

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

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Director's Report



It is my privilege to present the annual report for the year 2007-08 highlighting the contribution towards providing data, information and advisories on ocean environment and resources.

Indian National Centre for Ocean Information Services (INCOIS) is continuing to play a vital role in the Indian Ocean region and has emerged as a knowledge and information technology enterprise for the ocean realm for societal benefit. Significant achievements are given below:

- i. A state-of-art Tsunami Warning System along with the Tsunami Early Warning Centre has been set up within stipulated time and cost. The Centre was inaugurated on October 15, 2007 by the Hon'ble Union Minister of Science & Technology and Earth Sciences, Shri Kapil Sibal. The Centre has monitored 165 tsunamigenic earthquakes and issued advisories. The tsunamigenic earthquake of September 12, 2007 was monitored and it was found that advisories were very accurate. The system has certainly increased resilience to tsunamis.
- The potential fishing advisories are being issued regularly. The advisories also use information on satellite derived sea surface winds. This has certainly improved the success rate of forecast. Efforts have been initiated to provide forecast for tuna fishery.
- iii. Open ocean state forecast for waves and swells is enabling safe marine operations and navigation. Such forecasts at 0.5 x 0.5 degree grid have been provided to fishery, offshore and shipping industry as well as Coast Guards and Indian Navy. Experimental forecast (0.25 x 0.25 degree grid) at 3 hourly intervals for next 10 days has been initiated. Location–specific forecast for Pondicherry is being continued.
- iv. Forecasting of sea surface temperature and currents has been initiated using the state of the art ocean models. Extensive validation of these parameters is under progress.
- v. INCOIS continued to deploy Argo floats, receives and analyse data from more than 400 floats for various studies on ocean circulation and heat budget that plays an important role in climate studies.
- vi. Organisation of heterogeneous and voluminous data from both in-situ and satellite platforms has been initiated. A metadata base has been prepared and is available to users.

- vii. INCOIS website is a unique site for providing data, information and advisories. About 2000 users routinely access website.
- viii. In order to support operational ocean information advisory services and ocean modeling activities, computational infrastructure facilities have been substantially upgraded.

Active collaborations with international organizations and research institutes are underway in the field of ocean modeling and coastal hazards.

I have received tremendous support for carrying out these activities from Dr. P.S. Goel, Chairman, Governing Council and members of GC, as well as Chairman and members of Research Council and officials of the Ministry of Earth Sciences. I am extremely grateful to them.

sportanyalk

(Shailesh Nayak) Director

1. The Organisation

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 2 3 4 5 6 7 8	Secretary, Ministry of Earth Sciences Director, National Remote Sensing Agency Joint Secretary, Ministry of Earth Sciences Advisor, Ministry of Earth Sciences Director, National Institute of Oceanography Director, National Institute of Ocean Technology Director, National Centre for Antarctic & Ocean Research Director, Indian National Centre for Ocean Information Services	President Vice-President Member Member Member Member General Secretary			
INCOIS Governing Council					
1 2	Secretary, Ministry of Earth Sciences Dr. Harsh Gupta, Raja Ramanna Fellow, National Geophysical Research Institute	Chairman Vice-Chairman			
3	Director, National Remote Sensing Agency	Member			
4	Director General, India Meteorological Department	Member			
5	Financial Adviser, Ministry of Earth Sciences	Member			
7	Indian Institute of Tropical Meteorology	Member			
8	Joint Secretary, Ministry of Earth Sciences	Member			
9	Director, National Centre for Antarctica and Ocean Research	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	President	
2	Prof. B.N. Goswami, Director, Indian Institute of Tropical Meteorology	Vice-President	
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	

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:

- (i) To establish Early Warning System for Tsunami and Storm Surges,
- (ii) To undertake, aid, promote, guide and co-ordinate research in the field of ocean information and services including Satellite Oceanography,
- (iii) To establish, maintain and manage, hire the systems for data acquisition, analysis, interpretation and archival for Ocean Information and Services,
- (iv) To carry out surveys and acquire information using satellite technology, ships, buoys, boats, any other platforms and remote sensors, generate information on fisheries, minerals, oil, biological, hydrological, bathymetry, geological oceanography, meteorology, coastal zone management and associated resources and island development, mangroves and associated coastal, forest, soils, wetlands, estuarine mapping, seabed and to undertake studies in marine archaeology, environmental monitoring of India and Antarctica and surrounding oceans and land masses,
- (v) To generate and provide data and value added data products to user communities in coastal and ocean areas using space, aerial and conventional sources,

- (vi) To establish Ocean data bank, including acquisition of all data obtained from satellite, air-borne sensors, ships, boats, buoys and field surveys, storage, retrieval, dissemination, evaluation, scrutiny, synthesis, analysis, interpretation of information and providing services and consultancy,
- (vii) To cooperate and collaborate with other national and international institutions in the field of ocean remote sensing, oceanography, atmospheric sciences/meteorology and weather forecasting centres, coastal zone management, usage of satellite data and data acquisition by all technologically possible means in all allied science fields, subject to that prior approval of the Ministry of Earth Sciences shall be obtained for collaboration with institutions abroad,
- (viii) To provide support to research centres for conducting investigations in specified areas related to oceanic parameters, ocean atmospheric interaction studies, coastal zone information, synthesis, analysis, data collection and undertake developmental work,
- (ix) To organise training, seminars and symposia for advanced study and research related to oceanographic parameters, related sciences and technology and in allied fields related to ocean information services,
- (x) 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, provided that dissemination of data is as per guidelines of the Government of India,
- (xi) To provide consultancy services in the fields of ocean information and services,
- (xii) To co-ordinate with all space agencies to ensure continuity, consistency and state-of-the-art quality of ocean data derived from satellite observations,
- (xiii) Generate data, data products, value added data products and market for coastal and ocean applications,
- (xiv) To encourage and support governmental and non-governmental agencies or organizations for furthering ocean and related programmes in the generation of ocean information, and
- (xv) To undertake all such other lawful activities as may be necessary, incidental or conducive to the attainment and furtherance of all or any of the above objects of the Society.

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.

INCOIS presently has twenty eight scientific and three administrative regular posts, eight research fellows and twenty seven project/contract positions. Further, human resources are being developed with focused groups in several premier institutions, especially for implementation of INDOMOD and SATCORE Projects. Outsourcing has been effectively followed for system/software maintenance, operation and maintenance of technical support facilities, house keeping, canteen, transport and security services.

The organization structure of INCOIS is as given below:



The organisation structure

2. Coastal and Ocean Advisory Services

2.1. Potential Fishing Zone Advisory Service

India has a 7,500 kilometre coastline and an exclusive economic zone (EEZ) of about two million square kilometres. About seven million people living along the coast are dependent on fishing for their livelihood. The locating and catching of fish, however, become increasingly challenging as fish stocks dwindle and move further offshore. This increases the search time, cost and effort involved. A reliable and timely forecast on the potential zones of fish aggregation would benefit the fishing community by reducing search time and the effort involved in locating fishing.

