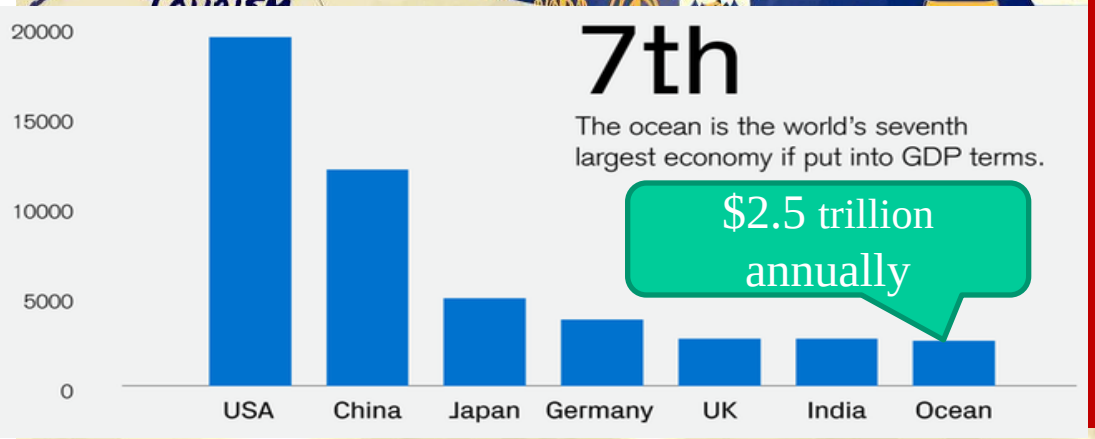
Societal applications of S2S Predictions for Ocean and Coasts

Dr. T.M. Balakrishnan Nair
Group Director & Scientist G
INCOIS, Hyderabad

The Maritime Nation-



Challenges to aspirations

- Increase number and intensity of cyclones
- Increase in Oxygen Minima Zones
- Ocean Acidification
- Depletion in Fishery
- Coastal erosion
- Sea Level rise
- Tsunami

Significance of Ocean Services for India

- India has a coastline of approximately 8,100 km and an Exclusive Economic Zone **of 2.37 million km^2**.
- Waters around India are used for - transportation, fishing, industrial waste and sewage disposal, extraction of oil and gas, etc.
- Ports located along the coastline are vital hubs for import and export of goods.
- Beaches along the coast are important centers for recreation.

- Total Fisher folk Population: 40,56,213
- Potential: About 4.41 million metric tonnes.
- The total area of 26 sedimentary basins of India is about 3.36 million sq. km
- *Major (12) and Minor (200) Ports*
- Traffic handled at 12 major ports : 141924 (in '000 tonnes).
- National Security

- Safe Navigations, Operations, National Security and Blue Economic growth demands Ocean forecast Services

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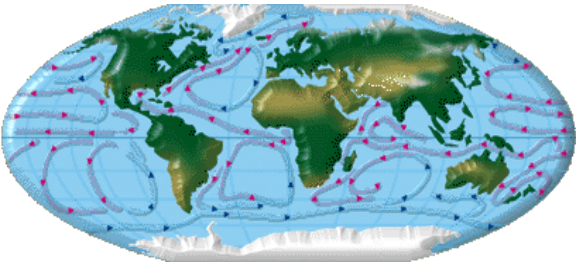
S2S Predictions: Important Ocean Parameters

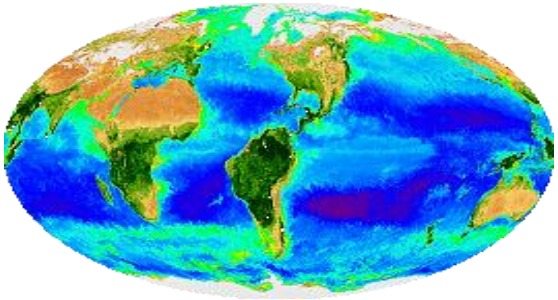
Sea state and marine meteorological

Wave, Swell, Wind, Cyclone, Storm surge



General circulation

Surface current, Sea Surface Temperature, Vertical profile , mixed layer depth, thermocline, undercurrents, tides



Ecological

Fishery, HAB, Coral bleach, productivity,

Marine Water Pollution

Ocean acidification, Oil spill, Pollutants etc.

Maritime Stake holders for S2s Predictions:

All those who depend on Sea for livelihood and those who live on the coasts

- **Fishermen:** INCOIS provides with the Potential Fishing Zone advisories (strengthens livelihood), but a green signal will be issued by OSF to proceed to these sites (to safeguard their life).
- **Disaster Management agencies and State Administration:** During extreme events, providing INCOIS-IMD joint bulletins which consists ocean state information with met. conditions
- **Port & Harbours: R**educes logistics cost for export-import and domestic trade with minimal infrastructure investment and the damages to the Ports during extreme conditions.
- **Maritime Industries (Oil, Shipping, Power)**: Extreme values of sea state given for Installations of new platforms , deployment of rigs, helps to plan their logistics, marine operations efficiently.
- **Navy, Coast Guard, Marine Police:** Smooth operations of their fleet, customised services..
- **Navigators:** Forecast along shipping routes application provides the forecast, along a proposed route and stationary points. Meteorological data and warnings for ship routes.
- **Coastal population and Tourism:** During extreme events and south-west monsoon season, forewarns the adverse situations. Rip current forecast services (in future).
- **Academia and Researchers:** supports the researchers in the fields of various branches of oceanography and meteorology by providing observational and the model data.

S2S Predictions

MARITIME USER NEEDS

RELIABLE AND ACTIONABLE FORECAST/INFORMATION FOR DECISION MAKING

- **SHORT RANGE 1-3 DAYS**
- **MEDIUM RANGE 3-10 DAYS**
- **EXTENDED RANGE(S2S) 10-30 DAYS**
- **LONG RANGE > 30 DAYS**

Impact Forecast

SHORT -TO MEDIUM RANGE WEATHER - INFLUENCED ACTIONS

- Issue warnings
- Distribute humanitarian aid
- evacuation

LONG - RANGE WEATHER - INFLUENCED ACTIONS

- Start monitoring forecasts
- Update contingency plans
- Inform strategic planning decisions

S2S WEATHER-INFLUENCED ACTIONS

Early Warning	Disaster Management Authorities (**Preparedness coastal flooding, storm/swell, High wave, financial risk rategies, Inform loss scenarios, Community updating**) Coastal Zone Management Authorities (Seasonal forecast in Coastal erosion)
Fishery/Ecco. Services	Fisheries Services (safety & Catch) Ecological Services (Habitat Suitability, Marine Heat waves)
Blue Economy	**Naval Exercises (Long term planning)** **Shipping (Optimum ship routing. Inland Vessel Limits)** **Oil Industries (Eddy forecast, Sub surface currents), Tourism (Planning the surf, Rip current)**

Generation-Early Warning Services

Threshold Values of parameters

Approved Standard Operating Procedure

Warning	Criteria
Storm Surge	Surge Height >0.5m
High Wind Wave Alert Services	Wind wave heights above thresholds (Alert:3.0-3.5m; Warning:>3.5m)
High Swell Wave Alert Services	Swell wave heights above thresholds (Alert:2.5-3.0m; Warning:>3.0m)
Swell Surge (Kallakadal)Alert)	Swell period > 18s
Kondalkattu Alert	Sudden increase in wind speeds to 25 m/s within a period of less than 3 hours
Perigean Tidal Flooding Alert	Spring tide coinciding with moon perigee (moon close to earth)

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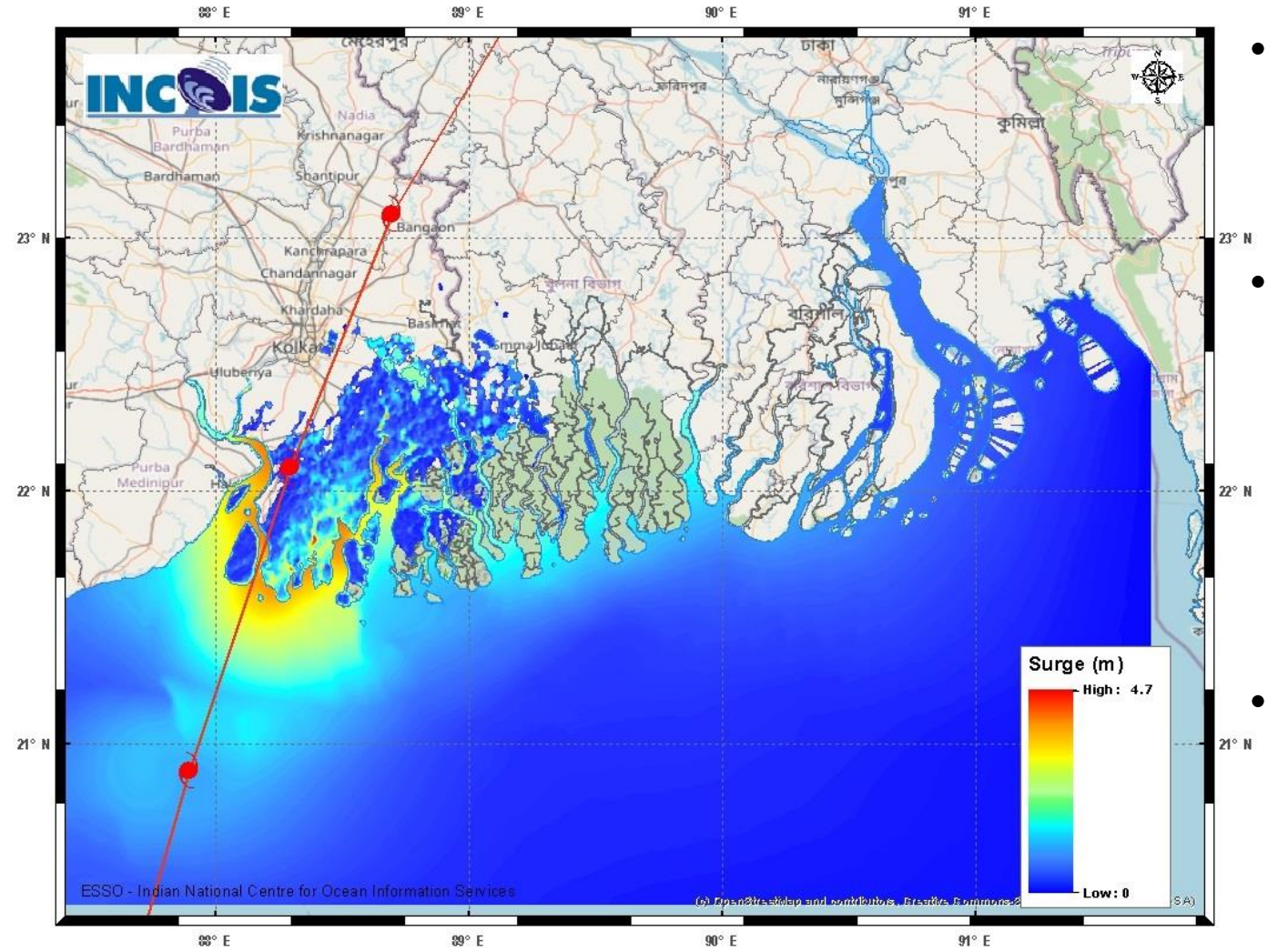
Storm Surge Advisory during Super Cyclone Amphan



