# Current status and future requirements of satellite Microwave data for NWP

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**with input from many colleagues**

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## Outline:

1. Monitoring of satellite microwave data at NCMRWF
2. Forecast impact
3. Current status
4. India's contribution: Past, Present, and Future
5. Active Microwave Instruments: Scatterometers
6. Summary

# 1. Monitoring of satellite microwave data at NCMRWF

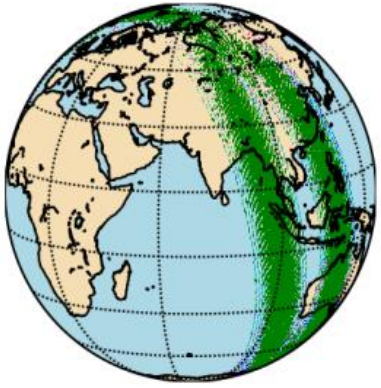
## 1.1 Microwave instruments used in the NCMRWF assimilation systems

| Instrument | Satellite | Source |
|---|---|---|
| ATOVS | NOAA and MetOp | NOAA/NESDIS, EumetCast , IMD, INCOIS, NRSC |
| ATMS | NPP, NOAA-20 | NOAA/NESDIS |
| AMSR-2 | GCOM-W1 | NOAA/NESDIS, EumetCast |
| GMI | GPM | NOAA/NESDIS, EumetCast |
| SSMIS | DMSP | NESDIS |
| MWHS/MWTS | FY3D | EumetCast (DBNet) |
| SAPHIR | Megha-Tropiques | ISRO |
| Scatterometers | MetOp | NOAA/NESDIS , EumetCast |

# 1.2 Data Reception (Global)

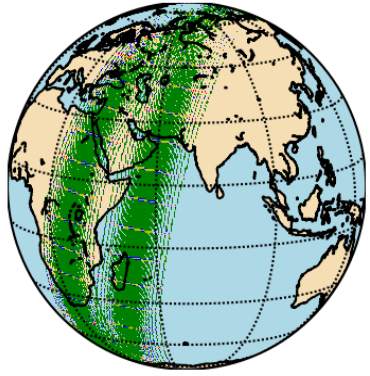
## Coverage : 00/12 Z assimilation cycles

AMSU-A: N15



AMSU-A/MHS: N19

ATMS (NPP, NOAA20)



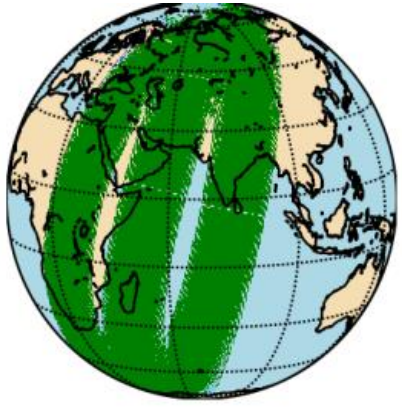
SSMIS (F17)

GPM-MI

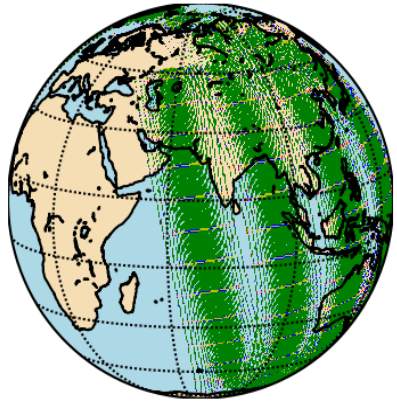
## Coverage : 06/18 Z assimilation cycles

AMSR-2

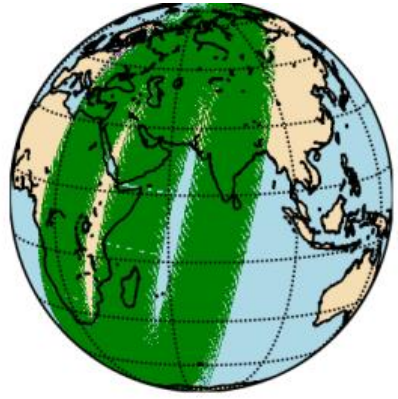
AMSU-A/MHS (MetOp)



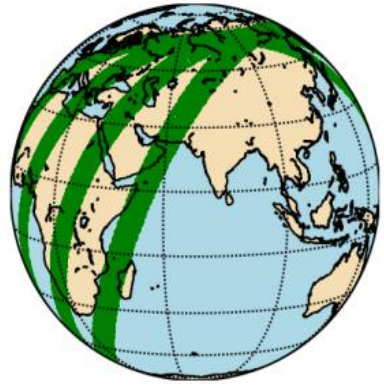
ATMS (NPP, NOAA20)



AMSU-A/MHS: N18



GPM-MI



# 1.3 : DBNet data reception and processing at NCMRWF

**NCMRWF receives real time low earth orbiting satellite operational DBNet data in level-1b format through GTS. This includes the DBNet Regional ATOVs Re-transmission Service (RARS) data from Australia, Korea, Japan, and Hong Kong.**

**NCMRWF also receives EUMETSAT's ATOVS Retransmission Service (EARS) data through EumetCast. Both RARS and EARS are routinely assimilated in the NCMRWF global and regional operational models.**

