ISRO updates since CGMS-52 and report on the medium to long-term future plans on Earth observation

Presented to CGMS-53 plenary session, agenda item [3]
CGMS-53-ISRO-WP-04

Nilesh M Desai

Director, Space Applications Centre (ISRO)
Ahmedabad (India)

Coordination Group for Meteorological Satellites

Executive summary

- Presently, **INSAT-3DR** (8-Sep-2016) at 74E and **INSAT-3DS** (17-Feb-2024) at 82E are operational in GEO.
- INSAT-3D is switched off since Jun 2024, replaced by INSAT-3DS at 82E.
- **EOS-06** (Oceansat-3), launched on 26 Nov 2022 is operational with Ku-band Scatterometer, and 13-band Ocean Color Monitor (OCM-3). Data is available to the users through BHUVAN web-portal.
- **EOS-08** (Microsat-2C) was launched on 16-Aug-2024 in low-inclination orbit with GNSS-R and EOIR payloads.
- **EOS-09/RISAT-1B** (C-band SAR) launch failed due to technical issue in launch vehicle on 18-May-2025
- Joint NASA-ISRO **NISAR** (L & S band SAR) is planned to be launched in Jun 2025
- **Oceansat-3A** with OCM3, Ku-band SCAT, SSTM, and MATHS payloads will be launched this year.
- ISRO-CNES joint mission **SARAL/AltiKa** is functioning in mis-pointing mode and the mission is extended till December 2025 provided the health of the satellite is satisfactory.
- Under **GSICS**, inter-calibration of INSAT-3DS observations were carried out - IR channels, w.r.t. MetOp-IASI and VIS/SWIR channels using Ray-matching method, w.r.t. MODIS.
- ISRO is presently working on the proposal received from MoES for INSAT-4th Generation satellite and defining the instruments onboard - Advanced Imager, Lightning Mapper and Hyperspectral Infrared Sounder

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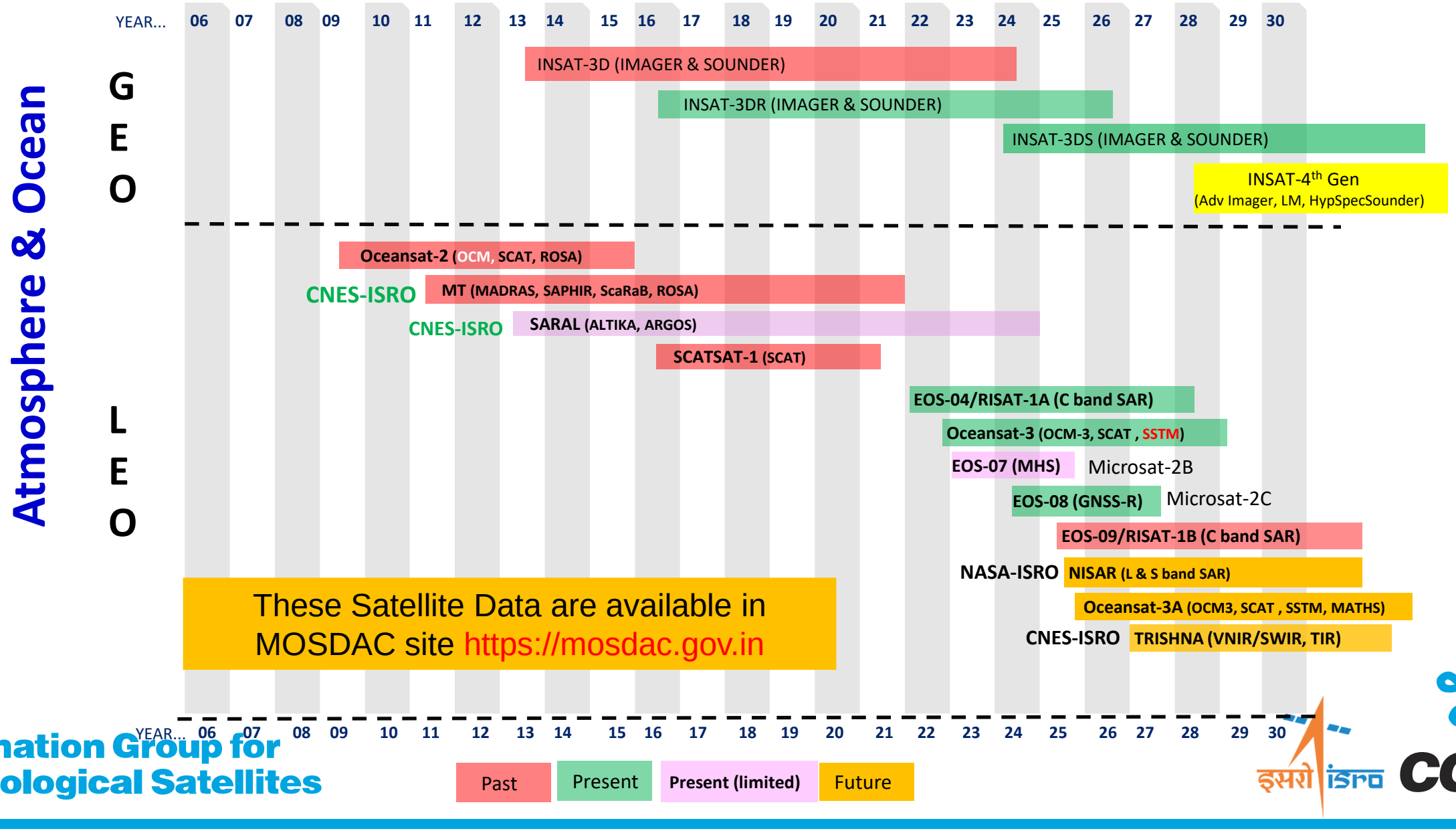
Overview - Planning of ISRO satellite systems



These Satellite Data are available in MOSDAC site https://mosdac.gov.in

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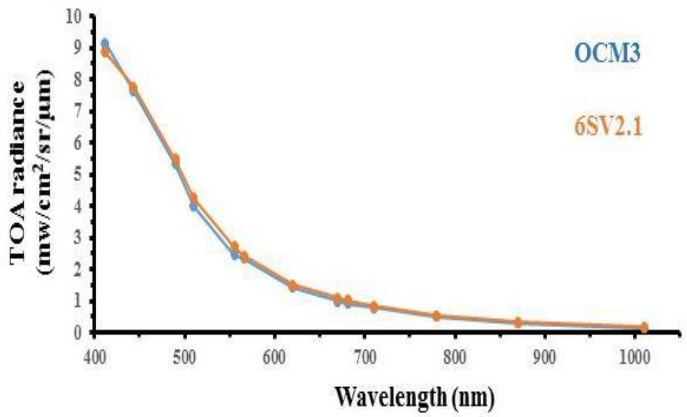
EOS-06/Oceansat-3 (OCM & SCAT) – Products & Dissemination

Operational Products (Bhoonidhi)

