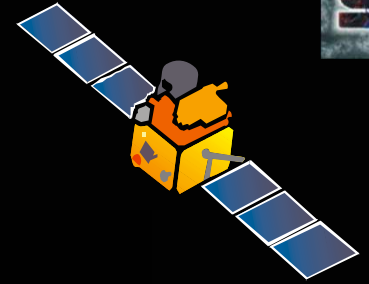


Transforming Lives through Space Applications



Space-based Ocean Science and Applications

Contributing to UN Ocean Decade Initiatives !!

Rashmi Sharma
Space Applications Centre
Indian Space Research Organisation
Ahmedabad

NRSC User Interaction Meet-2024: 12-13 Mar, 2024

- ❖ Oceans : Driver for Economic Growth !
- ❖ Oceans : Climate change impacts !

Blue Economy Components

- ❖ Traditional ocean industries: Fisheries, Tourism & Maritime transport
- ❖ New/Emerging: Renewable energy, Aquaculture, Seabed activities, Marine biotechnology & Bioprospecting

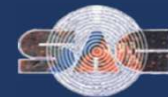
Ocean Decade

The science we need for the oceans we want

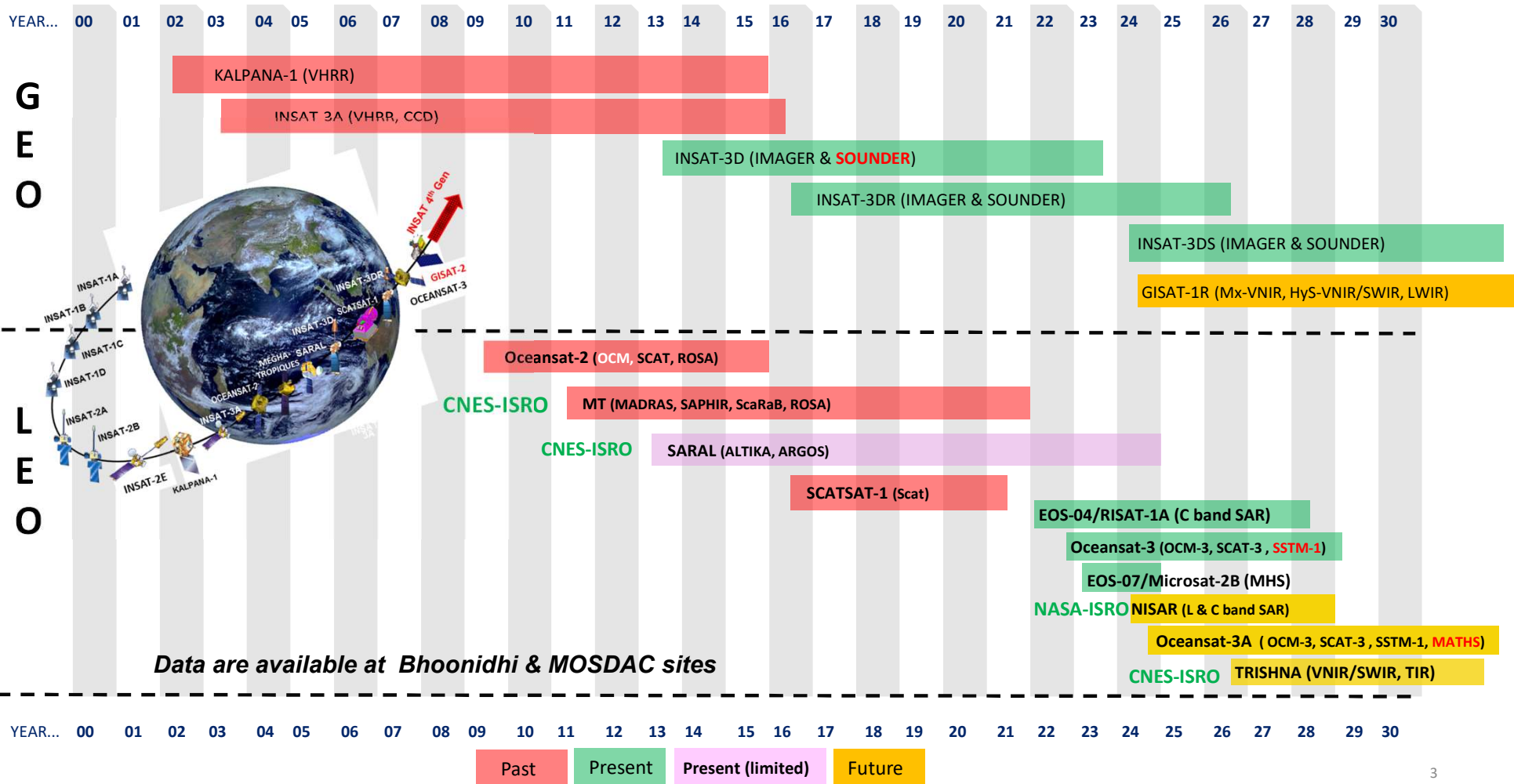
Challenges : Beat Pollution, Protect Ecosystem, Sustainably feed the population, Equitable Ocean Economy, Ocean solution to climate change, Increase community resilience to ocean hazards, Community resilience to hazards, **Expand Ocean Observing Systems**, Create digital representation, Skill, Knowledge & Technology, Change Human-Ocean relationship