The Ministry of Earth Sciences, Govt. of India had formulated a programme to provide the fishing community with credible advisories on Potential Fishing Zones (PFZ). These advisories are generated by using satellite data of the entire coastline of the country in a mission mode with active participation of all stakeholders. This mission became part of the Common Minimum Programme (CMP) of the Government of India.

PFZ advisories are generated based on the features such as oceanic fronts, meandering patterns, eddies, rings, up-welling areas as seen on sea surface temperature (SST) and chlorophyll images. The integrated PFZ advisories prepared in local languages and local measurement units were disseminated thrice a week during non-ban and cloud-free days, through electronic display boards and information kiosks at the fishing harbours, Doordarshan, print media, emails and through INCOIS web site supplemented by fax and telephone. This is the only short-term forecast available to the fishing community of the country.

The significant achievements during the period under report are as follows:



Generation and dissemination of PFZ advisories

During the year, 749 PFZ advisories were generated and disseminated to thirteen sectors, i.e. Gujarat, Maharashtra, Karnataka, Goa, Kerala, South Tamilnadu, North Tamilnadu, South Andhra Pradesh, North Andhra Pradesh, Orissa, West Bengal, Andaman & Nicobar and Lakshadweep Islands on every Monday, Wednesday and Friday. The chart above provides the statistics about the number of forecasts provided to each sector.

Improvements in generation and dissemination

The following activities were initiated for improvements in generation and dissemination of PFZ advisory service:

- Experimental PFZ forecast with wind parameter
- Experimental Forecast for Tuna Fishery using SST, Chl, Kd-490, MLD, etc.
- Generation of Mosaic/ Binned products of Sea Surface Temperature (AVHRR), Suspended Sediment Concentration (OCM) and Yellow Substance (OCM)
- Initiated process for procurement of 50 new generation Electronic Display Boards with LCD Display Panel, small LED panel, two communication channels for redundancy, online broadcast of voice messages and playback of recorded messages, secured siren system with audibility up to 1 km, Intelligent Power Management System, etc.
- Pilot Project on Integrated GPS & Radio Information System for providing Location –Based Services

The following chart shows the improvement in the number of users of PFZ advisories from 2007-08 for all modes (e-mail, Web-GIS and Web Text) of dissemination.



Improvement in the total number of users of PFZ Advisories by all modes of dissemination (Web Text, Web GIS, E-mail and Electronic Display Boards)

Electronic Display Boards

Modified Electronic Display Boards with voice, siren and alert system to cater for dissemination of disaster information in addition to the PFZ information were installed at Paradeep, Penthakotha, Astaranga, Arjipalli, Bahabalpur, Chudamani, Talachuan, Kharanasi of Orissa State, Harne Paj, Malvan and Deogad in Maharashtra.

These boards are capable of remote updation through GSM/CDMA communication technology and transfer of recorded voice messages and online broadcast of voice messages. The siren system in the board can provide immediate alert to coastal community (around 1 km distance) during any disaster.

PFZ Validation Projects

- A review meeting of the projects on validation of Potential Fishing Zone Advisories was organized on April 13, 2007 at INCOIS. Experts from Fishery Survey of India, Space Application Centre (SAC), other Research Institutes and academia participated in the meeting. The meeting discussed about the benefits of PFZ advisories in terms of reduction in search time and Catch Per Unit Effort (CPUE). In Kerala, a reduction in searching time was found as 60-70 per cent for oil sardine and 30- 40 per cent for mackerel. The validation experiments results indicated that the catches in the PFZ area gave more CPUE and net profit compared to the results of operations in the non-PFZ Areas. Fishermen are willing to travel longer distances to get catch, when PFZ advisories are available. The experts also suggested for providing PFZ information, in accordance to the specific requirement of the user, at a cost as an additional value-added service.
- Four new PFZ Validation projects (in addition to the existing 7 projects) have been sanctioned to

 the School of Oceanographic Studies, Jadhavpur University for carrying out the validation
 experiments off the West Bengal coast, (ii) the Central Institute of Fishery Technology (CIFT),
 Kochi for carrying out the validation experiments off the Gujarat Coast. CIFT, Veraval Regional
 Centre will be coordinating the project at Gujarat, (iii) the Central Agricultural Research Institute
 (CARI), Port Blair for carrying out the PFZ Validation project in the Andaman Sea and (iv) the
 Karnataka University for carrying out PFZ Validation Project off Karwar for a period of two years.

Awareness Workshops and Field Campaigns

INCOIS has organised field awareness campaigns at various fishing harbours with active participation from fishermen for providing information on PFZ Advisory Service and the benefits of the PFZ to the fishing community, at the following places.

- Ennore Kuppam Fish Landing Center, Tamilnadu on August 05, 2007 with the active participation of 40 fishermen and
- Kovalam Fish Landing Center, Tamilnadu on August 26, 2007 with the active participation of about 60 fishermen.

User-interaction workshop were organized at the following locations

- Cutbona, Goa during June 2007
- Kovalam Kuppam, Tamilnadu on July 26, 2007 and on August 26, 2007
- Anjengo, Kerala on Jan 08, 2008
- Vettoor, Kerala on Jan 15, 2008
- Mariyanadu, Kerala on Jan 22, 2008
- Malvan, Sindhudurg Dist., Maharashtra on January 21, 2008.
- Thiruvanmiyur, Tamilnadu on March 03, 2008
- Varkala (Anchuthengu), South Kerala on March 15, 2008

User-interaction workshops were also organized at Vizhinjam in Kerala, Gilakaladindi, Giripuram, Satravapalem villages around Machilipatnam and Fishing Harbour and Jalaripeta of Visakhapatnam in Andhra Pradesh.

User-Interaction Workshop at Malvan, Sindhudurg Dist., Maharashtra on January 21, 2008

Electronic Display Board inaugurated at Malvan, Sindhudurg Dist., Maharashtra on January 22, 2008

User-Interaction Workshop on the dissemination of PFZ Advisories held at Kovalam Kuppam, Tamilnadu on July 26, 2007

Fishermen community participated in the Awareness campaign on the dissemination of PFZ Advisories held at Kovalam Kuppam, Tamilnadu on August 26, 2007

Awareness campaign on usefulness of PFZ to Purse Seine Boat Owners/ Boat Operators at Purse Seine Boat Owners Co-operative Federation, Cutbona, Goa during June 2007

Lecture on PFZ to at Regional Workshop organized by FSI at Agathi, Lakshadweep Islands during May 2007

2.2 Ocean State Forecast:

Reliable and timely forecast of the ocean state is vital to the shipping, fishery, offshore industries, ports and harbours as well as to navy and coast guard for the safe travel and to plan their operations in the sea. INCOIS has been providing the ocean state forecast using the state-of-the-art ocean models forced with atmospheric models and in-situ and satellite data. A team dedicated for this assignment is working on adapting various numerical models, fine tuning, validating and disseminating the Ocean State Forecast (OSF) information to the users from industry and academia.

Ocean state forecasts are given for open ocean and coastal region. Open ocean forecast information is useful for people operating at deep sea, such as the Indian Navy, and for people onboard research vessels. Coastal ocean forecast information is useful to all classes ranging from common man through industry, operating near coast.