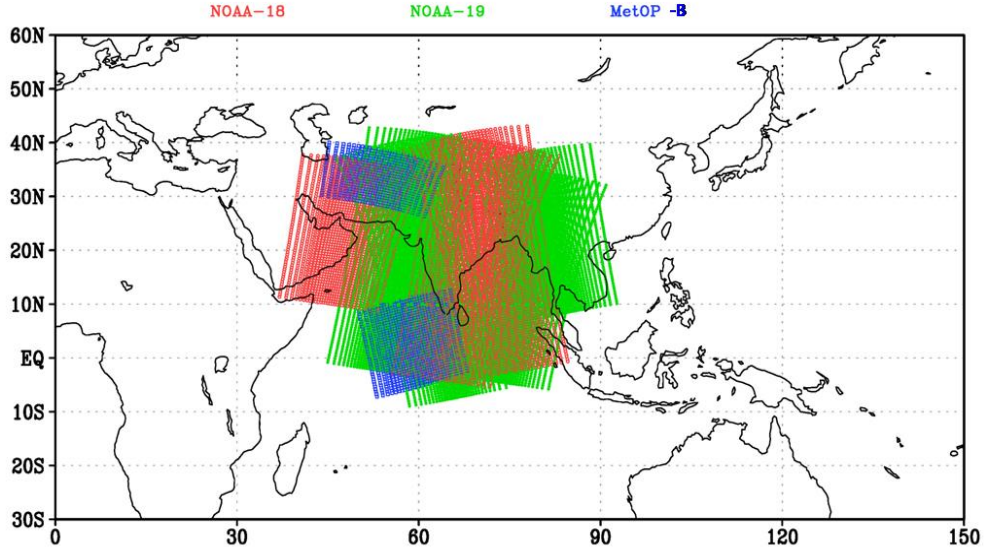
**Due to the non-functionality of IMD's existing High Resolution Picture Transmission (HRPT) stations, NCMRWF has taken the initiative to access and process the data from DBNet stations installed in India for Ocean (INCOIS, Hyderabad) and remote sensing (NRSC, Hyderabad) services.**

**Open source software and packages, ATOVS and AVHRR Pre-processing Package (AAPP), MetOpizer, and Community Satellite Processing Package (CSPP) Sensor Data Record (SDR) are used for the in-house processing of level-0 DBNet data**

| Station (Hyderabad) | Sensors | Satellites |
|---|---|---|
| INCOIS | AMSU-A | MetOp-B, NOAA18, NOAA19 |
| | HIRS | MetOp-B, NOAA18, NOAA19 |
| | MHS | MetOp-B, NOAA19 |
| | IASI (PC) | MetOp-B |
| NRSC | ATMS, CRIS | SNPP, NOAA-20 |

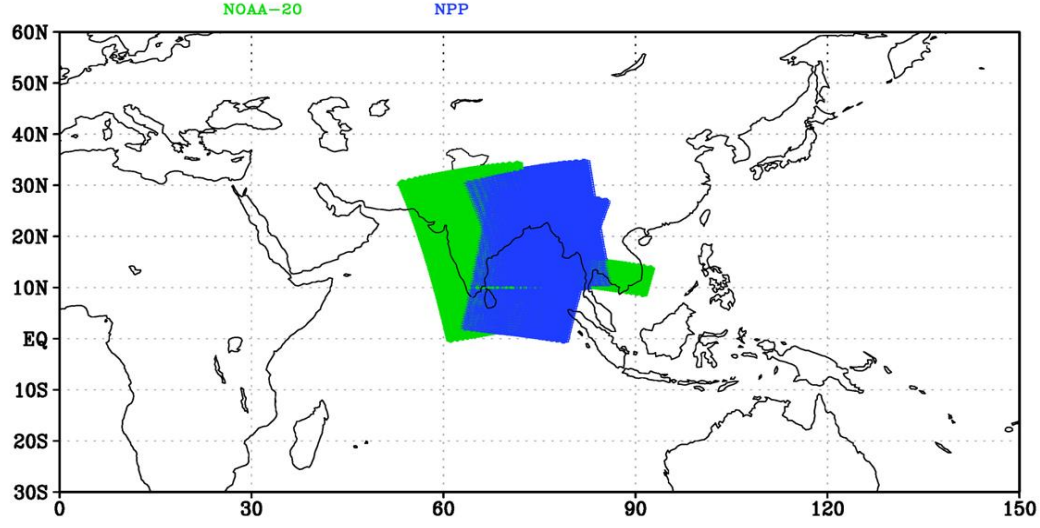
# 1.3 : Indian DBNet data Coverage (06 and 18 Z assimilation cycles)