ISRO satellite systems – Met & Ocean



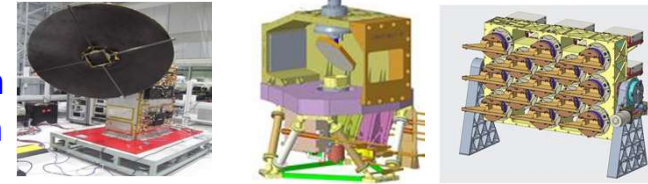
Atmosphere & Ocean



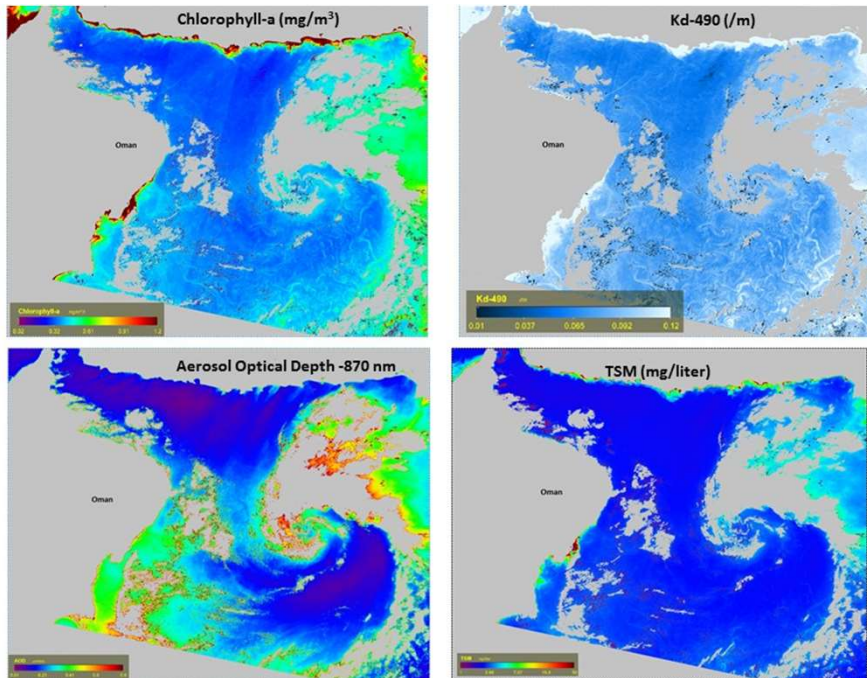
Oceansat-3 (EOS-6)

Oceansat-3 (2021) and Oceansat-3A:

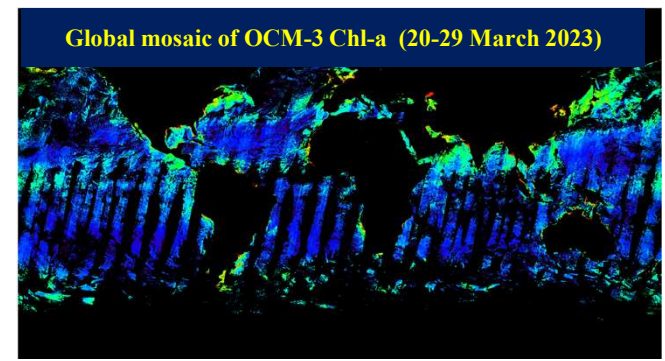
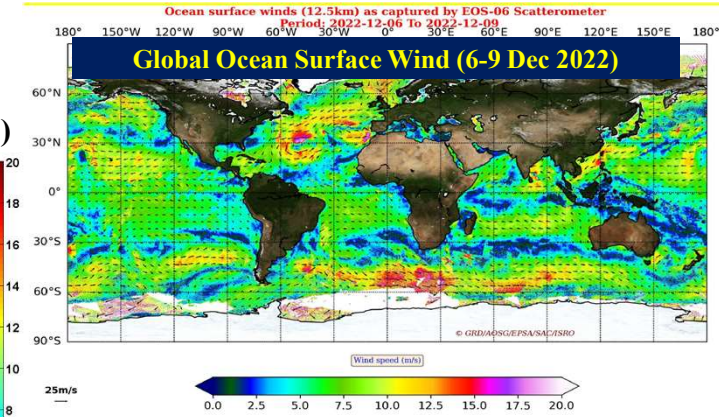
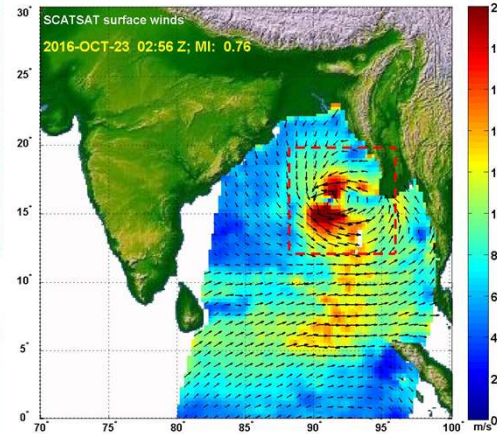
- Ku-band Scatterometer (SCAT-3), High resolution (12.5 km) mode, Exp. mode @5km
- 13-band Ocean Colour Monitor (OCM-3) – Additional bands with narrow bandwidth
- 2-band Sea Surface Temperature Monitor (SSTM) – Dual frequency thermal bands



OCM-3: Operational Products (20 Jan' 23)

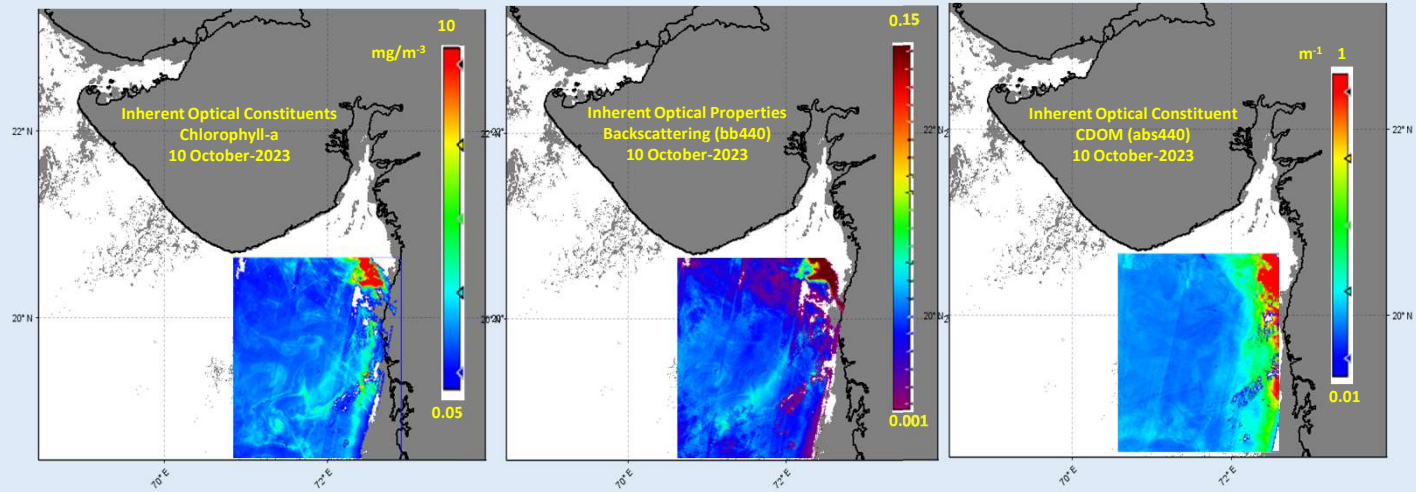


SCAT-3: Surface Winds (23 Oct' 23)

