GSICS Agency Report - ISRO 2024

Pradeep K Thapliyal, Munn V Shukla, Shivani Shah, Nitant Dube

Space Applications Centre (ISRO)

(pkthapliyal@sac.isro.gov.in)

ISRO, India

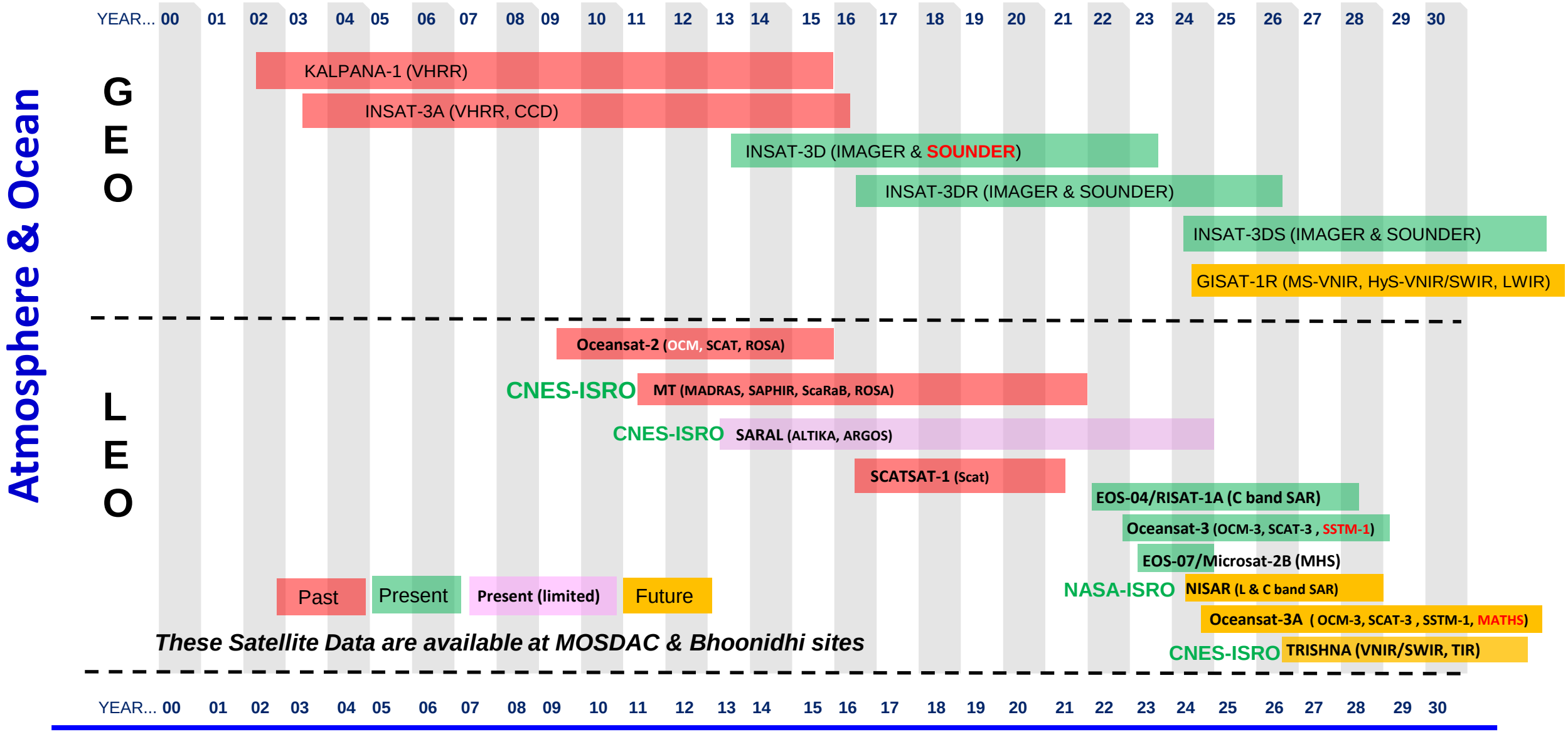
Presentation Overview

- Summary of Agency's GSICS Activities, Actions, and Achievements
- Agency's Instruments Updates & Planned launches that are relevant to GSICS
- Agency's Support to EP Activities
- Agency's Support to GDWG Activities
- Agency's Support to GRWG Activities
- Agency's Calibration Major Updates

Summary of ISRO's GSICS Activities, Actions, and Achievements

- Presently, 2 satellites INSAT-3D and INSAT-3DR are operational in GEO. Sounder onboard INSAT-3D is not functioning since Sep 2020.
- INSAT-3DS has been launched on 17-Feb-2024, with many improvements to mitigate the issues related to the blackbody calibration and mid-night sun-intrusion in INSAT-3D/3DR.
- EOS-06 (Oceansat-3), launched on 26 Nov 2022 is operational with Ku-band scatterometer, and 13-band Ocean Color Monitor (OCM-3). SSTM operations have been stopped due to in-orbit anomaly.
- Data from Scatterometer and OCM-3 has been released to the users through BHUVAN web-portal.
- EOS-07 (Microsat-2B) was launched on 10-Feb-2023 in low-inclination orbit with a 6-channel Microwave Humidity Sounder (MHS) onboard. MHS L1 and L2 data are available through MOSDAC web-portal.
- Under GSICS, inter-calibration of IR channels are in demo phase with IASI-B/C and will be extended to CrIS. Ray-Matching method has been developed for inter-calibration of Vis/SWIR channels using MODIS and 6 years (2014-2021) data has been processed for INSAT-3D VIS/SWIR channels.