- INCOIS issued 16 No of bulletins to IMD on storm surge forecast.
- The Maximum Surge forecast as **around 4.7 M near Bhangar –I, South 24 Parganas, West Bengal**
- Expected Maximum Inundation Extent was **around 15 - 20 km near Bhangar-1 & Diamond Harbour , South 24 Parganas.**

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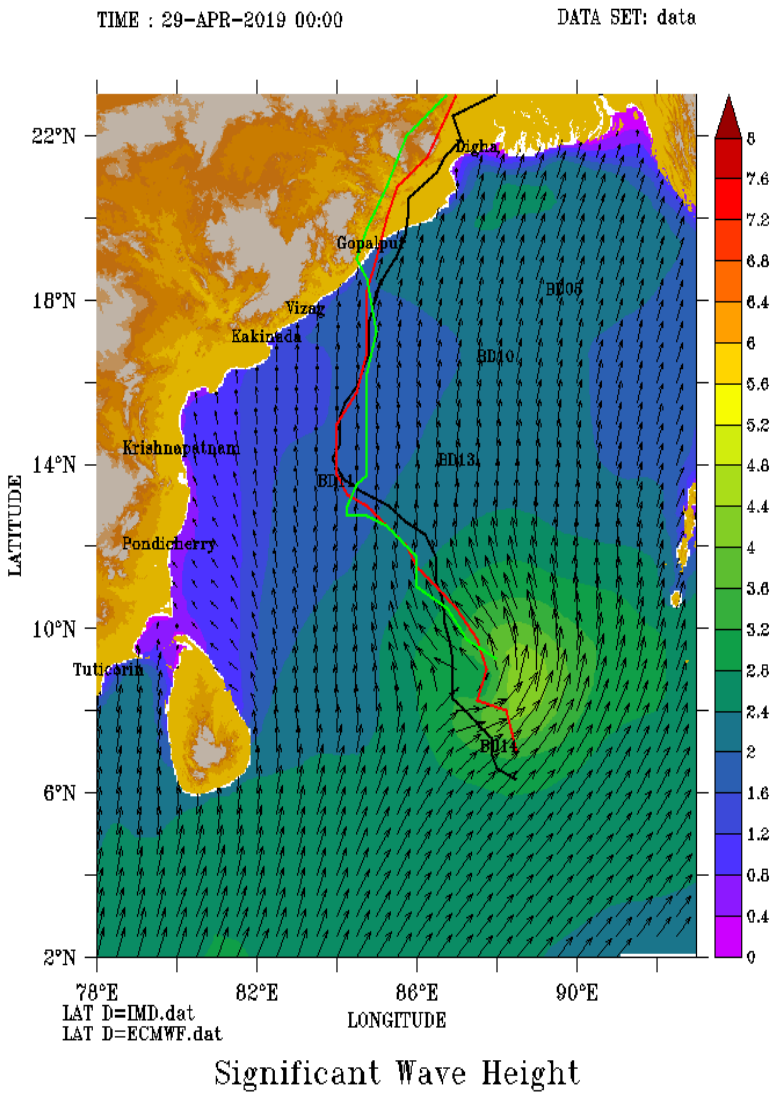
High Wave Warning



Significant Wave Height

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MESSAGE

FROM: ESSO-INDIAN NATIONAL CENTRE FOR OCEAN INFORMATION SERVICES (Ea
System Science Organisation, Ministry of Earth Sciences, Government of India) (E-Ma
osf@incois.gov.in, Website: www.incois.gov.in, FAX NO. +91-40-23892910)

INCOIS-IMD JOINT BULLETIN

: Senior MET Officer, Eastern Naval Command, Indian
Navy Commandant, Indian Coast Guard, East Region
Commandant, Indian Coast Guard, North East Region
Commandant, Indian Coast Guard, A & N Region
Commandant, Indian Coast Guard, West Region
Chief Secretary, Government of Andhra Pradesh
Chief Secretary, Government of Tamil Nadu
Chief Secretary, Government of West Bengal
Chief Secretary, Government of Odisha
Chief Secretary, Andaman & Nicobar Islands
Chief Secretary, Puducherry
Chief Secretary, Government of Kerala
State Disaster Management Authority, Andhra
Pradesh State Disaster Management Authority, Tamil
Nadu State Disaster Management Authority, Odisha
Chilika Development Authority (CDA; INCOIS Project),
Bhubaneswar Andhra University (INCOIS Project), Visakhapatnam
Basanti Devi College (INCOIS Project), Kolkata
IKSL- Odisha, Andhra Pradesh and West Bengal
State Disaster Management Authority, Kerala
Commandant, Indian Coast Guard, Southern Region
DNOM, Indian Navy
Reliance Foundation, Mumbai
MSSRF (INCOIS Project), Chennai
PMSSS, Puducherry
Administrator, UT Puducherry
Kamaraj College, Tuticorin
Ports in Andhra Pradesh, Tamil Nadu, Andaman & Nicobar, West Bengal,
Odisha Shipping Corporation of India.
T.V. & Radio channels and newspapers of relevant states/UT

Time of issue: 21:00 IST Dated: 02.05.2019, Bulletin No.: INCOIS/02/05/2019

Sub: INCOIS-IMD Joint Bulletin - Ocean State Forecast associated with Extre Severe Cyclonic Storm "FANI" over Westcentral Bay of Bengal: Cyclone Warnin Odisha, West Bengal and Srikakulam, Vijayanagaram & Visakhapatnam Distric Andhra Pradesh Coasts: Red Message

The Extremely Severe Cyclonic Storm "FANI" (pronounced as 'FONI') over Westcentral B Bengal moved northwards with a speed of about 15 kmph in last six hours and lay centred at urs IST of 02nd May, 2019 over Westcentral Bay of Bengal near latitude 17.5°N and long 84.8°E, about 275 km south-southwest of Puri (Odisha), 160 km east-southeas Vishakhapatnam (Andhra Pradesh) and 570 km south-southwest of Digha (West Bengal).

The current wind speed of the cyclone is 200-210 kmph gusting to 225 kmph. Light to moderate rainfall has already started in coastal districts of North Andhra Pradesh and South Odisha. Squally wind speed reaching 50-60 kmph reported over north coastal Andhra Pradesh and strong wind speed reaching 30-40 kmph reported over south coastal Odisha.

It is very likely to move north-northeastwards and cross Odisha Coast between Gopalpur and Chandbali, south of Puri during tomorrow the 3rd May forenoon with maximum sustained wind speed of 170-180 kmph gusting to 200 kmph. Landfall process is very likely to continue till noon/afternoon of tomorrow the 3rd May.

After the landfall the system is very likely to continue to move north-northeastwards, weaken gradually and emerge into Gangetic West Bengal as a Severe Cyclonic Storm with wind speed of 90-100 Kmph gusting to 115 Kmph by early morning of 4th. It is very likely to move further north-northeastwards and emerge into Bangladesh on 4th May evening as a Cyclonic Storm with wind speed 60-70 Kmph gusting to 80 Kmph.

High Wave/Ocean State warning/alert for Andhra Pradesh, Odisha,West Bengal and Tamil Nadu

Andhra Pradesh:

Table: Forecasted wave height and swell height for coastal region into the ocean upto 10 km off Andhra Pradesh

Location	From (IST)	To (IST)	Significant Wave Height (m)	Swell Height (m)
Srikakulam	2330hrs, 02-05-2019	2330 hrs, 03-05-2019	4.5-7.5	1.6-2.4
Vizianagaram	2330hrs, 02-05-2019	2330 hrs, 03-05-2019	3.3-4.9	2.5-3.0
Vishakhapatnam	2330hrs, 02-05-2019	2330 hrs, 03-05-2019	3.3-4.9	2.5-4.1
Godavari (East & West)	2330hrs, 02-05-2019	2330 hrs, 03-05-2019	3.1-3.5	2.0-2.9
Krishna	2330hrs, 02-05-2019	2330 hrs, 03-05-2019	3.0-3.5	1.5-2.5
Guntur	2330hrs, 02-05-2019	2330 hrs, 03-05-2019	2.0-2.5	1.5-2.5
Prakasam	2330hrs, 02-05-2019	2330 hrs, 03-05-2019	2.0-2.5	1.5-2.0
Nellore	2330hrs, 02-05-2019	2330 hrs, 03-05-2019	1.6-2.2	1.5-2.2

Offshore: High Ocean State associated with the cyclone Fani in the open ocean (off Andhra Pradesh): Waves heights in the range of 3.0 – 7.5 meters (approximately 100 Km away from the coast) are forecasted during 23:30 hours on 02-05-2019 to 23:30 hours of 03-05-2019. Surface Current speeds vary between 140 - 220 cm/sec.

Odisha:

Table: Forecasted wave height and swell height for coastal region into the ocean upto 10 km off Odisha

Location	From (IST)	To (IST)	Significant Wave Height (m)	Swell Height (m)
Balasore	2330hrs, 02-05-2019	2330 hrs, 03-05-2019	3.5-4.8	1.0-1.5

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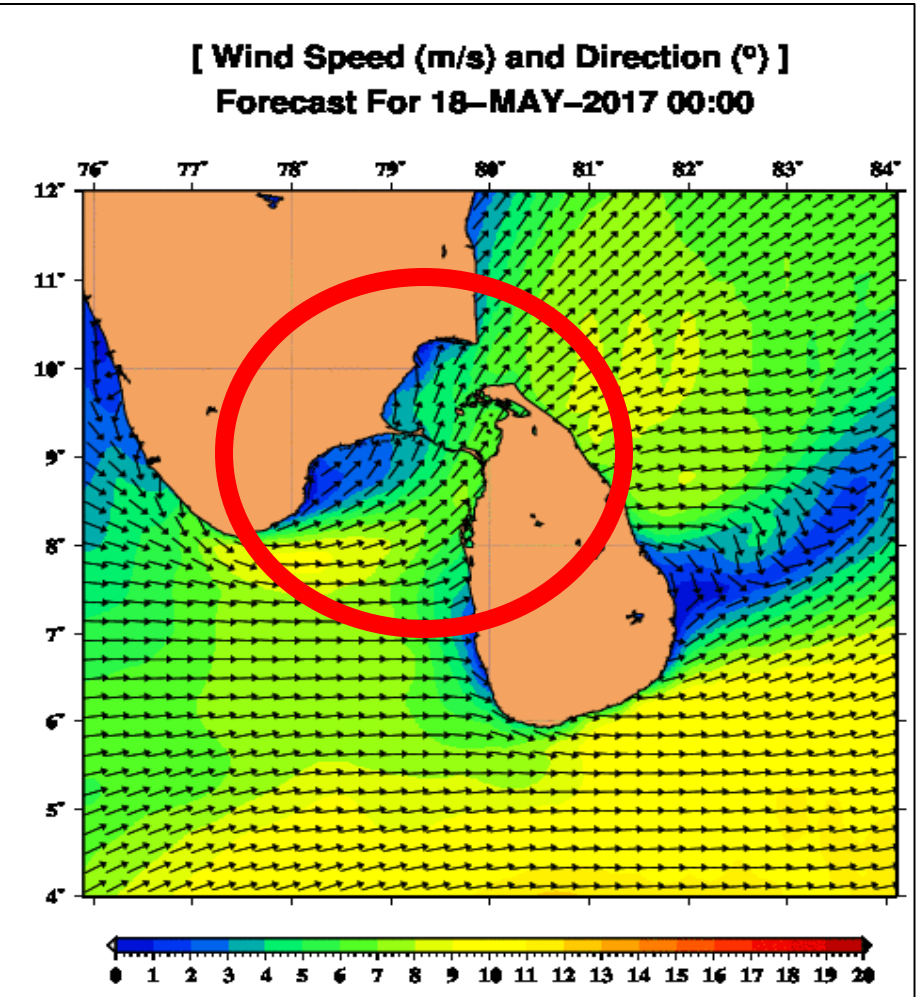
Early warnings (High Wave Alert-Kondal Kattu)

Kondalkattu forecasting (Location Specific Forecast) on high winds (for 18th May 2017)

Kondal Kattu is a **Gusty wind (nearly 25 m/s) that occurs near Rameswaram Coast during April - May**. And sustains 2-3 hours **. To forecast these gusty winds, high resolution WRF model was setup** for southern peninsular India).



