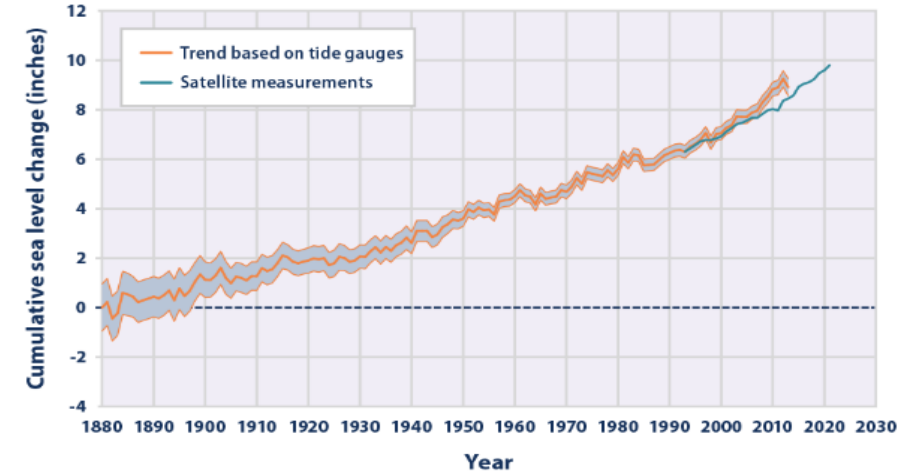


Ocean & Climate Studies Applications

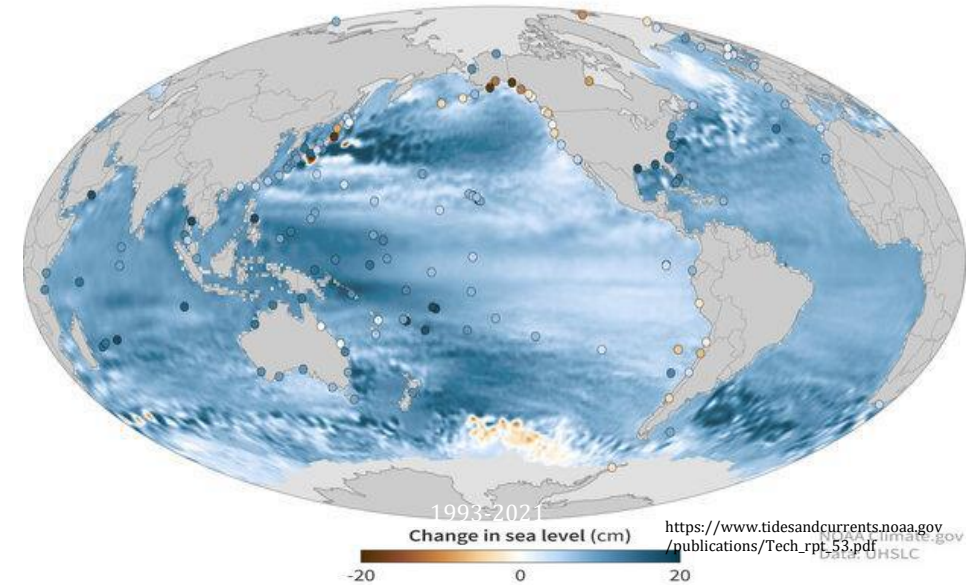
Dr. P.V.Nagamani
Ocean Sciences Group (OSG)
Earth and Climate Science Area (ECSA)
National Remote Sensing Centre (NRSC)

*By burning fossil fuels and other activities, humans are creating a thick blanket of **green house gases** around the Earth. This blanket of gases is trapping heat from the sun and **warming up** the planet. This is called **Climate Change**.*



The Impacts

- *Sea Level Rise*
- *Coastal Flooding*
- *Marine Heat waves*
- *Ocean Acidification*
- *Impact on Marine Biodiversity (Fisheries)*
- *Changes in Ocean Ecosystems*
- *More & Severe Extreme Marine Events*



Economic Value

Regulates weather & Climate
Produce half the oxygen Carbon sequestration-
absorb 30% of CO₂ emissions



\$3-6 trillion/year
Goods and services: ~ \$2.5 trillion/year



Fishery - US\$401 billion/year
Employment- 60 million people
20 % of avg. animal protein for 3.3 billion people



Minerals & Oil
Oil reserves- 41 Gt
(28% of the total production)
Gas reserves- 65 trillion m³

Transportation: 70-90 % of trade



Recreation
upto 50% GDP
Major economy for coastal & Island countries

- Scuba diving
- Water sports
- Cruise liners

Ecological Value

80 % of the planet's biodiversity

Coastal protection
Prevention of erosion
Water purification

Blue Carbon
Mangroves, seagrass & seaweeds remove C
from atmosphere **10 times faster** than
rainforest

Critical Habitats



Seagrass

Coral reef

Mangroves

Why Oceans

ICZM (LTL to 500m landward)

Will address and regulate the

- Coastal development,
- Livelihood,
- Tourism,
- Shoreline,
- Disaster,
- Ecosystem conservation and management

MSP LTL to EEZ (200 nm)

Intended to allocate proper zoning and space for

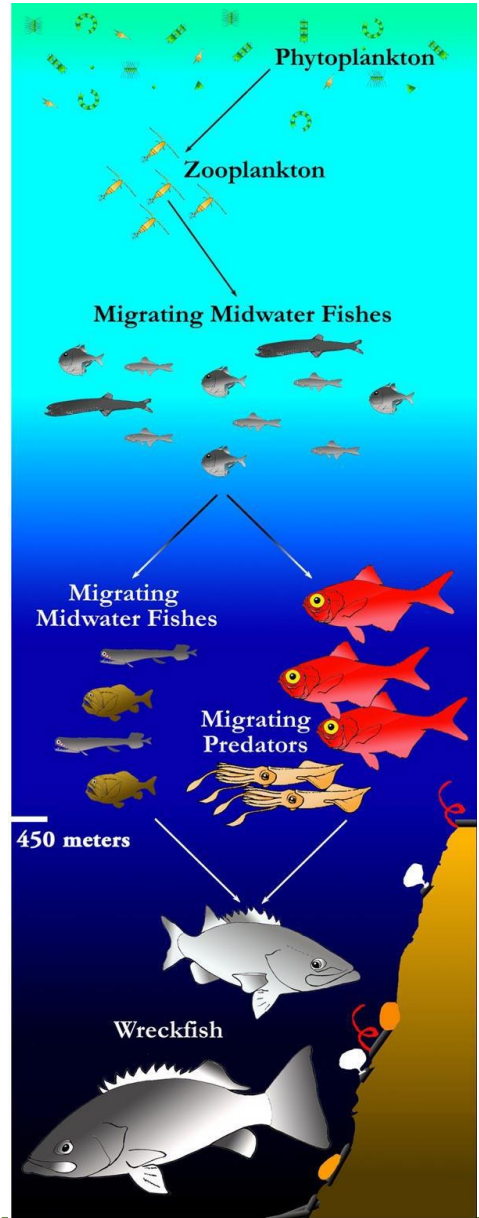
- Ecosystem management,
- Livelihood,
- Tourism,
- Fisheries,
- Port and Harbour,
- Shipping,
- Underwater cables,
- Mining,
- Coastal security,
- Aquaculture, etc.



Economy will integrate and implement all the activities from different sectors

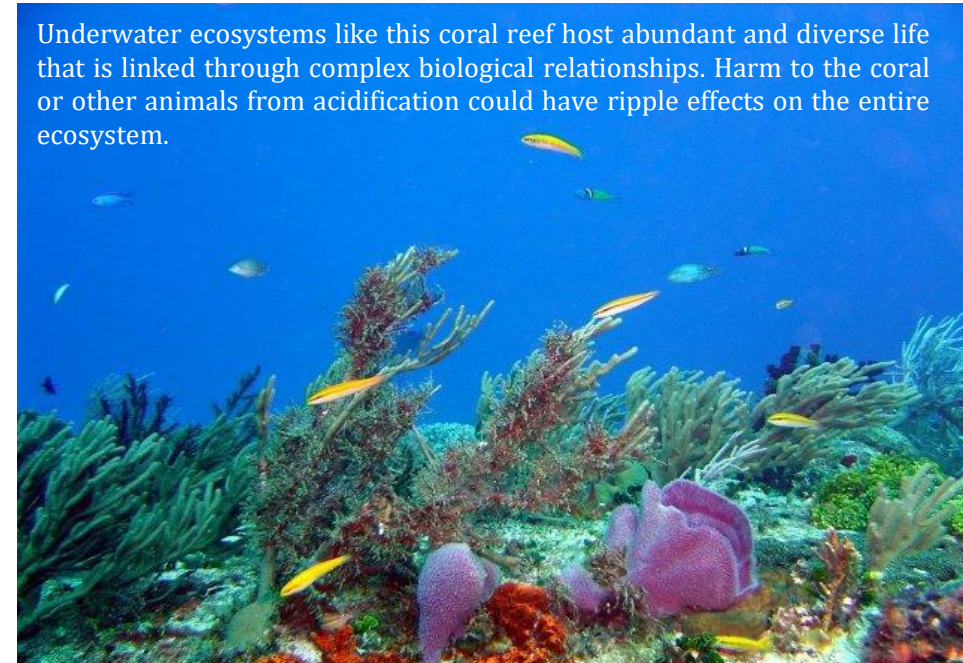
14 LIFE BELOW WATER

| | |
|--|--|
| 1 NO POVERTY MSP contributes to the sustainable development of maritime sectors with direct economic benefits for coastal communities, particularly SIDS and LDCs. | 2 ZERO HUNGER MSP facilitates the sustainable management of fisheries and aquaculture, and builds on new research and technology to improve food security. |
| 3 GOOD HEALTH AND WELL-BEING MSP encourages the use of marine resources for health research and development, and includes early warning, risk reduction and management of health risks. | 4 QUALITY EDUCATION Education provides skills and tools to enhance capacity and participation in marine economic activities, planning, science and technology and, raise awareness about conservation needs. |
| 5 GENDER EQUALITY MSP creates opportunities through science, technology and innovation to improve gender equality in ocean-related activities and decision-making. | 6 CLEAN WATER AND SANITATION Synergies between integrated coastal management and MSP improve access to safe water and better sanitation, and reduce pollution caused by solid waste, wastewater and marine litter. |
| 7 AFFORDABLE AND CLEAN ENERGY MSP promotes scientific research, technology and cooperation for the development of renewable energy at sea while preserving marine and coastal ecosystems. | 8 DECENT WORK AND ECONOMIC GROWTH MSP processes, associated with Sustainable Blue Economy strategies, facilitate opportunities for employment and growth based on ecological, economic and social objectives. |
| 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE MSP encourages the development and diversification of maritime industries and infrastructure as well as the transfer of marine technology to boost innovation. | 10 REDUCED INEQUALITIES MSP contributes to managing access to markets and resources in a way that benefits all actors, and increases their economic prosperity, particularly in SIDS and LDCs. |
| 11 SUSTAINABLE CITIES AND COMMUNITIES The integration of coastal management and MSP promotes a sustainable and climate-resilient transformation of coastal cities that guarantees citizens a safe access to the sea and its cultural and natural wealth. | 12 RESPONSIBLE CONSUMPTION AND PRODUCTION MSP aims to establish a Blue Economy that sustainably uses marine resources and ecosystems through a circular economy and certified production. |
| 13 CLIMATE ACTION MSP integrates adaptation and mitigation measures to build the resilience of marine ecosystems, and reduce exposure and vulnerability to climate change. | 15 LIFE ON LAND MSP applies integrated management strategies that take into account land-sea interactions in the context of an ecosystem-based approach. |
| 16 PEACE, JUSTICE AND STRONG INSTITUTIONS MSP is a multi-level decision-making process whose successful outcome depends on and strengthens participatory, transparent and effective governance. | 17 PARTNERSHIPS FOR THE GOALS MSP enhances regional partnerships at transboundary level for the achievement of the SDGs through cooperation in science, technology and capacity building. |



- Ocean life is very diverse, and increased acidity can harm or help individual plant and animal species in different ways.
- Some organisms are likely to become more abundant, and others less.
- For example, seagrasses may grow faster if more dissolved carbon dioxide is available, while the number of oysters may decrease as fewer larvae complete their life cycle due to increased acidity.
- If acidification reduces the populations of small animals like clams, oysters, and sea urchins, the larger animals like fish that feed upon those could run short of food, and soon up the food chain.

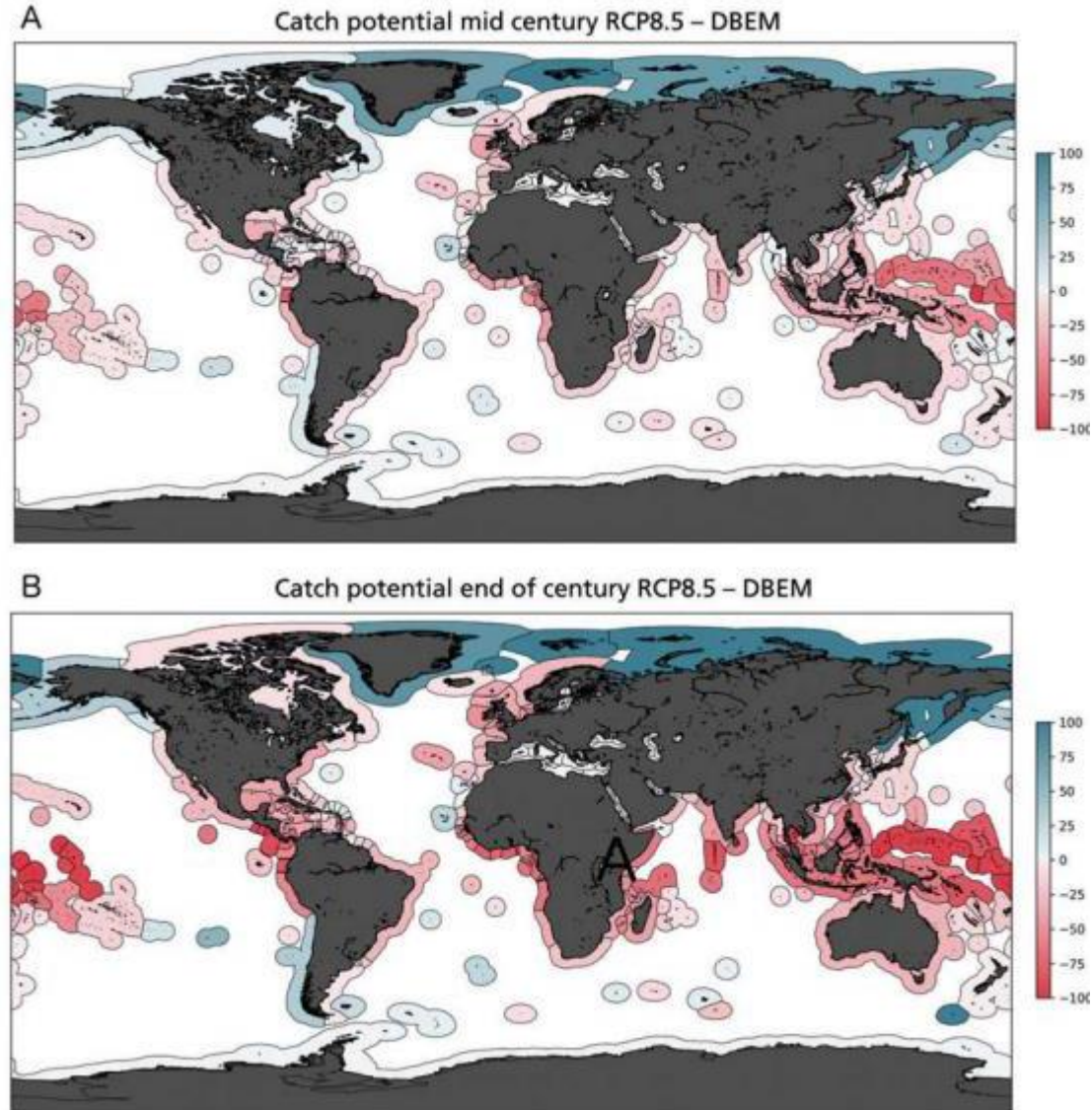
Food webs
Ecosystems
Ecosystem services
Traditional tribal fisheries



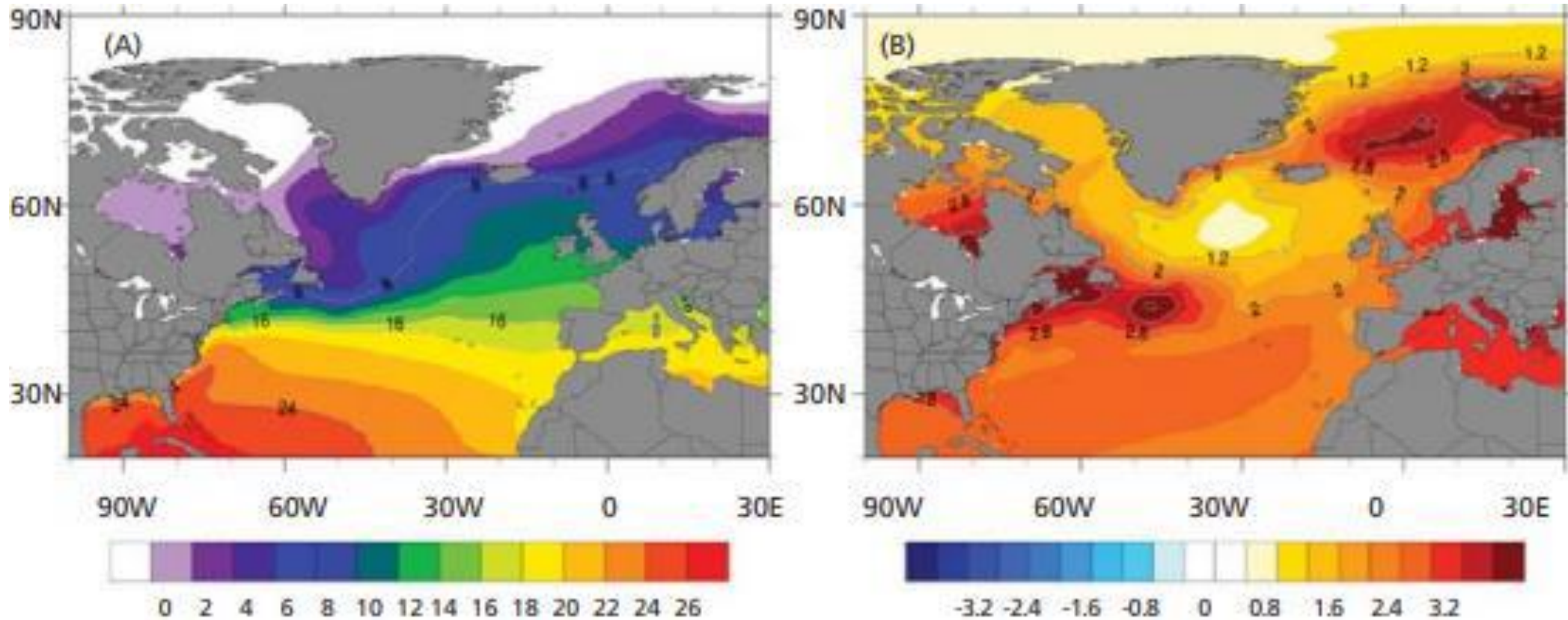
Underwater ecosystems like this coral reef host abundant and diverse life that is linked through complex biological relationships. Harm to the coral or other animals from acidification could have ripple effects on the entire ecosystem.