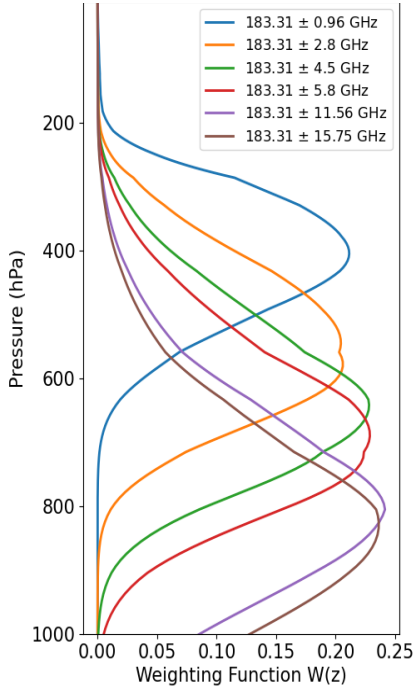
Agency's Instruments Updates & Planned launches



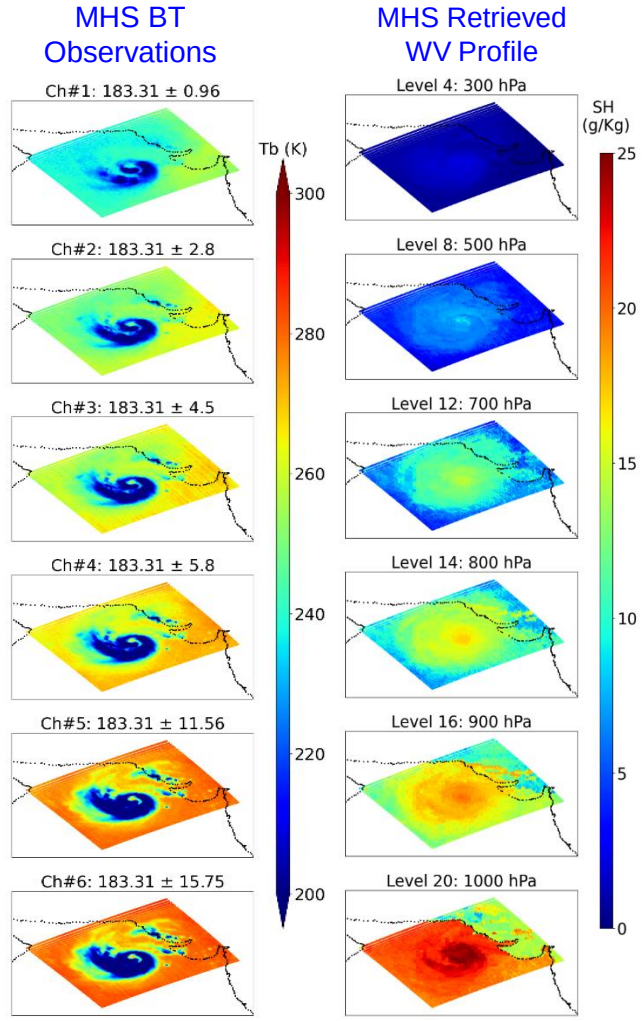
EOS-07 Millimeter-Wave Humidity Sounder (MHS)

Launch: 10-Feb-2023, SDSC/ISRO, SSLV-D2

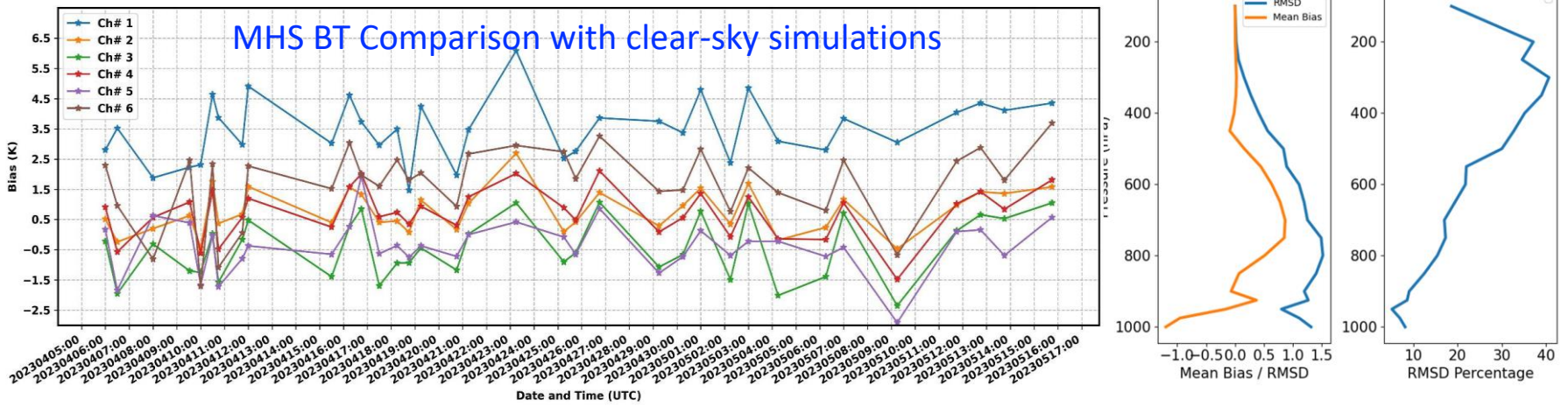
- Demonstration of in-house developed mm-wave technology
- 450 km altitude, 37 deg inclined orbit
- Swath: ~1000 km
- Experimental: 15 minutes of orbit coverage
- 6-channel cross-track scanning Radiometer operating at 183.31±15.75 GHz band
- Spatial resolution of 10 km @Nadir