Generation and Dissemination of Ocean State Forecast

Open Ocean Forecast:

INCOIS has been operationally providing forecast of wave, swell and wind parameters for next five days at six hourly intervals at 150 km spatial resolution for the tropical Indian Ocean. The new developments during this period are given below:

Improvements in the Open Ocean Forecast

- Open ocean wave forecast at 0.5 x 0.5 degree grid was initiated. Wave forecast model was setup in a 7-day forecast mode and forcing the same using forecast winds from European Centre for Medium-range Weather Forecasting (ECMWF). The forecast is provided for 7 days at 3 hourly intervals.
- Experimentation is underway for providing fine resolution open ocean forecast (0.25 x 0.25 degree) for next 10 days at 3 hourly intervals for the Arabian Sea, Bay of Bengal and the southern Indian Ocean (up to 60° S).

- Simulating Waves Near shore (SWAN) model was customized to accept buoy data along the three open ocean boundaries as boundary condition.
- Forecast data for the "ship track" was sent directly to the Coast Guard ship while their voyage to Japan for the period May 03, 2007 to June 22, 2007 on daily basis.

Validation of the forecast has been carried out using the significant wave height data from TOPEX satellite. Intense validation exercises are underway.

Significant Wave Height, Wave direction for Arabian Sea and Bay of Bengal (4th Oct, 2007, 00:00hrs)

Validation of Open Ocean forecast at different locations in Arabian Sea during SW Monsoon using TOPEX derived Significant Wave Heights (July 2007)

Validation of Significant Wave Height for the Cyclone 'Sidr' during Nov 11-16, 2007 using observed data from Moored buoy (DS4).

Coastal Forecast:

- Location Specific forecast activity was started on a pilot basis at Pondicherry, and the forecast information is disseminated to the users through various electronic media like All India Radio, Six television channels (twice daily), 20 Village Information Centers (thrice a day), Digital Display Boards and websites of NGO's. It is estimated that, about 25,000 population in the district of Pondicherry are expected to benefit out of this information.
- Forecast commenced for Tutucorin and Thirunelveli in Tamil Nadu.
- Wave-rider buoy has been deployed at Pondicherry and the wave height data is available real time at INCOIS on a regular basis and the same is used to compare the model generated wave height.
- Validation exercises are being carried out on a regular basis to check for the performance of the model.

Automatic Weather Station established at Pondichery to validate forecast winds.

Ocean State forecast broadcast through TV channels.

Inauguration of Ocean Information System at Pondicherry to Provide Present Sea State, Sea State Forecast, Fishery forecast and other information including warning through Digital display boards and 'Hello' FM radio.

Efforts for Nowcast and Validation

In collaboration with the National Institute of Oceanography (NIO), Goa, INCOIS has deployed a waverider buoy and a current meter in the Bay of Bengal, about 4 km off the coast of Pondicherry. The data obtained from the waverider buoy and the current meter would provide vital information required for the validation of various ocean state forecast products generated and disseminated by INCOIS and thereby improving services from the INCOIS. The data from the Waverider buoy is transmitted via Argos (received at NIO) and VHF set at Pondicherry Multipurpose Social Service Society (PMSSS) building. Awareness has been created among the local community, on protection of the oceanographic instruments deployed in ocean, through local church and Fishermen Panchayath. The President of the Fishermen Panchayath participated in the deployment exercise.

Waverider buoy and current meter deployed in the Bay of Bengal

The significant wave height and average wave period from the shallow water buoy SW7 was validated with the data from the waverider buoy for the period September 05-29, 2007. Significant wave heights match very well whereas average wave period show variations.

RMS error calculated using the data from wave rider buoys in coastal wave forecast for Pondicherry during Cyclone (Nov 12-21, 2007)

Improvements in Coastal Forecast activity

It is necessary to focus on improving the quality of the forecast and the following activities have been initiated.

- Fine tuning of the coastal forecast model for specified locations.
- Implementation of tidal current model.

User Interaction Workshops and Meetings

INCOIS has organized a user interaction workshop on ocean state forecast information at Pondicherry in collaboration with an NGO on December 11, 2007. The fishermen community got an opportunity to interact with INCOIS scientists to know about the ocean information system, safety and livelihood.

- The following user interaction meetings were with
 - * Officers of the Indian coast Guard at *ICG Priyadarshini* on dissemination and usage of Ocean forecast and information for Coast Guard on December 2007
 - * Officers of Naval Oceanographic Data Processing and Analysing Centre (NODPAC), Kochi and School of Naval Oceanography and Meteorology, Kochi on 31 March -01 April 2007 about coastal forecast products.
- In addition, interactions meetings were also held with officers from DG Shipping, Cairn Energy, Maharashtra Maritime Board, Gujarat Maritime Board, and Agha Khan Foundation at INCOIS.

Improvements in the OSF users.

The following chart shows the improvement in the number of users of Ocean State Forecast from 2005 to 2007.

Statistics of the OSF users during 2005 - 2007

2.3. Value Added Services

During the year INCOIS has taken up the following need-based user projects for coastal and offshore applications.

- Dispersal of the waste water flux in the Gulf of Kachchh for Tata Chemical Limited.
- Landuse classification for the Paradeep area in Mahanadi Deltaic Environs, Orissa Coast for Essar Steel Orissa Limited.
- Long-term and short term shoreline changes around the Kandaleru Creek, Krishnapatnam (Andhra Pradesh) coast for Krishnapatnam Port Authority.

• Wave simulations have been carried out for ten years (1998-2007) with an objective of finding out different wind/wave conditions for tanker berthing and loading through SPM buoy for Cairn Energy India Pvt. Ltd. The information provided on number of non-operational days for tanker berthing and loading in the said location.

Comparison between simulated and observed wave height as a part of consultancy project to M/s Cairn Energy India Pvt. Limited

 Gujarat Maritime Board (GMB) and Maharashtra Maritime Board (MMB) had approached INCOIS with a requirement of setting up Inland Vessel Limits for various port locations operating under them. INCOIS has agreed on providing forecast information on a daily basis.

3. Early Warning System for Tsunami and Storm Surges

Recognising the imperative to put in place an Early Warning System for mitigation of oceanogenic disasters that cause severe threat to nearly 400 million of our population that live in the coastal belt with devastation of life and property, and further driven by the national calamity due to the Indian Ocean Tsunami of December 26, 2004, the Ministry of Earth Sciences (MoES) has taken up the responsibility of establishing the National Tsunami Early Warning System. The Warning System has been established by MoES at a cost of Rs.125 Crore in collaboration with the Department of Space (DOS), the Department of Science and Technology (DST) and the Council of Scientific and Industrial Research (CSIR). The system was established as per schedule and within allotted funds.

Inauguration of Tsunami Early Warning Center at INCOIS

The Hon. Minister for Science, Technology and Earth Sciences, Shri. Kapil Sibal inaugurated the National Tsunami Early Warning System that has been set up at the Indian National Centre for Ocean Information Services (INCOIS), Hyderabad on October 15, 2007. Hon. Chief Minister of Andhra Pradesh, Dr. Y. S. Raja Sekhar Reddy has graced the occasion.

