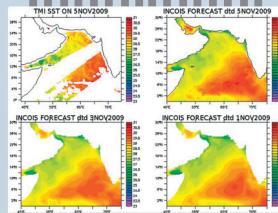
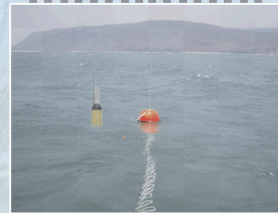


Annual Report 2009-2010



Total 52 Boards assigned
★ Apr 08-Mar 09 (40 Boards)
★ Apr 09-Mar 10 (12 Boards)

Indian National Centre for Ocean Information Services

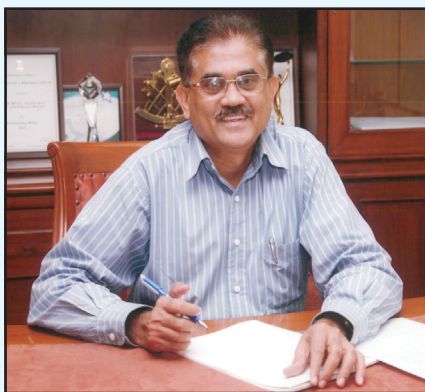
(An Autonomous Body under the Ministry of Earth Sciences, Government of India) 'Ocean Valley', Hyderabad - 500 055.

Table of Contents

Director's Report	3
1. Our Organization	4
2. Coastal and Ocean Advisory Services	8
2.1 Potential Fishing Zone Advisory Service	8
2.2 Ocean State Forecast	11
2.3 Dissemination network for PFZ advisories and ocean state forecasts	13
3. Early Warning System for Tsunami and Storm Surges	14
3.1 The Indian Ocean Wave (IO Wave09) Exercise	17
3.2 Hazard Mapping, Vulnerability and Risk Assessment	17
3.3 Establishment of an Integrated Seismic and GPS network of Stations operated by various national agencies	18
4. Ocean Observation Systems	19
4.1 Indian Argo Project	19
4.2 Other Ocean Observing Systems	22
4.3 Observations for validation of forecasts	24
5. Research and Modelling	25
5.1 Ocean General Circulation Models	25
5.2 Indian Ocean Modelling and Dynamics (INDOMOD) Project	27
5.3 Satellite Coastal Oceanographic Research (SATCORE) Project	28
5.4 Coral Reefs	28
6. Computational Facility and Ocean Information Bank	29
6.1 Computational and Communication Facilities	29
6.2 Web-based Services and Dissemination	29
6.3 Ocean Information Bank	30
6.4 Value added services	32
7. INCOIS – Infrastructure development, Operations and Maintenance	33
8. INCOIS in the International Scene	34
9. General Information	35
10. Finance	47

Annual Report 2009-2010

Director's Report



Welcome to our 2009-2010 Annual Report that outlines delivery of the 11th year of our centre. INCOIS has continued to serve the society by innovatively designing new products of information and disseminating them to the end users. In doing so, we generate data and understanding required to forecast the changes in the seas around India on shorter time scales.

This year saw the rapid growth in our computing capabilities and manpower. With the addition of 25 new entrants, our total staff strength doubled to 53. With the

addition of HPC system, our computing power exceeded 7.8 TF. We also expanded our campus horizontally with the addition of 10 acre land provided by Government of Andhra Pradesh. We are grateful to Government of Andhra Pradesh.

This year, also saw the growth in services and dissemination systems. While continue to provide the advisories on potential fishing zones and wave forecasts for the benefit of fishermen, navigators, ports and harbours, and marine industries, we also started providing short term (for 5 days) forecasts on sea surface currents, sea surface temperature, mixed layer depth and the depth of thermocline using ocean general circulation model. We consider this as a big stride towards predicting the behaviour of ocean on day-to-day basis. A new challenge will be to extend our forecasts to longer time scales, like seasonal.

Like the past years, forewarning the coastal population on impending tsunamis followed with underwater earthquakes remained our highest priority. During the year, the tsunami early warning centre detected 60 major earthquakes ($M > 6.5$) in the Indian Ocean and issued appropriate bulletins and advisories to appropriate government agencies and authorities.

As well as extending the services to the society, INCOIS scientists have been productive in their publishing. A total of 13 papers with IF 19.2 have been published in peer-reviewed journals. On the international scenario, INCOIS continued the lead role in Indian Ocean Global Ocean Observing System (IOGOOS), Regional Co-ordination of Argo Programme and Partnership for Observation of Global Ocean (POGO).

Our associated research projects run well and during the year, we funded and supported 90 projects in the areas of ocean science and modelling, observations, PFZ validations, in situ data collection for algorithm development, identification of paleo-tsunamis, etc. These projects contributed to the generation of data sets and in enhancing our understanding of oceans.

In conclusion, I would like to thank Dr. Shailesh Nayak, Chairman, Governing Council and members of GC for their support and guidance at every moment. I would also like to thank Chairman and members of Finance Committee and Research Advisory Council. Shri. E. Pattabhi Rama Rao, Dr. Sudheer Joesph and Shri. Raghavendra S. Mupparthy played the crucial roles in putting this report together. I am extremely grateful to them as well as to my colleagues in INCOIS and MoES.

S.S.C. Shenoi

1. Our Organization

The Indian National Centre for Ocean Information Services (INCOIS) is an autonomous body under the Ministry of Earth Sciences (MoES), Government of India, registered as a Society under the Andhra Pradesh (Telangana Area) Public Societies Registration Act 1350, Fasli at Hyderabad on February 3, 1999. The affairs of the Society are managed, administered, directed and controlled, subject to the Bye laws of the Society, by the Governing Council.

INCOIS Society

1	Secretary, Ministry of Earth Sciences	President
2	Director, National Remote Sensing Agency	Vice-President
3	Joint Secretary, Ministry of Earth Sciences	Member
4	Advisor, Ministry of Earth Sciences	Member
5	Director, National Institute of Oceanography	Member
6	Director, National Institute of Ocean Technology	Member
7	Director, National Centre for Antarctic & Ocean Research	Member
8	Director, Indian National Centre for Ocean Information Services	General Secretary

INCOIS Governing Council

1	Secretary, Ministry of Earth Sciences	Chairman
2	Dr. Harsh Gupta, Dr. N.K. Panikkar Chair, National Geophysical Research Institute	Vice-Chairman
3	Director, National Remote Sensing Agency	Member
4	Director General, India Meteorological Department	Member
5	Financial Adviser, Ministry of Earth Sciences	Member
6	Shri D.R. Sikka, Chairman, Research Advisory Council, INCOIS	Member
7	Joint Secretary, Ministry of Earth Sciences	Member
8	Director, National Centre for Antarctica and Ocean Research	Member
9	Director, National Institute of Oceanography	Member
10	Director, National Institute of Ocean Technology	Member
11	Principal Advisor (S&T), Planning Commission	Member
12	Director, Space Application Centre	Member
13	Director, Indian National Centre for Ocean Information Services	Member Secretary
14	Programme Officer, Ministry of Earth Sciences	Permanent Invitee

INCOIS Research Advisory Committee

1	Shri D.R. Sikka, Former Director, Indian Institute of Tropical Meteorology	Chairman
2	Prof. B.N. Goswami, Director, Indian Institute of Tropical Meteorology	Member
3	Dr. R. Siva Kumar, Head, Natural Resources Data Management System, Department of Science and Technology	Member
4	Dr. V. S. Hegde, Prog. Director, Disaster Management System, Indian Space Research Organisation	Member
5	Dr. B. K. Saha, Adjunct Professor, School of Oceanographic Studies, Jadavpur University, Kolkata	Member
6	Dr. M. Ravichandran, Head-MOG, Indian National Centre for Ocean Information Services	Member-Secretary

INCOIS Finance Committee

1	Additional Secretary and Financial Adviser, MoES	Chairman
2	Joint Secretary, MoES	Member
3	Director, INCOIS	Member
4	Director/Deputy Secretary (Finance), MoES	Member
5	Programme Officer, MoES	Member
6	Senior Scientist, INCOIS	Member-Secretary

The Mission

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

The major objectives of INCOIS are:

- To establish Early Warning System for Tsunami and Storm Surges,
- To undertake, aid, promote, guide and co-ordinate research in the field of ocean information and services including satellite oceanography.
- To establish, maintain and manage the systems for data acquisition, analysis, interpretation and archival for Ocean Information and Services.
- 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.

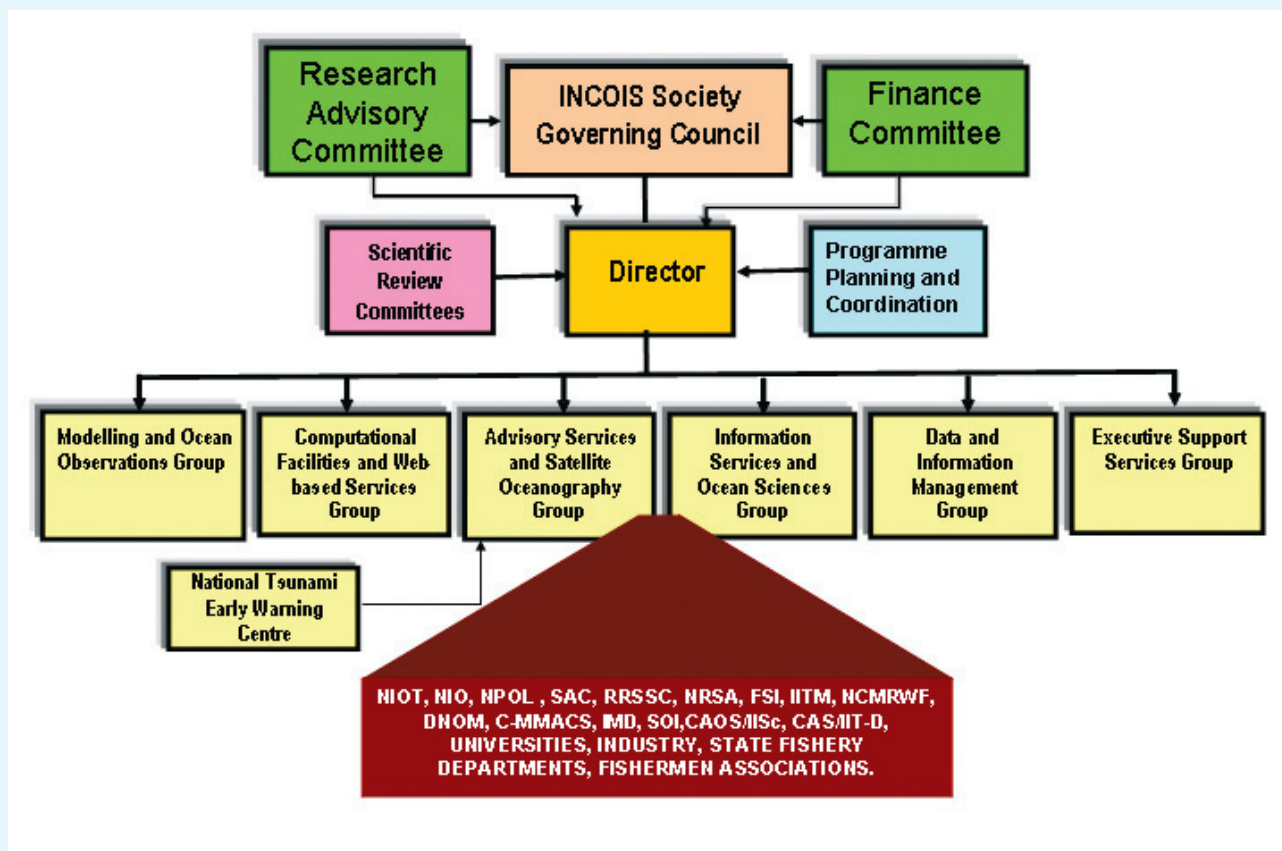
- v. To generate and provide data along with value added data products to user communities.
- vi. To cooperate and collaborate with other national and international institutions in the field of ocean remote sensing, oceanography, atmospheric sciences/meteorology and coastal zone management.
- vii. To support the research centres to conduct investigations in specified areas related to oceanic processes, ocean atmospheric interaction, coastal zone information, data synthesis, data analysis and data collection,
- viii. To organise training, seminars and symposia to advance study and research related to oceanography and technology,
- ix. To publish and disseminate information, results of research, data products, maps and digital information through all technologically possible methods like print, voice or electronic media to users for promoting research and to meet societal needs in improving environmental conditions and living standards,
- x. To provide consultancy services in the fields of ocean information and services,
- xi. To co-ordinate with the space agencies to ensure continuity, consistency and to obtain state-of-the-art ocean data from satellite observations.
- xii. To encourage and support governmental and non-governmental agencies/organizations for furthering programmes in the generation and dissemination of ocean information,
- xiii. 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 INCOIS.

INCOIS, in its pursuit for organisational excellence, national relevance and international significance, translates the scientific knowledge into useful products and services through synergy and knowledge networking with centres of excellence in ocean sciences, atmospheric sciences, space applications, and information and communication technology.

During this year, eighteen scientific (seven scientists and eleven scientific assistants) and seven administrative staff were inducted increasing the total staff strength to fifty three. In addition, seven research fellows and thirty project/contract scientists/engineers/administrative staff also work at INCOIS in various projects. INCOIS also supports the development of human resource at several premier institutions through specific projects like Indian Ocean Modelling and Dynamics (INDOMOD) and Satellite Coastal and Oceanographic Research (SATCORE), etc. During the year, seventeen project/technical/contract mode staff resigned from INCOIS and two project/technical/contract mode staff joined INCOIS under various

projects. Outsourcing has been effectively done for system/software maintenance, operation and maintenance of electrical and air conditioning facilities, house keeping, canteen, transport and security services.

The organization structure of INCOIS is as given below:



INCOIS Organogram

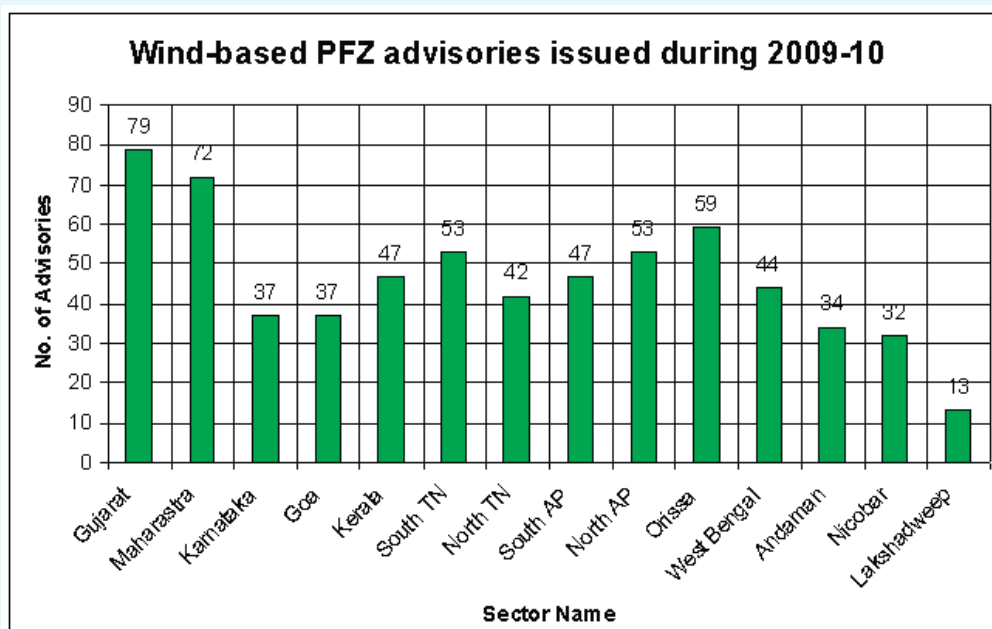
2. Coastal and Ocean Advisory Services

Considering the importance of understanding the coastal processes and their forecast for the benefit of society, specifically the coastal community, we have continued the two critical services: potential fishing zones (PFZ) and ocean state forecast (OSF) with improved delivery mechanisms and timely alerts on 'High Waves' during extreme weather conditions in the seas around India. In addition, the existing ocean state forecast has been enriched with the addition of 5-day forecasts on sea surface temperature (SST), sea surface current, mixed layer depth and depth of 20°C isotherm.

