



Dr. Harsh Vardhan
Hon'ble Union Minister for
Ministry of S & T and
Ministry of Earth Sciences

Ministry of Earth Sciences Earth System Science Organisation Government of India



Sh. Y.S. Chowdhary
Hon'ble Minister of State
for Ministry of S & T and
Ministry of Earth Sciences



E-Book on Recent Achievements December, 2014

www.moes.gov.in

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Foreword

The prime objective of the governance is to ensure an effective and efficient public service delivery system so that the benefits of Government policies and programmes reach all concerned.

Towards this effort, the Government of India has started publishing E-books showcasing their major activities and accomplishments for empowering the underprivileged by efficient and intelligent use of social media and multi-media tools, create awareness about assistance available from Government through its various schemes/programmes and also provide opportunities for availing of the benefits of such schemes/programmes.

We are very glad to present the very recent accomplishments from the various initiatives of the Earth System Science Organisation (ESSO) of the Ministry of Earth Sciences through the E-Book Platform.

We shall be very happy to account for any feedback and suggestions communicated to us.

31st December 2014
NEW DELHI.

Dr. Harsh Vardhan
Hon'ble Union Minister for
Ministry of S & T and
Ministry of Earth Sciences

वाई एस चौधरी
Y S CHOWDARY



राज्य मंत्री
विज्ञान और प्रौद्योगिकी एवं पृथ्वी विज्ञान
भारत सरकार
नई दिल्ली-110001
MINISTER OF STATE FOR
SCIENCE & TECHNOLOGY AND EARTH SCIENCES
GOVERNMENT OF INDIA
NEW DELHI - 110001

New Delhi, 10th February, 2015

MESSAGE

India, as an emerging knowledge super-power, shall have to be opening a window for dissemination of its technical skills in rendering knowledge-based services through various systems/solutions - IT, communication, satellite remote sensing, mapping etc., for an integrated multi-hazard early warning and decision support systems.

I am delighted to note that India is also offering a strategic and leadership role in Indian Ocean Region as Regional Specialized Meteorological Centre (RSMC) for cyclone warning and as Regional Tsunami Watch Provider (RTWP). I compliment the Ministry of Earth Sciences for building such world class and widely acclaimed services for minimizing the loss of life and for planning effective emergency response for minimizing the loss of property and life line infrastructure.

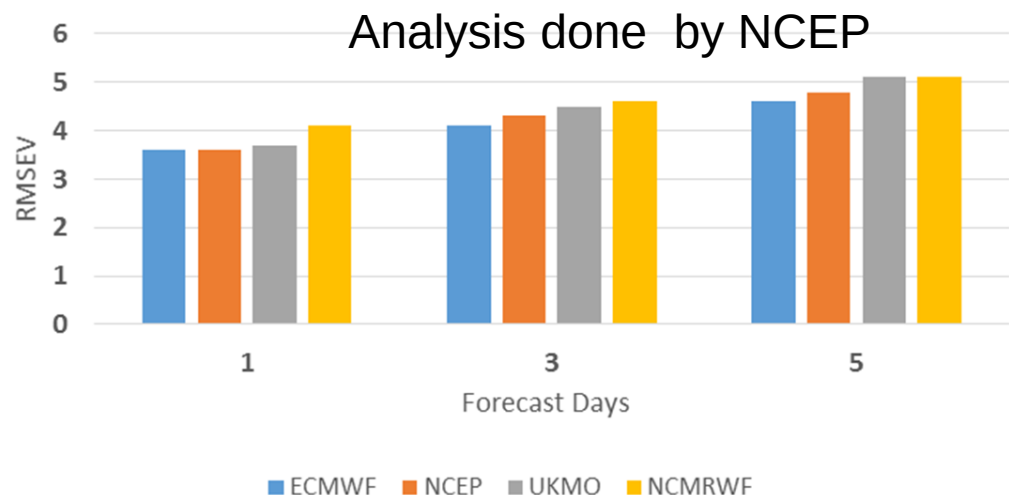
This E-book is an endeavour to showcase the professional service quality enhancements accomplished by India in recent times, for wider communication and better utilization.

(Y S CHOWDARY)

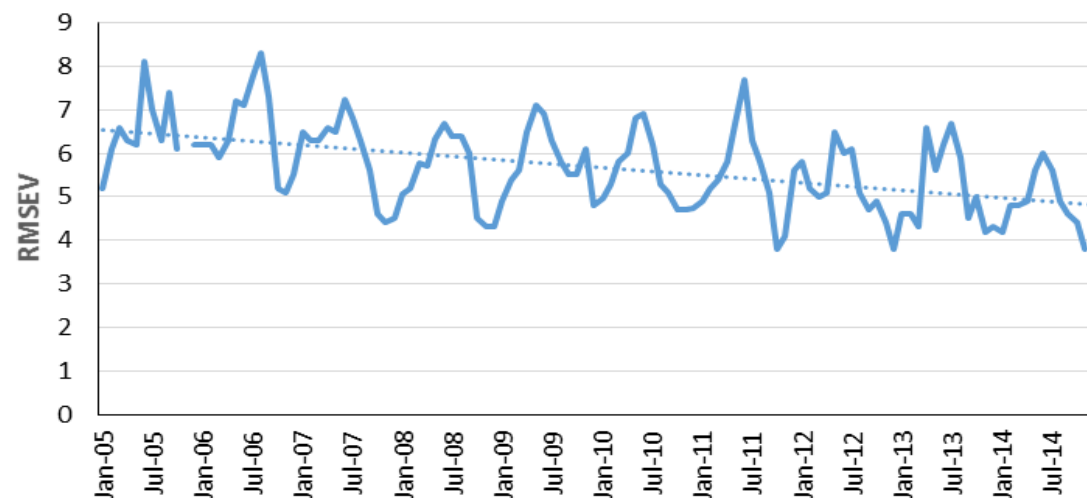
Weather Forecasting including Monsoon

Improvement in Weather Forecasts

Verification of forecasts against observations over tropics
850 hPa winds - December 2014



Verification of Day 03 forecasts against Radiosondes over India
Root Mean Square Error of 850 hPa Winds (m/s)



- This improvement in forecast of winds (input to models) was achieved through
 - Augmentation of observing systems including surface air, upper air, land surface, ocean, satellite and radar observations.
 - Development of advanced technology for assimilation of new observations in high resolution numerical weather prediction models (from 2 to 30 GB per day) made possible through High Performance Computing System (HPC).
 - Improved understanding of physical processes and development of advanced models.
 - Integration of scientific programs related to atmosphere, ocean, cryosphere and geosphere .

Monsoon Forecast

Review by the
Hon'ble Prime Minister
triggered series of contingency
measures

All India Monthly forecast for July & August
was predicted accurately.

All India	July	August	Aug-Sep
9 th June	93%	96%	95 %
August	-	96%	95 %
Observed	90 %	90 %	97 %

All India Seasonal forecast was predicted below Normal

Forecast Date	All India	NW India	Central India	Peninsular India	NE India
April	95 %	-	-	-	-
9 th June	93 %	85 %	94 %	93 %	99 %
9 th August	87 %	76 %	89 %	87 %	93 %
Observed Rainfall	88 %	79 %	90 %	93 %	88 %

The onset of Monsoon over Kerala was predicted accurately.

	Forecast Date	Actual Date
Monsoon Onset date over Kerala	June 5	June 6

WEATHER SERVICES FOR AMARNATH & MATA VAISHNO DEVI YATRAS

- 6 Automatic Weather Station (AWS) at (Phalgam, Chandanwari, Sheshnag, Panjtarni, Baltal & Holy Cave) have been installed.
- Route forecast from Jammu up to Holy Cave for both the routes (Baltal & Phalgam) provided at 0400h (M) & 1700h (E) at base camps at Baltal and Phalgam through display boards.
- Dedicated Web Page for the Amarnath Yatra and the Mata Vaishnodevi which contains
 - **Route wise forecast (Jammu to Katra to Bhavan).**
 - **Forecast issued twice daily separately for Amarnath Yathra and Mata Vishno Devi Yatra**
 - **Nowcast for Katra & Bhavan**
 - **Current observations**
 - **Satellite images & NWP products**
- Forecast Updates are provided on exigency through e-mail/SMS/Fax.

[Mata Vaishno Devi Yatra Forecast](#)

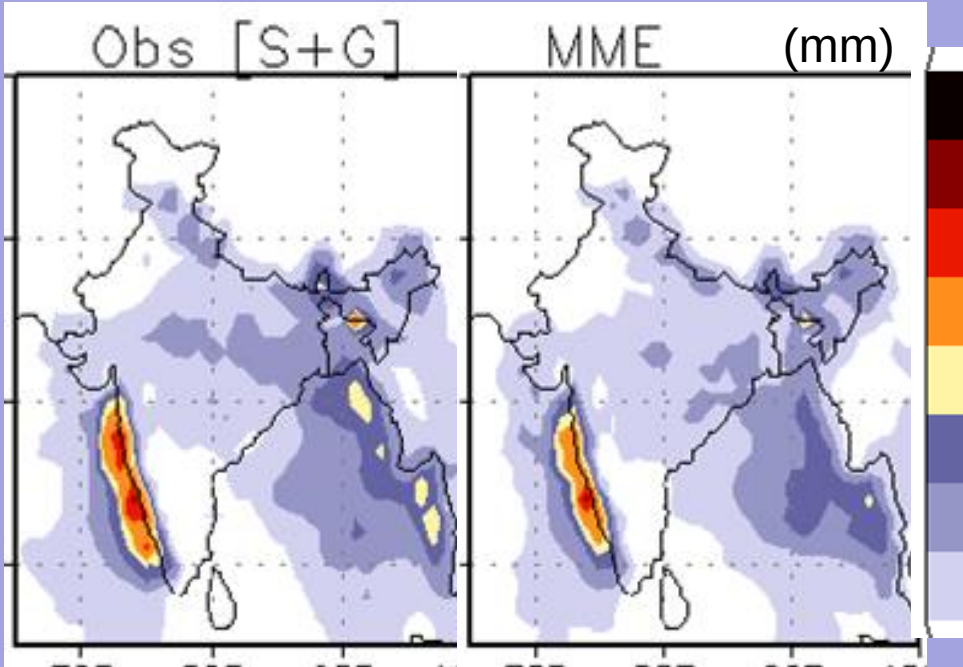
[Mountain Weather Forecast](#)

[Forecast for Tourists](#)

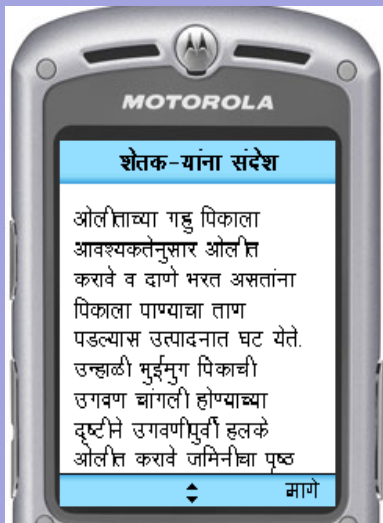
[Highway Forecast](#)



District Level Forecast & Agro-Met Advisories



- Based on Multi-Model Ensemble (MME), forecast issued for 596 districts (Rainfall, Max and Min temp., Total cloud cover, Surface Relative humidity & Wind). Accuracy: 70-75 %.
- Bi-weekly Agromet Advisory Bulletins (608 districts). State and national level composite advisories also issued. Advisories at block level to be initiated.
- Dissemination: Print, Radio, TV, Web, Mobile. 7 Million farmers use mobiles. About 50 % farmers are using the advisories.
- Estimated Contributions to National GDP Rs. 50,000 crores.



[Live Advisory](#)

City Weather Forecast

[Live Forecast](#)

- Covers 324 major cities and tourist locations
- Updated 2 times a day and contains
 - Daily weather observations
 - Forecasts for Temperature (Min. & Max.), Weather outlook (rainfall, fog, clear sky etc.) for next 7 days
 - Last 7 days temperature trend
 - General monthly climatology
 - Climatology of extreme weather events
 - Available on SMS as well



Local Weather Report and Forecast For: Safdarjung Dated :Dec 18, 2014

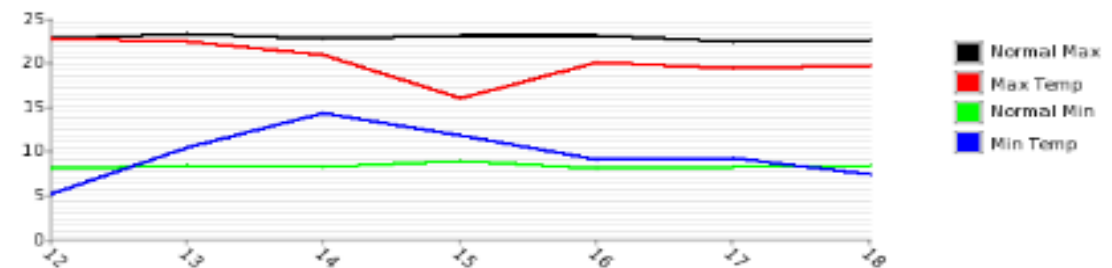
Delhi		Past 24 Hours Weather Data	
	Maximum Temp(°C)	19.6	
	Departure from Normal(°C)	-3	
	Minimum Temp (°C)	7.4	
	Departure from Normal(°C)	-1	
	24 Hours Rainfall (mm)	NIL	
	Today's Sunset (IST)	17:29	
	Tomorrow's Sunrise (IST)	07:08	
	Moonset (IST)	14:37	
	Moonrise (IST)	04:05	

Today's Forecast: MAINLY CLEAR SKY.FOG IN THE MORNING.THE MAXIMUM TEMPERATURE WOULD BE AROUND 19 DEGREE CELCIUS .