The Early Warning Centre receives real-time Seismic data from the national seismic network of the Indian Meteorological Department (IMD) and other International seismic networks. The system detects all earthquake events of more than 6 Magnitude occurring in the Indian Ocean in the less than 20 minutes of occurrence. Bottom Pressure Recorders (BPR) installed in the deep ocean are the key sensors to confirm the triggering of a tsunami. The National Institute of Ocean Technology (NIOT) has installed 4 BPRs in the Bay of Bengal and the 2 BPRs in the Arabian Sea. In addition, NIOT and Survey of India (SOI) have installed 30 tide gauges to monitor the progress of tsunami waves. Integrated Coastal and Marine Area Management (ICMAM) has customised and ran the Tsunami Model for five

historical earthquakes and the predicted inundation areas. The inundated areas are being overlaid on cadastral level maps of 1:5000 scale. These community-level inundation maps are extremely useful for assessing the population and infrastructure at risk. High-resolution coastal topography data required for modelling is generated by the National Remote Sensing Agency (NRSA) using Airborne Laser Terrain Mapper (ALTM) and Cartosat data. INCOIS has also generated a large database of model scenarios for different earthquakes that are being used for operational tsunami early warning.

Communication of real-time data from seismic stations, tide gauges and BPR's to the early warning centre is very critical for generating timely tsunami warnings. A host of communication methods are employed for timely reception of data from the sensors as well as for dissemination of alerts. Indian Space Research Organisation (ISRO) has made an end-to-end communication plan using INSAT. A high level of redundancy is being built into the communication system to avoid single point failures.

Communication facilities to receive data from seismic statins, tide gauges and BPRs in realtime

The state-of-the-art Early Warning Centre established at INCOIS with all the necessary computational and communication infrastructure enables reception of real-time data from all the sensors, analysis of the data, generation and dissemination of tsunami advisories following a Standard Operating Procedure (SOP). Seismic and sea-level data are continuously monitored in the Early Warning Centre using a custom-built software application jointly developed with M/s Tata Consultancy Services (TCS) that generates alarms/alerts in the warning centre whenever a pre-set threshold is crossed. Tsunami warnings/watches are then generated based on pre-set decision support rules and disseminated to the concerned authorities for action, following the SOP. The efficiency of the end-to-end system was proved during the large under-sea earthquake of 8.4 M that occurred on September 12, 2007 in the Indian Ocean.

The Early Warning Centre generates and disseminates timely advisories to the Control Room of the Ministry of Home Affairs for further dissemination to the public. For the dissemination of alerts to MHA a satellite-based virtual private network for disaster management support (VPNDMS) has been established. This network enables Early Warning Centre to disseminate warnings to the Ministry of Home Affairs (MHA), as well as to the State Emergency Operations Centres. In addition, messages will also be sent by phone, fax, SMS and e-mails to authorised officials. In case of confirmed warning,

Tsunami Early Warning Centre

the Early Warning Centre is being equipped with necessary facilities to disseminate the advisories directly to the administrators, media and public through SMS, e-mail, Fax, etc. The cyclone warning network of IMD and electronic ocean information boards of INCOIS could be effectively used for dissemination of warnings directly to the public.

R & D on Tsunami

With the main aim of understanding the tectonics, seismicity and paleotsunami history in the Andaman & Nicobar regions, INCOIS has initiated R & D efforts for detailed and integrated geophysical and geological studies in the region which will aid in better disaster preparedness.

A one day workshop was held at INCOIS on April 10, 2007 on reconstruction of historical tsunamis occurred in the Indian subcontinent. Several scientists from Physical Research Laboratory (PRL), Centre for Earth Science Studies (CESS), Anna University, Annamalai University, Cochin University of Science and Technology (CUSAT), Department of Science and Technology, National Geophysical Research Institute (NGRI), Jadavpur University, Manipur University, SASTRA University, Oil and Natural Gas Commission (ONGC) and Madras University were present. The need for an integral approach to be adopted including different methodologies such as paleo-siesmicity, sedimentary records and micro-paleontology for making best possible inferences about paleo-tsunami events was discussed during the workshop. This was followed by a one day workshop on Paleotsunami on January 02, 2008, to finalise various proposals.

3D GIS

A high resolution database on bathymetry, coastal topography, coastal land use, coastal vulnerability is being generated and updating as well as historic data base on tsunami to prepare tsunami hazard maps. Preliminary Surveys have already been conducted to acquire high-resolution bathymetry for a few vulnerable areas of the coastline. Preliminary maps have been prepared of coastal topography using CARTOSAT-1 stereo data for the Indian coast. 3000 sq km area has already been mapped with airborne LIDAR & Digital Camera data in conjunction with GPS control survey using photogrammetric techniques by the National Remote Sensing Agency (NRSA). These products have been used to prepare coastal vulnerability maps. Tunami N2 Model has been run for five historical earthquakes and

the predicted inundation areas are being overlaid on cadastral level maps of 1:5000 scale. These community-level inundation maps are extremely useful for assessing the population and infrastructure at risk. These maps will be provided using the web-GIS interface of the Application Software

The Integrated Tsunami Research and Information System (ITRIS) with high resolution bathymetry and coastal topography data sets along with 3D GIS models of buildings and infrastructure of vulnerable coastal regions will be used to estimate the possible inundation levels for a particular modeling scenario.

Capacity Building

Capacity building, education and training is one of the important components of this aimed at improving awareness and preparedness among public. Periodic workshops have been organized for the user community to familiarize them with the use of tsunami and storm surge advisories as well as inundation maps. Easily understandable publicity material on earthquake, tsunami and storm surges has been generated and will be distributed to the general public.

Capacity Building Workshop on Tsunami Early Warning System for the officials of the coastal states dealing with Disaster Management.

A capacity building workshop has been conducted during January 29-30, 2008 for the officials of State emergency departments from various coastal states of India. Officials from Gujarat, Maharashtra, Andhra Pradesh, Orissa, Andaman & Nicobar and Lakshadweep Islands participated in the Workshop. During the workshop the end to end functionally of Early Warning Centre and the interpretation of EWC message bulletins has been demonstrated.

4. Research and Modelling

4.1 Ocean Modelling

INCOIS continued ocean modelling activities essentially for

- Providing description of past, present and future state of ocean at appropriate time and spatial scales.
- Contributing to weather/monsoon/climate forecast by providing forcing for atmospheric models

- Understanding the variability of ocean and marine environment and
- Optimizing the marine observation system

Various steps involved in achieving these targets and significant accomplishments during the year are given below.

- Customize and set up the required ocean models.
- Make necessary changes such as mixing schemes used in the model, model physics, input forcing files, etc to simulate the observed climatological features.
- Conduct simulations with realistic forcing and validate the simulations with available observations.
- Assimilate available observations to obtain good initial conditions for the model for forecast simulations.
- Conduct hindcast experiments and validate the simulations with observations.
- Conduct forecast simulations in the experimental basis and validate the simulations with observations.
- Operationalize the forecasting system.