Ocean Heat
Ocean Acidity
Sea Surface Temperature
Marine Species Distribution
Atmospheric Concentrations of GHGs

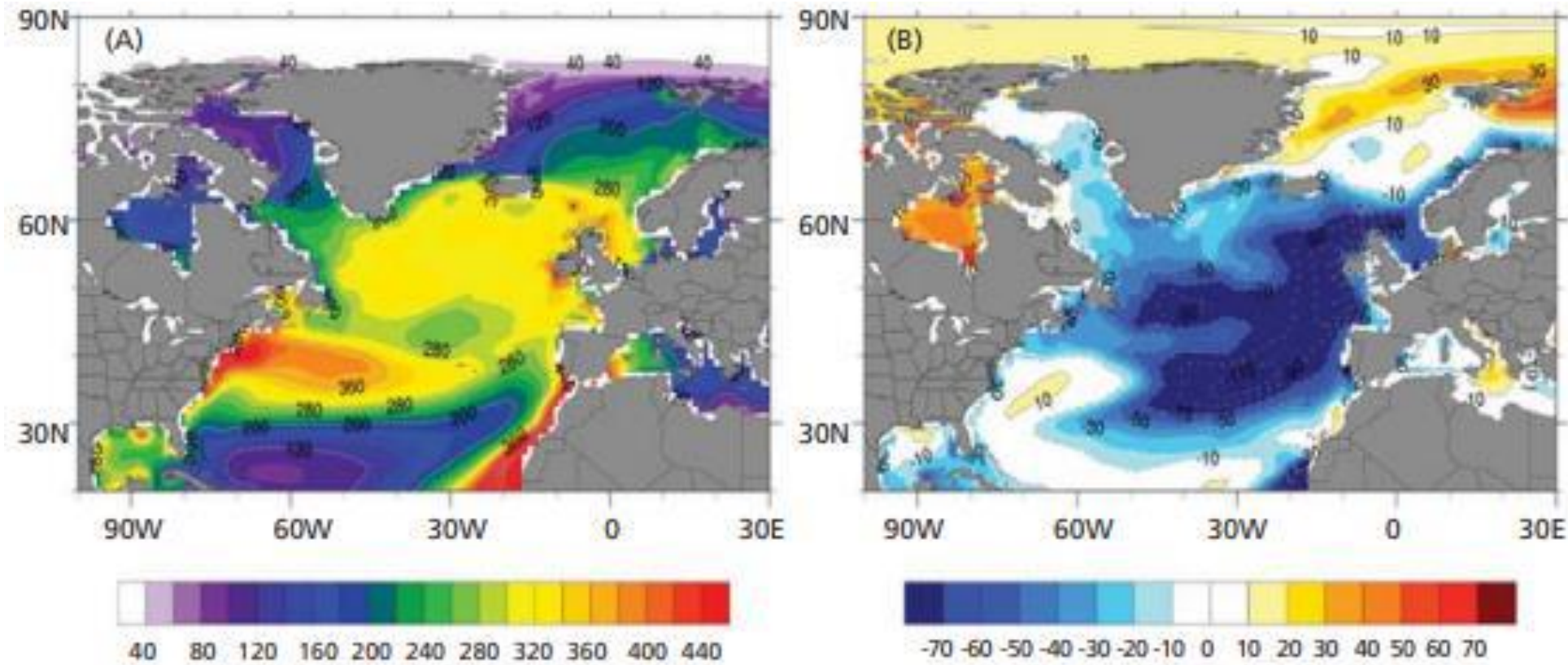
Maximum Catch Potential: Model Approach



Projected changes in maximum Catch Potential (%) under RCP 8.5 by 2050 (A: 2046 to 2055) and 2095 (B: 2091 to 2100) for the DBEM projection



Sea Surface Temperature (CMIP5) interpolated on a 1x1 grid. (A) Mean climate from the historical experiment for the period (1956 to 2005); (B) difference in the mean climate in the future time period (RCP8.5:2050 to 2099).

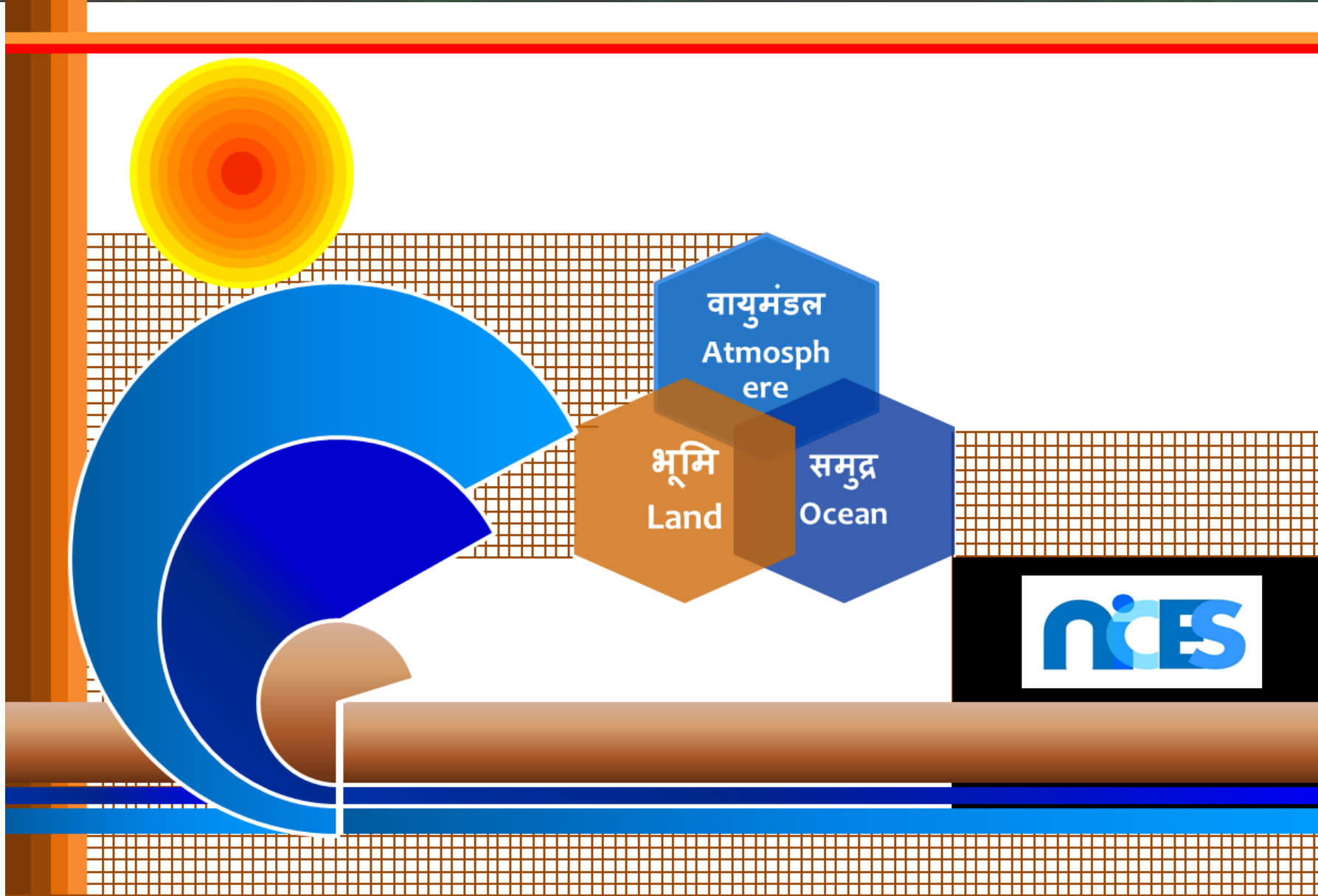


Sea Surface Temperature (CMIP5) interpolated on a 1x1grid. (A) Mean primary organic carbon production by all types of phytoplankton for the period (1956to2005); (B) difference in the primary productivity in the future time period (RCP8.5:2050to2099).

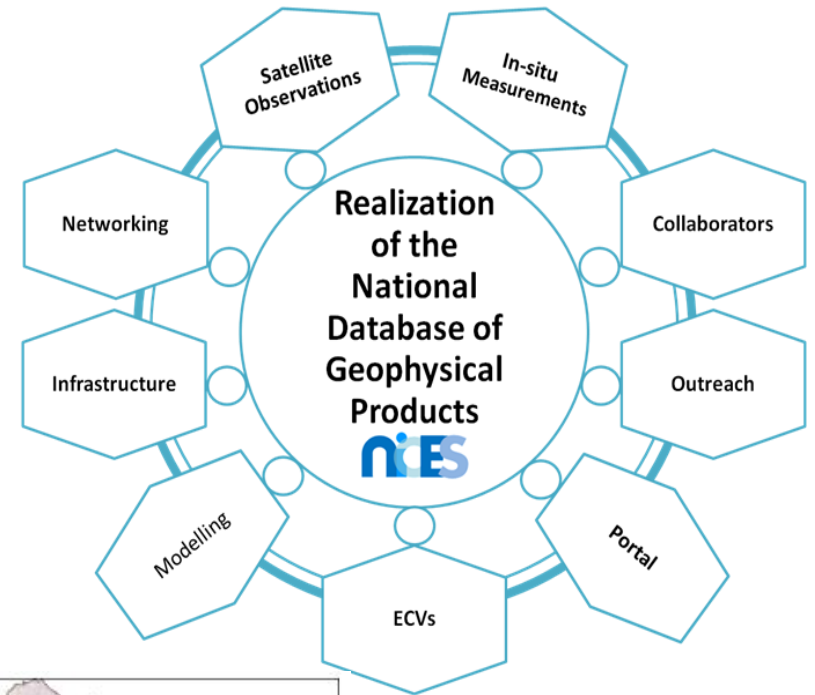
Reduction of climate change impact on the marine environment in many ways, include:

- **Adapt fishery management:** Fishing professionals and government officials can help people adapt to climate change by changing policies and practices to avoid over fishing and maintain healthy marine ecosystems.
- **Diversify fisheries:** Aquaculture, or sea food farming, helps build resilience against climate change.
- **Reduce energy use:** Every one can take steps to lower carbon emissions, which can help reduce ocean warming and acidification.
- **Shop sustainably:** Plan your meals with sustainably harvested sea food to keep ocean ecosystems healthy. These are fish and shell fish that have been caught using sustainable techniques and management practices.
- **Recreate responsibly:** Help protect coral reefs. When boating, be careful not to let anchors damage coral reefs or sea grass beds. Never touch coral reefs when diving or snorkelling. Also avoid using sun screens containing chemicals that can harm marine life.





- Established in **September 2012**, for Realization of nation level database of long term, consistent climate quality **geo/bio-physical products** pertaining to Terrestrial, Ocean, Atmosphere and Cryosphere for climate change studies
- Multi-institutional endeavour** (ISRO & other Scientific Organisations/Ministries) with contribution (*in-situ* observational & model outputs) from participating institutions
- Observational network for calibration & validation**
- Use of **Essential Climate Variables (ECVs)** for **impact assessment, adaptation, vulnerability, mitigation**, etc.
- Infrastructure, web-enabled services and product dissemination** – NICES under ISRO's geo-portal 'Bhuvan'



- Establishment and development of **linkages** with appropriate **observational networks**, and **calibration & validation sites**.
- Bio-geophysical parameter retrieval and development of methodologies for Essential Climate Variables (ECVs) generation **from Indian EO missions**.
- Acquisition and processing of international missions data and other relevant parameters to support Indian EO ECVs, cal/val experiments, and **generation of long term data records**.
- **Generation of spatially & temporally blended ECV products** based on Indian, foreign satellites and *in situ* observations through multi-institutional participation.
- To establish necessary infrastructure, including hardware and software for NICES and establishment of **NICES portal**.
- Development of methodologies to carry out scientific studies with national organisations in **using ECVs for impact assessment, adaptation, vulnerability, mitigation, etc.**
- To develop **outreach** and interaction mechanism **for the effective dissemination and scientific utilization of NICES ECVs and collaboration in the area of climate and environment.**

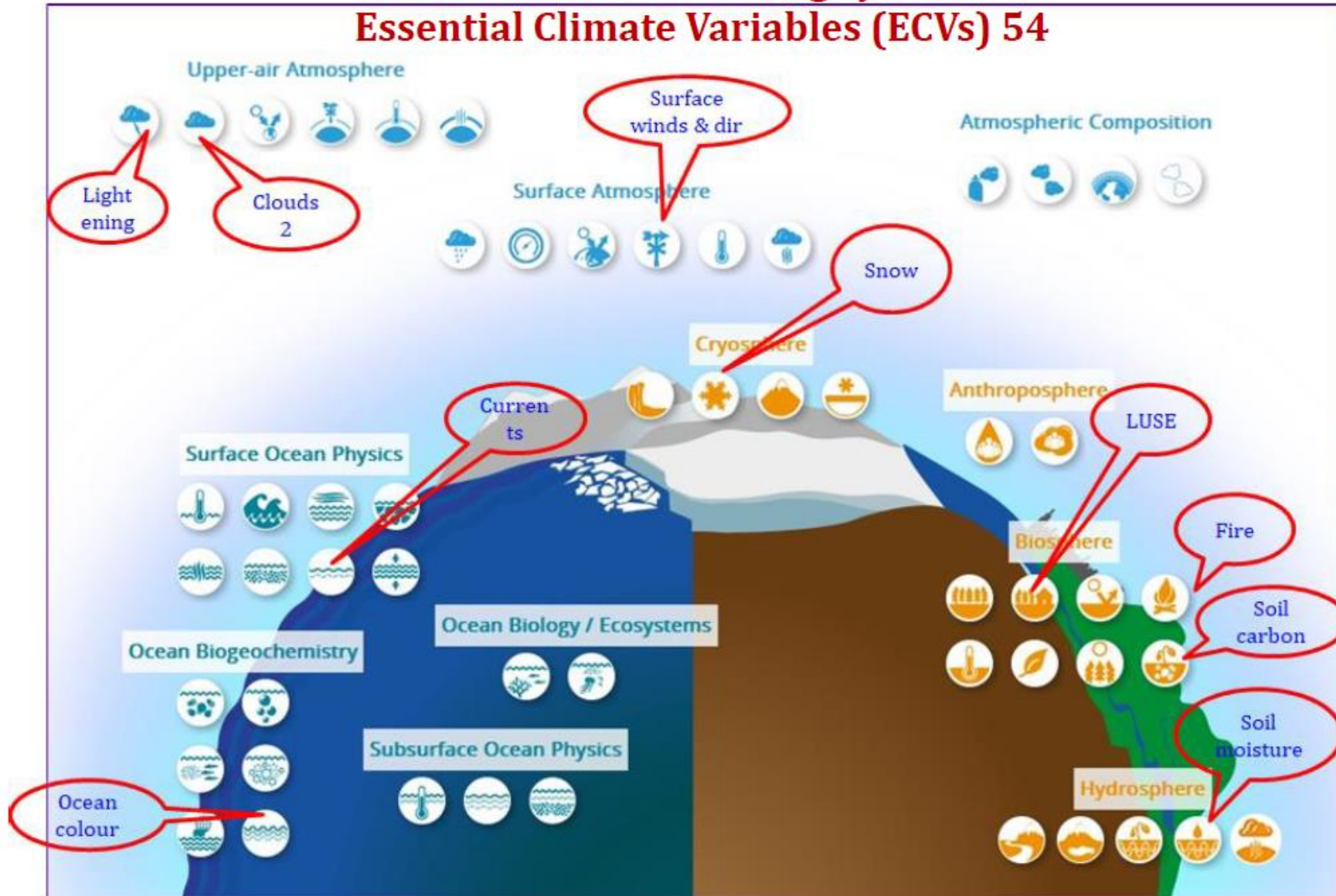
- **Capacity Building**

NICES Linkages:

- Ministry of Environment and Forest & Climate Change
 - Department of Science and Technology
 - Ministry of Earth Sciences
- Council of Scientific & Industrial Research (CSIR)
- Other Institutions & Academia (TERI, ICAR, IISc, IITs, NITs, Universities, etc)

- ECV is a physical, chemical, or biological variable or a group of linked variables that critically contribute to the **characterization** of Earth's climate.
- ECV datasets provide the empirical **evidence** needed to understand and predict the evolution of climate, to guide mitigation and adaptation measures, to assess risks and enable attribution of climatic events to underlying causes, and to underpin climate services.
- **Criteria for ECVs : *Relevance, Feasibility and Cost Effectiveness***
- **Current Status:**
- Currently **28 of 54** ECVs are amenable through satellites either directly or indirectly.
- Out of which, **15** ECV products are made available through NICES portal (Albedo, Surface water bodies, Soil moisture, Land cover, Lightning, Cloud fraction, cloud top temperature, Derived tropospheric ozone, Ocean surface current, Sea level, Ocean colour, Total alkalinity, Dissolved inorganic carbon, pCO₂ and Snow cover)

Global Climate Observing System Essential Climate Variables (ECVs) 54



Terrestrial (30)

Geophysical: Albedo, NDVI (4)

Hydrology: Surface water bodies, Soil moisture, ET, Runoff (4)

Land cover: MM-5, WRF compatible, Veg Fraction (3)

Terrain and Soil: OC, IOC, f-soil depth, f-soil texture, f-water erosion, f-wind erosion, f-salt affected, Soil moisture (8)

Vegetation and Ecosystem: Ann forest fire density, sd of AFFD, length of fire, f-forest, forest types, NSA, KSA, RSA, f-FA, NEP, NPP (11)

Ocean (26)

OHC700 (1)

TCHP (1)

OHC & OMT (2)

Ocean surface winds (2)

Wind stress (2)

Wind curl: Wind curl, Ekman currents, geostrophic current, SSHA, ocean surface current, EKE, MMSLA (7)

Co-tidal map (k101, M2s2) (2)

Model derived: 26 degree isotherm, TCHP (2)

Sea level (1)

Ocean color: Chlorophyll concn. (OC₂, OC₄), Kd₄₉₀ (6), **Total Alkalinity, Dissolved Inorganic Carbon, pCO₂**

Atmospheric (5)

- Number of Lightnings
- Cloud fraction, cloud top temperature
- Boundary layer height
- Derived tropospheric ozone

Cryospheric (5)

- Snow melt and freeze (Indian Himalaya)
- Snow melt and freeze (Antarctica)
- Snow cover fraction
- Himalayan glacial lakes and water bodies
- Snow albedo

Total 64 geo-biophysical products
15 of them can be taken up for ECV

Ocean Remote Sensing:

- Generation of Long-term Chl-a, Ocean Heat Content, Winds & Currents,
- Improved Atmospheric Correction - NRT Data
- Inherent Optical Properties for Retrieval of Rrs, PFTs & PSCs
- FLH based Chl & Phytoplankton Blooms Detection
- Detection of Phytoplankton Functional Types & Size Classes
- Ocean Primary Productivity Estimation
- Regional Sea Level Variability
- Fusion of Shallow Water Bathymetry (Optical & SAR)
- Member of OS-3 ATBD and Cal/Val Team

Ocean Bio-Geo-Chemistry:

- Generation of TA*, DIC* Maps
- Air-Sea Fluxes of CO₂ in BoB
- Hydro-Geochemistry of Cauvery Basin
- Ocean Acidification (Long Term In-Situ pH, TA in BoB)

Coastal Ecosystem Dynamics:

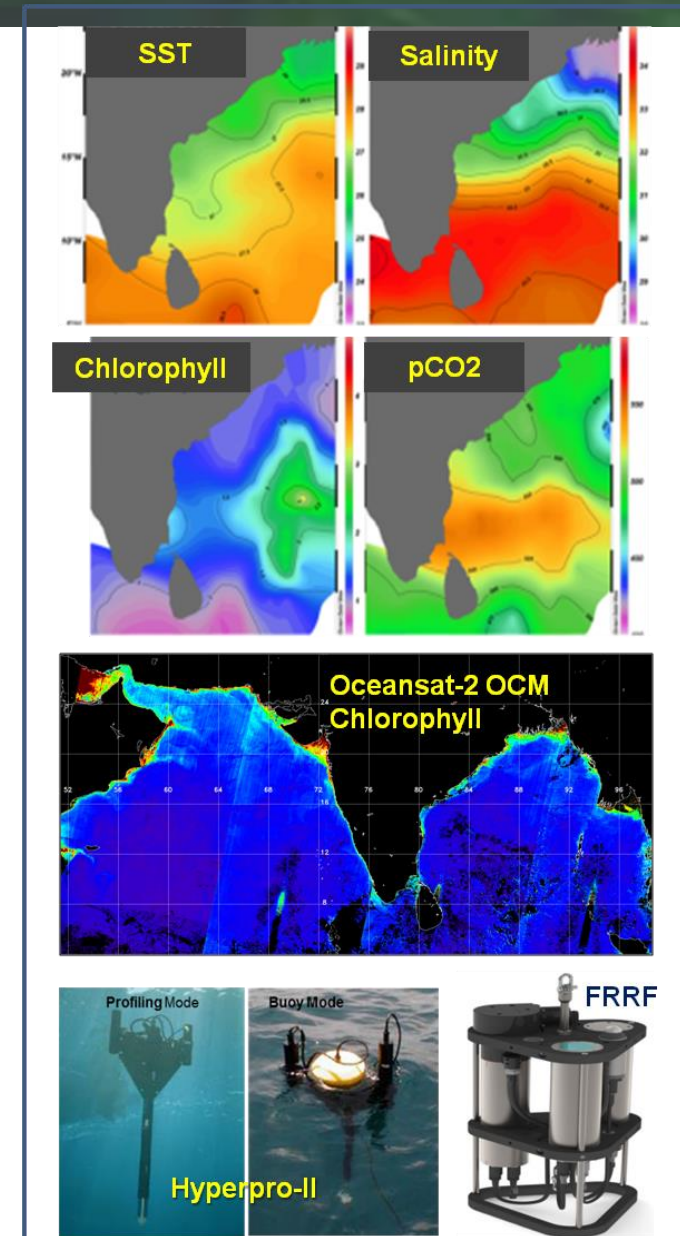
- Health of Ecosystems of Indian Coasts
- Aquatic Invasive Species - Quantitative Assessment