High Wave Alert (Associated with this Kondalkattu) issued on 17th May 2017:

There is a possibility of higher waves (2.5 to 3.5 m) particularly off the coast from Kolachal to Rameswaram from 20.30 hrs on 18-05-17 to 05.30 hrs of 19-05-2017 due to higher wind speeds. Fishermen are advised to be cautious while venturing into the sea.

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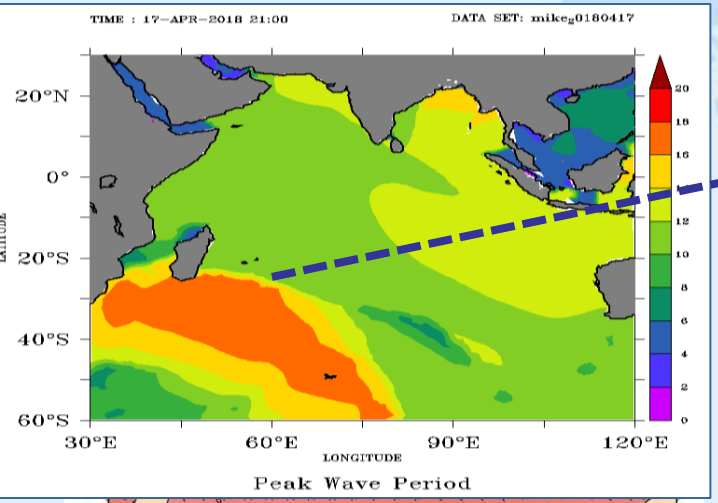
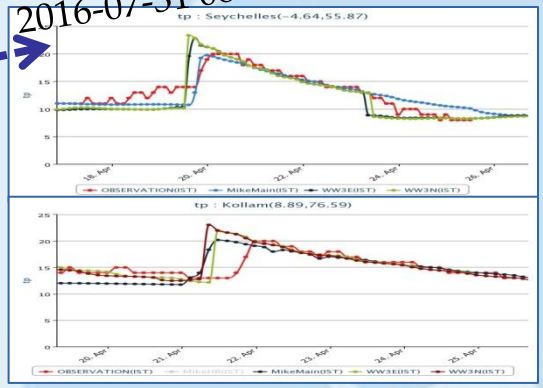
SWELL SURGE (Kallkadal) Warning

: 30 Jul- 03 Aug, 2016



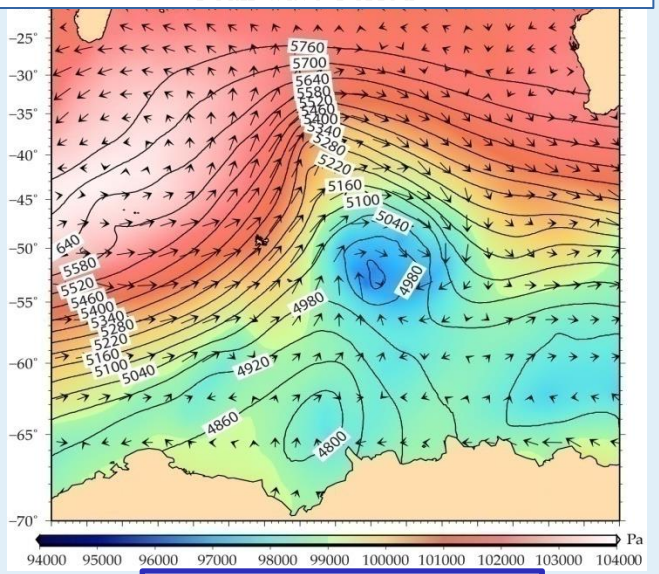
Caught in Seychelles Buoy
2016-07-31 08:00 UTC



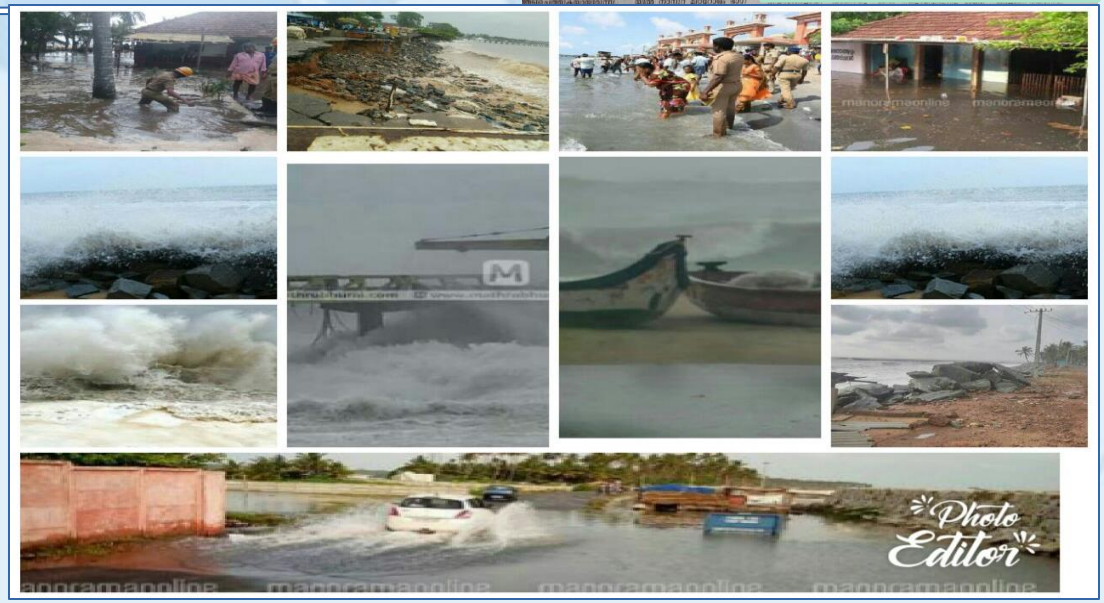
Swell surge during Unexpected sea surge at Alappuzha coast, **27 fishing boats washed away**, Indian Express, 2nd August 2016


പുന്നപ്രയിൽ സുനാമി മോഡൽ കടലേറ്റം
28 വള്ളങ്ങൾ തകർന്നു; നഷ്ടം മൂന്ന് കോടിയിലേ

Malayala Manorama



INCOIS Warning



INCOIS has issued wave surge alert for low lying coastal areas of Kerala from 30 Jul. 2016-03 Aug. 2016

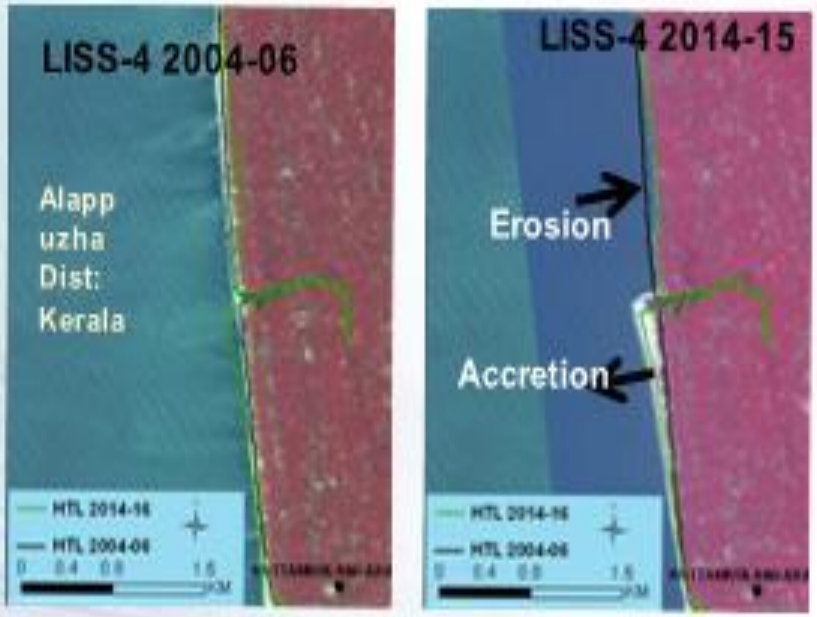
Coastal Erosion Forecast

Coastal Erosion

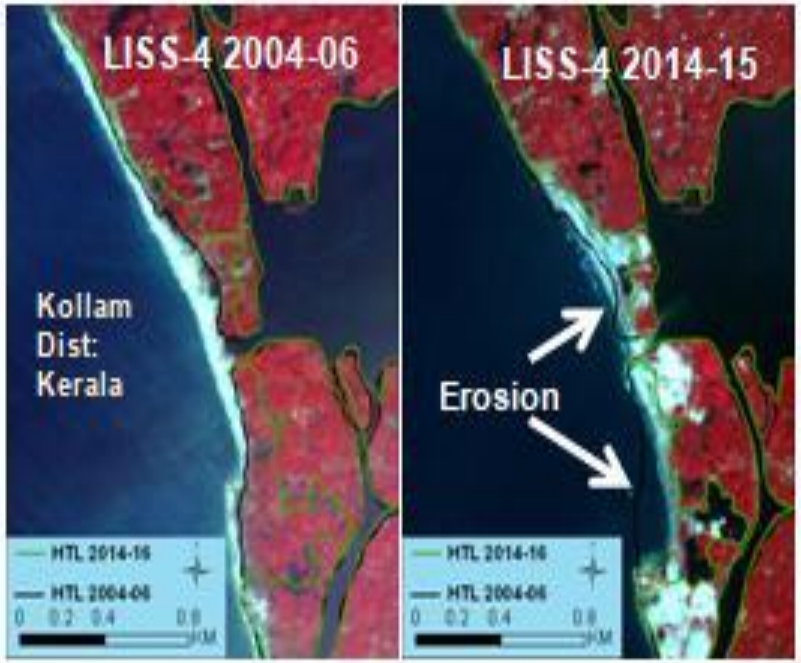
- Agriculture is one of the most vulnerable sectors to inundation by saltwater, particularly in low-lying coastal areas
- Costal erosion can be due to various reasons which can be man made or natural or climate driven
- South west monsoon waves are identified as one of the major reason for coastal erosion along coastal India