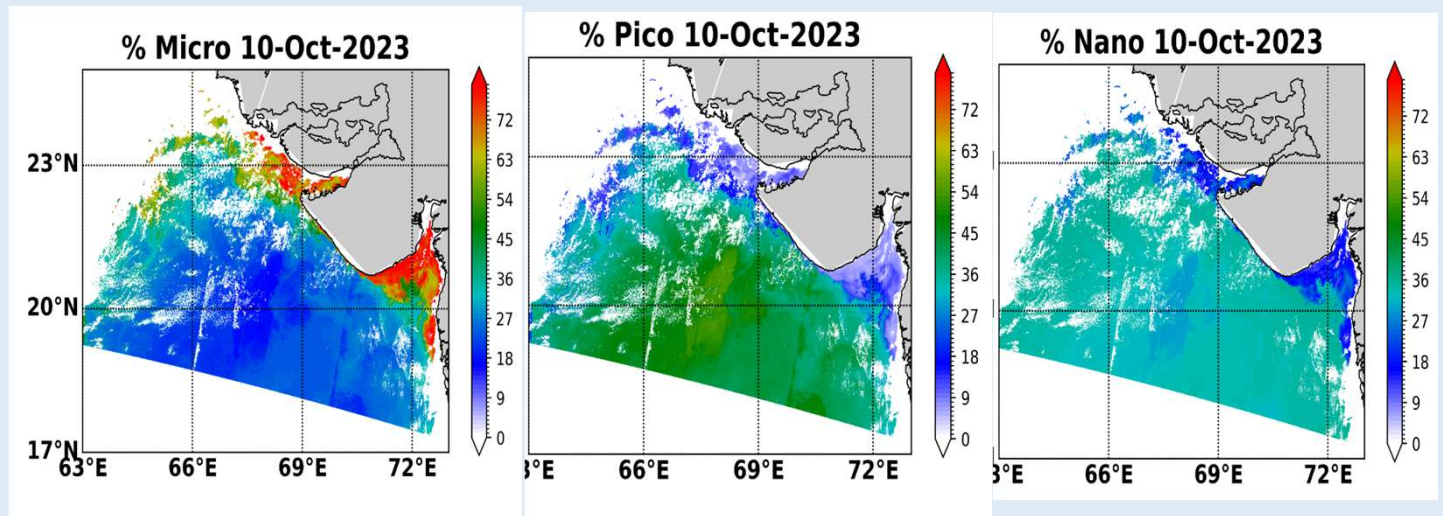


New Science Products from EOS-6/OS3 (OCM)

Inherent
Optical
Properties
(IOPs) &
Constituents



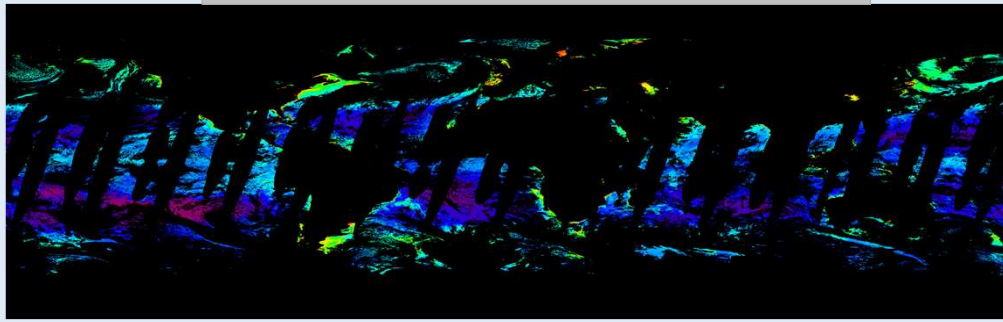
Phytoplankton
Community
Structure



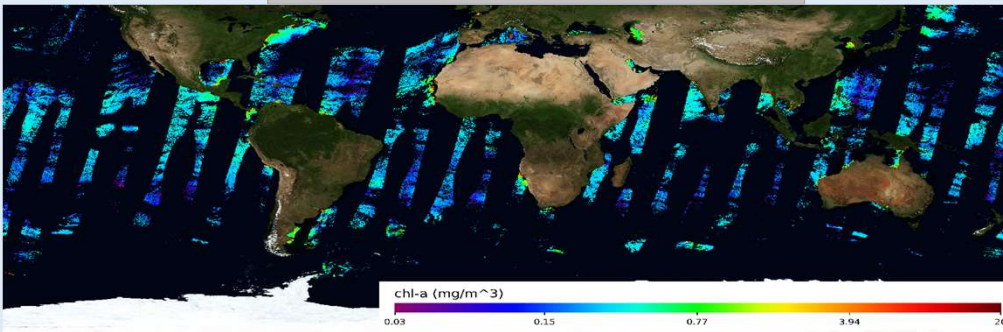
EOS-6/OS3 Ocean Colour Monitor: New Developments