Date	Temperature (° C)		Weather Forecast	
	Minimum	Maximum		
19-Dec	8.0	20.0	fog	Fog
20-Dec	8.0	20.0	fog	Fog
21-Dec	8.0	20.0	fog	Fog
22-Dec	10.0	20.0	fog	Fog
23-Dec	8.0	20.0	fog	Fog
24-Dec	8.0	20.0	fog	Fog

IMD

Weekly Variation Temp for :Safdarjung

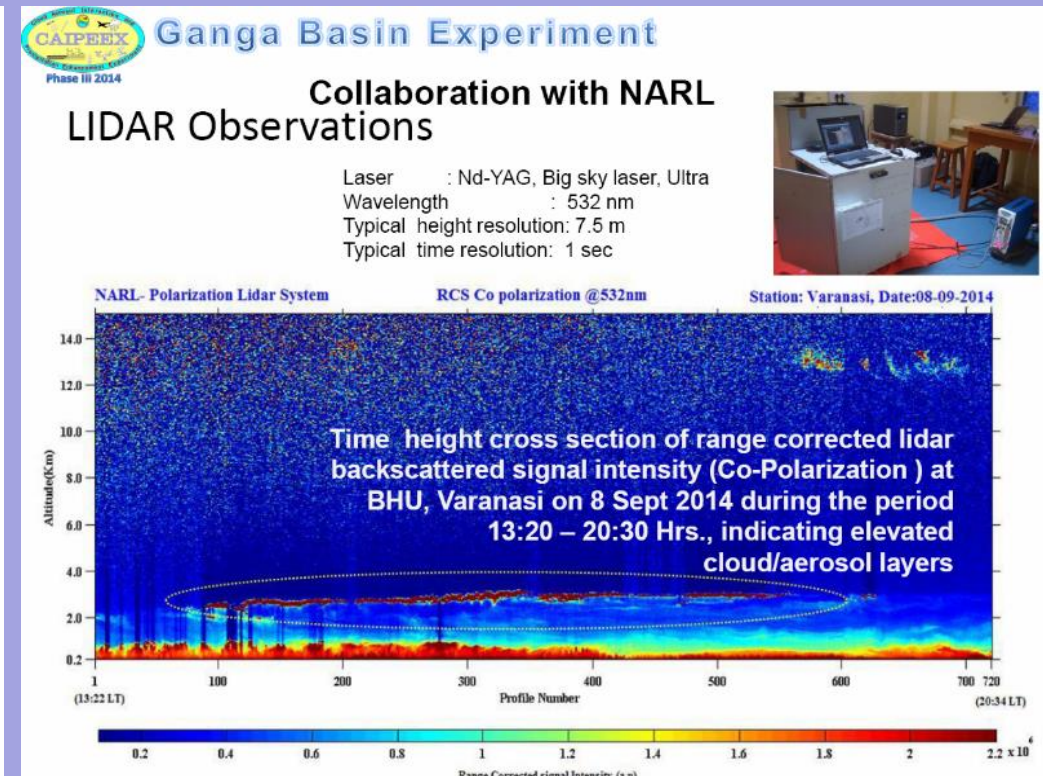
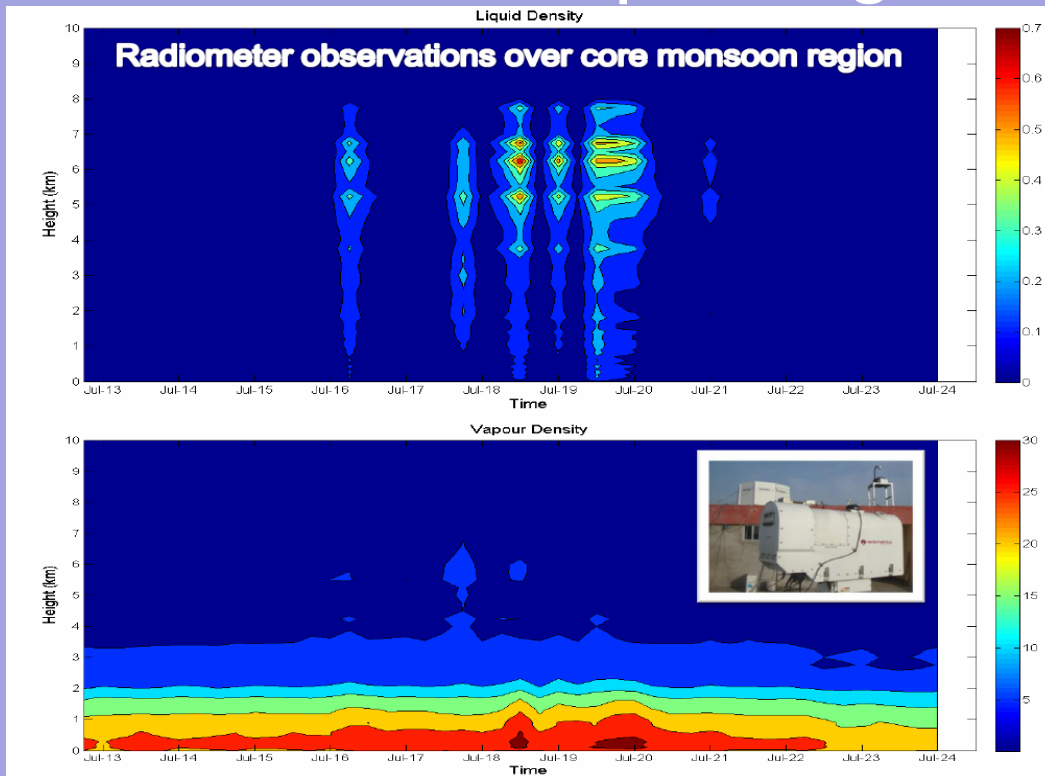


High Altitude Cloud Physics Lab



- Set up at Mahabaleshwar to study microphysical characteristics of aerosols and clouds and associated environmental conditions
- Understanding of interaction of aerosols and clouds and rainfall process.
- Development of microphysical parameterization scheme for numerical weather prediction models

Cloud-Aerosol Interaction over the Ganga Basin for improving Rainfall Predictions



Ground based observations at BHU

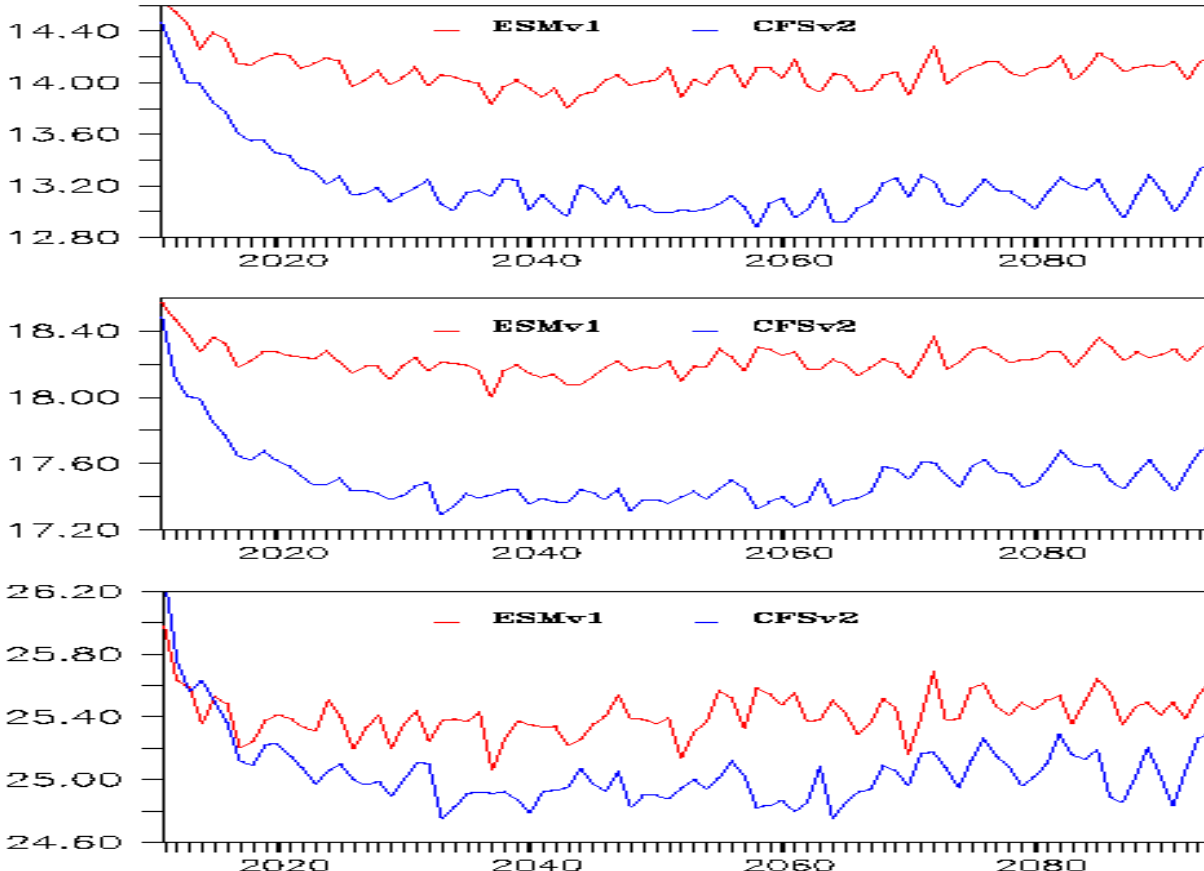
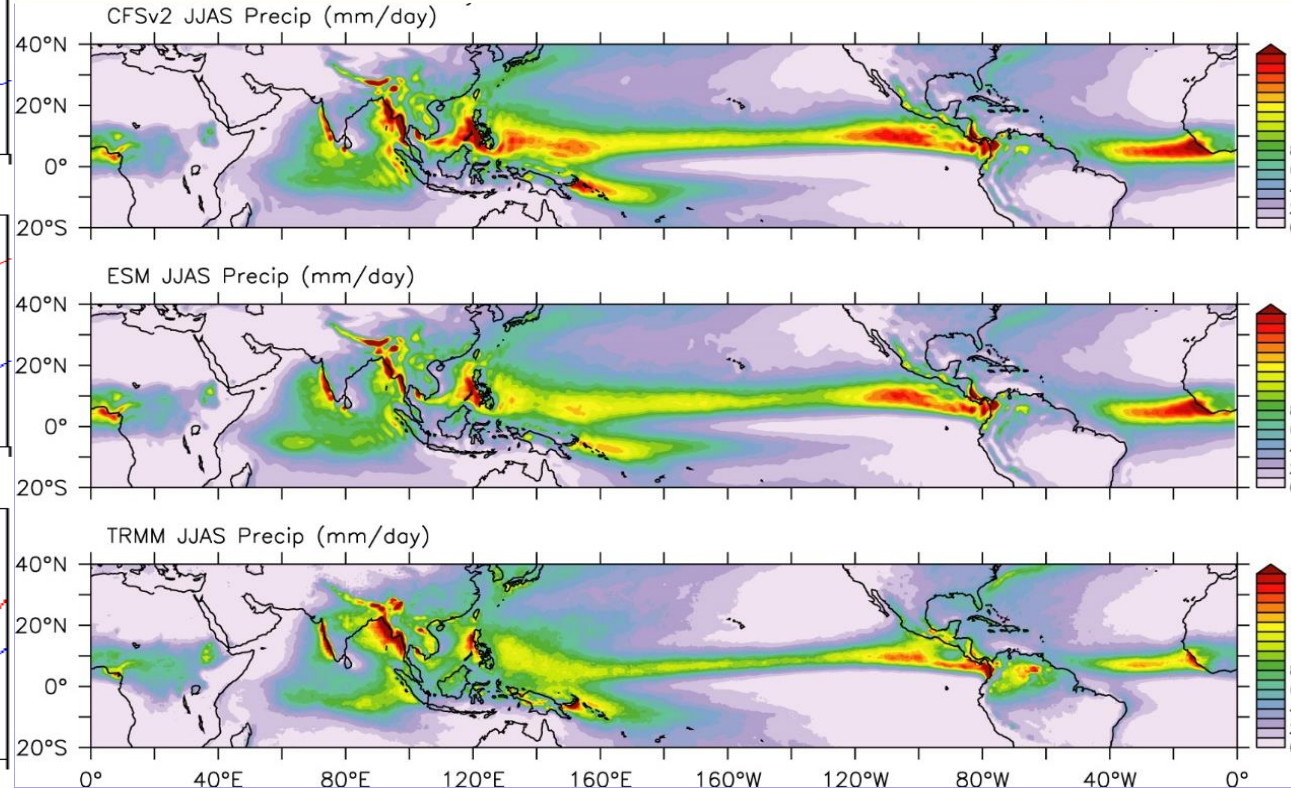
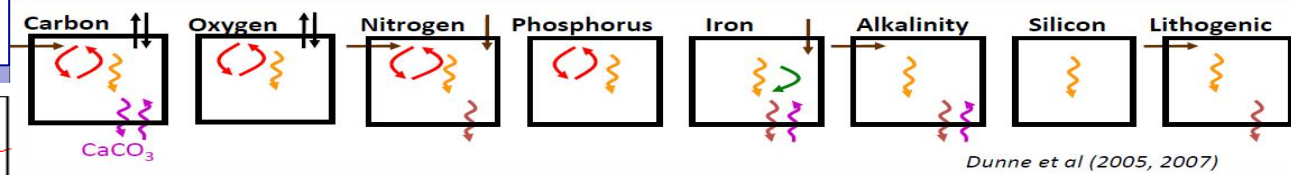
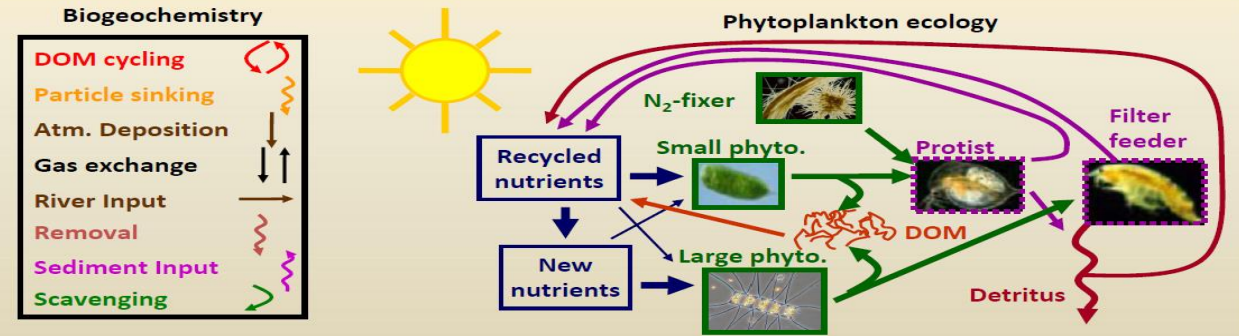
- Vertical Profiles of temperature, humidity and cloud liquid water
- Complete radiation and energy balance over monsoon core region
- Land surface processes data
- Observations of carbon and methane fluxes
- CCN measurements
- Aerosol Chemistry