Tropical Cyclone BIPARJOY (13 June 2023, 07:55 UTC)

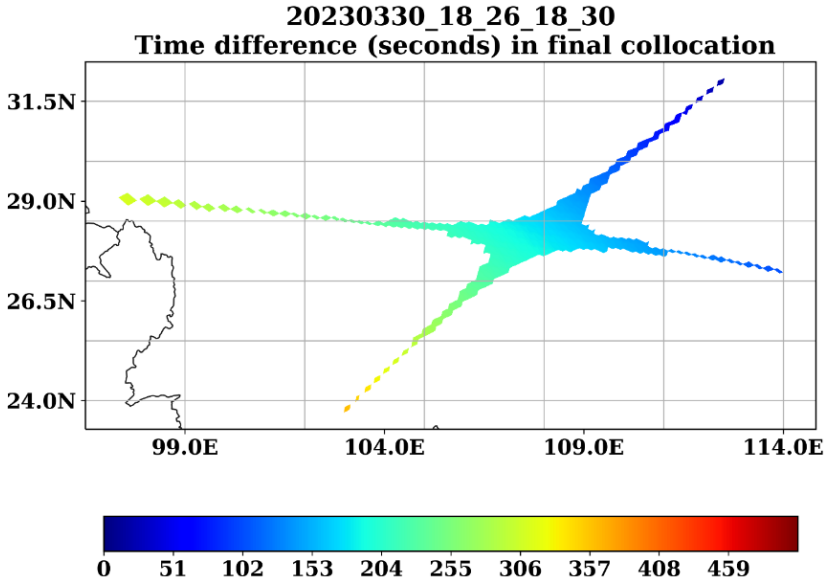


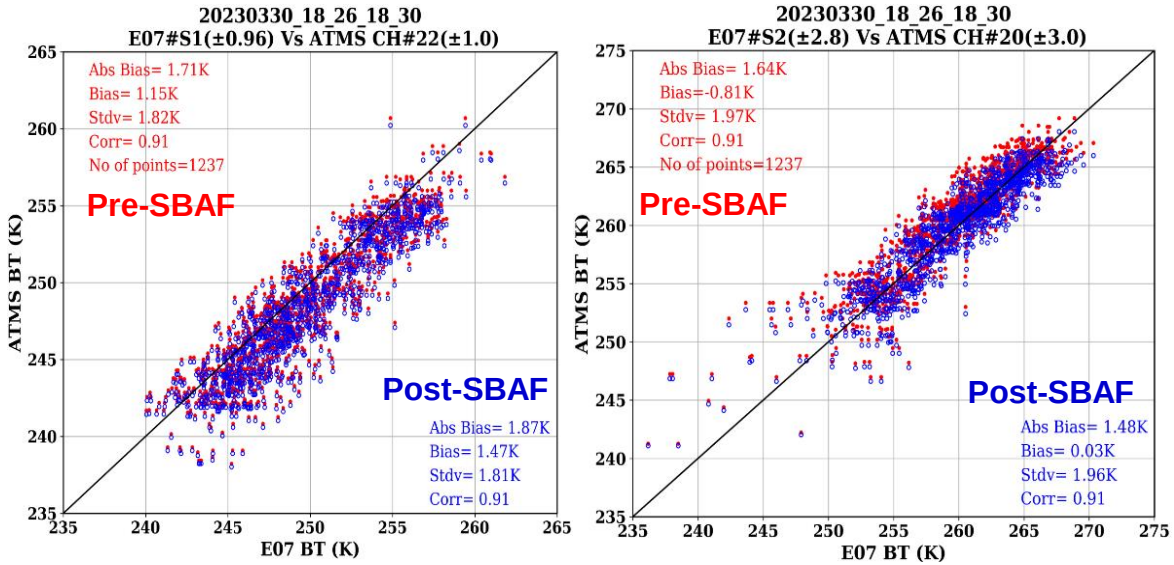
Comparison statistics of MHS L2 vs GFS (02 Apr 2023, 06:00 UTC)