Radiometric Analysis & VCal Results

TERRA-MODIS – 21st March 2023

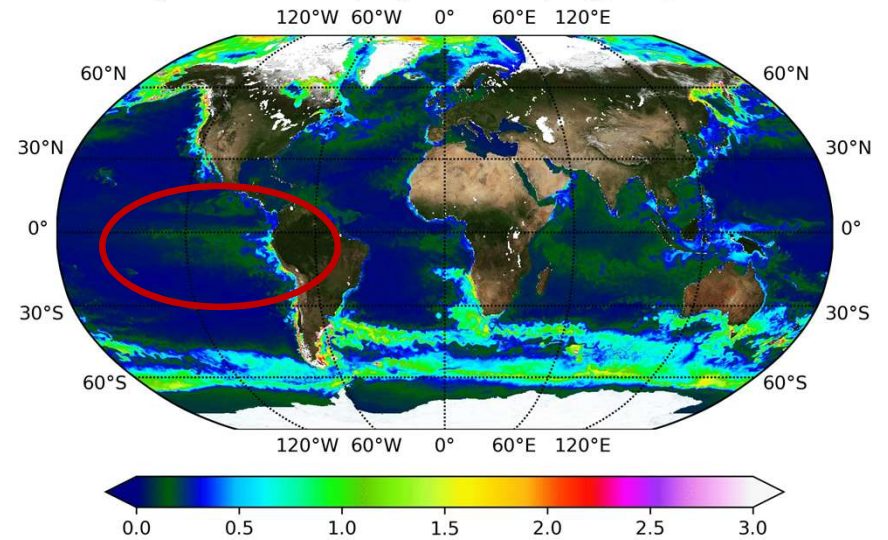


OCM3 – 21st March 2023



Global Analysed Daily Chlorophyll Product

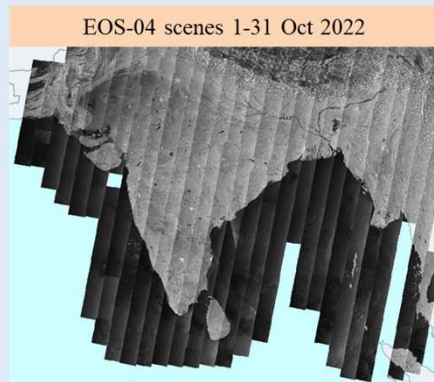
OCM-3 Analyzed Chlorophyll Field (mg/m^3) on 2023-09-05



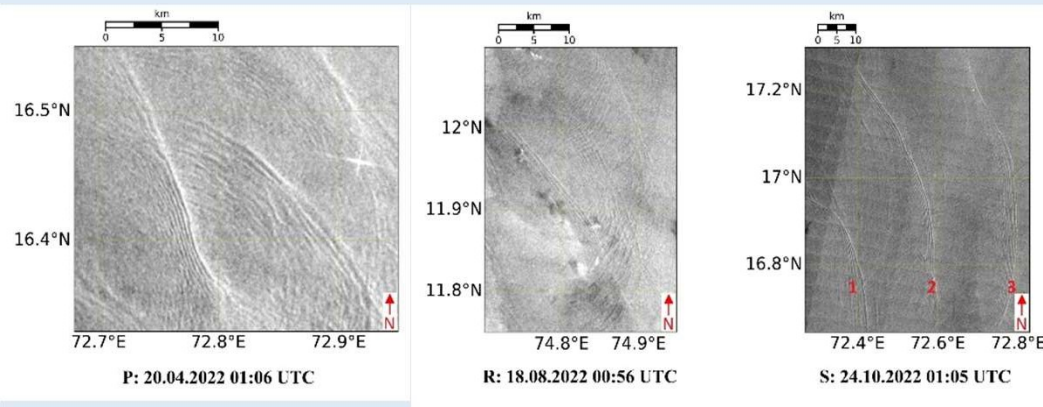
Science Question: Can one get an early signature of large scale climate events such as ENSO and IOD in the surface chlorophyll?

EOS-04: Ocean Internal Solitary Waves Studies

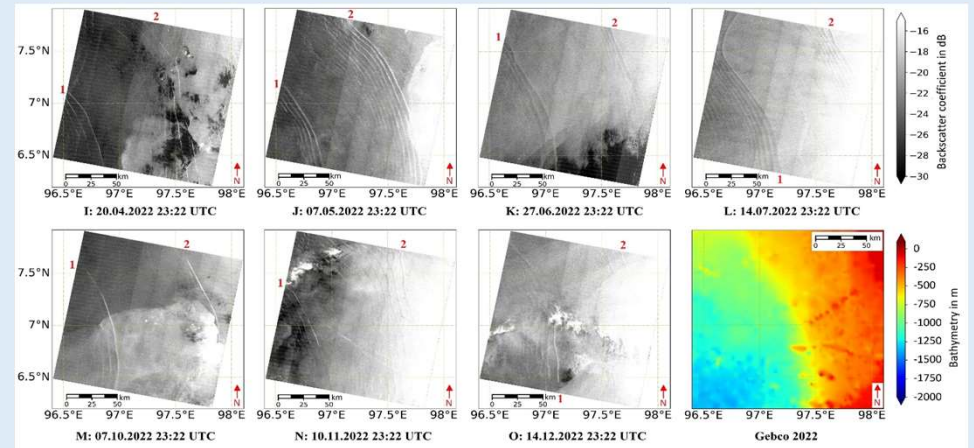
EOS-04 : Good Coverage over the Indian Ocean



Distinct ISW characteristics in the Arabian Sea captured by EOS-04



Seasonal variability of ISW in the Andaman Sea: Analysis using EOS-04 images

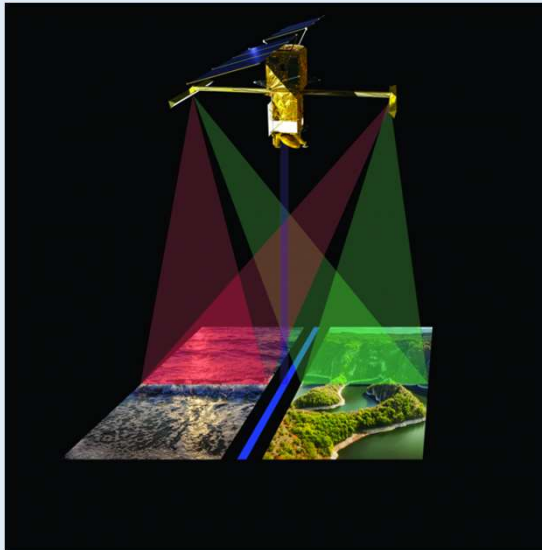


Characteristics and Variability of Internal Solitary Waves (ISW) in the Indian Ocean region ? (Anup et al., IJRS 2024)