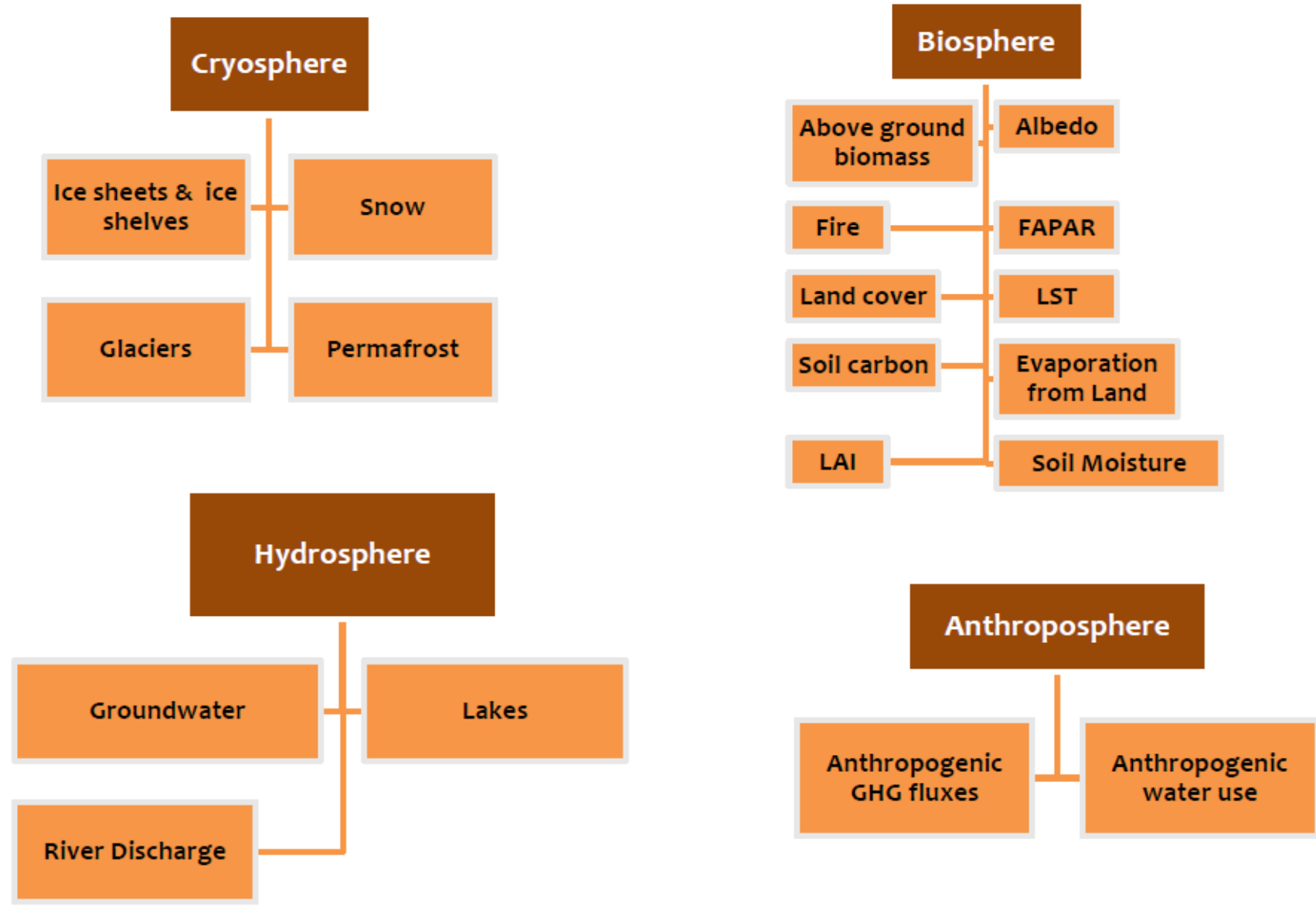
Permafrost Studies (Polar & Himalayan Regions)

- Establishment of Permanent Permafrost Monitoring Site in Svalbird and Planning in Indian Himalayas

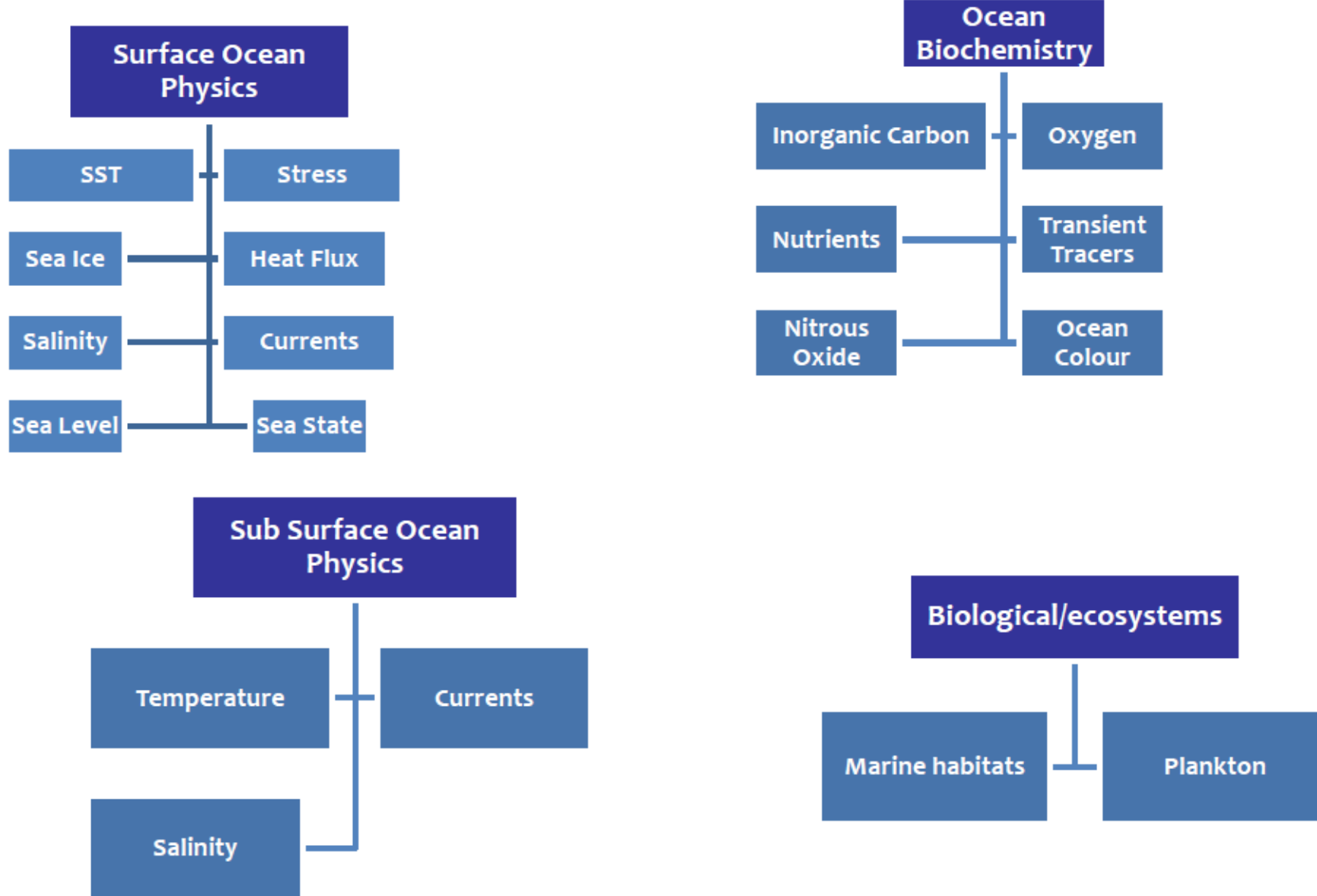
Field Data Collection & Utilization Programmes:

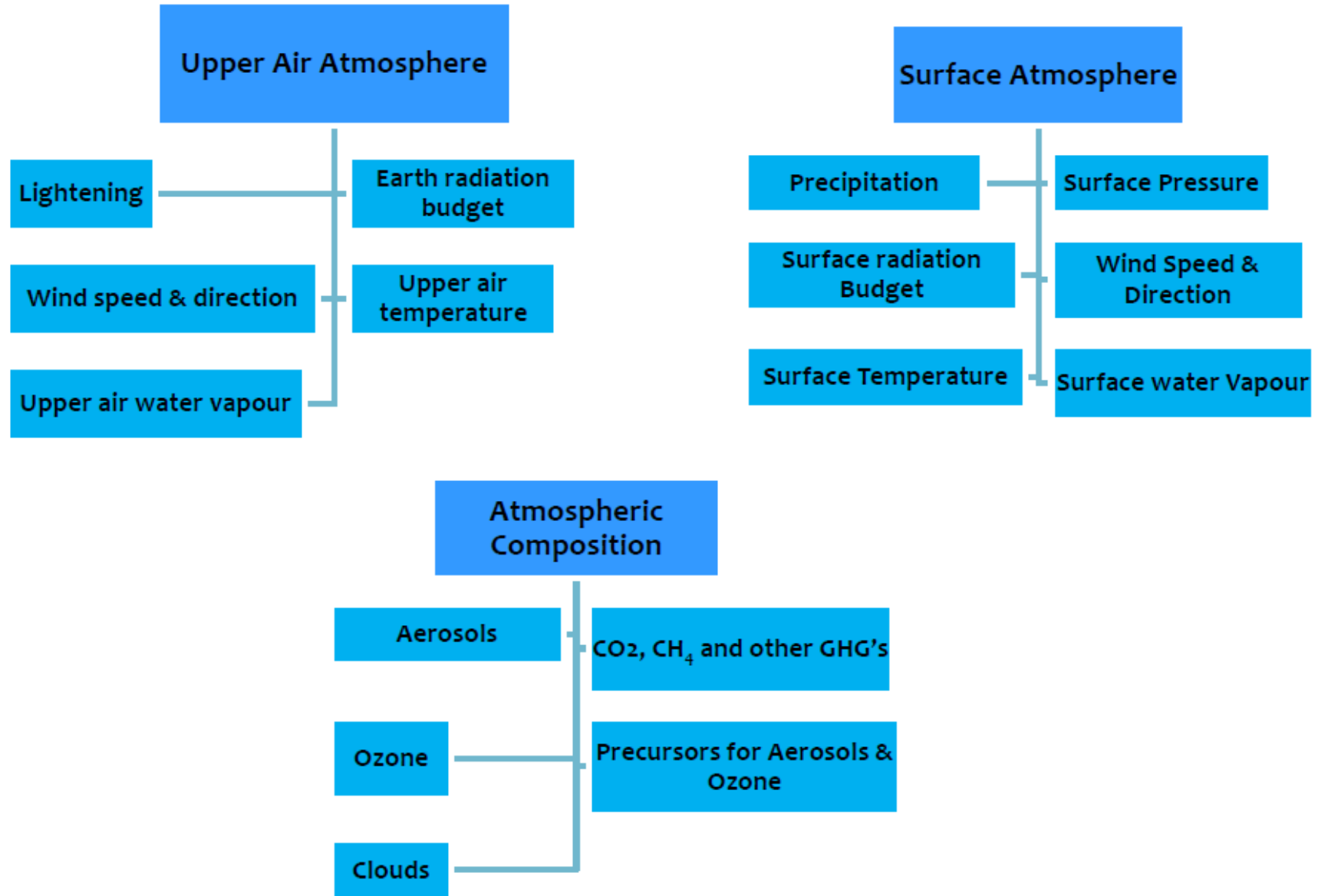
- Coastal and Open Ocean Cruises
- Ocean Monsoon Mixing (OMM)
- Expeditions - Southern Ocean, Arctic & Antarctic





Global ECVs as per GCOS-240 (2021 report) - Ocean





| Domain | ECV | Near future | Non-ECV products retrieved | Derived | Satellite + Model based products | Total |
|-------------|--------|-------------|----------------------------|---------|----------------------------------|-------|
| Terrestrial | 5 | 1 | 16 | 8 | 5 | 35 |
| Ocean | 3 | 2 | 5 | 11 | 8 | 29 |
| Atmosphere | 2(+1) | 1 | 0 | 2 | 0 | 6 |
| | 10(+1) | 4 | 21 | 21 | 13 | 70 |

| Time span (products) | NICES Geophysical products |
|----------------------|---|
| 20 - 30 years (4) | Ocean Heat Content, Ocean Mean Temperature, Tropical Cyclone Heat Potential, Eddy Kinetic Energy |
| 15 - 20 years (4) | Surface Soil Moisture, Forest Fire, Snow Melt and Freeze, Mean Sea Level Anomaly |
| 10 - 15 years (7) | Chlorophyll, Kd ₄₉₀ , LULC, Land degradation, Tropospheric Ozone, Net sown area (Agriculture), Cloud Cover and Cloud Fraction |
| 5 - 10 years (15) | Albedo, NDVI, Vegetation Fraction, Surface Water Body Fraction, Snow Cover Fraction, Himalaya Glaciers, Snow Albedo, Model-TCHP, Model-D26, Ocean Surface Currents, Total Alkalinity, Dissolved Inorganic Carbon, Planetary Boundary layer Height, Ocean Surface Winds, Wind Stress, Wind Curl, Sea Level Pressure. |

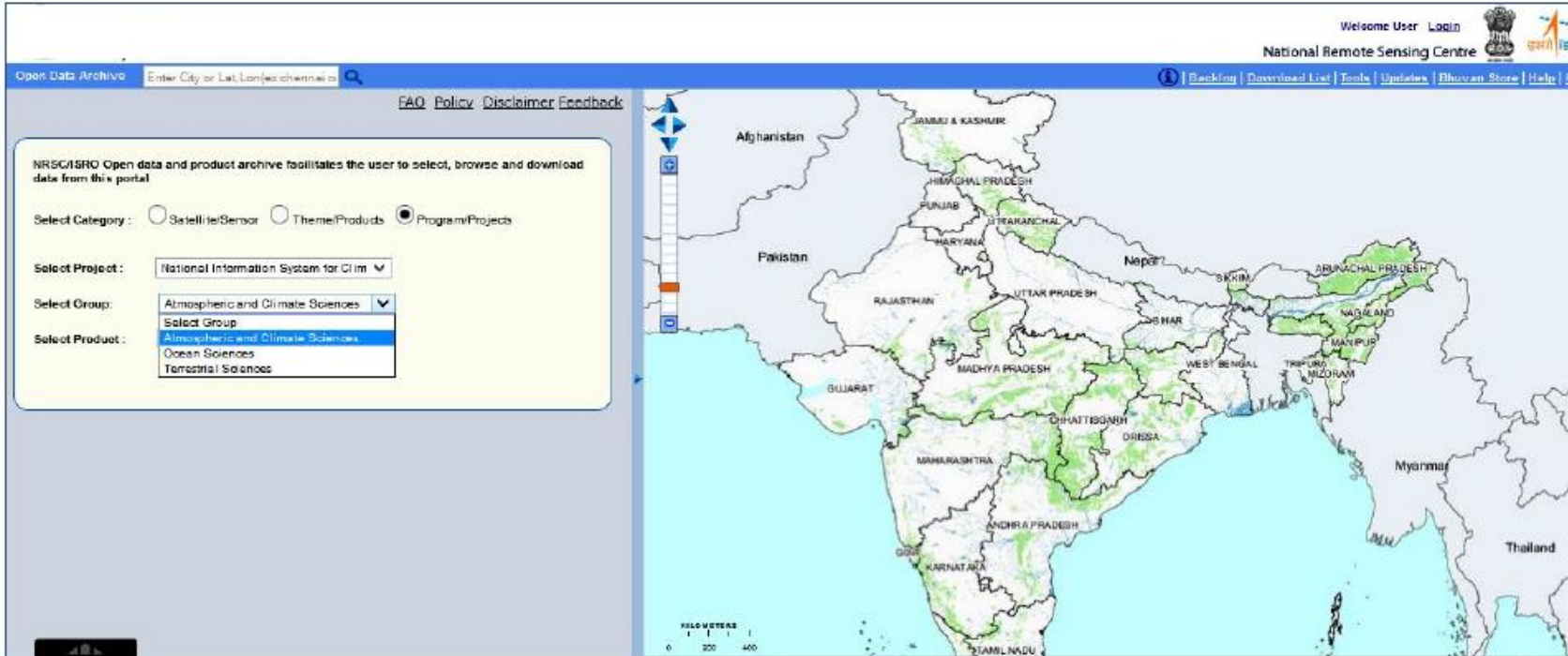
Terrestrial Products

Ocean Products

Atmospheric Products

Model Derived
Products

Cryosphere Products



The screenshot displays the 'Open Data Archive' web interface. At the top, it says 'Welcome User Login' and 'National Remote Sensing Centre'. Below this is a search bar and navigation links like 'Backlog', 'Download List', 'Tools', 'Updates', 'Bhuvan Store', 'Help', and 'Home'. The main content area features a map of India with state names labeled. On the left side, there is a selection panel with the following options:

- NRSC/ISRO Open data and product archive facilitates the user to select, browse and download data from this portal.
- Select Category: Satellite/Sensor Theme/Products Program/Projects
- Select Project: National Information System for Clim
- Select Group: Atmospheric and Climate Sciences
- Select Product: Atmospheric and Climate Sciences (highlighted), Ocean Sciences, Terrestrial Sciences



Instruments / Infrastructure

- Hyperpro-II
- IOP profiler
- FRRF
- Coulometer
- HPLC
- pH meter
- Nutrient Analyser
- pCO2 sensor
- CTD

Home / Products / Ocean

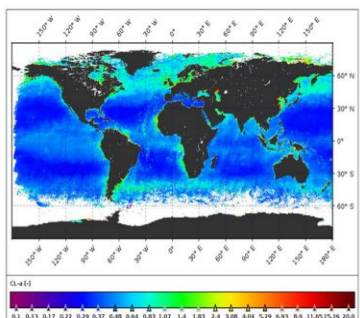
Ocean Sciences

To address the effects of climate change on different components of the complex Earth-Ocean-Atmospheric system, many products are being generated under NICES programme which represent the ocean dynamics such as Ocean Surface Winds, Ocean Wind Stress, Ocean Color, TOPE etc. These products play an important role in understanding the spatial and temporal distribution of sea surface salinity, ocean thermodynamics and its circulations etc. and the interaction between the ocean and atmosphere. Following table lists out the various products available under NICES.

Several products are generated which represent the ocean dynamics such as Daily Ocean Heat Content of 700m Layer, Daily Tropical Cyclone Heat Potential, Ocean Heat Content (OHC) and Ocean Mean Temperature (OMT) at different Depth, Ocean Surface Winds, Ocean Wind Stress, Wind stress curl, Ekman Currents, Geostrophic Currents, Sea Surface Height Anomaly of SARAL, AltiKa, Ocean Surface Currents, Eddy Kinetic energy EKE, Monthly Mean Sea Level Anomaly (MMSLA), Ocean Color Datasets for North Indian Ocean, Chlorophyll Concentration, Diffuse Attenuation, Sea Level Pressure, Co-Tidal Map, 20 Degree Isotherm, etc.