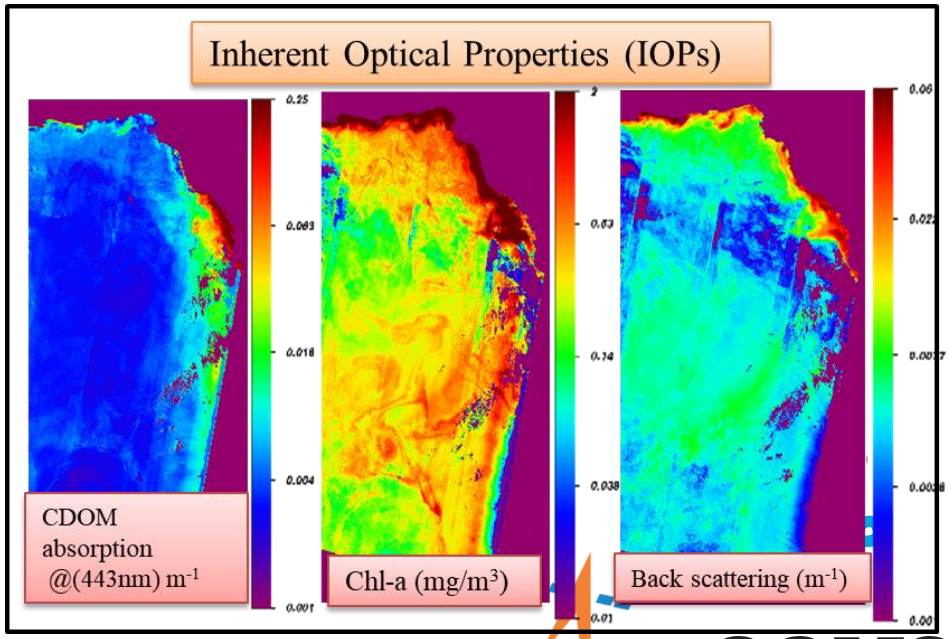
1. Ocean biophysical Products:
   - Chlorophyll-a Concentration
   - Remote Sensing Reflectance
   - Aerosol Optical Depth
   - Total Suspended Matter
   - Diffuse Attenuation Coefficient
2. Land biophysical Products:
   - NDVI
   - Vegetation Fraction
3. Sea Surface Wind Vector
4. Global sea ice extent (flagging)

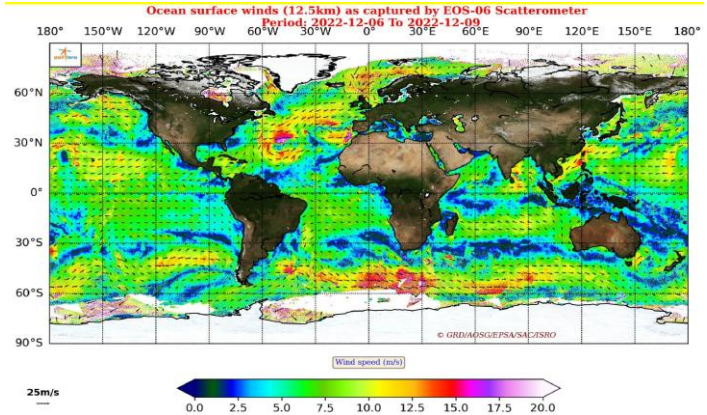


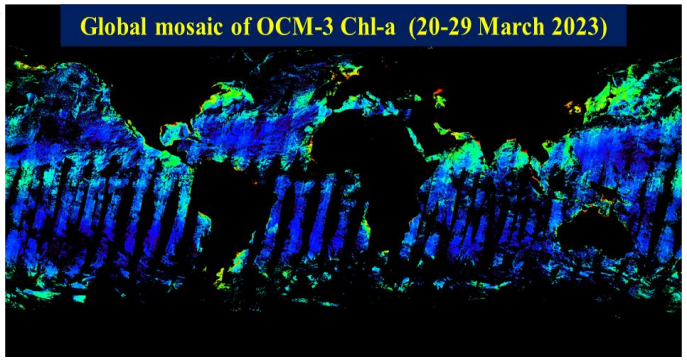
The mean OCM3 TOA radiance after Second Vicarious Calibration and mean simulation over MOBY site.

Value-added Products (MOSDAC)

1. Coloured Dissolved Organic Matter (CDOM)
2. Photo Synthetically Available Radiation
3. Phytoplankton Bloom Detection
4. Particulate and dissolved organic carbon
5. Aerosol Optical Depth (AOD)
6. Upwelling Indices
7. Analyzed Chlorophyll
8. Analyzed winds







Products available from:
https://bhoonidhi.nrsc.gov.in ; https://mosdac.gov.in

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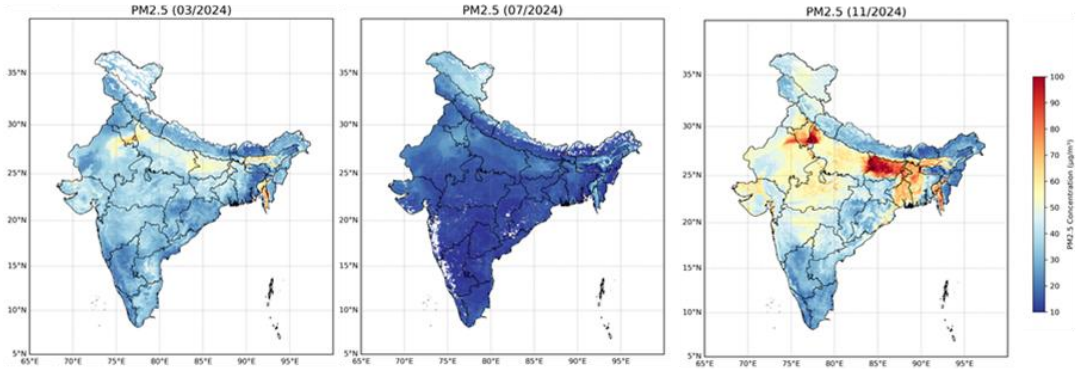
EOS-06 (Oceansat-3) : New Algorithm Development

Monitoring Particulate Matter (PM2.5) from OCM3

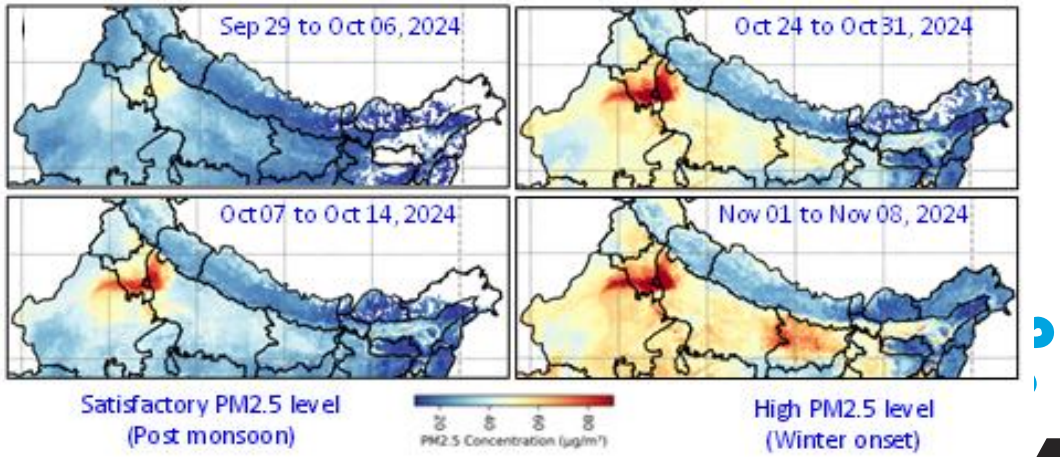
- AQI over Indian sub-continent dominated by particulate matter.
- Important constituent of AQI is PM2.5 (particles size of < 2.5µm)
- Ground-based PM2.5 monitoring is localized and limited.
- SAC/ISRO developed an advanced AI-based methodology using OCM3 data to retrieve PM2.5 for regular monitoring over Indian landmass, in addition to existing Aerosol Optical Depth (AOD) product.
- PM2.5 products are available at 1-km spatial resolution with uncertainty of less than 35%.
- Products generated for 2024 are hosted on VEDAS and will be available in near-real time from coming winter season.