2.1 Potential Fishing Zone Advisory Service

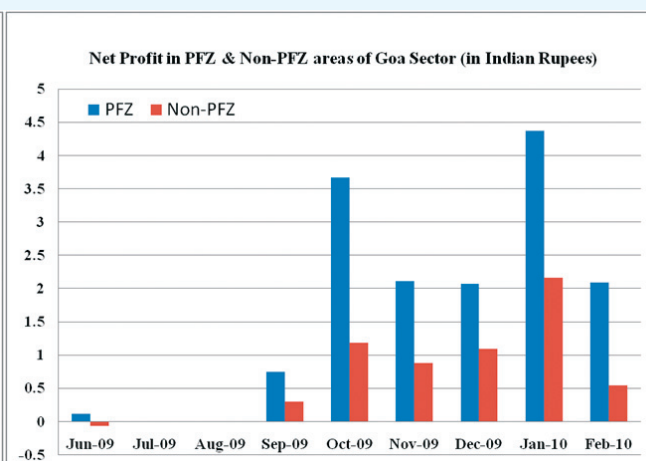
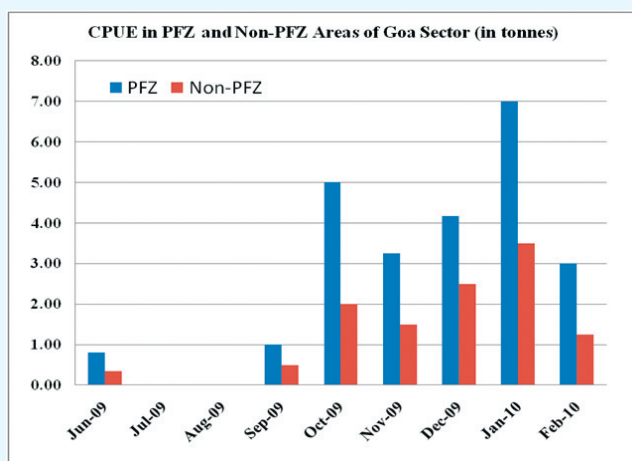
INCOIS continued issuing the PFZ advisories initiated by the Ministry of Earth Sciences (MoES) in 1999 with several improvements. The advisories generated, using the satellite data (SST, chlorophyll), thrice a week (Monday, Wednesday and Friday) on cloud free days during non-fishing ban days were disseminated to the fishermen of the country.

A total of 113 Integrated PFZ Advisories (SST + Chlorophyll + Wind) have been generated during the period: April 2009 – March 2010. These PFZ advisories were called as 'Integrated PFZ (IPFZ) advisories' because they indicated the likely movements of PFZs during the next two days due to winds. PFZ advisories were disseminated in eight Indian coastal languages as well as in English and Hindi to 136 nodes spread along the coast of India under 12 sectors namely: Gujarat, Maharashtra, Karnataka & Goa, Kerala, South Tamil Nadu, North Tamil Nadu, South Andhra Pradesh, North Andhra Pradesh, Orissa & West Bengal, Andaman Islands, Nicobar Islands and Lakshadweep Islands.



Sector wise dissemination IPFZ advisories

The PFZ programme funded 12 projects at various institutes and universities spread across the coastal states to assess the usefulness and validity of PFZ advisories. The reports from projects indicate that the PFZ advisories are particularly beneficial to artisanal, motorised and small mechanised sector fishermen engaged in pelagic fishing with ring seining, gill netting, etc. On an average, the success rate of PFZ advisories varied between 70 to 80%.

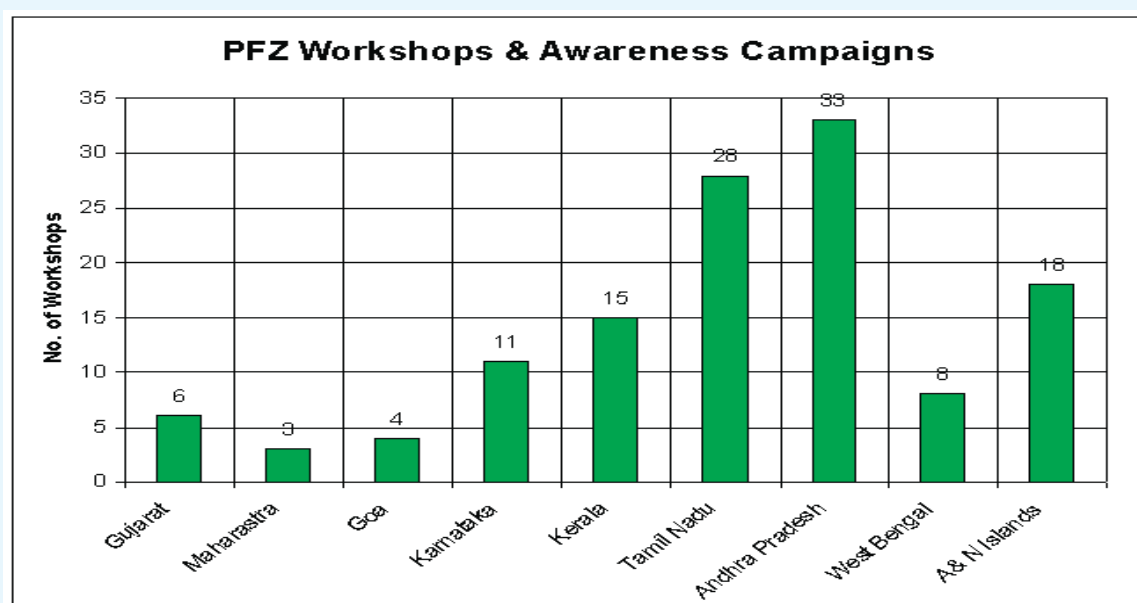


Results of control experiment in Goa sector: (a) CPUE (tonnes) obtained in PFZ and non-PFZ areas, and (b) Net profit (in INR) obtained from fishing in PFZ and Non-PFZ areas

To educate the fishermen on how to use the PFZ advisories and get benefited, 105 workshops/ awareness campaigns were conducted at various fishing villages during the year 2009-10.



PFZ mass awareness and user interaction programme at Visakhapatnam on August 28, 2009 and (b) Awareness campaign at Central Agricultural Research Institute, Port Blair on February 10, 2010



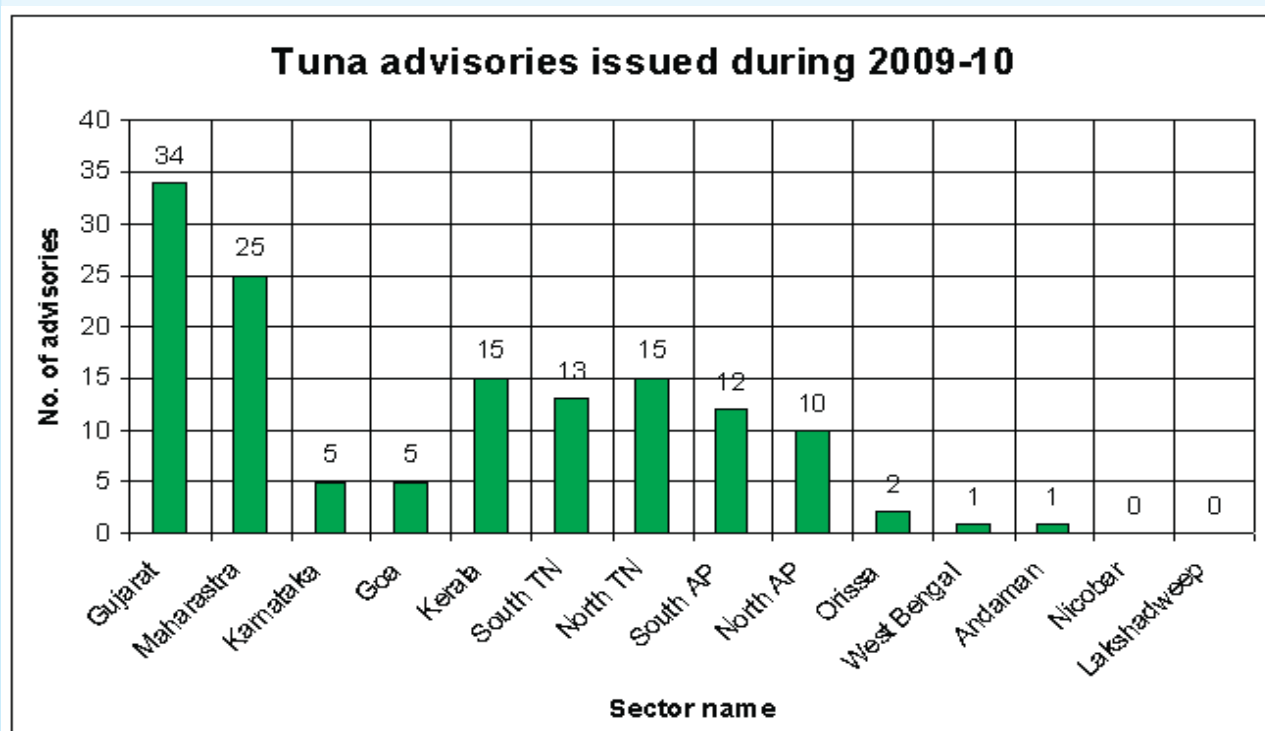
Number of workshops and awareness campaigns conducted in 2009-10

Also, on the request from Malaysian Fishery Department, a four day training programme on "Fish Forecasting-Generation and Dissemination" was conducted for the delegates from Malaysia during November 16 – 19, 2009 at INCOIS.



Delegates from the Malaysian Government who underwent the training programme at INCOIS from November 16-19, 2009

During the past year, INCOIS also made progress on issuing experimental forecasts for Tuna fishery. A total of 33 experimental advisories, similar to PFZ advisories, were generated and provided to designated Tuna long-liners on Tuesdays and Thursdays in map and text form together with satellite images via emails.

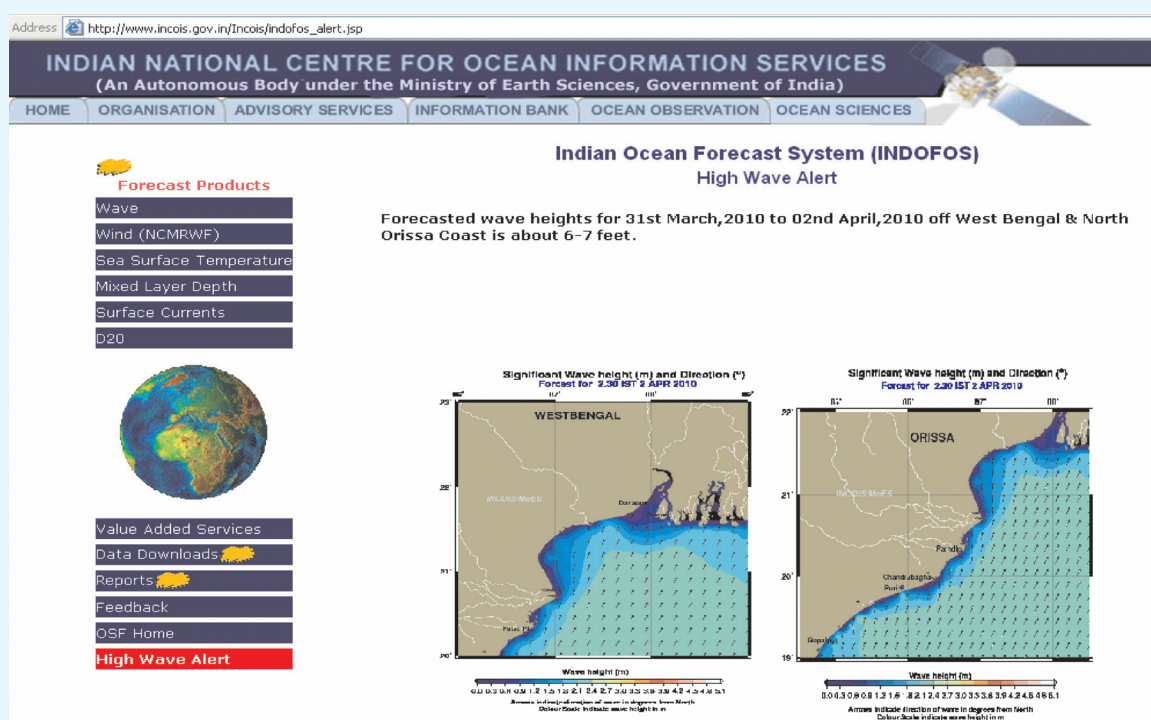


Number of experimental forecast advisories issued for Tuna fishery

2.2 Ocean State Forecast

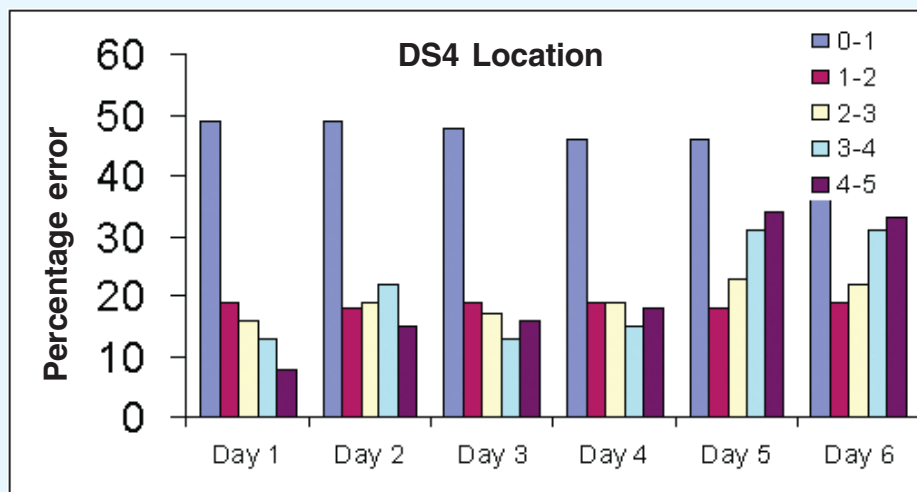
INCOIS continued the forecasts of ocean state represented by wave heights and wave directions using the forecasted winds from NCMRWF and ECMWF. This service informs the community (shipping, fishing, offshore industries, ports and harbours as well as for navy, Coast Guard, etc.) about the state of ocean 2, 5 and 7 days in advance. This service is provided 6 – 8 times a day, everyday, at global ($1^\circ \times 1^\circ$ spatial resolution), regional ($0.25^\circ \times 0.25^\circ$ spatial resolution), near coast (at 10×10 km, for Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Orissa, West Bengal) and at specific locations (for the villages in Puducherry, Tamil Nadu, Karwar, Rathnagiri and 52 fish landing centres in other states). The automation of wave forecasting procedure has helped in reducing the turn around time considerably.

Considering the repeated demand from the coastal community, especially from the fishing community, INCOIS designed a new product called “High Wave Alert” to provide information on expected high waves near the coastal sections during cyclones or high wind conditions. This was first introduced to inform the high wave conditions to fishermen in Karwar, Karnataka during the passage of cyclonic storm “PHYAN” over the Arabian Sea during November 09-12, 2009. Later this service provided for Tamil Nadu coast high wave information related to cyclonic storm “WARD” over the Bay of Bengal during December 10-15, 2009 and for Orissa and West Bengal coasts during March 31–April 2, 2010.

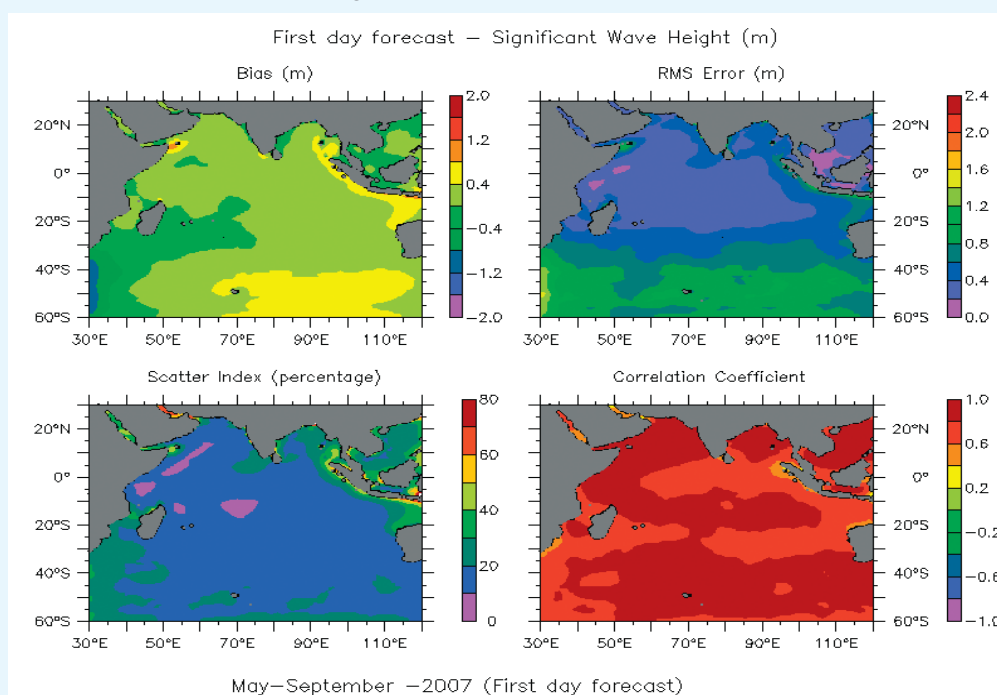


Web dissemination of “High Wave Alert” from INCOIS

During the year, INCOIS also achieved a breakthrough in forecasting four additional parameters that describe the ocean state. They are: sea surface temperature, sea surface current, mixed layer depth and depth of thermocline. This was achieved through the set-up and operationalisation of the ocean general circulation model, Regional Ocean Model System (ROMS). The forecasted winds and air-sea fluxes available from NCMRWF were used to force the model. The five day forecasts are issued for the Indian Ocean region (30° - 110° E; 20° S- 30° N) at $0.25^\circ \times 0.25^\circ$ spatial resolution. This forecast service was inaugurated on January 20, 2010.