Recent EOS-06 Products

OCM-3 Global Gridded / Mapped 4KM Resolution Ocean Surface Chlorophyll-a Concentration (mg/m³) April, May, Aug & Sep 2023 (Merged/4 month composite)




High Pressure Liquid Chromatography (HPLC)

- Lab Instrument
- Measures different Chlorophyll pigment concentrations of water column




905 Titrande

- Lab Instrument
- Used for Potentiometric titration for Total Alkalinity




Nutrient Analyzer

- Lab Instrument
- Nutrient concentrations of water samples (N, P etc)



Hyperspectral Underwater Radiometer

- Field Instrument
- Measures underwater Light Fields, nLw, Rrs, Chlorophyll, CDOM



Fast Repetition Rate Fluorometer

- Field Instrument
- Measures photosynthesis parameters of water column, [RCII], σPSII, PAR




LI-COR 840A

- Field Instrument
- Gives Atmospheric concentration of CO₂




Coulometer

- Lab Instrument
- Measures Dissolved Inorganic Carbon in water samples




Inherent Optical Profiler

- Field Instrument
- Measures Absorption & backscatterin g, Chl of water column



Conductivity Temperature & Depth Sensor (CTD)

- Field Instrument
- Measures temperature and salinity profiles of water column



Thermo Scientific Pacific P11 (Milli-q)

- Lab Instrument
- High Purity water for Lab titrations



Product Generation & Developments

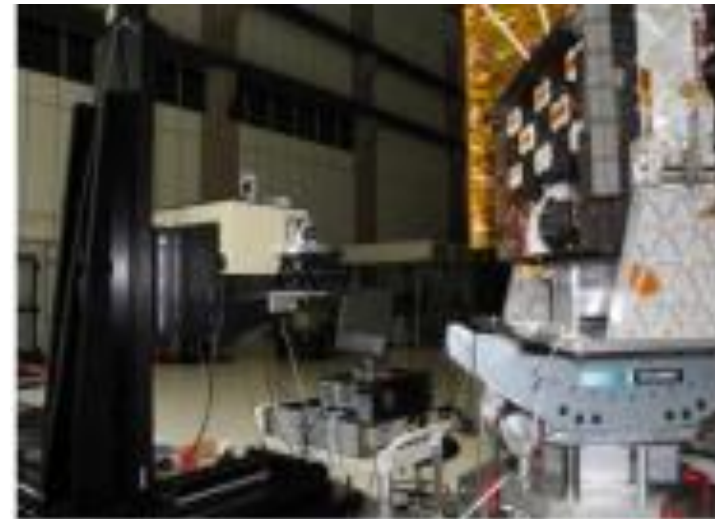
Payloads

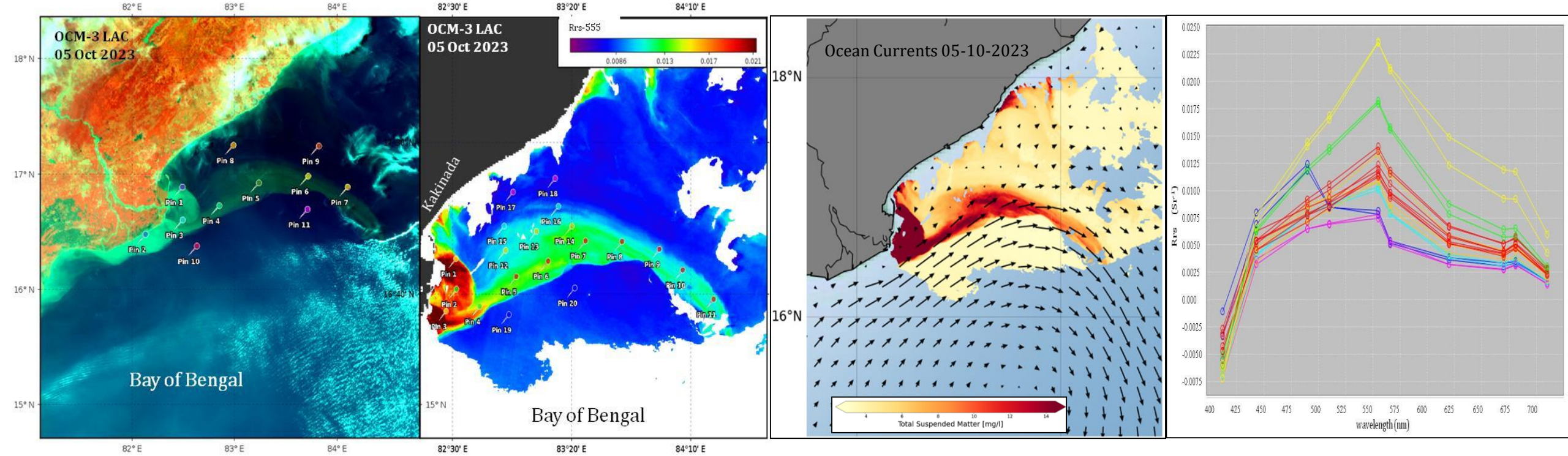
- Ocean Colour Monitor (OCM-3)
- Sea Surface Temperature Monitor (SSTM)
- Ku-Band Scatterometer (SCAT-3)
- ARGOS

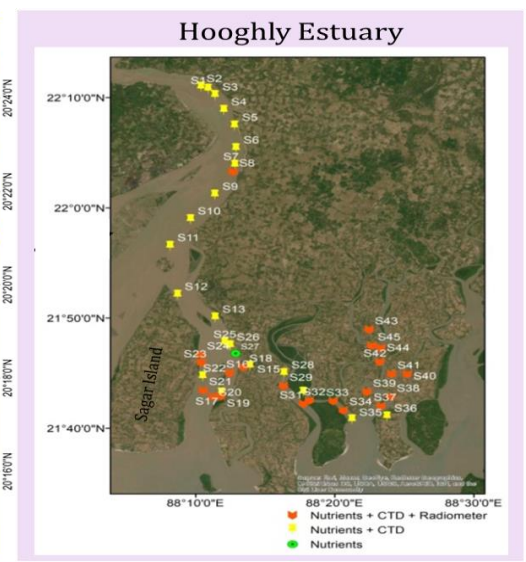
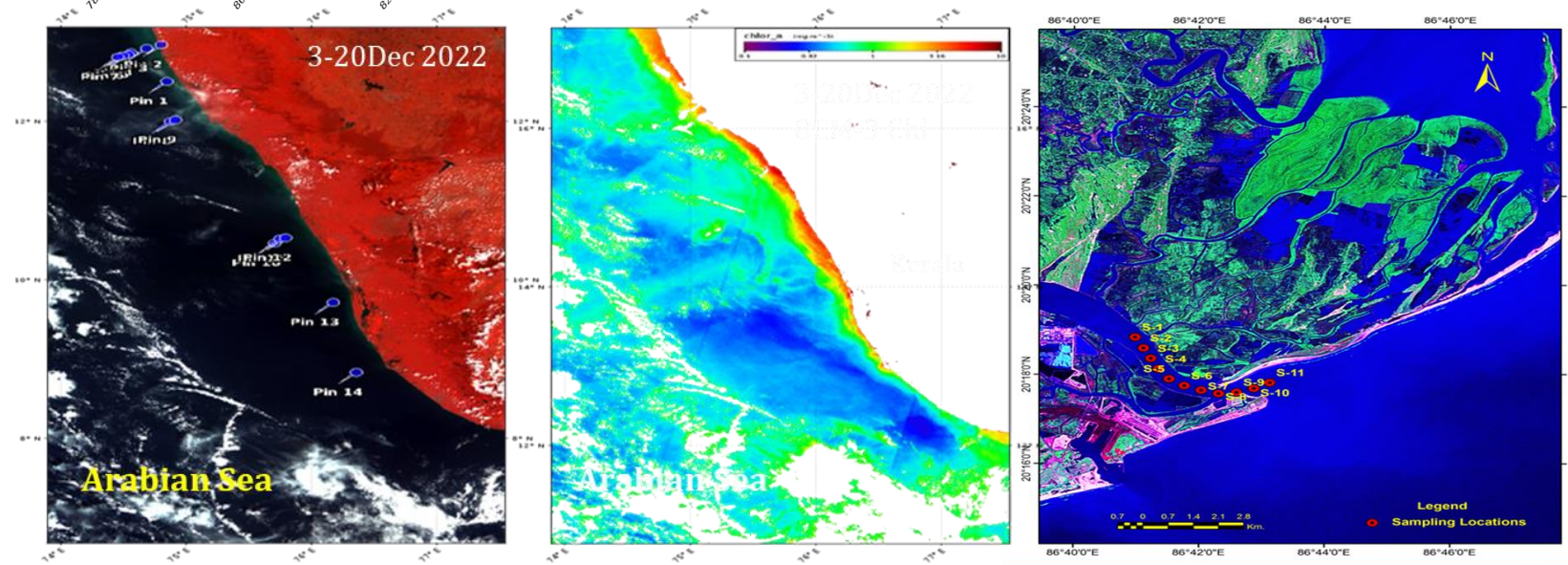
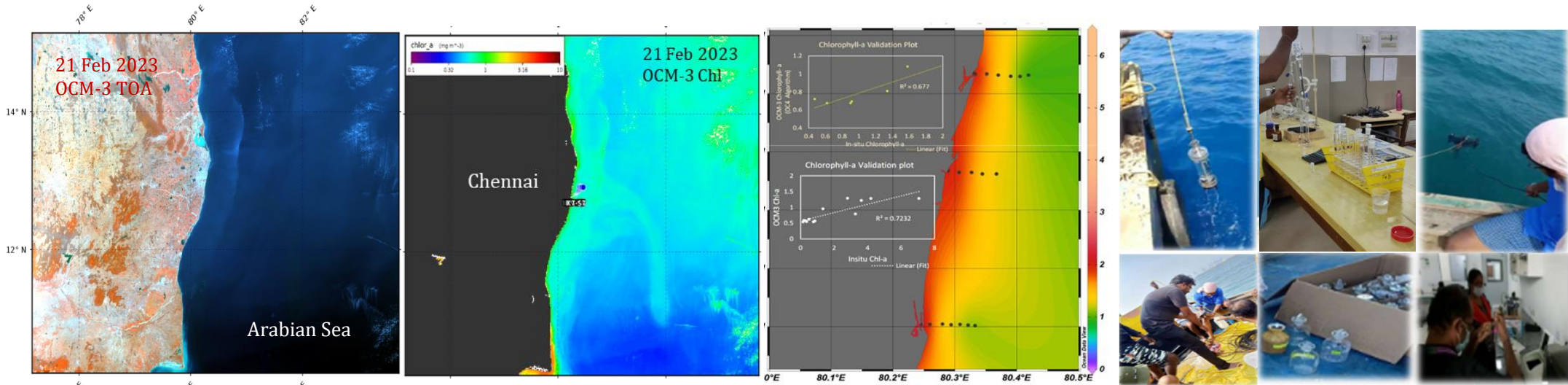
Mission Objectives

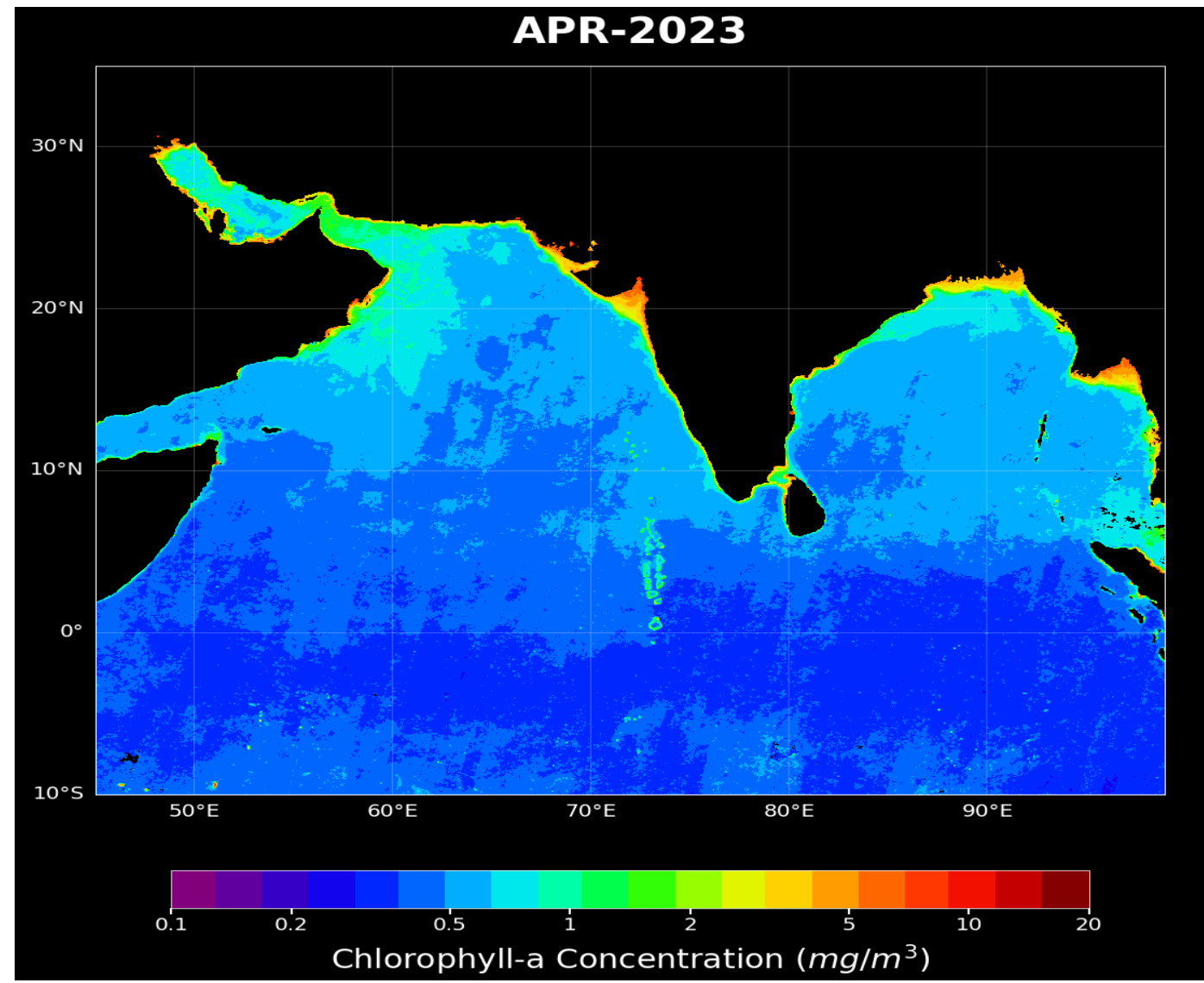
- To ensure the data continuity of Ocean colour and wind vector data to sustain the operational applications.
- To improve the applications, some additional datasets such as SST & more number of bands in Optical region for fluorescence and in IR region for atmospheric corrections.
- To develop / improve related algorithms and data products to serve in well-established application areas and to enhance the mission utility.

| Band Number | Centre Wavelength (nm) | Bandwidth (nm) | Ocean Reference Radiance ($\text{mW cm}^{-2} \text{sr}^{-1} \text{m}^{-1}$) | SNR @ spectral input / spectral radiance ($\text{W m}^{-2} \text{Sr}^{-1} \text{um}^{-1}$) | Application |
|-------------|------------------------|----------------|---|--|-----------------|
| BAND 1 | 412 | 10 | 9.1 | 1000 | CDOM |
| BAND 2 | 443 | 10 | 8.4 | 1000 | Chlorophyll |
| BAND 3 | 490 | 10 | 6.6 | 1000 | Chlorophyll |
| BAND 4 | 510 | 10 | 5.6 | 1000 | Chlorophyll |
| BAND 5 | 555 | 10 | 4.6 | 1000 | Chlorophyll |
| BAND 6 | 566 | 10 | 4.3 | 1000 | Bloom Detection |
| BAND 7 | 620 | 10 | 3.1 | 1000 | Sediments |
| BAND 8 | 670 | 10 | 2.5 | 1000 | FLH baseline |
| BAND 9 | 681 | 8 | 2.3 | 1000 | FLH Peak |
| BAND 10 | 710 | 10 | 2.0 | 1000 | FLH baseline |
| BAND 11 | 780 | 10 | 1.6 | 1000 | Atm. Corr |
| BAND 12 | 870 | 20 | 1.1 | 800 | Atm. Corr |
| BAND 13 | 1010 | 40 | 0.5 | 800 | Atm. Corr |

