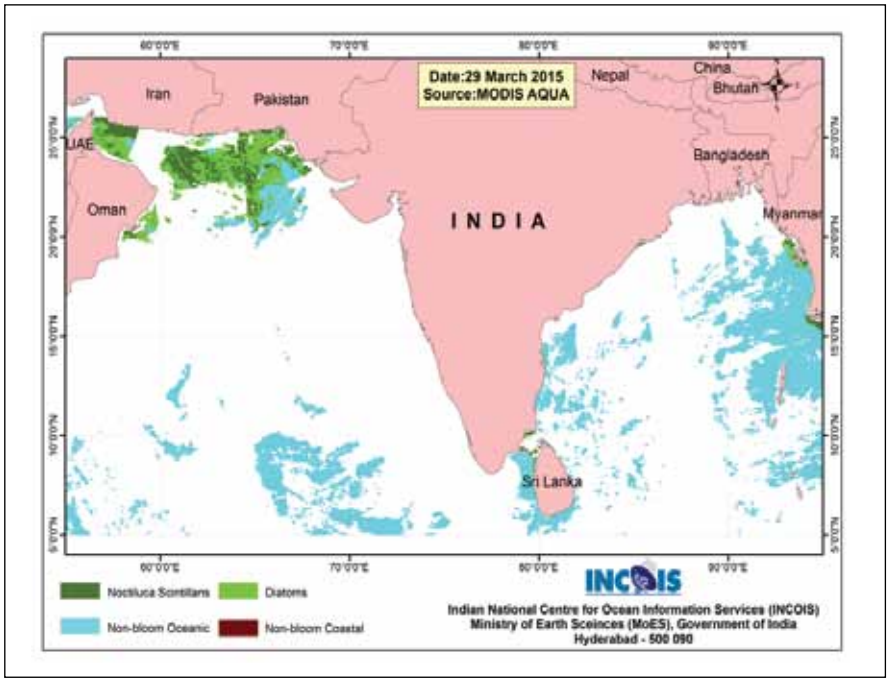
surface light is available at a depth of 20m in central BoB. The reduction of subsurface light due to recurring blooms off the Sri Lankan dome during summer monsoon is clearly depicted in the spatial map.



Empirical relation between diffuse attenuation coefficient at 490nm (k_d490) and photosynthetically active radiation (k_{PAR}) and variation in k_d490 during summer and winter in southern and northern Bay of Bengal (First row); Sub-surface light flux in Bay of Bengal based on MODIS-aqua derived PAR and modelled k_{PAR} were during summer (July) and winter (November) monsoon (Second row)

7.5 Satellite Detection and Monitoring of high biomass algal blooms

Different phytoplankton types (algal blooms) react to incoming electromagnetic radiation (such as sunlight) in a unique way in terms of reflectance, i.e. shape of the reflectance spectra is different for different phytoplankton classes. This information was inverted to detect the bloom as well as to identify its species from the reflectance pattern obtained from satellite data. Differences in spectral characteristics were used for detection of the two phytoplankton types (*Noctiluca scintillans* and diatoms) and non-bloom waters in the Indian Ocean. Specific ranges of derivatives were used to determine phytoplankton class on pixel by pixel basis using MODIS derived remote sensing reflectance data for 443, 488 and 531 nm band. The output image provides information on distribution (spatial extent) of *Noctiluca scintillans*, diatoms and normal (non-bloom) waters in the Indian Ocean.



Phytoplankton classified image of Indian Ocean of 29 March, 2015. [Product generated using MODIS-Aqua 3-Day composite datasets of Rrs 443, 488 and 531]

7.6 Identification of local water types in North Western Bay of Bengal

Cluster analysis based on Ward's method to understand the long-term distribution of biogeochemical parameters in the north western Bay of Bengal revealed two distinct clusters among all physico-chemical datasets, indicating the presence of two local water types on either side of the 30 m isobath. This indicated that the estuarine and terrestrial influence had reached up to the 30 m isobath from the coast which may have been to different physical forcings.

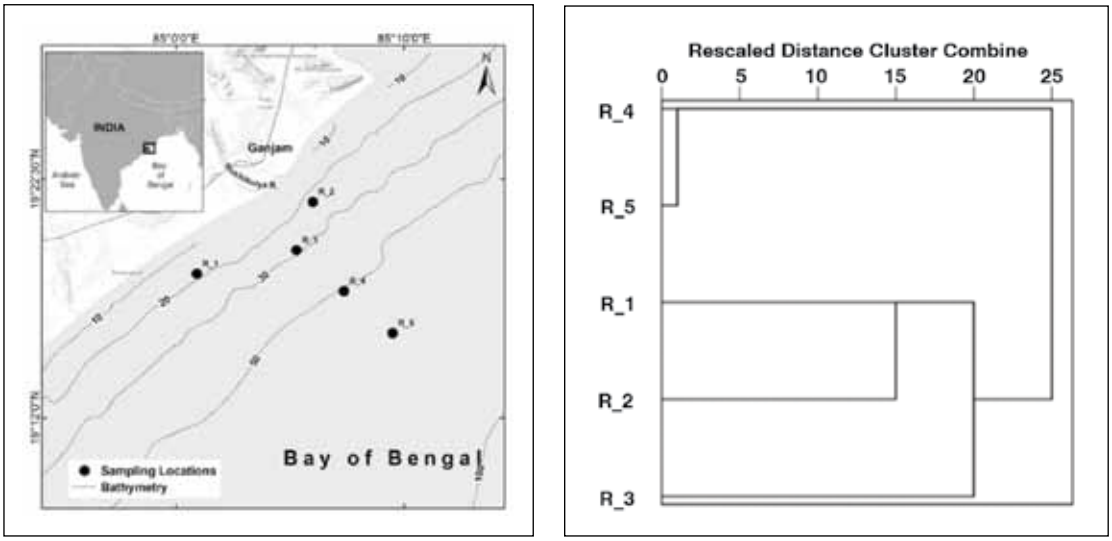


Figure (Left): Map of study area showing sampling stations (closed circles) and bathymetry (m). Location of Bay of Bengal (inset). After (Baliarsingh et al 2015). (Right): Dendrogram based on Ward's clustering method of biogeochemical parameters. Lines connecting each of the stations indicate their level of similarity. Connected lines closest to zero on the x-axis indicate a high level of similarity

8. Extramural Projects Funded by ESSO-INCOIS

ESSO-INCOIS provides financial support to deploy and maintain ocean observation systems and to carry out research and development activities that are important for the improvement of our services. Several such projects run by scientists of various universities/institutes in the country are funded by ESSO-INCOIS. Implementation of all such projects are monitored by an expert committee (Project Monitoring Committee, PMC) chaired/co-chaired by eminent scientists in respective fields. Following below is the category-wise list of ongoing extramural projects funded by ESSO-INCOIS.

8.1 The High-resolution Operational Ocean Forecast and reanalysis System

PMC Co-chairs: Prof. B. N. Goswami, Pisharoty Chair Professor, IISER, Pune and Dr. S. R. Shetye, Vice Chancellor, Goa University

Principal Investigator	Title of the project
P. N. Vinayachandran, IISc, Bangalore	Modeling physical-biological interactions in the Indian Ocean
Meenakhshi Chatterjee, Basanti Devi College, Kolkata	Sundarbans Estuarine Programme, Observational study of tidal propagation, salinity and temperature variations in the Sundarbans Estuarine System
Ravi S. Nanjundiah, IISc, Bangalore	Study of teleconnections and Ocean-Atmosphere coupling over Indian Region using AOGCM
Prasad Kumar Bhaskaran, IIT, Kharagpur	Development and implementation of coupled ADCIRC-SWAN model for the Indian seas
M. C. Deo, IIT, Mumbai	Improved predictions of sea surface temperature using neural networks
U. C. Mohanty, IIT Bhubhaneswar	High resolution regional ocean atmosphere coupled modeling system for the prediction of intense vortices over the Indian seas
I. Suresh, NIO, Goa	Dynamics of intraseasonal variability in the North Indian Ocean waveguide
A. S. Unnikrishan, NIO, Goa	Tidal currents on the continental shelf and slop off Indian Ocean

A. D. Rao, IIT Delhi	Development of an improved prediction system for storm surges and its inland inundation along the Indian coast
Arun Chakraborty, IIT Kharagpur	High Resolution Bay of Bengal Circulation using adjacent point source river discharge using ROMS
Vimlesh Pant, IIT Delhi	Assessment of the influence in the simulation of the general circulation features in a basin scale setup of ROMS by incorporating river discharge

8.2 Paleo-Tsunami and Tectonic Studies

PMC Chair: Dr. A. K. Singhvi, Outstanding Scientist and J. C. Bose National Fellow, PRL, Ahmadabad.

Principal Investigator	Title of the project
Dr. M. Ravi Kumar NGRI, Hyderabad	Investigation of Seismicity & Lithospheric Structure in the ANDaman-Nicobar Subduction Zone (ISLANDS)
Dr. Kusala Rajendran, IISc, Bangalore	Seismo-tectonic history, plate boundary deformation and state of stress in the Andaman-Sumatra subduction zone and its adjoining areas
Dr. C. P. Rajendran JNCSAR, Bangalore	Evaluating earthquake/tsunami recurrence along the Andaman arc from the study of shallow cores
Dr. Nilesh P. Bhatt, M.S. University of Baroda, Baroda, Gujarat	Studies of response control variables in application of geological signatures in paleo-tsunami investigations
Dr. Javed N. Malik, IIT Kanpur	Paleo-seismic and Paleo-Tsunami investigations along South-Middle Andaman & Car Nicobar Islands towards earthquake & tsunami hazard assessment of A & N Islands
Dr. S. Srinivasulu, Anna University, Chennai, Tamil Nadu	Tsunami and Storm dynamics from coastal sedimentary archives: A multi-proxy, multi-site, event to millennial timescale study to resolve the origin of paleo washover deposits

8.3 SATCORE Programme

PMC chair: Dr. R. Navalgund, Vikram Sarabhai Distinguished Professor at ISRO, Bangalore

Principal Investigator	Title of the project
Prof. Harilal B. Menon Goa University	Optical characterization of case II waters and retrieval of colour components from an optical sensor
Dr. P. Shanmugam IIT Madras, Chennai	Observations, Analysis and Algorithms for Characterization and Monitoring of Harmful Algal Blooms in Indian Coastal Waters
Dr. N. H. Joshi Junagadh Agricultural University, Gujarat	Effect of Optically Active Substances on diversity in Phytoplankton Community Structure off Gujarat
Dr. T. Suresh, NIO, Goa	Remote Sensing Of Phytoplankton Functional Types
Dr. Muhamed Ashraf P. Fishing Technology Division, Central Institute of Fisheries Technology (CIFT), Kochi	Retrieval of phytoplankton biomass and associated optical constituents based on long term bio-optical studies
Prof. Kali Charan Sahu, Berhampur University, Odisha	Characterizing coastal water quality using bio-optical properties with special emphasis to phytoplankton size class
Prof. Nittala S. Sarma, Andhra University, Visakhapatnam	Studies on CDOM variability, structure and affecting factors for improving Ocean colour algorithm in the mid-western Bay of Bengal
Prof. B. R. Raghavan Mangalore University, Mangalore	Size Distribution of Total Suspended Matter and Measurement of Optical Properties to Derive a Local Scale Algorithm in a Time Sequenced Scenario off Mangalore

8.4 The Ocean State Forecast programme

PMC Chair: Prof. P. Rajendra Prasad, Sir Arthur Cotton Chair Professor, Andhra University

Principal Investigator	Title of the project
Dr. V. Sanil Kumar, NIO, Goa	Real-time Wave data collection at six locations in the Indian water for Coastal Ocean Forecast
Dr. Prakash Mehra, NIO, Goa	Establishment of a network of near-real time reporting surface meteorological stations at selected coastal and Island locations of India
Mrs. Sheela Nair, NCESS, Thiruvananthapuram	Establishment and Maintenance of wave gauge stations along the Southwest coast of India
Prof. P. Bhanumurty, Andhra University, Visakhapatnam	Validation, Dissemination and Refinement of Location-specific Coastal Ocean State Forecast System
Dr. J. L. Rathode, Karnataka University, Karwar	Sea State Forecast Off Uttara Kannada-Dissemination, Validation and Societal Impact Studies
Dr. A. N. Vedpathak, CCMB, Ratnagiri	Development and usage of ocean state forecast products from the display boards and the wave rider buoys for application of soft computing techniques in reduction of errors along Maharashtra coast
Prof. Shreenivas Londhe, VIIT, Pune	Improving location specific wave forecast using Soft Computing Techniques
Prof. N. G. Akolkar, JAU, Okha	Ocean State Forecast Validation and research (off Okha and Veraval coasts of Gujarat)
Dr. Mohanraj, Kamaraj College, Tuticorin	Monitoring and dissemination of data from the wave rider buoy and compare physiochemical parameters along the Tuticorin coastal water

8.5 The Marine Fisheries Advisory System

PMC chairperson: Dr. B. MeenaKumari, Deputy Director General, Indian Council for Agricultural Research.

Principal Investigator	Title of the project
Dr. V. R. Madhu, Veraval Research Centre of Central Institute of Fisheries Technology (CIFT), Veraval	Studies on the ecological linkages between plankton production and Acetes sp. Abundance along Gujarat Coast
Dr. A. S. Kulkarni, RP Gogate College of Arts and Science and R V Jogalekar Collecge of Commerce, Ratnagiri	Monitoring marine phytoplankton community structure and seasonality as food-web indicator for commercially important fishes off Ratnagiri Coast
Dr. Gangadhara Gowda, College of Fisheries, Karnataka Veterinary, Animal and Fisheries Sciences University, Mangalore	Influence of Oceanographic Parameters on Plankton assemblage and Pelagic Fisheries using Satellite data along the Coast of Dakshina Kannada and Udupi Districts of Karnataka
Dr. V. Kripa, Central Marine Fisheries Research Institute (CMFRI), Kochi	Eco-biological investigations on major pelagic fishes and ecological modelling of epipelagic habitat off Kerala and Lakshadweep
Dr. R. Jyothibabu, CSIR-NIO, Regional Centre, Kochi	Advanced studies on the plankton food web in relation to the oceanographic environment in the PFZ off Kochi
Dr. T. Saravana Kumar, Annamalai University, Tamil Nadu	Influence of in situ bio-optical properties in determining the phytoplankton community structure and their role in ocean colour algorithms along the southeast coast of India and its application to fisheries
Prof. K. Sree Ramulu, Andhra University, Visakhapatnam	Impact of ocean parameters on fishery resources and development and validation of regional algorithms for ocean color constituents off Visakhapatnam coast
Dr. U. Sreedhar, Research Centre of Central Institute of Fisheries Technology (CIFT), Visakhapatnam	Validation of Tuna advisories off East Coast
Prof. Sugata Hazra, Jadavpur University	Bio-Optical studies and Ecological modeling in case II water of West Bengal coast towards Hilsa fishery forecast.

Dr. S. Dam Roy, Central Agricultural Research Institute (CARI), Port Blair	Location-specific augmentation of Potential Fishing Zones (PFZ) using satellite altimetry and fishing ground database
Ms. Nancy J. Anabel, M.S. Swaminathan Research Foundation, Chennai	Fisher Friend Programme – Capacity Building of Fisher folk for the effective use of ESSO-INCOIS Potential Fishing Zone Services for enhancing their lives and livelihoods in 5 states of Indian Coastline
Dr. Pratibha Rohit, Central Marine Fisheries Research Institute, Kochi	Satellite Telemetry Studies on Migration Patterns of Tunas in the Indian Seas (SATTUNA) – CMFRI Component 01
Dr. Premchand, Fishery Survey of India	Satellite Telemetry Studies on Migration Patterns of Tunas in the Indian Seas (SATTUNA) – FSI Component 02
Dr. V. S. Somvanshi, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad	Writing a scientific book entitled "Remote Sensing Science and Societal Benefits to Coastal Fishermen"
Mr. M. Nagaraja Kumar, ESSO-INCOIS	Procurement of Equipments under the above sub-projects for XII Plan Period

8.6 Data Management Programme

PMC co-chairs: Prof. B. N. Goswami, Pisharoty Chair Professor, IISER, Pune and Dr. S. R. Shetye, Vice-chancellor, Goa University

Principal Investigator	Title of the project
Dr. Debadatta Swain, IIT Bhubaneswar	Does Tropical Cyclone Heat Potential play a significant role in intensification of tropical cyclones? A comprehensive study for the Northern Indian Ocean
Dr. Jaya Sreevalsan Nayar, IIIT Bangalore	Interactive Three-dimensional Visualization of Large-scale ARGO Data

8.7 Ocean Observation Systems (OOS)

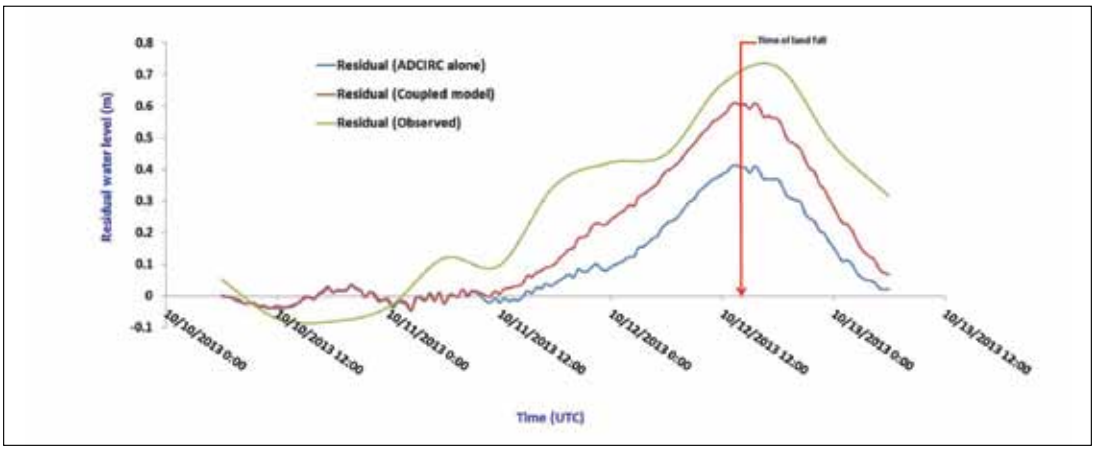
PMC Chair: Secretary, MoES

Principal Investigator	Title of the project
Dr. D. Shankar, NIO, Goa	Current Observation and Simulation in the Indian EEZ (COSINE)
Dr. V. S. N. Murty, NIO, RC, Visakhapatanam	Equatorial Mooring Array for Current Observations and Research on Indian Ocean Dynamics (EMAC-IOD)
Dr. V. V. Golapakrishna, NIO, Goa	Observed trends in the near surface layer temperature/salinity fields in the Indian Seas (XBT/XCTD)
Dr. V. V. Golapakrishna, NIO, Goa	Acquiring data on ocean surface current velocities, salinity and meteorological parameters using satellite tracked drifting buoys in the Indian Ocean

9. Research Highlights

9.1 A coupled hydrodynamic modeling system for PHAILIN cyclone in the Bay of Bengal

Simulations of the storm surge, still water level elevation and wave induced setup associated with 'Phailin', a very severe cyclonic storm that made landfall in the Odisha State, east coast of India, during October, 2013 by a coupled wave + surge hydrodynamic modeling system (ADCIRC + SWAN) provided a realistic description of the dynamic interaction of tides, wind, waves and currents, which are critical for operational needs. Numerical experiments which were carried out for both storm surge alone and coupled mode versions of the model setup suggested that dependent upon complex bathymetry and coastal geometry, inclusion of the wave-induced setup in coupled runs, results in an additional 23–36% increase of peak surge relative to an uncoupled, surge-tide simulation. The significant wave height from the coupled model also showed an excellent match with observed wave heights from a wave-rider buoy located off the Odisha coast.