(https://vedas.sac.gov.in/uva/index.html#app_id=visualization)

Monthly averaged PM2.5 maps for Mar, July and Nov-2024



Indo-Gangetic Plain (IGP) shows gradual increase in PM2.5 during Sept- to Nov-2024



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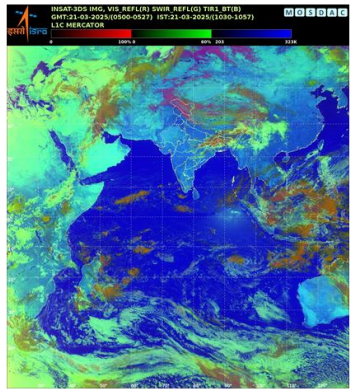
INSAT-3DS

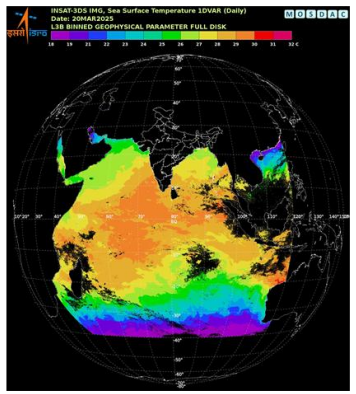
- Launched on 17-Feb-2024 from Satish Dhawan Space Centre (SDSC/ISRO)
- 6-Ch Imager (VIS, SWIR, MIR, WV, TIR-1/2) and 19-Ch (18 IR + 1 Vis) Sounder
- Improvements to mitigate the issues related to the BBCAL/mid-night sun
- **INSAT-3DS replaced INSAT-3D at 82E, Declared Operational during AOMSUC conference in Dec 2025**

Sample Imager Derived Products

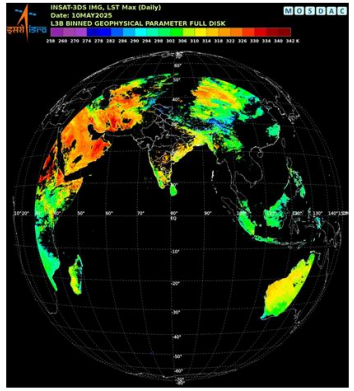
Day Microphysics



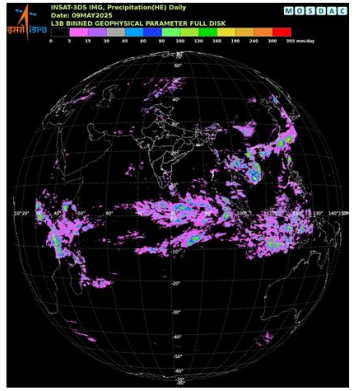
Daily SST



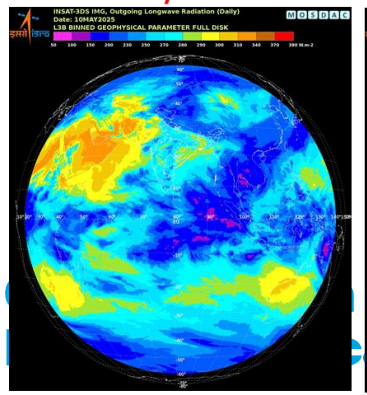
Daily Max LST



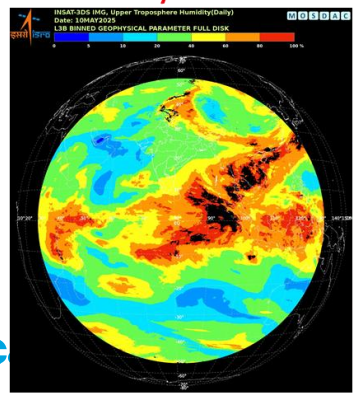
HE - Rain



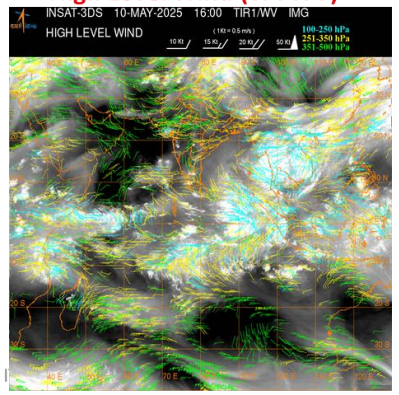
Daily OLR



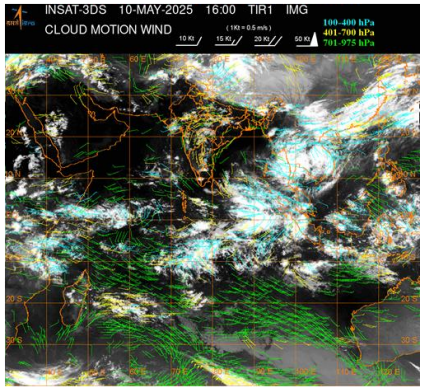
Daily UTH



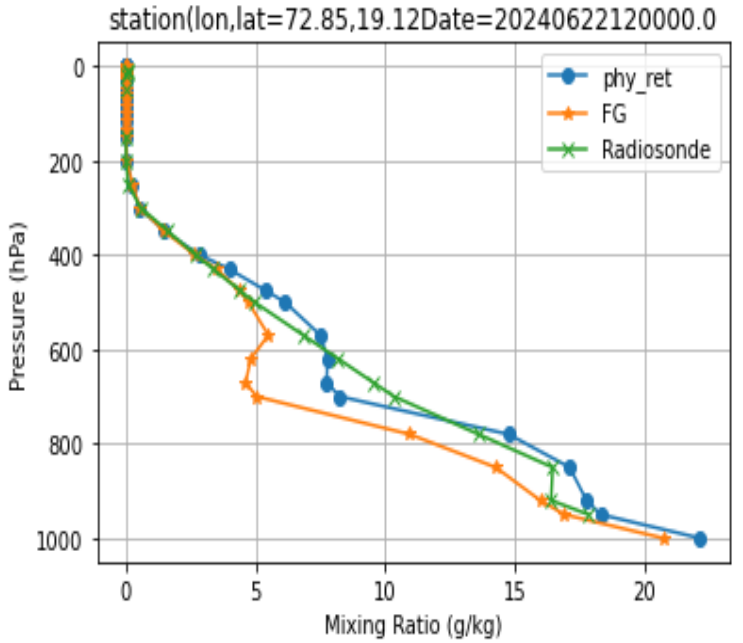
High Level Wind (WVWV)



Cloud Motion Vector (CMV)