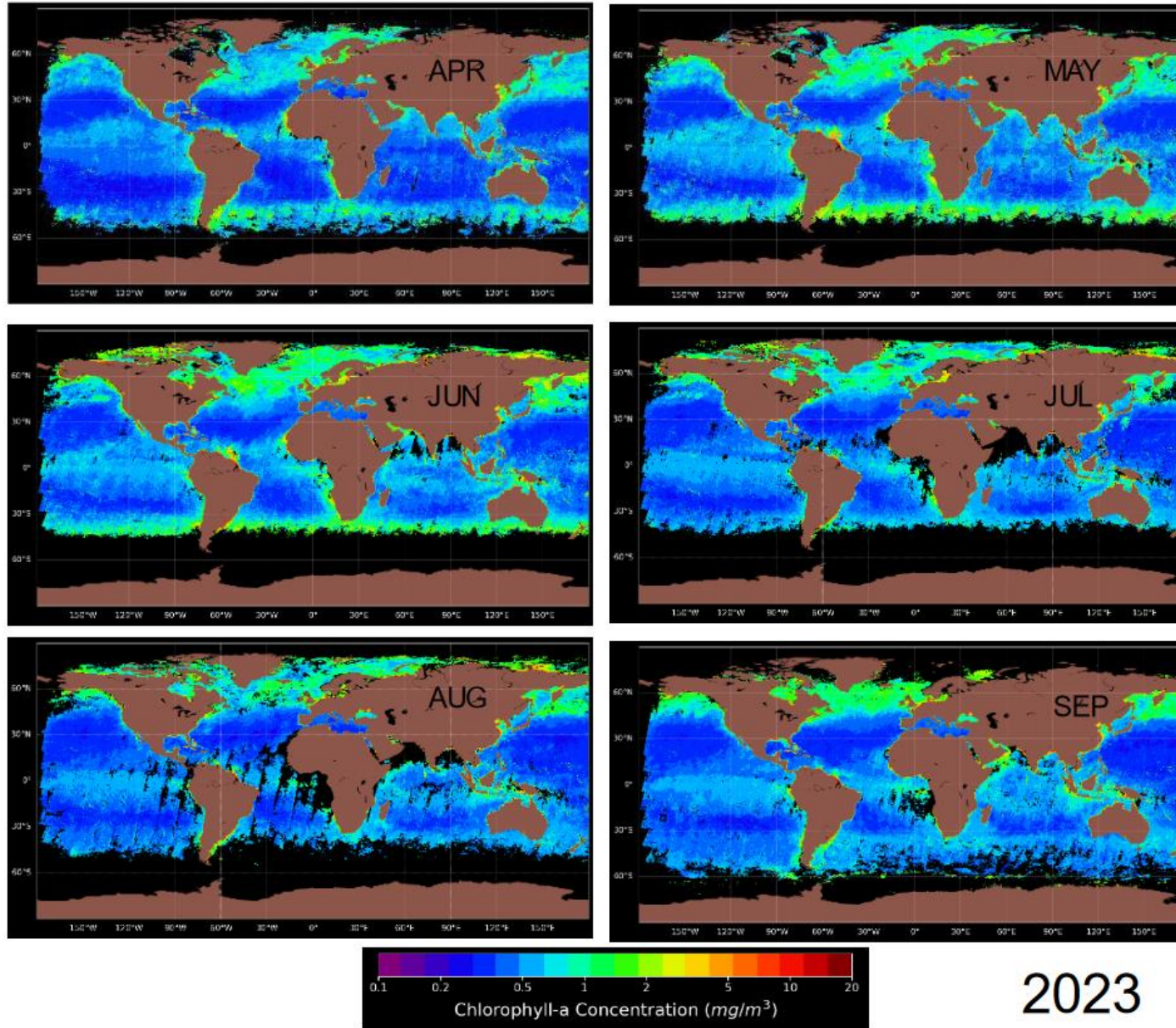




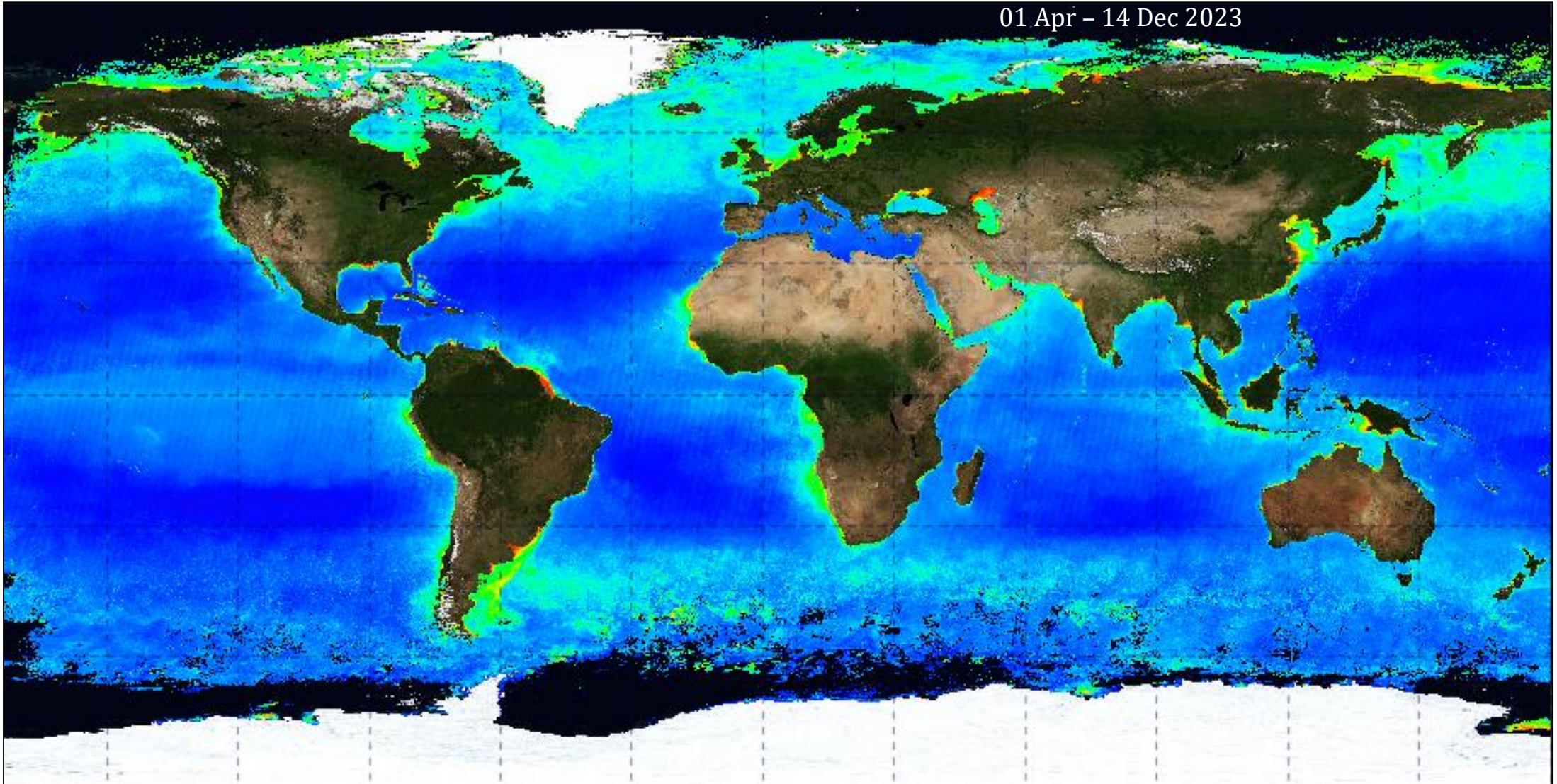


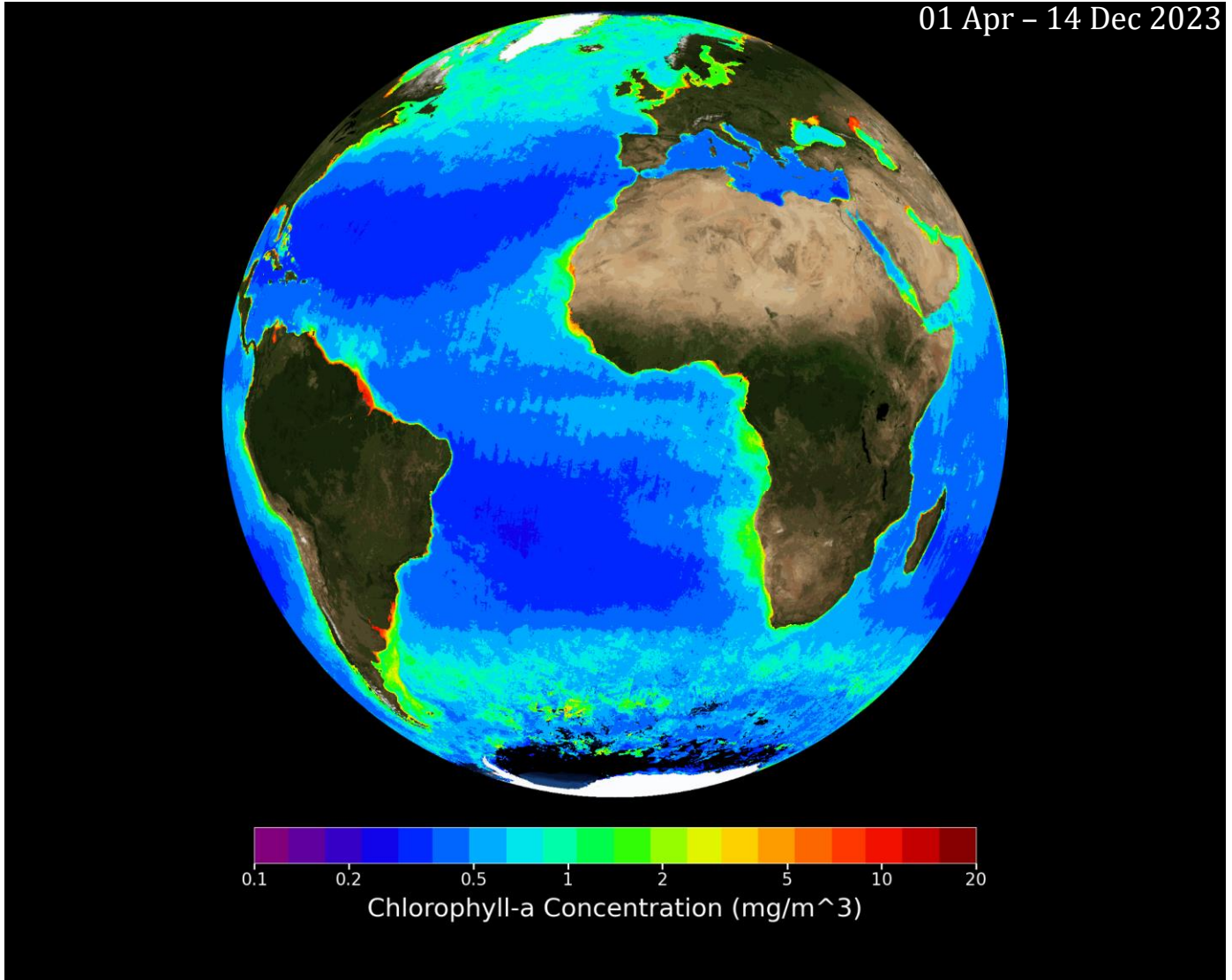


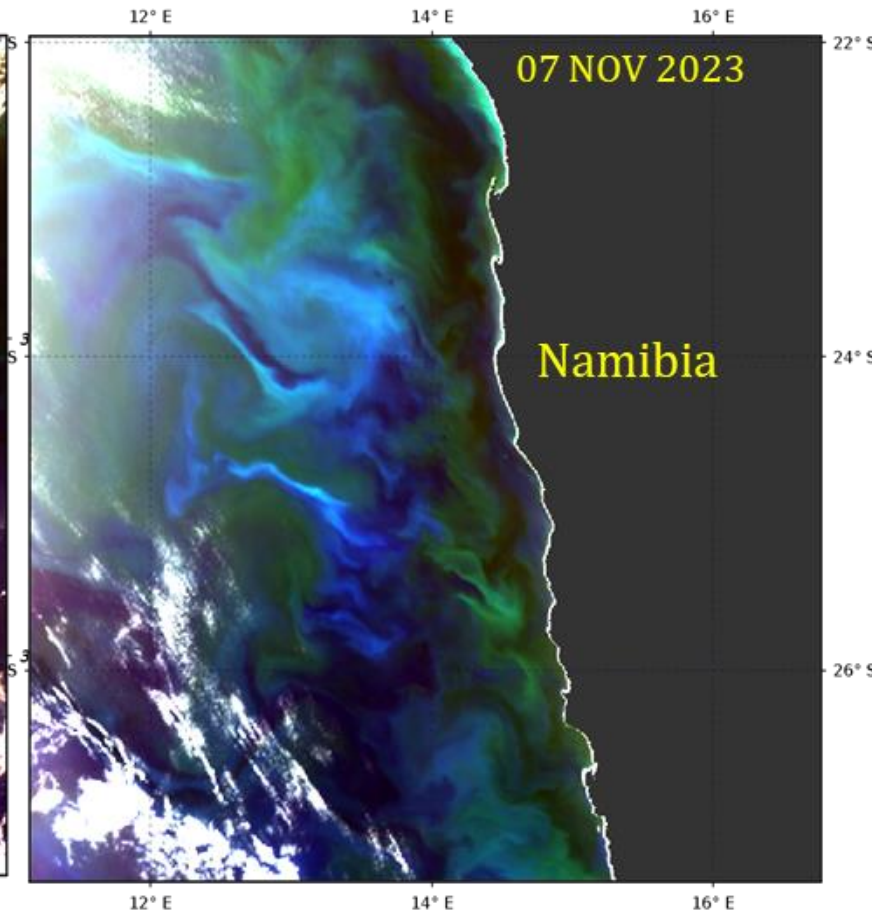
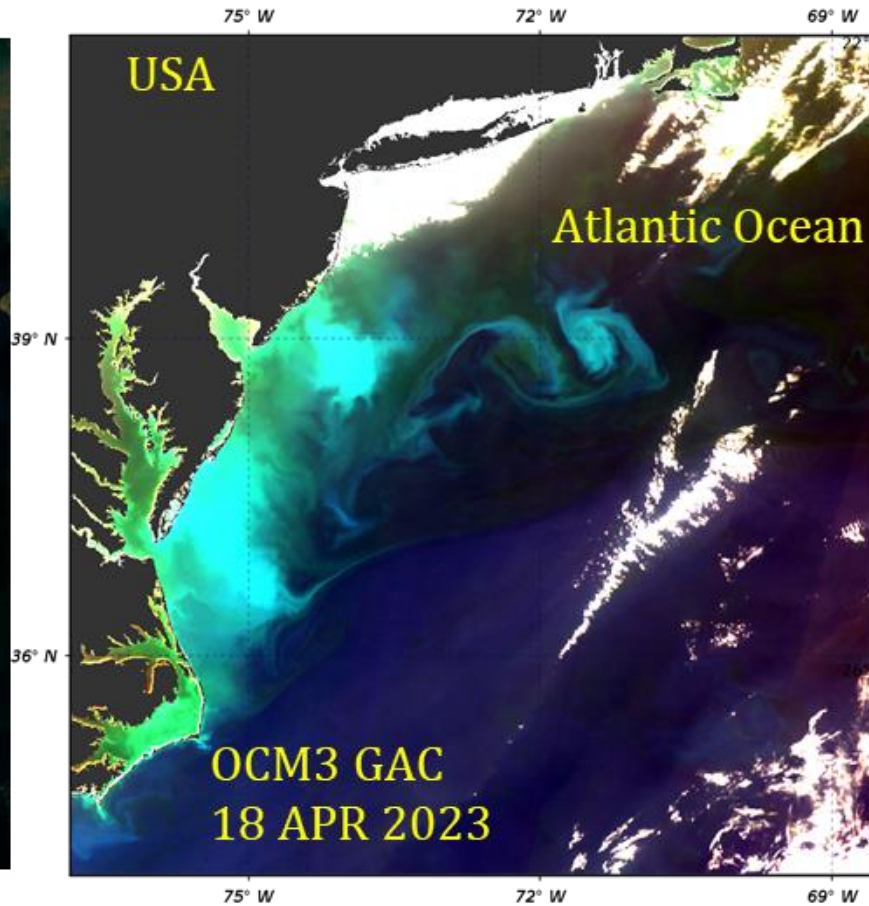
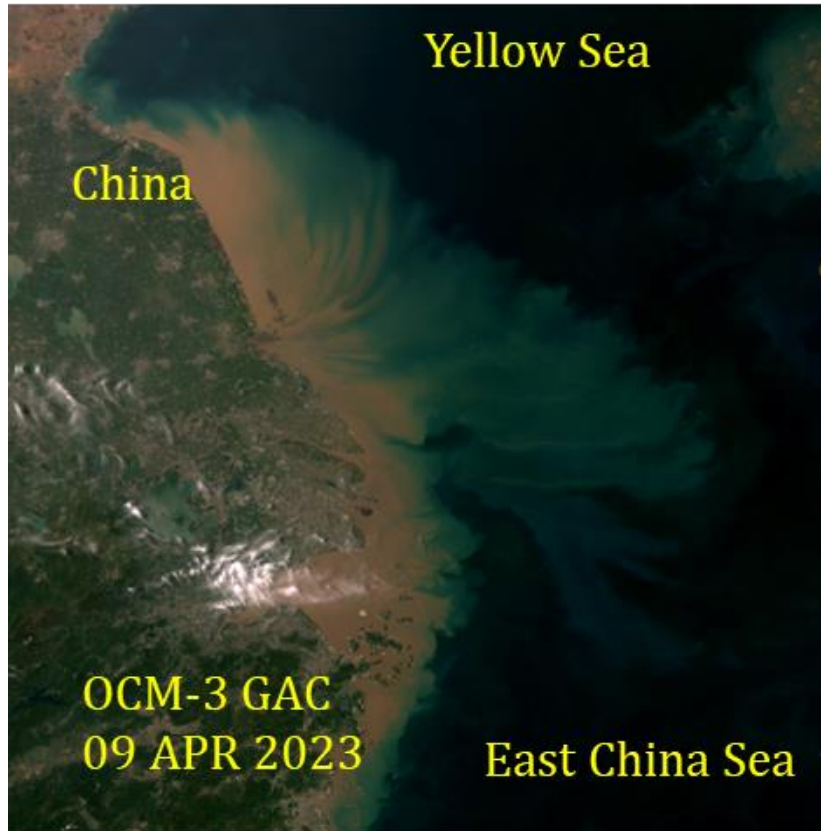
Level-3 Binned Global Mosaics of OCM-3

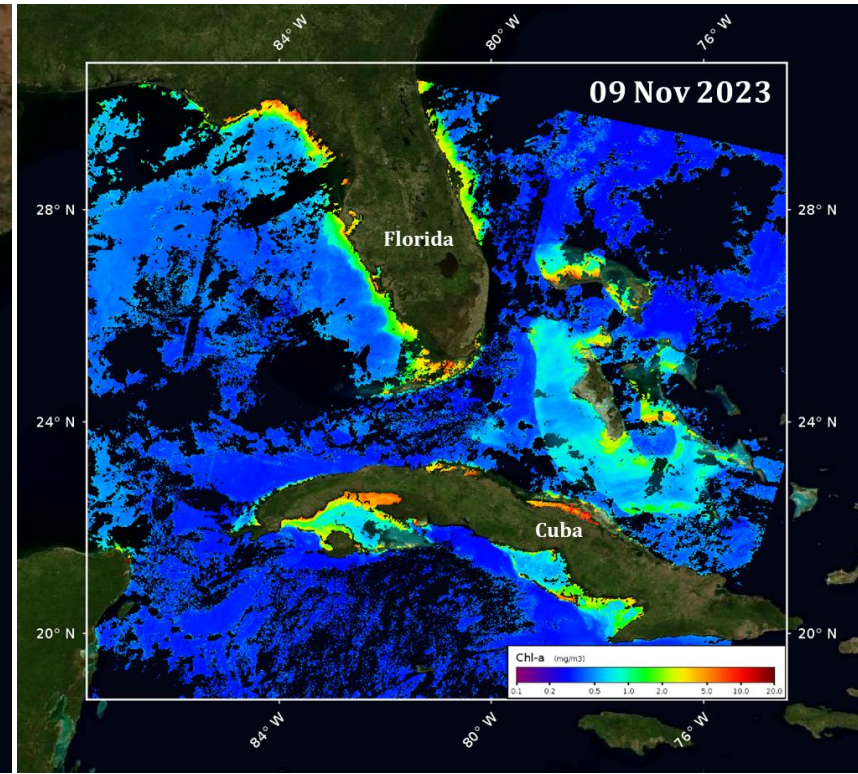
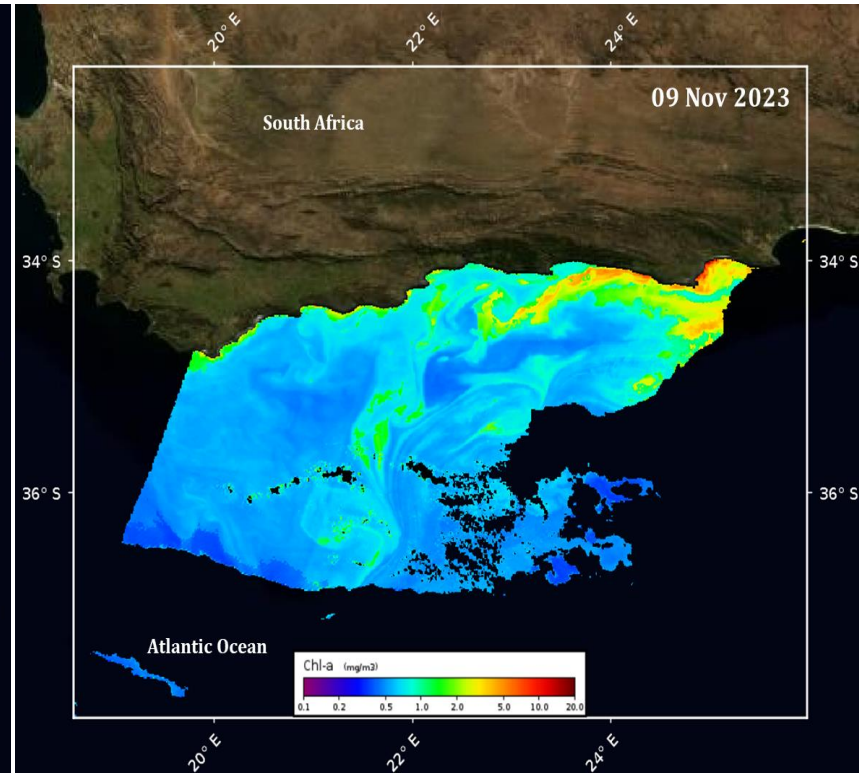
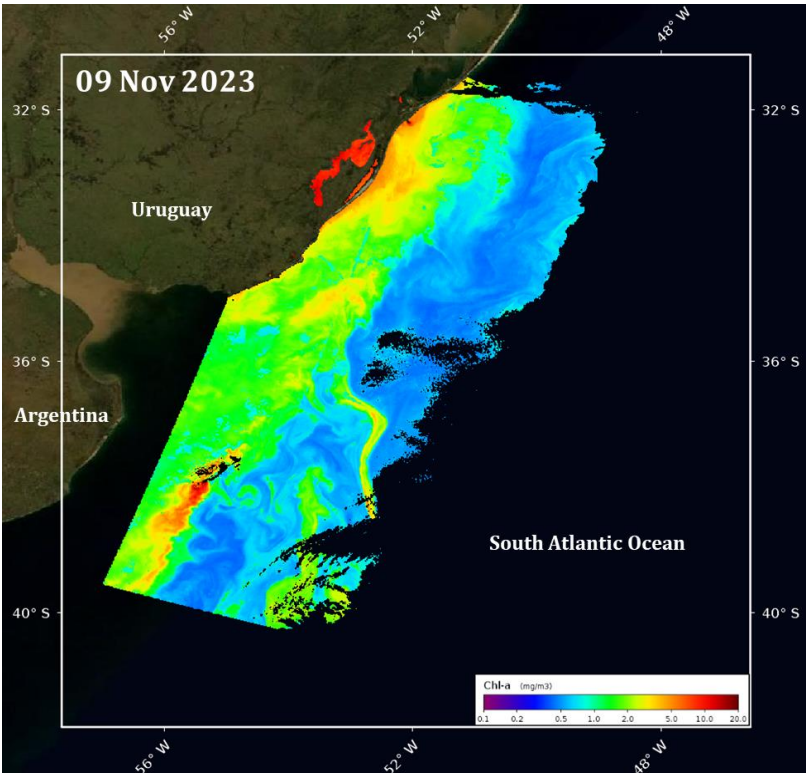