Few examples of coastal erosion along south west coast of India

Shoreline Change induced by coastal constructions



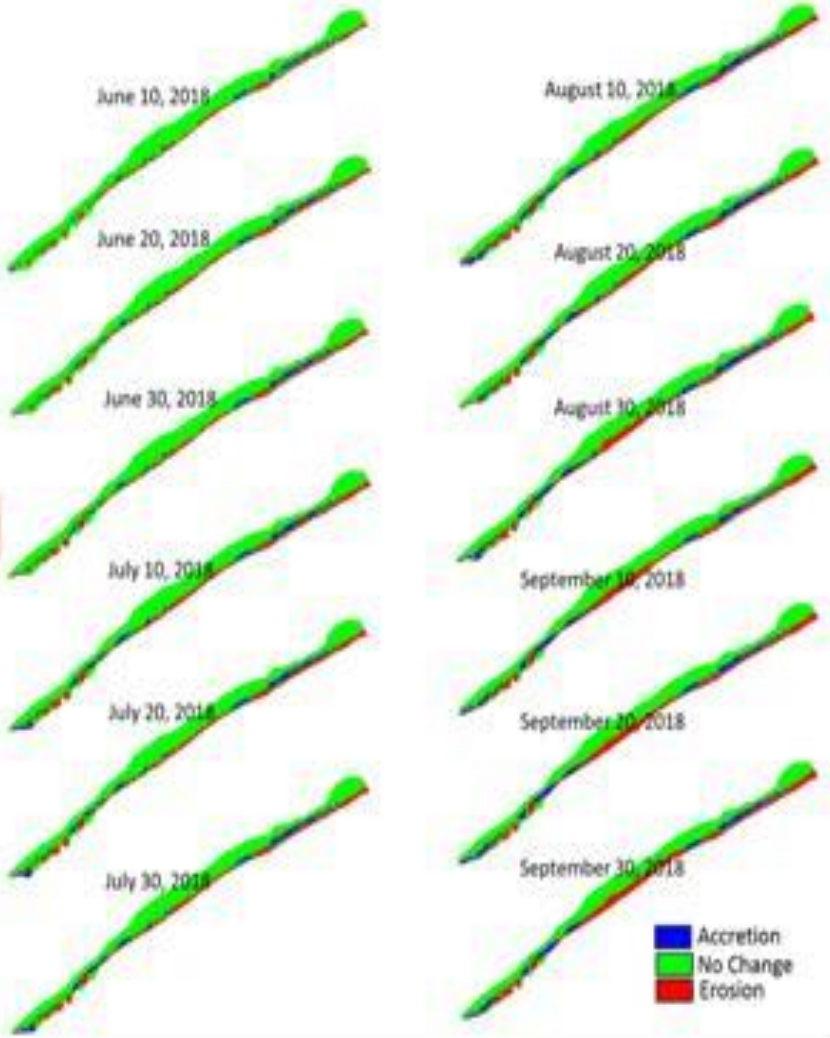
Coastal Erosion due to sand mining activities



Coastal Erosion Forecast

Beach Erosion Forecast during Monsoon Season – A way to handle monsoon wave induced coastal erosion

Beach erosion advisory provided with a lead period of 10 days.



Comparison of beach erosion prediction with insitu measurements

DRR: Ready-Set-Go!

S2S forecasts offer the opportunity for disaster risk reduction (DRR) managers.

Decision-making for disaster management that uses short- to long-range predictions.

1. Seasonal forecasts can provide the ‘Ready’ monitoring information and early contingency planning such pooling the infrastructure & agencies

2. Sub seasonal forecasts provide the ‘Set’ early warnings and alerting of Agencies such as NDRF, Coast Guard Navy etc.

3. Short-range weather forecasts the ‘Go!’ activation stage, including evacuation and distribution of aid

(Goddard et al., 2014, Vitart, 2014a)

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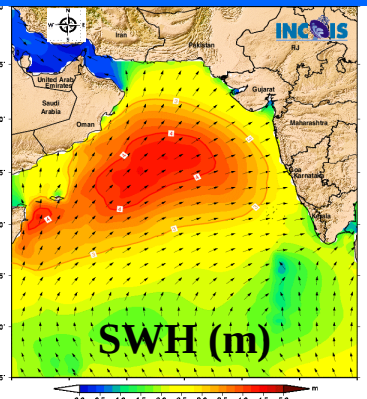
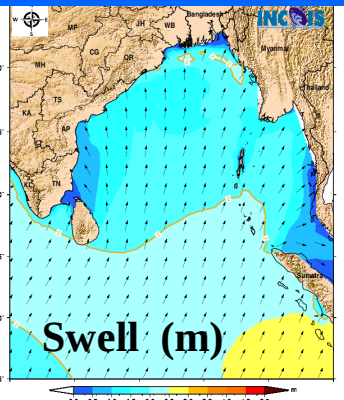
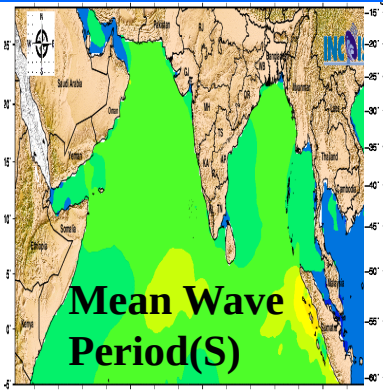
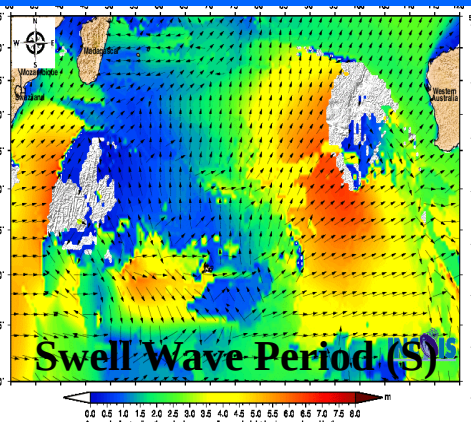
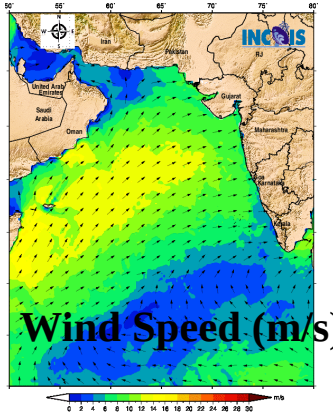
Extended Ocean State Forecast (OSF)

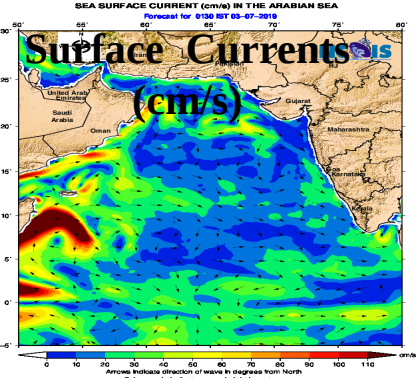


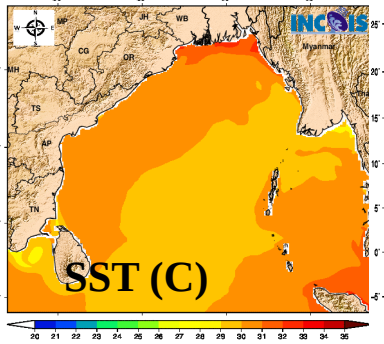


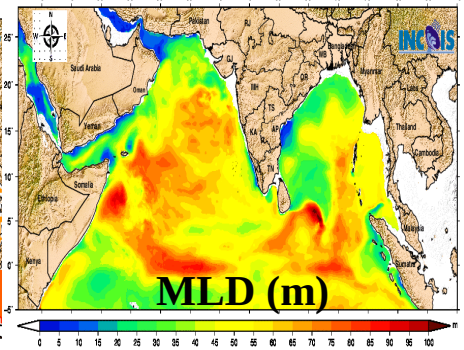


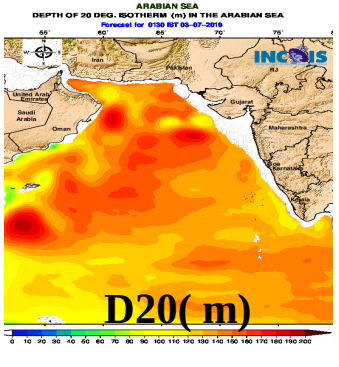


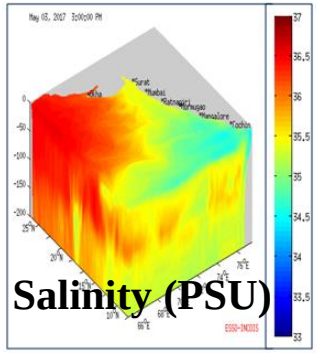




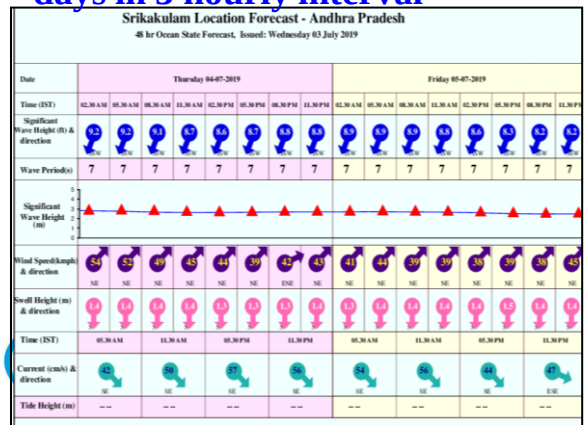




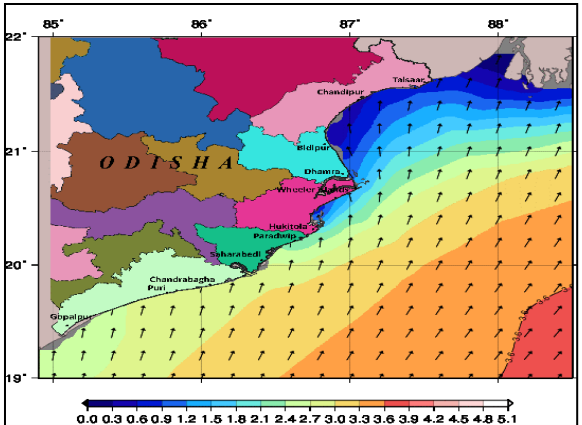




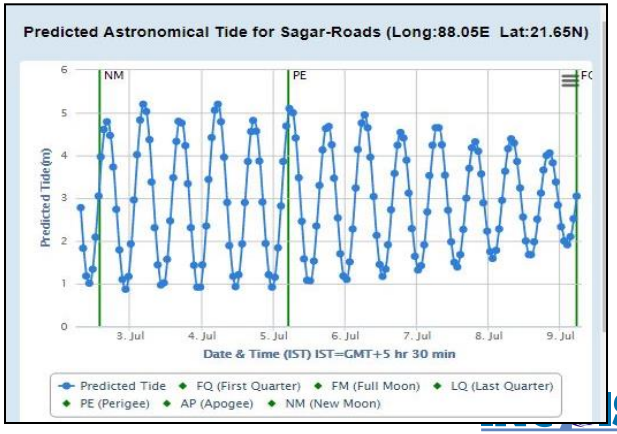
Location Specific Forecast for next 2 days in 3 hourly interval