**Typical day coverage of DBNet data received from INCOIS, Hyderabad, India**

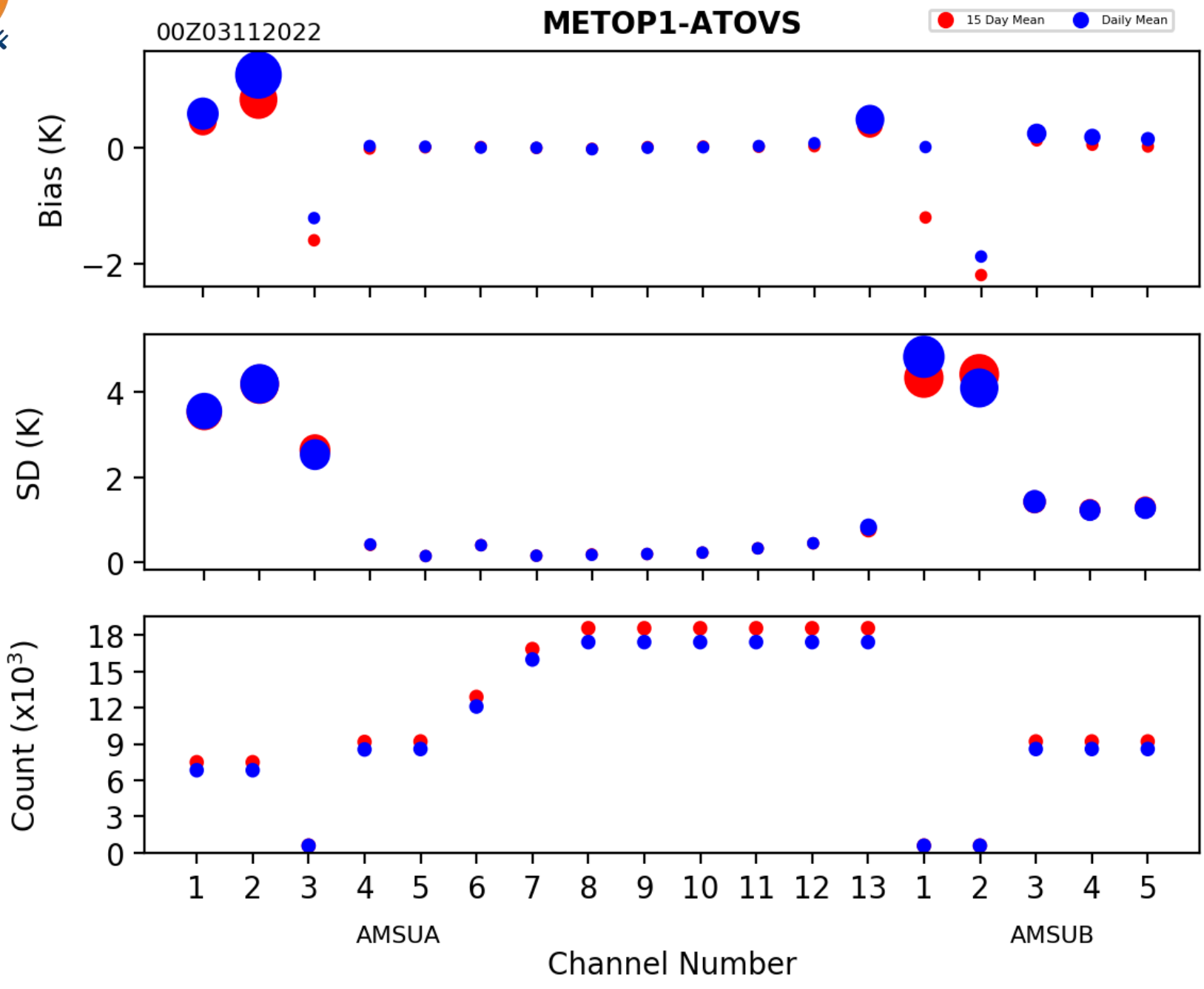



**Impact studies are going on …**

**Typical day coverage of DBNet data received from NRSC, Hyderabad, India**



# 1.4 Monitoring and Assimilation (O-B)



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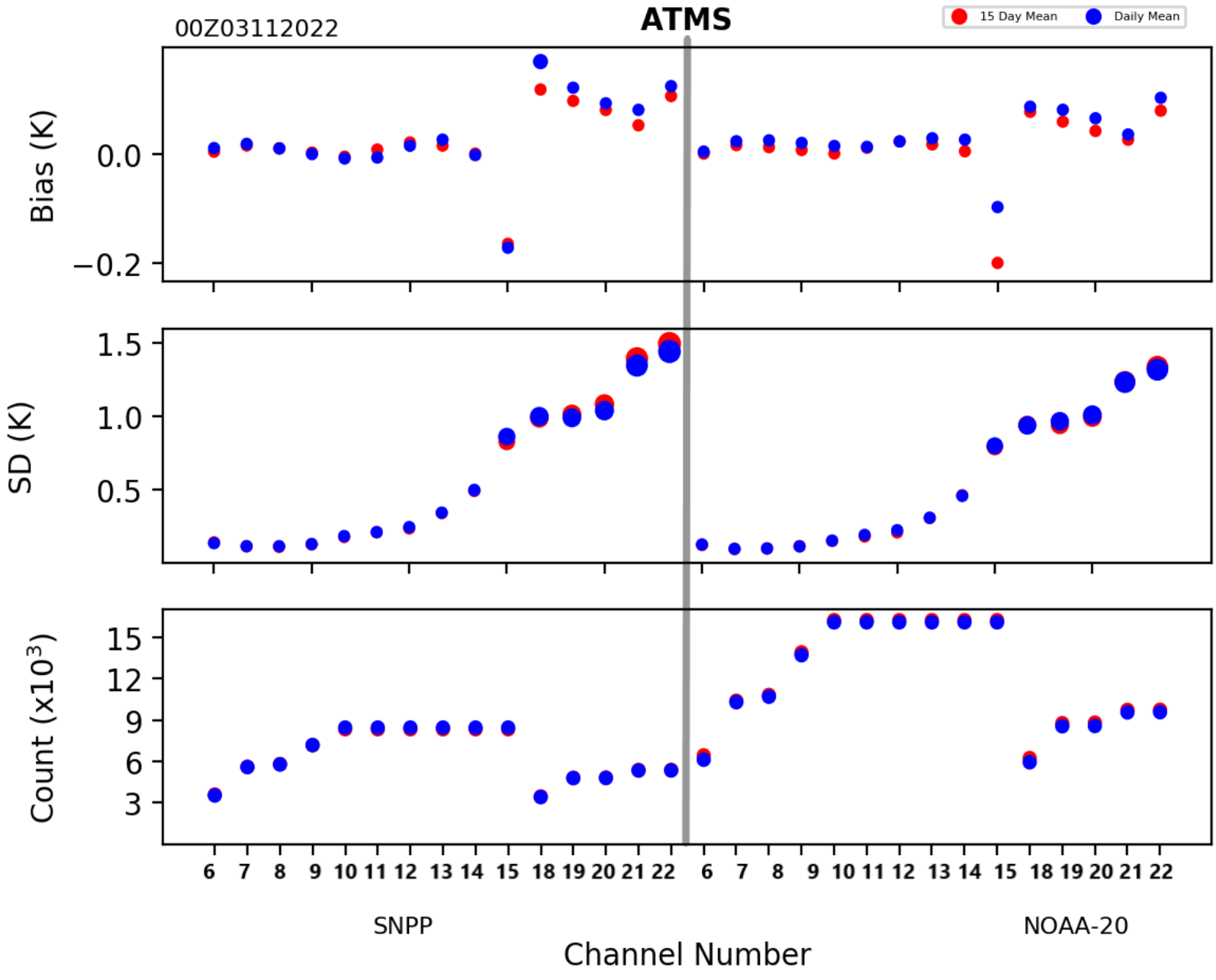
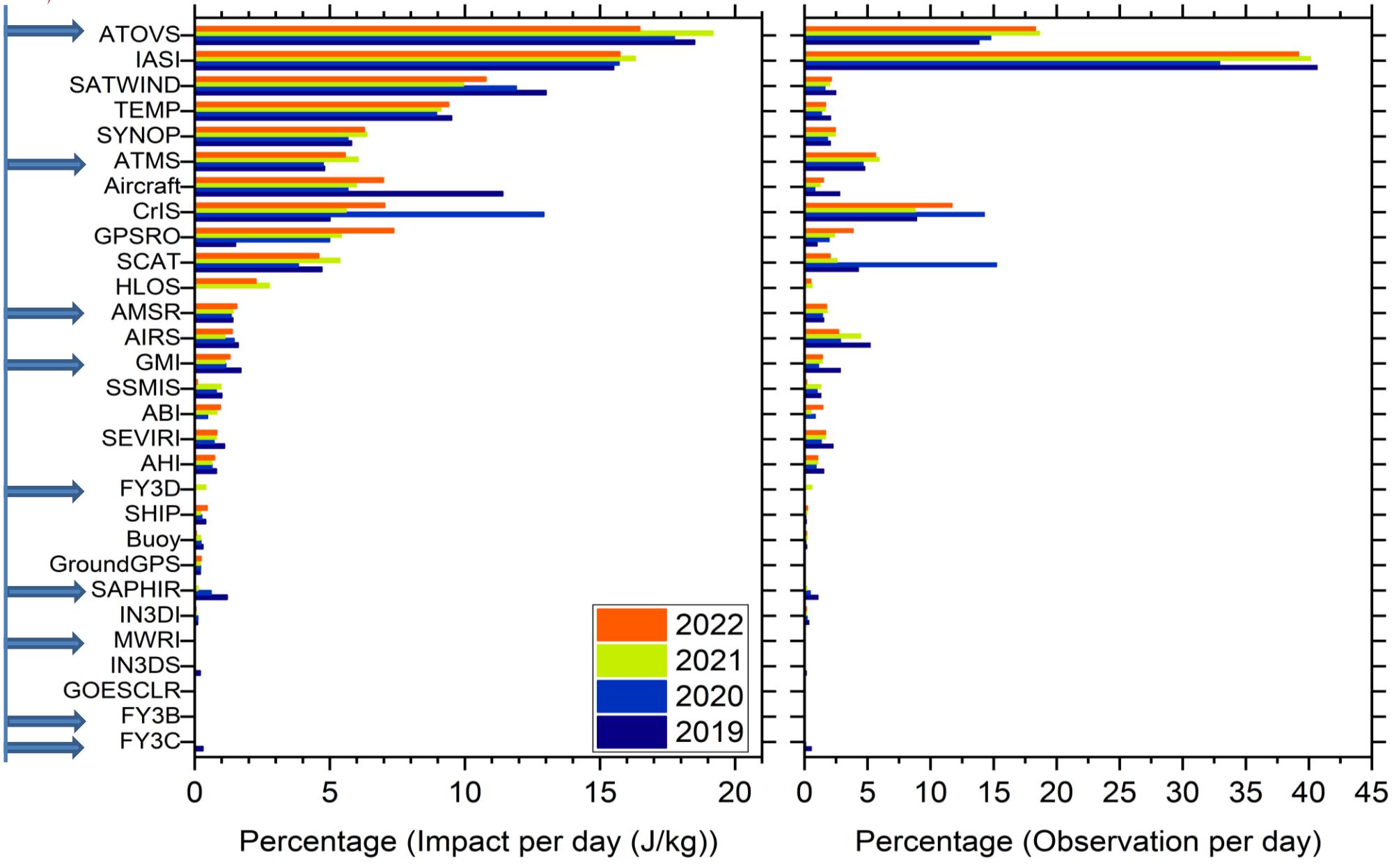
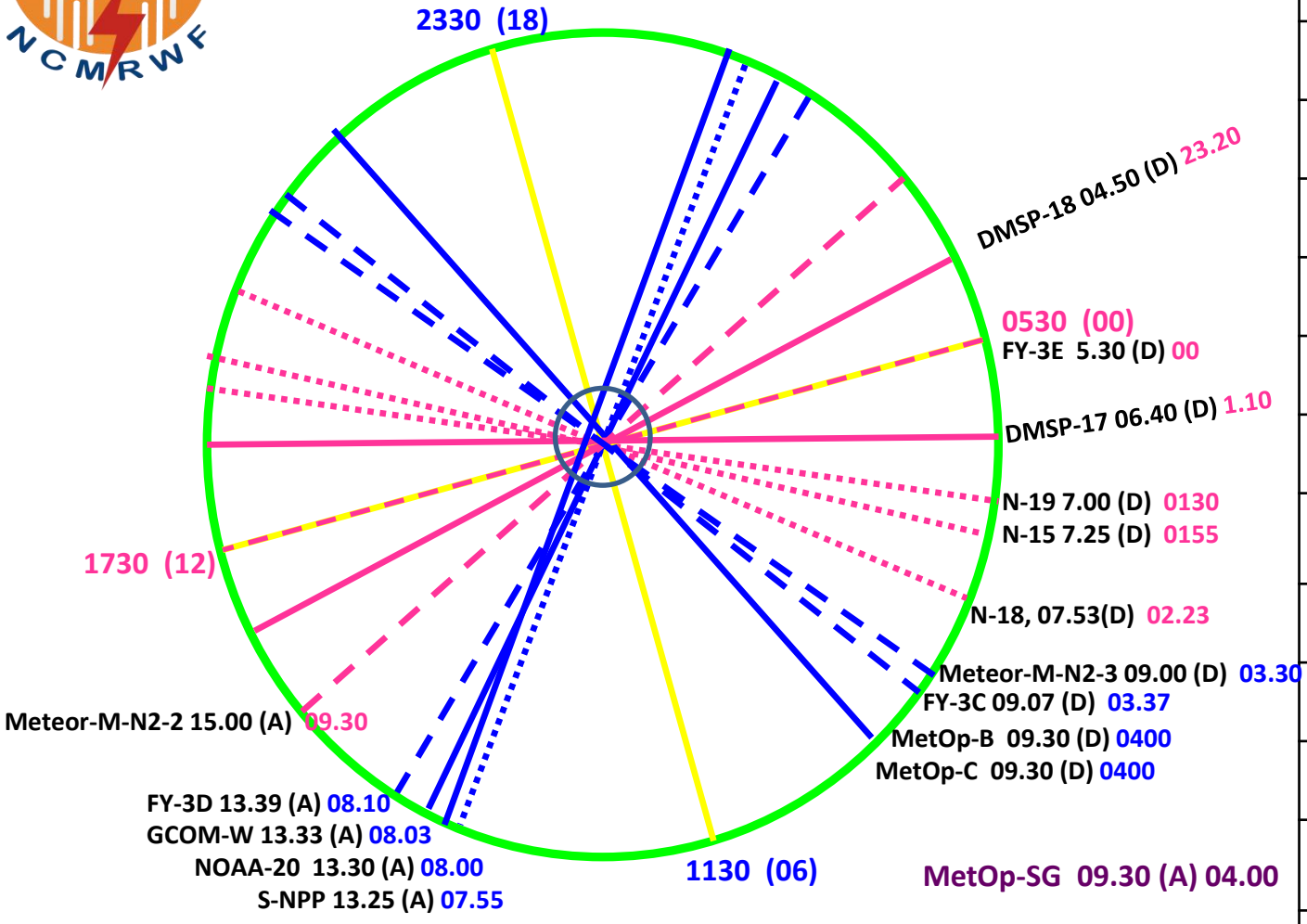