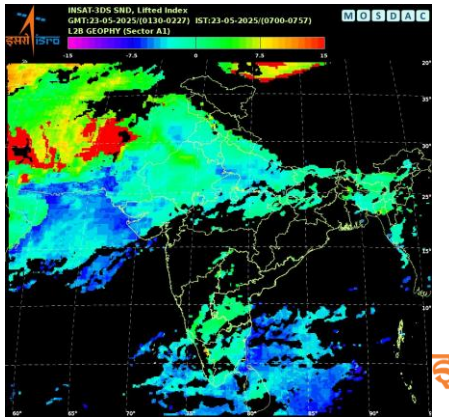


Sample INSAT-3DS Sounder profile (WV)

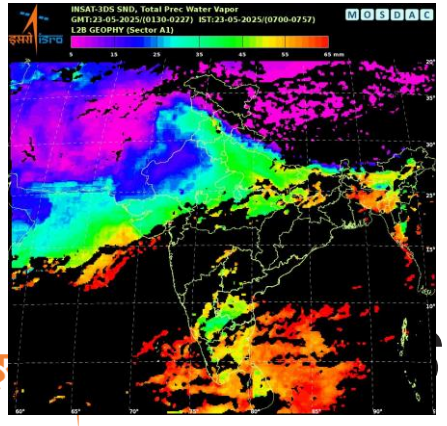


Sounder Products (23 May 2025, 0130-0230 UTC)

Lifted Index



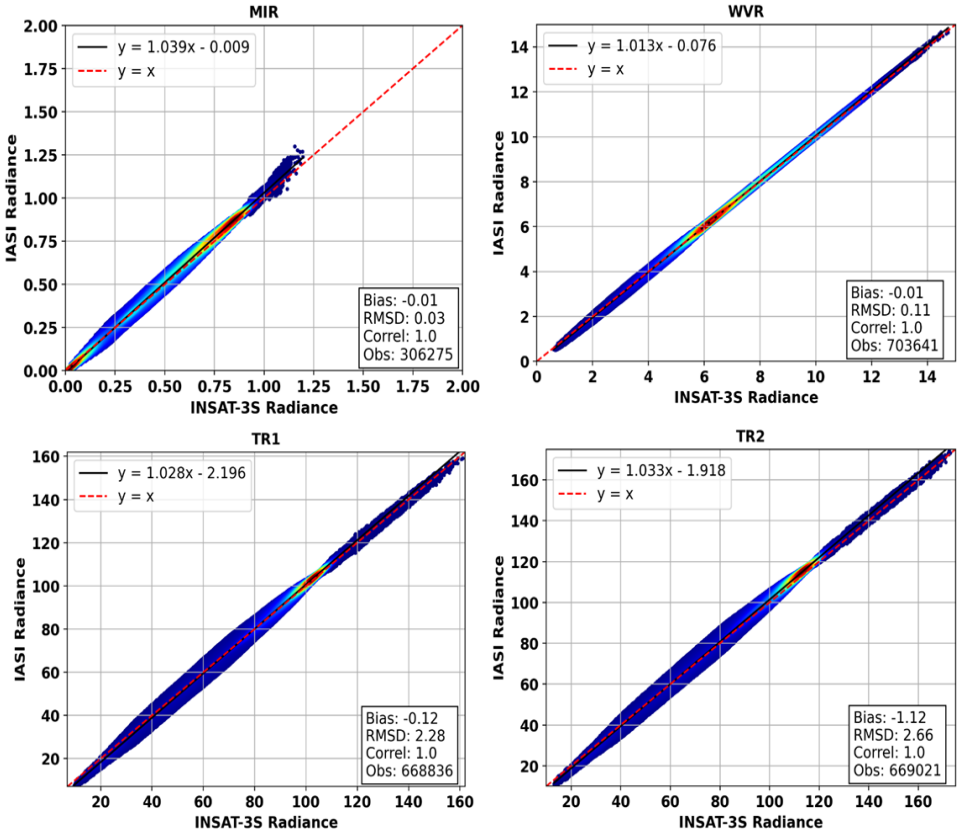
Total Precipitable Water



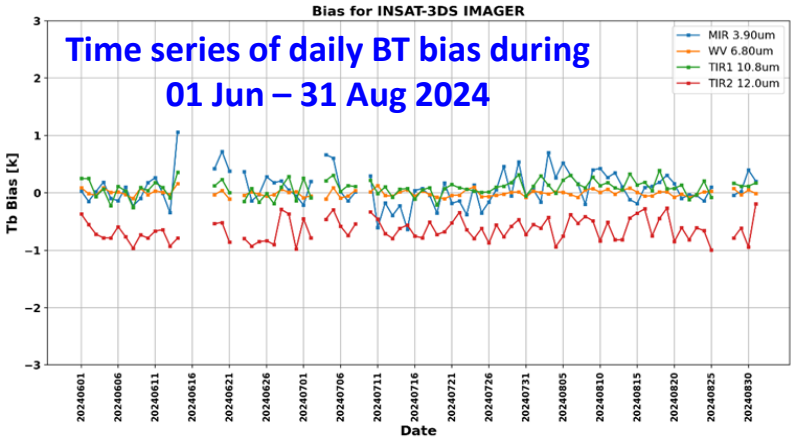
GSICS Inter-calibration of INSAT-3DS

(Discussed in detail during GSICS WG & EP Meeting 17-21 Mar 2025, China)

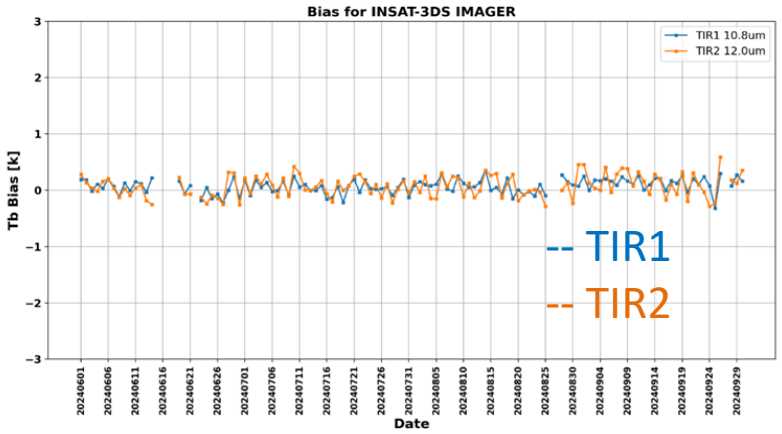
- Inter-calibration of Imager & Sounder IR-Channels, with MetOp-B/C IASI as reference
- Ray-matching method for VIS/SWIR channels, with MODIS as reference
- Vicarious Calibration of VIS/SWIR channels over Little Rann of Kutch