Earth System Model

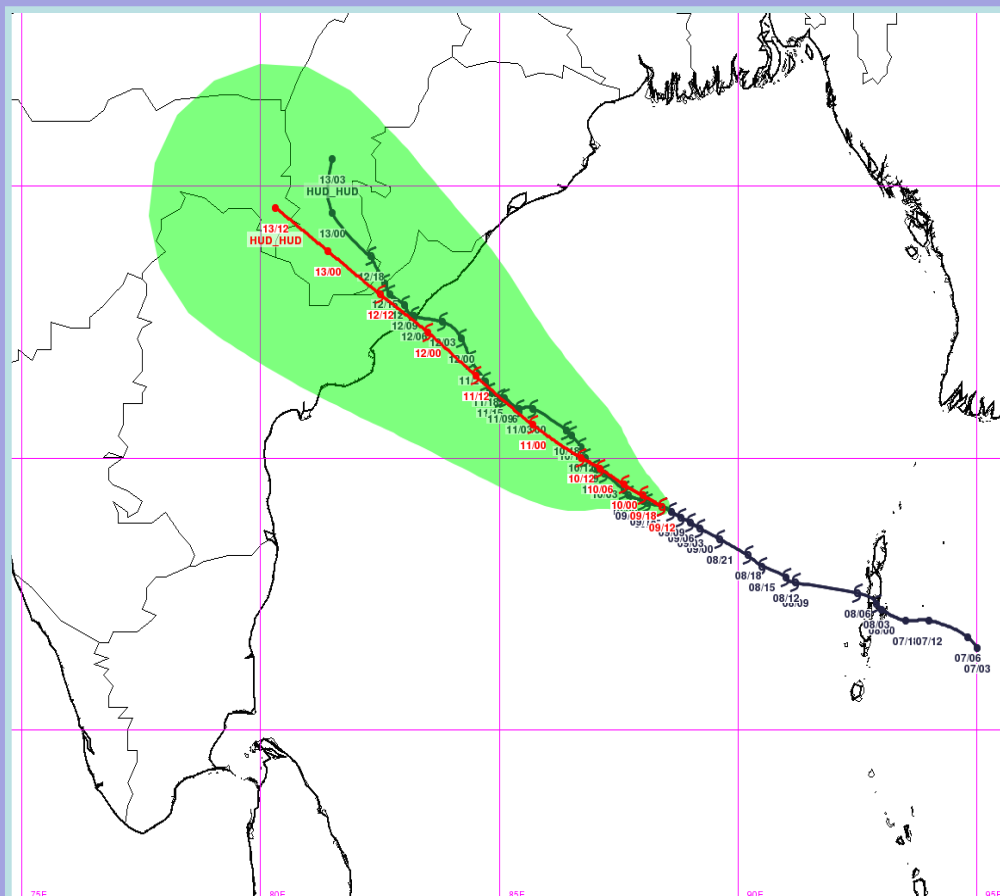
Developed an indigenous Earth System Model to address climate variability and change and developed simulations for this century

Transformation of a Seasonal Prediction Model to a Long Term Climate Model

Tracers Of Phytoplankton with Allometric Zooplankton (TOPAZ) simulates the mechanisms that control the ocean carbon cycle



Cyclone Monitoring -HUDHUD

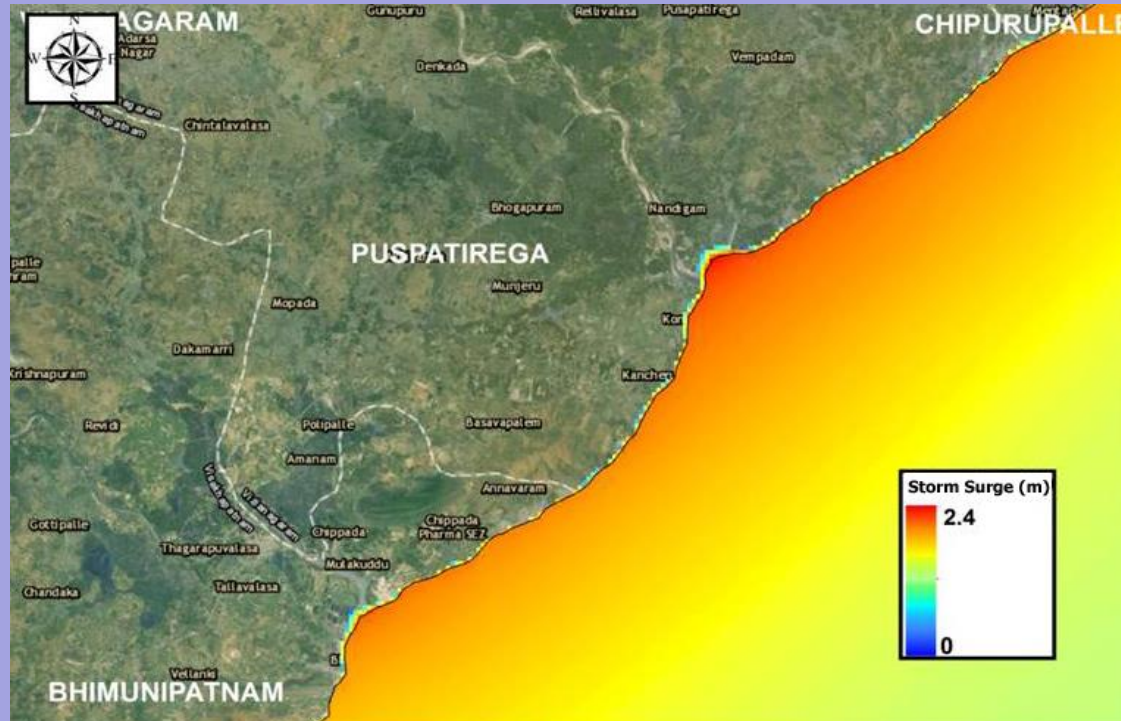


Lead Time (h)	Landfall Point Error (km)	Landfall Time Error (hours)
12	10	0
24	20	0
36	17	-4 h
48	04	-4 h
60	08	-3 h
72	02	-1 h
84	24	-3 h
96	40	- 3 h

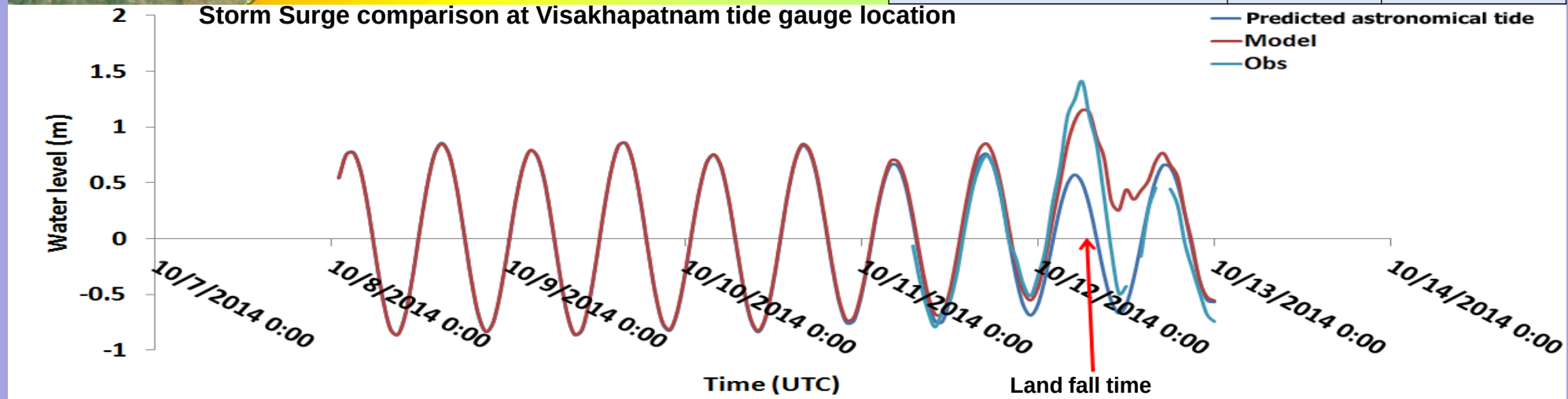
- Two Cyclones, *Hud Hud* and *Nilopher* were predicted well in advance and sufficient time was available to respond
- All aspects of genesis, intensity, track, landfall, associated rainfall, gale wind and storm surge were predicted accurately

Observed and Forecast Track of Cyclone, HUDHUD based on 1200 UTC of 09 October 2014 (67 hours before landfall) Landfall took place around 0700 UTC of 12 October 2014

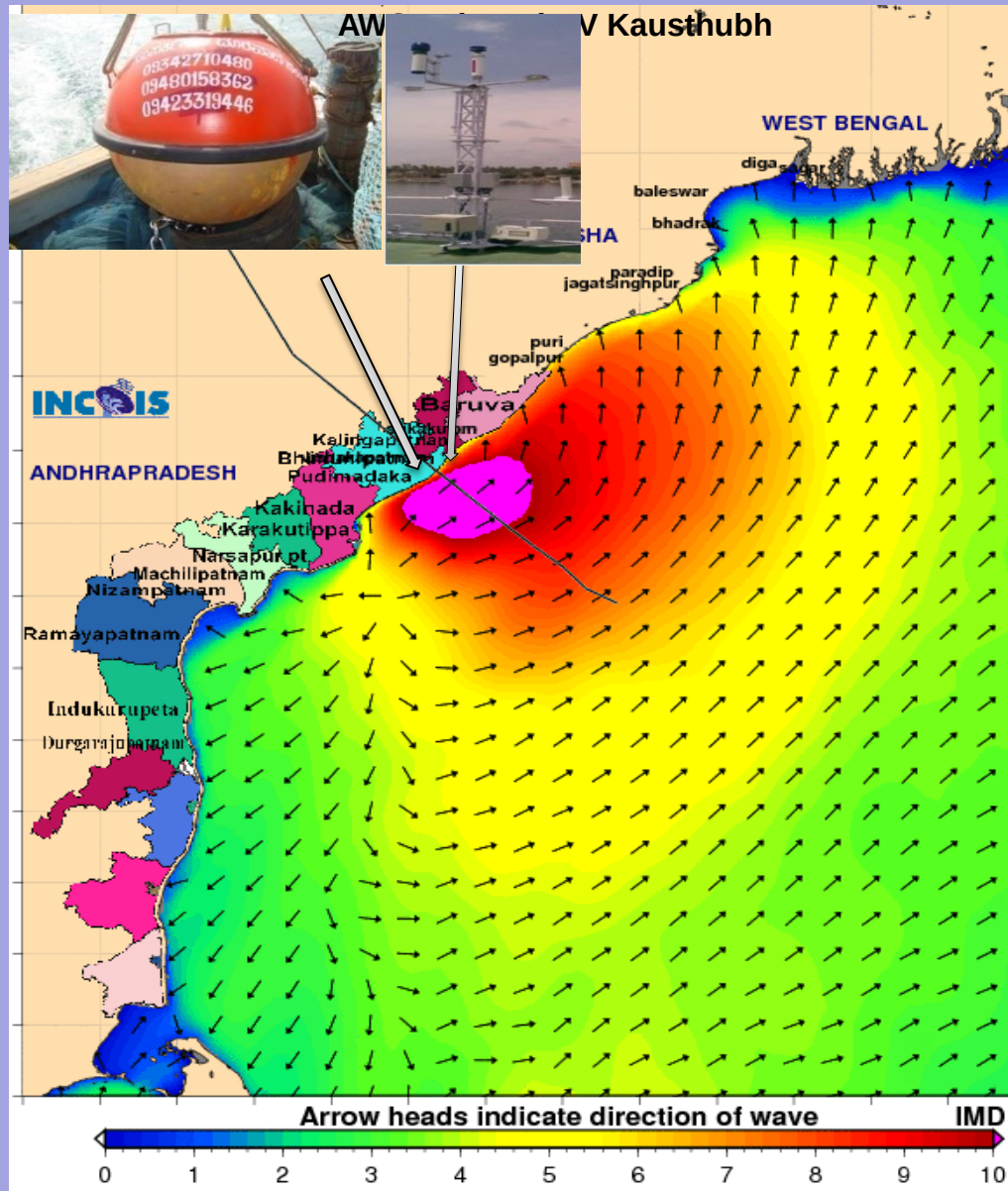
Storm Surge-Hud Hud Cyclone



Mandal	Storm Surge (m)	Inundation extent (m)
Anakapalli	0.6-0.8	Nil
Bhimunipatnam	1.6-2.2	~240
Chipurupalle	0.7-2.1	~230
Puspatirega	1.2-2.4	~ 400
Srikakulam	0.6-1.5	~240
Vishakhapatnam	0.6-1.5	Nil
Yellamanchaili	0.6-0.9	Nil