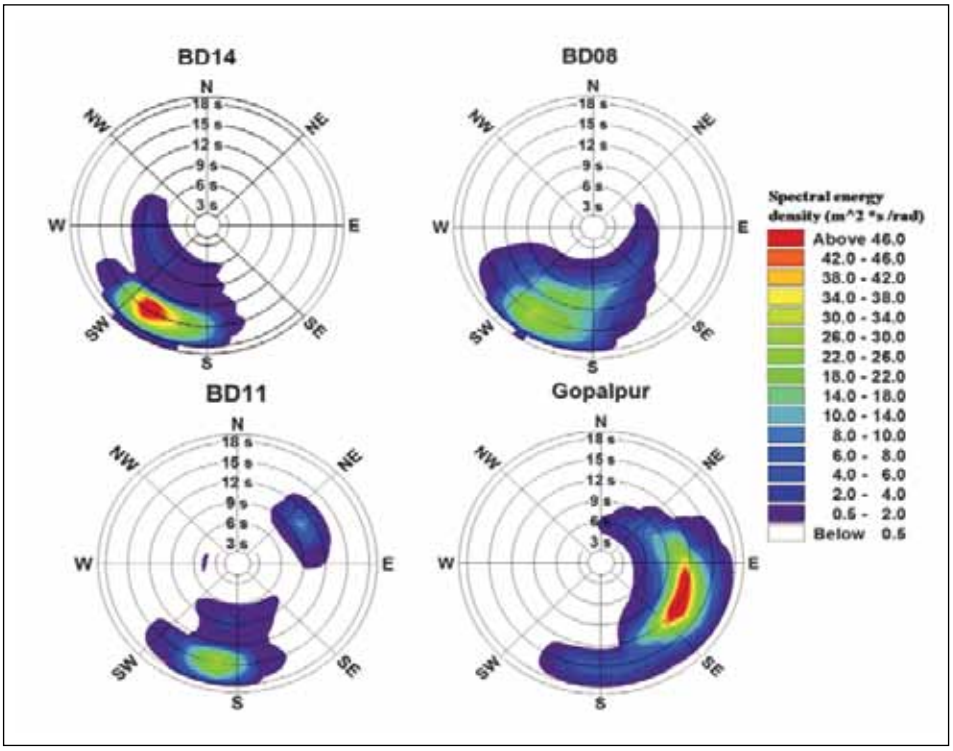
Surge residual (in metres) at Paradeep, Odisha with coupled/uncoupled runs validated against tide gauge observation

REF : Murty, P.L.N., Sandhya, K.G., Bhaskaran, P.K., Josec,F., Gayathri,R., Balakrishnan Nair, T.M., Srinivas Kumar T., Shenoi S.S.C (2014) A coupled hydrodynamic modeling system for PHAILIN cyclone in the Bay of Bengal, Coastal Engineering, 93, pp.71–81

9.2 Wave forecasting and monitoring during very severe cyclone Phailin in the Bay of Bengal

Wave fields, both measured and predicted during the very severe cyclone Phailin were compared with observations from the ESSO-INCOIS wave rider buoy moored off the coast of Gopalpur (19.28^0 N, 84.97^0 E) and deep-sea moored buoys BD08 (18.14^0 N, 89.67^0 E), BD11 (13.49^0 N, 83.98^0 E) and BD14 (7.03^0 N, 87.99^0 E) deployed by ESSO-NIOT. The wave forecast (issued on 11 October 2013) indicated that high waves of 6.95 m would hit the Gopalpur coast by

0600 UTC on 12 October 2013, and the observed wave height was 6.84 m. A statistical evaluation showed that the forecast and observed significant wave heights matched well at Gopalpur with correlation coefficient of 0.98, RMS error of 0.35 m and scatter index of 14%. The spectral analysis of the wave data confirmed the presence of long-period swells (>12 sec) nearly 80% of the time during the cyclone period. The study also revealed about 14% of the time, Southern Ocean swells with a peak period of 20–22 sec hit Gopalpur coast along with the cyclone-generated waves.



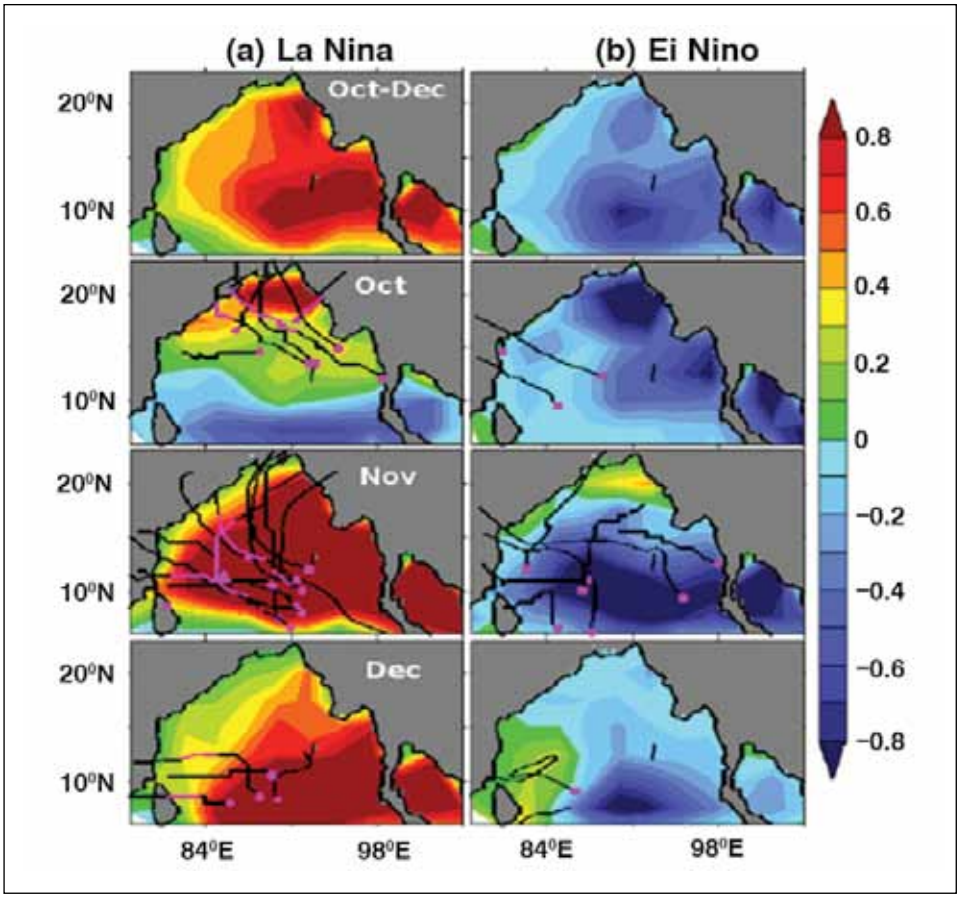
Model-derived two-dimensional wave energy spectra at (a) BD14 on 10 October 2013 at 1500 UTC, (b) BD08on 11 October 2013 at 1800 UTC, (c) BD11 on 11 October 2013 at 1800 UTC and (d) Gopalpur on 12 October 2013 at0600 UTC. The time steps are chosen in such a way that the southern swells and cyclone-generated waves are easily discernible

REF: Balakrishnan Nair, T.M., Remya, P.G., Harikumar, R., Sandhya, K.G., Sirisha, P., Srinivas, K., Nagaraju, C., Nherakkol, A., Krishna Prasad, B., Jeyakumar, C., Kaviyazhahu, K., Hithin, N.K., Kumari, R., Sanil Kumar, V., Ramesh Kumar, M., Shenoi, S.S.C., Nayak, S. Wave forecasting and monitoring during very severe cyclone Phailin in the Bay of Bengal (2014) Current Science, 106 (8), pp. 1121-1125

9.3 The role of ENSO and MJO on rapid intensification of tropical cyclones in the Bay of Bengal during October–December

The influence of El Niño/Southern Oscillation (ENSO) and Madden–Julian Oscillation (MJO) and their combined effect on the rapid intensification (RI) of tropical cyclones (TCs) in the Bay of Bengal (BoB) during the primary cyclone season (October–December) was investigated using an empirical index, called genesis potential index (GPI), which quantifies the relative importance of

four environmental parameters responsible for the modulation of TCs characteristics. It was found that TC frequency and RI of TCs are higher in La Niña than El Niño regime during the primary TC season in BoB. The combined effect of enhancement (reduction) in mid-tropospheric humidity (primary factor) and relative vorticity (secondary factor) played a major role in the enhancement (reduction) of the TC activity under La Niña (El Niño) regime. In addition, when the MJO is active over BoB (phases 3–4; characterized by enhanced convective activity in BoB) under La Niña regime, environmental conditions were more conducive for enhancement of TC activity and RI of TCs compared to corresponding MJO phase under El Niño regime. Increase in mid-tropospheric humidity and reduction in vertical wind shear were identified as the primary and secondary factors enhancing the likelihood of RI of TCs in BoB during phases 3–4 of MJO under La Niña regime. It is also found that the accumulated tropical cyclone heat potential (ATCHP) was large for TCs which undergo RI compared to TCs not undergoing RI.

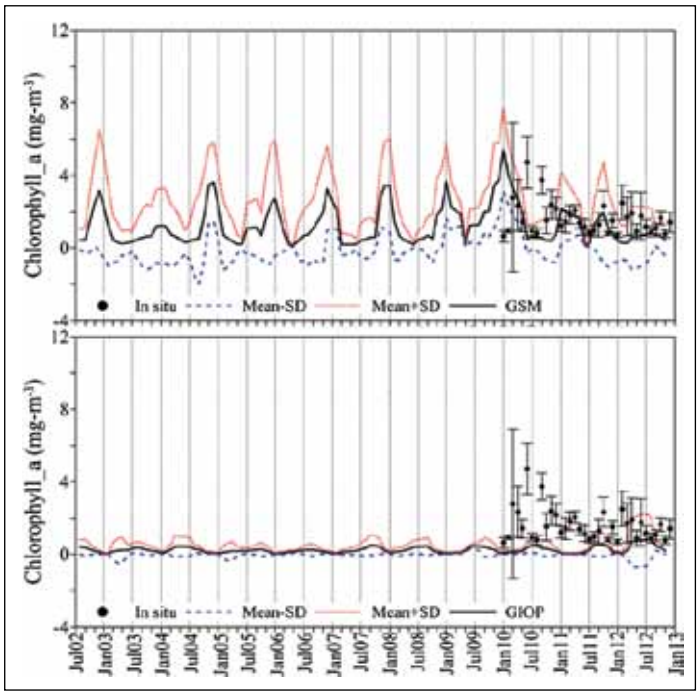


Seasonal (October–December) and monthly (October, November and December) composites of GPI anomaly under (a) La Niña and (b) El Niño regime in the BoB during 1985–2012. Tracks of TCs are marked by black curve (tracks of TCs undergoing RI are marked by pink line) and genesis locations are marked by pink circles

REF: Girishkumar, M.S., Suprit, K., Vishnu, S., Thanga Prakash, V. P., Ravichandran, M., The role of ENSO and MJO on rapid intensification of tropical cyclones in the Bay of Bengal during October–December (2014), Theoretical and Applied Climatology, 1-14. DOI- 10.1007/s00704-014-1214-z

9.4 Performance of Semianalytical Algorithm and Associated Inherent Optical Properties in Coastal Waters of North Western Bay of Bengal

Association of two semianalytical algorithms, Garver–Siegel–Maritorena (GSM) and Generalized IOP (GIOP) with their Inherent Optical Properties (IOP) such as phytoplankton absorption coefficient (aph), detritus absorption (adg) and particulate backscattering (bbp) were studied using Chlorophyll-a (Chl-a) derived from Moderate Imaging Spectroradiometer-Aqua (MODISA) data for a period of 10 years. Even though both the algorithms showed similar trend at an annual scale, magnitude of Chl-a from GSM was three times higher than that from GIOP. It was also found that the Chl-a retrieved from GSM was closer to in situ values. The variability of aph and adg was similar at long-term time scale. The peak observed in variability of aph and adg during premonsoon was due to the occurrence of bloom whereas the peak during monsoon was due to nutrient discharge from river. The observed peak in bbp during monsoon could be also attributed to the increasing concentration of total particulate matter from river as well as from bottom re- suspension. The poor association of IOP with Chl-a explains the limited accuracy of satellite retrieved Chl-a from these semianalytical algorithms. Hence it is required to generate IOP at the regional scale and tuning the semianalytical model for better accuracy.

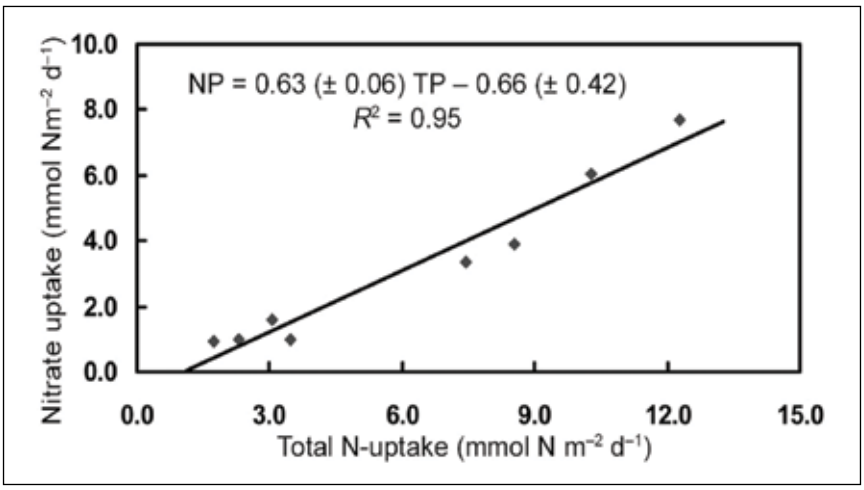


Time-series variability inmonthly mean distribution of Chl-a derived from MODISA using GSM (upper) and GIOP (lower) algorithms. The dotted line (red) represent the sum of mean and standard deviation . The dashed line (blue) represent the difference between mean and standard deviation. The dots represent the in situ Chl-a and the vertical lines are for standard deviation

REF: Lotliker, A.A., Baliarsingh, S.K., Sahu, K.C., Srinivasa Kumar T., Performance of Semianalytical Algorithm and Associated Inherent Optical Properties in Coastal Waters of North Western Bay of Bengal (2014) Journal of the Indian Society of Remote Sensing, DOI-10.1007/s12524-014-0399-z

9.5 Nitrogen uptake rates and f-ratios in the Equatorial and Southern Indian Ocean

Analysis was done to quantify the nitrate, ammonium and urea uptake rates using the water samples collected in the pre-monsoon season (May–June 2005) on board ORV Sagar Kanya (SK-220) along two transects, 77^0 E and 83^0 E with five stations along each transect, samples collected in late austral summer (February–March 2006) on-board Akademik Boris Petrov (ABP-15) at six different stations in Southern Indian Ocean and at two stations in the Equatorial Indian Ocean. It was found that, in the equatorial Indian Ocean, the productivity was low (~ 0.81–2.23 mmol N m^{-2} d^{-1}), but the f-ratio, which is the ratio of new production with total production, (0.13–0.45) was relatively high. In the Southern Indian Ocean total N-uptake rate varied from 1.7 to 12.3 mmol Nm^{-2} d^{-1}; it was higher in the Antarctic coast (69^0 S) and lower over most of the Southern Ocean, the lowest being at 58^0 S. The mean f-ratio in the Southern Indian Ocean was 0.50. Even though the f -ratio showed significant spatial variation in the Southern Indian Ocean, it was higher than the values at the Equatorial Indian Ocean. The nitrate-specific uptake rates and f-ratios appeared to have increased significantly in the recent past relative to earlier estimates. While productivity in the Southern Ocean was comparable to that in the Equatorial Indian Ocean, higher f -ratios in the former underscored its importance in the uptake of CO_2.