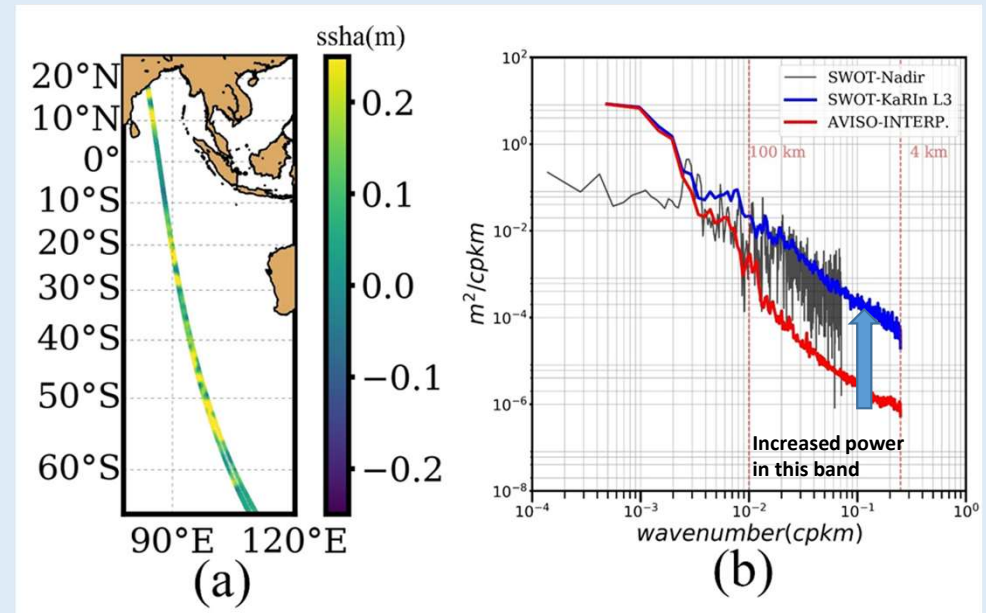
Science Questions: What is the effect of ISW on Ocean mixing in the Indian Ocean region ?

SWOT (NASA/CNES): Fine Scale Oceanography & Land Hydrology

First of swath altimeter Ka-band SAR Interferometry



Power Spectral Density from swath altimeter data



Drivers :

- Oceanography – Fine scale Oceanography
- Hydrology - Inventory of all terrestrial surface water bodies

- ❖ Small-scale ocean features contribute to the ocean-atmosphere exchange of heat and carbon, major components in global climate change.
- ❖ Significant impact of this cross-scale effects on biogeochemical cycles !!

Enhancing INDIA's Blue Economy: Use Case Applications

Ocean Decade Goals



Clean Ocean
- Oil-spill, Plastic litter



Productive Ocean
- PFZ, Mariculture, Energy



A Healthy & Resilient Ocean
- HAB, Ocean Heat Waves



Safe Ocean
- Maritime Navigation, rip current

Enabling Technologies

Region and event specific
Relocatable grid modeling

AI/ML for Data Assimilation &
Parametrization

Data/Image Processing -
Hyperspectral, SWOT

Geospatial and RS for site
suitability

Opportunities

Blue flag beach initiative (Safe &
litter free)

Macro-algae cultivation for biofuel
potential

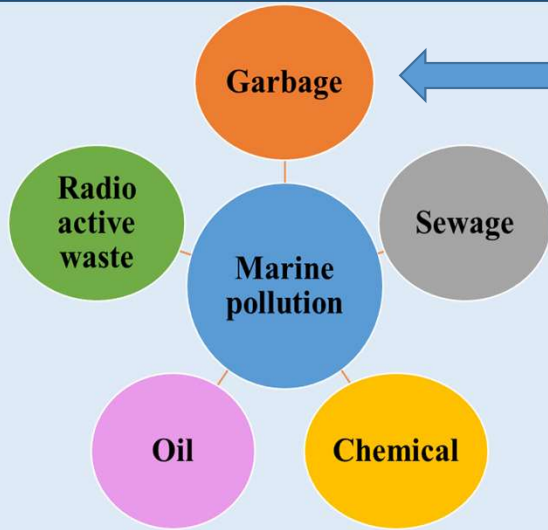
Smart Solution for Safe Navigation
for shipping

Design & development of low-cost
sensors (drifters)

Integrated Framework !

- Downstream Applications Development
- Addressing the science questions
- Understanding the gaps in the observations

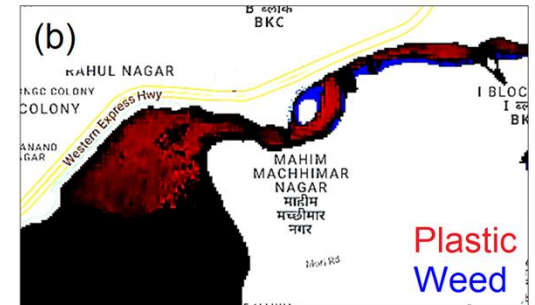
Clean Ocean !!



Plastic wastes make for nearly 80 % of the marine pollution

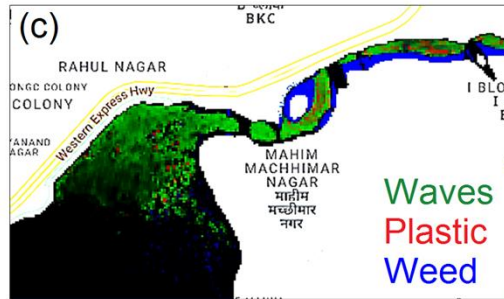
Plastic debris detection from Sentinel -2