# 2. Forecast impact (NCMRWF FSOI)



# 3. Current space based MW instrument Constellation: Equatorial Crossing Time



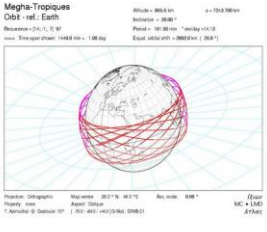

GMI, SAPHIR with more frequency over the Tropics

**GAP Area: 06 UTC (11.30 IST)and 18 UTC (23.30 IST) assimilation cycles**

| Satellite | LECT (A) | LECT (D) | Assimilation cycle |
|---|---|---|---|
| DMSP-F18 | 16.50 | 04.50 | 00,12 |
| FY-3E | 17.30 | 05.30 | 00,12 |
| DMSP-F17 | 18.40 | 06.40 | 00,12 |
| ***N-19*** | 19.00 | 07.00 | 00,12 |
| ***N-15*** | 19.25 | 07.25 | 00,12 |
| ***N-18*** | 19.53 | 07.53 | 00,12 |
| Meteor-M-N2-2 | 15.00 | 03.00 | 00,12 |
| ***S-NPP*** | 13.25 | 01.25 | 06, 18 |
| N-20 | 13.30 | 01.30 | 06,18 |
| FY-3D | 13.39 | 01.39 | 06,18 |
| Meteor-M-N2-3 | 21.00 | 09.00 | 06,18 |
| ***FY-3C*** | 21.07 | 09.07 | 06, 18 |
| M-B | 21.30 | 09.30 | 06,18 |
| M-C | 21.30 | 09.30 | 06,18 |
| GCOM-W | 13.33 | 01.33 | 06,18 |

# 4.India's contribution: Past, Present, and Future

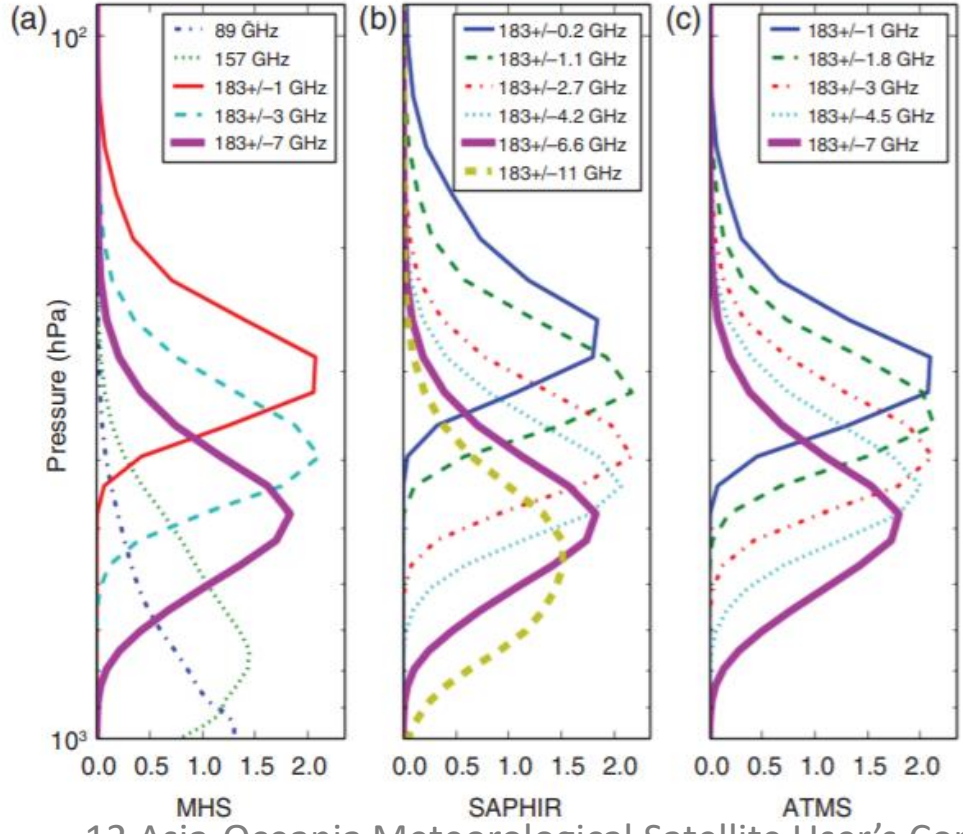
The Megha Tropiques (MT), a joint Indo-French satellite, was launched by the Indian launch vehicle, PSLV-C18 on 12 October 2011.