Percentage errors in forecast of wave heights for different ranges of significant wave heights during southwest monsoon season



Error statistics of wave forecasts compared with satellite (altimeter) measurements

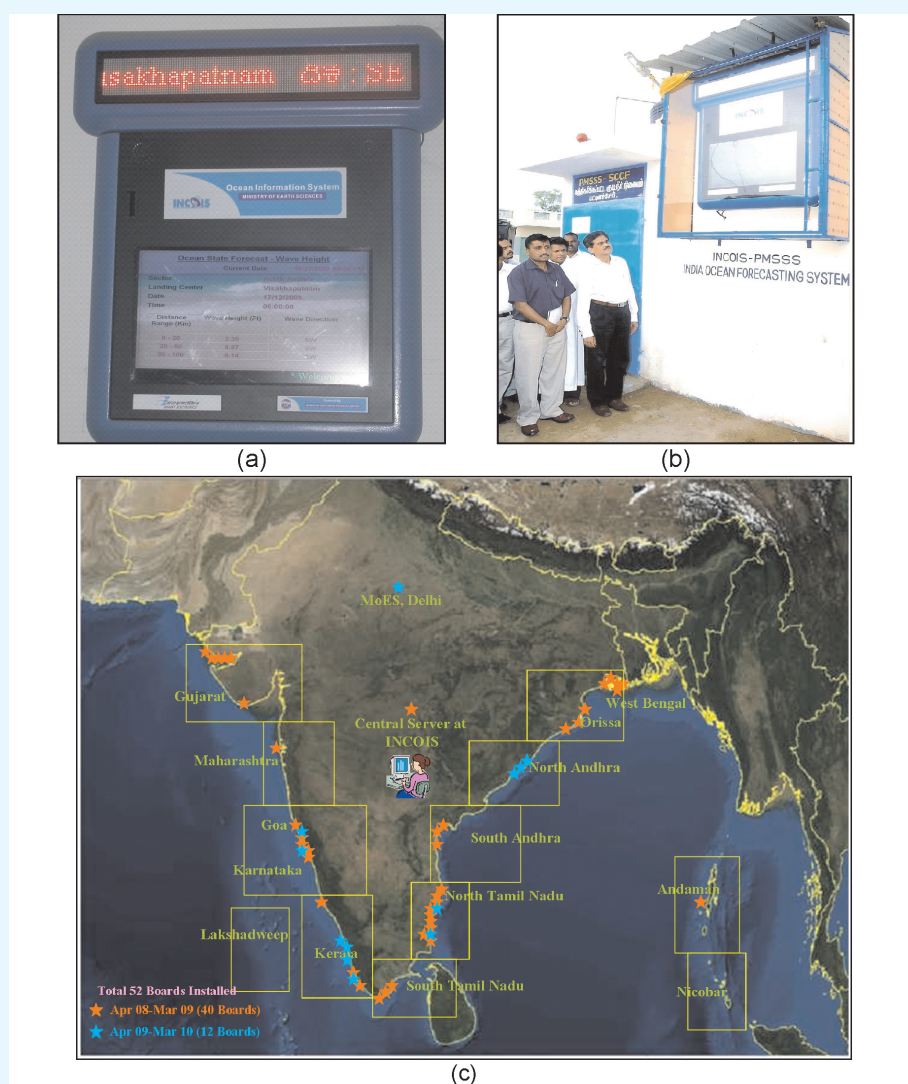


Dr. Shailesh Nayak, Secretary, Ministry of Earth Sciences, Government of India, inaugurating the operational service for forecasting of SST, surface currents, etc. over the north Indian Ocean on January 20, 2010

2.3 Dissemination network for PFZ advisories and ocean state forecasts

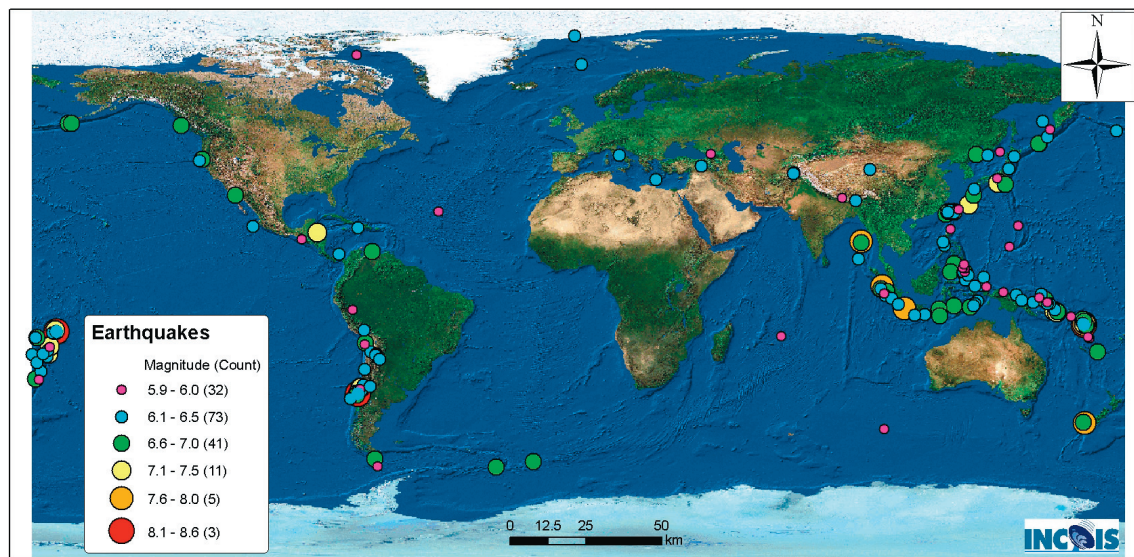
Electronic display boards (EDB), INCOIS web site, local television and radio, village information centers, and mobiles remained the main platforms for the dissemination of information on PFZ and OSF. The 'High Wave Alerts' too were disseminated through the EDBs, INCOIS web page and mobiles. The EDB network was further strengthened with the addition of eight more boards installed at Bestapalem (Bapatla), Adavipallipalyam, Iskampallipalem, Palamanapeta, PalakayaTippa and Nizampatnam, in Andhra Pradesh and at Poompuhar and Karaikkal in Tamil Nadu and by replacing the old boards with the new generation EDBs (at Malim in Goa). The new generation EDB is capable of displaying satellite data sets and images, PFZ and OSF maps and text Information. In addition, they are capable of two-way communication. EDBs set up along the 12 sectors of the Indian coastline.

Wave forecasts were also supplied to Tuna long-liners and to the ships ORV Sagar Kanya, and MV Swaraj Dweep and to Eastern Naval Command. The wave information was also provided to NIOT to plan the deployment operations of desalination plants at Androth Island (Lakshadweep).



3. Early Warning System for Tsunami and Storm Surges

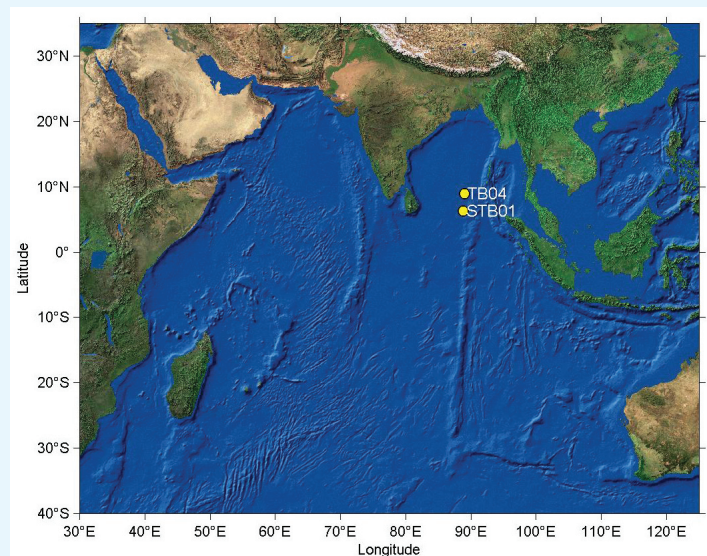
The National Tsunami Early Warning Centre (NTEWC) operated on 24x7 basis. It detected and reported 165 major earth quakes during April 2009 – March 2010.



Major Earthquakes ($M_w \geq 5.0$) detected by INCOIS between March 2009 – April 2010

The centre located the earthquake that occurred in Samoa Island Region on 29-Sep-2009 17:48:10 (UTC) within 4 minutes and the initial bulletin/emails were disseminated within 10 minutes stating that: "Tsunami threat does not exist for Indian Ocean region".

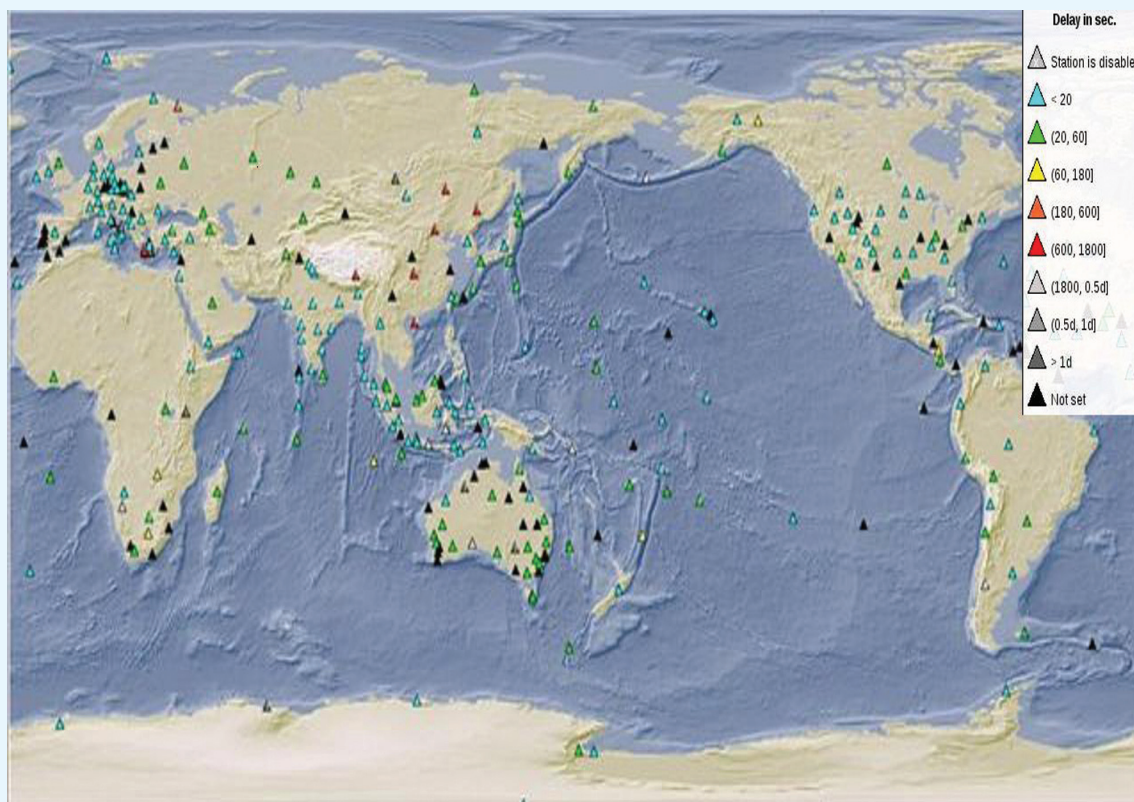
The earthquake that occurred in the Southern Sumatra, Indonesia on 30-Sep-2009 10:16:07 (UTC) was detected within 4 minutes and the first bulletin/email was disseminated within 6 minutes of the occurrence of earthquake. The second bulletin was issued after examining the model generated scenario after 38 minutes of the earthquake occurrence with updated information on earthquake and the statement that: "Model simulations do not indicate any significant change in water level at the Indian coast, there is NO tsunami threat for Indian Region".



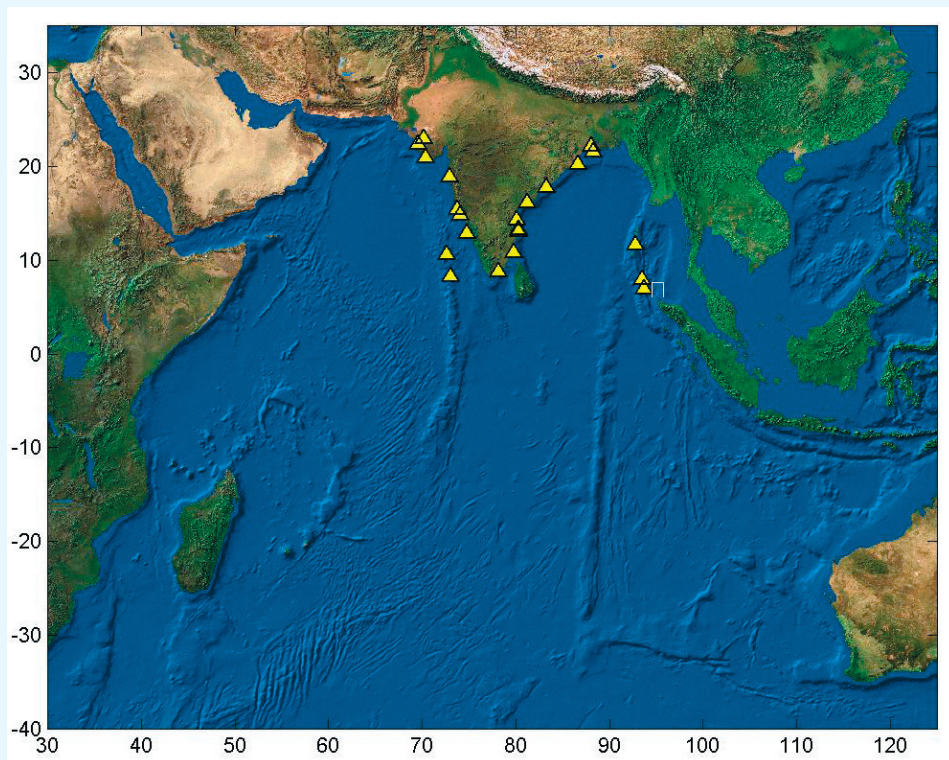
Location of two bottom pressure recorders (BPR) deployed in Bay of Bengal. The STB-01 indicates the location of SAIC buoy and TB04 indicates the location of the BPR deployed by NIOT, Chennai



SAIC buoy, STB-01. The data from this buoy deployed west of Andaman Islands at 6.25 °N, 88.65 °E, is being received at INCOIS in real-time through iridium communication link

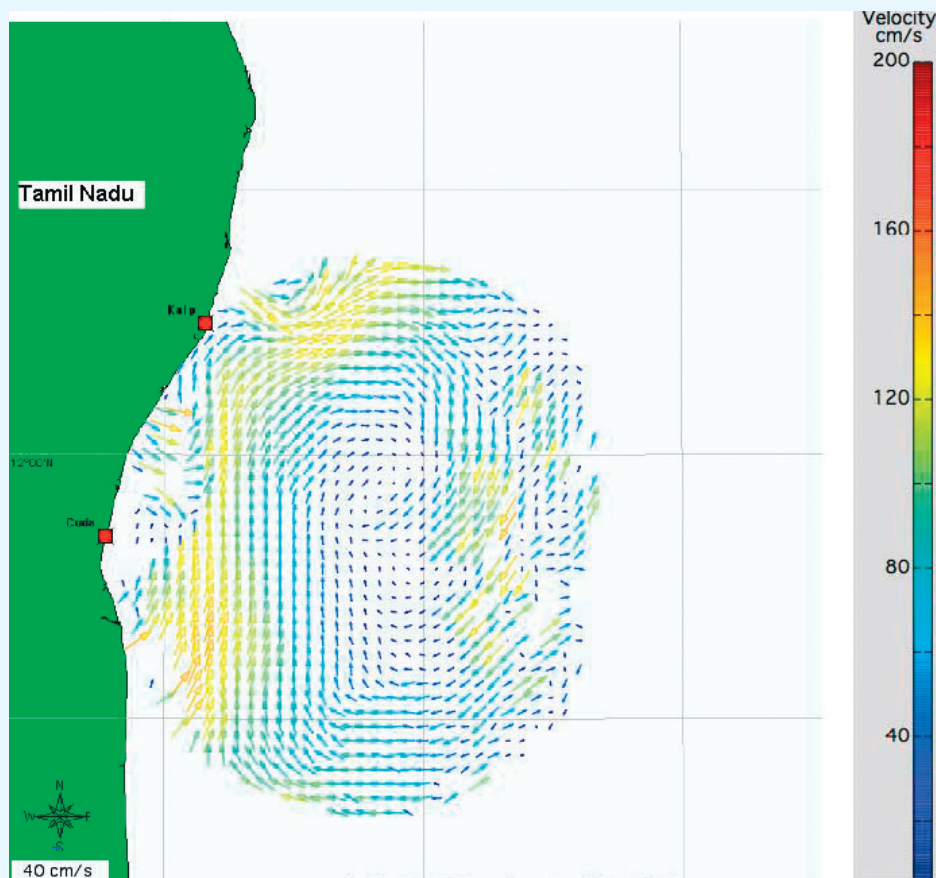


The data from 329 seismic stations [27 national and 302 international] were received and processed in Seiscomp software for real-time detection of earthquakes globally, shown here is the station latency time in detection of earthquakes



Sea level data from 22 tide gauge stations (NIOT-1 and Sol-21) are being received through INMARSAT and VSAT satellite communication systems respectively

Further, INCOIS has been receiving data from 60 international tide gauges stations in the Indian Ocean in real-time. Since, October 2009, INCOIS is also receiving the CODAR data in real-time from eight remote site locations.



CODAR Data acquired off the Tamil Nadu coast, showing surface currents

The scenario data base of 5000 unit sources were verified and made operational for generating the tsunami advisories. The unit source scaling algorithm to generate the scenario results for any magnitude and for any depth of an earthquake in Indian ocean was implemented for generating RTWP service Level II advisories for Indian ocean rim countries. The correction of scenario results, using real time water level observations is in progress.