Coastal Forecast for next 7 days in 3 hourly interval



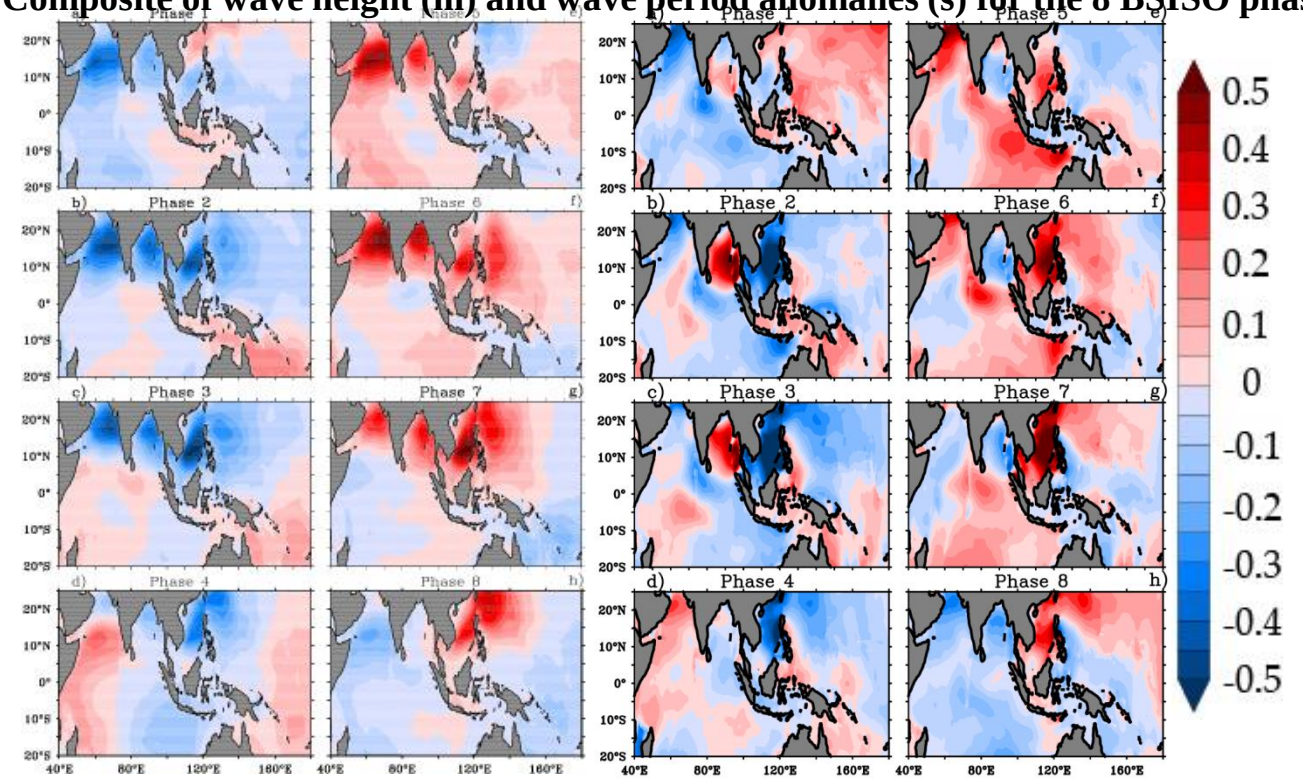
Tide Level forecast for next 6 days



Extended Wave and coastal erosion Forecast based on BSISO Index

IMD-ERF Model Forcing (32 days)

Composite of wave height (m) and wave period anomalies (s) for the 8 BSISO phases during JJA (1979–2017)



Phase 1-4

Windows for Marine Operations and Navigation

Phase 5-8

Coastal Erosion Preventive measures

1. **The active phases of BSISO creates significant positive anomaly of Hs in NIO during monsoon**
2. **The increase in Hs during the active phase of BSISO will strengthen this impact of wave on western coastal areas of India.**
3. **Conversely the break phases of BSISO will reduce the wave activity in the AS and the marine operations and coastal areas will be less impacted.**
4. **This study clearly shows that extended wave forecast advisories based on the BSISO phases will be more useful for the marine and costal community for the proper planning of the operations as well as for taking preventive measures during monsoon.**

Fishery Advisory & Forecast: Present Status

Identifying the Habitat suitability for fish aggregation

Validation by filed experiments and insitu data

Ocean Services	
Fishery Services	
PFZ	SST and Cholorophyll
Tuna	SST, Chl, Kd-490 (Water Clarity)
Hilsa	Salinity, temperature, chlorophyll and water quality
Ecological Services	
Algal Bloom Services	Chlorophyll-a, SST, bloom type, plankton size
Jelly Fish forecast services	Temperature, salinity, chlorophyll, suspended sediment
Coral bleach	Temperature

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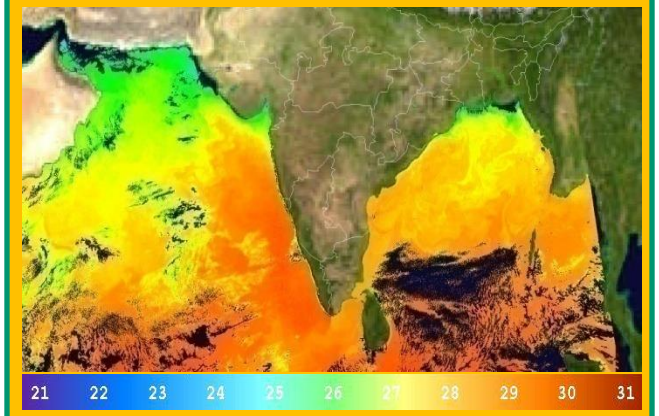
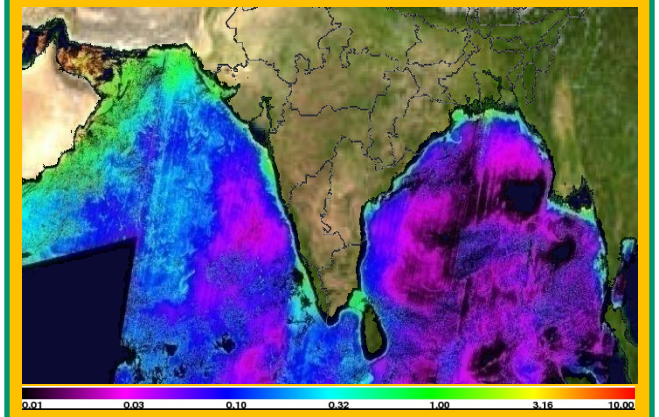
Fishery Advisory - Key Indicators