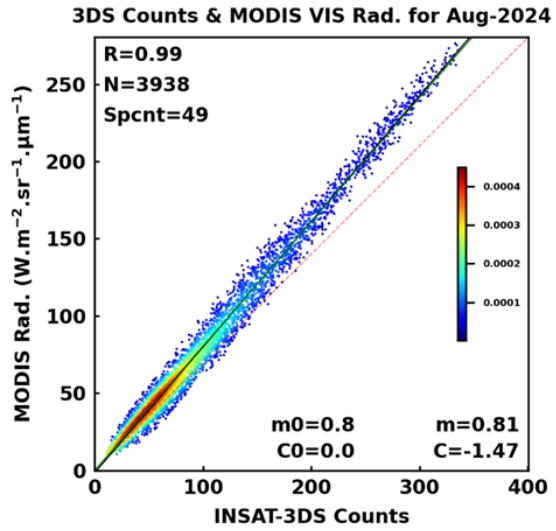
*Bias and RMSD are derived from x - y

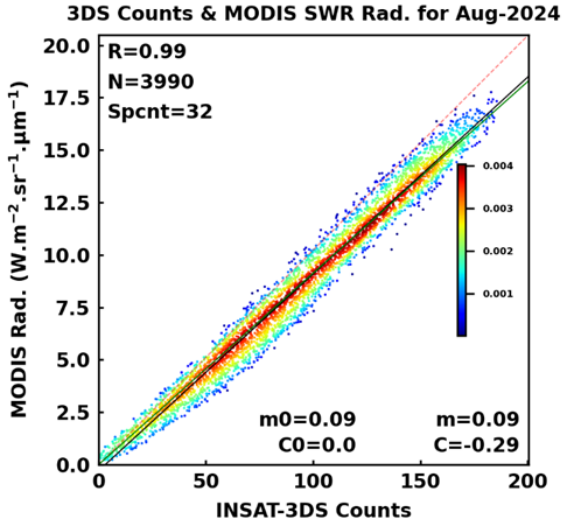


After GSICS Correction



GSICS Ray-matching method for VIS and SWIR channels





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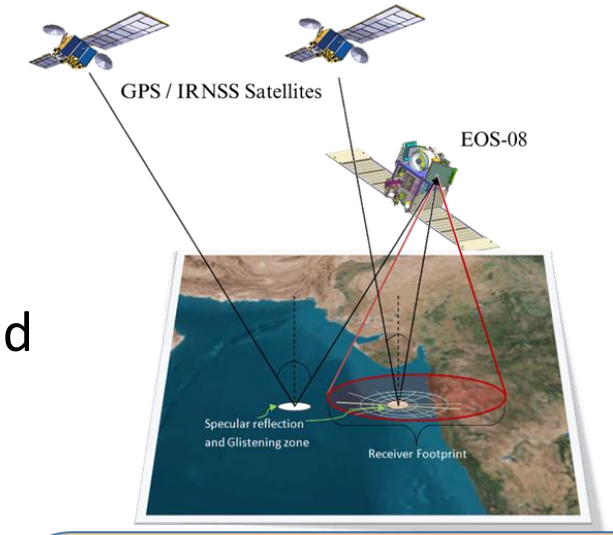
Radiance Unit: $mW.m^{-2}.Sr^{-1}.cm^{-1}$

Microsat-2C (EOS-08): GNSS-R and EOIR (Launch: 16-Aug 2024, SSLV)



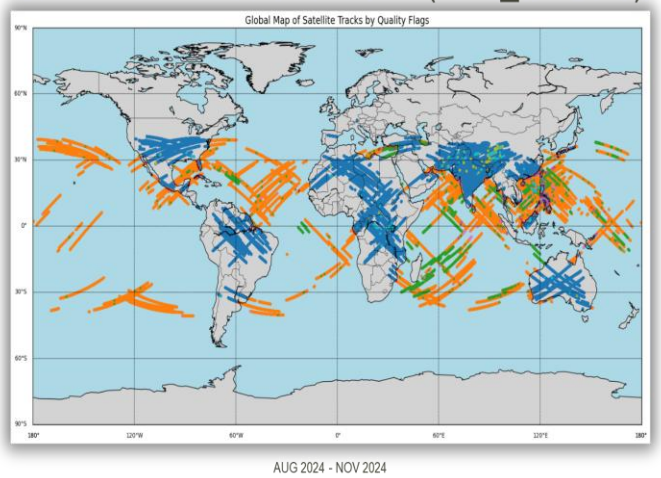
GNSS-R

- Soil Moisture
- Sea surface wind speed
- SWH

EOIR

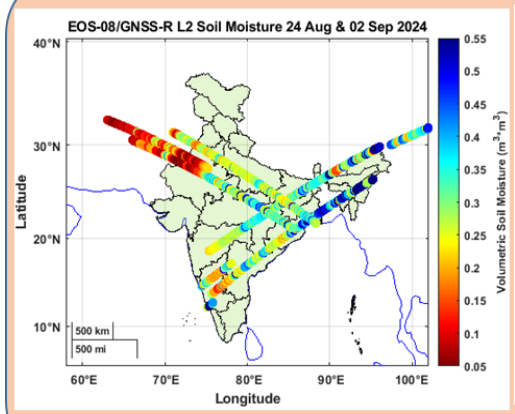
- High resolution **8m**, TIR and MIR
- Land surface temperature
- Forest/agriculture fire monitoring
- High resolution valley fog

SATELLITE TRACK PLOTS (EO8_GNSSR)

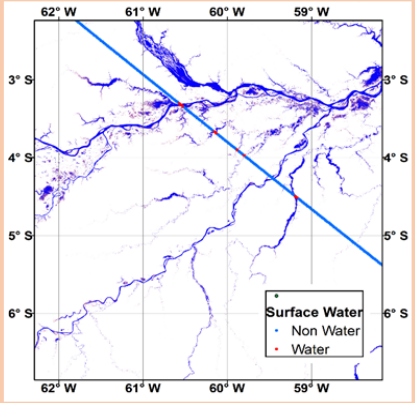


AUG 2024 - NOV 2024

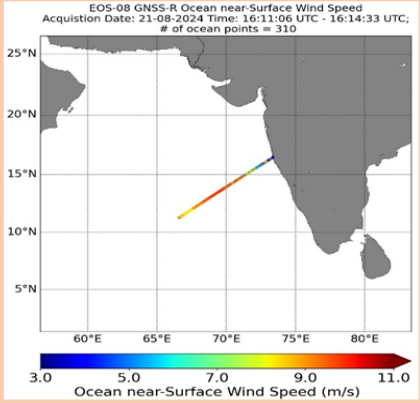
Application products demonstrated



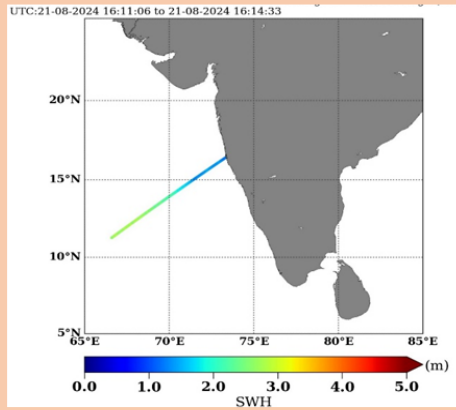
Soil moisture



Land inundation



Ocean wind speed



Significant wave height

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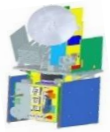
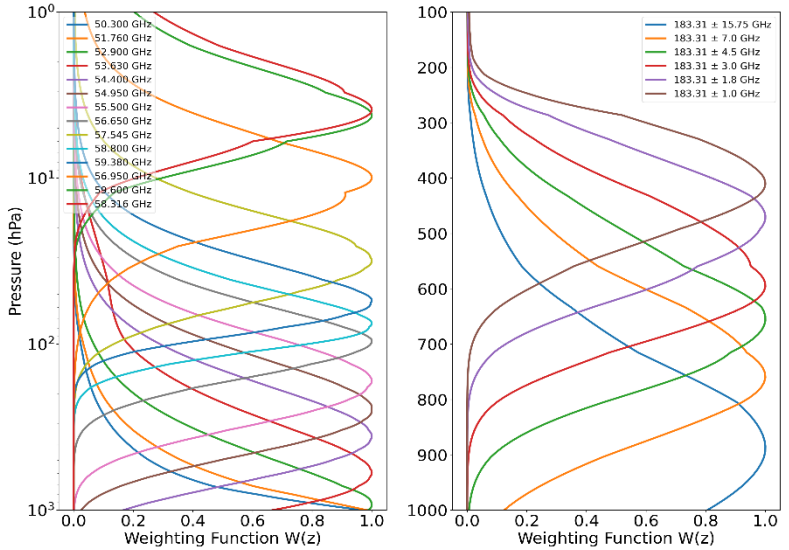
FUTURE INDIAN SATELLITES