Modular Ocean Model (MOM) of GFDL customised for the Indian Ocean domain with high vertical (40 layers) and spatial resolutions (0.25 degree X 0.25 degree) was configured on SGI Machine with 6 processors. The following experiments and studies were carried out with MOM.

- Control experiments A set of idealized conditions (5, 10, 15 years).
- Studies on vertical mixing schemes (PP, KPP).
- Studies on the influence of Viscosity (1/2, 1, 2).
- With Just Horizontal Diffusion and No Neutral Physics.
- Studies on various Advection Schemes.
- Tidal forcing (a. just M2 tide, b. 8 main constituents).
- No Heat and Fresh Water Fluxes.
- Indonesian Through Flow (open & close).
- Real Time Wind Forcing, Heat flux and fresh water flux for the year 1990 to 2000.

Forced with Quikscat winds and heat flux for the year 2002-2005.

Experimentation with MOM

The Regional Ocean Model (ROMS) is being fine tuned for realistic simulations by introducing 32 vertical levels and MY2 mixing scheme in the model. The present set up had been spin up for 9 years. The model simulations with realistic forcing are being carried out.

- The study area is 30°–140°E and 30°S 30°N with 1 degree resolution.
- Issues on vertical temperature and salinity profile and high salinity in the Head Bay are addressed by introducing 40 vertical levels using MY2.5 vertical mixing scheme and monthly climatology of river discharge into the model respectively.
- Various experiments based on Regional Ocean Modelling System (ROMS) to understand the sensitivity of the model to different parameterizations/options have been conducted and considerable progress in understanding the problems in simulating the sea surface temperature is obtained.
- Fine tuning of Regional Ocean Model for realistic simulation is underway. Simulation for 1998 2006 was carried out and compared with available observational data sets. Model simulated the observed interannual and intraseasonal variations in the Indian Ocean, realistically.
- Studies on relationship between surface oceanographic parameters over Indian Ocean and the Indian summer monsoon rainfall work is under progress.
- Various experiments were conducted to understand the influence of forcing fields in the model simulations. It was concluded that the simulations using forcing from OMIP (Ocean Model Intercomparison Project) gave best results.

Surface currents Validation (Model Vs Observations)

SST Annual Mean Climatology Comparison

4.2 Indian Ocean Modelling and Dynamics (INDOMOD) Project

The Indian Ocean Modelling and Dynamics (INDOMOD) project focuses on ocean predictability and enabling climate predictability in a mission-mode with concomitant efforts in modelling, data assimilation and validation. The project envisages participation of several institutions, with a mission to enhance the basic understanding and knowledge base on oceanic and atmospheric processes and catastrophic weather events and improve operational prediction.

Twenty five proposals from Indian Institute of Science (IISc), Bangalore, Indian Institute of Technology (IIT-D), Delhi, Indian Institute of Technology, Kharagpur (IIT-Kgp),

Kharagpur, National Institute of Oceanography (NIO), Goa, Centre for Mathematical Modelling and Computer Simmulation (C-MMACS), Bangalore, Andhra University (AU), Visakhapatnam, Hyderabad University, Hyderabad, Cochin University of Science and Technology (CUSAT), Kochi, Annamalai University, Chennai, Jadavpur University, Jadavpur, Allahabad University. The proposal have been organizedd under the following modules

- Ocean and Climate (8)
- Coastal Oceanography (6)
- Bio-Geo-Chemistry (3)
- Ocean Observation (5)
- Hazardous Weather Events, Atlas and Computational (3)

4.3 Satellite Coastal and Oceanographic Research (SATCORE)

The integrated information of chlorophyll and sea surface temperature is being used to understand state of marine ecosystem. There are several satellite missions which provide information on chlorophyll and SST. In the recent IOGOOS IV meeting, the remote sensing based derived parameters have been identified as IOGOOS contributions to the coastal ocean. The satellite based retrieval of chlorophyll, SST, suspended sediments and transparency is being carried out under the Chlorophyll Global

Integrated Network (ChloroGIN) Project. The ChlorOGIN project aims at the network for distribution of chlorophyll and SST maps and in-situ measurements to the users.

This project is being executed along with National Institute of Oceanography (NIO), Goa University, Indian Institute of Tropical Meteorology (IITM), Mangalore University, Central Institute of Fishing Technology (CIFT) – Kochi, Centre of Advanced Study in Marine Biology (CASMB) - Annamalai University and Andhra University.

Significant progress has been made as part of this activity.

- Daily and monthly composite products of MODIS-derived Chlorophyll, TSM, k_d490 and SST data were processed and published on INCOIS website, regularly.
- A Red Tide Index (RTI) algorithm is being developed to detect harmful algal blooms in the Arabian Sea.

Eco-morphological Zonation of Coral Reef Health Monitoring

INCOIS is participating in Coral Reef Project funded by the Ministry of Environment and Forests (MoEF), Govt. of India, and coordinated by the Space Applications Centre (ISRO), Ahmedabad to study the coral reefs of India and the tasks include zoning the coral reefs eco-morphologically and to assess the health of reefs.

 Under this project, eco-morphological zonation of coral reefs of Andaman and Nicobar group of islands, Gulf of Kachchh, Gulf of Mannar, and Malvan, Maharashtra at 1:25,000 scale using onetime IRS LISS III / LISS IV data has been initiated at INCOIS.

Coral Reef Zonation Map prepared for the SOI Grid no 41F14SE

5. Observation Networks

Indian Argo Project

Indian National Centre for Ocean Information Services (INCOIS), India acts as Argo Regional Data Centre (ARC) for the Indian Ocean region. The Indian Argo Project has been implemented by the Indian National Centre for Ocean Information Services (INCOIS), Hyderabad jointly with the National Institute of Ocean Technology (NIOT), Chennai, and the Center for Atmospheric and Ocean Sciences (CAOS) of Indian Institute of Science, Bangalore.

Several R&D institutions, operational agencies including the National Institute of Oceanography, Goa, Space Applications Centre, Ahmedabad, National Remote Sensing Agency, Hyderabad, Indian Institute of Tropical Meteorology, Pune, National Centre for Medium range Weather Forecasting, New Delhi, Centre for Mathematical Modelling and Computer Simulation, Bangalore participate in the utilization of Argo data. Efforts are underway to encourage and enable academic institutions in this endeavour.

Argo Floats & Products

- Twenty four Argo floats (including 10 floats with oxygen sensors) were deployed in the Indian Ocean by India during the year.
- Total 85 out of 153 floats deployed by India are actively providing subsurface temperature and salinity data. All the active floats, data are received from Satellite Data Acquisition and Processing System at INCOIS, processed and disseminated to user agencies after real time quality control. 517 floats are actively providing data from the entire Indian Ocean.
- Updated the value added products viz. float wise (waterfall plots for Temperature and Salinity, time series plots for Temperature, Salinity, surface Pressure and bottom Pressure, Temperature vs Salinity, float trajectories) and objectively analysed monthly data products (Temperature, Surface Salinity, Geostrophic Currents at various levels, Mixed Layer Depth, depth of 20°C and 26°C isotherms, Isothermal Layer Depth, Heat Content up to 300mts, Dynamic Height, Sea Surface Height Anomaly) till March 2008 and published them on INCOIS web site.
- The trajectory data derived from 112 Argo floats were generated in net common data format (netCDF) format and uploaded to the Global Data Assembly Centre (GDAC) at IFREMER, France and USGODAE, USA.
- Grided data sets of Argo T/S profiles, Sea Surface Height Anomaly, TMI SST, Quikscat Winds is updated up to March, 2008 and these products are made available on INCOIS live access server (LAS).
- Temperature and Salinity Climatology for 19 levels was developed using Argo data and is available in netCDF format for the users.