Google earth
screen shot



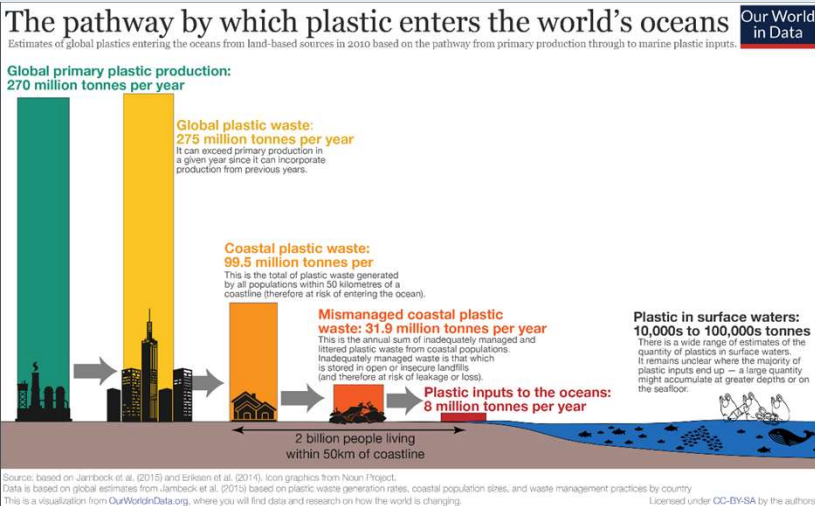
Spectral unmixing
using 2 class

Spectral unmixing
using 3 class



Detected plastic
pixels

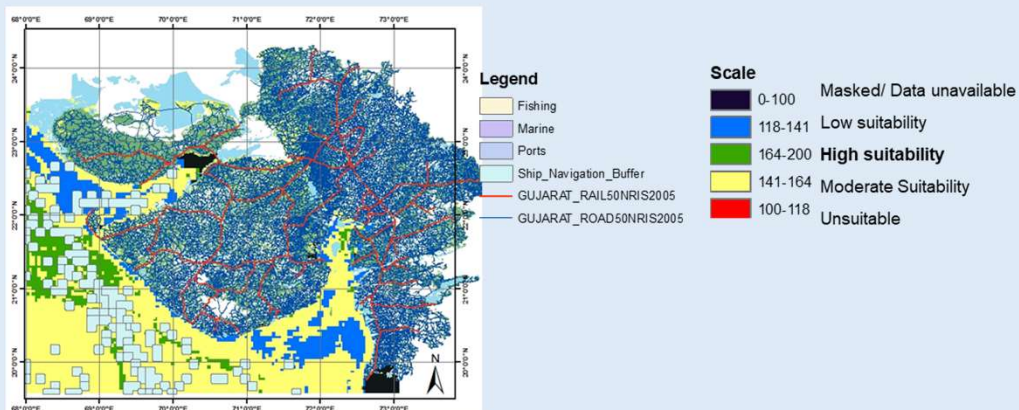
Satellite based information helping the circular Economy!!



Productive Ocean !!

Food Security & Ocean Renewable Energy

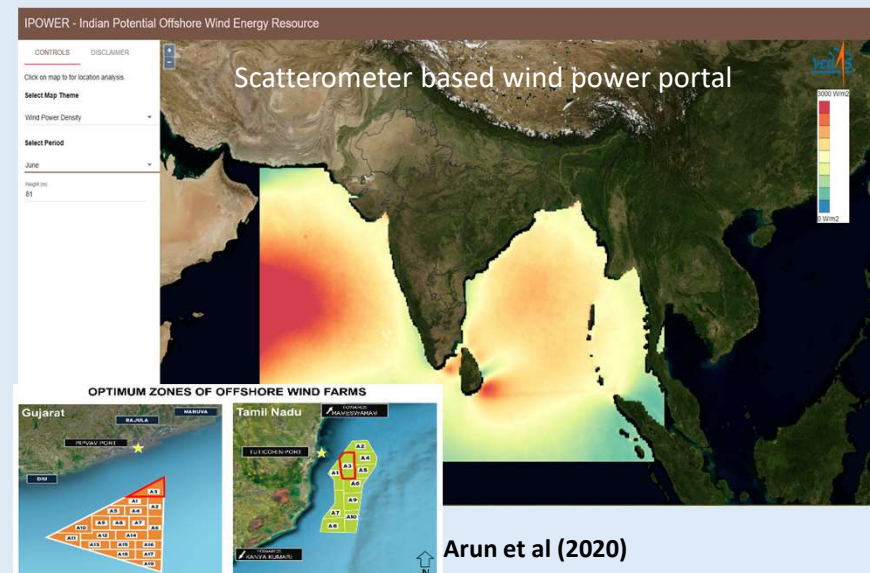
Aquaculture site suitability



Satellite and GIS techniques help in identifying Aquaculture Site suitability

Ocean Energy

- ❖ India has a net power production of 516 GW for G128 5MW turbines
- ❖ I-POWER web portal: Hosts 200+ offshore wind turbines data



Economic analysis suggest that tapping of satellite based ocean wind energy is viable and profitable.

Gujarat (A3) : 5 MW turbine – 6535 MWh; TamilNadu (A3) – 9630 MWh

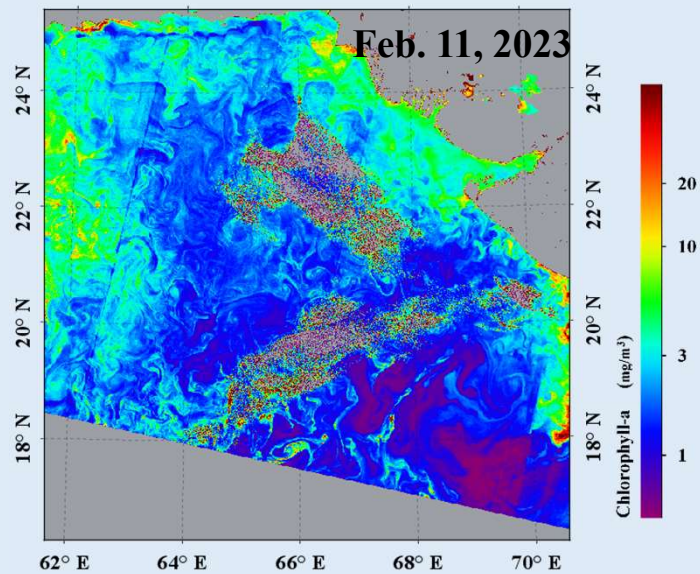
LCOE : Gujarat Rs 11.54 per KWh; TamilNadu Rs 8.43 per KWh

A healthy & Resilient Ocean !!