01 Apr - 14 Dec 2023

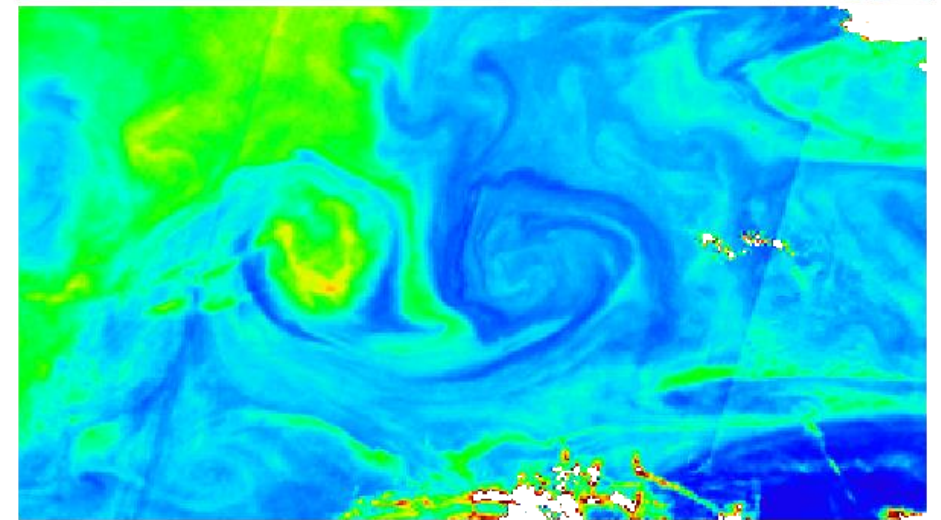
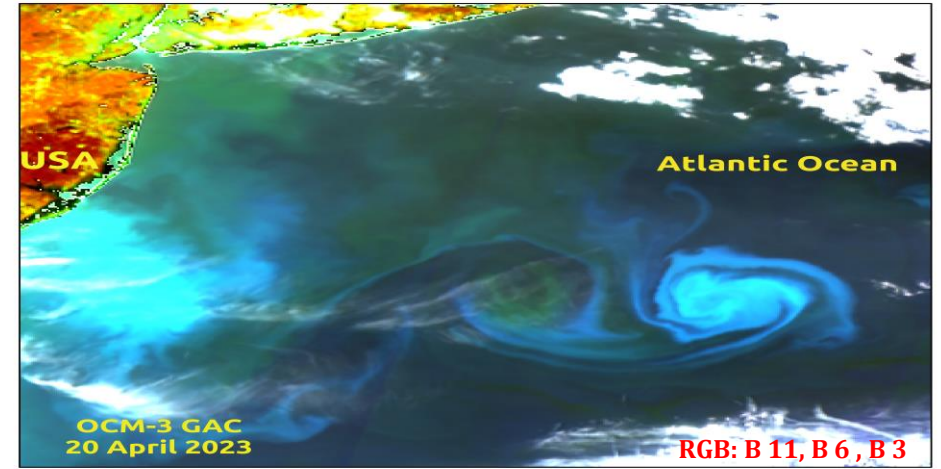
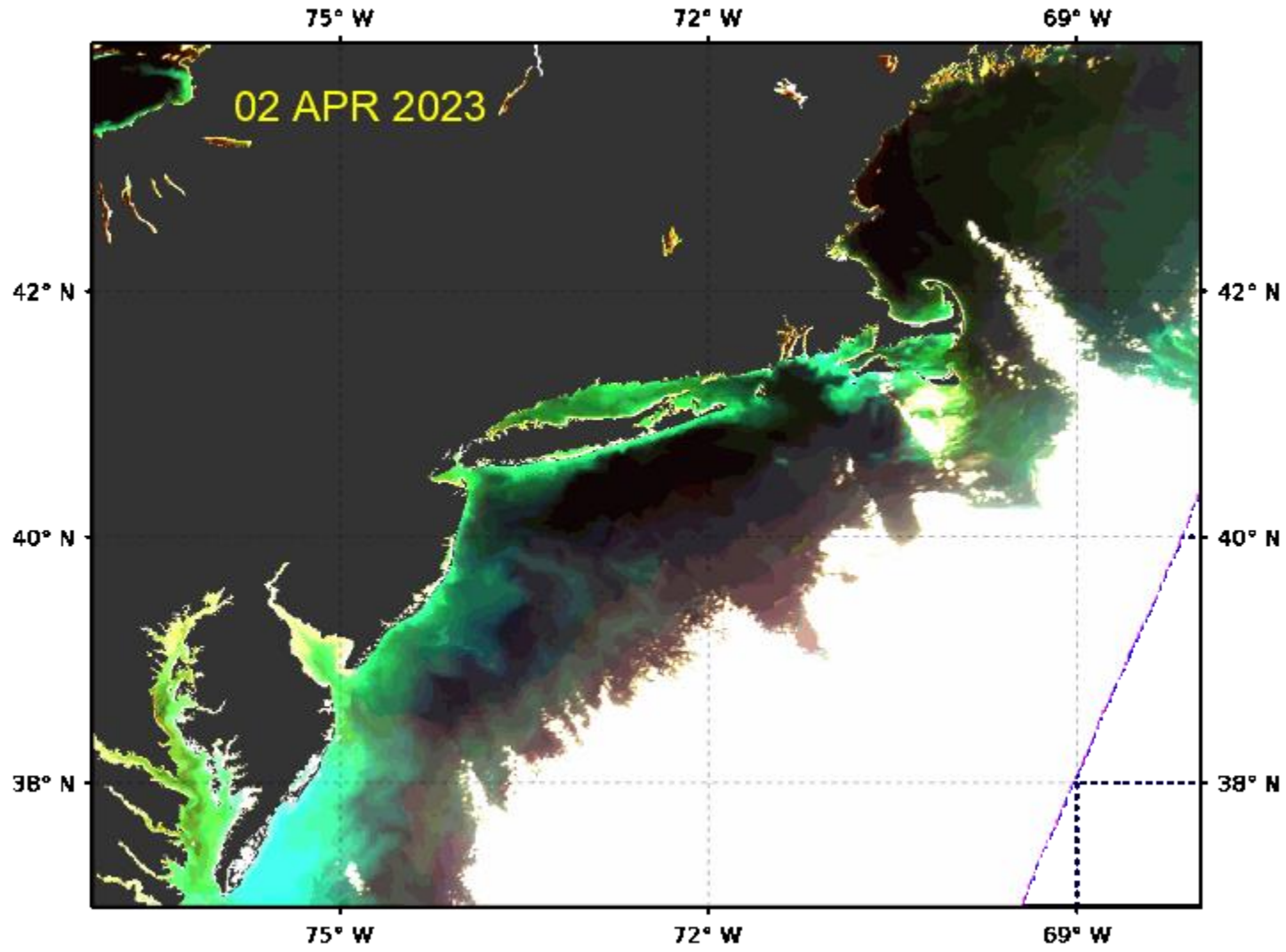


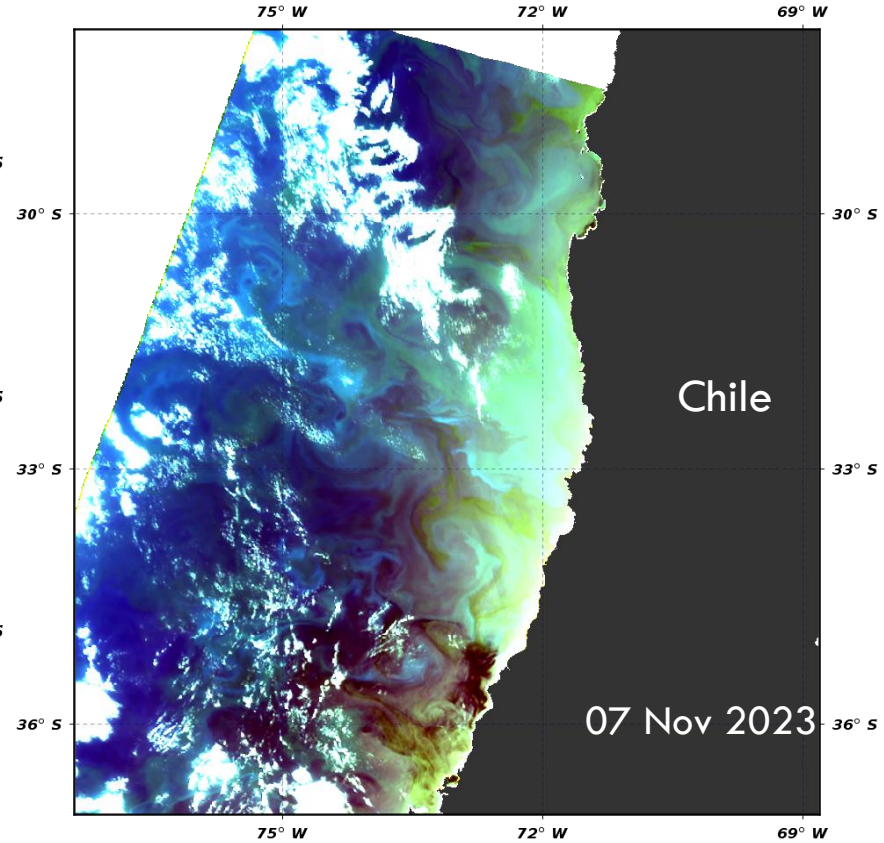
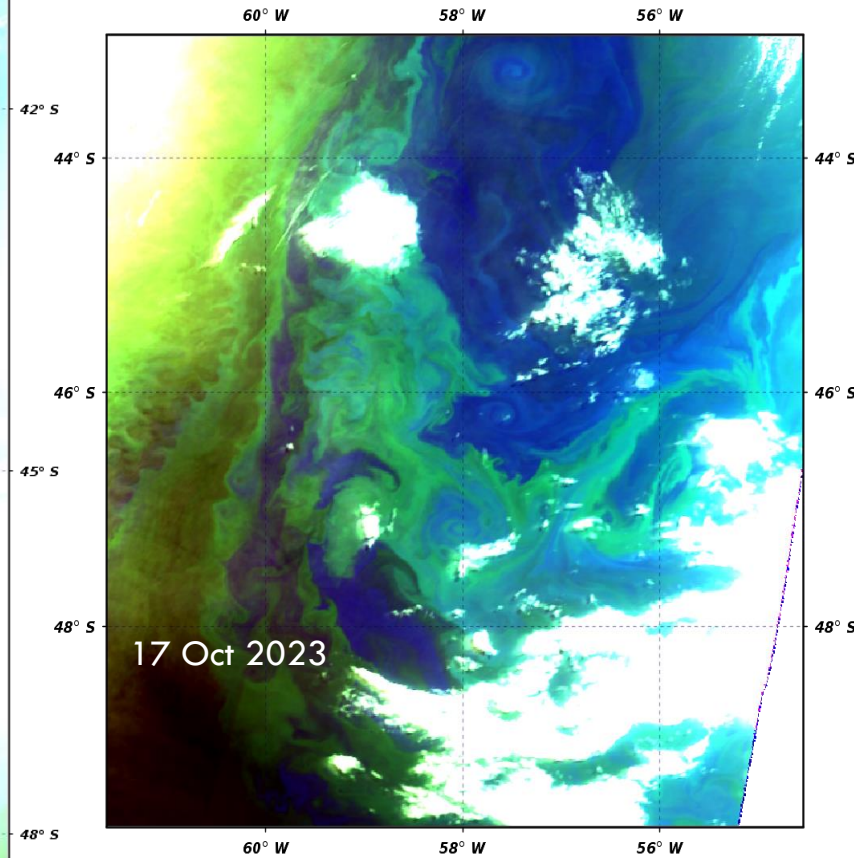
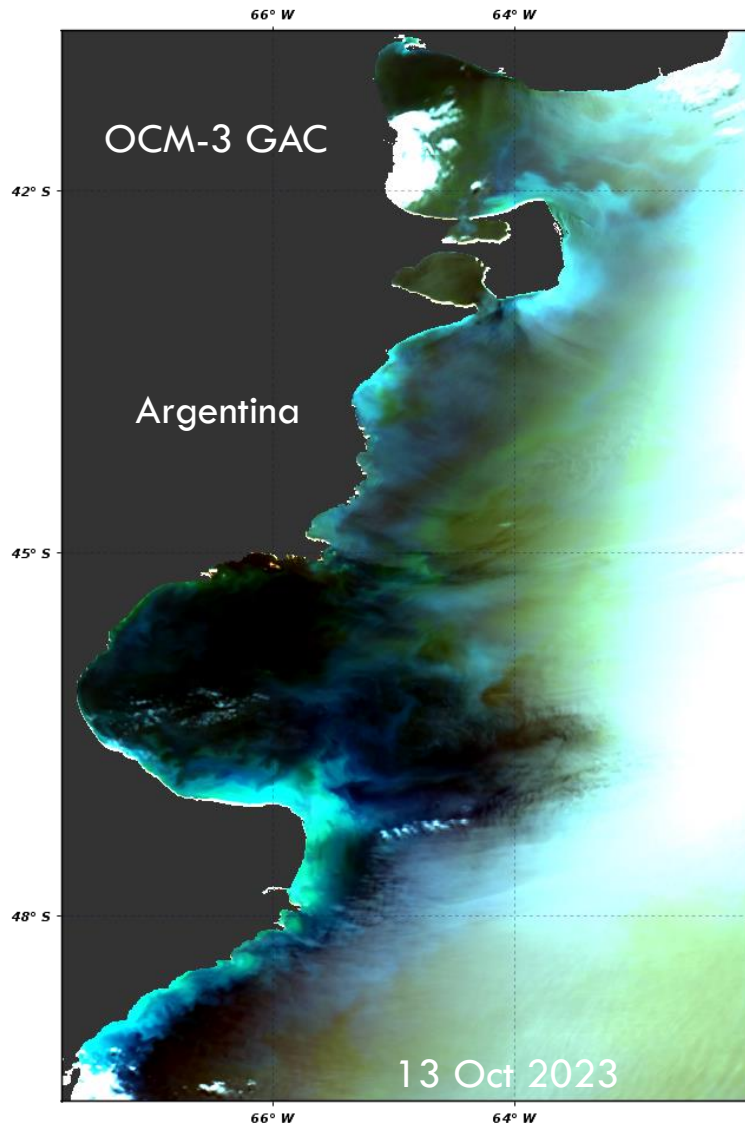






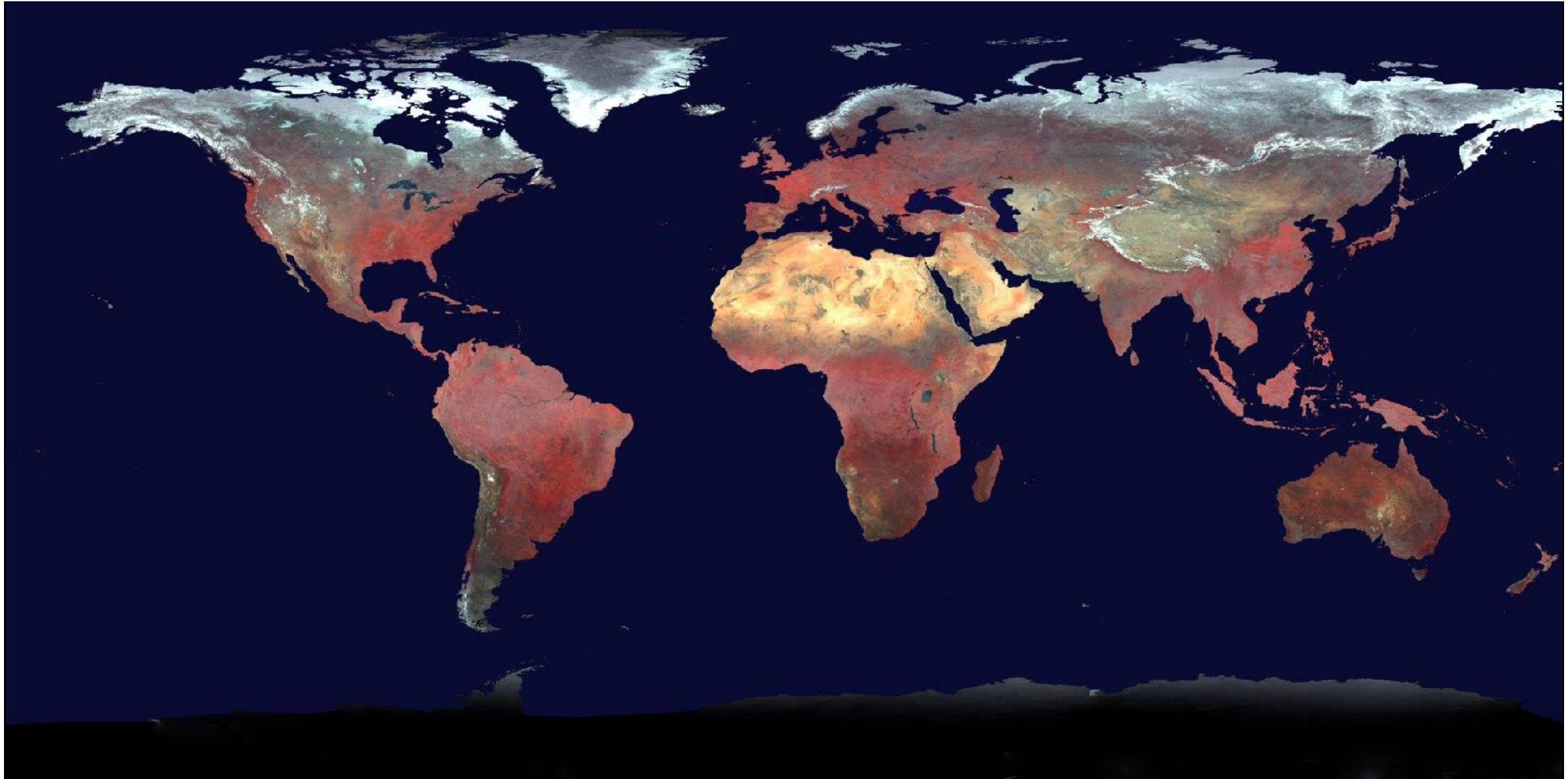
Evolution of Phytoplankton Bloom off the US East Coast



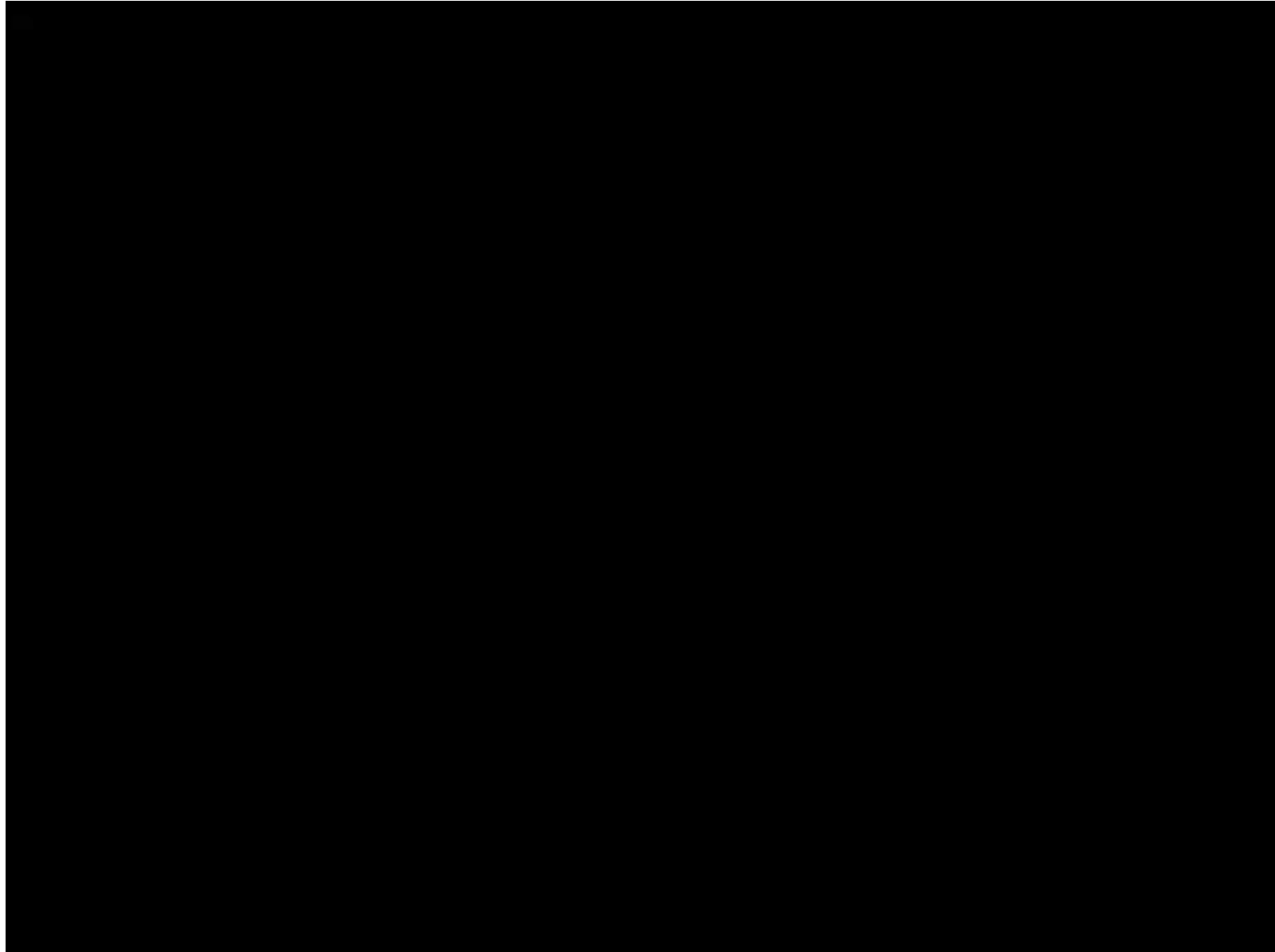


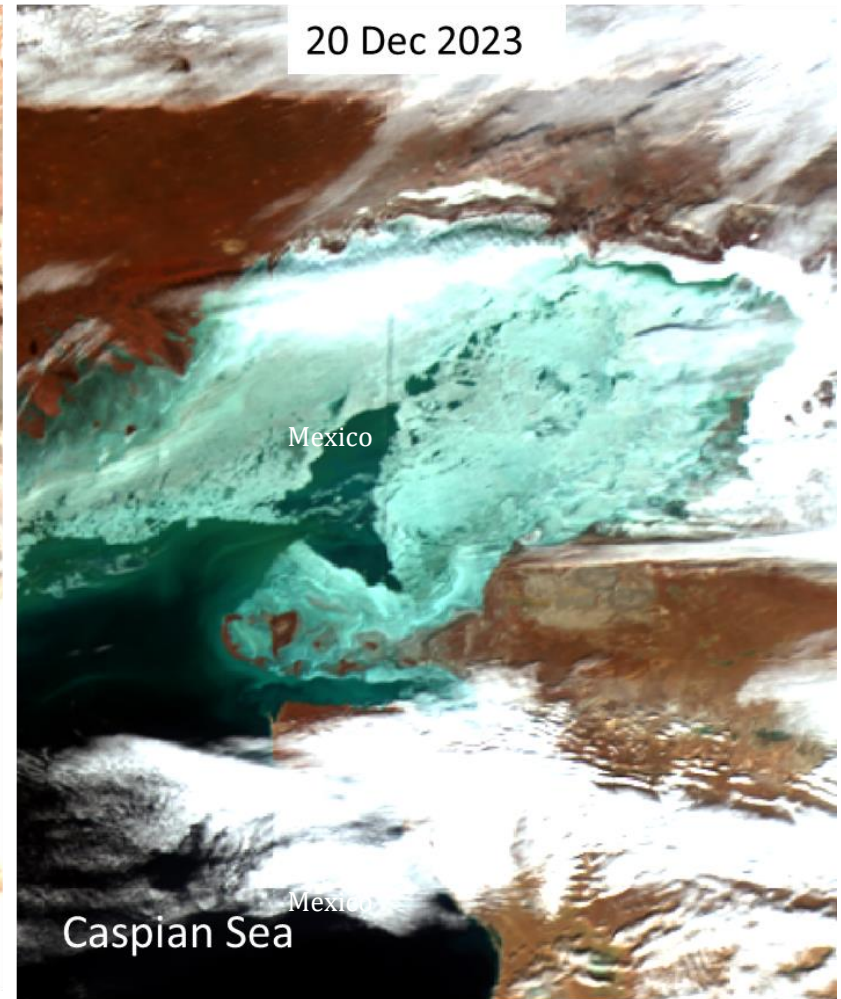
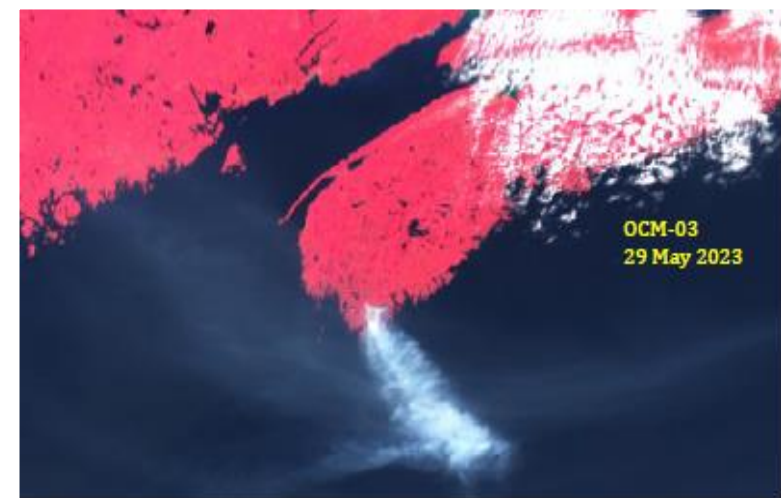
Recent Phytoplankton Bloom off the coast of
Argentina and Chile