Argo Data Utilisation

- Sensitivity studies related to the validation of AMSRE and TMI SST data ware carried out. The diurnal variability of SST along with the precipitation data was studied.
- The upper ocean thermohaline structure is observed before and during the passage of cyclone, using Argo float temperature and salinity profiles. Satellite derived surface parameters like sea

surface temperature (SST), precipitation and outgoing longwave radiation (OLR) data were used to compliment the study. More than thirty cyclones formed in the Indian Ocean during the period 2003-05 were analysed for upper ocean variability during cyclone genesis.

- Relationship between Indian Ocean surface oceanographic parameters and Indian summer monsoon rainfall was studied using satellite derived sea surface temperature and sea surface height anomaly.
- Argo/Altimeter based currents were integrated with Ekman currents derived from Quicksat winds for estimating total currents. Information on the available current meter data are being pooled for validation of the derived currents from Argo, Altimeter and Quicksat.

- Heat content in Indian Ocean was analysed for the period 1990 2006. The temperature at (0m, 100 m, 500 m and 2000 m) and heat content integrated up to (300 m, 500 m and 1000 m) were analysed with sea surface height anomaly. Trends and relation between temperature, heat content and SSHA are being analysed.
- Studied the Mixed Layer Depth (MLD) variability in the northern Arabian Sea based on daily data obtained from an Argo float (WMO 2900211).
- Studied the Sonic Layer Depth (SLD) variability in the central Arabian Sea monthly mean SLD obtained from temperature and salinity data for the period 2002 – 2006.

Time series of (a) MLD (blank squares, represent MLD from float and filled squares, represent MLD from objectively analysis product) (b) Wind Speed, (c) net surface heat flux along the float trajectory

Bay of Bengal Observations

The Bay of Bengal Cruise was organised to understand the upper ocean heat budget by conducting observations with CTD, hyper-spectral radiometer and other surface met flux measurements onboard ORV Sagar Kanya during Nov 10-23, 2007. Scientists from INCOIS, NIO, IISc, PMEL/NOAA, SAC and NCAOR participated in the cruise. During the cruise, ten argo floats, ten drifting buoys, two moored buoys (PMEL) and twenty two XBTs were deployed. The data collected during the cruise were utilized to study upper ocean behaviour of cyclone "Sidr".

Track of the Bay of Bengal Cruise onboard ORV Sagar Kanya (SK 242-A)

Other Observation System

During the year, 32 Drifting Buoys were deployed in the Indian Ocean, XBT observations were carried out along the major shipping lines and retrieved and redeployed the Equatorial Current Meter Mooring Arrays.

6. Computational Facility and Ocean Information Bank

6.1 Computational Infrastructure

The computational facilities of INCOIS comprising high-end UNIX servers, UNIX workstations, Windows 2000 servers, Windows 2000 workstations, Enterprise Storage Server, Pentium IV Desk Top Systems and peripherals connected using both fibre and Gigabit Ethernet network were utilised fully, and in some cases round-the clock.

Other major achievements during the year:

• Tsunami Early Warning Data Centre has been established at INCOIS by setting up of state-ofthe-art ICT infrastructure (IBM p590, p570 Servers, CISCO / RADWARE Network, etc)

Computational facilities at Tsunami Early Warning Centre

- An Itanium based SGI Altex machine with 80 processors is being added as pre processing system to support the ocean modeling activities.
- Technology refreshment of existing IBM hardware with state-of-the-art processors is being implemented.
- Initiated efforts to establish High Performance Computing Facility at INCOIS for ocean modeling & data assimilation activities.
- M/s IBM provides Facility Management Services and Comprehensive Annual Maintenance of IT infrastructure at INCOIS for three years starting from April 01, 2008.

INCOIS utilised for its operational and developmental studies, a wide range of software packages including:

a) Standard packages such as ERDAS, ENVI and E-Cognition (for image analysis), Arc/Info, Arc SDE and Arc IMS (for GIS), Oracle 9i (for RDBMS), MATLAB (for data processing and analysis), Websphere (for web server), MS Exchange, etc.

- b) Customised packages from SAC/RRSSC for OCM data processing and analysis and SST processing software
- c) Customised packages from SAC/IIT-D for WAM3GC Model, Price 1D Model and SST forecast
- d) Tidal Circulation model developed by NIO for the Gulf of Khambat
- e) Freeware for Ocean General Circulation Modelling (POM and MOM-4)

Web-based services

INCOIS Website (www.incois.gov.in) matured as a prime vehicle for delivery of ocean data, information and advisory services especially in the areas of (i) Potential Fishing Zone, (ii) Indian Ocean Argo Project, (iii) Ocean State Forecast and (iv) IOGOOS. The web-based multi-lingual on-line information delivery system with Web-GIS capability enables the users to query, analyse, visualise and download ocean data, information and advisories for their regions of interest. This has been widely used website among wide spectrum of users.

The content updation of INCOIS Website was carried out and several new web pages were developed. INCOIS has initiated the development of data warehouse and data mining facility to improve the functionality of the website and maintain a centralised repository of enterprise data. The data base was designed using Oracle data warehousing tools for managing in-situ as well as remote sensing data. The GIS-based interface for selection and retrieval of data from various observing platforms in the Indian Ocean was developed.

6.2. Ocean Information Bank

Ocean Information Bank is the one stop shop for providing information on physical, chemical, biological and geological parameters of ocean and coasts on spatial and temporal domains that is vital for both research and operational oceanography.

Ocean Data and Information System (ODIS), an end-to-end data base management system is being developed for providing web-based data services. The ODIS is supported by the data received from both the in-situ platforms and satellites, Global Telecommunication System (GTS), Project/Experiments funded by the Ministry of Earth Sciences, data from the other sources (web) and the historical data

exclusively retrieved for the Indian Ocean from historical data sets viz., World Ocean Data Base 2005 (WODB), World Ocean Circulation Experiment, etc.

Significant achievements during the year are as follows:

- Ocean Information bank was updated with the data from moored buoys in real time and remote sensing data from AVHRR (NOAA-17,18) and MODIS (Aqua and Terra) are being received in real time. Data products, viz. SST, chlorophyll, aerosol optical depth, clouds, etc. are being generated in real time and published on INCOIS web site.
- Connectivity has been established with the India Meteorological Department (IMD) for acquiring the met-ocean data, sea level data in real time from the Global Telecommunication System (GTS).
 Developed software application data extraction from GTS, loading into data base and web-interface for data delivery.
- Automated the data extraction and storing in to data base for the data received from drifting buoys through e-mail.