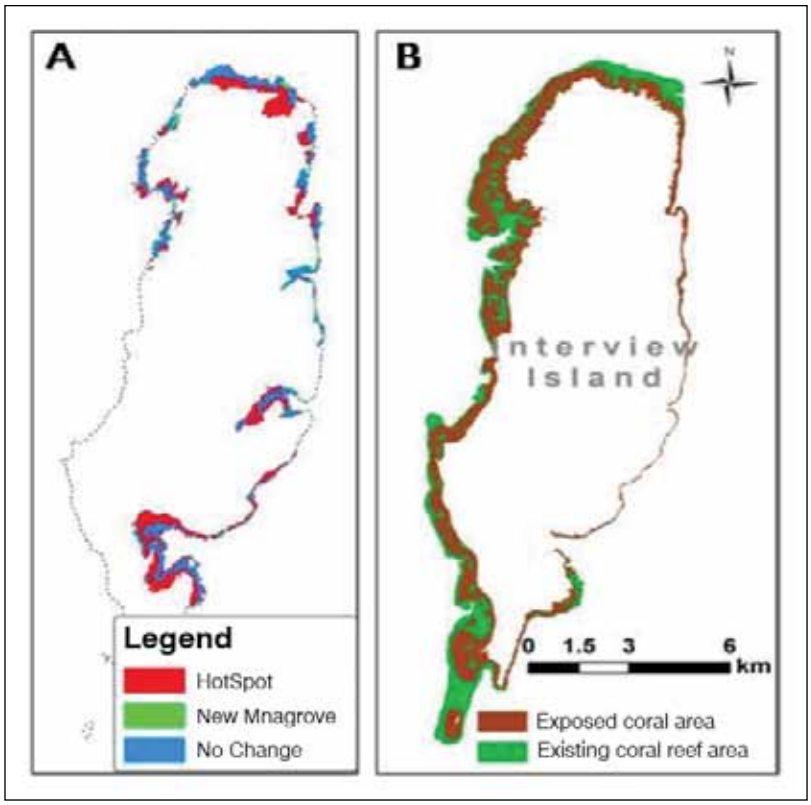


Relationship between total N-uptake and nitrate uptake in the Southern Indian Ocean. NP and TP represent new and total production respectively

REF: Prakash, S., Ramesh, R., Sheshshayee, M.S., Mohan, R., Sudhakar, M. Nitrogen uptake rates and f-ratios in the Equatorial and Southern Indian Ocean (2015), Current Sciences, 108 (2). pp. 239-245

9.6 Geospatial assessment of Coral and Mangrove Environs of the Andaman Islands

The 9.3 Mw Sumatra Earthquake occurred on December 26, 2004 not only generated a devastating tsunami, but also created lot of tectonic disturbances in the Andaman region. As result of this,



The spatio-temporal changes inthe mangrove cover (left) and coral eco-morphology (right)

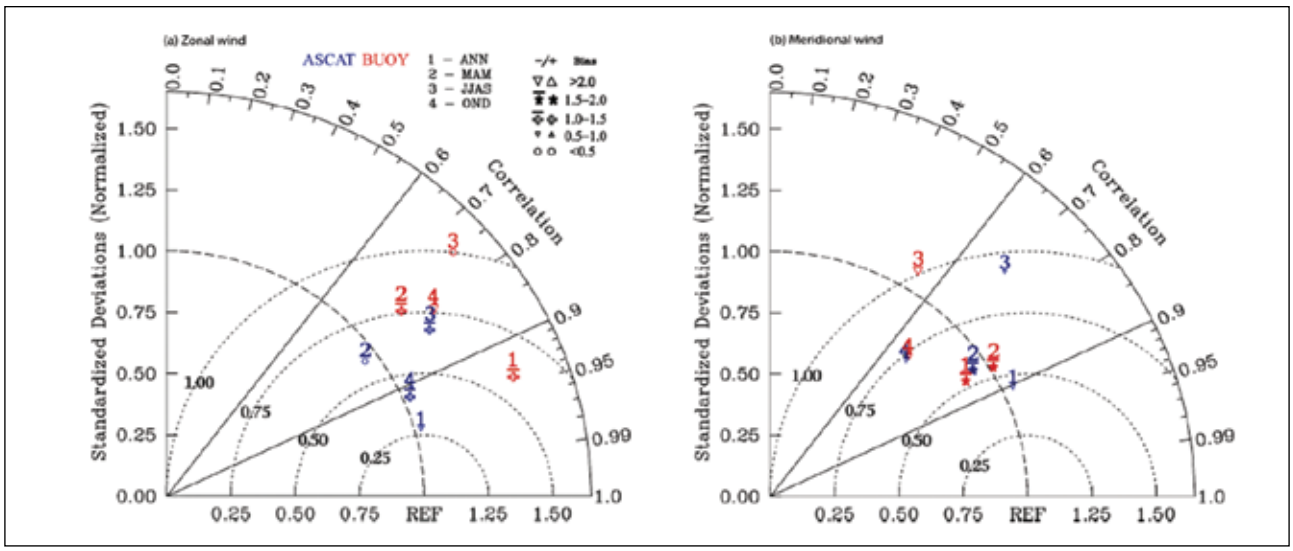
REF: Mahendra, R.S., Mohanty, P.C., Bisoyi, H., Srinivasa Kumar T., Geospatial assessment of coral and mangrove environs of the Andaman Islands (2014) International Journal of Earth Sciences and Engineering, 7 (1), pp. 275-279

northwestern parts of the land got uplifted a metre above from the earlier position. This resulted in the lot of spatial disturbances in the coastal environment. The shallow depth corals were exposed and degraded permanently. Moreover, the upstream mangroves in were also degraded. A case study from the Interview Island in the northern Andaman using the Landsat Enhanced Thematic Mapper (ETM) and Indian Remote Sensing (IRS) Linear Imaging Self Scanning Sensor (LISS)-III data to infer the spatial changes in the coral and mangrove environments revealed that the total coral reef area of 17. 82 km^2 was degraded. The mangrove also showed the same tendency of degradation of total 4.48 km^2 area. The findings are important as they would help to understand the spatial extent and the distribution of the damage caused due to the natural calamity on the coral and mangrove environment.

9.7 Evaluation of High-Resolution WRF Model Simulations of Surface Wind over the West Coast of India

Evaluation of the hindcasts of the surface wind using high-resolution-mesoscale atmospheric numerical model Advanced Research WRF (ARW3.3) model showed that the model could predict the surface wind fields fairly accurately over the west coast of India. The skill was very high for

the pre-monsoon season compared to other seasons. The correlation coefficients between the predicted zonal wind and ASCAT observations were in the range of 0.85–0.90. The model also predicted the diurnal variability of the surface wind with good accuracy. The model simulated the land- sea breeze cycle in the coastal region realistically, which was very clearly observed during the northeast monsoon and pre-monsoon season and was less prominent during the southwest monsoon season. However, a significant negative bias was seen for both components of wind during all seasons, with a maximum bias for the zonal wind during the northeast monsoon season. This negative bias could be due to the terrain-related model error, such as inaccurate representations of elevation, ruggedness and surface roughness.



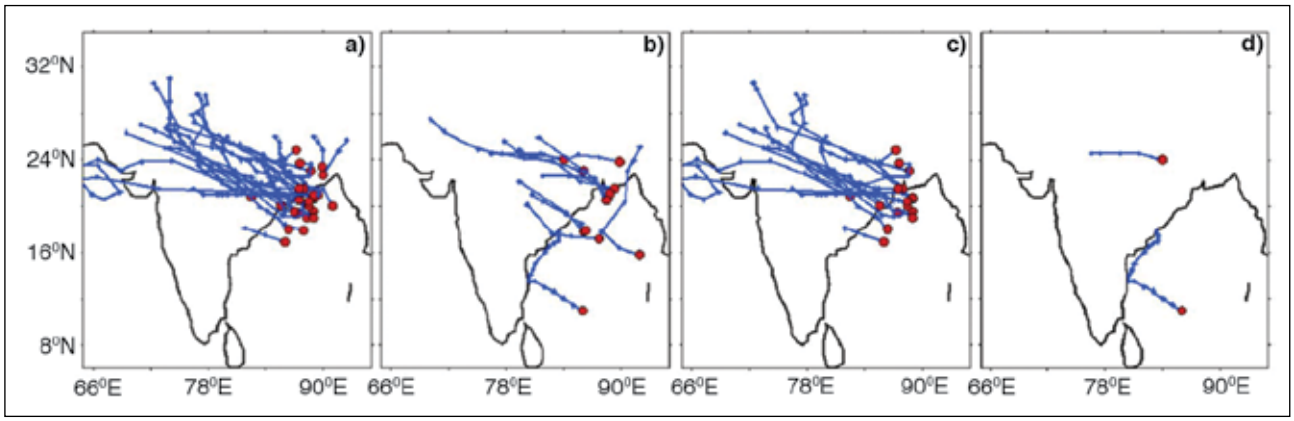
Taylor diagrams of model-simulated wind with the observations from ASCAT (blue) and the buoy (red): zonal wind (left) and meridional wind (right). Dotted semicircles over the horizontal axis represent the centered RMSE between model simulation and observations

REF: Vishnu, S., Francis, P.A. (2014) Evaluation of High-Resolution WRF Model Simulations of Surface Wind over the West Coast of India, Atmospheric and Oceanic Science Letters, 7(5), pp. 458-463

9.8 Influence of the Atlantic zonal mode on monsoon depressions in the Bay of Bengal during boreal summer

The analysis on the influence of the Atlantic Zonal Mode (AZM) or the Atlantic Niño on monsoon depressions in the Bay of Bengal during the boreal summer (June–August) showed that there is a statistically significant difference in the number of monsoon depressions in the Bay of Bengal between the warm and cold phases of the AZM; more (fewer) monsoon depressions form during the cold (warm) phase of AZM. The analysis also showed that there are differences in spatial pattern of trajectories of monsoon depressions; during the cold phase of AZM, the tracks are relatively long and clustered along the axis of core monsoon region compared to the warm phase of AZM. It was shown that the physical mechanism for these differences are increase (reduction) in low-level cyclonic vorticity and midtropospheric humidity but reduction (increase) in vertical

wind shear, which are favourable for the enhancement (suppression) of monsoon depressions during the cold (warm) phase of the AZM. These findings could have implications for enhancing monsoon prediction skill, especially during non-El Niño–Southern Oscillation years.



The genesis locations (red circle) and tracks of monsoon depressions (blue line) during (a and c) cold and (b and d) warm phases of AZM. Figures 4a and 4b represent all the corresponding AZM years and Figures 4c and 4d represent all the corresponding AZM years without ENSO years

REF: Pottapinjara, V., Girishkumar, M.S., Ravichandran, M., Murtugudde, R. Influence of the Atlantic zonal mode on monsoon depressions in the Bay of Bengal during boreal summer (2014) Journal of Geophysical Research: Atmospheres, 119 (11), pp. 6456-6469

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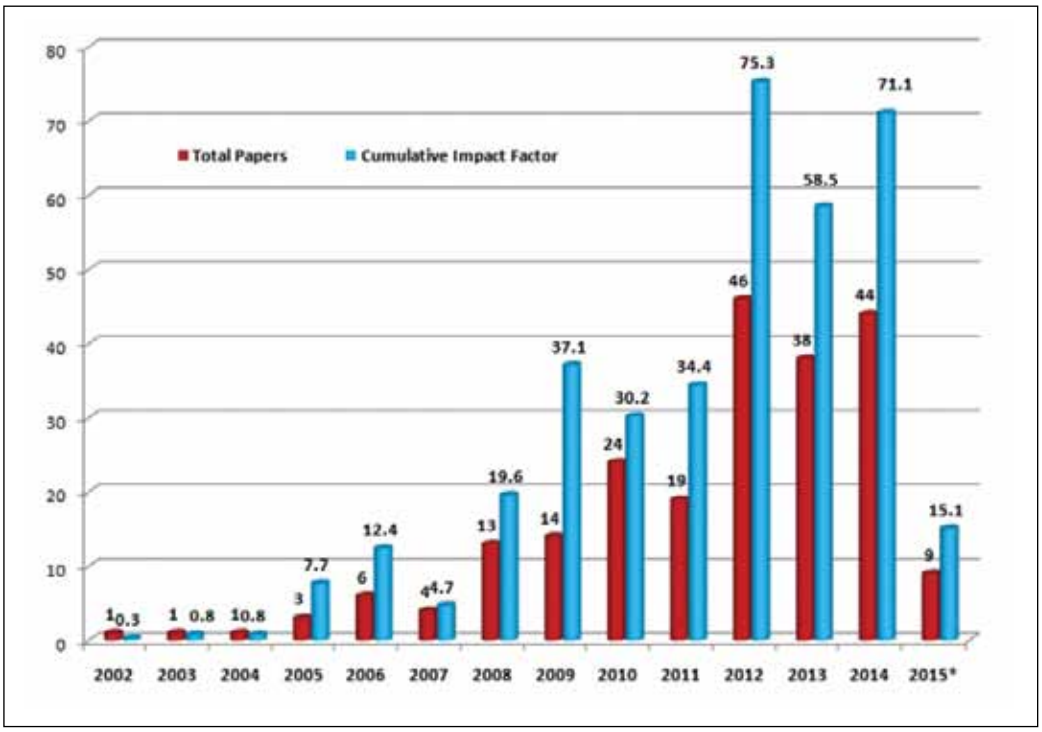


Year-wise number of publications from ESSO-INCOIS and their cumulative impact factors

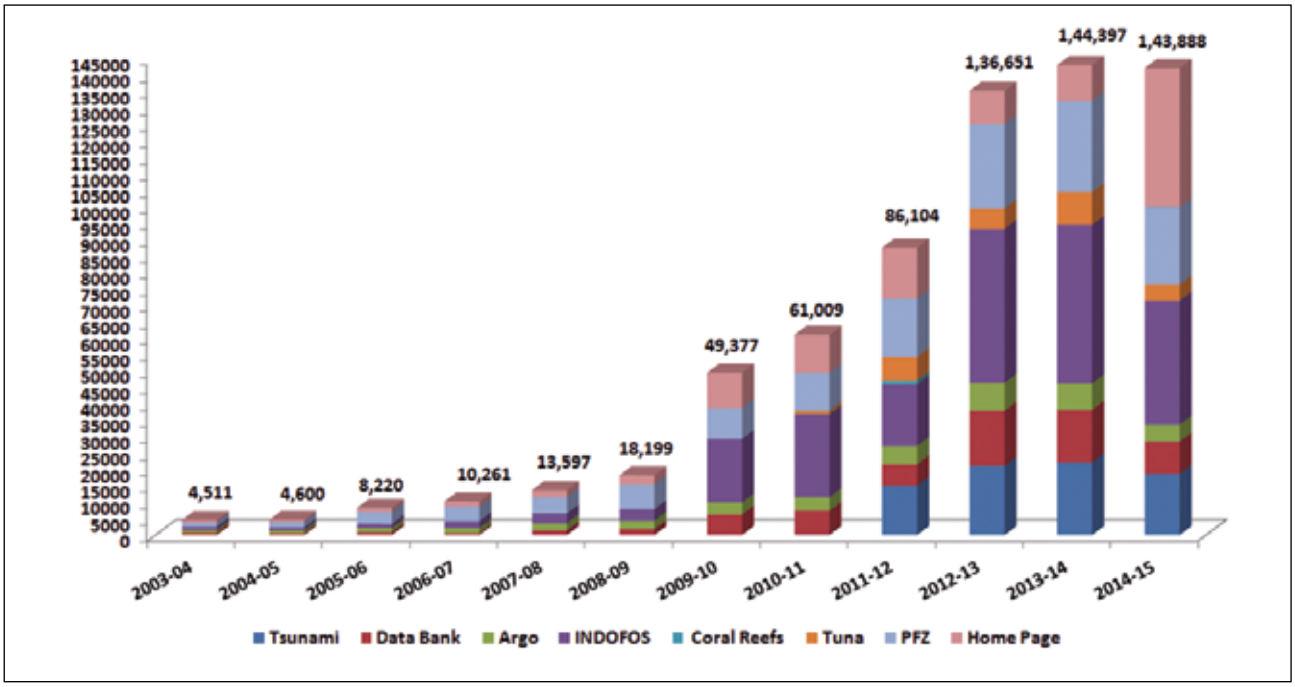
10. Computational Infrastructure and Web based Services

ESSO-INCOIS hosts state-of-the-art computational facilities that include a high performance computer and its allied infrastructure, 300 TB storage, ERP servers, FTP server, web & application servers, Live Access Server, workstations, desktops, laptops, link load balancers, application load balancers, firewalls, core switches, edge switches and a 30 km long campus-wide networking. The network and the infrastructure is set up in such a manner that no single point of failure can affect the operational services at ESSO-INCOIS. ESSO-INCOIS continued to maintain a computing and network infrastructure with an up time of 99% to support the operational and R&D projects. Backup policies are implemented on 300 TB centralised storage and available for operations. Implementation of LAN and Wi-Fi network within ESSO-INCOIS was completed as part of the second phase of building at ESSO-INCOIS. Connectivity between ESSO-INCOIS and ESSO-IITM is established for users to access the central computing facility (Aaditya) hosted at ESSO-IITM.

10.1 Features of New Website of ESSO-INCOIS and Ocean Data Portal

ESSO-INCOIS switched over to the new Website and Ocean Data Portal developed by the in-house web team on 1 September 2014. The design of the new website and data portal made it more user friendly. As the ESSO-INCOIS website is the most important medium to disseminate our products, the access to the ESSO-INCOIS web services is made even easier on the new website. The responsive layout of the website also enables access through a wider range of web browsers and devices, including mobiles and tablets. The new website can be accessed at www.incois.gov.in

New website of ESSO-INCOIS



Categorywise statistics of the ESSO-INCOIS website visitors

A snapshot of the WebGIS based web page for accessing information on the ocean observation

A WebGIS based application was developed for the real-time display of Ocean Observations Network (OON).

ESSO-INCOIS INTRANET is made available for the employees to access several organizational information and facilities.

11. Capacity Building, Outreach and Training

11.1 International Training Centre for Operational Oceanography (ITCOocean)

The International Training Centre for Operational Oceanography (ITCOocean) at ESSO-INCOIS continued to conduct relevant training courses in operational oceanography.