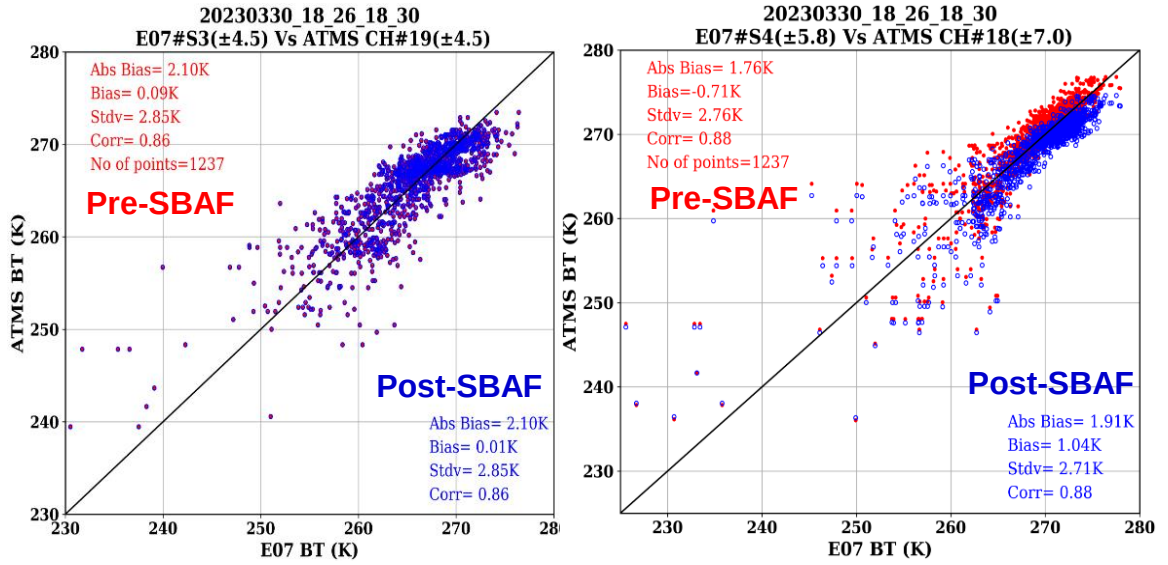


Inter-Calibration of EOS-07/MHS with JPSS/ATMS observations

- Special campaign for near simultaneous observation of MHS with ATMS was made
- 4 channels with closest central frequencies used
- SBAF was computed using RTTOV-v13 simulation for ATMS and MHS for ECMWF diverse profile
- More such collocated observations are required to make a robust statistics