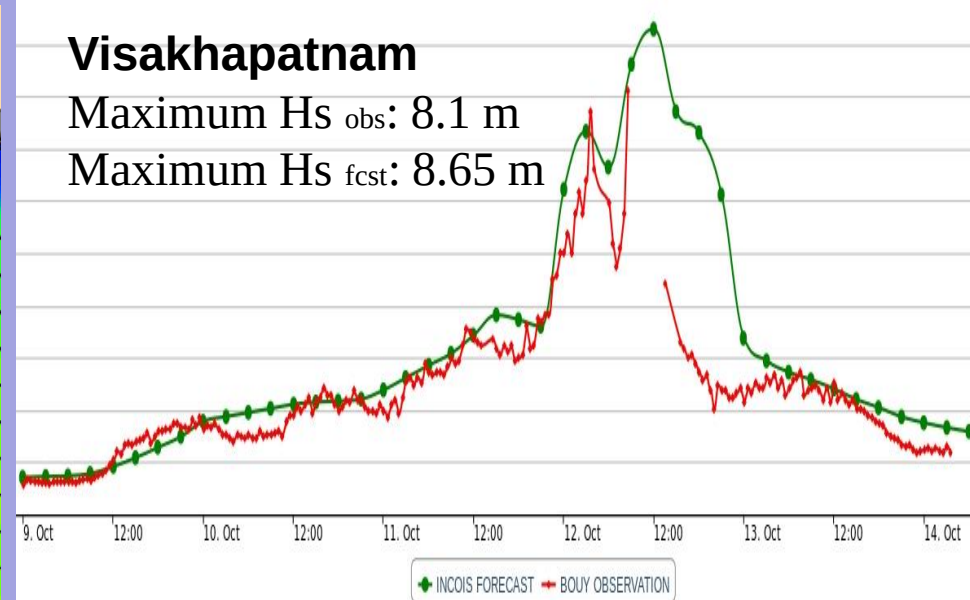
Significant Wave Height – Hud Hud Cyclone



Visakhapatnam

Maximum Hs obs: 8.1 m

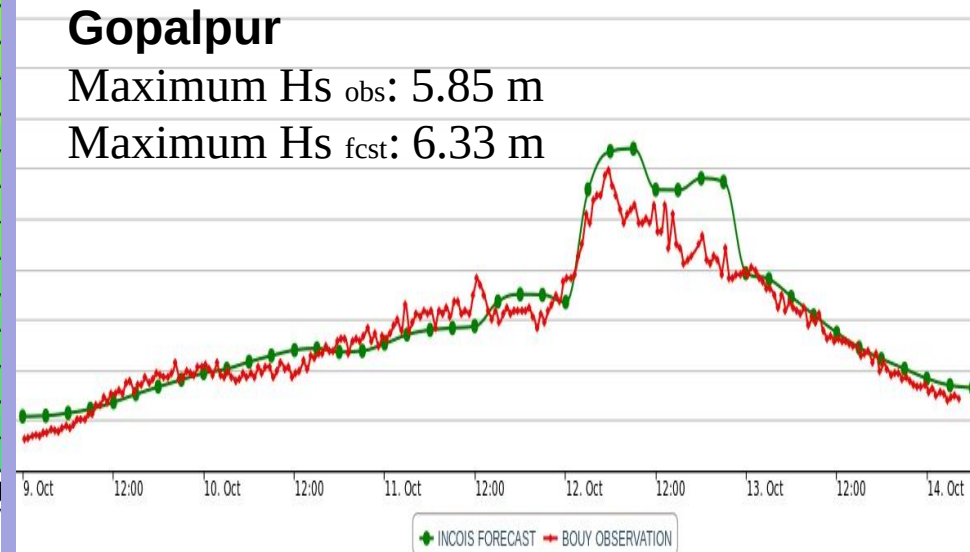
Maximum Hs fcst: 8.65 m



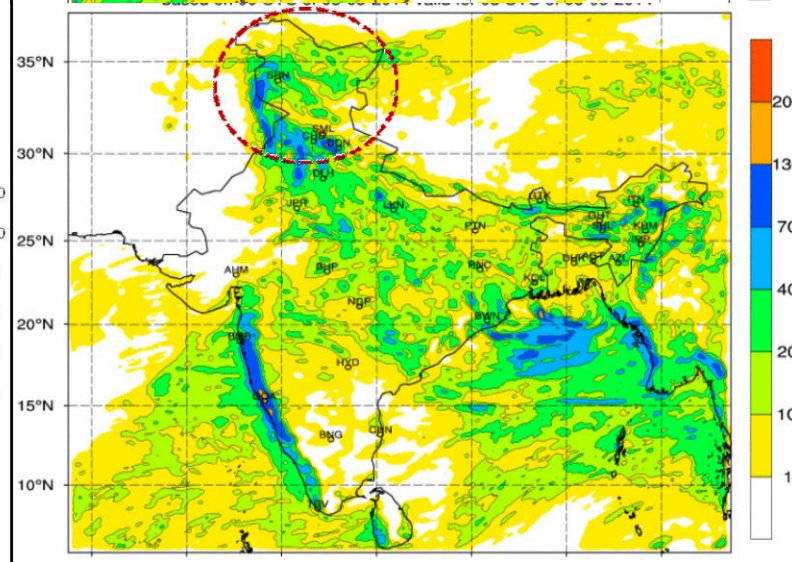
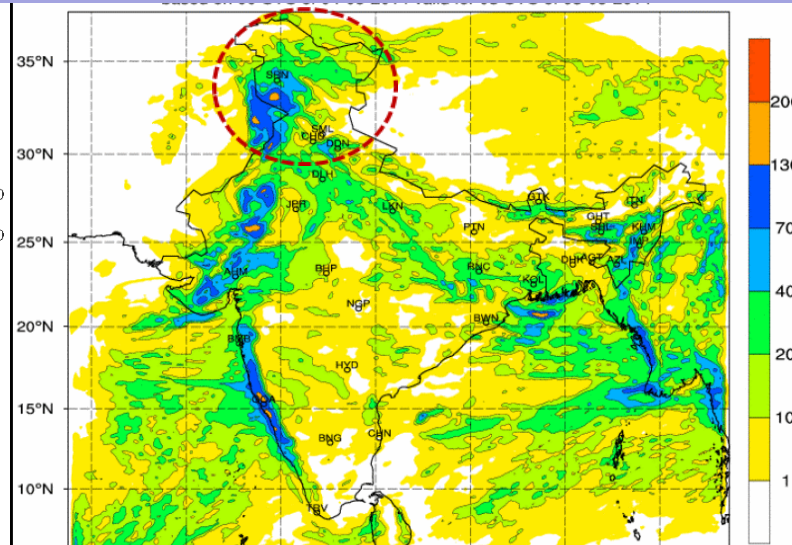
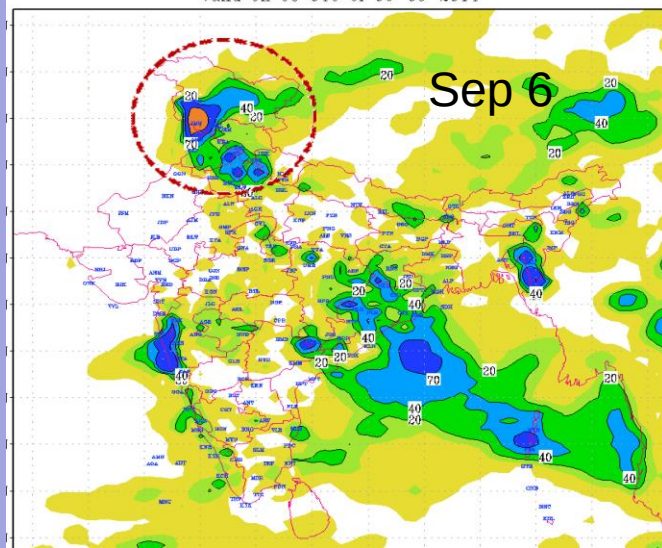
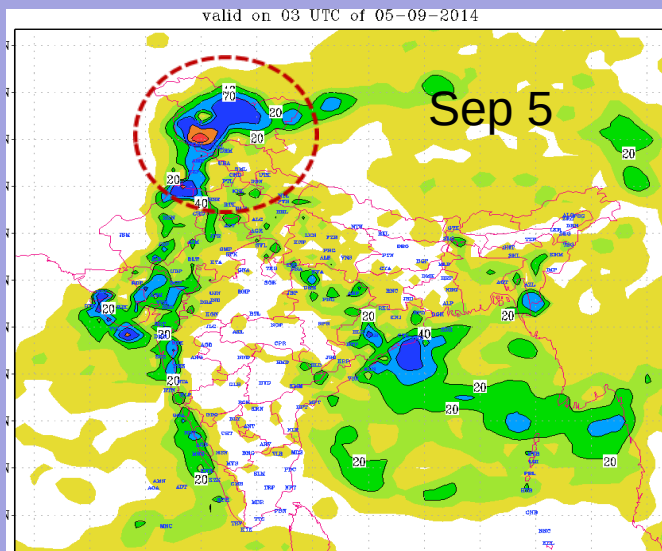
Gopalpur

Maximum Hs obs: 5.85 m

Maximum Hs fcst: 6.33 m



Forecasting 2014 Floods in J & K



Extreme heavy precipitation in the Kashmir valley was predicted 03 days in advance and state administration was alerted.



Ocean Observations and Services

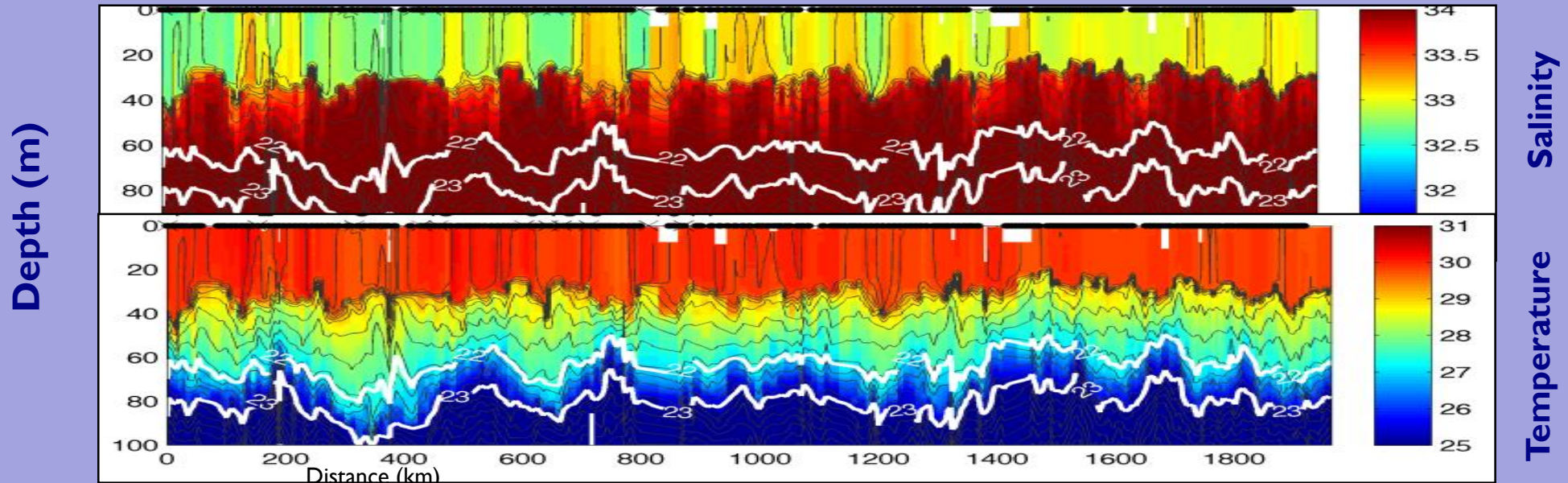
Ocean Mixing and Monsoon (OMM)