During 2014-15, eight short term courses were conducted by ITCOocean.

i. A course on "Ocean Information Services for Cyclone Forecasters" was held during April 2-3, 2014. Twenty-two participants from various national institutes attended the course.

ii. "On-Job Training" for Oman Tsunami Warning Centre Operators was conducted between 04 - 08, August 2015. Six officials participated in the training from National Multi Hazard Early Warning System (NMHEWS) under the Directorate General of Meteorology and Air Navigation (DGMAN), Oman.The course was conducted on request from IOC/UNESCO.

Omani officials attending a class during the course "On-Job Training for Oman Tsunami Warning Centre Operators"

Participants attending class during the course "Ocean Information Services for Cyclone Forecasters"

iii. A course on "Ocean Colour Remote Sensing - Data, Processing and Applications" was held between November 10-14, 2014. There were 20 national and 8 international participants (Madagascar, Romania, Ghana, Tanzania, Malaysia, Mauritius, Bangladesh, Romania).

iv. A training course for Trainers and operators of Ocean State Forecasts was held during 26-27 November, 2014. Sixty-four participants from various institutes in India attended this training.

Participants attending class during the course for "Operators w.r.t Ocean State Forecasts"

Participants attending class during the course "Ocean Colour Remote Sensing - Data, Processing and Applications"

v. In order to promote data awareness among the research community and university students, ESSO-INCOIS conducted a four day workshop on "Ocean Data Utilization and Ocean Observation Systems", for M.Sc. and M.Tech. students from IIT, Bhubaneswar during 03-06 December, 2014. Eighteen students attended the workshop.

vi. A short course on "Advanced Oceanography for Senior Naval Officers" was conducted for the officers of the Indian Navy during December 18 -19, 2014 to improve the understanding of oceanography and utility of ESSO-INCOIS' products and services.

Participants attending class during the course " Ocean Colour Remote Sensing - Data, Processing and Applications"

Indian Naval Officers interacting with faculty during the "Advanced Oceanography" course

vii. A short course on "Advanced Statistical Concepts in Atmospheric and Oceanic Sciences" was held during February 23-28, 2015 to familiarize oceanographers with statistical techniques and aids. Thirty participants from various national organizations attended the course.

Participants attending a lecture in the new state-of-the art e-classroom during the statistical concepts course

11.2 Regional Workshop on Standard Operating Procedures (SOP) for Tsunami Warning and Emergency Response for Northern and Western Indian Ocean Countries

ESSO-INCOIS hosted the Regional Workshop on Standard Operating Procedures for Tsunami Warning and Emergency Response for Northern and Western Indian Ocean Countries during June 23 - 27, 2014.

IOTWS WG-2 and IOWave14 Task Team meetings were also held together with the workshop. TSP-India along with the other TSPs participated and familiarized the representatives of NTWCs, DMOs and Media with the IOTWS service and the TSP products. Thirty participants from Iran, Yemen, Kenya, Tanzania, Mozambique, Mauritius, Maldives, Comoros, Madagascar and Seychelles and 10 subject experts from ITIC, JTIC, ABU, BoM, BMKG and ITEWC participated in the workshop and meetings.

Participants at the Regional Workshop on Standard Operating Procedures (SOP) for Tsunami Warning and Emergency Response for Northern and Western Indian Ocean Countries, Hyderabad

11.3 6th National Workshop on Science of Climate Change: Indian Ocean and Monsoon

The workshop on "Science of Climate Change: Indian Ocean and Monsoon" organised together with Centre for Climate Change Research (CCCR), ESSO-IITM, Pune, was held during 1-2 September 2014 at ESSO-INCOIS.

Dr. Krishnaswamy Kasturirangan, member of the Planning Commission of Government of India and the Chancellor of Jawaharlal Nehru University inaugurated the workshop. The new

Clockwise: Inaugural function of the 6th National Workshop on "Science of Climate Change: Indian Ocean and Monsoon", participant presentation, launch of new ESSO-INCOIS website and participant interaction

ESSO-INCOIS website and CCCR's Climate Data Portal were also unveiled at the function. Forty-five researchers and scientists presented their work at the workshop.

11.4 National Workshop on "Indian Tsunami Early Warning System: Progress, Challenges and Future Road Map: A review of the developments during last decade"

On the occasion of the 10th anniversary of the Indian Ocean Tsunami, a one-day national workshop was organised at ESSO-INCOIS on 26th December 2014 to reflect on the achievements during the last decade and to identify the areas that require refinement in both science as well as response procedures. Discussions were also held on the incorporation of sea level inversion, real-time inundation modelling, use of near-field GPS measurements for real-time rupture characterisation and 3D mapping of vulnerable coastal areas.

The workshop comprised of two parallel sessions, one focused on the technical roadmap for the warning system and the other focussed on the development of standard operating procedures for disaster management authorities. Twenty-five representatives from NGRI, IMD, SoI, NIOT, NRSC, PRL, JNCASR, ICMAM and IISc participated in the technical session that reviewed the progress and future plans of ITEWS. Twenty-five participants representing National/state level DMOs (MHA,

Clockwise: Inauguration of 10th anniversary national workshop of the Indian Ocean Tsunami, launch of SOP booklets, officials visiting ITEWC, officials attending the inauguration function, Table-top exercise in progress, presentation on status of ITEWS and inauguration of the Staff Quarters and Guest house

NDMA, NIDM, NDRF, Indian Navy, Coast Guard, etc), Ports, Atomic Power Stations and Media participated in the session on disaster management.

A tabletop exercise was also conducted during which a hypothetical earthquake event of M 9.2 off the west coast of Northern Sumatra was considered and an emergency situation was simulated to elicit discussion from the participants to enhance their plans, policies and procedures.

Hon'ble Union Minister for Science & Technology and Earth Sciences, Dr. Harsh Vardhan inaugurated the workshop. Shri. Y. S. Chowdary, Hon'ble Minister of State for Science & Technology and Earth Sciences were Guests of Honour. Dr. Shailesh Nayak, Secretary, MoES and former MoES secretaries Dr. H.K. Gupta and Dr. P.S. Goel and Hon'ble MLA Shri.Vivekananda graced the occasion.

Dr. Harsh Vardhan also inaugurated the newly constructed residential complex during the workshop.

11.5 National Conference on "Spatial Technologies for Disaster Management"

To celebrate the 25th year anniversary of the Andhra Pradesh Geographical Society (APGEOS-http://www.apgeos.in/) a national conference on "Spatial Technologies for Disaster Management" was organized by APGEOS and the ESSO-INCOIS on 23rd-24th January 2015 at ESSO-INCOIS. APGEOS focuses on "Digital Geography" which encompasses all branches of science with Spatial Technology and Computer Science.

The conference was inaugurated by the Chief Guest Dr. V. K. Dadhwal, Director, NRSC, Hyderabad and Maj. Gen.(Retd) Dr. R. Sivakumar, Pro-Vice Chancellor (R&D), Gitam University, Hyderabad was the Guest of Honour.

Inauguration of National Conference on "Spatial Technologies For Disaster Management", Student interactions with Senior Scientists, Instrumental exhibit and Professional Paper Presentation session

Geospatial professionals from Osmania University, CSIR-NGRI, Hyderabad Central University and Telangana University presented papers on the developments in satellite technology. A large number of school and college students participated in the conference through special interactive sessions arranged with senior scientists.

Exhibits from Indian Institute of Remote Sensing (IIRS), Dehra Dun and from Survey of India were also arranged to expose the students and young professionals to latest technological developments and opportunities in spatial technology.

11.6 5th ESSO-INCOIS User Interaction Workshop

The 5th ESSO-INCOIS User Interaction Workshop was conducted at ESSO-INCOIS on 8th March, 2015. Shri. A.K. Gupta, Chairman & Managing Director, Shipping Corporation of India (SCI) presided over the inauguration as Chief Guest while Dr. B. Meena kumari, Deputy Director General (Fisheries), Indian Council of Agricultural Research (ICAR) and Capt. A. A. Hebbar, DIG, Coast graced the function as Guests of Honour. Shri. Bal Mane, Ex-MLA Ratnagiri and Cmdr. M. K. Singh, DNOM also graced the occasion.

Clockwise: Inaugurationof the 5th User Interaction Workshop, release of PFZ atlas, release of the MSSRF Market Study Report , launch of Ocean State Forecast along Standard shipping routes, Feedback Session, launch of Multi-lingual SMS Services for PFZ, launch of Buoy Drift Alert System, launch of Android based PFZ Application, inauguration of Operational High-resolution Ocean Forecast Model for the west coast of India

The workshop featured the launch and release of ESSO-INCOIS services/products :

- Inauguration of Operational High-resolution Ocean Forecast Model for the west coast of India.
- Releases of the *"Atlas of Potential Fishing Zones (PFZ) in Indian EEZ"* and the MSSRF Market Study Report on *"Utility of INCOIS services: Reflection of Fishers from Andhra Pradesh, Tamil Nadu, Puducherry and Kerala"*
- Launch of *Android based Application for Ocean Information Services - Version 1.0 (PFZ), Multi-lingual SMS Services for PFZ advisories, Buoy Drift Alert System,* the Bulletin service of Ocean State Forecast along Standard shipping routes.

The participating delegates included fishermen representing fishing communities in Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Odisha and West Bengal, officials of ONGC, Indian Navy, Coast guard, Ports and Harbours, NGOs, Universities and various Scientific organizations. The feedback from users on existing services and their additional requirements are expected to help ESSO-INCOIS to further improve services as well as to develop new services and data products.

11.7 Student Projects

During April 2014 - March 2015, fifty students carried out their B.Tech/M.Tech/M.Sc./Summer projects at ESSO-INCOIS.

Sl No.	Name of Student	Name of University/College/ Institute	Project Guide from ESSO-INCOIS
1	L. Bheerappa	Badruka College, Hyderabad	S.P. Vighneshwar
2	M.K. Sinsha	Central University of Karnataka	P.A. Francis
3	V. Vithin	Central University of Karnataka	P.A. Francis
4	Rashmi Bhaktani	University of Madras	N. Srinivasa Rao
5	Puja Paul	University of Madras	N. Srinivasa Rao
6	Ritupurna Bardhan	University of Madras	N. Srinivasa Rao
7	Y.K. Abhishek	Walchand College of Engineering, Sangli	Sudheer Joseph
8	Pritish Uday Naik	Walchand College of Engineering, Sangli	Sudheer Joseph
9	P. Pranav	Central University of Karnataka	R.S. Mahendra
10	Basheer Ahammed	Central University of Karnataka	R.S. Mahendra
11	C. Neenuja	Cochin University of Science and Technology, Kochi	Satya Prakash
12	Jofia Joseph	Cochin University of Science and Technology, Kochi	T.M. Balakrishna Nair

13	M.T. Aswathi Das	Cochin University of Science and Technology, Kochi	P.A. Francis
14	R. Prasanth	Cochin University of Science and Technology, Kochi	P.A. Francis
15	M. Anju	Cochin University of Science and Technology, Kochi	S.S.C. Shenoi
16	Nirmala Nair	Cochin University of Science and Technology, Kochi	S.S.C. Shenoi
17	D. Anusha	Indian Institute of Surveying & Mapping, Hyderbad	R.S. Mahendra
18	M. Sai Sindhu	Vidya Bharathi Institute of Technology, Hyderabad	V. Venu Gopala Rao
19	N. Reshma	Vidya Bharathi Institute of Technology, Hyderabad	V. Venu Gopala Rao
20	G. Preethi	Vidya Bharathi Institute of Technology, Hyderabad	V. Venu Gopala Rao
21	D. Srividya	Vidya Bharathi Institute of Technology, Hyderabad	V . Venu Gopala Rao
22	D. Vaishnavi	Vidya Bharathi Institute of Technology, Hyderabad	V. Venu Gopala Rao
23	B. Senthil	Bharathidasan University, Tamilnadu	R. Hari Kumar
24	S. Devi Kumari	Sri Padmavati Mahila Visvavidyalayam, Tirupati	R. Venkat Shesu
25	Divya Basuti	Jawaharlal Nehru Technological University, Hyderabad	N. Srinivasa Rao
26	Pavani Manogna	Jawaharlal Nehru Technological University, Hyderabad	N. Srinivasa Rao
27	M. Pujitha	V R Siddhartha Engineering College , Vijaywada	T.V.S. Udaya Bhaskar
28	M. Anuhya	V R Siddhartha Engineering College , Vijaywada	T.V.S. Udaya Bhaskar
29	S. Kavya	Sreenidhi Institute of Science and Technology, Hyderabad	S.P. Vighneshwar
30	S. Sowjanya	Sreenidhi Institute of Science and Technology, Hyderabad	S.P. Vighneshwar
31	M. Mahesh	Jawaharlal Nehru Technological University, Hyderabad	R.S. Mahendra
32	N. Naresh Naik	Jawaharlal Nehru Technological University, Hyderabad	R.S. Mahendra
33	D. Dhana Laxmi	Andhra University, Visakhapatnam	T. Srinivasa Kumar
34	J.V.S. Siva Charan	Annamalai University, Tamil Nadu	M. Nagaraja Kumar

35	Salik Saif	Indian Institute of Technology, Kharagpur	T.M. Balakrishna Nair
36	Chandu R Kumar Gupta	SASTRA University, Thanjavur	Murali Krishna
37	N. Sunanda	Cochin University of Science and Technology, Kochi	P.A . Francis
38	P. Deepthi	Malla Reddy Engineering College, Hyderabad	G. Vijay
39	Sangeetha Shenoi	Malla Reddy Engineering College, Hyderabad	G. Vijay
40	U. Anumol	Malla Reddy Engineering College, Hyderabad	G. Vijay
41	K. Pradeep	Indian Institute of Technology, Kharagpur	Satya Prakash
42	B.B. Pranaya	Andhra University, Visakhapatnam	S.S.C. Shenoi
43	V. Shravan	Jawaharlal Nehru Technological University Hyderabad	M. Nagaraja Kumar
44	S.N .Swetha	Jawaharlal Nehru Technological University Hyderabad	M. Nagaraja Kumar
45	Shrikant Dora	University of Hyderabad	P.A. Francis
46	A. Boyaj	University of Hyderabad	R.S. Mahendra
47	Santosh Kumar Verma	Jawaharlal Nehru Technological University, Hyderabad	S. Siva Reddy
48	K. Krishna Mohan	Jawaharlal Nehru Technological University, Hyderabad	T.V.S. Udaya Bhaskar
49	P. Krishna Priyanka	Jawaharlal Nehru Technological University, Hyderabad	T.V.S. Udaya Bhaskar
50	M. Sumanth Reddy	Jawaharlal Nehru Technological University, Hyderabad	M. Nagaraja Kumar

12. International Interface

12.1 IOGOOS (Indian Ocean-Global Ocean Observation System) Secretariat

The IOGOOS secretariat hosted at ESSO-INCOIS is responsible for (i) maintenance of IOGOOS membership details and focal contacts (ii) coordination and organisation of annual and general body meetings that includes preparing agenda in consultation with the officers, mobilizing funds, preparation of annual meeting reports, vacancy notifications, maintenance of financial accounts, etc. (iii) time to time circulation of rules or procedures amended by the annual general body meetings and (iv) coordination with subsidiary bodies of IOGOOS and other international organisations.

During April 2014–March, 2015, IOGOOS secretariat coordinated IOGOOS activities including the annual meeting and capacity building activities. The XIth annual meeting was held between 29 October–1 November 2014 at Thailand-China Joint Laboratory for Climate and Marine Ecosystem, Phuket, Thailand. The meeting was attended by Dr. S.S.C Shenoi, Director, ESSO-INCOIS, Dr. T. Srinivasa Kumar, Head, ASG (IOGOOS officer for the Central Indian Ocean) and Shri. M. Nagaraja Kumar, Scientist-D, ASG (Secretary, IOGOOS) .

12.2 SIBER (Sustained Indian Ocean Biogeochemistry and Ecosystem Research) International Programme Office

The SIBER International Programme Office, functioning at ESSO-INCOIS since 2010, significantly contributes to the SIBER community by making logistical arrangements for holding annual Science Steering Committee (SSC) meetings, enabling information sharing and maintenance of the SIBER website. ESSO-INCOIS is represented in SIBER by M. Ravichandran, Head-MOG and the programme office is managed by Dr. Satya Prakash, Scientist-D, ISG who attended the 5th SSC meeting held in conjunction with the 11th Indian Ocean GOOS (IOGOOS) meeting and the 5th IndOOS Resource Forum (IRF) meeting in Phuket, Thailand during 29 October–1 November 2014.

12.3 International Society for Photogrammetry and Remote Sensing (ISPRS)

ISPRS is a non-governmental organization dedicated to enabling international cooperation for the advancement of photogrammetry, remote sensing and related applications. Dr. T. Srinivasa Kumar, chairs the Working Group - VIII/1 on Disaster and Risk Reduction under the Technical Commission VIII (Remote Sensing Applications and Policies) and Shri. E. Pattabhi Rama Rao, chairs the Working

Group - IV/4 on Geospatial Data Infrastructure under the Technical Commission IV (Geospatial Databases and Location Based Services) during the current inter-sessional period 2012-16.

The ISPRS Technical Commission VIII Mid-Term Symposium on "Operational Remote Sensing Applications: Opportunities, Progress and Challenges" was organised in Hyderabad by Indian Society of Remote Sensing (ISRS), jointly with Indian Society of Geomatics (ISG) during 9-12 December, 2014.

12.4 International Oceanographic Data Exchange

The programme "International Oceanographic Data and Information Exchange" (IODE) of the "Intergovernmental Oceanographic Commission" (IOC) of UNESCO was set up in 1961 to enhance marine research, exploitation and development, by facilitating the exchange of oceanographic data and information between participating member states. IODE designated ESSO-INCOIS as the responsible National Oceanographic Data Centre (NODC) for India a structural element of IODE in 2004.

Shri E. Pattabhi Rama Rao is the National Coordinator from India for 'Data Management' under the IODE Programme. He also serves on the Steering Groups on Ocean Biogeographic Information System (SG-OBIS) and IODE Quality Management Framework (SG-IODE QMF).