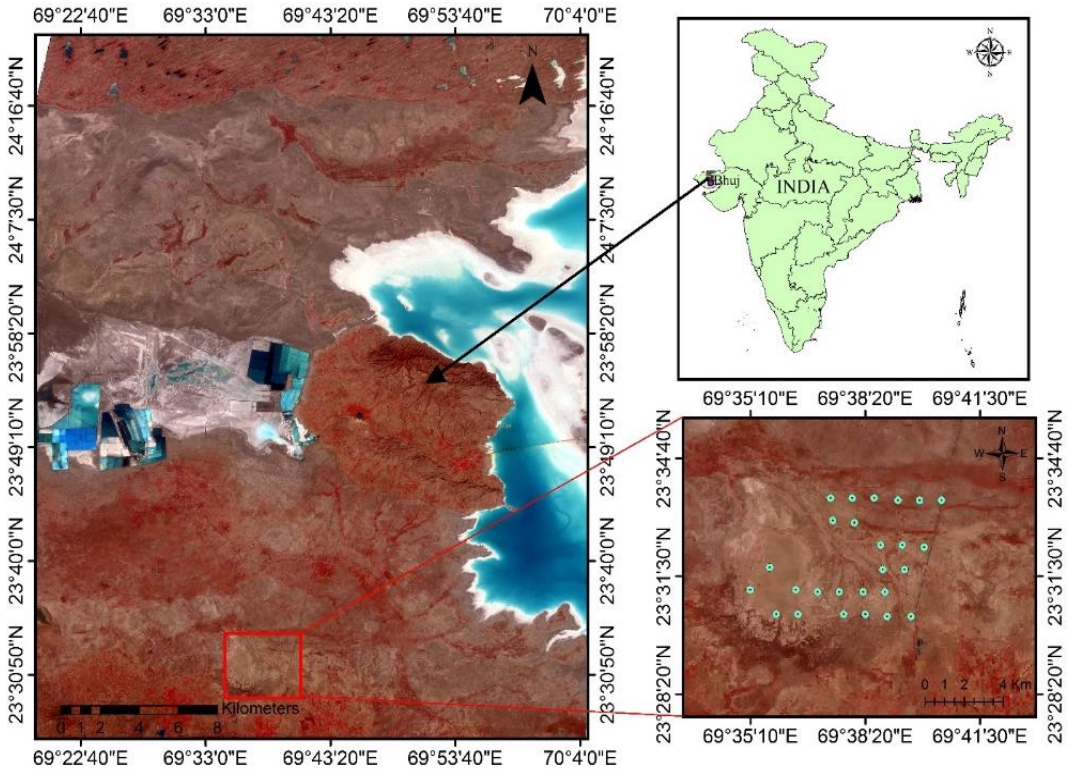


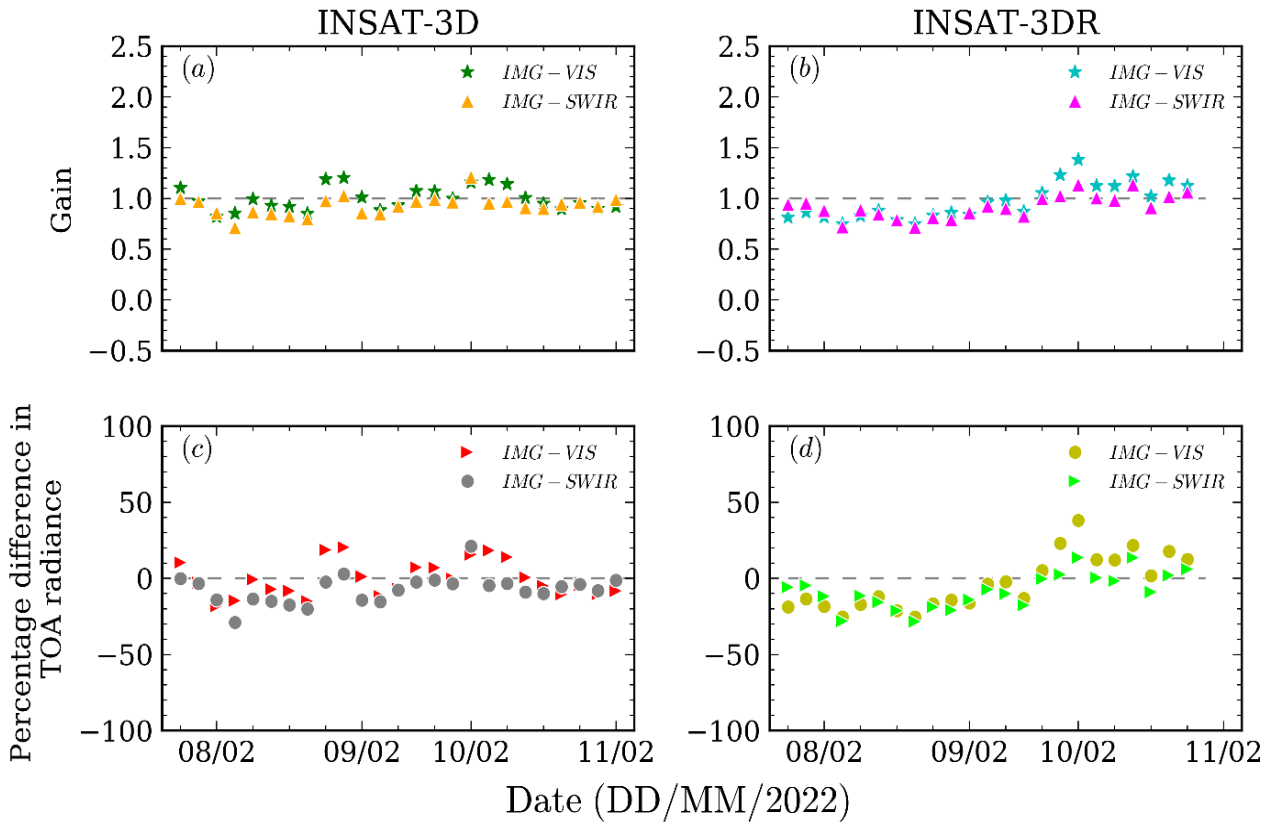




Vicarious Calibration of GEO Satellites: INSAT-3D/3DR (Joint ISRO-IMD Activity)

Greater Rann of Kutch, Gujarat





Top panel: Gain for VIS and SWIR bands derived from IMAGER TOA radiance and simulated (6S TOA radiance)

Bottom panel: The percentage difference in TOA radiance determined using (INSAT – 6SV)/6SV.

ISRO'S support to GDWG activities

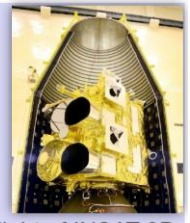
- Generation of regular NRTC coefficients
- Presently Data is processed at IMD Delhi server with SAC/ISRO Software
- Planning to shift processing to SAC Ahmedabad
- Working on reprocessing of the entire INSAT-3D/3DR Imager data to fix the issues related to the Satellite Yaw-flip operation during eclipse period, 21-24 Mar, 21-24 Sep
- RAC coefficients will be generated once NRTC files are reprocessed for entire period.
- ISRO is discussing the modalities to display GSICS correction coefficients from IMD's RAPID tool. (Action on ISRO/IMD under GDWG)

ISRO'S support to GRWG activities

- Developed methodology for visible and SWIR channels inter-calibration using ray-matching method with MODIS as reference.
  - 8 years (2014-2021) data has been processed for INSAT-3D VIS/SWIR
- Completed a case study to diagnose the calibration anomalies of INSAT-3D/3DR IR channels during pre and post yaw-flip period.
- A project has been taken along with IMD to reprocess historical data of Kalpana-1.
- Methodology for inter-calibration using CrIS as reference for INSAT-3D/3DR Imager is under progress.
- GEO-GEO intercalibration of INSAT-3D/3DR Imager with MSG-SEVIRI is being carried out
- Intercalibration for Microsat-2B MHS carried out with limited data using ATMS

INSAT-3DS

- Launched on 17-Feb-2024 using GSLV-F14 rocket, from Satish Dhawan Space Centre (SDSC/ISRO)
- Improvements to mitigate the issues related to the blackbody calibration and mid-night sun-intrusion
- **Presently, in IOT phase at 83E. After IOT it will replace INSAT-3D at 82E**