3.1 The Indian Ocean Wave (IO Wave09) Exercise

INCOIS participated in the major Indian Ocean Wave09 drill coordinated by IOC on October 14, 2009. A table-top exercise was conducted on September 14, 2009 at 1400 hrs in the Tsunami Warning Centre, prior to the Indian Ocean Wave 09 drill, to test the procedures, bulletin formats and functionality of the DSS software.

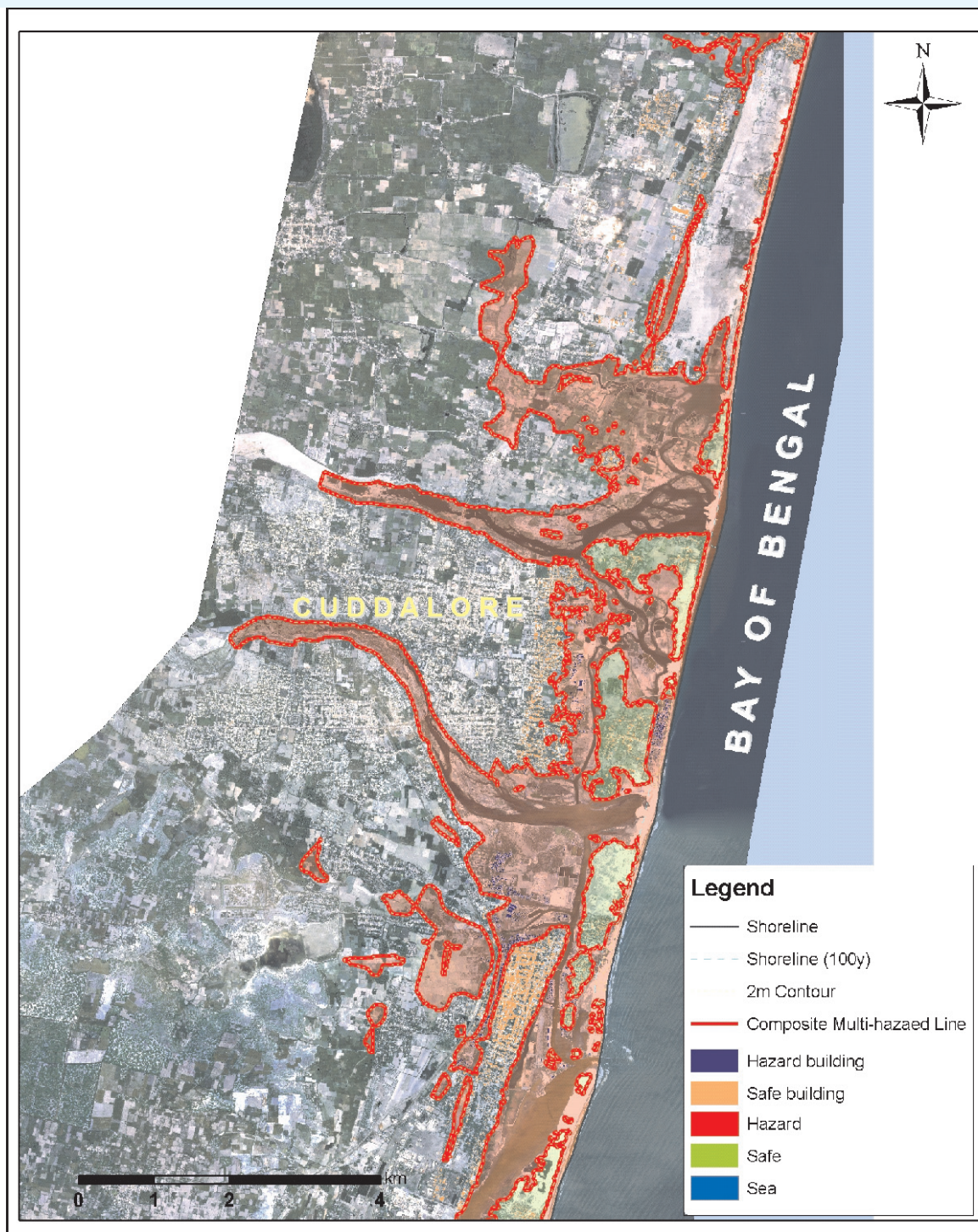
The Indian Ocean Wave (IO Wave09) exercise was conducted on 14 October 2009. The exercise was carried out in real-time mode lasting for 12 hours, during 06:30 IST and 18:30 IST. The earthquake on 26 December 2004 off Northern Sumatra was used as an example. INCOIS disseminated timely bulletins to MHA, MoES and RTWPs (Australia and Indonesia). Also, INCOIS received timely tsunami information bulletins from PTWC and JMA. All Indian Ocean countries participated in this exercise. The feedbacks from the exercise was documented and presented to the Ministry and IOC-UNESCO. Regular exercises and drills ensure better disaster preparedness of all the components and entities involved.



Top row: Table top exercise; Bottom row: The Indian Ocean Wave (IOWave09) Exercise being conducted at INCOIS on October 14, 2009

3.2 Hazard Mapping, Vulnerability and Risk Assessment

Preparation of coastal vulnerability maps for Kerala, West Bengal and Maharashtra states are under progress. The case study for the multi-hazard mapping for Cuddalore area has been completed.



Multi Hazard Vulnerability Mapping (MHVM) of Cuddalore District

3.3 Establishment of an Integrated Seismic and GPS network of Stations operated by various national agencies

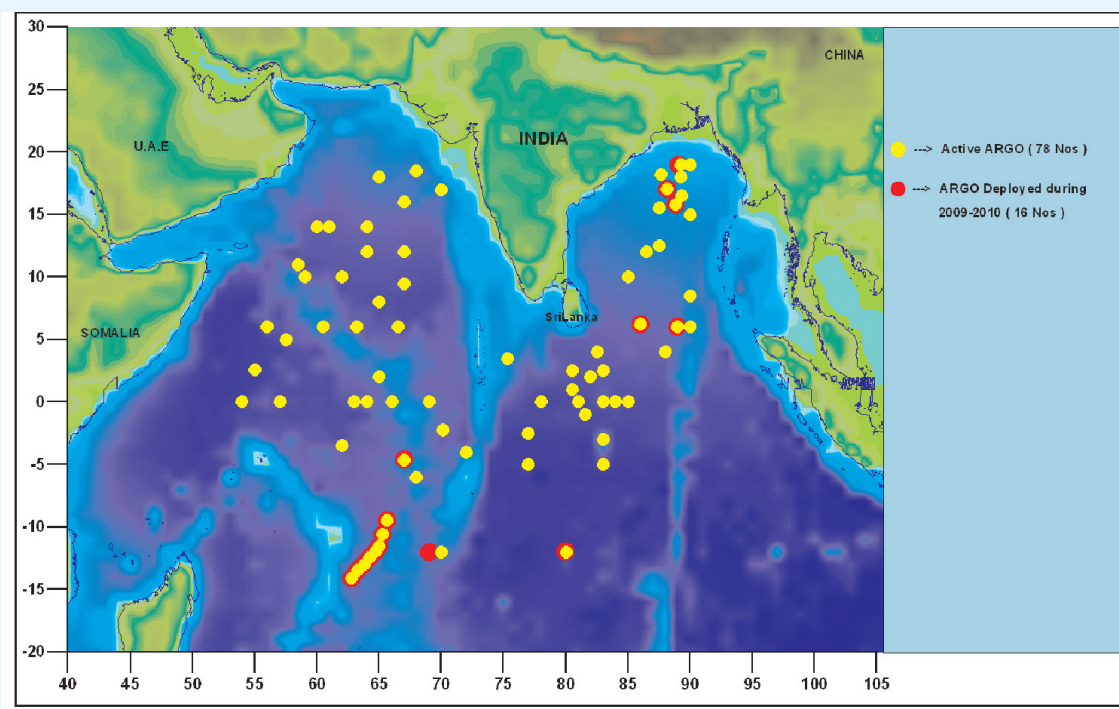
A new project titled "Establishment of an Integrated Seismic and GPS network of Stations operated by various National Agencies" was initiated to establish remote connectivity to the seismic and GPS stations operated by various national agencies. This project will establish data centres at INCOIS and IMD, New Delhi through VSAT connectivity.

4. Ocean Observation Systems

A network of observation systems was supported to critically gauge the ocean dynamics and its influence on weather and climate at different temporal and spatial scales.

4.1 Indian Argo Project

During the year, INCOIS continued to act as Argo Regional Data Center (ARC) for the Indian Ocean region.



The map shows the locations of Argo float deployments during the year and the locations of all floats as on 31 March 2010

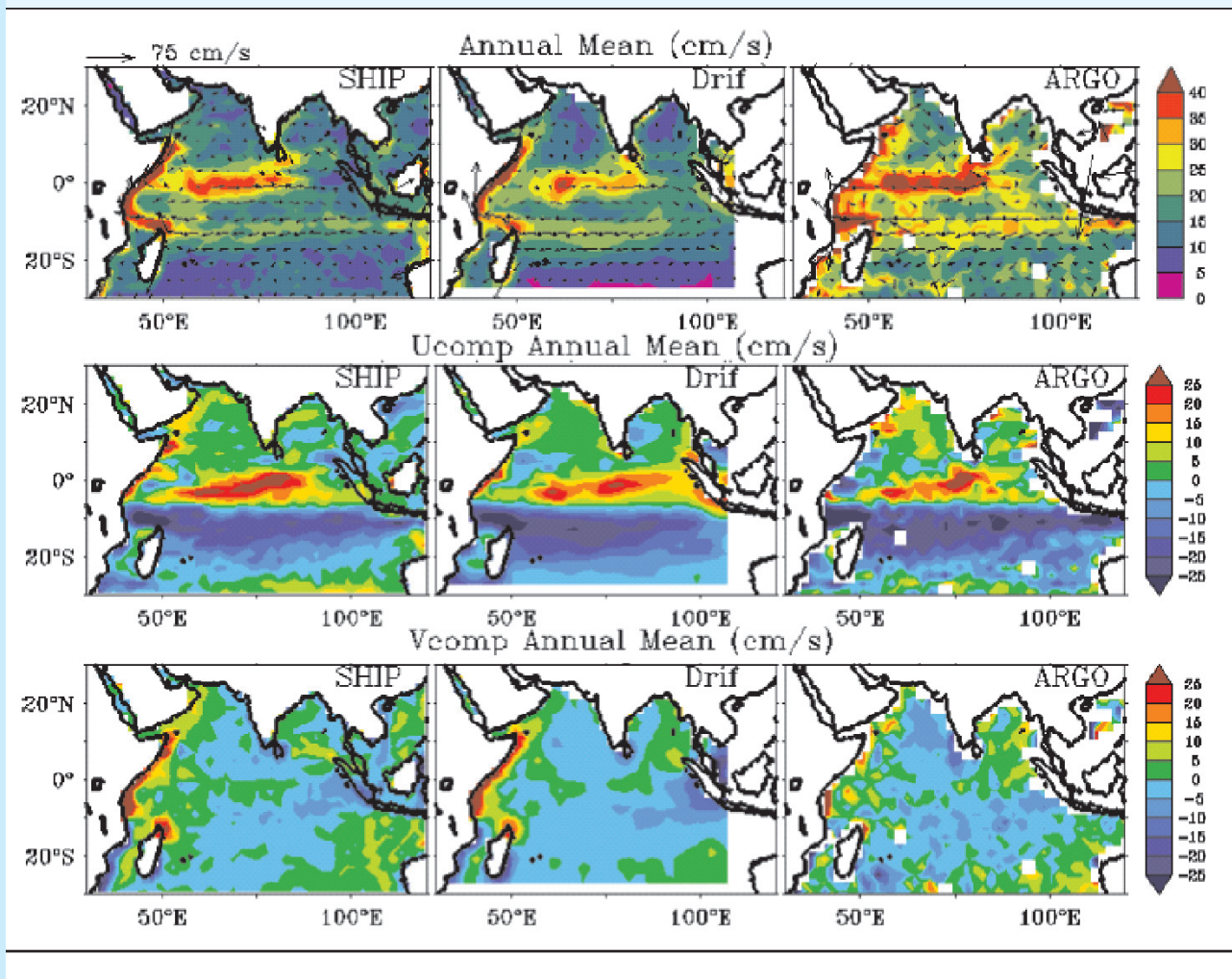
Eighteen Argo floats with facility for the measurement of near surface temperature were deployed in the Indian Ocean. In addition, three Argo floats provided by University of Washington were also deployed (using ORV Sagar Sampada) in the Arabian Sea. Two of them contained additional sensors for oxygen and the other contained the sensor for chlorophyll as well (called BIO-ARGO).

Seventy nine floats out of 175 floats, deployed by India over the past years provided subsurface temperature and salinity data. Currently, 621 floats including those deployed by other countries are providing data to regional data centre at INCOIS.

4.1.1 Studies using Argo Data

(i) Surface currents

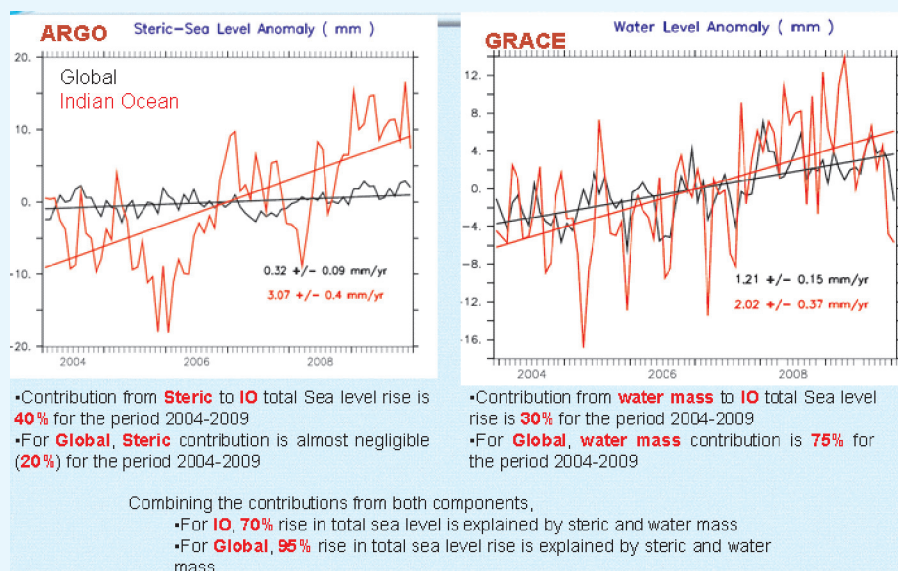
Surface currents derived from the Argo data are compared against the ship drifts and surface drifters. The analysis of the past five years of data in the Indian Ocean showed that the Argo data is overestimating the surface currents



Surface currents climatology obtained from (a) ship drift, (b) drifters and (c) Argo

(ii) Understanding sea level rise

The estimated rate of increase of sea level for the period 1993-2003 using satellite altimetry showed similar magnitudes for Global Ocean and Indian Ocean (3.10 and 3.18 mm/yr respectively). However, the reanalysis of the altimeter sea level for the period 2003-2008, the period corresponding to the Argo's era, showed slowing of global mean sea level rise globally (2.01 mm/yr). On the contrary during the same period, the sea level rose at a faster rate (7.052 ± 0.6 mm/yr) in the Indian Ocean. Further analysis using the Argo and GRACE data, showed that the contributions from the thermal expansion and from the increasing mass of the water in the Global Ocean was 0.16 ± 0.6 mm/yr and 2.01 ± 0.6 mm/yr respectively. On the contrary, in the Indian Ocean, the contribution from the thermal expansion (2.63 ± 0.3 mm/yr) was almost half of the total rate of sea level rise. The increasing water mass contributed to the other half (3.01 ± 0.2 mm/yr). This means that the sea level in the Indian Ocean is rising both due to thermal expansion and increase in water mass at much higher rates than the global average.



Deciphering sea-level rise in the Indian Ocean using Argo data

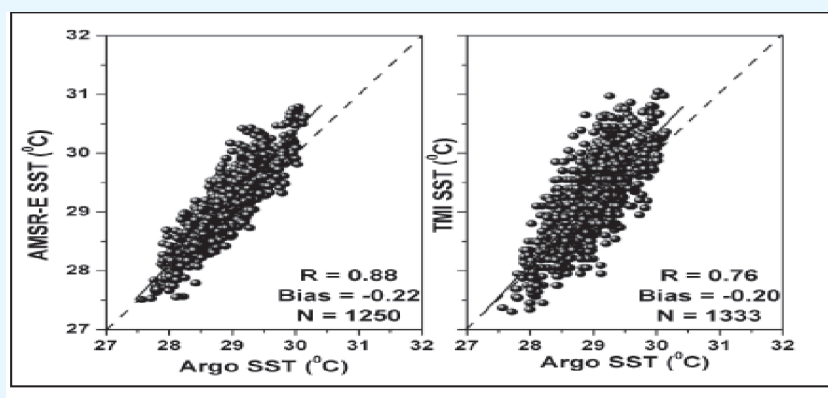
(iii) Freshwater pool in the Bay of Bengal

The 2002–2007 data, from 5-day repeat cycle Argo floats, showed the presence of fresh water pool in the central Bay of Bengal due to the advection of freshwater from rivers and rains elsewhere. The presence of freshwater there generated a shallow halocline with substantial variability of mixed layer salinity. The eddies and filaments appear to help the advective process.