Oceansat-3A (2025)



- ARGOS in Oceansat-3 will be replaced by Millimeter-wave Atmospheric Temperature and Humidity Sounder (MATHS) Payload
- A 20-channel cross-track scanning Radiometer operating at 50-60GHz and 183.31± 16.25GHz bands
- Spatial resolution of 25 km and 15 km, for O_2 and H_2O bands, respectively.



O_2-Band weighting Function H_2O-Band weighting Function

GEO: INSAT-4th Generation Satellite

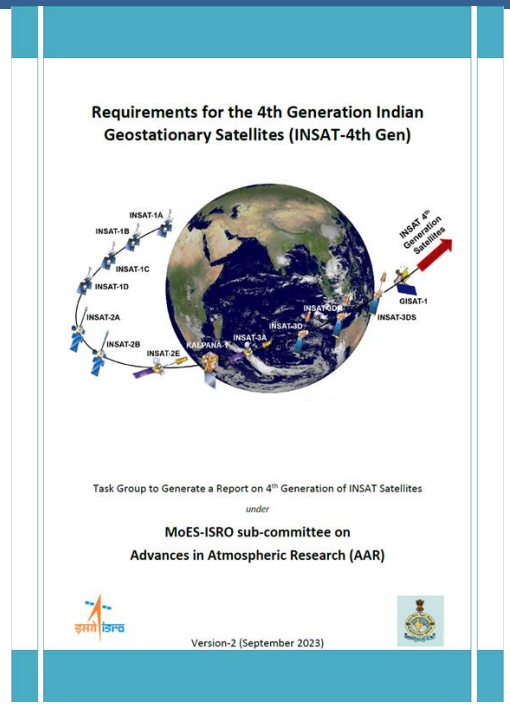
(Proposal received from MoES, India)

a) Advanced Imager

- 18 bands from 0.5 – 13.5 µm with spatial resolution 500m for VIS and 2 km for IR
- Faster scanning for nowcasting applications

b) Lightning mapper

c) Hyperspectral Infrared Sounder



Other LEO Missions: (Suggested by MoES, India)

a) MW Temperature & Humidity Sounder in low-inclination orbit

b) 6-89 GHz MW Radiometer in low-inclination orbit

c) Dual Frequency Scatterometer, C/Ku

d) Hyperspectral Infrared/Microwave Sounder

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Upcoming Earth Observation Missions

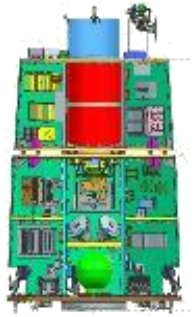
NISAR
(L & S Band SAR)

All-weather;
Day & Night Imaging

Oceansat-3A
(OCM3, SCAT, SSTM, MATHS)

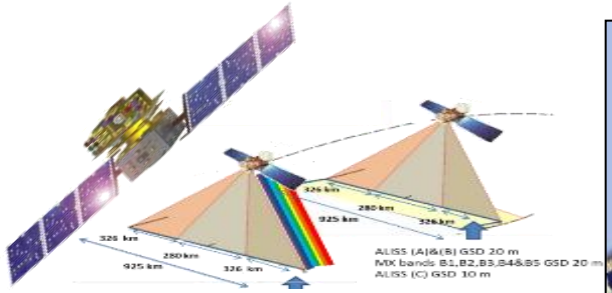
Ocean Color & Wind vector
– Continuity + SST

HRSAT



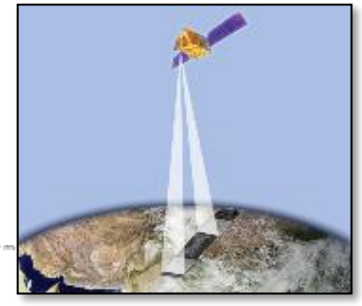
Daily re-visit of
Area of Interest

Next Generation Resourcesat



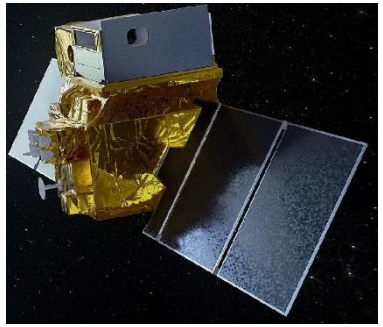
Wide Swath imaging with
improved spatial resolution

High resolution Stereo



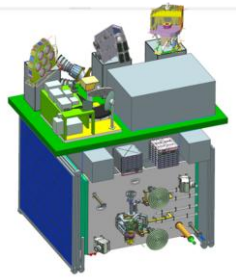
Concurrent Stereo &
MX imaging

High resolution TIR/SWIR



Thermal Imaging

G20 Satellite



Environment &
climate change

Monitoring Environment and climate variables:

- Polarization sensor- cloud & Aerosol
- GHG monitoring system
- Active Forest detection sensor
- Hy-Maths (T/H Profiles)