Underway CTD (UCTD) operation during OMM cruise

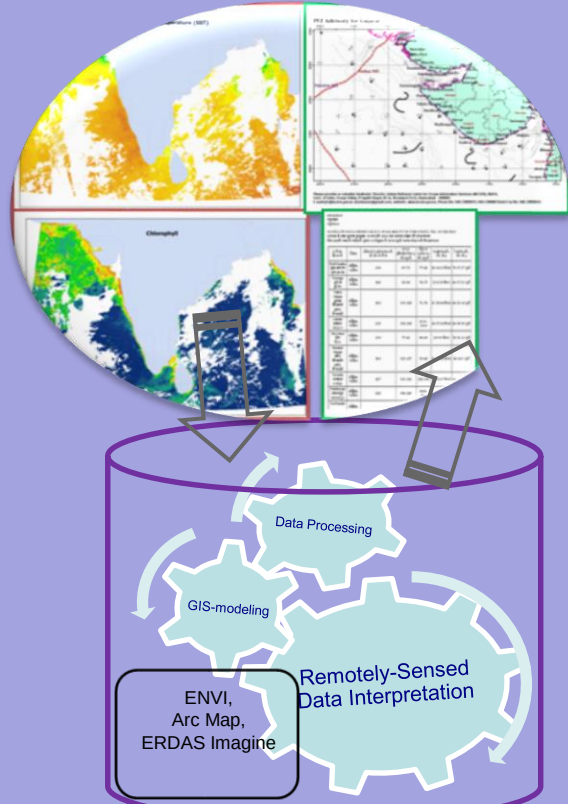


High resolution (spatial and temporal) Salinity (PSU) (top) Temperature ($^{\circ}\text{C}$) (bottom) profiles measured in the upper ocean along the ship track in the BoB

Deployment of Air-Sea Interaction METeorology (ASIMET) system in the northern Bay of Bengal (18°N and 89.5°E) during 11 November, 2014



Marine Fishery Advisory Service

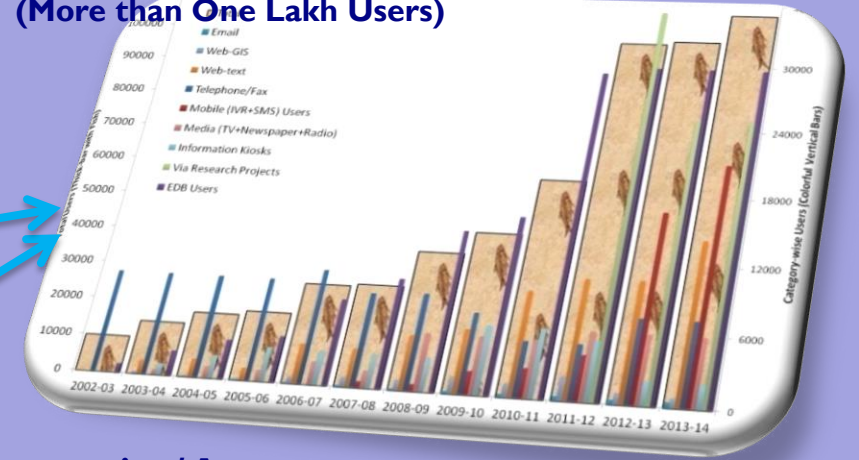


Generation

Dissemination



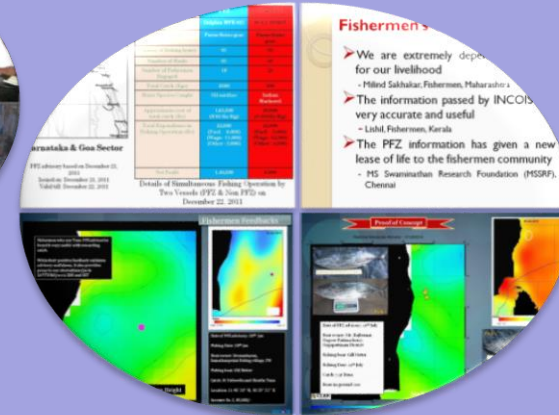
**Increased User Base
(More than One Lakh Users)**



User Interaction/ Awareness



Validation & Feedbacks



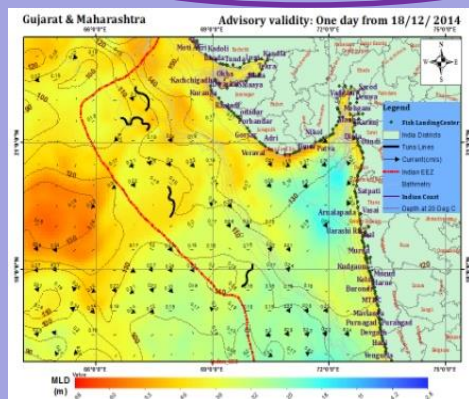
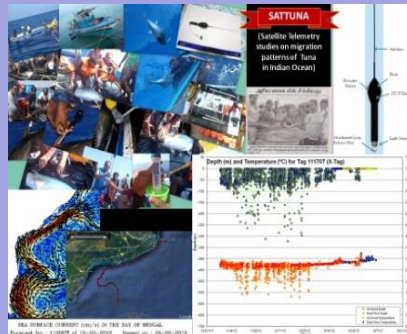
Benefits

- **Success Rate: ~ 80%**
- **Net Profit: 03 – 04 times**

Total Annual Net income due to use of PFZ could be Rs.34,000 to Rs. 50,000 Crore – NCAER Report, 2010

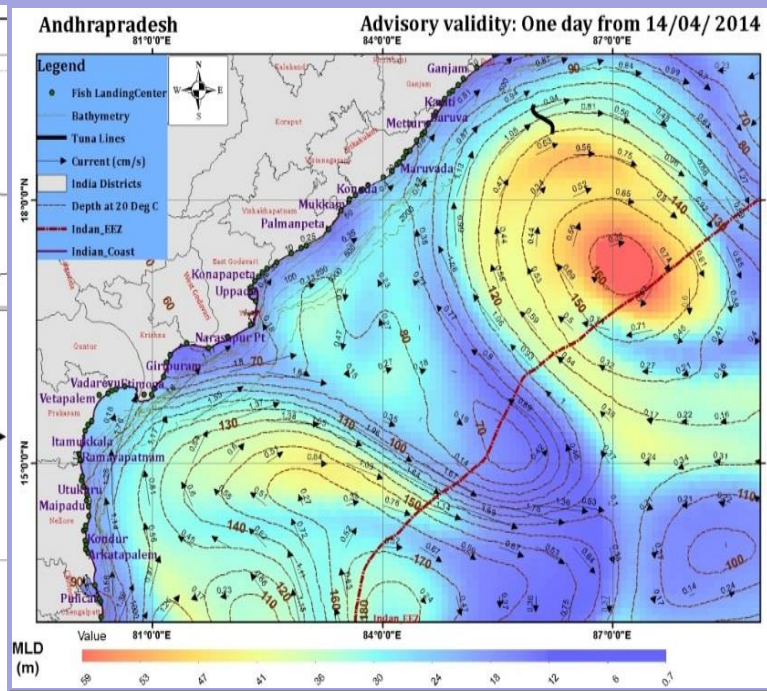
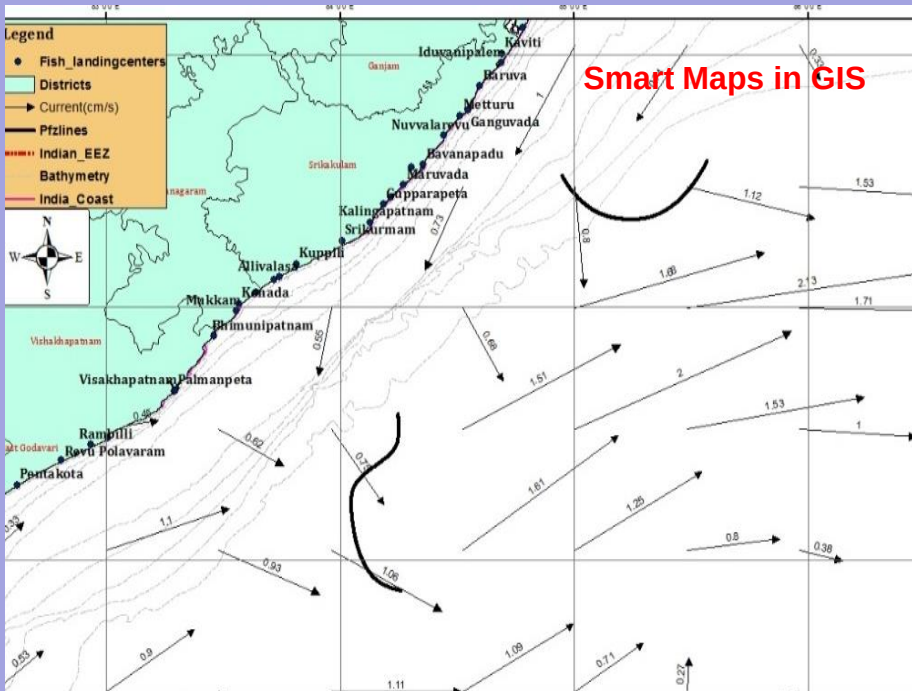
A fishing village of 32 fishing boats in Raigad Dt., Maharashtra could save 70,000 liters of diesel in a month (equivalent 150000 kg of CO₂ (@ 2.7 kg/l) emission) – Annual Report of National Agricultural Innovation Project (NAIP), ICAR, 2011-12

R & D for Improvement: Tagging of Tuna



Species-specific Advisories for Tuna

Potential Fishery Advisories

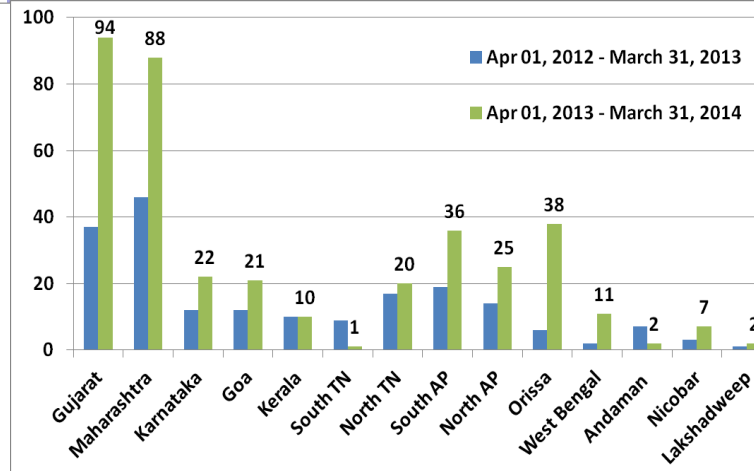
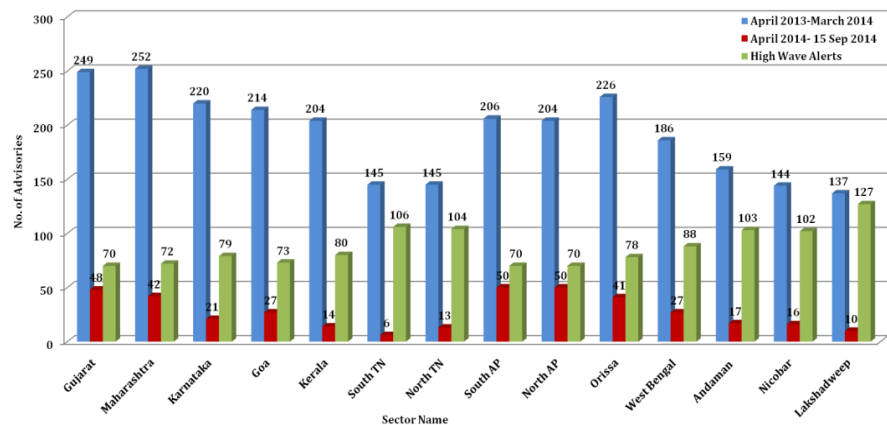


Forecast on Potential Fishing Zones and ocean state for India and Indian Ocean countries.