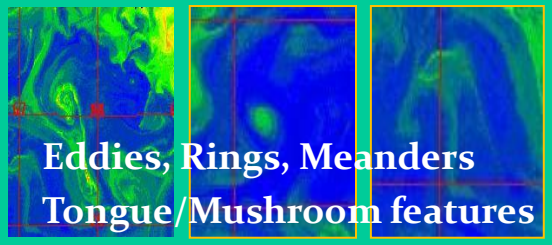
Sea Surface Temperature



Chlorophyll



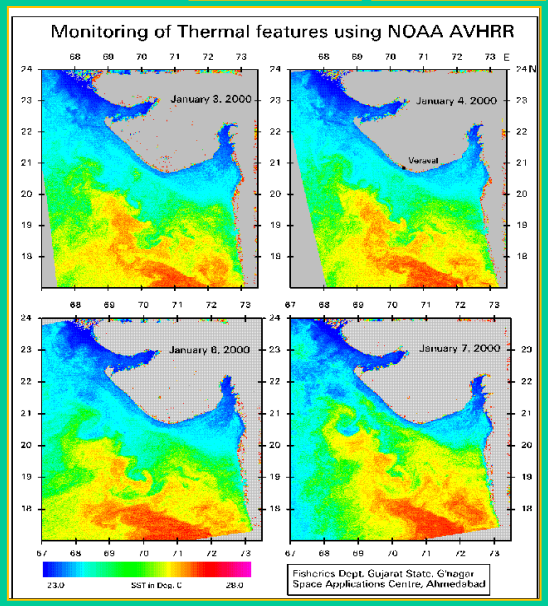
Satellite Data Products



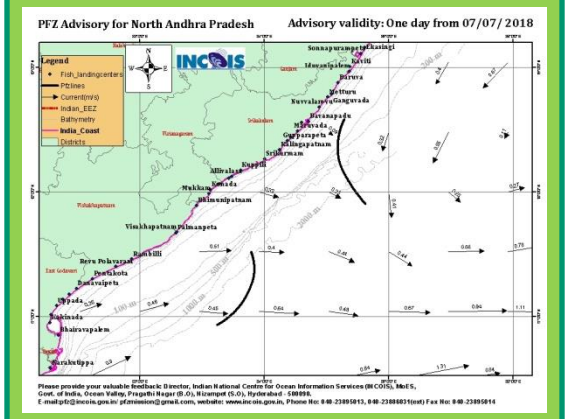
Eddies, Rings, Meanders

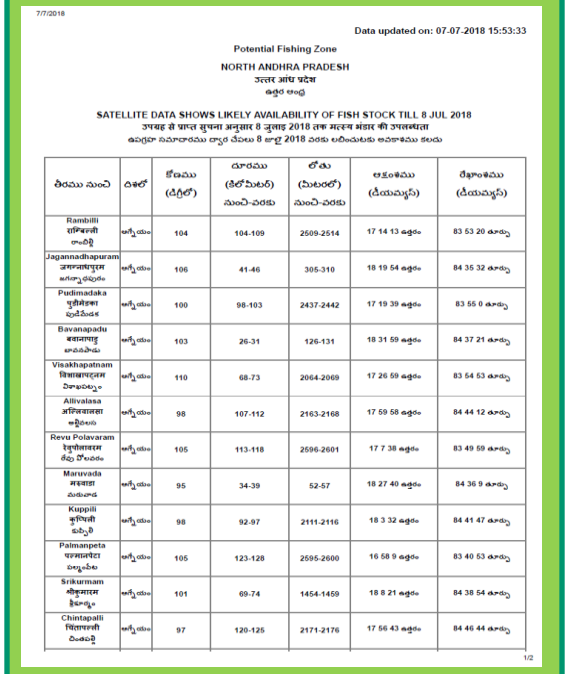
Tongue/Mushroom features

Upwelling ,Thermal Fronts



Key Indicators





7/7/2018

Data updated on: 07-07-2018 15:53:33

Potential Fishing Zone

NORTH ANDHRA PRADESH

SATELLITE DATA SHOWS LIKELY AVAILABILITY OF FISH STOCK TILL 8 JUL 2018

తీరము నుంచి	దిశలో	కోణము (డిగ్రీలో)	దూరము (కిలోమీటర్) నుంచి-చరకు	లోతు (మీటరులో) నుంచి-చరకు	ఆక్షాంశము (డీయమ్మగు)	రేఖాంశము (డీయమ్మగు)
Rambilli రాంబిల్లి	అన్నీయం	104	104-109	2509-2514	17 14 13 ఉత్తం	83 53 20 తూర్పు
Jagannadhapuram జగన్నాధపురం	అన్నీయం	106	41-46	305-310	18 19 54 ఉత్తం	84 35 32 తూర్పు
Pudimadaka పుడిమేడక	అన్నీయం	100	98-103	2437-2442	17 19 39 ఉత్తం	83 55 0 తూర్పు
Bavanapadu భవనాపాడు	అన్నీయం	103	26-31	126-131	18 31 59 ఉత్తం	84 37 21 తూర్పు
Visakhapatnam విశాఖపట్నం	అన్నీయం	110	68-73	2064-2069	17 26 59 ఉత్తం	83 54 53 తూర్పు
Allivalasa అల్లివలస	అన్నీయం	98	107-112	2163-2168	17 59 58 ఉత్తం	84 44 12 తూర్పు
Revu Polavaram రేవుపోలవరం	అన్నీయం	105	113-118	2596-2601	17 7 38 ఉత్తం	83 49 59 తూర్పు
Maruvada మరువాడ	అన్నీయం	95	34-39	52-57	18 27 40 ఉత్తం	84 36 9 తూర్పు
Kuppili కుప్పిలి	అన్నీయం	98	92-97	2111-2116	18 3 32 ఉత్తం	84 41 47 తూర్పు
Palmanpeta పాలమాంపేట	అన్నీయం	105	123-128	2595-2600	16 58 9 ఉత్తం	83 40 53 తూర్పు
Srikurmam శ్రీకూర్మం	అన్నీయం	101	69-74	1454-1459	18 8 21 ఉత్తం	84 38 54 తూర్పు
Chintapalli చింతపల్లి	అన్నీయం	97	120-125	2171-2176	17 56 43 ఉత్తం	84 46 44 తూర్పు

1/2

PFZ Advisories

Fishery: Implication of S2s Forecast

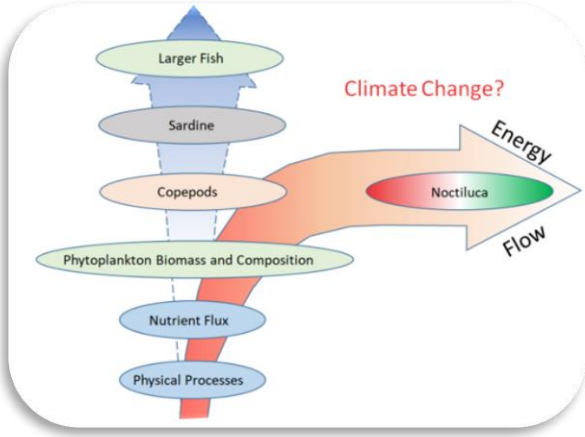
Predicting Habitat Suitability	Mari-culture site suitability

Dynamical seasonal forecasts to predict water temperatures, thermal fronts and Ocean Currents help in PFZ services and Species wise forecast such as Tuna and Hilsa.

Advance warning of both extremely warm or cold water temperatures would give Mariculture managers time to respond and adapt management strategies to maximize production (e.g. balanced nutritional requirements) and minimise mortality (e.g. from disease).

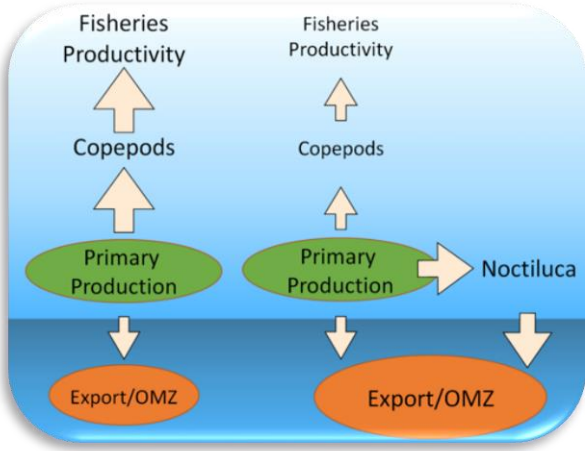
Algal Bloom Information Service

Tourism



Food chain malfunct

Fish kill



Water Quality

ESSO

INCOIS

Coral Bleaching Alert System (CBAS)

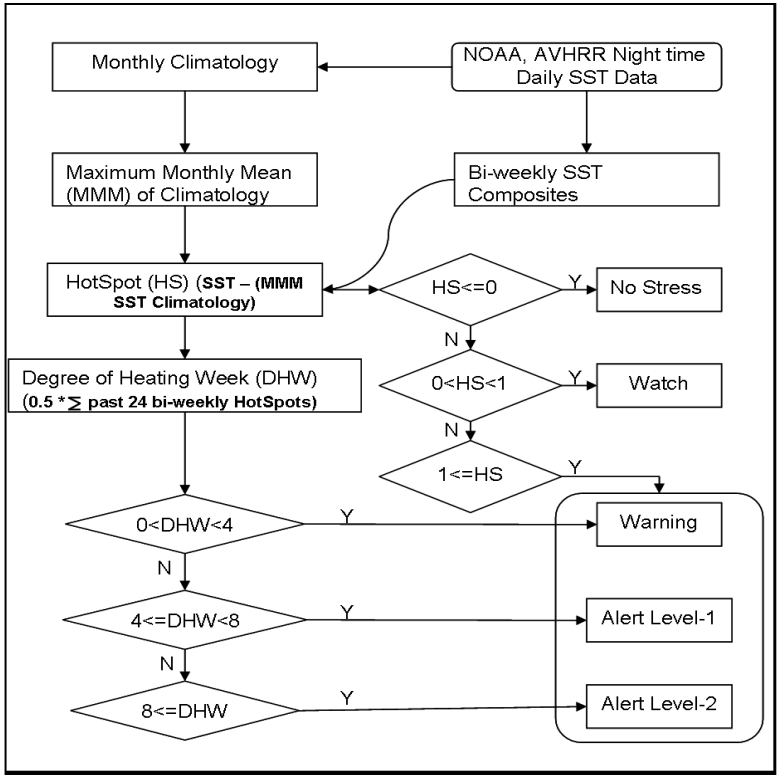
"Satellite based coral bleaching alert service to assess the thermal induced coral health"

Objectives:

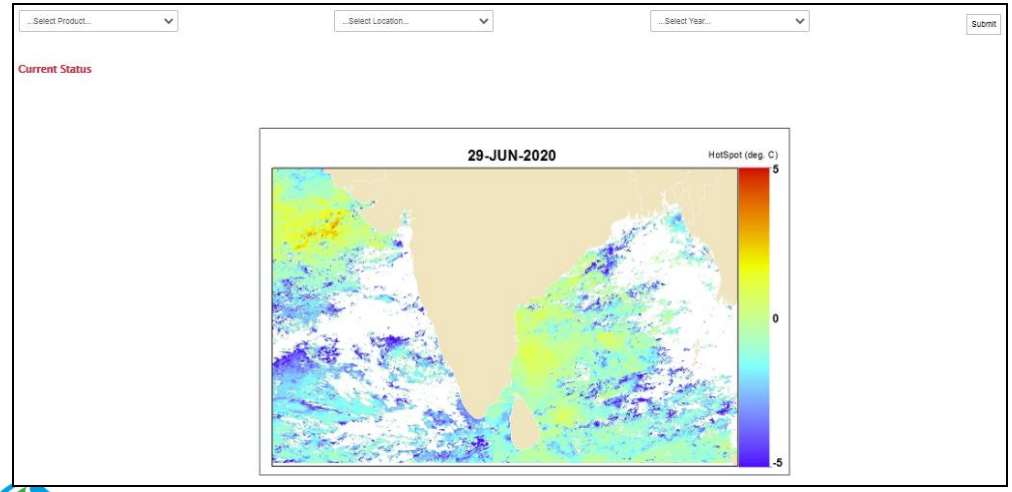
1. **Generation of bi-weekly product of HotSpot (HS) and Degree of Heating Weeks(DHWs) based on satellite derived SST in order to assess the thermal stress accumulated in the coral environs which leads to coral bleaching.**

Hot Spot (° C) = SST – (MMM SST)

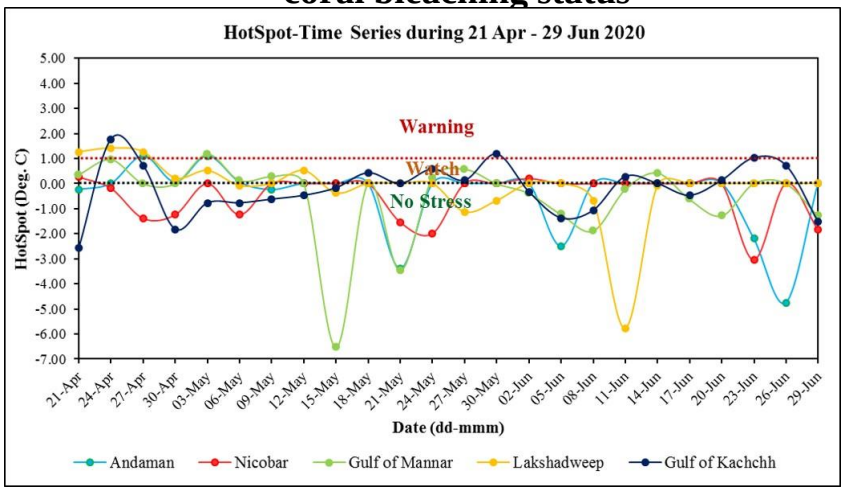
DHWs (° C-week) = 0.5 * ∑ preceding 24 bi-weekly HS