(iv) SST and heat flux studies

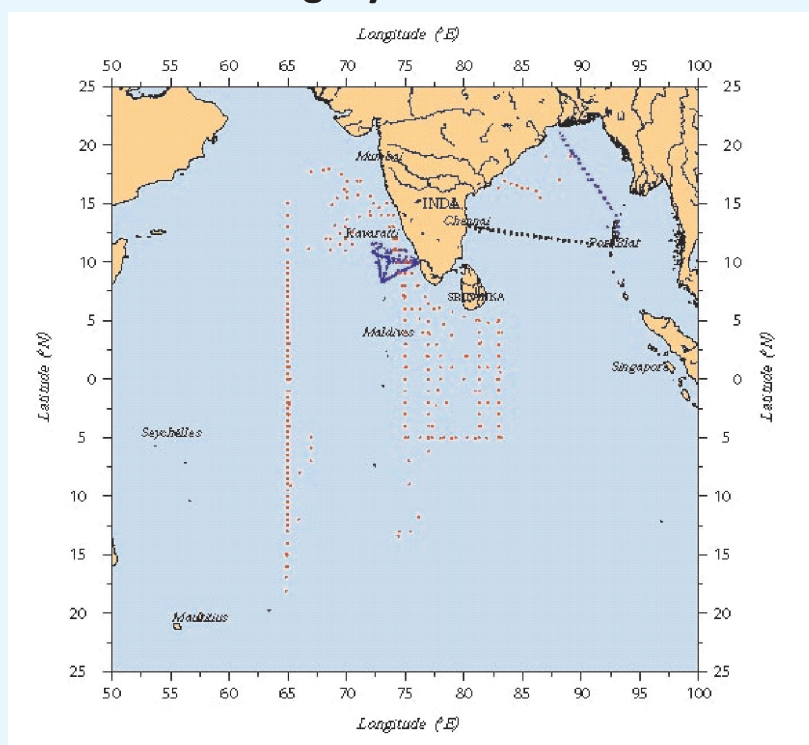
The near-surface temperature obtained from Argo floats seems to be better correlated with the Sea surface temperature (SST) measurements from the Advanced Microwave Scanning Radiometer for the Earth Observing System (AMSR-E) rather than the Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI).

An analysis of latent heat flux (LHF) from National Centers for Environment Prediction (NCEP) reanalysis and the moored buoy observation in the south-eastern Arabian Sea suggest that the LHF flux is controlled by the winds during the pre-monsoon. But during monsoon, wind as well as the relative humidity, controls the LHF.

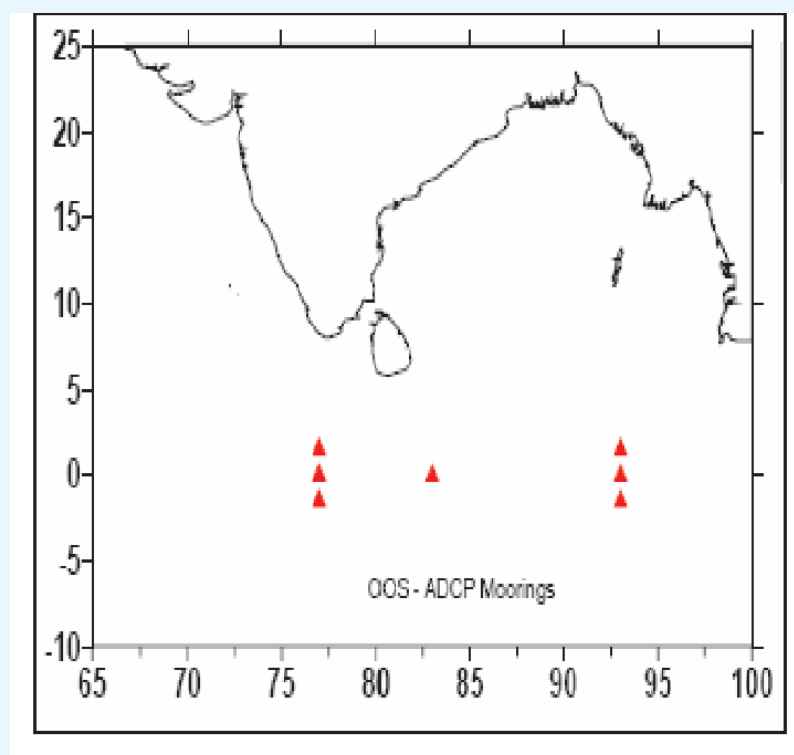


Scatter plots of (a) AMSR-E and Argo SST and (b) TMI and Argo SST during October 2006 to April 2007 at equatorial Indian Ocean

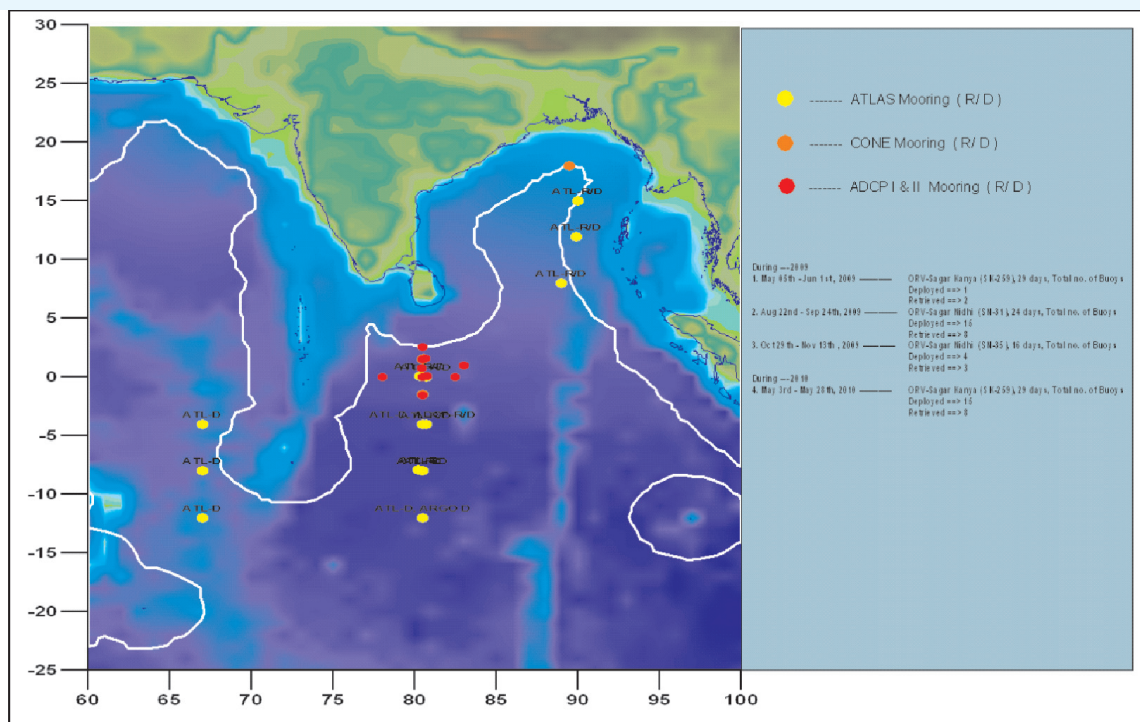
4.2 Other Ocean Observing Systems



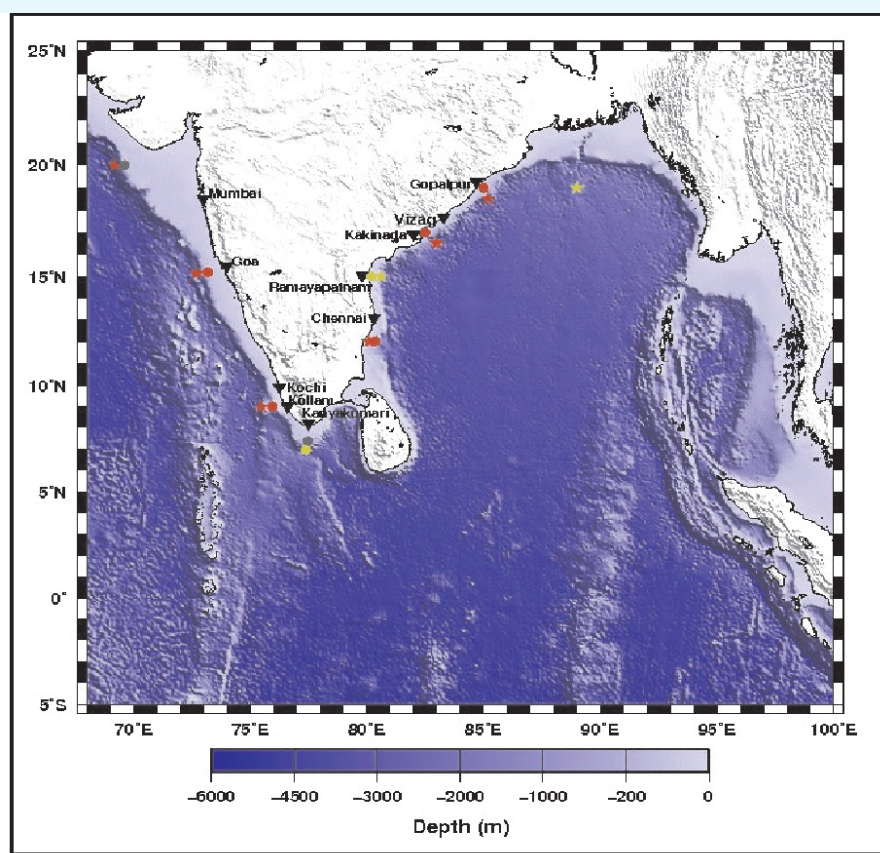
XBT(412 profiles) and XCTD (56 profiles) observations were carried out along the major shipping lines. Surface salinity (1113) and phytoplankton samples (1816) were also collected along these lines



Four more deep-sea current meter mooring arrays were deployed during SK264 cruise, in addition to the existing 3 equatorial current meter mooring arrays at equator



Two cruises were organized for recovery / deployment of ADCP /FLUX/ ATLAS moorings under the RAMA programme in collaboration with PMEL/NOAA



Location of ten ADCP moorings deployed around the Indian coast for the long term measurements of the coastal currents. The moorings are serviced and re-deployed once in a year



Mooring being deployed in the Northern bay (at 18 °N, 89.5 °E) using ORV Sagar Nidhi on 9 November 2009 under the Bay of Bengal. Mooring carries one upward looking current meter (5 m), one SST sensor (1 m), six temperature and salinity sensors (MicroCATs at 4, 7, 15, 25, 50 and 100 m) with a sampling interval of 10 minutes

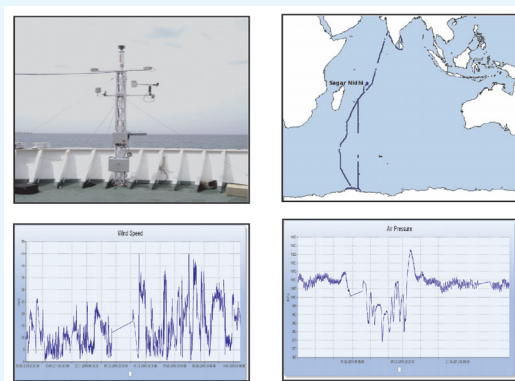
4.3 Observations for validation of forecasts

To strengthen the validation activities, a wave rider buoy was deployed off Visakhapatnam in coordination with Gangavaram Port officials. The data from the wave rider buoys deployed off Visakhapatnam, Puducherry and Ratnagiri are received in real time at shore stations as well as at INCOIS.



Deployed two wave rider buoys off Vishakhapatnam, AP coast (left) during May 2009 and Rathnagiri, Maharashtra coast (right) on 12 January 2010

INCOIS installed an Automatic Weather Stations (AWS) onboard ORV Sagar Nidhi to measure wind, air temperature, humidity, air pressure, long wave and shortwave radiation and SST. The data is being received at INCOIS in real time through INSAT. The data is used for real time validation of ocean forecasts as well as for weather predictions by IMD.



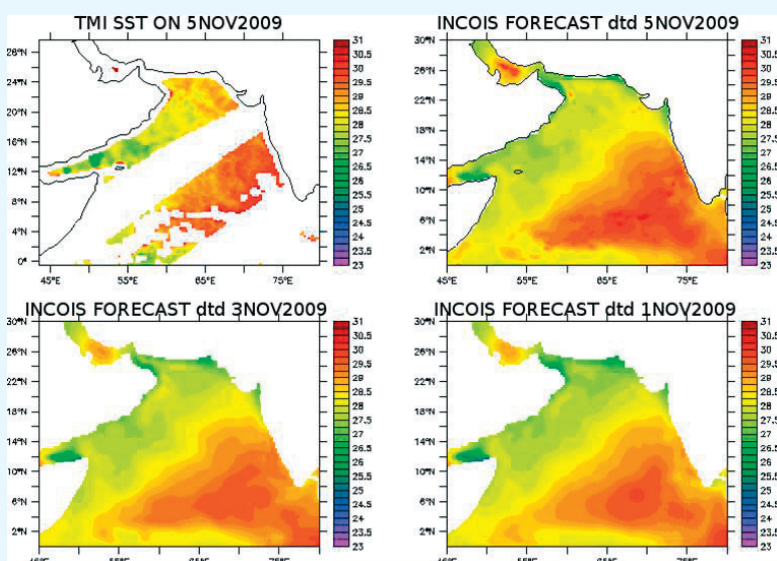
AWS installed onboard ORV Sagar Nidhi and real time data received through INSAT during her voyage to Southern Ocean

5. Research and Modelling

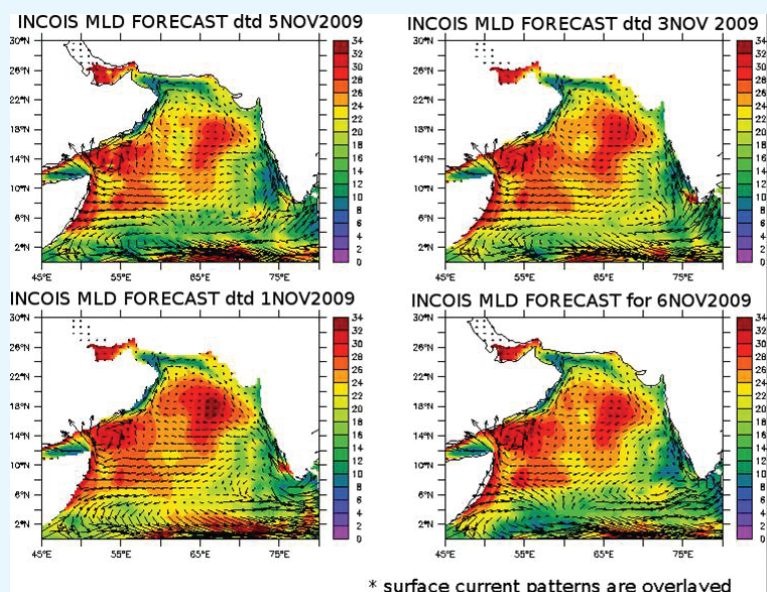
5.1 Ocean general circulation models

INCOIS continued the ocean modelling activities using four ocean general circulation models namely Regional Ocean Modelling System (ROMS), Modular Ocean Model (MOM), Hybrid Coordinate Ocean Model (HYCOM), and Colorado University Princeton Ocean Model (CUPOM). After a detailed inter-comparison exercise, it was decided to use ROMS for operational purposes. Thus ROMS was set up for the Indian Ocean Forecasting System (INDOFOS) which is first of its kind in the Indian Ocean.

The model is forced with the 5-day forecasted surface winds and atmospheric fluxes obtained from National Centre for Medium Range Forecast (NCMRWF), New Delhi. The simulations, for the period 2000-2008, were extensively validated against the observations from in-situ platforms and satellites.



INDOFOS SST forecast for 5th Nov2009 and its comparison with satellite observation



* surface current patterns are overlayed

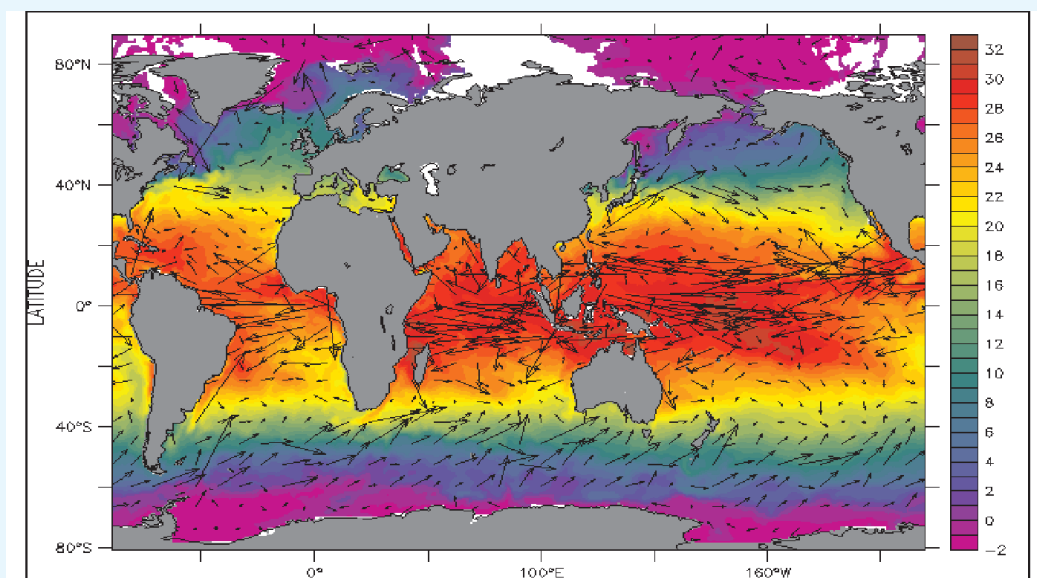
INDOFOS MLD and Surface current forecasts for 5th and 6th November 2009

The INDOFOS forecasts Sea Surface Currents, Sea Surface Temperature, Mixed Layer Depth and the depth of the 20 °C isotherm (the depth of thermocline).