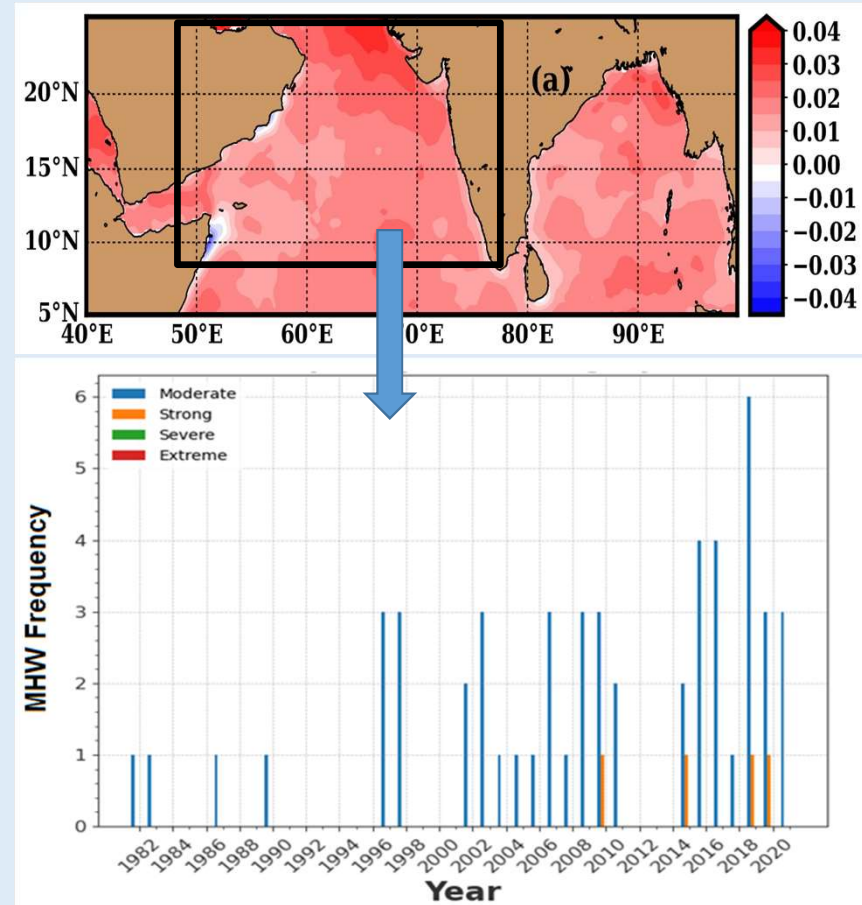
Algal Blooms

- ❖ Healthy & Resilient ocean - Thriving Marine Ecosystem
- ❖ Climate Change impacts & Harmful Algal blooms are major threats

EOS-06 (OCM)



Marine Heat Waves (Deg C/Yr)



Predicted Ocean (Beach Tourism) !!

Rip Current Forecasting System

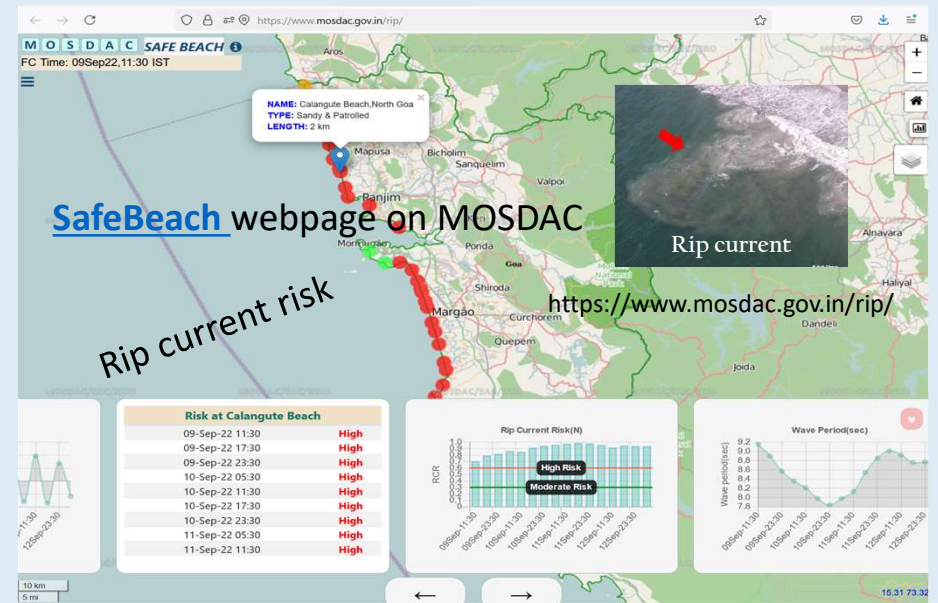
- SAC has developed a fully-automated Rip current Forecasting system and issuing warnings for 175 Indian beaches on Safe Beach portal on MOSDAC (SAMUDRA Project).
- Operational Rip Current warning board at Rushikonda Beach, Visakhapatnam to issue alerts to the public and helping lifeguards.
- High-resolution satellite data for rip current identification and ML model training

India's First Rip current Warning System at Rushikonda Beach



Regular updates on newspapers and media are given to create more awareness among the common people

- Fully-automated Rip current warning (High risk – Red, Moderate Risk – Orange and Low Risk – Green)
- Installed at Rushikonda, AP (Blue Flag certified beach).
- Supported by Police Commissioner, AP Tourism dept, Govt. of AP.