Methodology and the decision criteria for the coral bleaching status

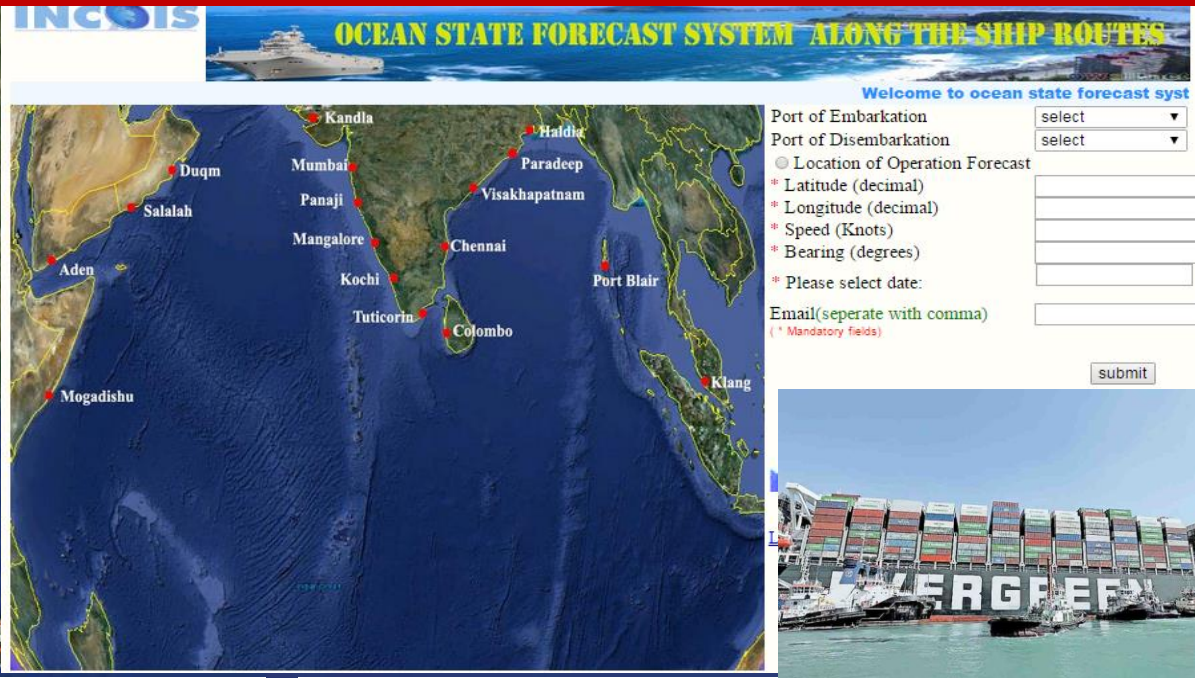


CBAS web home page



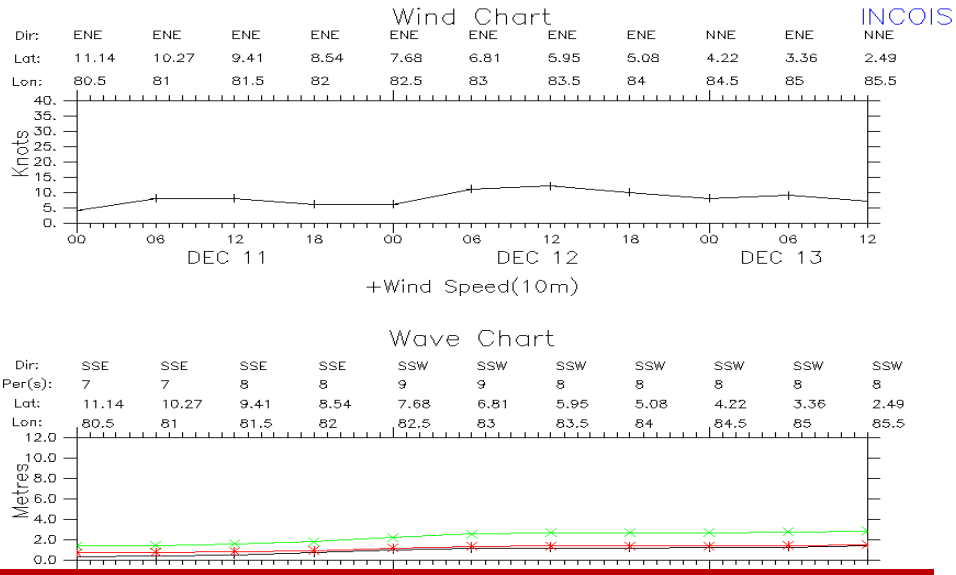
HotSpot Time Series at coral environs

Optimum Ship Routing



Valid at	Lon	Lat	Wind Dir	Wind speed	Wind-sea	Swell Dir	Swell Height	Swell period	SWH	MWH	Current speed	SST
11-DEC-2014 00	80.51	11.14	ENE	4	0.61	SSE	0.68	7.21	0.30	1.35	.722	27.45
11-DEC-2014 06	81.02	10.27	ENE	8	0.60	SSE	0.71	7.37	0.37	1.40	.285	27.57
11-DEC-2014 12	81.52	9.41	ENE	8	0.63	SSE	0.80	7.61	0.49	1.57	1.43	27.84
11-DEC-2014 18	82.03	8.54	ENE	6	0.61	SSE	0.91	8.42	0.67	1.78	2.37	27.55
12-DEC-2014 00	82.53	7.68	ENE	6	0.57	SSW	1.13	8.96	0.97	2.17	.473	27.50
12-DEC-2014 06	83.04	6.81	ENE	11	0.66	SSW	1.30	8.76	1.11	2.51	.692	29.04
12-DEC-2014 12	83.54	5.95	ENE	12	0.74	SSW	1.37	8.49	1.14	2.65	.801	29.45
12-DEC-2014 18	84.04	5.08	ENE	10	0.72	SSW	1.36	8.35	1.15	2.63	.811	29.35
13-DEC-2014 00	84.54	4.22	NNE	8	0.65	SSW	1.37	8.06	1.20	2.64	.933	29.54
13-DEC-2014 06	85.04	3.36	ENE	9	0.69	SSW	1.41	8.00	1.23	2.73	.935	29.84
13-DEC-2014 12	85.54	2.49	NNE	7	0.58	SSW	1.46	7.89	1.34	2.82	.662	30.26

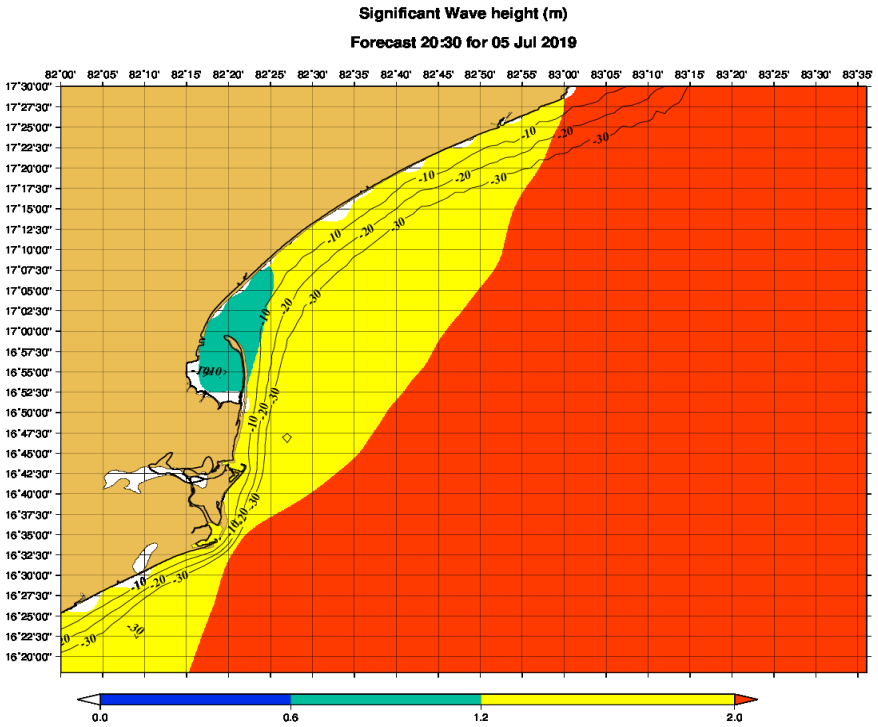
Notes: Time is in GMT format. Wind speed and current are in Knots. Wind-sea and swell height are in metres. SST is in Centigrade. Swell period is in seconds. The Significatnt wave height(SWH) is defined as the average of the highest 1/3rd of waves. The Maximum wave height(MWH) is the average of the highest 1% of the waves. -999.0 is bad value.



User: Shipping, Cruise liners

Dynamic Inland Vessel limits (IVL) Forecast

The Inland Vessel Limits (IVL) facilitates the extension of usage of inland waterways by vessels. IVL categorizes the safety of vessels by dividing the inland water area into three zones based on maximum significant wave height criteria; Zone 1 (1.2M ≤ SWH≤ 2M), Zone 2 (0.6 M ≤ SWH≤ 1. 2 M), and Zone 3 (SWH <0.6 M).



Dynamic IVL near the Andhra Pradesh coast on 05-07-2019

IVL forecast (7 days) on daily basis for Andhra Pradesh, Andaman & Nicobar and Maharashtra coasts.

ESSO

User: Maritime Boards

OIL COMPANIES: Forecast of ocean currents and waves:

S2s Prediction of Eddies
S2s Prediction of Swells

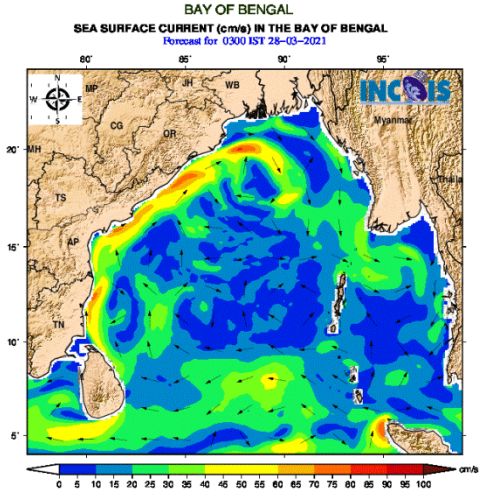
Location Specific Forecast For ONGC

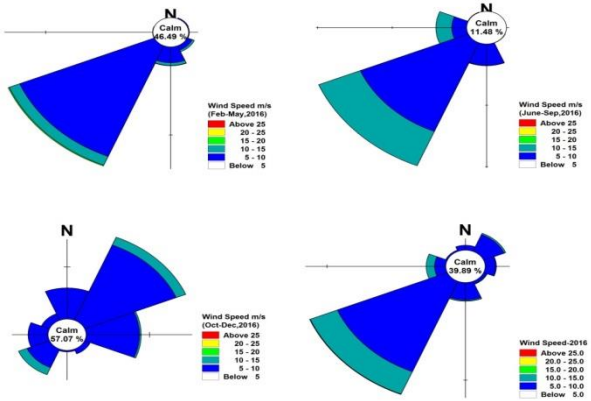
6 Day Sea State Forecast, Issued: Monday 13 August 2018

Lat : 16.313 Lon : 82.296 Depth : Surface Well Name:KDG–E

Date	Monday 13 August 2018 (Eddy Current : Absent, Loop Current : Present)								Tuesday 14 August 2018							
Time (IST)	02.30 AM	05.30 AM	08.30 AM	11.30 AM	02.30 PM	05.30 PM	08.30 PM	11.30 PM	02.30 AM	05.30 AM	08.30 AM	11.30 AM	02.30 PM	05.30 PM	08.30 PM	11.30 PM
Current Speed (knots) & direction	2.2 S 171	1.9 S 179	1.6 S 174	1.7 SSE 155	1.9 SSE 155	2.0 SSE 162	2.0 S 175	1.9 S 171	1.7 SSE 168	1.8 SSE 159	1.9 SSE 162	1.8 SSE 165	1.7 SSE 164	1.7 SSE 151	1.5 SSE 153	1.4 SSE 149
CurrentSpeed (Knots)	6 5 4 3 2 1 0															

Date	Wednesday 15 August 2018								Thursday 16 August 2018							
Time (IST)	02.30 AM	05.30 AM	08.30 AM	11.30 AM	02.30 PM	05.30 PM	08.30 PM	11.30 PM	02.30 AM	05.30 AM	08.30 AM	11.30 AM	02.30 PM	05.30 PM	08.30 PM	11.30 PM
Current Speed (knots) & direction	1.6 SE 129	2.1 ESE 114	2.6 ESE 108	2.9 ESE 107	2.9 ESE 111	2.8 ESE 115	2.6 ESE 118	2.6 ESE 120	2.4 ESE 124	2.4 SE 129	2.2 SE 137	1.7 SSE 160	1.6 SW 215	1.6 SW 223	1.5 SW 217	1.5 SSW 208
CurrentSpeed (Knots)	6 5 4 3 2 1 0															