12.5 Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES)

RIMES operates from the campus of the Asian Institute of Technology in Pathumthani, Thailand. It is an international, intergovernmental, non-profit registered with the United Nations. RIMES aims to provide regional early warning services and build the capacity of its Member States in end-to-end early warning of tsunamis and hydro-meteorological hazards.

As per the MoU between MoES, Govt. of India and RIMES for provision of forecast services to RIMES member countries, Ocean State Forecast services of ESSO-INCOIS, Hyderabad are provided to the Maldives Islands in the Indian Ocean on a daily basis.

The RIMES Council in its sixth meeting on 30 May 2014 in Bangkok (Pathumthani), Thailand, resolved to collaborate with INCOIS RTSP to provide tsunami services to RIMES Members. Under this arrangement, INCOIS RTSP now provides regional tsunami watch services to RIMES Member States in the Indian Ocean.

12.6 OceanSITES

OceanSITES is a global time series programme which is a recognized component of the Global Ocean Observing System and part of the international JCOMM structure. Since 1999, the international OceanSITES science team has shared both data and costs in order to capitalize on the potential of moorings and ship-based time series. The growing network now consists of about 30 surface and 30 subsurface arrays. Satellite telemetry enables near real-time access to OceanSITES data by scientists and the public. The OceanSITES Data Management Team aimed at development of the data management system by developing standards, formats and quality control procedures for the time series data from oceans. Considering the role of ESSO-INCOIS in this important activity for the Indian Ocean region, ESSO-INCOIS has been identified as the OceanSITES Data Assembly Centre (DAC). Shri. E. Pattabhi Rama Rao represents ESSO-INCOIS on the OceanSITES Data Management Team.

12.7 Partnership for Observation of the Global Oceans (POGO)

POGO is a forum that was created in 1999 by directors and leaders of major oceanographic institutions around the world to promote global oceanography, particularly the implementation of an international and integrated global ocean observing system. ESSO-INCOIS continued to extend its support to POGO as a representative of India.

12.8 Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS)

The Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS) established by the Intergovernmental Oceanographic Commission (IOC) coordinates the implementation of Indian Ocean Tsunami Warning System that is being established as a network of national systems. The network comprising of respective National Tsunami Warning Centres (NTWCs) of member states (which receive tsunami advisories from the Regional Tsunami Service Providers (RTSPs)) has the capability to issue regional tsunami bulletins for the Indian Ocean. The Indian Tsunami Early Warning Centre (ITEWC) operated by ESSO-INCOIS serves as one of the RTSPs for the Indian Ocean. Dr. T. Srinivasa Kumar currently serves as the Vice Chair of the ICG/ IOTWS and also chairs the task team on "Tsunami Watch Operations" of the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWSWG).

12.9 GODAE Ocean View

GODAE Ocean View is a group of scientists representing agencies who provide operational ocean forecasts and managing in situ as well as remote sensing observation platforms. This forum provides an excellent platform for the scientists who are involved in the development of operational ocean forecasting systems, to exchange their experiences and collectively carry out inter-comparison exercises of various ocean forecast and analysis products. ESSO-INCOIS has been part of this group from October 2010 as a member of the science team. From July 2013 onwards, Dr. S. S. C. Shenoi, Director, ESSO-INCOIS serves as a member on the patrons' group of GODAE Ocean View which is responsible for guiding the GODAE Ocean View Science Team to attain various targets and for supporting the project office established in the UK Met Office. 5th Annual Meeting of GOVST was held in Beijing, China during 13-17 October 2014. Dr. Francis P. A., Scientist, represented ESSO-INCOIS in this meeting.

13. Workshops/Lectures/Events

13.1 16th Foundation Day

The 16th Foundation Day lecture was delivered by Prof. Goverdhan Mehta, National Research Professor, School of Chemistry, University of Hyderabad.

An "Open Day" was organised for school and college students that included a detailed tour of the Centre and interaction with staff. More than 800 students from 11 schools and 2 colleges in Hyderabad visited ESSO-INCOIS.

Chief Guest Dr. Goverdhan Mehta delivering the 16th Foundation Day lecture and Students participating in the Open day programme

13.2 Seminars/Lectures:

- Dr. Fabian Durand, Scientist, LEGOS, Toulouse and Dr. Matthieu Lengaigne, Scientist, L'OCEAN, Paris delivered a talk on "Salinity variability in the Bay of Bengal on recent years" on 9 April, 2014.
- Dr. John Gunn, Chief Executive Officer, Australian Institute of Marine Science delivered lectures on "Marine Nation 2025: Marine Science for Australia's Growing Blue Economy" and " Global Ocean Observing System to include Ocean Biology and Biogeochemistry" on April 10 & 11, 2014.
- Dr. C P Rajendran, Senior Associate, JNCASR delivered a lecture on "Slow Slip Acceleration beneath Andaman Islands Triggered by the 11 April 2012 Indian Ocean Earthquakes" on 21 April 2014.

- Dr. Saji N. Hameed, ARC-ENV, Center for Advanced Information Science and Technology, University of Aizu, Tsuruga, Japan delivered a talk on "Observed and Modeled Teleconnections along the Equatorial Waveguide during IOD-ENSO Interactions" on 28 April 2014.
- Dr. Vijay Tallapragada, Environmental Modeling Center (EMC), NOAA/NWS/NCEP lectured on" State-of-the-art Atmosphere-OceanCoupled Tropical Cyclone Forecast Modeling for Operations and Research: Progress and Challenges" on 5 June 2014.
- Dr. R. M. Dwivedi, Emeritus Scientist, CMLRE, Kochi made a presentation on "Remote sensing of harmful algal bloom" on 10 October 2014.
- Dr. John McGregor, CSIRO, Marine and Atmospheric Research presented a lecture on" Development of cube-grid atmospheric and oceanic models at CSIRO" on 20 October, 2014.
- Prof. Raghu Murtugudde, University of Maryland, USA lectured on "A Modeling-Observational Proposal for Multi-Scale Interactions between the MJOs and the Indonesian Throughflow" on 25 November, 2014.
- Dr. Theresa Paluszkiewicz, Programme Manager, Office of Naval Research, Arlington, Virginia, USA and Dr. Amit Tandon, University of Massachusetts Dartmouth, USA made a presentation on "Air-Sea Interactions in the Northern Indian Ocean – Regional Initiative & Ocean Mixing and Monsoons (ASIRI-OMM) collaboration and its elements "on 12 December, 2014.
- Dr. S. Karunanidhi, Scientist 'G', & Dy. Director, Research Centre Imarat (RCI), Hyderabad delivered a talk on "Vidya" on January 1, 2015.
- Dr. D. D. Ozha, Sr. Scientist, Joint Hindi Advisory Committee, Govt. of India delivered a lecture in Hindi on "WATER & HEALTH" on January 5, 2015.
- Dr. Ram Yerubandi, Research Scientist & Section Head - Integrated Modelling, Environment Canada presented a lecture "Atmosphere-inland seas coupled model: development and verifications" on 23 December, 2014.
- Dr. Frank Marks, Director, HRD, NOAA made a presentation on "NOAA's Hurricane Research - Hurricane Forecast Improvement Project (HFIP)" on 5 February, 2015.

1st Row: Dr. Fabian Durand, Dr. John Gunn, Dr. C P Rajendran, Dr. Saji N. Hameed

2nd Row: Dr. Vijay Tallapragada, Dr. R. M. Dwivedi, Dr. John McGregor, Prof. Raghu Murtugudde

3rd Row: Dr. Theresa Paluszkiewicz, Dr. Amit Tandon, Dr. S.Karunanidhi, Dr. D.D. Ozha

4th Row: Dr. Ram Yerubandi, Dr. Frank Marks

14. General Information

14.1 Honours and Awards

1. The Computer Society of India (CSI) presented the CSI-Nihilent e-Governance Award 2013-14, under the Category "Appreciation for Sustenance" to ESSO-INCOIS. The award was presented during the 49th Annual CSI Convention (CSI-2014).

ESSO-INCOIS scientists receiving the Award at the Convention (CSI-2014)

2. K. Annapurnaiah, was awarded a Certificate of Merit for his contributions in Ocean Sciences and S. Nirmala Devi was awarded a Certificate of Best Employee for an outstanding contribution in maintaining the communication systems at ESSO-INCOIS. The certificates were presented on MoES Foundation Day.

K. Annapurnaiah receiving the Certificate of merit and S. Nirmala Devi receiving the Certificate of Best Employee on MoES Foundation Day, 2014

3. The ESSO-INCOIS exhibit won the overall Second Prize at the World Ocean Science Congress 2015 Expo held at Kochi, Kerala during 5-8 February 2015.

S.J. Prasad, Scientist, Co-ordinator of ESSO-INCOIS-Expo receives the award on behalf of ESSO-INCOIS during WOSC 2015

14.2 Promotion of Hindi

Activities during Hindi Pakhwara 2014

A special programme Hindi Pakhwara was organised during 1-15 September 2014 to promote Hindi. The programme included competitions on essay writing, extempore, Hindi noting etc. for ESSO-INCOIS staff and a special elocution competition for children of ESSO-INCOIS staff (judged by Sashikala Kumari. - Retd. Hindi Teacher). The highlight of this celebratory fortnight was a one-day "Hindi Scientific Seminar" in which ESSO-INCOIS ' scientists presented their work, followed by lectures delivered by Dr. Ravi Ranjan (Head, Hindi Department, University of Hyderabad) on "Indian Culture and Language" and Dr. D.D. Ozha (Sr. Scientist, Hindi Advisory Committee, MoES & DST) on "Mobile Phone-A new alarm of danger to health".

14.3 Visitors

To spread the awareness of the services and products available through ESSO-INCOIS, Open Day programmes and on-request Group Visit sessions were organized. The Centre also hosted several field visits for government officials as well.

More than 3500 visitors were hosted in this period, that included 269 government officials, 1363 college students, 1729 school students and general public visitors.

Government officials, students and general public visitors at ESSO-INCOIS

14.4 Deputations

No.	Name of Official	Meeting/Conference/Training
1	S S C Shenoi, Director, ESSO-INCOIS	• To attend the 47th Session of the Intergovernmental Oceanographic Commission (IOC) Executive Council at UNESCO Head Quarters, Paris, France during July 01-04, 2014. • To attend the SCOR IIOE-2 meeting and XXXII SCOR General Meeting At Bremen, Germany during September 12-17, 2014. • To participate in the Indian Ocean Global Ocean Observing System (IOGOOS) Workshop and 11th Annual meeting preceded by the 5th meeting of Sustained Indian Ocean Bio-geochemical and Ecological Research (SIBER) and 5th meeting of IndOOS Resource Forum (IRF) at Phuket, Thailand during October 29, 2014 to November 01, 2014. • To participate in the 10th session of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System at Muscat, Oman during March 24-26, 2015.
2	M. Ravichandran, Scientist 'G'	• To participate in the Pan CLIVAR meeting during July 14-19, 2014 at the Hague, the Netherlands and GCOS/GOOS/WCRP ocean observations Panel for Climate (OOPC) during July 21-23, 2014 at Barcelona, Spain. • To participate in the 16th Argo Steering Team (AST-16) meeting held at IFREMER, Brest, France during March 17-20, 2015.

3	T. Srinivasa Kumar Scientist 'F'	• To attend BRICS workshop on "Climate Change and Prevention and Mitigation of Natural Disasters" at Brasalia, Brazil during May 07-08, 2014 . • To participate in 6th RIMES Council meeting During May 29-30, 2014 in Bangkok, Thailand. • To participate in the meeting of the TOWS-WG Inter-ICG Task Team on Tsunami Watch Operations at Tokyo, Japan during October 21-22, 2014. • To participate in the Indian Ocean Global Ocean Observing System (IOGOOS) Workshop and 11th Annual meeting preceded by 5th meeting of Sustained Indian Ocean Bio-geochemical and Ecological Research (SIBER) and 5th meeting of IndOOS Resource Forum (IRF) at Phuket, Thailand during October 29, 2014 to November 01, 2014. • To participate in the International Conference commemorating the 10th Anniversary of the Indian Ocean Tsunami and to attend the ICG/IOTWS Steering Group meeting held at Jakarta, Indonesia during November 24-26, 2014. • To participate in the Meeting of the Inter-ICG Task Team on Tsunami Watch Operations, the Working group meeting on Tsunami and Other Hazards related to sea level warning and mitigations systems and also to attend the Working Session on "Lessons learned from Mega Disasters - Earthquakes and Tsunamis Earthquakes & Tsunamis" organized on the sidelines of UNWCDRR and held at Morioka, Japan during March 11-15, 2015.
4	T.M. Balakrishnan Nair, Scientist 'F'	• To participate in the event on "The Future of Multi-Hazard Early Warning in Asia Pacific" at the 6th Asian Ministerial Conference on Disaster Risk reduction (AMCDRR) at Bangkok, Thailand during June 22-26, 2014 and to discuss the implementation plan for setting up ocean forecast and real-time wave rider buoys with RIMES team on June 27, 2014. • To participate in the 8th Session of the JCOMM Ship Observations Team (SOT-8) held in Cape Town, South Africa, during April 20-24, 2015.

5	E. Pattabhi Rama Rao, Scientist 'E'	• To participate in the ISPRS Technical Commission-IV symposium at Suzhou, China during May 14-16, 2014. • To participate in the first meeting of the WMO Steering Committee of the Indian Ocean Data Rescue Initiative (INDARE-SC) at WMO, Geneva, Switzerland during September 29, 2014 to October 01, 2014. • To participate in the OceanSITES steering committee and data management team meeting during November 03-06, 2014 at Recife, Brazil. • To participate in the 23rd Session of the IOC committee on International Oceanographic Data and Information Exchange (IODE-XXIII) and one day Scientific Conference meeting held at Bruges, Belgium during March 16-20, 2015 .
6	Sudheer Joseph, Scientist 'E'	• To participate in ETOOFS-4 (JCOMM) meeting held during September 08-10, 2014 at Paris, HQ, UNESCO. • To attend the SCOR IIOE-2 meeting and XXXII SCOR General Meeting at Bremen, Germany during September 12-17, 2014.
7	P.A. Francis, Scientist 'E'	• To participate in 5th meeting of the GODAE OceanView Science Team (GOVST) at Beijing, China during October 13-17, 2014.
8	T.V.S. Udaya Bhaskar, Scientist 'E '	• To participate in the 15th meeting of Argo Data Management Team (ADMT-15) scheduled to be held at Ottawa, Canada during November 03-07, 2014.

9	M. Nagaraja Kumar, Scientist 'D'	• As a trainer in the African Summer School on Application of Ocean and Coastal Ocean Data and Modelling Products to Accra, Ghana during June 09-13, 2014 and to Nairobi, Kenya during August 18-22, 2014. • To participate in Indian Ocean Global Ocean Observing System (IOGOOS) Workshop and 11th Annual meeting preceded by 5th meeting of Sustained Indian Ocean Bio-geochemical and Ecological Research (SIBER) and 5th meeting of IndOOS Resource Forum (IRF) at Phuket, Thailand during October 29, 2014 to November 01, 2014. • To attend OTGA Steering Group Meeting during January 13-16, 2015 and OTGA Train the Trainers workshop during January 13-23, 2015 conducting by IOC/IODE at Oostende, Belgium.
10	Satyaprakash, Scientist 'D'	• To participate in the Indian Ocean Global Ocean Observing System (IOGOOS) Workshop and 11th Annual meeting preceded by 5th meeting of Sustained Indian Ocean Bio-geochemical and Ecological Research (SIBER) and 5th meeting of IndOOS Resource Forum (IRF) at Phuket, Thailand during October 29, 2014 to November 01, 2014.
11	R. Harikumar, Scientist 'C',	• To participate in the workshop on the establishment of a Centre of Excellence on Ocean Sciences and Environment for the Indian Ocean Rim Association (IORA) Member held at Colombo, Sri Lanka during June 30, 2014 to July 01, 2014.
12	Ch. Patanjali Kumar, Scientist 'C'	• To attend workshop for "Standard Operating Procedure (SOP) on Tsunami Warning System" conducted by DG-MET/PACA at Muscat, Oman during January 11-13, 2015.

13	Girishkumar M.S., Scientist 'C',	• To participate in the training programme "Targeted Training Activity : Challenge in Monsoon Prediction" which will be conducted at ICTP, Italy during June 23 - July 04, 2014.
14	Kunal Chakraborty, Scientist 'C'	• To participate in the IMBER Open Science Conference (OSC) 2014 "Future Oceans Research for Marine Sustainability: Multiple Stressors, Drivers, Challenges and Solutions" and Data Management and Capacity Building Workshops June 22-27, 2014 at Bergen, Norway. • To participate in the PICES Summer School on "End-To-End Models for Marine Resources Management and Research" held at Gangneung-Wonju National University (GWNU), Korea during August 26-29, 2014.
15	M. Vijaya Sunanda, Scientist 'C',	• To attend the training programme organised with collaboration of GFZ on "Research in Advanced Techniques for Tsunami Early Warning System using GPS and Accelerometer data" at Potsdam, Germany during February 9 - May 09, 2015.
16	Abhisek Chatterjee, Scientist 'C',	• To participate in International winter school on "Coastal and ocean processes in the Bay of Bengal in a changing climate, and their impacts on society" at Dhaka, Bangladesh during October 12-18, 2014.
17	S. Siva Reddy, Scientist 'B',	• To participate in the "GODAE Ocean View-GSOP-CLIVAR-E-AIMS" international workshop at CLS, Toulouse, France during December 10-12, 2014
18	Suprit Kumar, Scientist 'B',	• To participate in the "Quality Management System Essentials for National Oceanographic Data Centres Training Course (QMF Training Course)" held at Oostende, Belgium during December 08-11, 2014.
19	Sourav Maity, Project Scientist 'B',	• To participate in a summer school on "End-to-End Models for Marine Resources Management and Research" held at Gangneung- Wonju National University (GWNU), South Korea during August 26-29, 2014.
20	S. J. Prasad, Project Scientist 'B'	• To participate in International Oil Spill Conference (IOSC) 2014 at Savannah, Georgia, USA during May 5-8, 2014.