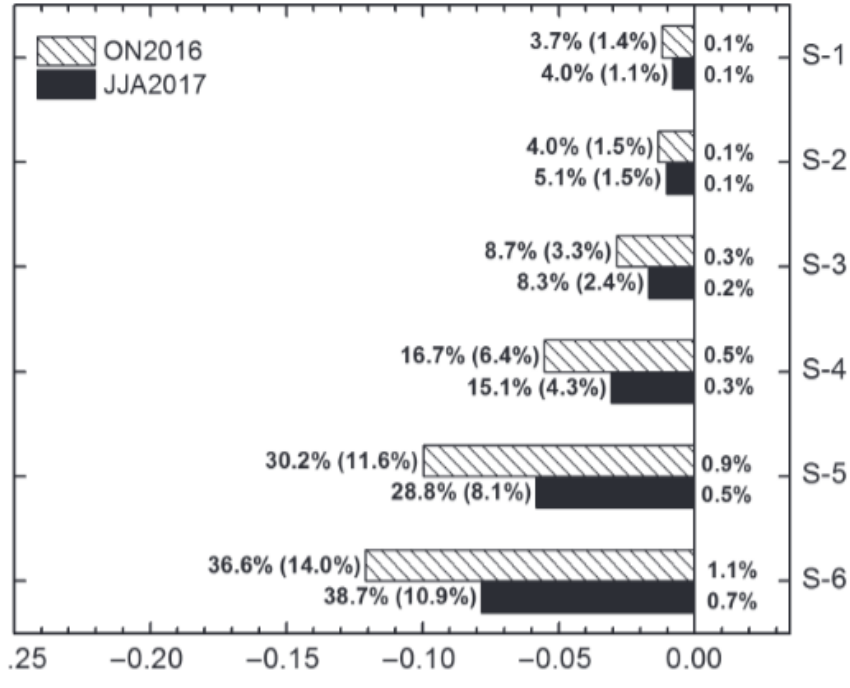

MT is positioned in a highly inclined equatorial plane of 20°at a height of 867 km above the Earth so as to orbit the tropical region (30°Sto 30°N) nearly 14–15 times per day.

The four payloads on-board MT consisting of a microwave radiometer(MADRAS), a microwave humidity sounder (SAPHIR), a radiation budget instrument (SCARAB) and a radio-occultation sounder (ROSA) are important for the study of tropical convective systems and hydrological cycle

**Weighting functions (MHS, SAPHIR, ATMS)**

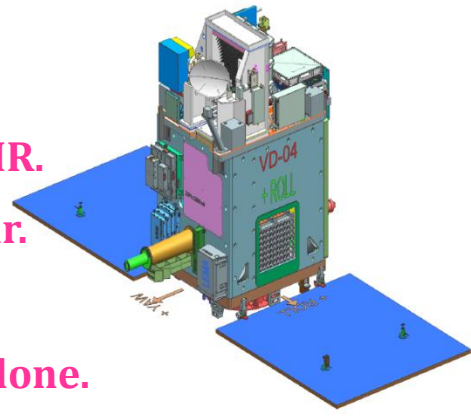



SAPHIR channel-6 (183±11 GHz) is unique and showed highest impact in the NWP system in the initial periods of the mission



# Mm Wave Humidity Sounder (Microsat-2B) on SSLV-D2

- Experimental mission
- 3-D humidity profiling from surface to 12km; follow-on to SAPHIR.
- Vertical resolution < 2km and spatial resolution of 10 km @nadir.
- Analysis of the diurnal cycle of water vapour distribution.
- To aid in improving operational forecasts including Tropical cyclone.




## Mm Wave Humidity Sounder (MHS) on MICROSAT-2B

| Parameter | Specifications |
|---|---|
| Orbit | Circular, 37° inclination |
| Altitude | 450 km |
| Swath | 1050 km |
| Frequency band | 183.31±16.25 GHz |
| Spatial resolution @ Nadir, Swath Edge | 10 km, 20 km |
| Dwell/ Integration time | 4msec |
| Scan Rate | 50 rpm |
| Mission Life | 12 months |

## MHS Channel Specifications

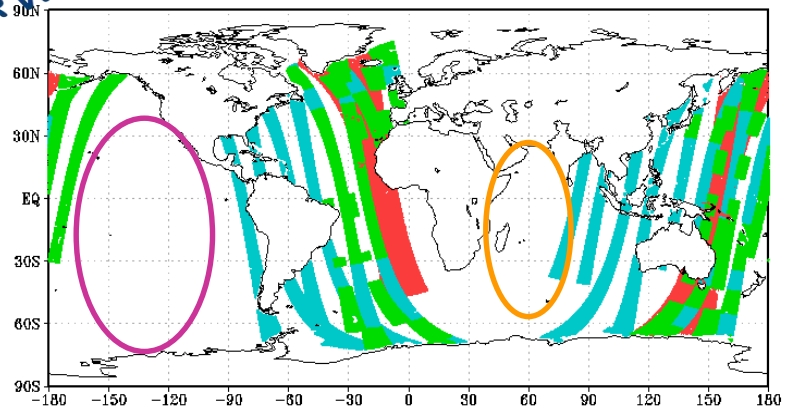
| No. | Frequency (in GHz) | Noise (dB) | risatio n | BW (in MHz) | NEDT (K) at 300 K at 4ms |
|---|---|---|---|---|---|
| 1 | 183.31±0.96 | 7 | QH | 300 | 1.5 |
| 2 | 183.31±2.8 | 6 | QH | 600 | 0.85 |
| 3 | 183.31±4.5 | 7 | QH | 1000 | 0.85 |
| 4 | 183.31±5.8 | 7 | QH | 700 | 1 |
| 5 | 183.31±11.56 | 8 | QH | 900 | 1 |
| 6 | 183.31±15.75 | 6.8 | QH | 1000 | 0.8 |