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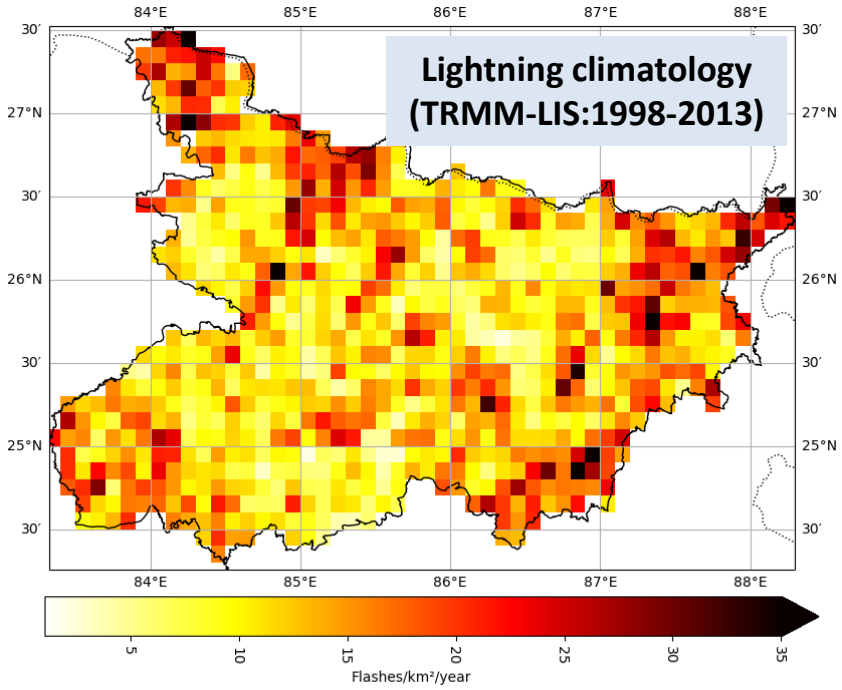
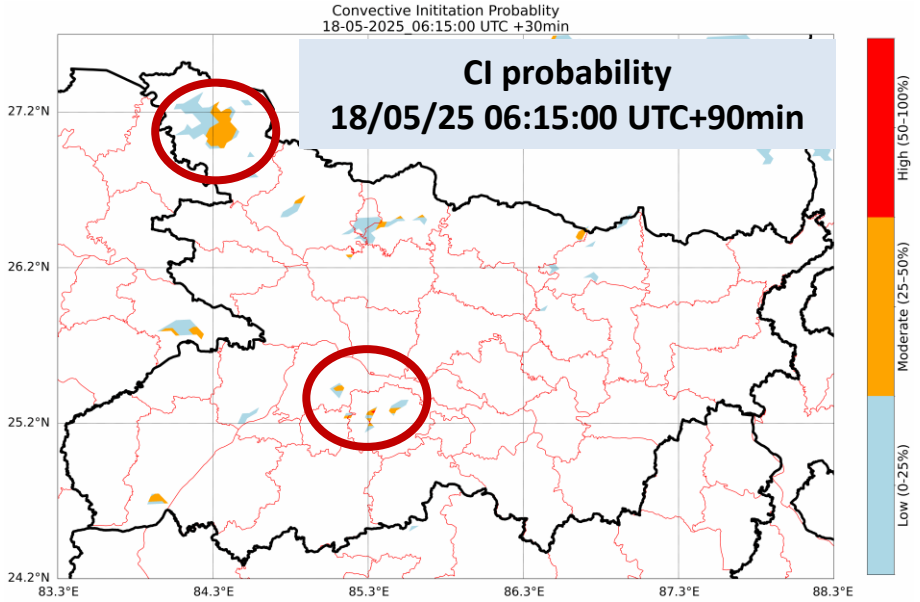
ISRO-Eumetsat Collaboration

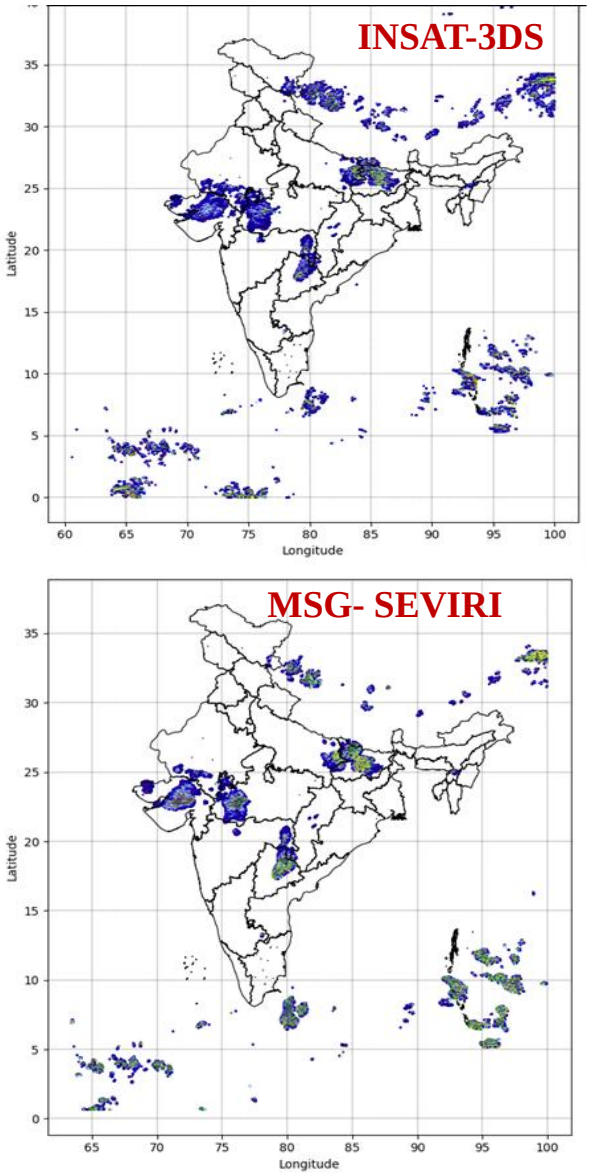
(IODC NWCSAF Product generation at MOSDAC/SAC)

- Meteosat-9 SEVIRI data received at SAC/ISRO (Eumetcast)
- NWCSAF-GEO software to generate nowcasting products from MSG-IODC SEVIRI
- **Use Case Demonstration** – BMSK/BSDMA (Govt of Bihar, India) for thunderstorm nowcasting during May 2025





NWCSAF-GEO software tool customised for INSAT-3DS Imager **(Convective Rain rate)**



AI/ML Based Initiatives at ISRO

AI/ML in Retrieval

- Statistical Downscaling of Satellite Based Sea Surface Temperature using Generative Adversarial Network
- GNSS-R: Soil moisture, Sea surface wind speed, significant wave height
- Significant wave height (SWH) in the Indian Ocean using Analyzed winds/bathymetry.
- OCM3: AOD and PM2.5 from OCM3
- OCM3: Atmospheric correction, bio-optical characterization over coast