21	Sanjiba Kumar Baliarsingh, Project Scientist 'B'	• To participate in the NF-POGO training programme on "Phytoplankton bio-optical variability, application to the study of coastal systems" at California, Ensenada, Mexico during January 19- February 06, 2015.
22	Sidhartha Sahoo, Scientific Assistant 'A'	• To participate in Ocean Teacher Global Academy Train the Trainers Workshop during January 19-23, 2015 at Oostende, Belgium.

14.5 Vigilance Activities

Dr. M. Ravichandran, Scientist 'G' & Head - MOG continued to serve as the Vigilance Officer at ESSO-INCOIS. During the period April, 2014 to March 2015 one complaint related to vigilance was received which was promptly disposed."Vigilance Awareness Week" was observed at ESSO-INCOIS from October 27, 2014 to November 01, 2014 and staff took the Vigilance Pledge on October 27, 2014.

14.6 Right to Information Act

In fulfilment of the "Right to Information" Act (RTI), 2005, information related to ESSO-INCOIS was regularly updated on the ESSO-INCOIS website in the prescribed format, during the period April, 2014 to March, 2015.

Shri E. Pattabhi Rama Rao, Scientist 'E' & Head - DMG is the Public Information Officer and Dr. S.S.C. Shenoi, Director, ESSO-INCOIS is the First Appellate Authority. Nine requests under RTI were received and the requested information was provided. No appeals were received during this period.

14.7 ESSO-INCOIS Human Capital

ESSO-INCOIS Human Capital category wise as on 31.03.2015:

Particulars	Permanent	Project mode
Scientific Staff:		
Scientist 'G'	2	-
Scientist 'F'	3	-
Scientist 'E'	4	-
Scientist 'D'	9	-
Scientist 'C'	14	3
Scientist 'B'	12	20

Scientific Support Staff:		
Scientific Assistant B	15	25*
Scientific Assistant A	4	-
Administrative Support:		
Dy.CAO	1	-
Jt. Manager	3	-
Asst. Manager	2	-
Sr. Executive	4	5
Lab Attendants	-	5
Driver-cum-Attendant	-	4
Others:		
Consultants	-	3
Quick Hire Fellows	-	2
Research Fellows under Ph.D Programme	-	4
Total :	73	71
Grand Total :	**144**	

*(*including System Operator-1 No., Project Assistant (civil) - 1No.)*

List of Acronyms

- 3D GIS - Three Dimension Geo Information System
- 3DVAS - Three Dimension Visualization and Analysis System
- A&N - Andaman and Nicobar islands
- ABU - Asia-Pacific Broadcasting Union
- ADCIRC - Advanced Circulation (Storm surge model)
- ADCP - Acoustic Doppler Current Profiler
- ALTM - Air Bourne Laser Terrain Mapping
- AMCDRR - Asian Ministerial Conference on Disaster Risk Reduction
- AMS - Accelerated Mass Spectrometer
- AoI - Area of Interest
- AOP - Apparent Optical Properties
- APGEOS - Andhra Pradesh Geographical Society
- APWD - Andaman Public Works Department
- ARC-ENVI - Aizu Research Cluster for Environmental Informatics
- Argo/ARGO - Array for Real-time Geotropic Oceanography
- ARW3.3 - Advanced Research WRF (Version 3.3)
- AOP - Apparent Optical Properties
- ASG - Advisory Services Group, ESSO-INCOIS
- ASIRI - Air-Sea Interactions in the northern Indian Ocean–Regional Initiative
- AST - Argo Steering Team
- ATCHP - Accumulated Tropical Cyclone Heat Potential
- AVHRR - Advanced Very High Resolution Radiometer
- AVISO - Archiving, Validation and Interpretation of Satellite Oceanographic
- AWS - Automatic Weather Station
- ATLAS - Autonomous Temperature Line Acquisition
- BoB - Bay of Bengal
- BoM - Bureau of Meteorology, Australia
- BMKG - Badan Meteorologi, Klimatologi dan Geofisika (Meteorology and Geophysics Agency, Indonesia)
- BRICS - Brazil, Russia, India, China and South Africa
- CARI - Central Agricultural Research Institute
- CCCR - Centre for Climate Change Research, IITM, Pune
- CCMB - Centre for Cellular & Molecular Biology: CSIR, Hyderabad
- Chl-a - Chlorophyll-a

- CIFT - Central Institute of Fisheries Technology, Cochin
- CLIVAR - Climate Variability and Predictability (World Climate Research)
- CMEC - Challa Malla Reddy Engineering College, Hyderabad
- CMLRE - Centre for Marine Living Resources & Ecology, Cochin
- COMMs - Communications Test
- COSINE - Current Observation and Simulation in the INdian EEZ
- CRS - Central Receiving Station
- CSI - Customer Satisfaction Index
- CSIR - Council of Scientific and Industrial Research
- CSIRO - Commonwealth Scientific and Industrial Research Organization
- CTCZ - Continental Tropical Convergence Zone
- CTD - Conductivity-Temperature-Depth
- CUSAT - Cochin University of Science and Technology, Cochin
- DA - Data Assimilation
- DBT - Dry Bulb Temperature
- DGMAN - Directorate General of Meteorology and Air Navigation, Oman
- DG-MET/PACA - Directorate General of Meteorology and Public Authority for Civil Aviation, Oman
- DIG - Deputy Inspector General
- DIVA - Data-Interpolating Variation Analysis
- DMG - Data Management Group, ESSO-INCOIS
- DMO - Disaster Management Official
- DNOM - Directorate of Naval Oceanology and Meteorology (Indian Navy)
- DPT - Dew Point Temperature
- DSS - Decision Support System
- DST - Department of Science and Technology
- DTM - Digital Terrain Model
- ECMWF - European Centre for Medium-Range Weather Forecasts
- EEZ - Exclusive Economic Zone
- EICC - East India Coastal Current
- EMAC-IOD - Equatorial Mooring Array for Current Observations and Research
- EMC - Environmental Modeling Center (NOAA)
- ENSO - El Nino Southern Oscillation
- Envisat - Environmental Satellite
- EQ - Earth Quake
- ERP - Enterprise Resource Planning

- ERS - ERS (European Remote Sensing) d'Archivage et de Traitement, France
- ESSO - Earth System Science Organisation
- ETM - Landsat Enhanced Thematic Mapper
- FORV - Fisheries Ocean Research Vessel
- FTP - File Transfer Protocol
- GCOS - Global Climate Observing System
- GFZ - GeoForschungsZentrum - German Research Centre
- GIS - Geographic Information System
- GNOME - GNU Gnetworking Object Model Environment where GNU stands for "GNU's Not Unix"
- GNSS - Global Navigation Satellite System
- GODAE - Global Ocean Data Assimilation Experiment
- GODAS - Global Ocean Data Assimilation System
- GOOS - Global Ocean Observing System
- GOVST - Ocean View Science Team
- GPI - Genesis Potential Index
- GPRS - General Packet Radio Service
- GPS - Global Positioning System
- GSM - Garver–Siegel–Maritorena
- GSOP - Global Synthesis and Observation Panel
- E-AIMS - Euro-Argo Improvements for the GMES (Global Monitoring for Environment and Security) Marine Service
- GUI - Graphical User interface
- GWNU - Gangneung- Wonju National University, South Korea
- HF Radar - High Frequency Radar
- HFIP - Hurricane Forecast Improvement Project
- HOOFS - High Resolution Operational Ocean Re-Analysis and Forecast System
- HRD - Hurricane Research Department (NOAA)
- HWRF - Hurricane Weather Research and Forecast
- ICAR - Indian Council of Agricultural Research
- ICG/IOTWS - Intergovernmental Coordination Group for the Indian Ocean Tsunami
- ICMAM - Integrated Coastal and Marine Area Management
- ICTP - International Centre for Theoretical Physics, Italy
- ICWRCOE 2015 - International Conference on Water Resources, Coastal and Ocean Engineering, NIT Surathkal

- IIIT - International Institute of Information Technology
- IIOE - International Indian Ocean Expedition
- IISc - Indian Institute of Science, Bangalore
- IIT - Indian Institute of Technology
- IITM - Indian Institute of Tropical Meteorology, Pune
- IMBER - Integrated Biogeochemistry and Ecosystem Research
- IMD - Indian Meteorological Department
- INCOIS - Indian National Centre for Ocean Information Services
- IndOOS - Indian Ocean Observing System
- INSAT - Indian National Satellite System
- IOC - Intergovernmental Oceanographic Commission
- IOD - Indian Ocean Dipole
- IODE - International Oceanographic Data and Information Exchange
- IOGOOS - Indian Ocean Global Ocean Observing System
- IOM - Indian Ocean Model
- IOP - Inherent Optical Properties
- IORA - Indian Ocean Rim Association
- IOSC - International Oil Spill Conference
- IOTWS WG-2 - Indian Ocean Tsunami Warning System Worging Group - 2
- IOWave14 - IOTWS Indian Ocean Tsunami Exercise 2014
- IRF - IndOOS (Indian Ocean Observation System) Resource Forum
- IRS - Indian Remote Sensing
- ISG - Indian Society of Geomatics
- ISGN - Integrated Seismic and GNSS Network
- ISLANDS - Investigation of Seismicity & Lithospheric structure in the
- ISPRS - International Society for Photogrammetry and Remote Sensing
- ISRS - Indian Society of Remote Sensing
- IST - Indian Standard Time
- ISV - IntraSeasonal Variability
- ITCOocean - International Training Centre for Operational Oceanography,
- ITEWC - Indian Tsunami Early Warning Centre, ESSO-INCOIS
- ITEWS - Indian Tsunami Early Warning System
- ITIC - International Tsunami Information Center, USA
- JAU - Junagadh Agricultural University, Okha
- JCOMM - Joint Technical Commission for Oceanography and Marine Meteorology

- JNCASR - Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore
- JTIC - Jakarta Tsunami Information Centre, Indonesia
- JTWC - Joint Typhoon Warning Center (JTWC) - U.S. Navy
- L'OCEAN - Laboratoire d'Oceanographie et du Climat, France
- LAN - Local Area network
- LEGOS - Laboratoire d'Etudes en Géophysique et Océanographie Spatiales
- LISS - Linear Imaging Self Scanning Sensor
- MATLAB - MATrix LABoratory
- Met - Meteorological
- METOP - Meteorological Operational (satellite programme)
- MFAS - Marine Fisheries Advisory Services
- MHA - Ministry of Home Affairs
- MHVM - Multi-Hazard Vulnerability Map
- MJO - Madden–Julian Oscillation
- MLA - Member of the Legislative Assembly
- MLD - Mixed layer Depth
- MODIS - Moderate Resolution Imaging Spectro radiometer
- MODISA - Moderate Imaging Spectroradiometer-Aqua
- MoES - Ministry of Earth Sciences
- MOG - Modelling Ocean Group, ESSO-INCOIS
- MOM - Modular Ocean Model
- MoU - Memorandum of Understanding
- MSSRF - M.S. Swaminathan Research Foundation
- MVHM - Multi-Hazard Vulnerability Map
- NCEP - National Centers for Environmental Prediction, USA
- NCESS - National Centre for Earth Science Studies
- NCMRWF - National Centre for Medium Range Weather Forecasting, Noida
- NDBP - National Data Buoy Programme
- NDMA - National Disaster Management Authority
- NDRF - National Disaster Response Force
- NEM - North East Monsoon
- NetCDF - Network Common Data Format
- NF-POGO - Nippon Foundation-Partnership for Observation of the Global Oceans
- NGO - Non Governmental Organization
- NGRI - National Geophysical Research Institute, Hyderabad

- NIDM - National Institute of Disaster Management
- NIO - National Institute of Oceanography, Goa
- NIOT - National Institute for Ocean Technology, Chennai
- NMHEWS - National Multi Hazard Early Warning System
- NOAA - National Oceanic and Atmospheric Administration, USA
- NOC - No Objection Certificate
- NODC - National Oceanographic Data Center, USA
- NODPAC - Naval Oceanographic Data Processing and Analysis Centre
- NOSDCP - National Oil Spill Disaster Contingency Plan
- NRSC - National Space Research Centre, Hyderabad
- NS - *Noctiluca scintillans*
- NTWC - National Tsunami Warning Centre
- NWS - National Weather Service
- OBIS - Ocean Biogeographic Information System
- OceanSITES - Ocean Sustained Interdisciplinary Time series Environment
- OCM - Ocean Colour Monitor
- OD - Other Dinoflagellates
- OGCM - Oceanic General Circulation Model
- OMM - Ocean Monsoon and Mixing project
- OMNI - Ocean Moored Buoy Network for Northern Indian Ocean
- OMZ - Oxygen Minimum Zone
- ONGC - Oil and Natural Gas Corporation
- ONI - Oceanic Niño Index
- OON - Ocean Observations Network
- OOPC - Ocean observations Panel for Climate
- OOS - Ocean Observing System
- OOSA - Online Oil Spill Advisory System
- ORV - Ocean Research Vessel
- OSCAT - Oceansat-2 Scatterometer
- OSF - Ocean State Forecast
- OTGA - Ocean Teacher Global Academy
- PAR - Photosynthetically Active Radiation
- PFZ - Potential Fishing Zone
- PMC - Project Management Committee
- PMC - Project Monitoring Committee
- PMEL - Pacific Marine Environmental Laboratory, USA

- POGO - Partnership for Observation of the Global Oceans
- PRL - Physical Research Laboratory, Ahmedabad
- PSAT - Pop-Up Satellite Archival Tag
- QMF - Quality Management Framework
- Quick SCAT, QSCAT - Quick Scatterometer
- R&D - Research & Development
- RADAR - RAdio Detection And Ranging
- RAMA - Research Moored Array for African-Asian-Australian Monsoon Analysis
- RCI - Research Centre, Imarat
- RI - Rapid Intensification
- RIMES - Regional Integrated Multi-Hazard Early Warning System for Africa
- ROMS - Regional Ocean Modeling System
- RTI - Right to Information Act
- RTSP - Regional Tsunami Service Provider
- RTWP - Received Total Wideband Power
- RV - Research Vessel
- S & T - Science and Technology
- SAC - Space Application Centre, Ahmedabad
- SAIC - Science Applications International Corp ,USA.
- SAP - System Application Products
- SATCORE - Satellite Coastal and Oceanographic Research
- SATTUNA - Satellite Telemetry Studies on Migration Pattern of Tuna in Indian Seas
- SCOR - Scientific Community on Ocean Research
- SeaWifs - Sea-Viewing Wide Field-of-view Sensor
- SG - Steering Group
- SIBER - Sustained Indian Ocean Biogeochemistry and Ecosystem Research
- SMA - Strong Motion Accelerograph
- SMS - Short Messaging Service
- SOI - Survey of India
- SOT - Ship Observations Team
- SSC - Science Steering Committee
- SSH - Sea Surface Height
- SST - Sea Surface Temperature
- STB - Science Applications International Corporation (SAIC) Tsunami Buoy
- SWAN - Simulating Waves Nearshore (Model)

- SWH - Sea Wave Height
- SWM - Sea Wave Measurement
- T - Temperature
- T & S - Temperature & Salinity
- TC - Tropical Cyclone
- TFLEX - Tropical Flexible Data Aquisition System
- TI - Temperature Inversion
- TIO - Tropical Indian Ocean
- TMI/TRMM - Tropical Rainfall Measuring Mission Tropical Rainfall Measuring
- TOPEX - Topography Experiment
- TOWSWG - Tsunamis and other Ocean hazards Warning and mitigation Systems-Working Group
- TSM - Total Suspended Matter
- TSP - Tsunami Service Providers UCSD - University of California, San Diego
- UNESCO - United Nations Educational, Scientific and Cultural Organization
- UNWCDRR - United Nations World Conference on Disaster Risk Reduction
- US /USA - United States of America
- UT - Union Territories
- UTC - Coordinated Universal Time
- VECS - VSAT-Aided Emergency Communication System
- VIIT - Vishwakarma Institute Of Information Technology, Pune
- VOS - Voluntary Observing Ships
- VSAT - Very Small Aperture Terminal
- VSCS - Very Severe Cyclonic Storm
- WCRP - World Climate Research Programme
- WebGIS - Web Geo Information System
- WHM - Wave Height Meter
- WIO - Western Indian Ocean
- WMO - World Meteorological Organization
- WRF - Weather Research and Forecasting model
- WW - Wire Walker
- XBT/XCTD - Expendable Bathythermograph Expendable Conductivity-Temperature

FINANCE

The report of the auditors and audited accounts of INCOIS for the year 2014-2015 are placed in Appendix-1 to this report.

Appendix-1

B.SRINIVASA RAO & CO.,
CHARTERED ACCOUNTANTS

Head Office:
Flat No.316, B-Block, 3rd Floor,
Ameer Estate, S.R. Nagar,
Hyderabad-500 038.
✆: 040-23757406 Fax: 66737406
E-mail: bsrandco@gmail.com

AUDITORS' REPORT

To

The Chairman and Members,
Governing Council,
ESSO-INDIAN NATIONAL CENTRE FOR
OCEAN INFORMATION SERVICES,
"Ocean Valley", Pragathinagar (BO), Nizampet (SO)
Hyderabad – 500 090

We have audited the attached Balance Sheet of the ESSO-INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES as at 31st March 2015, and also the Income & Expenditure Account and Receipts & Payments Account for the year ending on that date annexed thereto. These financial statements are the responsibility of the Society's Management. Our responsibility is to express an opinion on the financial statements based on our Audit.

We conducted our audit in accordance with auditing standards generally accepted in India. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material mis-statements. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall financial statement presentation. We believe that our audit provides a reasonable basis for our opinion and report that:

1. We have obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purposes of our Audit.
2. In our opinion, proper books of accounts as required by the Society, have been kept by the Society so far as appears from our examination of such books.
3. The Balance Sheet, Income & Expenditure Account, Receipts & Payments Account are in agreement with the Books of Account.
4. In our opinion and to the best of our information and according to the explanations given to us and subject to the notes forming part of accounts, the Balance Sheet as at 31st March 2015, Income & Expenditure Account and Receipts & Payments Account for the year ending on that date together with the Schedules and Notes on Accounts Annexed therewith give a true and fair view of the state of affairs of the Society.