Display of Moored Buoy data and Remote Sensing data in real-time on INCOIS website

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Metadata base

Web-interface for the COMAPS datasets

- Metadata base was generated for moored buoys, drifting buoys and XBT data sets.
- Application software was developed for (a) real-time quality control check of the moored buoy data and storing the data into data base (b) quality control of the current meter data and storing the data into data base.
- Data base has been generated for the data received from moored buoys, drifting Buoys, XBT and current meter mooring array.
- Real time data display system was developed for the moored buoy data, remote sensing data and also a web-interface for COMAPS data query and display system.

INCOIS plans to strengthen the ocean information bank with the data generated from the chain of marine data centres, MoES institutions, academia, etc. by networking of these centres and enabling them on the INCOIS web-site with appropriate access privileges.

Apart from serving as a national repository of marine data, the INCOIS as the National Oceanographic Data Centre from India, also acts as national contact point for the International Oceanographic Data and Information Exchange (IODE), and Global Ocean Observing System (GOOS)-programmes of Intergovernmental Oceanographic Commission (IOC).

7. Infrastructure Development, Operations and Maintenance

INCOIS is functioning from its permanent campus developed at Hyderabad in a 50 acre land with state-of-the-art facilities and the right ambience for an S&T institution. Acquisition of adjacent land is under progress. Initiated the planning and tendering process for extension of INCOIS building, residential quarters, guest house and hostel accommodation.

The Board Room in the Conference Block was furnished with necessary equipment.

INCOIS was dedicated to the nation by Shri. Kapil Sibal, Hon. Minister for Science and Technology and Earth Sciences on October 15, 2007

8. INCOIS in the International Scene

8.1 Intergovernmental Oceanographic Commission (IOC): India is the founder member of IOC and also a Member of the Executive Council. Director, INCOIS participated in the 24th Session IOC Assembly at Paris, France during June 19-28, 2007.

8.2 Regional Alliance in Indian Ocean for GOOS (IOGOOS): INCOIS, as the Secretariat for IOGOOS till 2008, has been effectively leading IOGOOS that has taken a place of pride among such GOOS Regional Alliances. Since its formal launch at the First Indian Ocean Conference held in Mauritius on November 05, 2002, IOGOOS membership has grown from 19 to 25 institutions from 15 countries. Some of the major initiatives of IOGOOS are (i) the 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 Capacity Building Strategy, (iv) Prawn Pilot Project, (v) Keystone Ecosystems Project, (vi) Shoreline change monitoring project, etc. IOGOOS members have played a key role in Argo deployments and enhancing the tropical moored buoy array.

Major accomplishments of IOGOOS during the year are as follows:

 IOGOOS Secretariat coordinated and arranged the IOGOOS Workshop, 5th Annual Meeting (IOGOOS-V) and High Level meeing of the representatives of the countries putting observation systems in the region at Phuket, Thailand during Nov 30 – Dec 03, 2007.

IOGOOS-V Meeting and Second High-Level Review Meeting of Indian Ocean Panel held at Phuket, Thailand

8.3 International Argo Project: International planning for Argo programme is coordinated by the International Argo Steering Team (IAST). Director, INCOIS is the Member of IAST and also the Regional Coordinator for the International Argo Programme in Indian Ocean. INCOIS has been identified as the Regional Argo Data Centre for the Indian Ocean region. Regional Argo Data Centre has been set up at INCOIS and Basin-level Coordination is being implemented by INCOIS.

8.4 Partnership for Observation of Global Ocean (POGO):

Partnership for Observation of Global Ocean (POGO) is an international network of major oceanographic institutions in the world and established to promote and enhance the implementation and integration of global oceanographic activities. As of now, POGO has 26 institutional members from 16 countries. INCOIS is the Member of POGO since 2004 and Director, INCOIS is the Executive Committee Member of POGO from 2006 onwards.

9. General Information

9.1 Deputations

Official	Meeting/Conference/Training	Period
Dr. Shailesh Nayak	8 th Meeting of I-GOOS during and the 24 th Session IOC Assembly at	Jun 13-16, 2007 Jun 19-28, 2007
	Annual Joint Meeting of the Technical Committee IV on Geo-databases and Digital Mapping of International Society of Photogrammetry and Remote Sensing (ISPRS)	Aug 21-25, 2007

	Workshop on 'The User and GEOSS Architecture XVII Earth Observation to benefit Tsunami' Kuala Lumpur, Malaysia	Nov 13-15, 2007
	IOGOOS Workshop, 5 th Annual Meeting (IOGOOS-V) and High Level meeting of the representatives of the countries putting observation systems in the region at Phuket, Thailand	Nov 30 – Dec 3, 2007
	Participated in the meeting of 'Working Group on the future of Intergovernmental Oceanographic Commission'.	Feb 18-22, 2008
Dr. M. Ravichandran	4 th Indian Ocean Panel (IOP) meeting at Pretoria, South Africa	Apr 23-25, 2007
	IOGOOS Workshop, 5 th Annual Meeting (IOGOOS-V) and High Level meeting of the representatives of the countries putting observation systems in the region at Phuket, Thailand	Nov 30 – Dec 3, 2007
	Participated in 9 th Argo Steering Team (AST-9) held at UK Met Office (UKMO), Exeter, UK .	Mar 17-20, 2008
Shri. T. Srinivasa Kumar	ICG-IOTWS Working Group 5 Task Team meeting held at Melbourne, Australia	Jun 05 – 07, 2007
	The intensive 2 week certificate programme on 'Tsunami Science and Preparedness' at University of Washington, Washington, USA	Jul 21, 2007 – Aug 02, 2007
	IOGOOS Workshop, 5 th Annual Meeting (IOGOOS-V) and High Level meeting of the representatives of the countries putting observation systems in the region at Phuket, Thailand	Nov 30 – Dec 03, 2007
	Participated in the meeting of the International Ocean Colour Coordinating Group (IOCCG) at Paris, France.	Feb 12-14, 2008
Shri Ch. Patanjali Kumar	UNESCO-IOC Training Course on "Tsunami Numerical Modelling Course – II – Tsunami Inundation Modelling", Bangkok, Thailand	Jun 29, 2007 to Jul 06, 2007

Dr. Sudheer Joseph	The Argo Data Management Meeting at Hobart, Australia.	Nov 10-18, 2007
Mr. T V S Udaya Bhaskar	The Argo Data Management Meeting at Hobart, Australia.	Nov 10-18, 2007
Mr. B. Ajay Kumar	Attended an intensive academic program leading to certification in "Tsunami Science and Preparedness" at Asian Institute of Techonology in Bangkok, Thailand.	Mar 10-26, 2008

9.2 Memorandum of Understanding

9.2.1 MoU with Nansen Environmental and Remote Sensing Center (NERSC)

 An agreement was signed between the Nansen Environmental and Remote Sensing Center (NERSC) and the University of Bergen (UoB), The agreement is expected to be the foundation for an extensive scientific cooperation, and exchange of scientists and research scholars in the coming years.