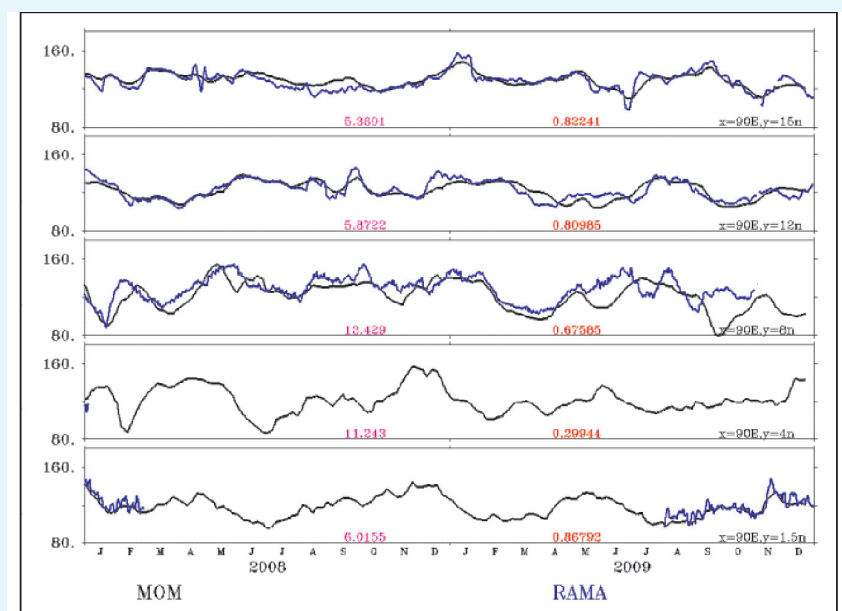
5.1.1 Data assimilation experiments with MOM model

Data assimilation code (GODAS) provided by NCEP was used in the existing MOM model ported on INCOIS HPC system. The model was forced by momentum flux, heat flux and fresh water flux from the NCEP atmospheric Reanalysis-2 data product. Temperature-salinity profiles obtained from Argo profiling floats and Reynold's SSTs were assimilated once in 5 days.

Results from initial validation shows that the model is able to produce SST within ± 0.5 °C, MLD within ± 7.0 m and thermocline within ± 10.0 m. The surface currents simulation is not good.



Average sea surface temperature simulated from GODAS for the month of December 2009. The surface currents for the month of December 2009 are also overlaid

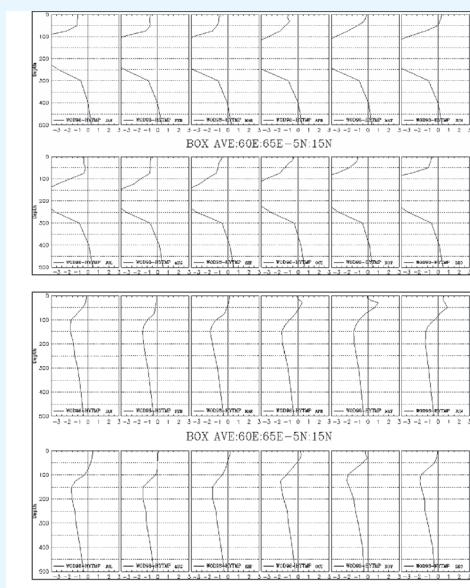


Comparison of thermocline depth (D20) estimated from RAMA mooring (blue) and MOM model (black)

5.1.2 HYCOM- Improvements in the simulation of temperature profiles

The initial set up of HYCOM had large temperature differences of up to 9 °C in thermocline region. A new setup configured on HPC using the standard HYCOM from NRL, USA with quarter degree resolution obtained an improved solution with less than 2.5 °C difference for

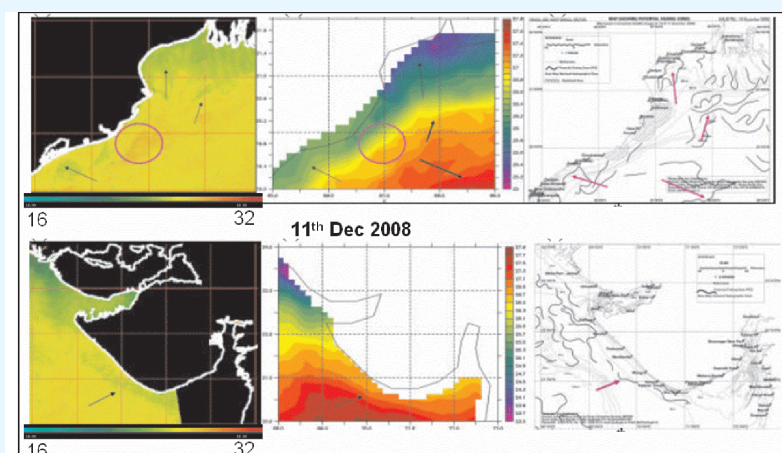
thermocline temperature and less than 0.5 °C for SST. This result is comparable to the other setups of HYCOM across the globe.



Improvements in the simulation of the vertical profiles of temperature earlier simulation (top), new simulation (bottom).

5.1.3 Colorado University Princeton Ocean Model (CUPOM)

The SST simulated using CUPOM configured at very high spatial resolutions (1/8 of degree (approx 12.5 km) and 1/16 deg (approx 6.25 km)) seems to be producing most of the features useful for the generation of PFZ advisories.



SST maps for 11 December 2008 from (a) MODIS 1 km SST, (b) CUPOM 12.5 km (1/8 deg) SST and (c) PFZ advisory generated using AVHRR 1 km SST. Top panels are for Orissa sector and bottom panels are for Gujarat sector

5.2 Indian Ocean Modelling and Dynamics (INDOMOD) Project

Twenty five projects funded by INCOIS to Indian Institute of Science, Bengaluru, Indian Institute of Technology, Delhi, Indian Institute of Technology, Kharagpur, National Institute of Oceanography, Goa, Centre for Mathematical Modelling and Computer Simulation, Bengaluru, Andhra University, Visakhapatnam, Hyderabad University, Hyderabad, Cochin University of Science and Technology, Kochi, Annamalai University, Chennai, Jadavpur University, Jadavpur, Allahabad University under INDOMOD were reviewed by a committee of experts on March 11-12, 2010 at INCOIS. Twenty one peer reviewed publications came out from these projects during the past year.

5.3 Satellite Coastal Oceanographic Research (SATCORE) Project

During 2009-10 also, INCOIS, continued the coordination of SATCORE programme by strengthening the value added services, conducting Cal/Val exercises, organizing dedicated bio-optical cruises, and modelling initiatives. The programme also continued its close links with the international programme ChloroGIN through the Indian Ocean GOOS (IOGOOS) network. The programme continued the generation dissemination of chlorophyll, and SST maps (for Indian Ocean region countries, namely, India, Sri Lanka, Iran, Kenya, Maldives, Oman, Tanzania and Thailand) and the in situ time-series measurements of chlorophyll and radiances along the selected transects around India.

Additionally, several value-added-services like custom mapped and binned satellite data products, and the data on total suspended matter (TSM) also were generated and disseminated on a routine basis.

An intercomparison exercise, named SICOME-001, was conducted off Visakhapatnam to establish the variances in the measurements made by various PIs of SATCORE network.

SATCORE Inter-Comparison Exercise (SICOME001) November 12-14, 2009	
Sr. No	Participating Agencies
1	INCOIS
2	NIO, Goa
3	Goa University
4	Mangalore University
5	CIFT, Kochi
6	Annamalai University
7	Andhra University
8	Bethangur University
9	NIO-RC, Visakhapatnam
Sr. No	Vessels
1	CRV Sagor Paechimi
2	MV Janakiraman
Sr. No	Instruments operated
1	Four Satlantic™ Hyperspectral Radiometer
2	Three Microtops II spectrophotometers
3	Ten sets of water samples for chlorophyll collected in duplicate



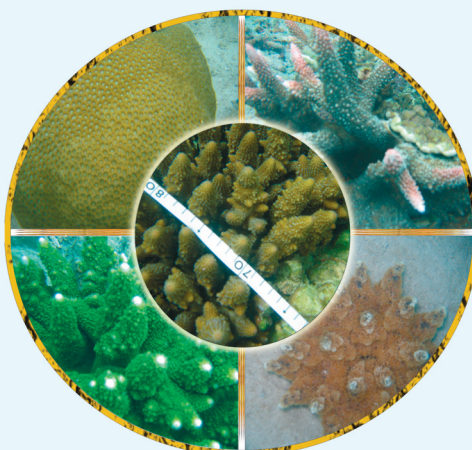
Objectives:

- To understand the variance in data collected by participating agencies.
- Inter compare radiometric & photometric instruments.
- Cross compare sample analysis methods for chlorophyll.

First Inter-comparison exercise under the SATCORE programme

5.4 Coral Reefs

Coral reefs of Andaman and Nicobar Islands were mapped in collaboration with SAC-ISRO for a Ministry of Environment and Forests (MoEF) project. An Ecomorphological Atlas of Coral Reefs in the India Waters has been completed and published. The coral reefs in Andaman and Nicobar Islands were classified and mapped. The classification was done based on eco-morphology of the reefs and field visits.



A collage of different Coral reefs encountered off Andaman & Nicobar Islands

6. Computational Facility and Ocean Information Bank

6.1 Computational and Communication Facilities

One of the major achievements during the year is the installation and commissioning of HPC facility. HPC system installed at INCOIS is built over 64 Bit Risc based SMP cluster architecture which delivers peak performance of 7.2 tera-flops with a total of 512 Power 6 processor cores working together and 2 TB of memory including 166 TB usable storage. The system is backed up by reliable and redundant technical support services viz., DG power, UPS power, precision ACs, water process cooling system on 24x7 basis..



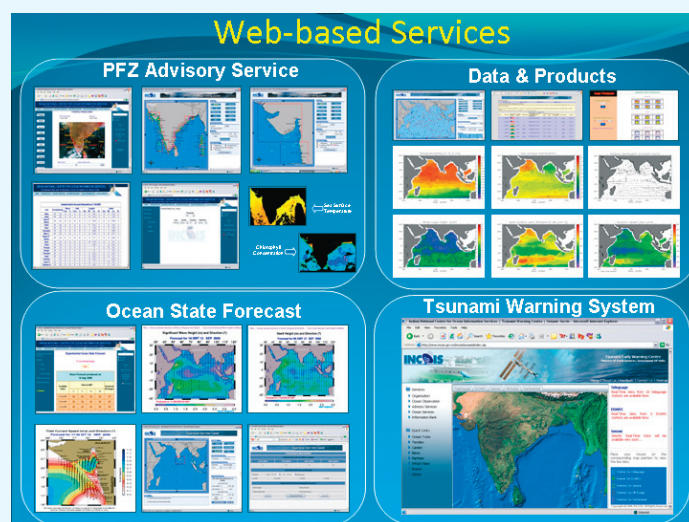
HPC facility at INCOIS

During the year, the web-server was upgraded to achieve better performance and the mail server was secured with server mail security appliances (CISCO™)

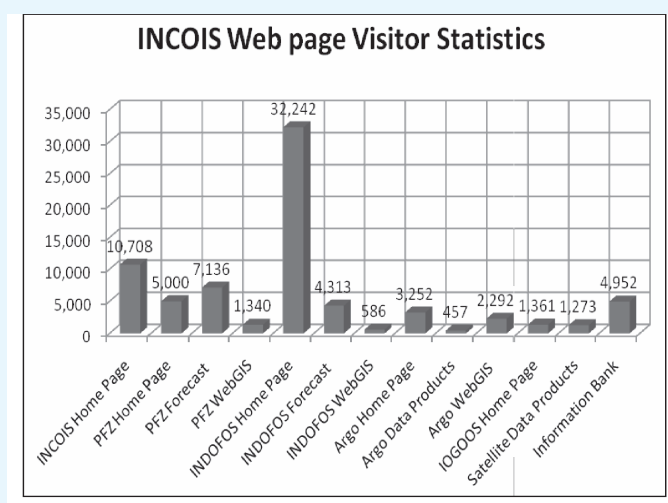
6.2 Web-based Services & Dissemination

INCOIS website (www.incois.gov.in) continued the dissemination of ocean data, information and advisory services in the areas of (i) Potential Fishing Zone, (ii) Ocean State Forecast, (iii) data from Argo floats and other in situ platforms.

The web services were improved by adding new content or updating the existing content. An online submission of application for recruitment of scientific and administrative staff was devised and made operational. The 'Human Capital' page was redone to provide more information. A new webpage was created for dissemination of forecasts and data products from the Indian Ocean Forecasting System. The data from Coastal Ocean Monitoring and Prediction System (COMAPS) is now available from INCOIS web site.



Delivering products and services through the web



INCOIS Web User Statistics from April 2009 – March 2010

6.3 Ocean Information Bank

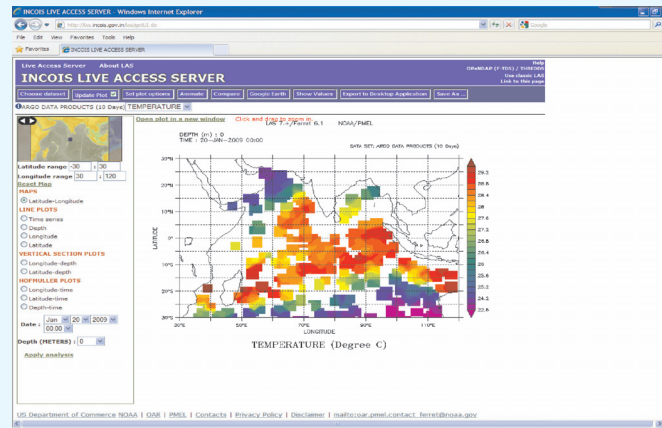
INCOIS is the central repository for the oceanographic data in the country and IODE/IOC designated as NODC. INCOIS also serves as the National Argo Data Centre and Argo Regional Data Centre for the Indian Ocean Region.

One of the major achievements during the year was the development of an Integrated *in-situ* Ocean Data and Information System (ODIS) and its integration with the existing data base. This allows the user for querying, searching, visualising and downloading of *in-situ* data on-line from a wide variety of *in-situ* ocean observation systems. The application was developed using Open Source software/tools viz., UMN MapServer, MySQL and the commercial software ChartDirector™.

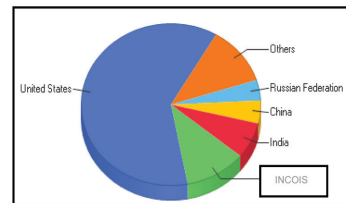
Other notable achievements are:

- Sustained the data reception, processing, quality control and dissemination of moored buoy data to the users: the Indian Meteorological Department (Delhi and Chennai), Directorate of Naval Oceanology and Meteorology (Mumbai, Port Blair, Vizag, Goa, and Kochi), and Coast Guard (Chennai) by email.

6.4 Value added services



LAS Web-page Hits	Page Views	Visitors
1,13,163	75,718	5,877



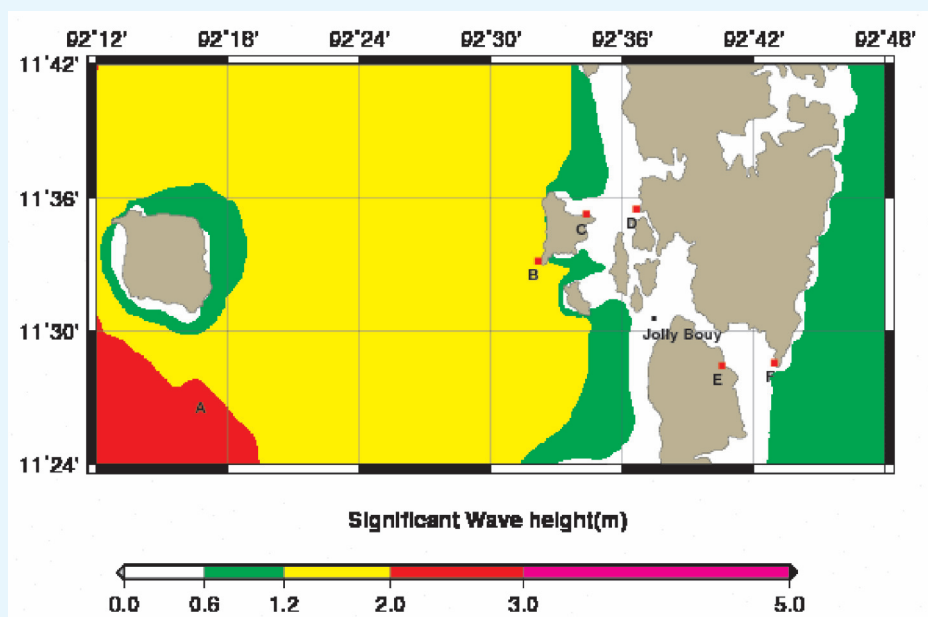
LAS and its User Statistics

During the year, INCOIS took up consultancy and user need based projects for coastal and offshore applications for the below agencies.