**Slide courtesy: ISRO**

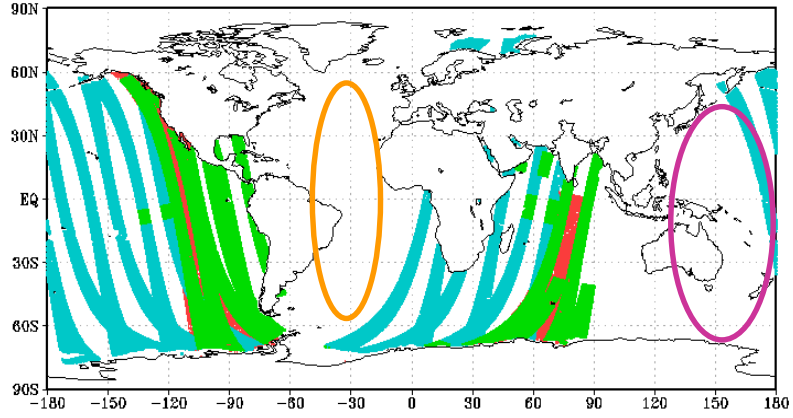
# 5. Passive Microwave instruments: Scatterometer sea surface wind

**SCATSAT-1** **ASCAT-A** **ASCAT-B**

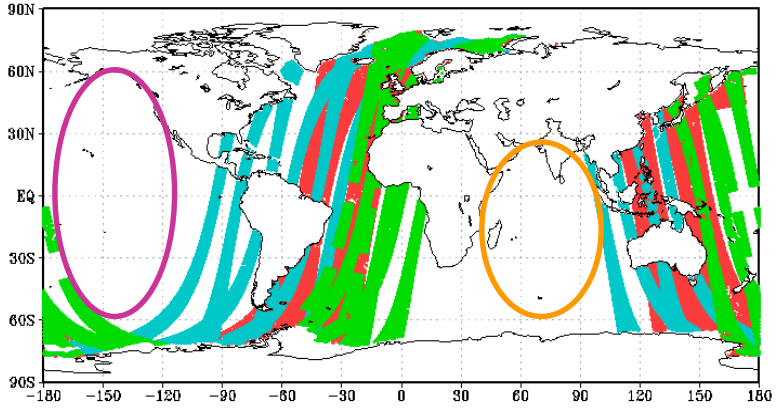
00 UTC



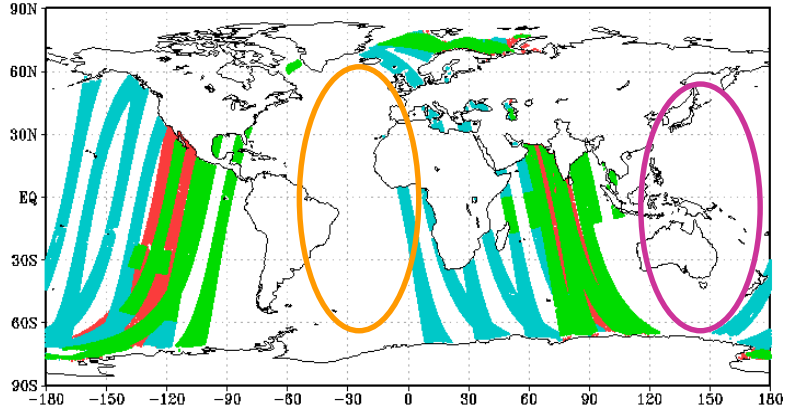

06 UTC




12 UTC




18 UTC




**During 00 and 12 UTC assimilation cycles, there is no scatterometer coverage over the Indian Ocean region and West Pacific Ocean.**

**During 06 and 18 UTC data sparse region over East Pacific and Atlantic Oceans**

# Oceansat-3 Mission EOS 06 - Status

- Oceansat-3 – with 13 band OCM, SSTM, Scatterometer + Argos payload
- Integrated tests are progressing.
- Launch on a PSLV C-54.
- Data will be downloaded every orbit, engaging Ground stations at Shadnagar, Antarctica, Svalbard and Fairbanks.
- Near Real time products will be available from SCAT and SSTM within 180 minutes.
- Data sharing agreement with NOAA, EUMETSAT.

**Requirements**

- Participation of MoES (IMD, NCMRWF, INCOIS, IITM, NIOT) in the Cal/Val activities after the launch.
- Requirement of Ship cruises for validation campaign in Feb/March, 2023 timeframe.


**Slide courtesy: ISRO**

# 6. Summary

- NCMRWF regularly monitors, processes and assimilate satellite microwave radiances
- Microwave radiances helps ~30-35% error reduction in the 24 hour forecast (FSOI)
- Considering the 6 hourly intermittent assimilation: current constellation of space based microwave instruments shows huge gap in the 06 and 18 UTC assimilation cycles.
- Megha-Tropiques SAPHIR was one of the most exploited microwave humidity sensor by leading global operational NWP centres
- ISRO is planning a follow-on mission to SAPHIR in a low earth circular orbit of $37^{o}$ inclination at an altitude of 450 km, with a life period of ~ 1 year
- Current scatterometer missions also leave a huge gap in the global coverage during the 6 hourly intermittent assimilation cycles.
- Active microwave instruments in the early morning and afternoon orbits are essential for the NWP systems, particularly during extreme weather events.

# Thank you