9.2.2. MoU with Asian Disaster Preparedness Centre (APDC), Thailand

Memorandum of Understanding (MoU) has been signed between the Asian Disaster Preparedness Centre (ADPC) of Thailand and the Indian National Centre for Ocean Information Services (INCOIS) on 12th February, 2008 to establish linkages between the two institutions for early warning arrangement, preparedness and mitigation of coastal hazards, especially for tsunami early warning.

9.3 INCOIS Lecture Series

- Prof. Julian P. McCreary, Jr., Director, International Pacific Research Center (IPRC) and Professor of Oceanography, School of Ocean and Earth Science & Technology, University of Hawaii, Hawaii, USA delivered a lecture on 'Dynamics of Indian Ocean Circulation' on October 1, 2007
- Prof. Vinod K. Gaur, Distinguished Professor, Indian Institute of Astrophysics, Bangalore delivered a lecture on 'Physical and dynamical basis of climate variability' on September 20, 2007
- Dr. Baldev Sahai, Former Deputy Director, SAC, ISRO delivered a lecture on "Vedic Saraswati" on 17th April 2007.

9.4 Meetings

- Second meeting of the Research Advisory Committee of INCOIS was held on Aug 14, 2007 at INCOIS.
- Joint Steering Committee for INDOMOD-SATCORE, ARGO and Tsunami Projects was held on Aug 17, 2007 at INCOIS.
- The eleventh meeting of the INCOIS Finance Committee (FC-11) was held on November 23, 2007 at INCOIS.
- The Parliamentary Standing Committee on Science & Technology, Environment and Forests visited INCOIS on the December 19, 2007.

Parliamentary Standing Committee visit to INCOIS

- Second Meeting of the ICG/IOTWS Working Group 5 Task Team on Development of implementation plan for an interoperable system for provision of tsunami watches in the Indian Ocean, held at INCOIS on February 05-07, 2008.
- The 13th Meeting of INCOIS Governing Council and the 2nd meeting of INCOIS Society were held on Feb 29, 2008 at MoES, Delhi.

9.5 Publications

9.5.1 Papers published in Journals

• Francis P. A., Sulochana Gadgil and Vinayachandran. P. N., Triggering of the positive Indian

Ocean dipole events by severe cyclones over the Bay of Bengal, Tellus (2007), 59A, 461-475.

- Nayak S., Srinivaskumar T., and Nagarajakumar M., Satellite-based Fishery Service in India, "The Full Picture" Group on Earth Observation (Social Benefits Area – Agriculture), p. 256-257, ISBN 978-92-990047-0-8, Geneva, Switzerland.
- Udaya Bhaskar. T.V.S., Swain. D., and Ravichandran. M., Mixed Layer Variability in Northern Arabian Sea as Detected by an Argo Float, Ocean Science Journal, Vol. 42 No. 4, 241-246(2007).
- Sulochana Gadgil,, Rajeevan. M., and Francis. P. A., Monsoon variability: Links to major oscillations over the equatorial Pacific and Indian oceans, Current Science, Vol. 93, NO. 2, 25 July 2007, p. 182 194.
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- R.R.Rao., Girish Kumar M.S., Ravichandran M., Gopalakrishna V.V., Thadathil P.A., Cold pool south of Indo-Sri Lanka channel and its intrusion into the South eastern Arabian Sea during winter, Deep Sea Research Part I: Oceanographic Research Papers, Vol. 55, No. 8, p. 1009-1020.
- Gopalakrishna V V., Rao R.R., Nisha K., Girishkumar M.S., Pankajakshan T., Ravichandran M. Johnson Z., Girish K., Aneeshkumar N., Srinath M., Rajesh S., and Rajan C.K., Observed anomalous upwelling in the Lakshadweep Sea during the summer monsoon season of 2005, Journal of Geophysical Research (Ocean) 113, C05001, doi:10.1029/2007JC004240.

9.5.2. Conference / Symposium Proceedings

- Jaiswal R.K. and Santosh Mishra, Seismic Instrumentation: Indian Perspective, 7th International, Conference & Exposition on Petroleum Geophysics "Hyderabad 2008", P385, p.1-6.
- Anitha Gera, Ravichandran M. and Sengupta D., Intraseasonal Heat and Fresh Water changes in Bay of Bengal, Proceedings of International Conference on "Celebrating the Moonsoon".
- Nayak S., and Pattabhi Rama Rao E., Ocean Observations to Services, National Symposium on "Emerging Trends in Meteorology and Oceanography (METOC-2007), p. 7 – 11.
- Swain D., Udaya Bhaskar TVS. and Ravichandran M., Mixed Layer Depth Variability in the Western Indian Ocean from Argo Observations, National Symposium on "Emerging Trends in Meteorology and Oceanography (METOC-2007), p.119 -123.
- Udaya Bhaskar TVS., D Swain and Ravichandran M., Sonic Layer Depth Variability in The Arabian Sea, National Symposium on "Emerging Trends in Meteorology and Oceanography (METOC-2007), p. 125-128.

9.5.3. Technical Reports

Sudheer Joseph and Ravichandran M., Indian Argo Project - Oxygen Floats: Part-A: Matlab software for Data decoding & Dissemination, Part-B: The Data Comparison with Climatology, Report No: INCOIS-ISG-OSF-TR-02-2007, Date: 12 April 2007

- Udaya Bhaskar T.V.S., Devender. R, and Ravichandran M., Data Processing. Report No: INCOIS-MOG-ARGO-TR-03-2007, Date: 27 April 2007.
- Udaya Bhaskar T.V.S., Ravichandran M. and Devender R, An operational Objective Analysis system at INCOIS for generation of Argo Value Added Products, Report No: INCOIS-MOG-ARGO-TR-04-2007, Date: 27 April 2007
- Srinivasa Kumar T., Nagaraja Kumar M., Padmaja, Naga Swetha, Nayak S., Mane.U. H., Subramanian. S., Radhakrishnan. K. V., Narayana Pillai. V., Anil Kumar. N.C., Nammalwar Rajan. P., Gopala Reddy. K. and Kumar. P. Validation of Potential Fishing Zone (PFZ) Advisories (2006 – 2007), Report No: INCOIS-ASG-PFZ-TR-08-2007, Date: 29 August 2007
- Data and Information Management Group, INCOIS, Ocean Data and Information System, INCOIS-DMG-DM-TR-01-2008, February 2008.
- Balakrishnan Nair, T. M, Annapurnayya, K. Sandya K. G, Kali Prasad, Rakhi Kumari and Shailesh Nayak (2008). Report on Wave/Wind Categorization Off Bhogat on Arabian Sea Coast, Report No: INCOIS-ISG-OSF-TR-02-2008, March 05, 2008.
- Anitha Gera and Ravichandran M., Indian Argo Trajectories and Surface Currents, Report No: INCOIS-MOG-ARGO-TR-03-2008, March 13, 2008.

10. Finance

The Report of the Auditors and Audited Accounts of INCOIS for the year 2007-08 are placed as Appendix-1 to this Report.

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