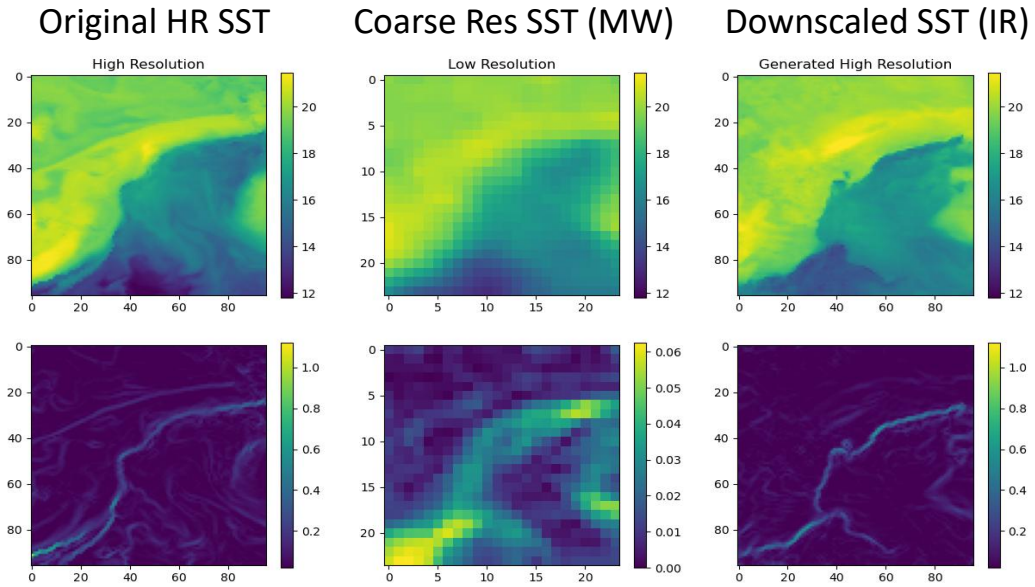
Applications

- Severe Weather Monitoring and Prediction

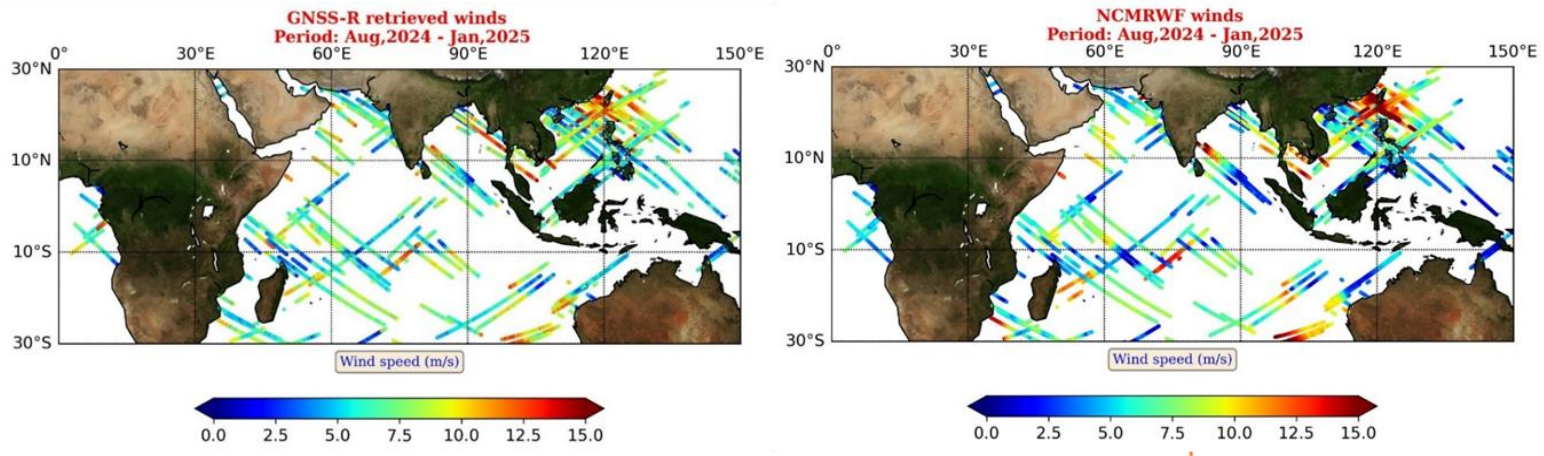
NWP Modeling

- Hybrid weather forecasting (NWP + AI/ML)
- AI/ML for Data Assimilation

Downscaling of Satellite MW SST using AI/ML technique



Microsat-2C GNSS-R Retrieval of Wind Speed using AI/ML technique



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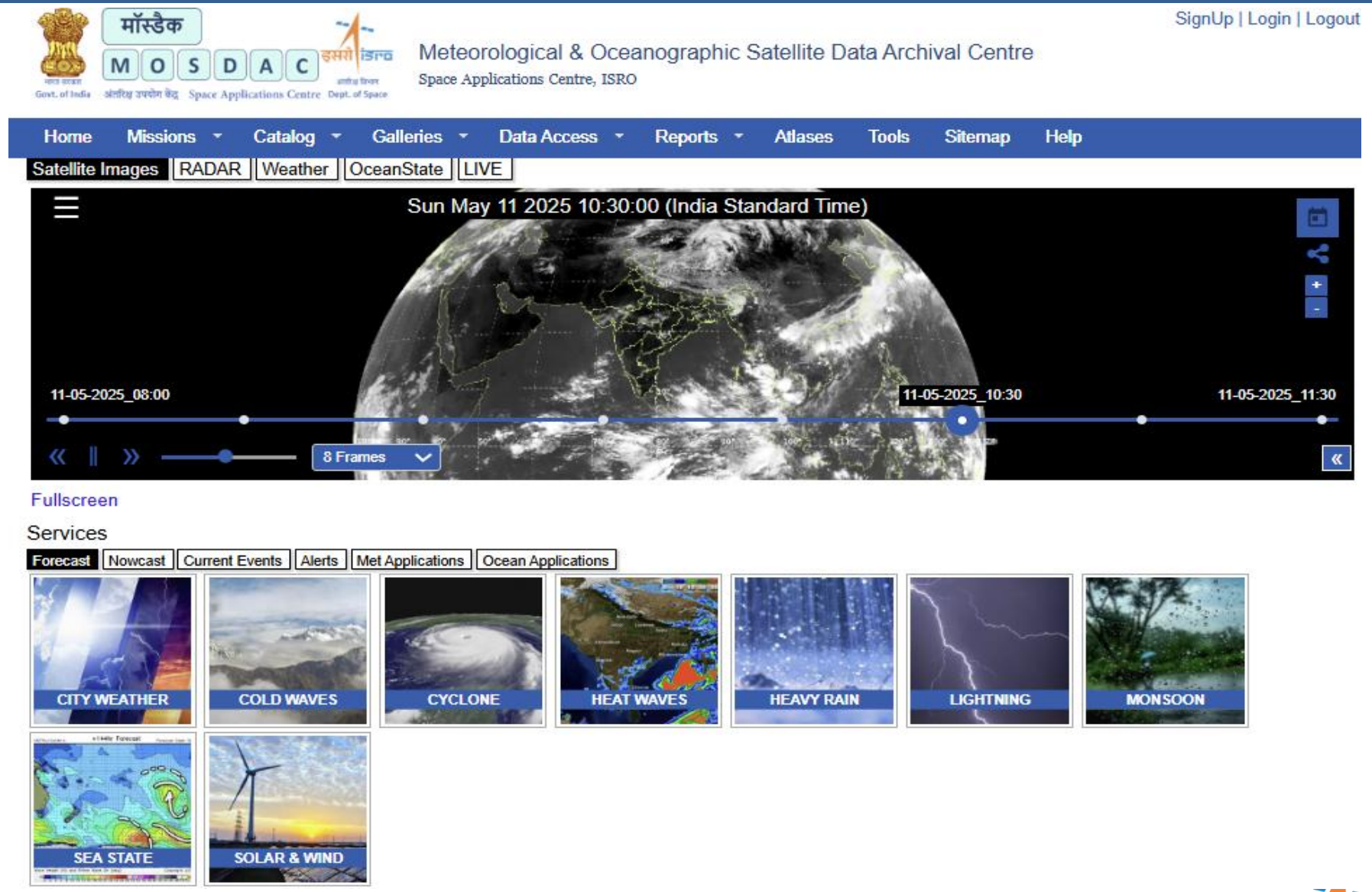

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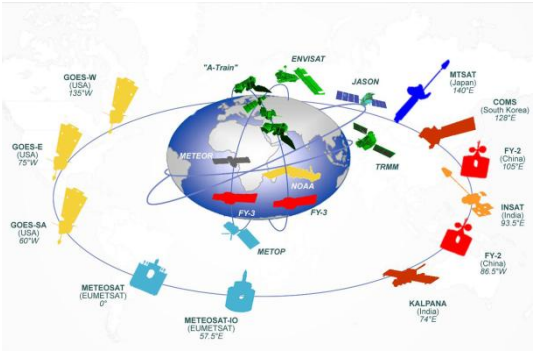

Data available through:

https://mosdac.gov.in/

https://bhoonidhi.nrsc.gov.in

Thank you

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