[PFZ Advisory](#)

[Tuna Advisory](#)

No. of PFZ Advisories issued during April 2013- March 2014 & April 2014 - 15 Sep 2014



Standard for Heavy Metals as Sea Water Quality Criteria(SWQC)

1. Developed Standards for heavy metals
2. SWQC for Nickel ($\mu\text{g/L}$) has been derived and compared

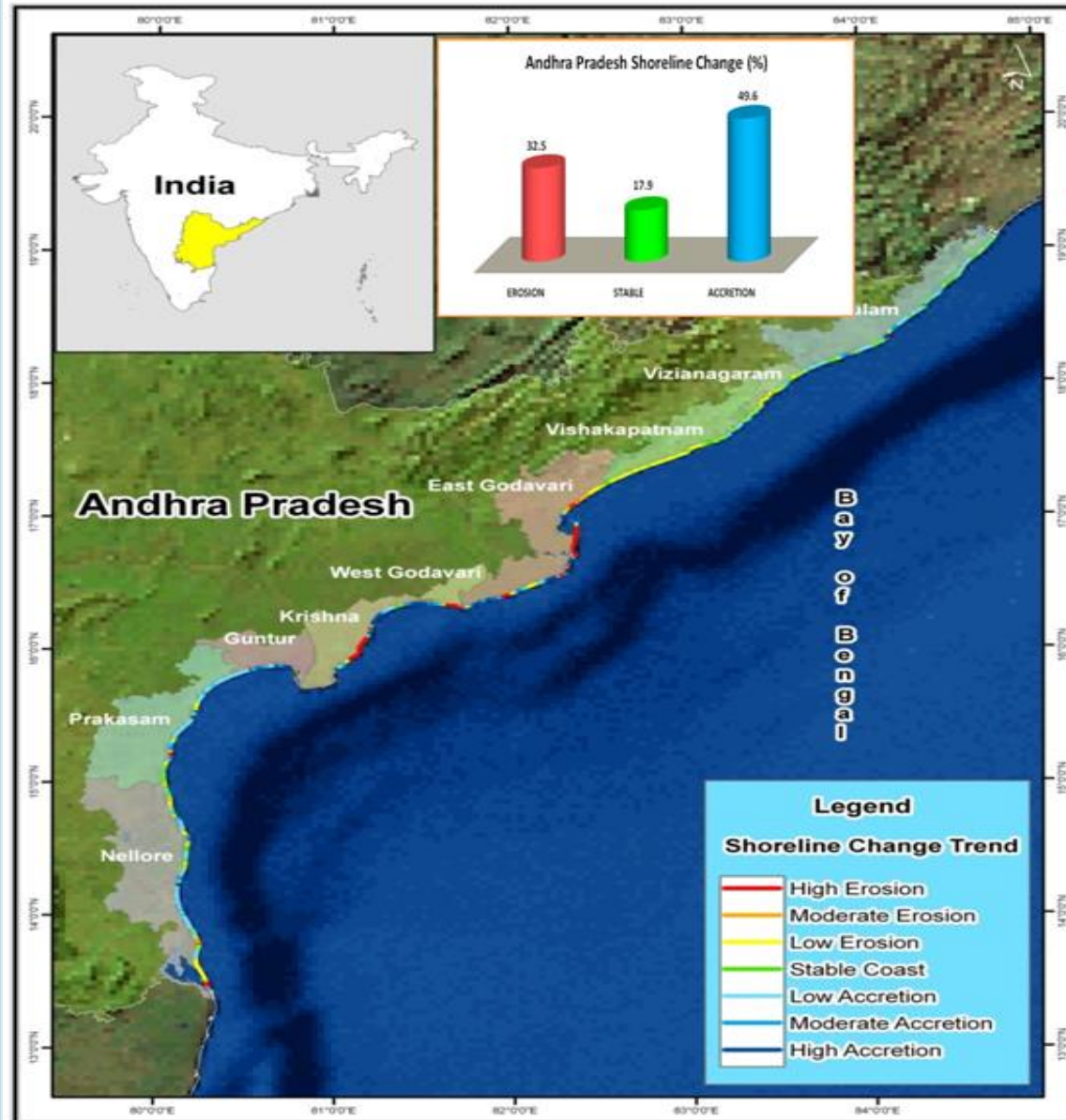
US EPA (2002)	Thailand (1994)	EEC (1999)	Present study
8.2	10.0	30.0	8.7

3. Histo-pathological changes in the gill of *Perna viridis* exposed to Nickel
4. Standardization of protocol for DNA fragmentation assay in untreated samples
5. Completion of 2 Acute toxicity tests of Cu on *Etroplus suratensis* and mean 96 h LC_{50} was found to be 3.8 mg/L

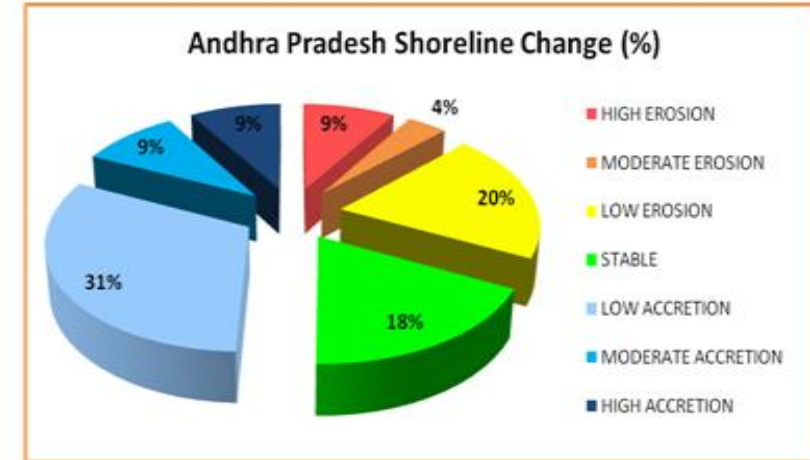
Metal	Ennore ($\mu\text{g/l}$)	MoEF (1998) SW-I criteria ($\mu\text{g/l}$)
Copper	4.1	NA
Cadmium	3.0	10
Mercury	0.4	10
Zinc	10.6	NA
Lead	4.6	10
Arsenic	3.5	NA
Chromium	8.0	NA

MoEF (1998) PRIMARY WATER QUALITY CRITERIA FOR CLASS SW-I WATERS
(For Salt pans, Shell fishing, Mariculture and Ecologically Sensitive Zone)

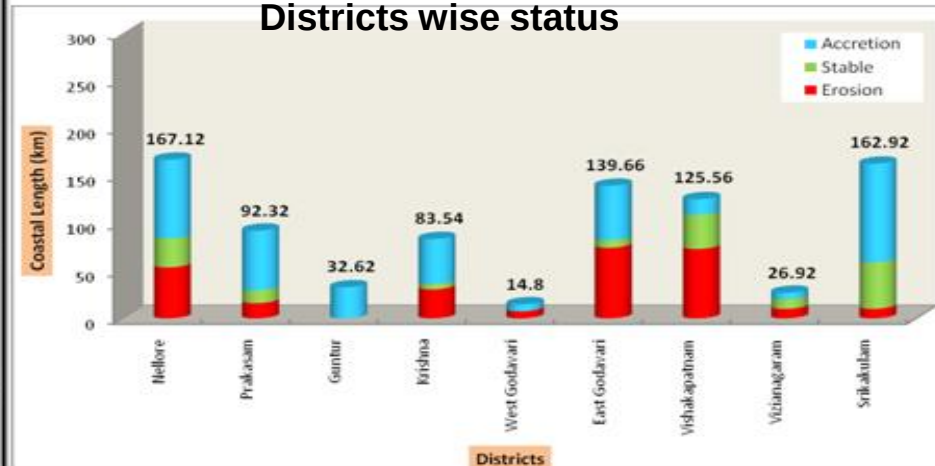
Long-term shoreline changes



Shoreline changes observed Andhra Pradesh coast (1990-2012)

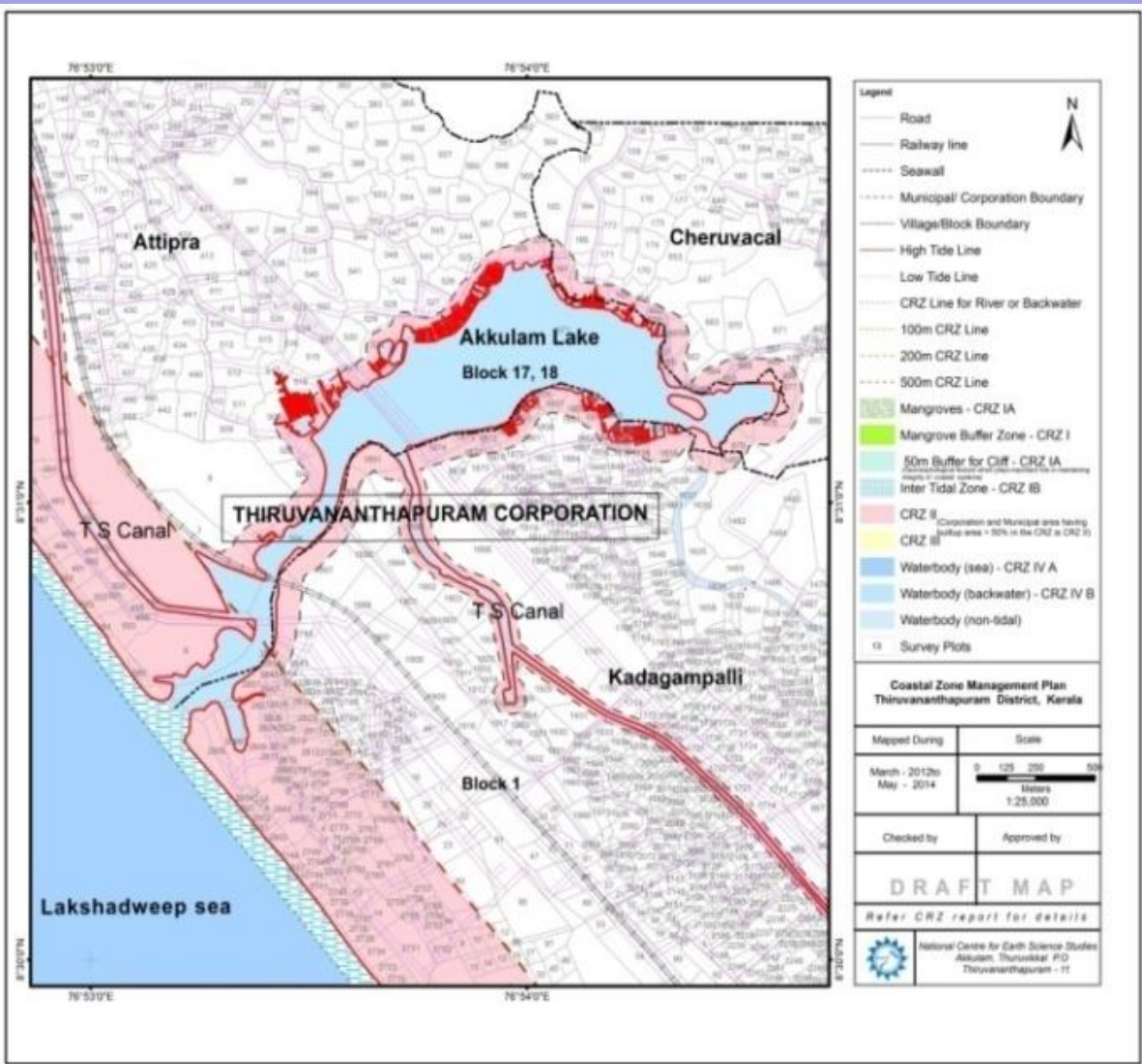


Districts wise status



Coastal Zone Management

Thiruvananthapuram Dist.: Akkulam area

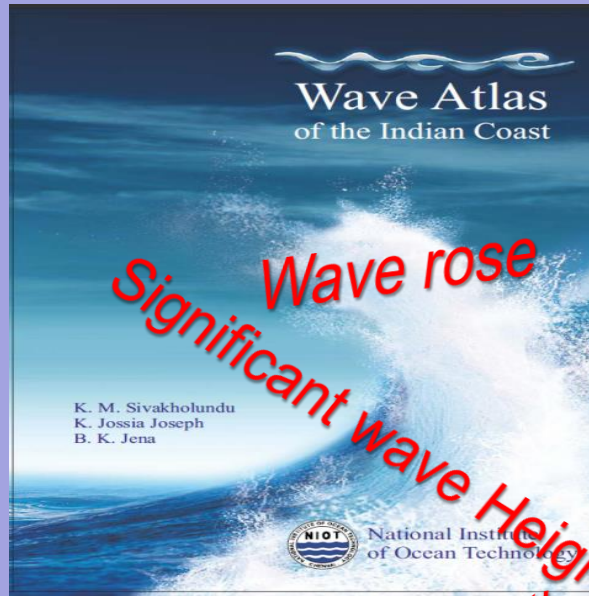


- Plan for 3 districts viz., Thiruvananthapuram, Kollam and Alappuzha in Kerala completed.
- Zoning consists of CRZ I, CRZ II, III and CRZ IV.