Meteorological Payloads -
- 19 Channel Sounder
- 6 Channel Imager
  - Both the instruments have heritage of INSAT-3D
  - Design identical to INSAT-3D with improvements in light of INSAT-3D onboard observations

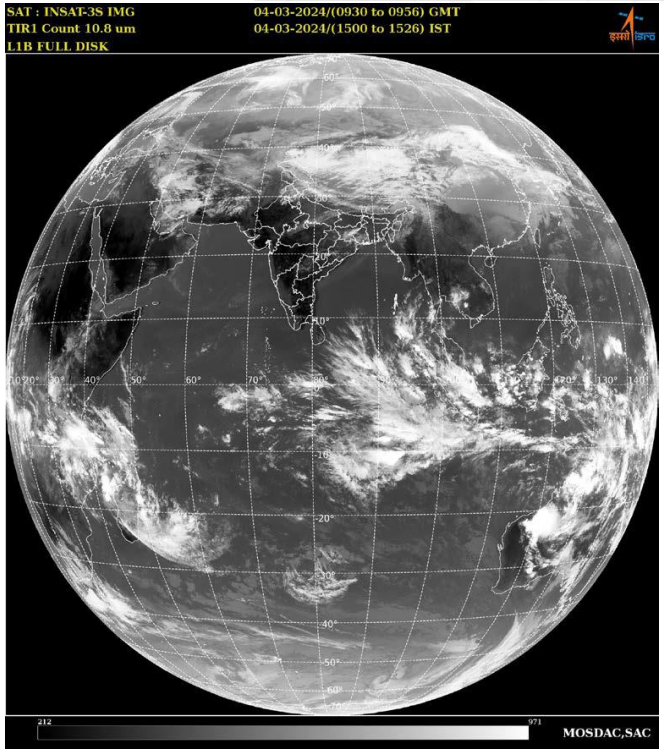
Communication Payloads –
- Data Relay Transponder (DRT)
- Satellite Aided Search & Rescue (SAS&R) Transponder
- MET Transmitter

6-Channel Imager

Channel	Spectral Band (μm)	Spatial Resolution at Nadir (km)	SNR @ 100% or NEΔT@300K
VIS	0.55-0.75	1 km	SNR>150
SWIR	1.55-1.68	1 km	SNR>150
MIR	3.80-4.00	4 km	1.4K
WV	6.5-7.1	8 km	1.0K@230K
TIR-1	10.3-11.3	4 km	0.35K
TIR-2	11.5-12.5	4 km	0.35K

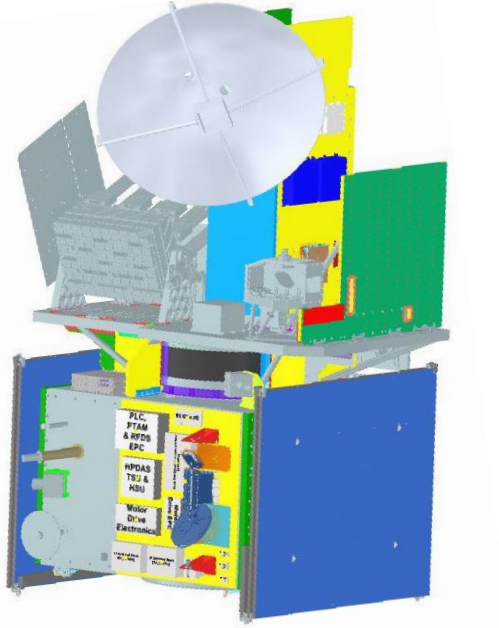
19 - Channel Sounder (18 IR + 1 VIS)

Detector	Ch. No.	λ_c (μm)	ν_c (cm^{-1})	Principal absorbing gas	Purpose
Long wave	1	14.68	681	CO_2	Stratosphere temperature
	2	14.36	696	CO_2	Tropopause temperature
	3	14.06	711	CO_2	Upper-level temperature
	4	13.69	731	CO_2	Mid-level temperature
	5	13.35	749	CO_2	Low-level temperature
	6	12.63	792	H_2O	Total precipitable water
	7	12.01	833	H_2O	Surface temp., moisture
Mid wave	8	11.00	909	Window	Surface temperature
	9	9.72	1029	O_3	Total ozone
	10	7.43	1347	H_2O	Low-level moisture
	11	7.03	1422	H_2O	Mid-level moisture
	12	6.51	1537	H_2O	Upper-level moisture
Short wave	13	4.60	2174	N_2O	Low-level temperature
	14	4.55	2200	N_2O	Mid-level temperature
	15	4.48	2235	CO_2	Upper-level temperature
	16	4.16	2404	CO_2	Boundary-level temperature
	17	4.01	2493	window	Surface temperature
	18	3.76	2659	window	Surface temperature, moisture
Visible	19	0.695	14367	visible	Cloud detection during daytime



Oceansat-3A

- Oceansat-3A will be launched in 2024
- ARGOS in Oceansat-3 will be replace 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
- Atmospheric vertical Temperature & Humidity profiles with nadir spatial resolution of 25 km and 15 km, respectively.
- Developed in-house through Technology Development Program at SAC



MATHS Payload

FUTURE INDIAN GEO SATELLITES: (GISAT-1R)

MX-VNIR: Multispectral - Visible Near Infrared, HySI-VNIR: Hyperspectral Imager - Visible Near Infrared,
HySI-SWIR: Hyperspectral Imager - Short Wave Infrared, MX-LWIR: Multispectral - Long Wave Infrared.