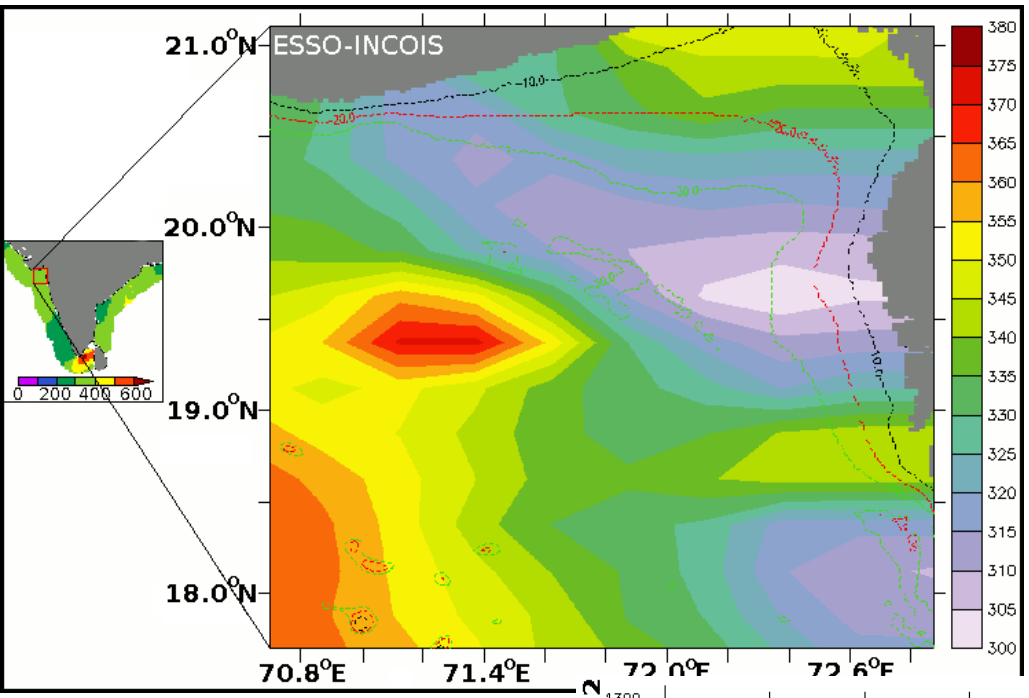


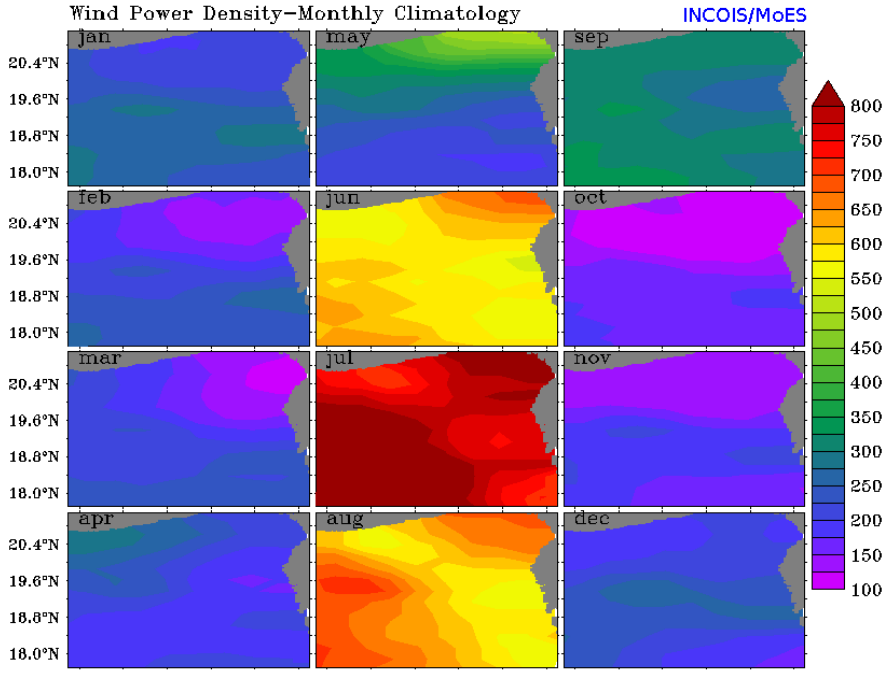
Histograms of wind and current and directions during the year 2016.

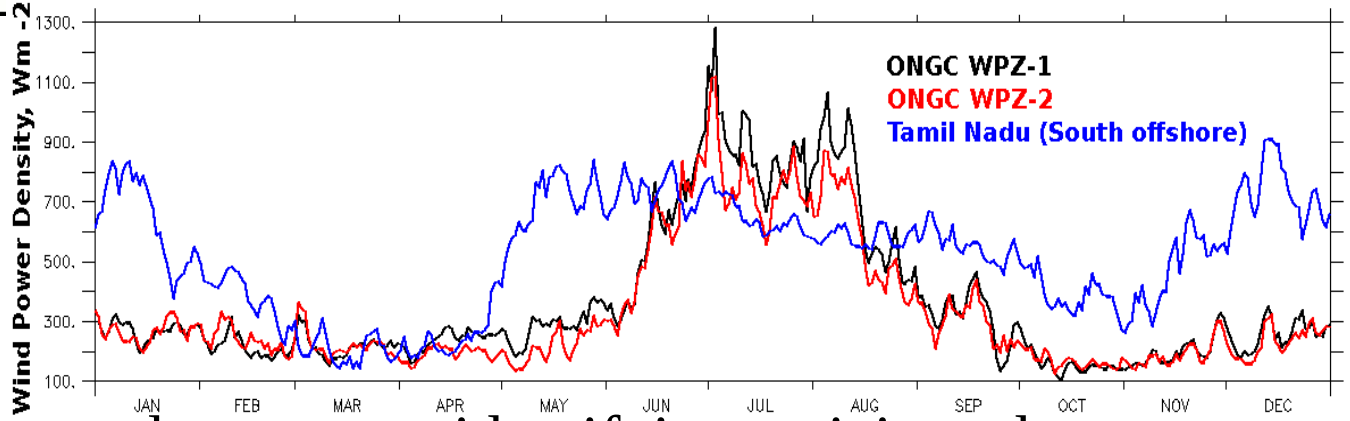
Providing hindcast and forecast data for 3 years at EOA KG-DWN-98/2 site off the east coast of India

ESSO

FORECAST OCEAN WIND AND WAVE POWER DENSITY







S2S forecasts could be used to support identifying anticipated energy peaks and other weather-related energy trading opportunities and risks

ESSO

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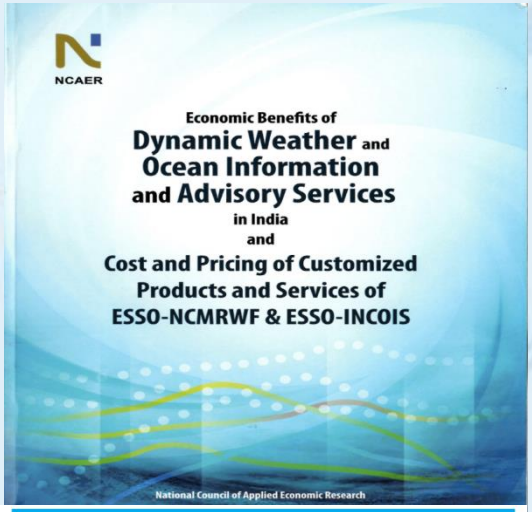
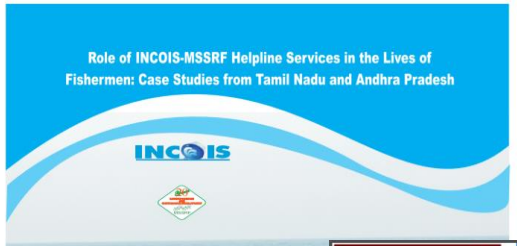
Impact and socio-economic benefits of services





- Identifications of PFZs as well as Ocean State forecast by INCOIS are found to be both timely, accurate and of significant value to the fishing community.

- **"The overall economic benefits due to OSF services would be the cumulative benefits realized by Indian Navy, Indian Coast Guard, value addition to oil and gas exploration etc. as per our computations exceed Rs. 3.7 trillion.**

- **The environmental effect of savings in diesel consumption computed as carbon credit would work out to an annuity of Rs 36,200 crore.**

- **"Since five 'no go ahead mission' advisories were provided since 2013 till date, the net benefits during 2013-2015 works out to be Rs. 4161.9 crore". (Indian Navy)**

INCOIS

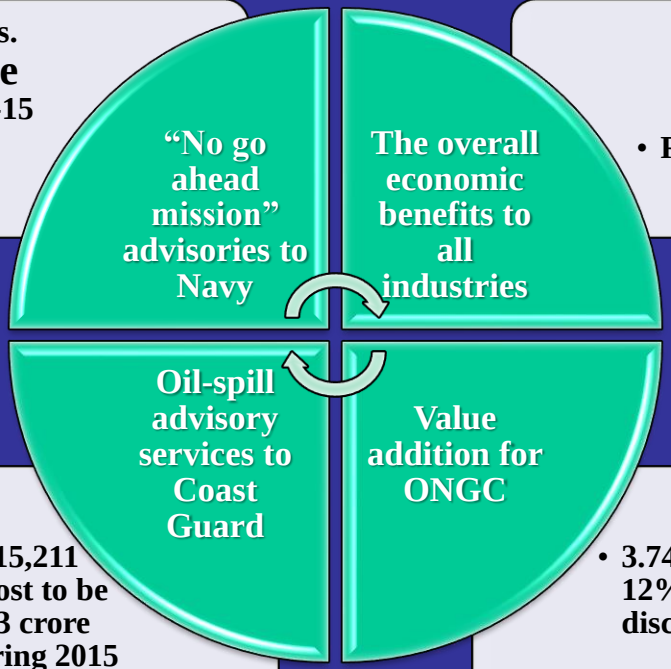
Impact and socio-economic benefits of Ocean services

Economic Benefits of Services

Annual Economic Benefit	Additional profit in hands of fishers	Per boat Profits	Reaching entire fishermen community
Rs. 34,000 to 50,000 Crore	Rs 3,000 Cr annuity with investment of Rs.32 Crore	Success : ~ 80% Profit: 03–04 times Less Search Time:30 to 70%	Marine fisheries GDP increase from 3.9% - 7.8 % per annum

Forecast Services

- Benefit by Rs. 4161.9 crore during 2013-15



- Rs 3.7 trillion
- Spill of 15,211 tonne, cost to be Rs. 89.43 crore only during 2015
- 3.74 trillion at 12% social discount rate

Fishery Services

Executive Summary of National Council of Applied Economic Research (NCAER) Survey Report and Results of PFZ Validation Experiments during X – XI Plan Period

Concluding....

S2S Predictions have significant role to pay for improving Early Warning and t Marine Services for Oceanogenic DRR, Fishery Services and Support the Blue Economy Stakeholders

Thank you very much

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