District	HTL Length (km)	Mangroves (CRZ IA) (km ²)	Inter Tidal Zone (CRZ IB) (km ²)	Mangrove buffer zone (CRZ I) (km ²)	CRZ II (km ²)	CRZ III (km ²)
Kollam	799.13	0.95	5.94	2.52	13.46	40.25
Alappuzha	1057.17	1.43	11.07	5.40	4.75	53.75
Thiruvananthapuram	507.35	0.02	4.53	0.1	17.87	27.44

Ocean Technology

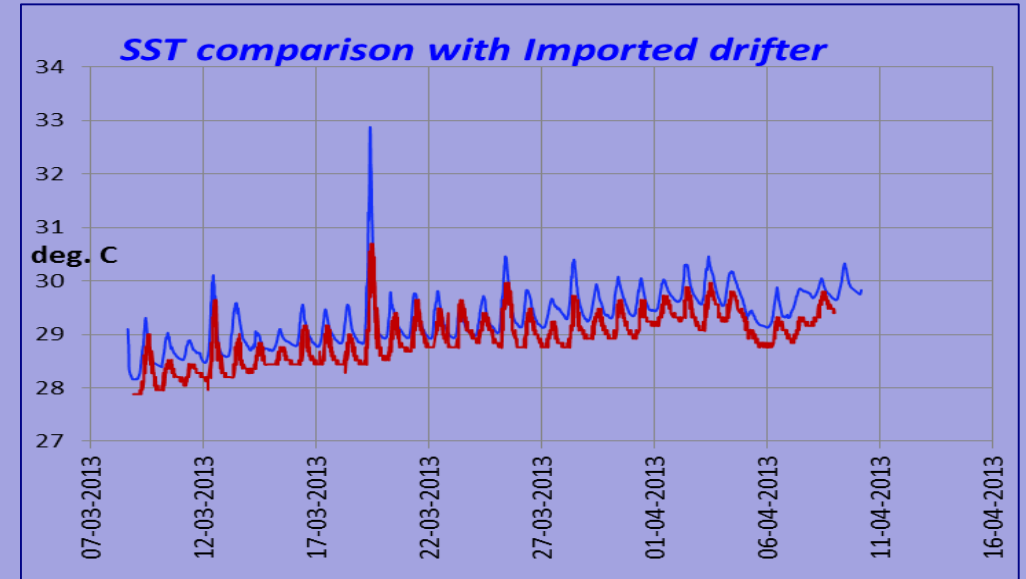
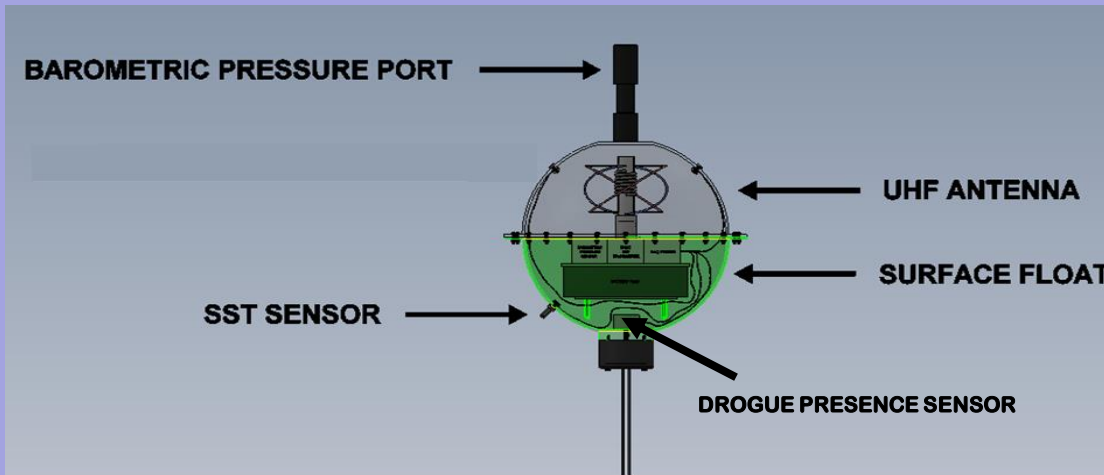
Wave Atlas



- Reference for basic wave related information
- Presents statistics derived from past information using simulated wave data of 15 year for various coastal engineering applications
- Probable maximum wave height at a user selected location for 50 years are presented for planning design of marine structures, beach protection, and environmental protection etc.
- Facilitates for site selection for industrial and other development corridors.



Drifter Buoy with INSAT Communication (Pradyu)



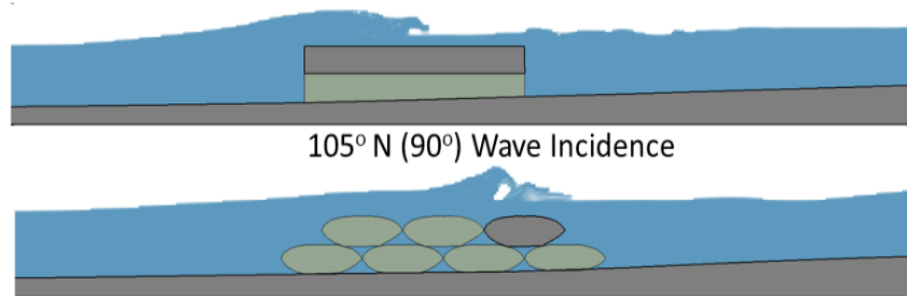
- Drifter Buoy with INSAT communication is developed. The technology is transferred to industry for tail production.
- Drifter is used for measurement of Sea surface temperature, Atmospheric pressure and Ocean currents.
- This data is used for studying air-sea heat exchange, upper ocean processes, weather forecast, circulation pattern, Satellite Data validation.



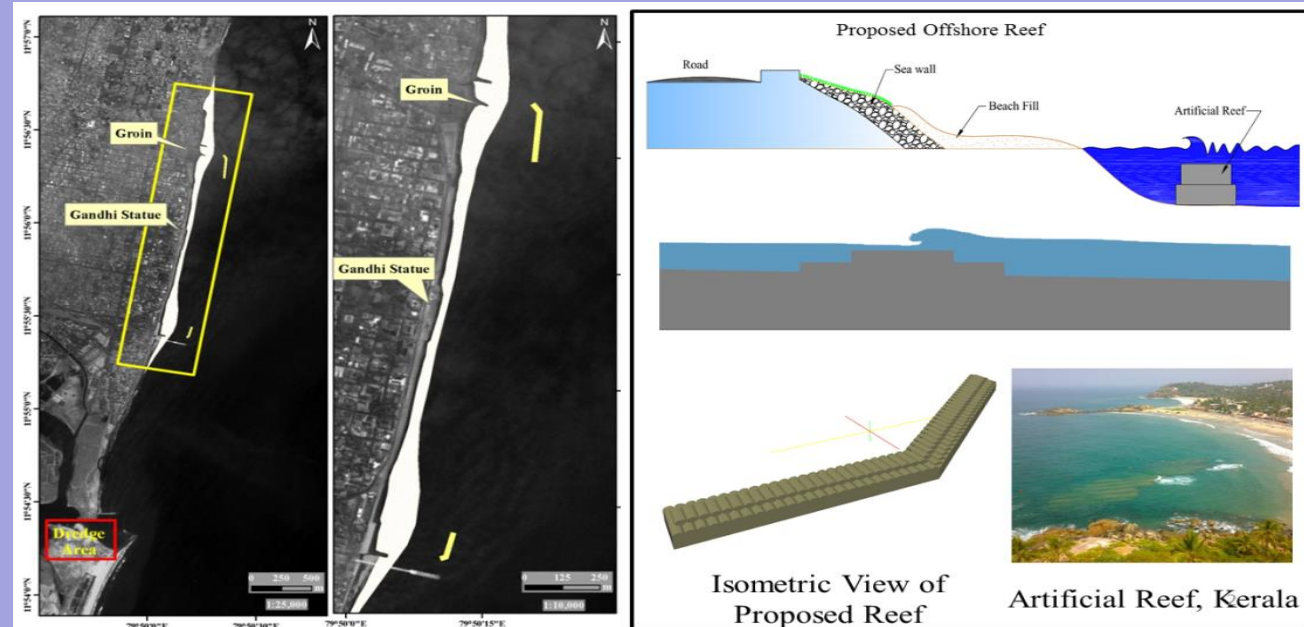
Pradyu in sea

Design of Coastal Protection Structures

- Addressing the issue of continuous erosion along Puducherry coast
- Puducherry government implemented the Beach Nourishment prescribed by ESSO-NIOT which resulted in formation of 60m wide beach near New Pier.
- Now Puducherry government has requested for restoration of beach
- Preliminary Desk Studies are carried out for Hybrid Solution.
- An Offshore Submerged Reef in 4-5m depth along with Beach Nourishment is being considered for the Puducherry Beach Restoration



Numerical Modeling of Offshore Reef



Lay out of proposed Hybrid Solution

Polar Science

34th Indian Scientific Expedition to Antarctica 2014-15

- Expedition initiated in November 2014**
- A total of 31 scientific projects have been approved for initiation during 2014-15**

Sr. No.	Discipline	No. of projects	No. of institutions
1.	Atmospheric Science, Meteorology	10	09
2.	Biology and Environmental Science	04	04
3.	Human Physiology & Medicine	01	01
3.	Earth Science and Glaciology	15	08
4.	Student Participation Scheme	01	01
Total		31	23

INDIAN ARCTIC PROGRAM 2014

- **Field studies and data collection under the various projects carried out in a staggered manner over five phases- a late-winter/early-spring phase between 27th March and 24th April 2014 and four summer phases between May and November.**

Research Outcomes :

- CTD observations coupled to sampling for measuring water column nutrients, phytoplankton and zooplankton diversity and bacterial load was carried out for the peak summer period. Structural mapping has revealed zones of high strain in three selected areas in Broggerhalvoya
- Summer ablation measurements for mass balance and installation of new stakes on the glacier for enhancing the coverage of stake network. A network of high-precision GPS was installed on the Vestre Broggerbreen glacier for measuring the surface velocity, direction and altitudinal changes of glacier surface

Arctic Observing System

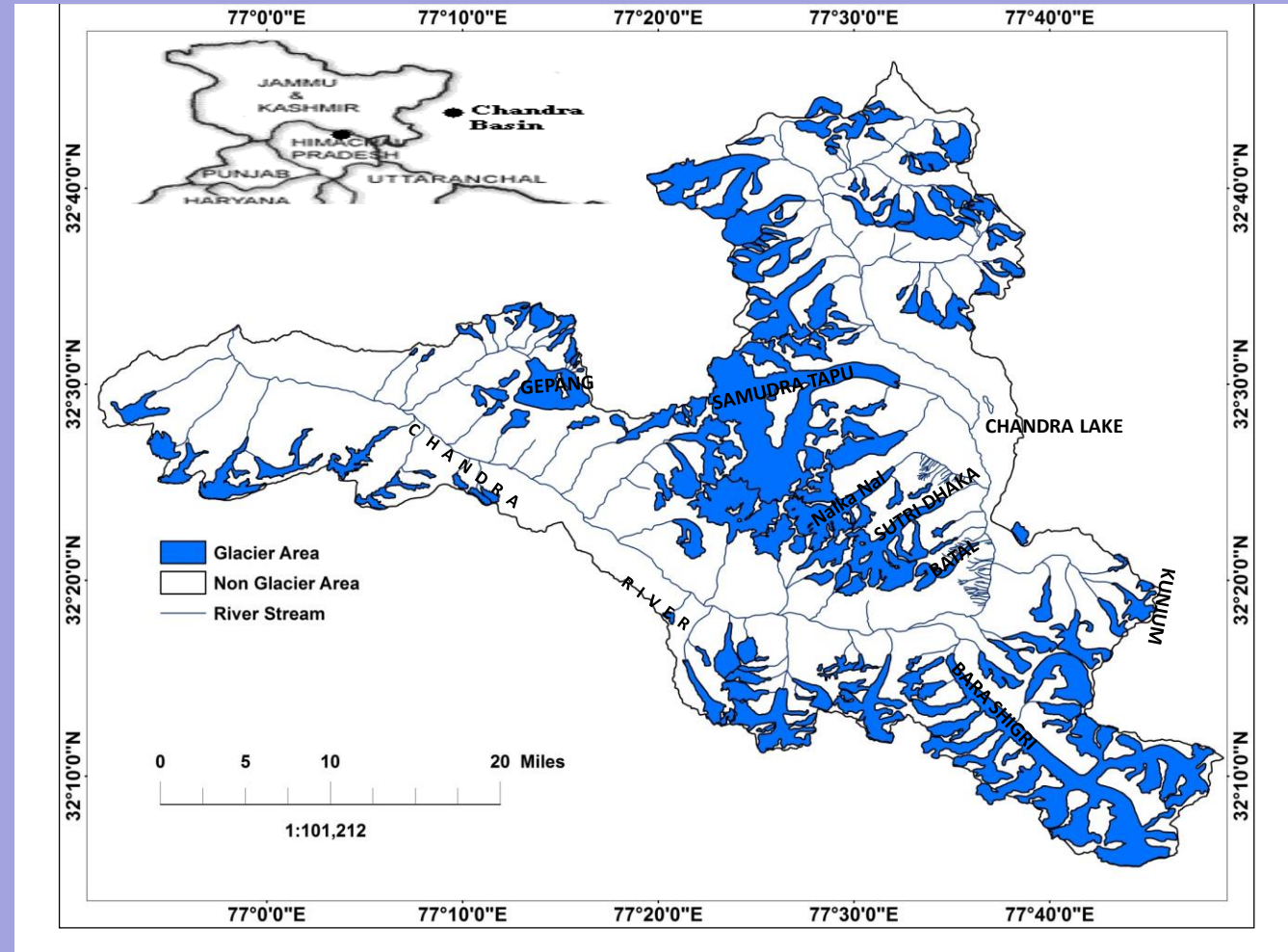


- Multi-sensored Moored Observatory off the Kongsfjord, Norway for time series observations sea water temp., salinity, currents, etc.
- Anchored at 192 m, about 1100 km away from the North Pole.
- To understand interaction between fjord and sea as well as the response of the Arctic to climate variability.

HIMALAYAN CRYOSPHERE

Initiated monitoring 7 glaciers (306km²) of Chandra Basin, which constitutes ~ approx. 43% of total basin glacier area

- Installed more than 100 stakes (each ~10 m deep ablation stakes) so far
- High melting rate (7-10 cm/ day) during July-August 2014 in lower ablation zone
- High melting in C-type (debris-free) glaciers than D-type (debris-covered) glaciers
- Debris cover over the glacier surface significantly controlled melting rates of ice; however accelerated snow melting above debris
- No accumulation at Bara Shigri main accumulation zone this year. Only feed by avalanche and subsidiary glaciers!