GISAT Strengths: (i) High spatial (1.2 km) and temporal resolution (10 minutes) from LWIR

GISAT Geophysical Products/Applications

VNIR/SWIR Bands

- Cloud Microphysics (Nowcasting Applications)
- ***Aerosol Optical Depth***

LWIR Bands

- Nowcasting Applications
  - Cloud properties (type, amount, phase, height)
  - Atmospheric Stability Indices (Lifted Index)
  - Mid/Lower-Tropospheric Humidity
  - Total Precipitable Water (TPW)
  - Surface Skin Temperature (LST/SST)
- Aviation Applications
  - Thunderstorm Prediction
  - FOG Monitoring
  - Upper Air Turbulence
- High spatio-temporal resolution Rainfall
- Atmospheric motion vectors (AMV)
- Cyclone Monitoring

Band	Ch	SNR/ NEdT @300K	IFOV (m)	Range (μm)	Channels bandwidth (μm)
MX-VNIR	6	> 200	42	0.45 - 0.875	0.45-0.52 0.52-0.59 0.62-0.68 0.77-0.86 0.71-0.74 0.845-0.875
HyS-VNIR	158	> 400	320	0.375 - 1.0	Δλ : 4 nm
HyS-SWIR	256	> 400	190	0.9 - 2.5	Δλ : 7 nm
MX-LWIR	6	< 0.15K	1200	7.0 – 13.5	7.1-7.6 8.3-8.7 9.4-9.8 10.3-11.3 11.5-12.5 13.0-13.5

MX-VNIR: Multispectral Imager - Visible Near-IR,
HySI-VNIR: Hyperspectral Imager - Visible Near-IR
HySI-SWIR: Hyperspectral Imager - Short Wave Infrared
MX-LWIR: Multispectral - Long Wave InfraRed.

GISAT Scan scenario

Scan area for two scan scenario (5° & 10 °)

Other Satellites/instruments: In consideration

GEO: INSAT-4th Generation Satellite

a) Advanced Imager (legacy: GOES-ABI)
- 16 bands from 0.5 – 13.5 µm with spatial resolution 250-500m for VIS and 1-2 km for IR
- Faster scanning for nowcasting applications
- FD (Full Disk), India (3000 km x 3000 km) and Mesoscale (1000 km x 1000 km)
- Capability to provide FD image every 5 minute, Indian landmass every 2 minutes and Mesoscale images every 30 seconds.

b) Lightning mapper

c) Hyperspectral Infrared Sounder

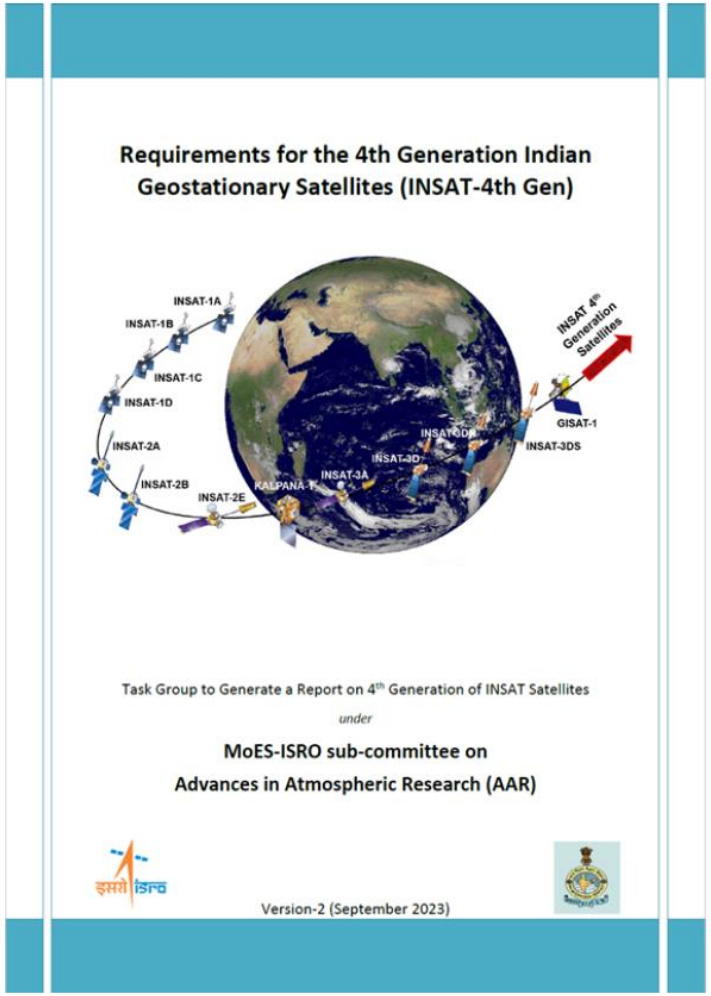
LEO:

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 with 5 km (Regional)/25 km (global)

d) Hyperspectral Infrared Sounder



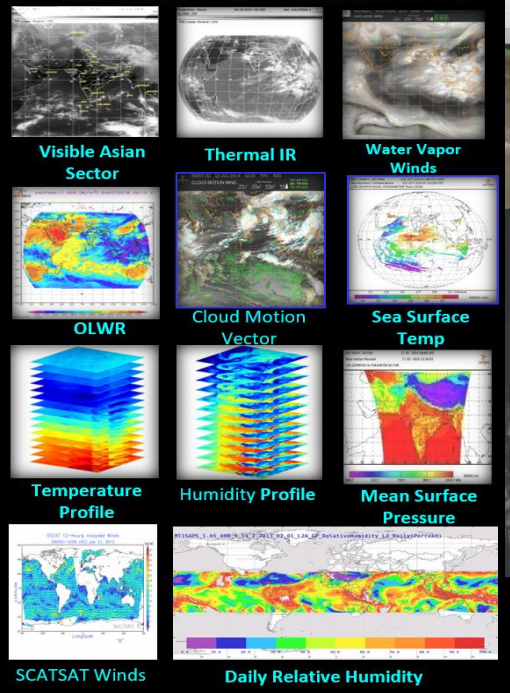
MOSDAC Meteorological and Oceanographic Satellite Data Archival Centre

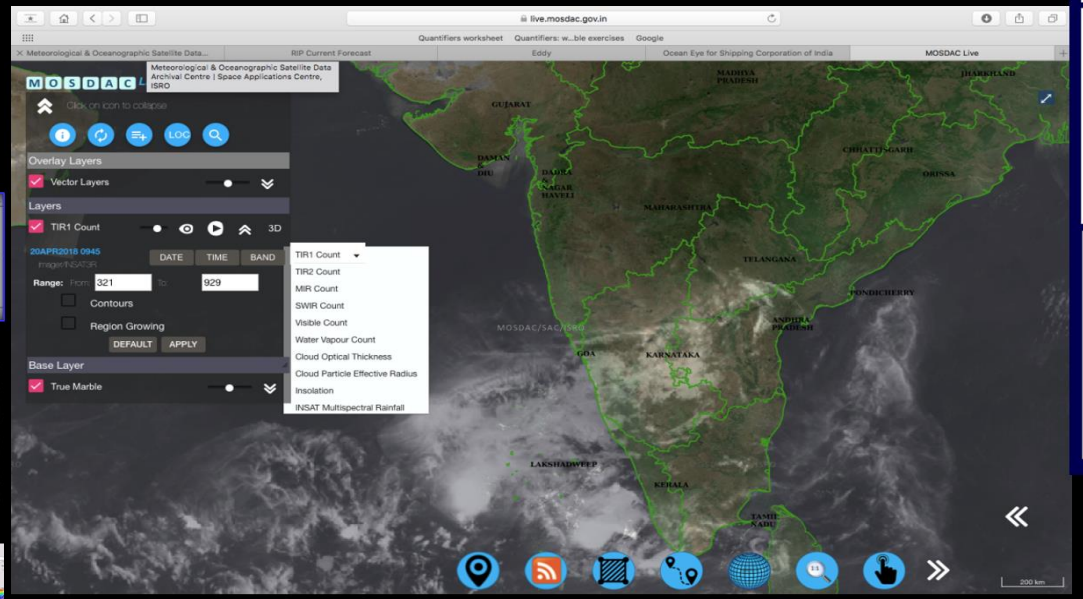
Multi Mission Satellite Data Repository

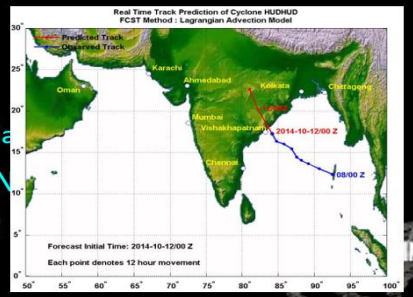
Application of Space Technology for the benefit of the common man

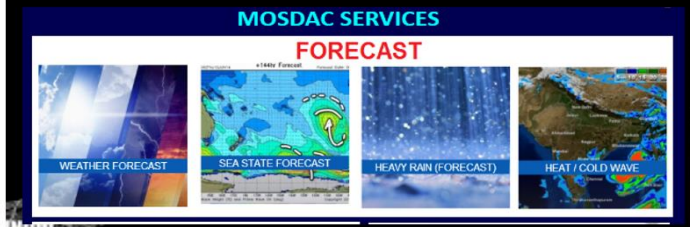
Weather and Sea state forecasting, alerts, cyclone prediction and continuous weather and ocean data availability

MET. & OCEAN DATA PRODUCTS









Major weather applications from ISRO'S Ea

Research Opportunities with INDIAN
by MOSDAC Research Group (EPSA)

Email: admin@mosdac.gov.in

http://www.mosdac.gov.in

Agency's Personnel supporting GSICS

❖ *Points of contacts/meeting participants:*

– *EP: Dr Pradeep Thapliyal (pkthapliyal@sac.isro.gov.in)*

– *GRWG: Dr Munn Vinayak Shukla (munnvinayak@sac.isro.gov.in)*

Dr Abhisek Chakraborty (abhisek1984@sac.isro.gov.in)

– *GDWG: Dr Nitant Dube, (nitant@sac.isro.gov.in)*

– *GSICS Point of Contact for Operational Matters: Ms Shivani Shah (shivanishah@sac.isro.gov.in)*

Thank You