Video Monitoring station has been setup to improve the forecasting capability

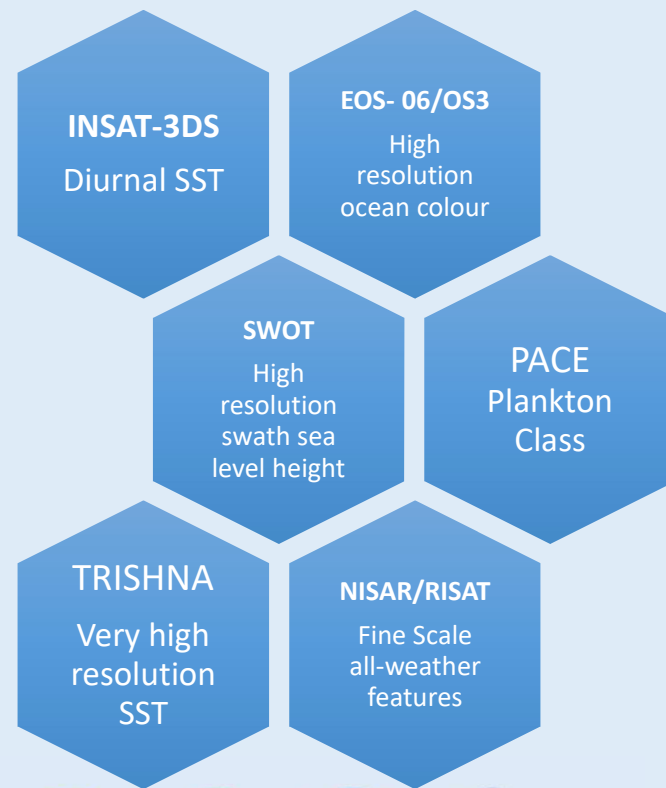
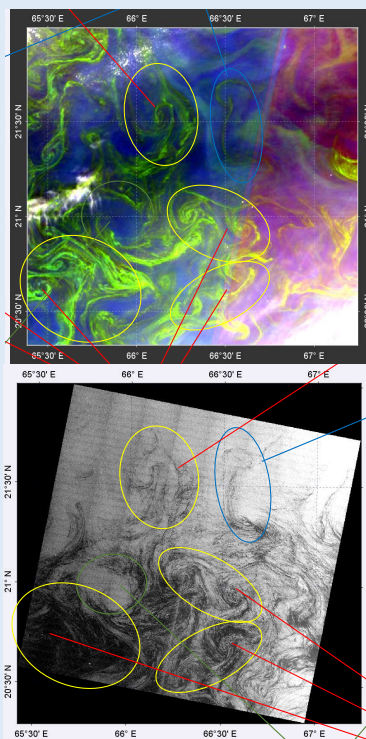
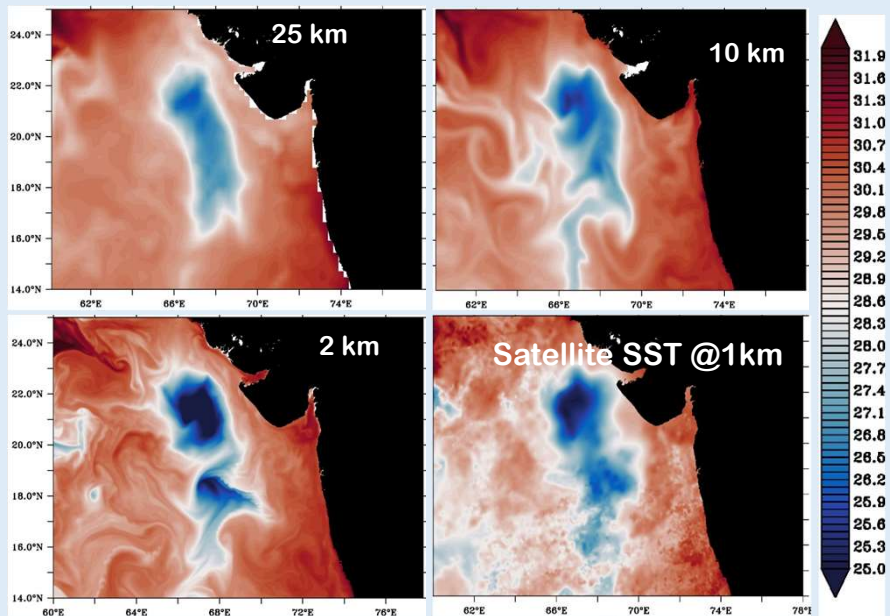


Rip current detected from TIMEX video data

Overarching question

How do the fine-scale ocean dynamics interact with mesoscale (wavelength >100 km) and affect the possible pathways of Energy cascading, Vertical mixing and associated Biological Feedbacks?

Model Simulations- Setting the Context !



Plankton, Aerosol, Cloud, ocean Ecosystem

Collaborations & Engagements: Meeting the Decade Goals !

**Science Partners /Users/
Stakeholders - Ministries, State
Departments, Disaster Management
Agencies, Academia, Private
Industries, Start-ups, NGOs**

**MoES : Deep Ocean Mission
(Collaborating in Climate Vertical)**

Meteorological and
Model Data
Exchange
SCAT Data Analysis



GSMaP Rainfall,
QUAD



SCATSAT Wind Calibration
and Validation



NISAR,
SCAT Cal-Val



TPHNA mission
CFOSAT & SWOT



SCATSAT-1/Oceansat-3,
QUAD



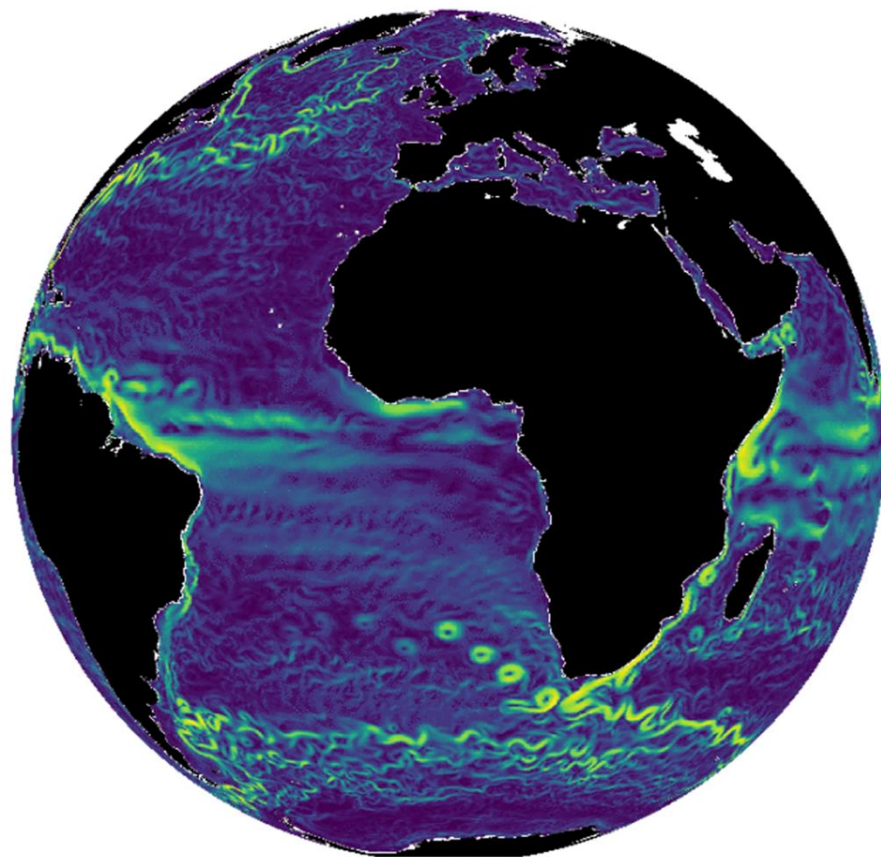
Members in Working
Groups and Virtual
Constellations, CEOS-
COAST AHT

International collaborations



CSSTEAP

Sea Surface Current Speed (m/s)



17-JAN-1987

Let's join hands for achieving the decade goals !

Inputs from my ISRO colleagues for preparing this presentation are thankfully acknowledged !

Thanks