For **B.SRINIVASA RAO & CO.,**
Chartered Accountants

(Ch.Anand)
Partner
M.No. : 222732
FRN No.: 008763S

Place: Hyderabad
Date: 30-07-2015

ESSO-INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES
(Ministry of Earth Sciences, Govt. of India)
"Ocean Valley", Pragathinagar (BO), Nizampet (SO), Hyderabad - 500 090

BALANCE SHEET AS AT 31st MARCH 2015

(Amount in Rs.)

Particulars	Schedules	Current Year (2014 - 15) ₹	Previous Year (2013 - 14) ₹
LIABILITIES			
Corpus fund	1	7,99,24,417	6,36,37,102
Earmarked funds	2	17,69,98,716	40,02,71,148
Current liabilities & Provisions	3	6,56,26,574	3,49,95,548
Total		**32,25,49,707**	**49,89,03,798**
ASSETS			
Fixed Assets	4	2,99,47,594	2,14,32,861
Current Assets, Loans & Advances	5	29,26,02,113	47,74,70,937
Total		**32,25,49,707**	**49,89,03,798**
Notes forming part of Accounts	11		

As per our report of even date
For **B. SRINIVASA RAO & CO.,**
Chartered Accountants

(Ch. Anand)
Partner
M. No. 222732
FRN No: 008763S

For and on behalf of **ESS0-INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES**

(S. Nageswara Rao)
Accounts Officer

(K.K.V. Chary)
Dy. C A O

(S.S.C. Shenoi)
Director

Place : Hyderabad
Date : 30-07-2015

ESSO-INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES
(Ministry of Earth Sciences, Govt. of India)
"Ocean Valley", Pragathinagar (BO), Nizampet (SO), Hyderabad - 500 090

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st MARCH 2015

(Amount in Rs.)

Particulars	Schedules	Current Year (2014 - 15) ₹	Previous Year (2013 - 14) ₹
INCOME			
Income from Sales / Other Income	6	11,18,502	4,18,263
Interest Earned on Investments	7	7,91,226	11,29,139
Recurring Grants	8	26,00,00,000	14,30,00,000
Total-A		**26,19,09,728**	**14,45,47,402**
EXPENDITURE			
Establishment Expenditure	9	7,90,48,771	6,27,96,092
Other Administrative Expenses	10	13,13,08,255	12,40,31,551
Depreciation	4	2,77,65,387	1,24,14,506
Total-B		**23,81,22,413**	**19,92,42,149**
Excess of Income over expenditure (A-B)	1	**2,37,87,315**	**-5,46,94,747**
Add / Less: Prior Period Items		-	- 2,17,111
Balance being net income / deficit transferred to Corpus Fund		**2,37,87,315**	**-5,49,11,858**
Notes forming part of Accounts	11		

As per our report of even date
For **B. SRINIVASA RAO & CO.,**
Chartered Accountants

(Ch. Anand)
Partner
M. No. 222732
FRN No: 008763S

Place : Hyderabad
Date : 30-07-2015

For and on behalf of **ESS0-INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES**

(S. Nageswara Rao)
Accounts Officer

(K.K.V. Chary)
Dy. C A O

(S.S.C. Shenoi)
Director

ESSO-INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES
(Ministry of Earth Sciences, Govt. of India)
"Ocean Valley", Pragathinagar (BO), Nizampet (SO), Hyderabad - 500 090

RECEIPTS AND PAYMENTS ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2015

(Amount in Rs.)

RECEIPTS	CURRENT YEAR 2014-15		PAYMENTS	CURRENT YEAR 2014-15	
Opening Balance	₹	₹	**Establishment Expenses**	₹	₹
INCOIS Current A/c-SBI-HAL Campus Br.	9,77,21,295		Pay, Leave Salary Allowace	6,78,12,266	
INCOIS Current A/c-AB-Pragathi Nagar Br.	45,36,409		NPS, CPF, IDBPS	46,74,638	
INCOIS Consultancy SB A/c - Pragathi Nagar Br.	7,80,127		Staff Welfare	17,51,176	
Short Term Deposits with Bank	26,70,00,000	37,00,37,831	Leave Travel Concession	15,56,077	
			IDBPS Trust Account	70,00,000	8,27,94,157
Earmarked Funds			**Administrative Expenses**		
Ocean Information and Advisory Services (O-IAS)	14,90,00,000		Maintenance & Repairs	4,98,34,744	
Ocean Observation Systems (OOS)	11,53,00,000		Travel Expenses - Inland	5,66,012	
International Training Centre for Operational	11,71,90,000		- Foreign	2,18,265	
Oceanography			- Others	9,56,908	
V Sat Terrestrial Link	2,68,07,000		Membership Fee	35,169	
Monsoon Mission	4,00,00,000		Vehicle Hiring	8,19,549	
Characterization of seismic sources in the	18,00,000	45,00,97,000	Garden Expenses	13,33,837	
peninsular shield			House Keeping Expenses	49,74,961	
			Security Expenses	82,16,593	
Recurring Grants	26,00,00,000	26,00,00,000	Electricity Expenditure	2,99,42,947	
			Water Expenses	47,59,775	
Other Receipts			Postage & Telegraphs	97,067	
Consultancy Projects - Sundry Debtors	4,395		Telephone & Fax Expenditure	6,52,965	
Earnest Money Deposits	35,43,000		Honorarium to External Experts	1,32,405	
Security Deposits	85,38,501		Conveyance Expenses	1,35,801	
Service Tax received	1,530		Internet Expenses	13,89,323	

LTC Advance	98,710		Printing & Stationery	7,02,549	
Vehicle advance to employees	2,74,620		Advertisement & Publicity	14,59,957	
Interest on Short Term Deposits	1,90,69,124		Papers & Periodicals	22,539	
Interest on Bank Account	2,40,941		General Expenses	11,84,999	
Interest on Margin Money TDRs	62,05,166		Audit Fee	19,999	
Inspire Fellowship	2,70,000		Seminar, Conference & Workshop Expenses	23,46,426	
Income from Staff Quarters	12,683		International Interface	1,31,31,766	
Other Receipts	6,72,011		Material Consumable	18,81,062	12,48,15,618
Liquidated Damages	51,37,495				
Sale of Tender Forms	36,700	4,41,04,876	**Payments Against Earmarked Funds**		
			a) Ocean Information and Advisory Services (O-IAS)		
Unspent Balances received from Sub Projects			Equipment	1,63,88,953	
Ocean Information and Advisory Services (O-IAS)	18,79,457		Consumables	21,94,601	
Ocean Observation Systems (OOS)	8,81,535		Advance to Sub Projects	4,37,72,920	
Satellite Coastal and Oceanographic Research (SATCORE)	64,44,226	92,05,218	Advance to Purchase	13,25,10,891	
			Technical Support Expenses	3,06,91,494	
Margin Money			Travel Expenses	64,47,955	
Ocean Information and Advisory Services (O-IAS)	2,46,64,500		Manpower	1,93,97,202	
Satellite Coastal and Oceanographic Research (SATCORE)	15,32,000		Margin Money	2,46,64,500	
			Deposit Work - APWD	93,89,144	
Ocean Observation Systems (OOS)	14,33,11,912		Administrative Expenses	28,27,873	28,82,85,533
Monsoon Mission	54,83,000				
Computational Facilities & Web based services and Operation and Maintenance of INCOIS	98,05,000	18,47,96,412	**b) Satellite Coastal and Oceanographic Research (SATCORE)**		
			Equipment	7,77,455	
			Advance to Sub Projects	86,00,890	
			Advance to Purchase	50,58,128	
			Travel Expenses	4,17,421	
			Margin Money	38,60,000	
			Manpower	8,47,698	
			Administrative Expenses	2,72,732	1,98,34,324

			c) Ocean Observation Systems (OOS)		
			Equipment	17,63,306	
			Software/Hardware	7,67,948	
			Technical Support Expenses	56,37,190	
			Consumables	24,166	
			Advance to Purchase	14,48,49,394	
			Advance to Sub Projects	6,00,00,000	
			Travel Expenses	15,17,402	
			Manpower	20,09,506	
			Administrative Expenses	79,65,162	
			Margin Money	8,98,66,912	
			Data Transfer Charges	94,21,165	32,38,22,151
			d) HROOFS		
			Equipment	11,89,117	
			Advance to Sub Projects	1,85,09,333	
			Advance to Purchase	16,48,006	
			Technical Support Expenses	2,78,091	
			Travel Expenses	6,30,360	
			Manpower	3,84,888	
			Administrative Expenses	46,75,440	2,73,15,235
			e) International Training Centre for Operational Oceanography (ITCOO)		
			Equipment	1,84,39,620	
			Administrative Expenses	39,94,808	
			Travel Expenses	9,94,907	
			Deposit Work		2,34,29,335
			f) Monsoon Mission		
			Advance to Purchase	7,95,683	
			Margin Money	1,83,33,000	1,91,28,683
			g) Construction of New Building (Phase II)		
			Architech Fee	20,290	
			Construction of Building	6,41,38,558	6,41,58,848

			h) RIMES Afro Asian Region	3,39,00,000	3,39,00,000
			i) V Sat Terrestrial Link	4,53,89,575	4,53,89,575
			j) Multi Hazard Vulnerability mapping for Indian Coast	4,75,83,282	4,75,83,282
			Expenditure on Fixed Assets		
			Office Equipment	51,37,974	
			Computer/Peripherals	2,04,79,104	
			Library	61,88,176	3,18,05,254
			Other Payments		
			Earnest Money Deposits	39,15,000	
			Security Deposits	50,23,951	
			Performance Deposit	45,000	
			Service Tax paid	29,958	
			Experiment over BOB-IITM	3,67,736	
			Inspire Fellowship	13,548	
			Electricity Deposit	6,38,974	
			LTC Advance	11,74,918	
			Seminar, Conference & Workshop Advance	1,26,500	
			Margin Money	45,93,000	
			Advance under Purchase	1,38,21,177	2,97,49,762
			Closing Balance		
			INCOIS Current A/c-SBI-HAL Campus Br.	1,24,37,005	
			INCOIS Current A/c-AB-Pragathi Nagar Br.	31,41,737	
			INCOIS Consultancy SB A/c - Pragathi Nagar Br.	6,50,838	
			Short Term Deposits with Bank	14,00,00,000	15,62,29,580
Total	**1,31,82,41,337**	**1,31,82,41,337**	**Total**	**1,31,82,41,337**	**1,31,82,41,337**

As per our report of even date
For **B.SRINIVASA RAO & CO.,**
Chartered Accountants

(Ch. Anand)
Partner
M. No. 222732
FRN No: 008763S

Place : Hyderabad
Date : 30-07-2015

For and on behalf of **ESSO-INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES**

(S. Nageswara Rao)
Accounts Officer

(K.K.V. Chary)
Dy. C A O

(S.S.C. Shenoi)
Director

ESSO-INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES
(Ministry of Earth Sciences, Govt. of India)
"Ocean Valley", Pragathinagar (BO), Nizampet (SO), Hyderabad - 500 090

SCHEDULES FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2015

SCHEDULE 1 – CORPUS FUND

(Amount in Rs.)

Particulars	Current Year (2014 - 15) ₹	Previous Year (2013 - 14) ₹
Corpus Fund at the beginning of the year	6,36,37,102	11,85,48,960
Less: Transfer to Ministry of Earth Sciences, New Delhi	75,00,000	-
Add: Net income transferred from Income & Expenditure Account	2,37,87,315	-5,49,11,858
BALANCE AS AT THE YEAR END	**7,99,24,417**	**6,36,37,102**

ESSO - INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES

SCHEDULE 2 - EARMARKED FUNDS

(Amount in Rs.)

Particulars	FUND-WISE BREAK UP												TOTALS	
	Building Fund	Ocean Information and Advisory Services (O-IAS)	Ocean Observation Networks	SATCORE	ITCOO	HROOFS	IT & E Governance Fund	V SAT Node	MH Vulnerability	Monsoon Mission	RIMES	CSS	Current Year 2014-15	Previous Year 2013-14
a) Opening balance of the funds	5,69,67,756	4,48,59,236	-1,36,76,144	2,08,02,899	6,28,57,047	7,82,60,955	25,42,299	-	8,76,57,100	-	6,00,00,000	-	40,02,71,148	40,16,06,499
b) Additions to the Funds:														
i. Grants	-	14,90,00,000	11,53,00,000	-	11,71,90,000	-	-	2,68,07,000	-	4,00,00,000	-	18,00,000	45,00,97,000	60,04,26,617
ii. Interest if any	13,94,331	3,90,356	20,58,667	7,91,821	1,20,83,986	36,71,710	1,63,928	1,02,968	53,25,209	12,78,801	16,87,542	67,730	2,90,17,049	3,01,93,352
iii. Advance for sub projects utilised	-	14,14,48,650	5,33,36,133	2,75,06,124	-	67,26,022	-	-	-	-	-	-	22,90,16,929	11,15,44,362
iv. Advance for purchase Utilised	4,84,837	23,56,172	-	-	80,50,446	11,89,117	-	14,43,173	-	-	-	-	1,35,23,745	16,53,38,337
v. Margin Money Reversed	-	2,46,64,500	14,33,11,912	15,32,000	-	-	-	-	-	54,83,000	-	-	17,49,91,412	18,99,15,866
vi. Mobilisation Advance reversed	-	-	-	-	-	-	-	-	-	-	-	-	-	1,81,71,187
vii. Other Revenue	43,17,546	10,500	10,942	57,750	3,48,044	-	-	-	-	-	-	-	47,44,782	1,40,25,471
TOTAL (a+b) - A	6,31,64,470	36,27,29,414	30,03,41,510	5,06,90,594	20,05,29,523	8,98,47,804	27,06,227	2,83,53,141	9,29,82,309	4,67,61,801	6,16,87,542	18,67,730	1,30,16,62,065	1,53,12,21,691
c) Utilisation/Expenditure														
i. Capital Expenditure														
W.I.P	6,60,28,058	-	-	-	-	-	-	-	-	-	-	-	6,60,28,058	8,69,68,566
Architect fee	20,290	-	-	-	-	-	-	-	-	-	-	-	20,290	11,34,443
Equipments	-	76,89,626	4,07,20,093	56,05,067	2,70,27,590	9,33,610	-	-	-	-	-	-	8,19,75,986	20,25,15,609
Computers / Software	-	1,31,84,537	7,67,948	7,84,603	-	24,50,116	-	-	-	-	-	-	1,71,87,204	1,88,23,736
Other Assets	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	6,60,48,348	2,08,74,163	4,14,88,041	63,89,670	2,70,27,590	33,83,726	-	-	-	-	-	-	16,52,11,538	30,94,42,354
ii. Revenue Expenditure														
Technical support	-	3,42,18,696	56,37,190	-	-	2,78,091	-	3,13,31,209	-	-	-	-	7,14,65,186	4,75,21,504
Adminisrtrative expenses	-	4,16,75,046	1,86,88,064	1,88,44,038	39,89,081	88,28,775	-	96,95,342	30,000	-	-	-	10,17,50,346	7,44,93,798
Travel	-	96,01,215	27,33,032	20,00,246	9,94,907	14,90,084	-	-	3,568	-	-	-	1,68,23,052	1,97,62,673
Consumable Materials / Data	-	9,52,96,134	1,32,80,680	24,76,411	5,726	-	-	-	-	-	-	-	11,10,58,951	7,26,86,389
Total	-	18,07,91,091	4,03,38,966	2,33,20,695	49,89,714	1,05,96,950	-	4,10,26,551	33,568	-	-	-	30,10,97,535	21,44,64,364
iii. Others														
Advance against subprojects	-	4,37,72,920	6,00,00,000	86,00,890	-	1,85,09,333	-	-	-	-	3,39,00,000	-	16,47,83,143	9,54,36,724
Advance for Purchase	-	13,25,10,891	14,48,49,394	50,58,128	80,50,446	28,37,123	-	58,06,198	4,75,49,714	7,95,683	-	-	34,74,57,577	23,66,71,585
Depository Work (APWD)	-	93,89,144	-	-	-	-	-	-	-	-	-	-	93,89,144	5,00,00,000
Margin Money against LC	-	2,46,64,500	8,98,66,912	38,60,000	-	-	-	-	-	1,83,33,000	-	-	13,67,24,412	17,68,21,705
Total	-	21,03,37,455	29,47,16,306	1,75,19,018	80,50,446	2,13,46,456	-	58,06,198	4,75,49,714	1,91,28,683	3,39,00,000	-	65,83,54,276	55,89,30,014
TOTAL (i+ii+iii) - B	**6,60,48,348**	**41,20,02,709**	**37,65,43,313**	**4,72,29,383**	**4,00,67,750**	**3,53,27,132**	**-**	**4,68,32,749**	**4,75,83,282**	**1,91,28,683**	**3,39,00,000**	**-**	**1,12,46,63,349**	**1,08,28,36,732**
Amount Refunded- C		-	-		-	-	-	-	-	-	-		-	4,81,13,811
NET BALANCE AS AT THE PERIOD END {A-(B+C)}	**-28,83,878**	**-4,92,73,295**	**-7,62,01,803**	**34,61,211**	**16,04,61,773**	**5,45,20,672**	**27,06,227**	**-1,84,79,608**	**4,53,99,027**	**2,76,33,118**	**2,77,87,542**	**18,67,730**	**17,69,98,716**	**40,02,71,148**

ESSO-INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES

SCHEDULE - 3 CURRENT LIABILITIES & PROVISIONS (Amount in Rs.)