Acquisition of Polar Research Vessel

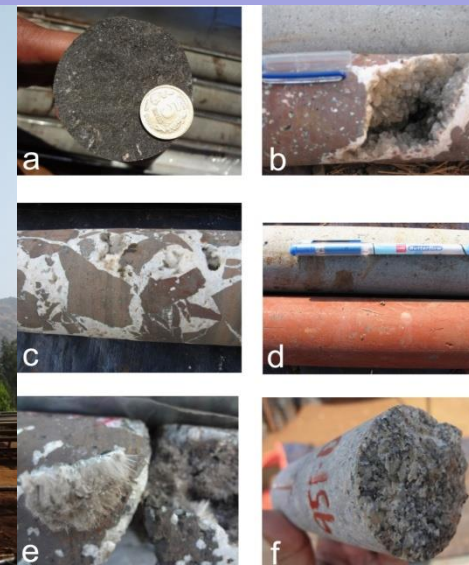
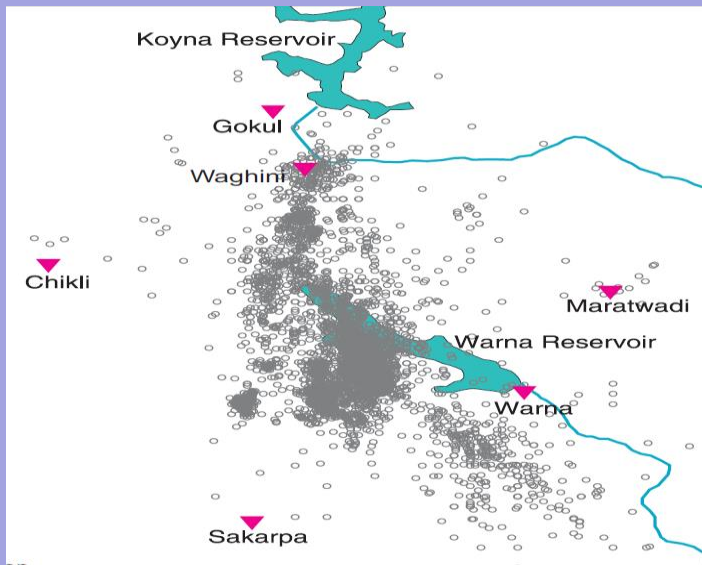
Acquisition of Polar Research Vessel approved to boost polar research.



Length	: 132 m
Breadth	: 23 m
Draft	: 8.4 m
Endurance	: 120 days (60 days steaming & 60 days station work)
Speed	: 15 knots
Scientific Complement	: 61
Container carriage	: 50 TEU
Fuel carriage for	: 1250 KL.
Base camp	
Ice Navigation	: PC5 (Polar Class 5)

Geoscience

Earthquake Research – Global Leadership



- More than 200 earthquakes above magnitude 4.0 occurred in the Koyna area at shallow depths. Deep borehole of 6-7 km to observe rock media before, after and during earthquakes has been planned.
- Completed the Preparatory phase of scientific deep drilling in Koyna and identified sites for pilot boreholes up to 4.5 km deep.
- Seven preliminary boreholes up to 1.5 km has been drilled and cores recovered. Borehole Geophysics Lab is being established. Two seismometers placed in boreholes. Analysis of borehole data is in progress.
- Analyzed Trap thickness: 933 – 1100 m, Granite-gneiss basement and No sediments below Traps.

Evolution of Himalaya and Origin of Monsoon



- Earth's structure and history recorded in oceanic sediments and rocks.
- A comprehensive Science Plan – history of erosional sediments from Himalayas (Indus Fan), nature of crust, geodynamic evolution, for the Laxmi basin.
- Drilling platforms - JOIDES Resolution (USA) - 2015.

Infrastructure

Infrastructure Development

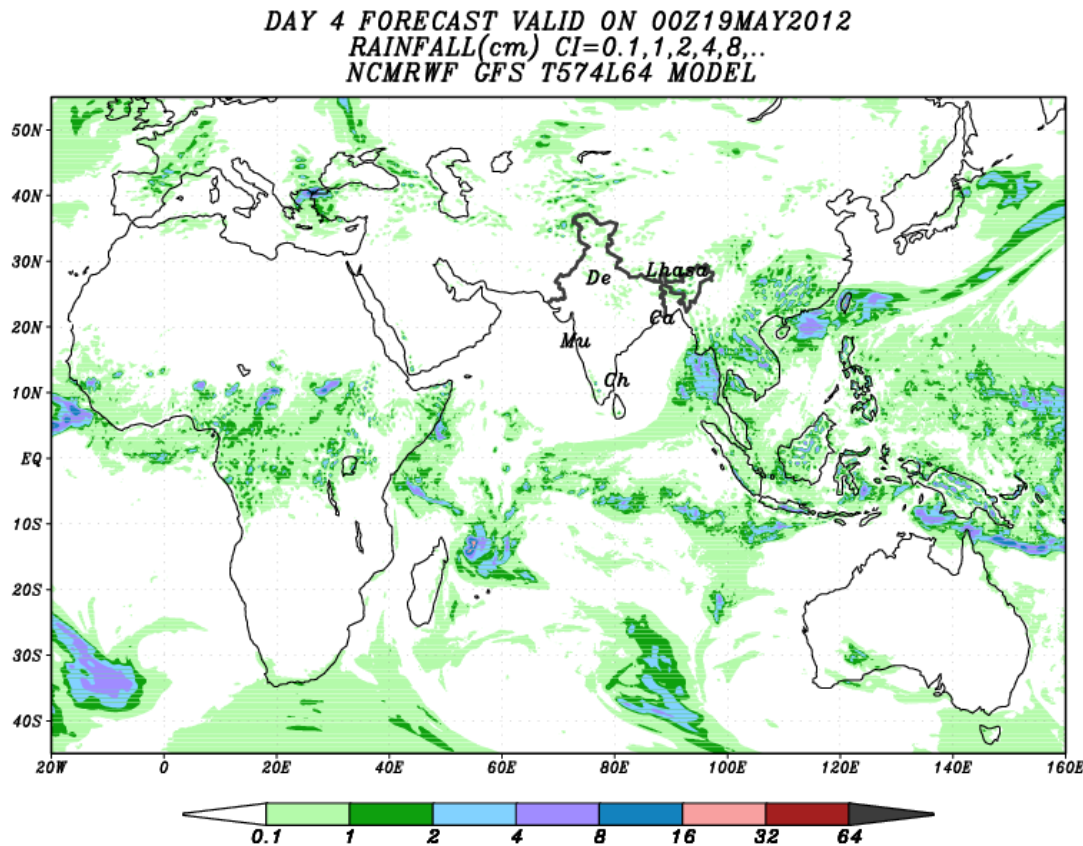


- High Performance computing resources of aggregated capacity of 1.2 PETAFLOPS has been commissioned for weather and climate modelling
- Augmenting capacity from current 1 petaflop to 10 petaflops

Capacity Building

BIMSTEC Centre for Weather Forecasting

Rainfall in cm 4 days in advance



- BIMSTEC Centre has been set up to enhance capability to generate and disseminate weather forecast.
- First training course was organised during August 2014.

[Live Forecast](#)

Tsunami Early Warning System *ICG/IOTWS Regional SOP Workshop*



- Regional Standard Operating Procedures (SOP) workshop on Tsunamis during 23-27 June, 2014 at Hyderabad was organized.
- 30 participants representing NTWCs, DMO and Media from the Indian Ocean rim countries - Iran, Yemen, Kenya, Tanzania, Mozambique, Mauritius, Maldives, Comoros, Madagascar, Seychelles; participated.
- 10 subject experts from ITIC, JTIC, ABU, BoM, BMKG, ITEWC gave talks.
- Tabletop exercise on 26 June 2014. During this event, a hypothetical earthquake of M 9.0 off the Makran Coast was introduced.

Workshop on SAARC Monsoon Initiative Programs

The **second Meeting of SAARC working Group on Monsoon and Seminar on “Monsoon and its prediction in all time scales over SAARC region”** was held at IMD, Pune during 9 – 12 December, 2014.



WMO group training on “Maintenance and Calibration of instruments”

- WMO Regional Training Centre organized a group training program on “Maintenance and Calibration of instruments”, during 3-28 November 2014 at Pune,
- Objective was to enhance knowledge and practical skills in measurements and calibration
- 24 foreign participants from 21 different countries participated



International Training Centre for Operational Oceanography (ITCOcean)

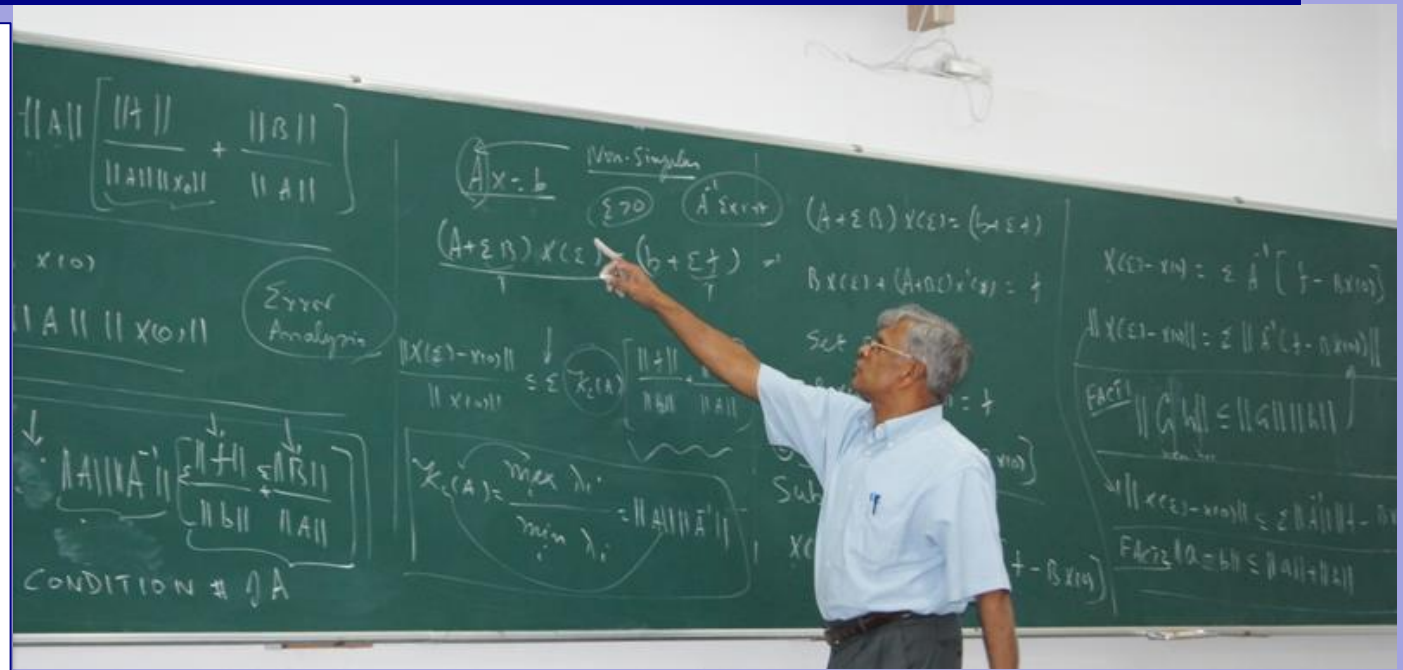
- i. International Training on Ocean Colour Remote Sensing - Data, Processing and Applications 10 – 14 November 2014
 - 28 Participants attended -- 8 International participants from 7 countries (Bangladesh, Gana, Madagascar, Malaysia, Mauritius, Romania and Tanzania); 20 from India
- ii. A short course on “ Remote Sensing of Potential Fishing Zones and Ocean State Forecast “ was held during March 24-29, 2014.
 - 24 trainees attended the course - 15 from India and 9 from Seven countries – South Africa, Italy, Comoros, Madagascar, Mauritius, Bangladesh and Sri Lanka
- iii. Training Workshop on “ Ocean Information Services for Cyclone Forecasters”, April 2-3, 2014
 - 22 Cyclone Forecasters from India Meteorological Department attended the course organized at INCOIS during April 2-3, 2014
- iv. On job training for Oman Tsunami Warning Centre Operators during 4-8 August 2014.
 - 6 officers from Oman attended the training.



International Training Centre for Operational Oceanography (ITCOcean)

A training Course on “Ocean Colour – Data, Processing and Applications”, Co-sponsored by IODE/ IOC during November 10-14, 2014.

- 60 Applications including 45 from India and 15 from 10 from other countries (Bangladesh, Cuba, Kenya, Madagascar, Malaysia, Mauritius, Mexico, Nepal, Romania and Tanzania) have been received.



International Co-operation

Agreements with International Organizations

- **Cooperation with University Corporation for Atmospheric Research, USA:** MoU signed on 24 September 2014- enhanced cooperation involving various academic institutes in both countries for capacity building in the field of Earth System Science
- **Cooperation with Research Council of Norway (RCN):** MoU signed on 14th October 2014, joint programs on common areas of interest will be developed through joint calls in the field of Earth System Science with special emphasis on Polar research and Geo-hazards.
- **Cooperation with Kuwait Institute for Scientific Research, Kuwait** signed on 11th November 2014 for Scientific Research and Technology Development in areas of Earth System Sciences
- Letter of Intent with UNESCO signed on 25th November 2014 for Cooperation for Reducing Disaster Risks and Capacity Building in the Earth Sciences