- Maharashtra and Gujarat Maritime Boards
- Port Authority of Andaman and Nicobar Islands.

Further, INCOIS carried out the specialized studies using satellite data for various clients. A project report submitted to Tata Chemicals is listed below.

- "A satellite based study for landuse/landcover mapping, spatio-temporal changes in vegetation around Tata Chemicals Limited (TCL), Mithapur Environs", Gujarat.



Significant Wave Height in the Macpherson Strait (Andaman & Nicobar Islands) during August

7. INCOIS – Infrastructure development, Operations and Maintenance

With the addition of ten acre land adjacent to the INCOIS campus, the total area of campus is enhanced to 60 acres.

The preparatory work for the phase II expansion of the campus, the extension of INCOIS building, residential buildings, guest house and hostel, etc., is in progress.

Establishment of Oceansat-2 ground station.

- Finalized the antenna (7.5 m diameter) size (for the reception of Oceansat-2 OCM data) and the location for ground station building (Antenna Control Room and Data Processing Systems)
- Initiated process for tendering of civil works for the ground station
- Procurement of Data Processing Systems (Servers-10, Workstations-4, Storage, Backup System, networking components) is under progress

8. INCOIS in the International Scene

Since its inception, INCOIS has played a key role in establishing frameworks of collaboration with oceanographic research institutions worldwide for gathering and sharing of data, enhancing capacity by taking a lead in capacity building programs.

8.1 Intergovernmental Oceanographic Commission (IOC)

India is the founder member of IOC and continued to be a Member of the Executive Council. Director, INCOIS participated in the 42nd session of executive council and 25th Session of General Assembly of the International Oceanographic Commission (IOC) in Paris, France during June 16-25, 2009.

8.2 Regional Alliance in the Indian Ocean for GOOS (IOGOOS)

The IOGOOS secretariat has been functioning at INCOIS since its inception in 2002. The IOGOOS membership has been grown from 19 to 25 institutions representing 15 countries. Some of the major initiatives of IOGOOS are: (i) setting up of Indian Ocean Panel working towards a strategy and implementation plan for Indian Ocean Observations for Climate, (ii) Data & Information management, (iii) Remote Sensing and Capacity Building Strategy, (iv) Prawn Pilot Project, (v) Keystone Ecosystems Project, (vi) Shoreline change monitoring project and (vii) Indian Ocean ChloroGIN Initiative. IOGOOS members have played a key role in Argo deployments and enhancing the tropical moored buoy array. The functioning of IOGOOS secretariat at INCOIS has been extended till 2013.

8.3 International Argo Project

INCOIS continued to serve as the Regional Argo Data Centre for the Indian Ocean region.

8.4 Partnership for Observation of Global Ocean (POGO)

INCOIS continued to play a major role in the POGO, an international network of major oceanographic institutions in the world established to promote and enhance the implementation and integration of global oceanographic activities.

8.5 India Brazil South Africa Cooperation Network (IBSA)

IBSA –Ocean is an emerging trilateral cooperation among India, Brazil and South Africa. In the field of ocean science and technology, this trilateral cooperation will be a major milestone in understanding the regional influence in global climate variability and utilization of Ocean resources and space.



The 2nd workshop of IBSA in Goa during May 04-08, 2009

INCOIS in collaboration with Ministry of Earth Sciences and National Institute of Oceanography organised the 2nd workshop of IBSA at International Centre, Goa during May 04-08, 2009. Dr. Shailesh Nayak, Secretary, Ministry of Earth Sciences, Government of India inaugurated the Workshop. Four working groups were formed and thirteen collaborative projects have been formulated. Nine scientists from South Africa, seven scientists from Brazil and 56 scientists from different institutes in India participated in the meeting.

9. General Information

9.1 Promotion of Hindi

INCOIS is constantly promoting and propagating the official language, Hindi. Regular meetings of the official language implementation committee were held to monitor the progress.

During 2009-10, various efforts were made to promote the use of Hindi in the institute. INCOIS Annual Report 2008-09, News Letters, and other letters were prepared in Hindi. The potential fishing zone advisories were also issued in Hindi along with local languages.

Hindi *Pakhwara* celebrations were organised at INCOIS by the Hindi Committee in September 2009. A seminar on official language was held on September 10, 2009. Dr. Shashi Mudiraj, Head, Department of Hindi, Hyderabad University, Hyderabad delivered a lecture in Hindi. Essay writing competition in Hindi was held among INCOIS staff and prizes were distributed to the participants on this occasion.

INCOIS celebrated *Hindi Vaigyanik Sangosti* on March 15, 2010. On this occasion, Dr. D. D. Ojha, Senior Scientist & Secretary Indian Society of Health Environment Education and Research, Jodhpur delivered a lecture on "Ocean and Society".



Hindi Pakhwara celebrations at INCOIS

9.2 Vigilance Activities

Dr. Ravichandran, Scientist 'F' and Head, MOG has been functioning as the Vigilance Officer at INCOIS. The Vigilance Awareness Week was observed from 3-7 November 2009. The pledge related to the Vigilance Awareness was administered to the officers and staff of INCOIS on 3 November, 2009 at 11.00 A.M. During the period April 2009- March 2010, no complaints related to vigilance were received.

9.3 Reservation Policy

Government of India's reservation policy for the recruitment of posts is being implemented at INCOIS.

9.4 Right to Information Act

Right to Information Act, 2005 is being administered at INCOIS. Dr. S.S.C. Shenoj, Director, INCOIS and Shri. E. Pattabhi Rama Rao, Scientist 'D' and Head, DMG functioned as the

Public Information Officer and Assistant Public Information Officer respectively. Information about the activities of the INCOIS and staff were published on the website in the prescribed format under Right to Information Act 2005 pages. Annual return form for the year 2008-09 prepared as per the guidelines of the Central Information Commission is also published on INCOIS website. During the period Apr 2009 – Mar 2010, four requests (including three requests from MoES), were received under the Right to Information Act 2005 and the information was provided.

9.5 Key Meetings/Workshops/Training Programmes by INCOIS

- INCOIS organised its meeting of "Sixth Session of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS-VI) at Hyderabad International convention Centre (HICC), Hyderabad during April 07-09, 2009.
- The 4th meeting of INCOIS Research Advisory Committee (RAC) meeting was held on July 23, 2009 at INCOIS.
- The 14th meeting of INCOIS Governing Council (GC-14), 13th meeting of INCOIS Finance Committee (FC-13) and 3rd meeting of INCOIS Society were held on July 24, 2009 at INCOIS.
- A Training Workshop on Marine Resources Sampling, Data Collection and Interpretation for South Asia Seas" organised by South Asian Seas Programme, South Asia Co-operative Environment Programme, was held at INCOIS on September 22, 2009.
- INCOIS organized the IOC COAST MAP Workshop on 'Drafting Project Proposal to International Financial Agencies' during November 04-07, 2009. 13 members from 10 Indian Ocean countries participated in the workshop.
- NCOIS organized and provided training to delegates from Malaysian Fisheries Department on Fish Forecasting Techniques from November 16-19, 2009.
- Joint International Workshop of International Society for Photogrammetry and Remote Sensing (ISPRS) WG IV/1, VIII/8 and IV/3 on 'Geospatial data cyber infrastructure and real-time services with special emphasis on disaster management' was organised at INCOIS during November 25-27, 2009.



Participants and trainers of workshop on WAVEWATCH-III

- INCOIS hosted the National Conference on “Digital Geography – Spatial Technologies for Environment” organised by Andhra Pradesh Geographical Society during Jan 21-22, 2010.
- To strengthen the wave forecasting system and wave modeling activities in India, INCOIS in association with NCEP/NOAA organized a training program at INCOIS during 26-29 January 2010. Dr. Hendrik Tolman, Branch Chief, NCEP and Dr. Arun Chawla supporting scientist at NCEP/NOAA trained the participants in operational wave modeling using WAVEWATCH III and SWAN. Twenty two participants from NIOT, ICMAM, NPOL, IIT, NIO, CESS and NCMRWF participated in the workshop.

9.6 Lectures and Colloquiums at INCOIS

Foundation Day Lecture:

Prof. J. Srinivasan from IISc delivered the foundation day lecture on “Climate Change, Oceans and Monsoons” on INCOIS Foundation Day on February 3, 2010.

Lectures/colloquiums at INCOIS

Sr. No.	Lecture Title	Presenter & Affiliation	Dates
1.	German Seismology contribution to the Early Tsunami Warning System of Indonesia	Prof./Dr. Rainer Kind, GFZ German Research Center for Geosciences.	July 14, 2009
2.	North Indian Ocean warming and its climatic impacts	Dr. C. Gnanaseelan, Indian Institute of Tropical Meteorology, Pune.	August 7, 2009
3.	Pacific Northwest Chinook Survival in relation to the ocean environment for the last 3 decades: Dealing with spatial scale in assessing long term changes to productivity?	Dr. Rishi Sharma, Columbia River Intertribal Fish Commission, USA	September 01, 2009
4.	Indian Ocean circulation and climate variability	Prof. Julian McCreary's, University of Hawaii.	October 26, 2009
5.	Applications of Satellite Data for Marine Fishery Forecasting and Validation of PFZ Advisories – Methods and Results	Dr. V N Pillai, Former Director and Emeritus Scientist, CMFRI, Kochi	November 17, 2009
6.	Remote Sensing – Thermal (Retrieval of SST)	Dr. K H Rao, Scientist, NRSC, Hyderabad	November 17, 2009

9.7 Visit of foreign delegation to INCOIS

A delegation from Joint Australian Tsunami Warning Centre (JATWC) comprising Dr. Chris Ryan and Dr. Tony Legget visited INCOIS and the Indian Tsunami Warning Centre on August 20, 2009. The discussions focussed on enhancing the networking of Regional Tsunami Watch

Provider (RTWP) for Service Level-II operations and understanding each other's standard operating procedures.

A delegation from NOAA's Office of Oceanic and Atmospheric Research (OAR), headed by Dr. Richard W. Sprinrad visited INCOIS on October 1, 2009. Along with him, the delegation included Dr. Rene Eppi, Prof. Sundereshwar Palloor and Dr. Mridula Srinivasan.

A delegation from South Africa comprising Dr. Ashley Johnson and Deputy Director General Dr. Monde Mayekiso visited INCOIS on February 24, 2010 to discuss on six-point cooperation mechanism for research on Indian Ocean.

9.8 Distinguished Visitors

INCOIS felicitated its founding director Dr. K. Radhakrishnan on November 17, 2009 on his appointment as Secretary DOS and Chairman ISRO.



9.9 Training programmes attended by INCOIS staff

Sr. No.	Training Name	Date & Venue	Participants
1.	Fortran Libraries and Numerical Algorithms	INCOIS, November 16, 2009	Dr. M. Ravichandran Mr. Y. Ravikumar Dr. Sudheer Joseph Dr. Anita G Dr. Francis Pavanathara Dr. R. Harikumar Dr. Vimlesh Pant Dr. Girishkumar M.S Mr. Kiran Kumar Mr. S.P. Vighneshwar Mr. Ch. Patanjali Mr. B. Ajay Kumar Mr. Sambasiva Rao Ms. G. Geetha

2.	HPC Users Training	INCOIS, February 4-6, 2010	Dr. M. Ravichandran Mr. Y. Ravikumar Dr. Sudheer Joseph Dr. Anita G Dr. Francis Pavanathara Dr. R. Harikumar Dr. Vimlesh Pant Dr. Girishkumar M.S Mr. Kiran Kumar Mr. S.P. Vighneshwar Mr. R.S. Mahendra Mr. Ch. Patanjali Mr. B. Ajay Kumar Mr. Prakash C. Mohanty Dr. K. Srinivas Mr. Sambasiva Rao Ms. G. Geetha
3.	Training session on Wave Watch III	INCOIS, January 26 – 29, 2010	Mr. Annapurnniah Ms. Sandhya K. G Dr. Francis Pavanathara Dr. K. Srinivas Ms. Sirisha Mr. L. Sabique
4.	Remote Sensing Applications in Fisheries and Ecosystem Analysis.	Kochi, SAFARI February 11-13, 2010.	Dr. Aneesh A. Lotliker and Ms. Jemima U.

9.10 Deputations abroad

Name	Meeting/Conference/Training	Country and Period
Dr S. S. C. Shenoi	25 th Session of the Intergovernmental Oceanographic Commission General Assembly	UNESCO, Paris Jun 16-25, 2009
	Meeting of the ICG/IOTWS Working Group 5 on “Establishment of a System of Interoperable Advisory and Warning Centres for the Indian Ocean Tsunami Warning System”	Perth, Australia 30 Nov, 2009 to 04 Dec, 2009
Dr. M. Ravichandran	World Ocean Conference on ‘Climate Change Impact to Ocean and the role of Ocean to Climate Change’.	Manado, Indonesia 11-15 May, 2009
	6 th Indian Ocean Panel (IOP) meeting of IOGOOS	La Re Union, France Jun 03-06, 2009
	GODAE Summer School on Ocean observations, assimilating and forecasting Oceans	Perth, Australia 11-22 Jan, 2010
	11 th Argo Steering Team (AST-11) meeting	Lu Jolla, USA 22-25 Mar, 2010

Mr B. V. Satyanarayana	29 th Annual ESRI user conference	San Diego, USA 13-17 Jul, 2009
Dr. T. Srinivasa Kumar	ICG/IOTWS workshops of RTWP Task Team & Working Group-6 inter-sessional meetings and IO Wave09 SOP workshop & Tabletop exercise	Jakarta, Indonesia 10-14 Aug, 2009
	OceanObs'09 Conference	Venice, Italy 21-25 Sep, 2009
	Meeting of the ICG/IOTWS Working Group 5 on "Establishment of a System of Interoperable Advisory and Warning Centres for the Indian Ocean Tsunami Warning System"	Perth, Australia 30 Nov, 2009 to 04 Dec, 2009
Dr T. M. Balakrishnan Nair	Meeting with NCEP/NOAA	Washington DC 24 Apr, 2009
	Workshop on "Waves in shallow Environment (WISE-2009)"	Baja California, Mexico, 26-30 Apr, 2009
Mr. E. Pattabhi Rama Rao	20 th Session of the IOC Committee on International Oceanographic Data and Information Exchange (IODE-XX)	Beijing, China 04-08 May, 2009 Venice, Italy
	Ocean SITES Steering Committee and Data Management Team Meeting and the OcenObs'09 Conference	17-25 Sep, 2009
	Fifteenth Session of the Commission for Climatology (CCI-XV) of World Meteorological Organization	Antalya, Turkey 19-24 Feb, 2010
Dr. Sudheer Joseph	Factory Acceptance Test of CIPS and Clisys	Toulouse, France 28 Sep, 2009 to 02 Oct, 2009
	GODAE Summer School on Ocean observations, assimilating and forecasting Oceans	Perth Australia 11-22 Jan, 2010
Dr Hasibur Rahaman	CLIVAR WGOMD Workshop on "Ocean Mesoscale Eddies"	Exeter, UK 27-29 Apr, 2009
	GODAE Summer School on Ocean observations, assimilating and forecasting Oceans	Perth, Australia 11-22 Jan, 2010
Mr. T.V.S. Udaya Bhaskar	10 th Meeting of Argo Data Management Team (ADMT-10)	Toulouse, France 28 Sep, 2009 – 02 Oct, 2009
Dr. Aneesh Lotliker	The Inversion Procedures in Ocean Colour Remote Sensing	Hamburg, Germany 10-14 Aug, 2009

Mr. M. Nagaraja Kumar	Regional Training Programme on "Physical Oceanography and Ocean Remote Sensing".	Mauritius 11-12 Jun, 2009
Dr. Vimlesh Pant Dr. Girishkumar M.S	Workshop on "Modelling Oceanic and Atmospheric Processes".	Muscat, Oman 21-22 Mar, 2010
Mr. R Venkat Shesu	International Conference on Marine Data and Information Systems (IMDIS 2010)	Paris. France 29-31Mar, 2010
Mrs. M Vijaya Sunanda	International Workshop on Tsunami Early Warning in the Indian Ocean Workshop	Jakarta and Citeko-West Java, Indonesia 22 Jan – 14 Feb, 2010

9.11 Publications

1. B. Prasad Kumar, Rahul Barman, S. K. Dube, P. C. Pandey, M. Ravichandran, and Shailesh Nayak (2009), "Development of a New Comprehensive Ocean Atlas for Indian Ocean utilizing ARGO Data", *Int. J. Climatology*, Vol. 30 (2), Mar 2009, pp: 185-196, DOI: 10.1002/joc.1885.
2. Swain D., S. H. Rahman, and M. Ravichandran (2009), "Comparison of NCEP turbulent heat fluxes with in situ observations over the south-eastern Arabian Sea Meteorology and Atmospheric Physics", *Meteorol. Atmos Phys*, Vol. 104 (3-4), pp: 163-175, DOI 10.1007/s00703-009-0023-x.
3. Deshpande C. G., Vimlesh Pant, A. K. Kamra (2010), "The ultrafine particles over the southern mid-latitude Indian Ocean – wind-generated or advected down with subsidence?", *Atmos. Res.*, Vol. 96, pp: 544–552, DOI: 10.1016/j.atmosres.2010.01.002.
4. Francis P.A., and Sulochana Gadgil, (2009), "The aberrant behaviors of the Indian monsoon in June 2009", *Curr. Sci.* Vol. 97(9).
5. Solanki H. U., Prince Prakash, R. M. Dwivedi, Shailesh Nayak, Arvind Kulkarni, and V.S. Somvamshi (2010), "Synergistic application of oceanographic variables from multi-satellite Sensors for forecasting potential fishing zones: methodology and Validation results", *Int. J. Rem. Sens.* Vol. 31(3) pp: 775–789, DOI: 10.1080/01431160902897833.
6. Hamza Varikoden, R. Harikumar, S. Murali Das, S. Sampath, and G. Mohan Kumar (2009), "Properties of cloud base height during southwest monsoon period over a tropical station Thiruvananthapuram", *Curr. Sci.* 96(4), pp: 562-568.
7. Nisha K., Suryachandra A. Rao, V. V. Gopalakrishna, R. R. Rao, M. S. Girishkumar, T. Pankajakshan, M. Ravichandran, S. Rajesh, K. Girish, Z. Johnson, M. Anuradha, S. S. M. Gavaskar, V. Suneel, and S. M. Krishna (2009), "Reduced near-surface thermal inversions in 2005-2006 in the Southeastern Arabian Sea?", *J. Phys. Oceanogr.*, 39, 1184-1199, DOI: 10.1175/2008JPO3879.1.
8. Kamra A. K., Devendraa Siingh, Vimlesh Pant (2009) "Scavenging of atmospheric ions and aerosols by the drifting snow at Antarctica" *Atmos. Res.*, Vol. 91, pp: 215 – 218, DOI: 10.1016/j.atmosres.2008.02.018.