Particulars	Current Year (2014 - 15) ₹	Previous Year (2013 - 14) ₹
A. CURRENT LIABILITIES		
Earnest Money Deposit	24,61,000	28,33,000
Security Deposit	75,67,082	40,52,532
Performance Deposit	-	45,000
Outstanding Expenses	2,33,39,243	1,25,16,046
Sundry Creditors	1,69,30,873	31,81,284
RTF-DCS Fellowship	2,56,452	-
Monsoon Mission Fund (IITM)	-	3,67,736.00
Total – A	**5,05,54,650**	**2,29,95,598**
B. PROVISIONS		
Gratuity	45,77,847	40,56,116
Accumulated Leave Encashment	1,04,94,077	79,43,834
Total – B	**1,50,71,924**	**1,19,99,950**
Total (A+B)	**6,56,26,574**	**3,49,95,548**

ESSO-INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES

SCHEDULE – 4 FIXED ASSETS

(Amount in Rs.)

DESCRIPTION (% of Depreciation)	GROSS BLOCK			DEPRECIATION			NET BLOCK	
	As at 31.03.2014	Additions during the year	As at 31.03.2015	As at 31.03.2014	For the year 2014-15	As at 31.03.2015	As at 31.03.2015	As at 31.03.2014
1. Land (0%)	1,000	-	1,000	-	-	-	1,000	1,000
2. Plant, Machinery & Equipments (15%)	4,53,57,169	-	4,53,57,169	4,39,12,743	2,16,664	4,41,29,407	12,27,762	14,44,426
3. Furniture & Fixtures (10%)	1,52,02,448	-	1,52,02,448	93,84,940	5,81,751	99,66,691	52,35,757	58,17,508
4. Office Equipment (15%)	28,53,596	17,500	28,71,096	20,99,696	1,16,497	22,16,193	6,54,903	7,53,900
5. Computer / Peripherals (60%)	1,94,93,063	2,49,53,970	4,44,47,033	1,22,47,512	1,92,87,649	3,15,35,161	1,29,11,872	72,45,551
6. Electric Installations (10%)	20,66,959	-	20,66,959	8,66,527	1,20,043	9,86,570	10,80,389	12,00,432
7. Library Books (100%)	4,96,24,736	61,88,176	5,58,12,912	4,63,43,260	64,23,002	5,27,66,262	30,46,650	32,81,476
8. Other Fixed Assets (15%)	13,53,222	51,20,474	64,73,696	3,78,006	9,12,779	12,90,785	51,82,911	9,75,216
9. Vehicles (15%)	18,49,835	-	18,49,835	11,36,483	1,07,002	12,43,485	6,06,350	7,13,352
Total	**13,78,02,028**	**3,62,80,120**	**17,40,82,148**	**11,63,69,167**	**2,77,65,387**	**14,41,34,554**	**2,99,47,594**	**2,14,32,861**
Previous Year	12,04,07,879	1,73,94,149	13,78,02,028	10,39,54,661	1,24,14,506	11,63,69,167	2,14,32,861	1,64,53,218

ESSO-INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES

SCHEDULE - 5 CURRENT ASSETS, LOANS & ADVANCES

(Amount in Rs.)

Particulars	CURRENT YEAR 2014-15 (₹)		PREVIOUS YEAR 2013-14 (₹)	
A. CURRENT ASSETS				
1. Inventories (Valued at cost)	6,53,999	6,53,999	8,79,068	8,79,068
2. Cash & Bank Balance:				
a) With Scheduled Banks – Current Account				
State Bank of India HAL CAMPUS A/c	1,24,37,005		9,77,21,295	
Andhra Bank Pragathinagar A/c	31,41,737		45,36,410	
Andhra Bank Pragathinagar-Consultancy A/c	6,50,838	1,62,29,580	7,80,127	10,30,37,832
b) Short Term Deposits with SBI	14,00,00,000		26,00,00,000	
c) Short Term Deposits with AB	-	14,00,00,000	70,00,000	26,70,00,000
TOTAL A:		**15,68,83,579**		**37,09,16,900**
B. LOANS, ADVANCES & OTHER ASSETS				
1. Deposits				
a) Telephone	2,04,350		2,04,350	
b) Electricity	55,30,514		48,91,540	
c) Gas	13,100		13,100	
d) Petrol/Diesel	1,01,400	58,49,364	1,01,400	52,10,390
2. Advances & other amounts recoverable in cash or in kind or for value to be received				
a) Vehicle Advance to Employees	7,31,550		9,79,452	
b) Advance - NRSA (NDC)	13,93,239		15,18,639	
c) Advance to Seminars/Conference	1,26,500		-	
d) Interest Accrued	62,65,490		17,10,618	
e) Other Advances	73,98,063		47,71,329	
f) Advance for Purchase	9,10,68,545		6,69,40,864	
g) Sundry Debtors	-		2,32,586	
h) Tour Advance – Foreign	-		18,641	
i) LTC Advance	90,900		86,400	
j) TDS Opening Balance	1,59,31,451		1,17,66,390	
k) TDS Accumulation during the year	29,21,765		41,65,061	
l) Margin Money against Bank Guarantee	39,41,667	12,98,69,170	91,53,667	**10,13,43,647**
TOTAL B: (1+2)		13,57,18,534		10,65,54,037
GRAND TOTAL (A + B)		**29,26,02,113**		**47,74,70,937**

ESSO - INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES

SCHEDULE 6 - INCOME FROM SALES / OTHER INCOME

(Amount in Rs.)

Particulars	CURRENT YEAR 2014- 15 (₹)	PREVIOUS YEAR 2013- 14 (₹)
a) Sale of Tender Forms	36,700	84,505
b) Other Receipts	10,64,724	1,45,775
c) Consultancy Services	4,395	1,87,983
d) Income from staff quarters	12,683	-
TOTAL	**11,18,502**	**4,18,263**

SCHEDULE 7 - INTEREST EARNED

a) Interest on Short Term Deposits & Others	4,59,390	7,56,094
b) Bank Accounts	2,40,941	2,55,997
c) Staff Advances	90,895	1,17,048
TOTAL	**7,91,226**	**11,29,139**

SCHEDULE 8 - IRRECOVERABLE GRANTS & SUBSIDIES RECEIVED

a) Central Government (Recurring Grant received from MoES)	26,00,00,000	14,30,00,000
TOTAL	**26,00,00,000**	**14,30,00,000**

SCHEDULE 9 - ESTABLISHMENT EXPENDITURE

a) Salaries, Wages & Allowances	7,10,66,880	5,53,37,571
b) Staff Welfare Expenses	17,51,176	24,10,312
c) Contributory Provident Fund	2,63,406	2,73,974
d) New Pension Scheme	31,78,780	26,82,143
e) IDBPS Trust	12,32,452	10,75,438
f) Leave Travel Concession	15,56,077	10,16,654
TOTAL	**7,90,48,771**	**6,27,96,092**

ESSO-INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES

SCHEDULE 10 - OTHER ADMINISTRATIVE EXPENSES

(Amount in Rs.)

S.No.	Particulars	CURRENT YEAR 2014 - 15 (₹)	PREVIOUS YEAR 2013 - 14 (₹)
1.	Electricity & Power Expenses	3,24,36,322	3,03,07,994
2.	Water Charges	52,10,895	31,18,612
3.	Operation & Maintenance Expenses	5,31,00,982	4,68,91,538
4.	Garden Expenses	11,99,093	12,29,335
5.	Vehicle Hiring Expenses	7,98,225	12,13,900
6.	Postage, Telephone, Fax & ISDN Charges	7,73,182	10,27,727
7.	Printing & Stationery	7,02,549	8,95,401
8.	Travelling Expenses :		
	Inland	5,66,012	13,76,968
	Foreign	2,18,265	4,86,507
	Others	9,56,908	15,14,069
9.	Seminar/Workshops Expenses	23,46,426	1,23,95,292
10.	General Expenses	11,84,943	5,18,843
11.	Audit Fee	20,291	19,999
12.	House Keeping Expenses	50,51,794	47,50,750
13.	Security Expenses	85,42,356	63,64,003
14.	Advertisement & Publicity	14,59,957	12,91,110
15.	Membership / Registration fees	35,169	3,76,962
16.	Internet Expenses	13,89,323	20,22,478
17.	Legal Expenses	-	61,890
18.	Papers & Periodicals	22,539	29,636
19.	Conveyance Expenses	1,47,734	1,39,237
20.	Material/Consumable	18,81,062	39,48,786
21.	International Interface	1,31,31,766	39,98,590
22.	Others	1,32,462	51,924
	TOTAL	**13,13,08,255**	**12,40,31,551**

SCHEDULE NO.11

NOTES FORMING PART OF ACCOUNTS:

1. **Significant Accounting Policies:**

a) **Basis of Accounting:**

The Society follows the mercantile system of Accounting and recognizes Income and Expenditure on accrual basis. The accounts were prepared on the basis as a going concern.

b) **Income Recognition:**

The Grant-in-aid was received by the Society from Ministry of Earth Sciences in the form of recurring grant and ear-marked funds.

The Grant-in-aid received from Ministry of Earth Sciences for the purpose of meeting revenue expenditure is treated as Income to the Society and to the extent utilized for capital expenditure is added to the Corpus Fund. During the year 2014-15, the Society received ₹26.00 Crores towards Recurring Grant as shown in the Schedule-8.

The remaining Grant-in-aid of ₹45.00 Crores received from Ministry of Earth Sciences is being utilized for specific purposes for which they were intended and are disclosed under the Earmarked Funds-Schedule-2.

c) **Fixed Assets and Depreciation:**

- Fixed Assets register was maintained by the Society.
- The management verified the assets physically by appointing a sub-committee.
- The additions to the fixed assets during the period of audit were stated at cost.
- Depreciation on Fixed Assets was provided on written down value, on pro-rata basis, as per the rates prescribed under the Income Tax Rules.

d) **Inventories:**

Inventory of stores, stationery items and other material of significant value are valued at cost.

e) **Building:**

As per the guidelines provided to the Central Autonomous Bodies, the Funds inflow and outflow relating to the building are initially to be shown under Building Fund in the Earmarked Funds under Schedule-2 and on completion of the building; the value of building is to be transferred to the Fixed asset schedule.

f) **Employee Benefits:**

i) **Gratuity:**

The present value of the INCOIS obligations under Gratuity is recognized on the basis of an actuarial valuation made by LIC of India Ltd., as at the year end.

ii) **Pension:**

The IDBPS (INCOIS Defined Benefit Pension Scheme) is managed by a separate trust and employers contributions for the year 2014-15, towards pension for the employees joined prior to 01-01-2004, was transferred from INCOIS to LIC of India Ltd.

Directives received from MoES vide letter No.DOD/16/06/2005-Estt., dated June 6, 2014 for refund of ₹1.23 Cr to MoES. Accordingly, the accumulated amount under consultancy services of ₹0.75 Cr returned to MoES giving effect to the Corpus Fund account under Schedule-1. Noted that the balance amount of ₹0.48 Cr will be returned by INCOIS from the revenues generated in future.

iii) **Leave encashment:**

The present value of the INCOIS obligations under Leave encashment is recognized on the basis of an actuarial valuation made by LIC of India Ltd., as at the year end.

iv) Periodical contributions made towards Contributory Provident Fund (CPF), New Pension Scheme (NPS) and IDBP Scheme (INCOIS Defined Benefit Pension Scheme) are charged to revenue.

g) **Interest on Deposits:**

The Society invested surplus funds from time to time in Short Term Deposit in Nationalized Banks. For the year 2014-15, an amount of ₹2,26,61,300/- was earned as interest on the Short Term Deposits in the bank. Since, the interest received on Short Term Deposits, relate to the grants accruing to the various projects and recurring grants received by INCOIS, the management decided to spread the interest on Short Term Deposits to such projects and INCOIS Society. Accordingly, out of total interest of ₹2,26,61,300/-, the management had transferred an interest of ₹2,26,16,890/- to various projects classified in Earmarked Funds under Schedule-2 and the balance interest of ₹44,410/- was considered as income of the Society under Schedule-7. The details are furnished below:-

(Amount in ₹)

a	Interest earned on regular STDRs	1,93,26,771.00
b	Add: TDS deducted by bank on interest earned	25,43,261.00
c	Add: Accrued Interest as on 31.03.2015	13,62,606.00
d	Total Interest	2,32,32,638.00
f	Less: Accrued Interest as on 31.03.2014	5,71,338.00
g	Net Interest earned for the F Y 2014-15	2,26,61,300.00

In addition to the above an amount of ₹4,14,980/- earned as interest on the consultancy revenues during the year 2014-15. Interest on Short terms Deposits as apportioned to the Society is ₹44,410/-. Thus, the interest earned by the Society during the financial year is ₹4,59,390/- as shown in the Schedule-7.

2. **Notes on Accounts:**

a) **Earmarked Funds:**

The Society during the year 2014-15, received ₹45.00 Crores as Grant-in-aid towards Earmarked Funds from the Ministry of Earth Sciences (MoES) and other institutions in the form of Recurring and Non-Recurring grants as specified under Schedule-2.

The amounts advanced to various Earmarked Funds under Schedule-2, shall initially be shown as Advances to Sub Projects' under "Others" category in the Earmarked Funds

Schedule, and, on receipt of Utilisation Certificates from the respective project heads, the utilized amounts are transferred to either Capital expenditure or Revenue expenditure based on the nature of utilization.

The INCOIS is making payments for the acquisition of equipment for the various projects classified under Earmarked Funds of Schedule-2. These payments are initially shown as 'advance for purchase' under Schedule-2, and later, on completion commissioning of the equipment, the total value of equipment is transferred to equipments under the same Schedule. The total value of "Advance for Purchase" as on 31-03-2015 was ₹82.84 Crores.

The accumulated value of the capital expenditure as on 31-03-2015 (excluding advances to sub-projects and advances for purchases), incurred in each year and specified in the Earmarked Funds under Schedule-2, are stated below:

Sl. No.	Name of the Fund/Project	As on 01-04-2014 ₹	Additions 2014-15 ₹	Total Amount as on 31-03-2015 ₹
i)	Building Fund	44,33,13,441	6,60,48,348	50,93,61,789
ii)	MDC & Equipment Fund	6,59,21,618	0	6,59,21,618
iii)	Ocean Information and Advisory Services (O-IAS)	1,12,76,66,548	2,08,74,163	1,14,85,40,711
iv)	Computational Facilities	15,28,06,467	0	15,28,06,467
v)	INDOMOD & SATCORE Projects	37,94,75,810	63,89,670	38,58,65,480
vi)	Ocean Observation Systems (OOS)	26,03,38,326	4,14,88,041	30,18,26,367
vii)	International Training Centre for Operational Oceanography (ITCOO)	5,66,633	2,70,27,590	2,75,94,223
viii)	HROOFS	13,800	33,83,726	33,97,526
ix)	HPC System - INCOIS	13,64,14,440	0	13,64,14,440
x)	IT & E Governance Fund	5,76,21,080	0	5,76,21,080
xi)	HPC Systems - Others	1,33,61,57,396	0	1,33,61,57,396
xii)	V SAT Node	7,11,82,783	0	7,11,82,783
xiii)	Ernet India	72,00,000	0	72,00,000
xiv)	IOAS	51,25,986	0	51,25,986
	Total	**4,04,38,04,328**	**16,52,11,538**	**4,20,90,15,866**

b) Projects and Utilisation Certificates:

The Committees comprising the heads of respective projects and other technical/ scientific experts are monitoring the status of the various projects, including the financial budgets etc. The recommendations of the committee are being reviewed from time to time by the competent authority.

The various assets of the projects and sub projects, purchased either by the INCOIS or by the respective sub projects, are located at such projects and sub projects. The confirmations of the assets held by them are being submitted from time to time.

The respective project heads submitted the utilization certificates for the year ending 31st March of each financial year and these certificates are received by the INCOIS during the subsequent financial year. Hence, the management had decided to pass the entries relating to the Utilisation Certificates actually received upto 31st March of each financial year.

c) **Contingent Liabilities:**

i) Contingent liabilities not provided for : NIL
ii) Estimated amount of Contracts remaining to be executed on capital account-NIL
iii) Claims against the company not acknowledged as debts-NIL

d) The society had placed an order with M/s. Victory Genset Pvt. Ltd for purchase of two 600 KVA DG sets in the year 2009 and released 90% payment by irrecoverable LC as per terms agreed. But, M/s. Victory Genset Pvt. Ltd had supplied only one DG set. The society claims that the documents were fabricated by supplier and hence, filed a criminal and civil suit in 2009 against the supplier.

The III Additional Chief Judge of City Civil Court, Hyderabad, had passed a decree for ₹64,89,747/- plus damages ₹10,00,000/- with future interest till the date of payment by the firm vide their Order OS No.69 of 2010, dated 18-04-012. During the proceedings of the case, an amount of ₹18,50,907.98 was blocked through injection petition in the current account of M/s Victory Genset Pvt.Ltd. at SBI, Varsova Branch, Mumbai.

Upon grant of decree by Hon'ble court, the society on the advise of legal advisor had requested SBI Varsova Branch, Mumbai to transfer the available amount to INCOIS and to provide the details of assets of M/s Victory Genset Pvt.Ltd. to file the recovery petition to recover the balance amount. As SBI, Varsova Branch refused to honour the court decree, the society had written letters to Governor, Reserve Bank of India & Secretary, Ministry of Finance, Govt. of India complaining against the SBI, Varsova Branch for not adhering to the court decree. Responses are awaited from RBI and Ministry of Finance.

Execution petition for recovery of ₹18.5 lakhs from the firm's bank account maintained at SBI, Varsova Branch, Mumbai has been filed by INCOIS at City Civil Court, Hyderabad and the case is in progress.

e) Figures of the previous year were regrouped wherever necessary.

f) Paise had been rounded off to the nearest rupee.

As per our report of even date
For B.SRINIVASA RAO & CO.,
Chartered Accountants

(Ch. Anand)
Partner
M. No. 222732
FRN No: 008763S

For and on behalf of **ESSO-INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES**

(S. Nageswara Rao)
Accounts Officer

(K.K.V. Chary)
Dy. C A O

(S.S.C. Shenoi)
Director

Place : Hyderabad
Date : 30-07-2015

ESSO-Indian National Centre for Ocean Information Services

(An autonomous body under the Ministry of Earth Sciences, Govt. of India)

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