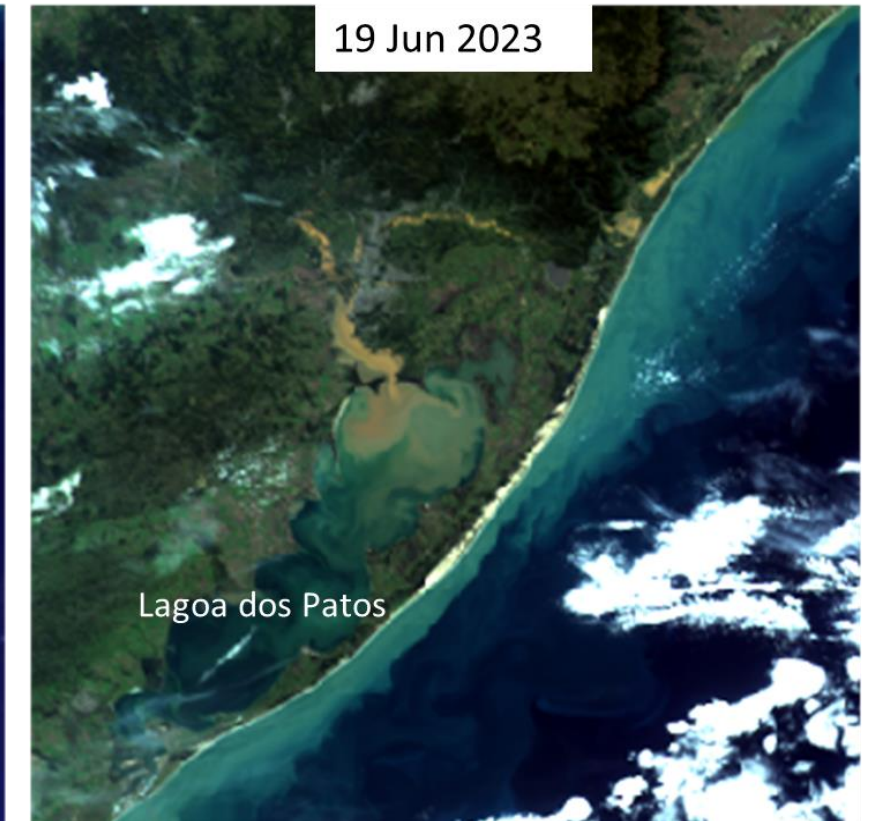
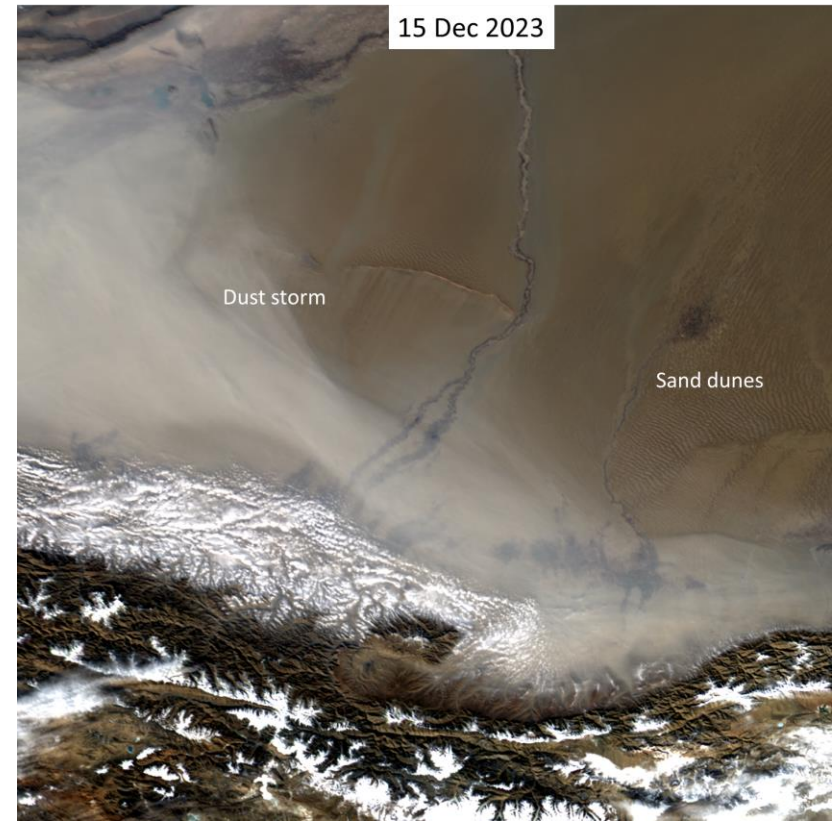
Monthly Global Mosaic of OCM-3 (Apr-May 2023)



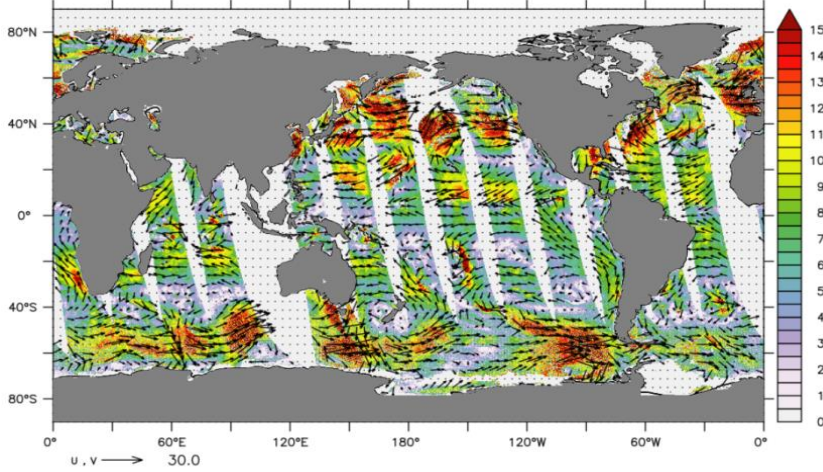
NDVI from OCM-3 (Jun-Oct 2023)



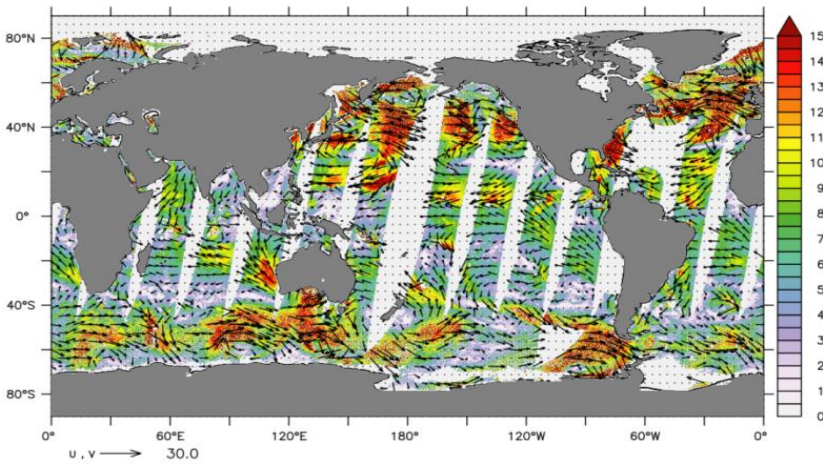




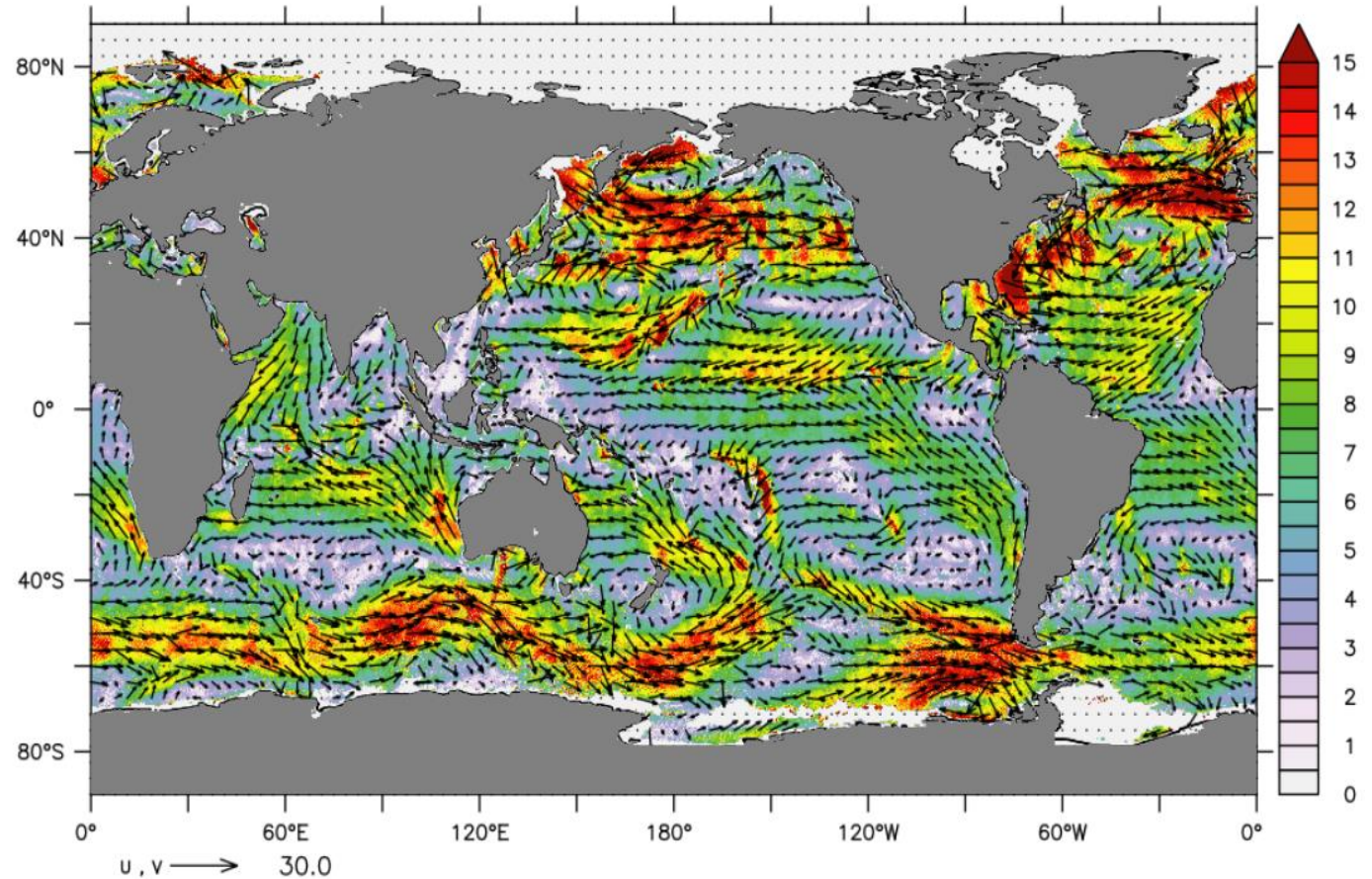
Sample Global Coverage of O3SCAT Winds (m/s)
(Data from 14th January 2023) (**Ascending Passes**)



Sample Global Coverage of O3SCAT Winds (m/s)
(Data from 14th January 2023) (**Descending Passes**)



Sample Global Coverage of O3SCAT Winds (m/s)
(Data from 14th & 15th January 2023) (**ALL Passes**)



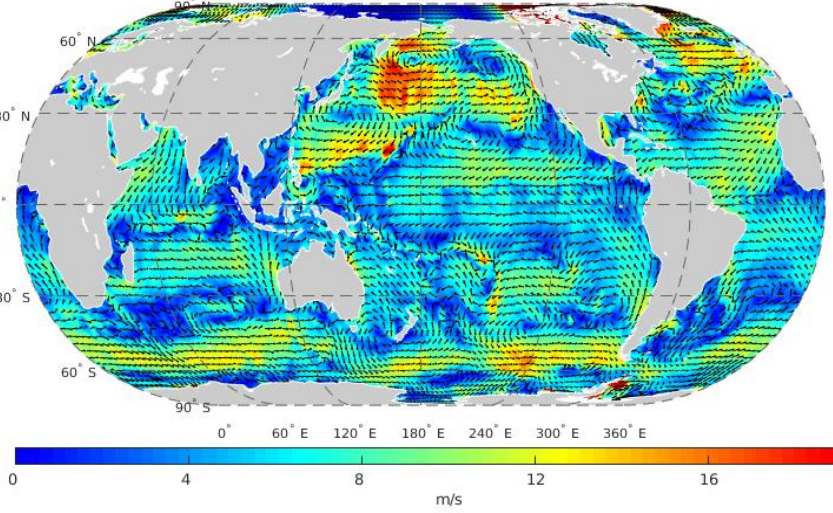
Operational Applications :

- ❖ Cyclone Forecasting
- ❖ Ship Routing
- ❖ Shoreline Management Studies
- ❖ Harbor and port management
- ❖ Oil spill management
- ❖ Search and rescue
- ❖ Ship Detection in coastal waters
- ❖ Pollution Dispersion studies

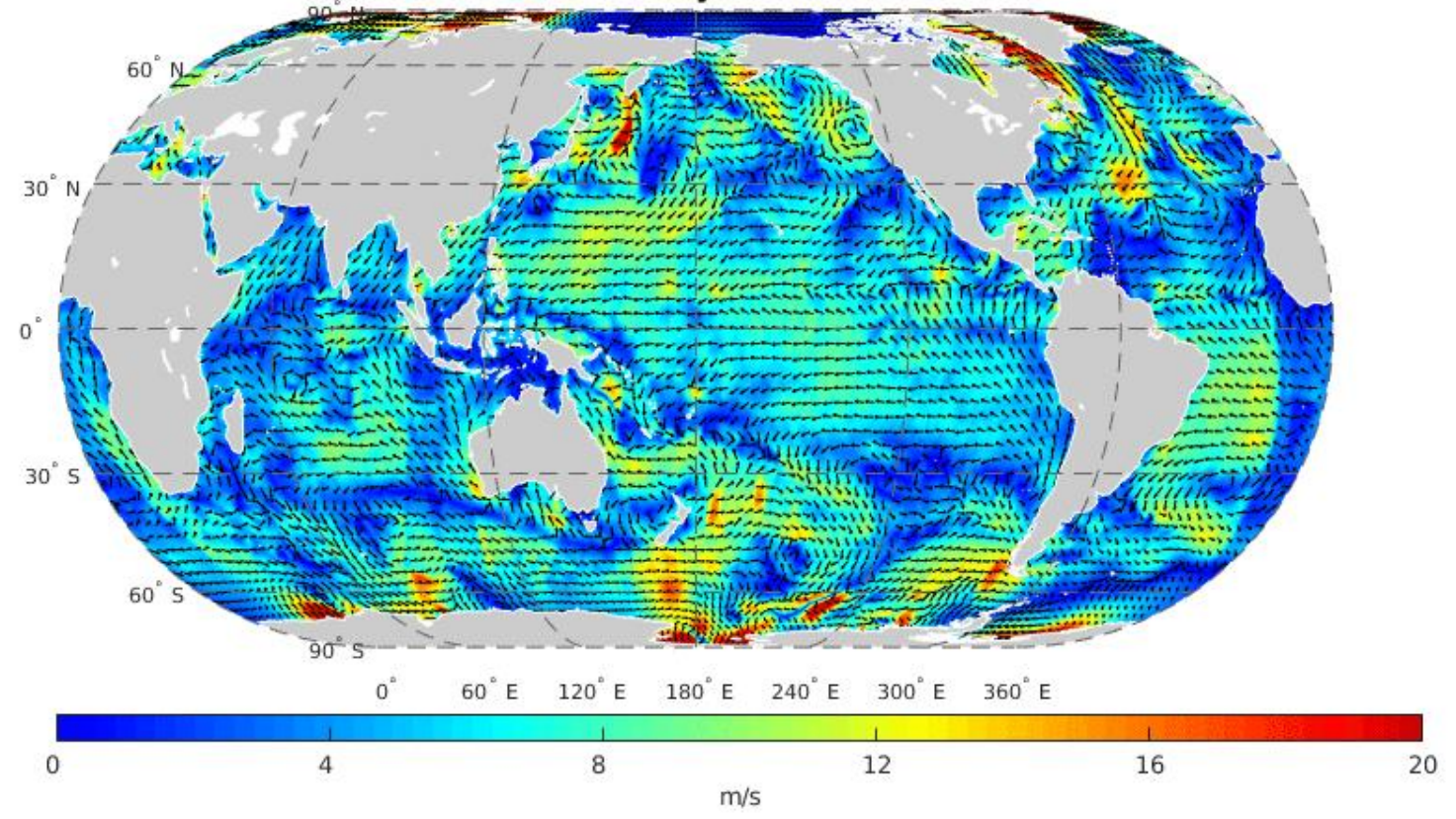
Scientific Studies:

- ❖ Designated as ECV- Climate studies of ocean circulation variability, Heat Transport etc.,
- ❖ Wind-Wave-Current Interaction studies
- ❖ Understanding Coastal Ocean circulation
- ❖ Air-Sea interaction studies
- ❖ PFZ Forecast studies