9. M. J. McPhaden, G. R. Foltz, T. Lee, V. S. N. Murty, M. Ravichandran, G.A. Vecchi, J. Vialard, J. D Wiggert, and L.Yu (2009), "Ocean-Atmosphere Interactions During Cyclone Nargis", *EOS* Vol. 90(7).
10. M. J. McPhaden, G. Meyers, K. Ando, Y. Masumoto, V. S. N. Murty, M. Ravichandran, F. Syamsudin, J. Vialard, L. Yu, and W. Yu (2009), "RAMA: The Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction", *Bull. Am. Meteorol. Soc.*, Vol. 90 (4), 479-459.
11. Pant Vimlesh, C. G. Deshpande, A. K. Kamra (2009) "The concentration and number size distribution measurements of the Marine Boundary Layer aerosols over the Indian Ocean" *Atmos. Res.*, Vol. 92, pp: 381 – 393, DOI: 10.1016/j.atmosres.2008.12.004.
12. R. Harikumar, S. Sampath, and V. Sasi Kumar (2009), "An Empirical Model for the Variation of Rain Drop Size Distribution with Rain Rate at a few Locations in Southern India", *Adv. in Space Res.*, Vol. 43, pp: 837-844, DOI: 10.1016/j.asr.2008.11.001.
13. R. Harikumar, V. Sasi Kumar, and S. Sampath (2009), "Variation of Rain Drop Size Distribution with Rain Rate at a few Coastal and High altitude Stations in Southern Peninsular India", *Adv. Space Res.*, DOI: 10.1016/j.asr.2009.09.018.
14. R. B. S. Yadav, D. Shanker, S. Chopra, and A. P. Singh (2010), "An application of regional time and magnitude predictable model for long-term earthquake prediction in the vicinity of October 8 2005 Kashmir-Himalaya earthquake", *Nat. Hazards*, DOI: 10.1007/s11069-010-9519-4.
15. R. B. S. Yadav, Jayant Nath Tripathi, Bal Krishna Rastogi, Mridul Chandra Das, and Sumer Chopra (2010), "Probabilistic Assessment of Earthquake Recurrence in Northeast India and Adjoining regions", *Pure Appl. Phys.* DOI: 10.1007/s00024-010-0105-1.
16. R. R. Rao, M.S. Girish Kumar, M. Ravichandran, A.R. Rao, V.V. Gopalakrishna, and P. Thadathile (2010), "Interannual variability of Kelvin wave propagation in the wave guides of the equatorial Indian Ocean, the coastal Bay of Bengal and the southeastern Arabian Sea during 1993–2006", *Deep-Sea Res. I*, Vol. 57 pp: 1–13.
17. Rahman, S. H., D. Sengupta, and M. Ravichandran (2009), "Variability of Indian summer monsoon rainfall in daily data from gauge and satellite", *J. Geophys. Res.* Vol. 114 (D17113), DOI: 10.1029/2008JD011694.
18. Rao A. D., M. Joshi, and M. Ravichandran (2009), "Observed low-salinity plume off Gulf of Khambhat, India during post-monsoon period", *Geophys. Res. Lett.*, Vol. 36 (L03605), DOI: 10.1029/2008GL036091.
19. Shenoi S.S.C., T. Srinivasa Kumar, T.M. Balakrishnan Nair, E. Pattabhi Rama Rao, M. Nagaraja Kumar, Ch. Patanjali Kumar, E. Uma Devi, K.G. Sandya and K. Annapuraiaha (2009), "Forecasting the oceans: The oceanographic services from the Indian National Centre for Ocean Information Services", *Mausam Diamond Jubilee Volume*, pp: 225-238.
20. Saheb Paul, Arun Chakraborty, P. C. Pandey, Sujit Basu, S. K. Satsangi, and M. Ravichandran (2009), "Numerical simulation of Bay of Bengal circulation features from Ocean General Circulation model", *Mar. Geod.* Vol. 32 (1), pp: 1-18.
21. Shankar D., S.G. Aparna, J.P. McCreary, I. Suresh, S. Neetu, F. Durand, S.S.C. Shenoi, and M.A. Al Saafani (2010), "Minima of interannual sea-level variability in the Indian Ocean", *Prog. Oceanogr.*, Vol. 84, pp: 225–241, DOI: 10.1016/j.pocean.2009.10.002.

22. Shenoi S.S.C., N. Nasnodkar, G. Rajesh, K. Jossia Joseph, I. Suresh, and A. M. Almeida (2009), "On the diurnal ranges of Sea Surface Temperature (SST) in the north Indian Ocean", *J. Earth Syst. Sci.*, Vol. 118, pp: 483–496.
23. Tummala K. Srinivasa, Raghavendra S. Mupparthy, M. Nagaraja Kumar, Shailesh R. Nayak (2009), "Phytoplankton bloom due to Cyclone Sidr in the central Bay of Bengal", *J. Appl. Rem. Sens.*, Vol. 3, 033547, DOI: 10.1117/12.850782.
24. Udaya Bhaskar T. V. S., Rahman S. H., Pavanl. D., Ravichandran M., and Nayak S (2009), "Comparison of AMSR-E and TMI sea surface temperature with Argo near-surface temperature over the Indian Ocean", *Int. J. Rem. Sens.*, Vol 30 (10), pp: 2669 — 2684.
25. Uma Devi E., N. Purnachandra Rao, and M. Ravi Kumar (2009), "Modelling of sPn phases for reliable estimation of focal depths in northeastern India", *Curr. Sci.*, Vol. 96 (9), pp: 1251-1255.
26. Vialard J., S. S. C. Shenoi, J. P. McCreary, D. Shankar, F. Durand, V. Fernando, and S. R. Shetye (2009), "Intraseasonal response of the northern Indian Ocean coastal waveguide to the Madden-Julian Oscillation", *Geophys. Res. Lett.*, Vol. 36 (L14606), doi: 10.1029/2009GL038450.
27. Vinayachandran. P., Francis P.A., and Suryachandra A. Rao (2009), "Indian Ocean Dipole: Processes and Impacts", *Ind. Acad. Sci.*, (Special volume on current trends in Sciences).

9.12 Conference Proceedings & Posters

1. Harikumar, R., Sampath, S., Mohan Kumar, G., Sasi Kumar, V., "Simultaneous Evidence for the origin of rain from Stratiform or Convective Clouds from the Micro Rain Radar Bright Band Signature and the Vertical profiles of Z-R Empirical relation", Proc. International Conference on Megha-Tropiques Science and Applications, pp. 109-113, Bengaluru, India, March-2009.
2. Harikumar, R., Sampath, S., Mohan Kumar, G., "Spatial Variability of Rain Drop Size Distribution-Study at High Altitude and Coastal Tropical Stations in Peninsular India", Proc. International Conference on Megha-Tropiques Science and Applications, pp. 114-117, Bengaluru, India, March-2009.
3. Harikumar, R., Sampath, S., Mohan Kumar, G., Sasi Kumar, V., Gairola, R.M., "Preliminary Comparison of TRMM precipitation data with Micro Rain Radar, Disdrometer and Manual Rain Gauge data during different monsoon seasons at Coastal and High altitude Stations in Peninsular India", Proc. International Conference on Megha-Tropiques Science and Applications, pp. 104-108, Bengaluru, India, March-2009.
4. P.A. Francis, M. Ravichandran and R. Harikumar, "Contrasting Summer Monsoon Cold Pools South of Indian Peninsula", ROMS/TOMS Asia-Pacific Workshop-2009, Sydney Institute of Marine Sciences, Sydney, Australia, March 2009.
5. Debadatta Swain and TVS Udaya Bhaskar, "Study of sonic layer depth variability in the northern Indian ocean utilizing Argo profiles and climatological salinities", P03.11/21316, MOCA July 19-29, 2009 Montreal, Canada.
6. Harikumar, R., Sampath, S., Mohan Kumar, G., "Altitudinal variation of Radar Reflectivity Factor-Rain rate (Z–R) relation at a tropical site observed using a Micro Rain Radar: A

- valuable information for remote sensing of rain", Proc. Seminar on Climate Change, Causes, Measures and Preparedness, pp. 60-61, Hyderabad, India, August 2009.
7. Prince Prakash, "Long term change of chlorophyll over North Arabian Sea from satellite observations", Seminar on "Climate Change: Cause, Measure and Preparedness" held Centre for Earth and Space Sciences, University of Hyderabad, Hyderabad, India, August 24-26, 2009.
 8. Satya Prakash, "Variability of dissolved oxygen in the Northern Indian Ocean", Seminar on "Climate Change: Cause, Measure and Preparedness" held Centre for Earth and Space Sciences, University of Hyderabad, Hyderabad, India, August 24-26, 2009. [This presentation won the 1st prize under the Young Scientist Award].
 9. Pant Vimlesh, "Role of sea-salt aerosol particles in control of global warming" Seminar on Climate Change-Causes, Measures and Preparedness", August 24-26, 2009, Hyderabad, India.
 10. Harikumar, R., Sampath, S., Mohan Kumar, G., "Evidence of the orographic effect on rain from rain drop size distribution at coastal and high altitude stations", 46th Annual convention and meeting of Indian Geophysical Union, Dehradun, India, October 2009
 11. Girishkumar M.S., M. Ravichandran, Vimlesh Pant, "On the observed intraseasonal thermocline variability in southern Bay of Bengal", Indo-Russian workshop on Regional Climate Change (Indoruss'09), October 8-9, 2009, Cochin, India.
 12. Mahendra, R. S., Mohanty, P. C., Bisoyi, H., Srinivasa Kumar T. and Nayak, S., "Coastal Multi-hazard Vulnerability Mapping along the Cuddalore Coast, East Coast of India using the Remote Sensing and GIS". Joint International Workshop of ISPRS WG IV/1, WG VIII/1 and WG IV/3 on 'Geospatial Data Infrastructure and Real-time Services with special emphasis on Disaster Management', November 25 – 27, 2009, Hyderabad, India.
 13. N. Kiran Kumar, Ch. Patanjali Kumar, R.S. Mahendra, Sridevi Tiwaria, T. Srinivasa Kumar and B.V. Satyanarayana, "Interactive WebGIS Services For Tsunami Early Warning System". Joint International Workshop of ISPRS WG IV/1, WG VIII/1 and WG IV/3 on 'Geospatial Data Infrastructure and Real-time Services with special emphasis on Disaster Management', November 25-27, 2009, Hyderabad, India.
 14. Ch. Patanjali Kumar, Raghavendra S. Mupparthy, R.S. Mahendra, B Ajay Kumar, Prakash C. Mohanty, T. Srinivasa Kumar and Shilesh Nayak, "Decision support system and Standard Operating Procedure for Tsunami Early Warning Centre". Joint International Workshop of ISPRS WG IV/1, WG VIII/1 and WG IV/3 on 'Geospatial Data Infrastructure and Real-time Services with special emphasis on Disaster Management', November 25-27, 2009, Hyderabad, India.
 15. Siva Reddy, and M. Ravichandran, "Recent Trends in Sea Level over Indian Ocean", Joint International Workshop of ISPRS WG IV/1, WG VIII/1 and WG IV/3 on 'Geospatial Data Infrastructure and Real-time Services with special emphasis on Disaster Management', November 25-27, 2009, Hyderabad, India.
 16. R. Venkat Shesu, E. Pattabhi Rama Rao, and TVS Udaya Bhaskar, "A WebGIS interface for an integrated in situ Ocean Data and Information System", Joint International Workshop of ISPRS WG IV/1, WG VIII/1 and WG IV/3 on 'Geospatial Data Infrastructure and Real-time Services with special emphasis on Disaster Management', November 25-27, 2009, Hyderabad, India.

17. E. Pattabhi Rama Rao, TVS, Udaya Bhaskar, and R. Devender, "Web based Argo Data Services", Joint International Workshop of ISPRS WG IV/1, WG VIII/1 and WG IV/3 on 'Geospatial Data Infrastructure and Real-time Services with special emphasis on Disaster Management', November 25-27, 2009, Hyderabad, India.
18. T. Srinivasa Kumar, and Shailesh R. Nayak, "Geospatial Applications for Tsunami Early Warning", Joint International Workshop of ISPRS WG IV/1, WG VIII/1 and WG IV/3 on 'Geospatial Data Infrastructure and Real-time Services with special emphasis on Disaster Management', November 25-27, 2009, Hyderabad, India.
19. Sumisha Velloth, Mahendra R.S., Prakash C. Mohanty, Hrusikesh Bisoyi, Srinivasa Kumar T. and Shailesh Nayak, "Impact of the 2004 Earthquake on the Coral Environs using Remote Sensing and GIS: A case study of North Sentinel Island, Andaman", SAFARI International Symposium, Kochi, Feb 15-17, 2010.
20. Jemima U., Gayatri Dudeja. Venkat Shesu Reddem, Anil Kumar Vijayan, Aneesh A. Lotliker, Raghavendra S. Mupparthy, Srinivasa Kumar T., "A Framework for an Operational Ocean Color Data Processing Chain", SAFARI International Symposium, Kochi, Feb 15-17, 2010.
21. Anil Kumar Vijayan, Jemima U., Gayatri Dudeja, Aneesh A. Lotliker, Raghavendra S. Mupparthy, and Srinivasa Kumar T., "A Band Ratio Scheme For The Detection And Monitoring Of Algal Bloom Events In Arabian Sea", SAFARI International Symposium, Kochi, Feb 15-17, 2010.
22. Gayatri Dudeja, Jemima U., Anil Kumar Vijayan, Aneesh A. Lotliker, Raghavendra S. Mupparthy, T. Suresh, and Srinivasa Kumar T., "Comparison of Atmospheric Correction Schemes using MODIS – Aqua Data in the Arabian Sea". SAFARI International Symposium, Kochi, Feb 15-17, 2010.
23. Siingh Devendraa, Vimlesh Pant, A.K. Kamra, "The information of the background aerosols from the measurements of the coarse particle and ion-mobility spectra at Maitri (Antarctica)", IASTA Conference on 'Aerosols & Clouds: Climate Change Perspectives', March 24-26, 2010, Darjeeling, India.

9.13 Technical Reports

1. T V S Udaya Bhaskar, M. Ravichandran and E. Pattabhi Rama Rao. Mixed layer depth climatology for the Indian Ocean based on ARGO observations. INCOIS Technical Report No: INCOIS-DMG-ATLAS-02-2009, April, 2009.
2. Sudheer Joseph and M. Ravichandran (MOG). Delayed Mode Quality control of Indian Argo Floats. INCOIS Technical Report No: INCOIS-MOG-TR-01-2009, June, 2009.

9.14 Awards

INCOIS received the Special Achievement in GIS (SAG) Award at the 2009 ESRI International User Conference (ESRI UC) held in San Diego (CA, USA) during July 13-17, 2009. INCOIS received this honour for its vision, leadership, and innovative use of geographic information system (GIS) technology. INCOIS was selected from more than 300,000 organisations worldwide and recognized during SAG awards ceremony.

The Tsunami Early Warning System, INCOIS received the Special Jury Award of CSI-Nihilent e-Governance for 2008-09 under Project Category during the CSI Annual conference held at Pune on October 09, 2009.

Tsunami Early Warning Centre of INCOIS received the prestigious 'Disaster Mitigation Award-2009' by National Institute of Disaster Management (NIDM) during the Second India Disaster Management Congress at New Delhi on November 04, 2009.

Shri. E. Pattabhi Rama Rao, Head, DMG, INCOIS was awarded Certificate of Merit for 2008-09 in the field of Ocean Sciences for his significant contributions in Ocean Data and Information Management, during the MoES Foundation Day celebrations held at Vignan Bhavan, New Delhi on July 27, 2009.



Dr. S.S.C. Shenoi was elected as the fellow of National Academy of Sciences, India, Allahabad.



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