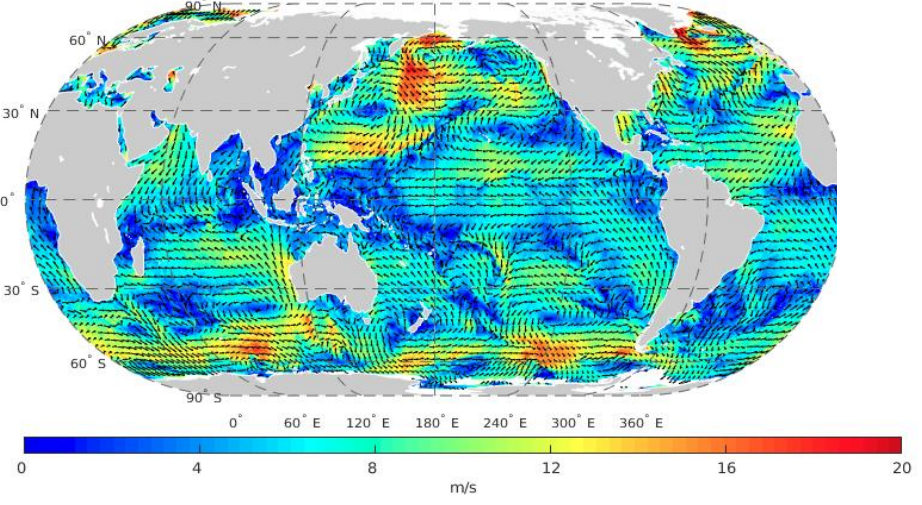
O3SCAT Wind Velocity 25 km- 13-Jan-2023

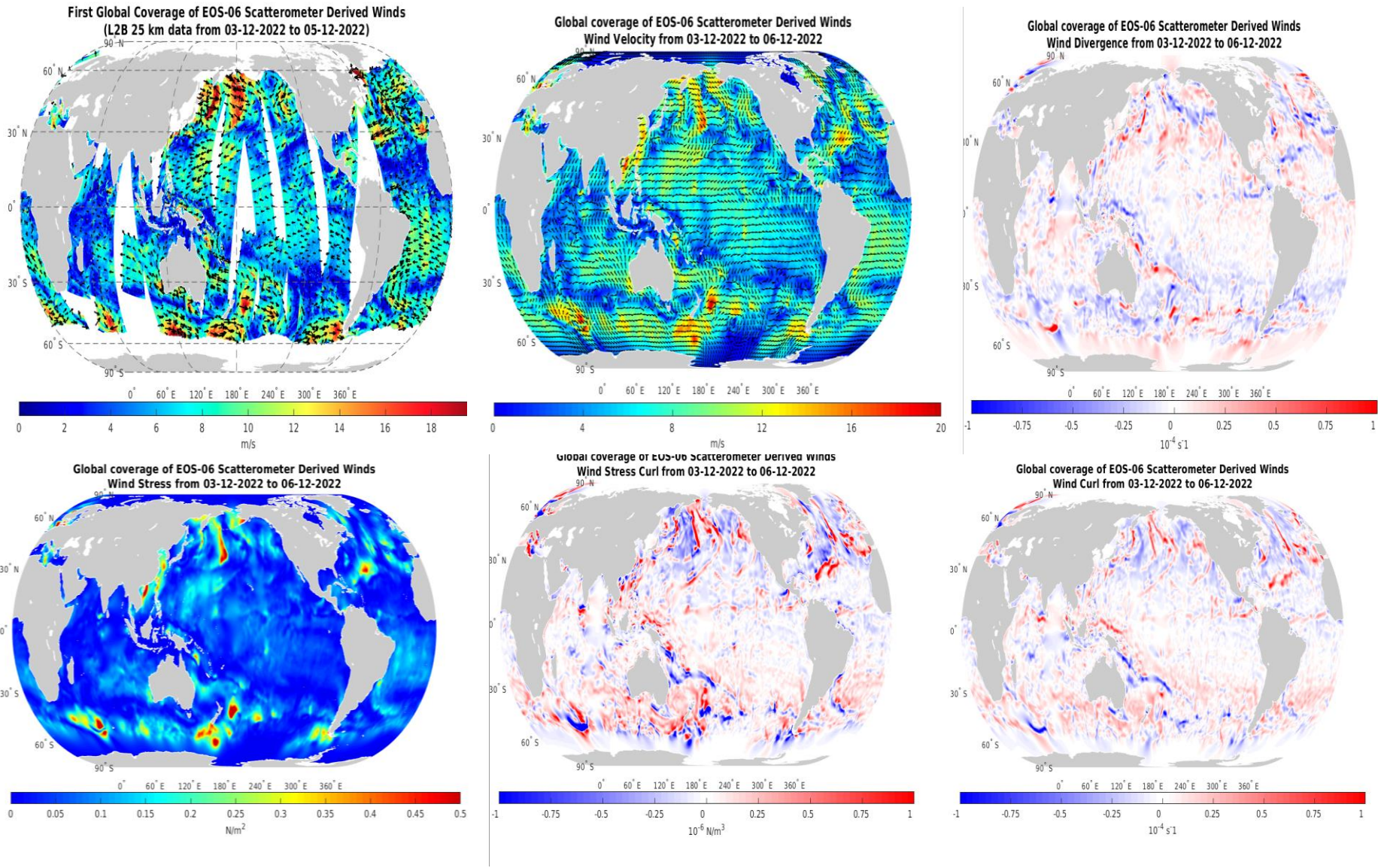


O3SCAT Wind Velocity 25 km- 04-Dec-2022

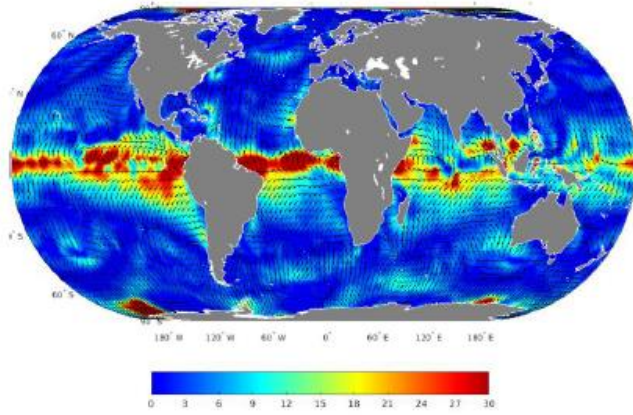


ASCAT Wind Velocity 25 km- 13 Jan 2023

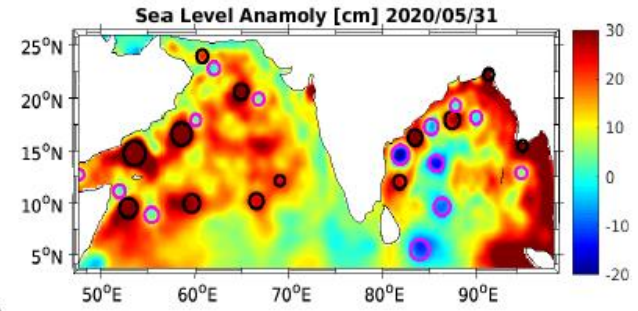
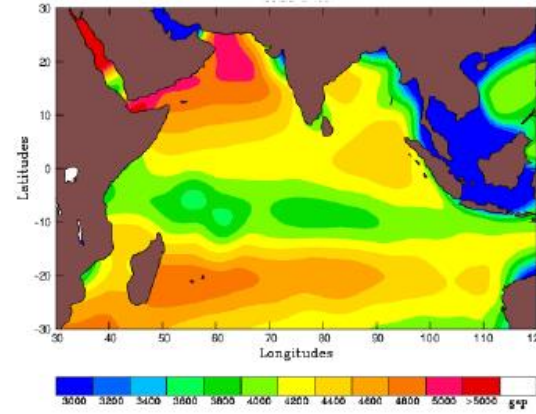




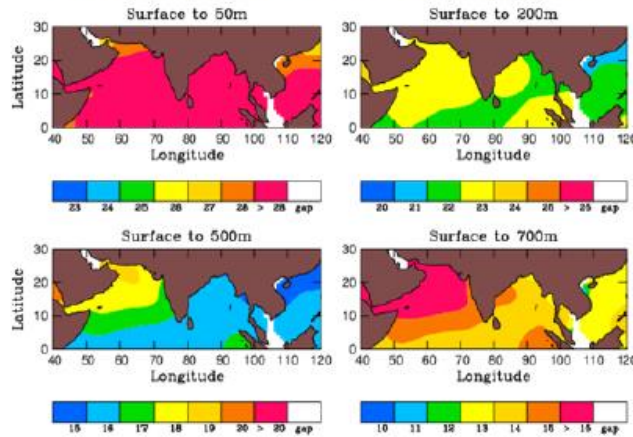
22 सितंबर, 2020 के लिए एकमान धाराएं (सेमी/सेकंड)
Ekman Currents (cm/sec) for Sept 22, 2020



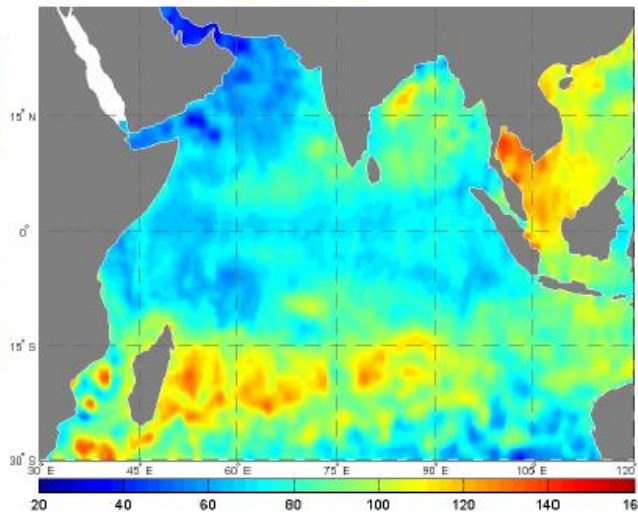
OHC 700 (KJ/cm²) on May 25, 2022



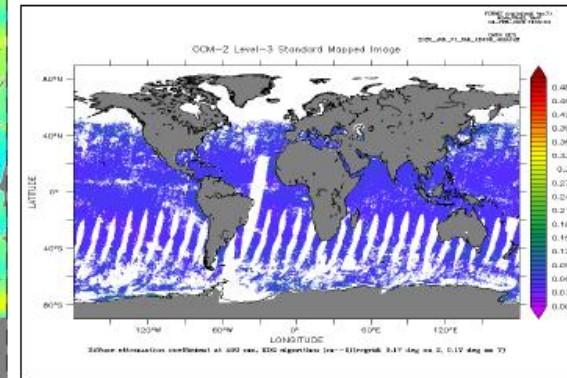
Ocean mean temperature (°C) on 25.5.2022



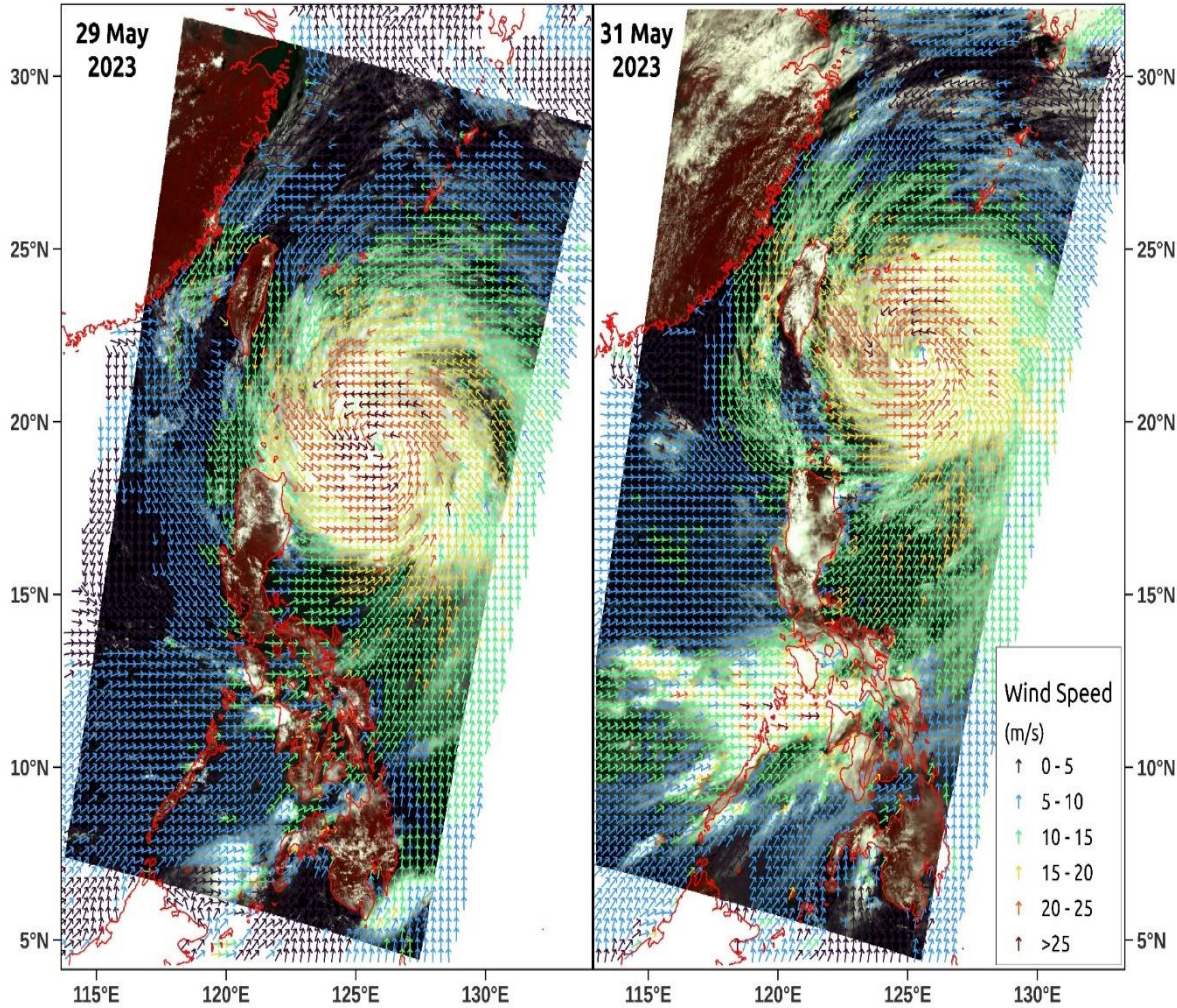
SSHA map



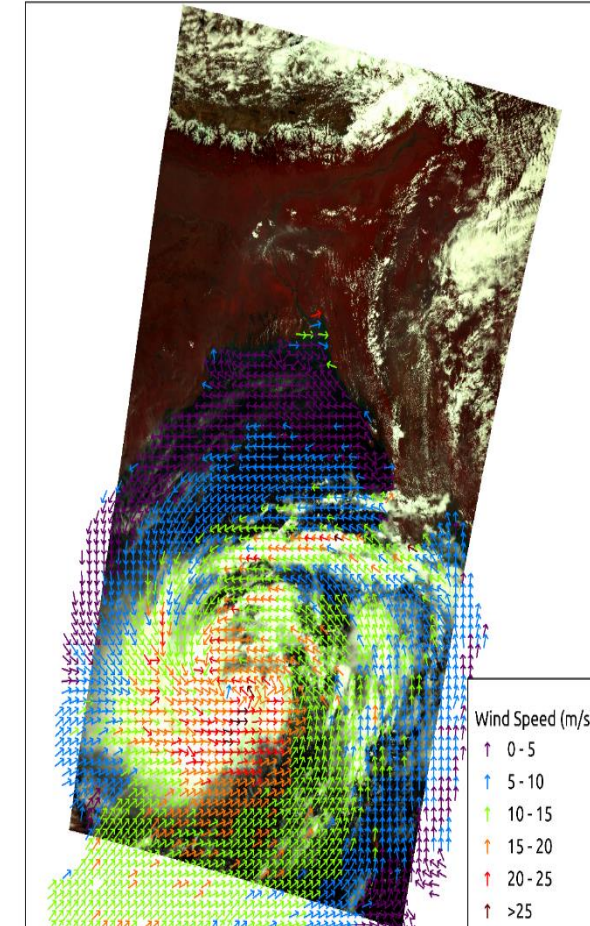
Kd at 490 nm Global (4km) in January, 2020



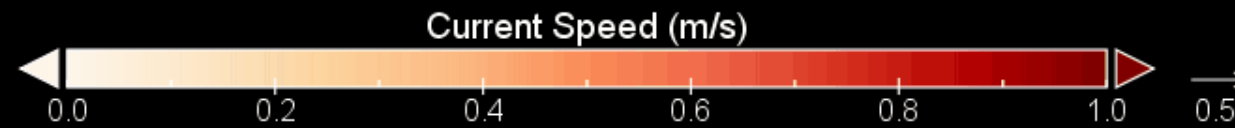
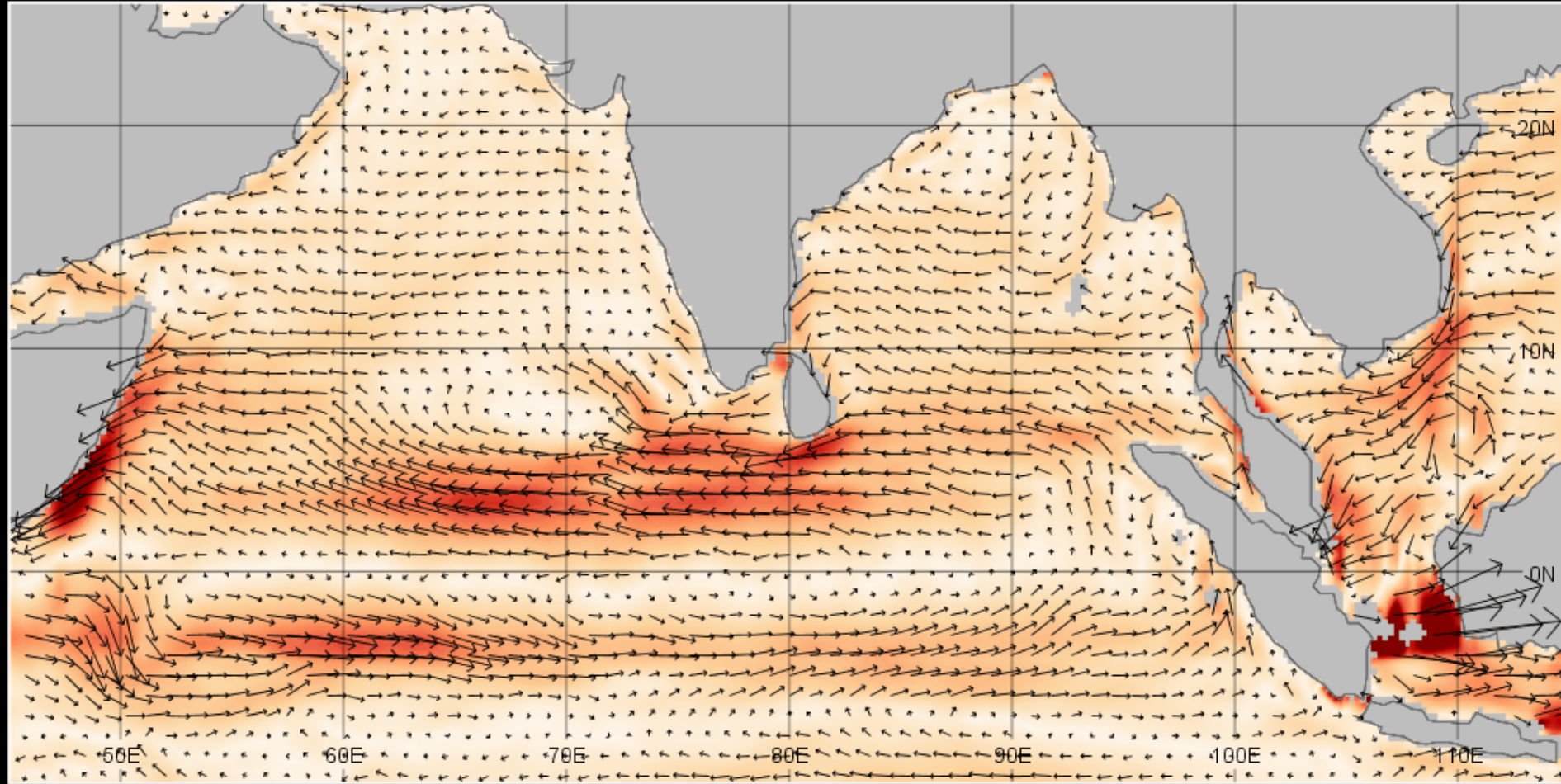
EOS-06 Scat Winds over OCM3
Cyclone Mawar



Scatterometer Winds over OCM3 (11-May-2023)



SATCUR Climatology - JANUARY



जलवायु और पर्यावरण अध्ययन के लिए राष्ट्रीय सूचना प्रणाली
National Information System for Climate and Environment Studies
(NICES)

NEWSLETTER
Dec 2023

Highlights

- Geophysical products –
 - Indian soil data sets
 - Sea Level Pressure
 - Snow melt and Freeze
- Latest Publications by ECSA Team
- Report on “Space-based Greenhouse Gases, Air Quality and Climate Change” workshop
- Other Activities



Climate Studies

Ocean

Cryosphere

Atmosphere

Land

पृथ्वी और जलवायु विज्ञान क्षेत्र
Earth And Climate Sciences Area

राष्ट्रीय सुदूर संवेदन केन्द्र
National Remote Sensing Centre




जलवायु और पर्यावरण अध्ययन के लिए राष्ट्रीय सूचना प्रणाली
National Information System for Climate and Environment Studies
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NEWSLETTER
Jan 2024

Highlights

- Geophysical products –
 - AWIFS Snow Albedo
 - Total Alkalinity
- Latest Publications by ECSA Team
- Decadal Study on Eddy dynamics in the Bay of Bengal (1993-2022)
- Latest EOS-06 ocean products
- Other Activities



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Earth And Climate Sciences Area

राष्ट्रीय सुदूर संवेदन केन्द्र
National Remote Sensing Centre



Director

National Remote Sensing Centre
Indian Space Research Organisation
Department of Space, Govt. of India,
Hyderabad 500 037
Phone:+91-40-23884001
director@nrsc.gov.in

Programme Director (NICES)

National Information System for Climate and
Environment Studies
National Remote Sensing Centre
Indian Space Research Organisation
Department of Space, Govt. of India,
Hyderabad 500 037
Phone:+91-040-23884890 +91-040-23884212
ddecsa@nrsc.gov.in

Thanks for your kind
Attention!