Impact of Microsat-2B Radiance Data Assimilation in the NCMRWF Global Forecast System

presented by

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Outline

- About MHS-Microsat-2B
- Experimental Setup
- O-B and O-A Statistics
- Mean statistics of meteorological variables
- Case studies: Biparjoy & Monsoon Depression
- Summary

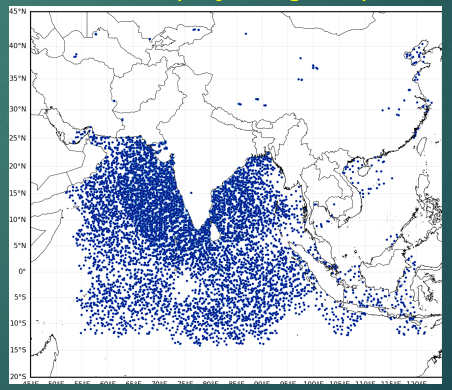
Microsat-2B (EOS-07)

- **Microsat-2B is an experimental mission, launched by ISRO on 10th February 2023, and it is similar to the SAPHIR satellite.**
- **It carries six humidity-sounding channels in the 183.31 ± 15 GHz band**
- **The radiance data from Microsat-2B is assimilated into the NCMRWF GFS modeling system using in-house developed spectral and transmittance coefficient files**

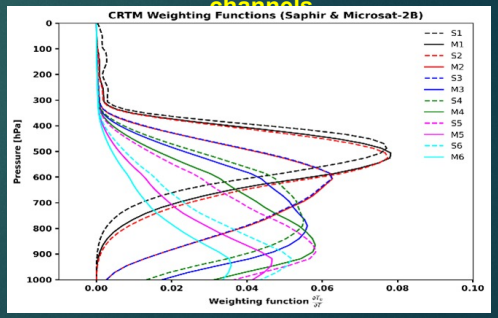
Parameters	Specifications
Orbit	Circular (37° inclination)
Altitude	450 km
Swath	1050 km
Frequency band	183.31±15 GHz
Spatial Resolution	10 km (nadir), 20 km (Swath edges)

S.No	Frequency (GHz)	Noise (dB)	Polarization	Bandwidth (MHz)	NEDT (K)
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

Spatial Coverage of M2B over Indian Ocean (May – Aug 2023)



CRTM weighting functions for SAPHIR and Microsat-2B channels



Experimental Setup

- Two Observation System Experiments (OSEs) are conducted during May-August 2023:

  CNTL: Assimilated all conventional observations

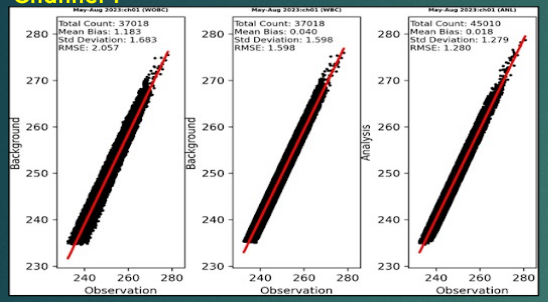
  M2B: Assimilated Microsat-2B (M2B) data along with all conventional observations as in CNTL

- All six channels of M2B radiance data are assimilated at a resolution of T574L64 in 4 cycles (00, 06, 12 & 18 UTC) into the NCMRWF GDAS/GFS system using GSI-3DVAR and employed CRTM version 2.2.3 as the observation operator

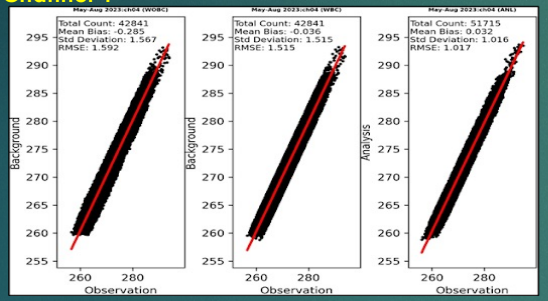
- GPM IMERG Rainfall, IMD Best Track Data, and ERA5 are used as a reference to verify the model's performance

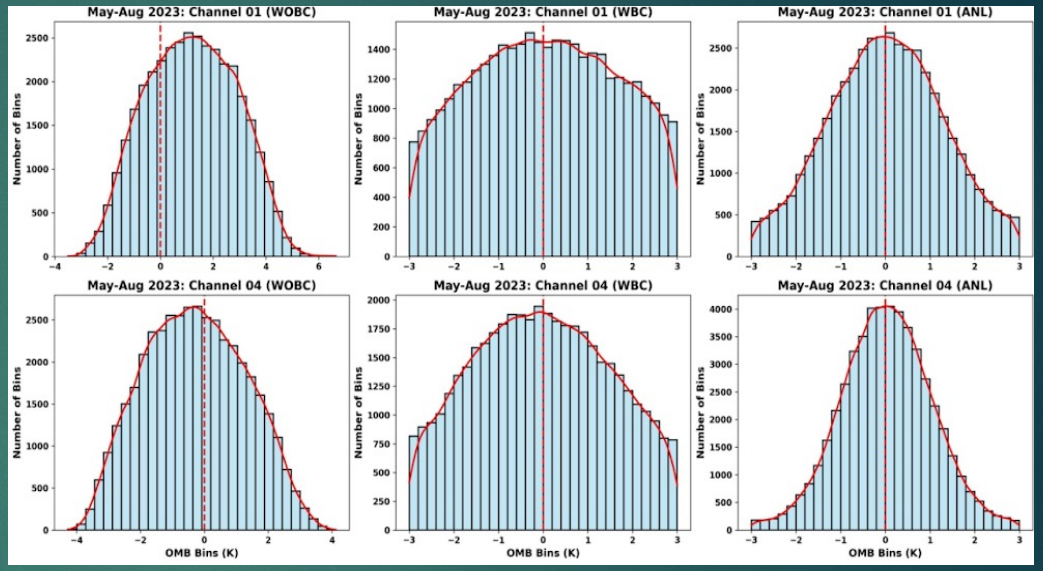
Impact of M2B on Analysis

Channel 1



Channel 4



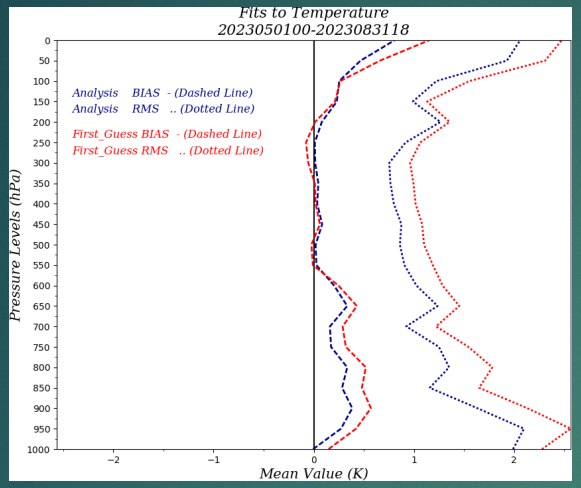


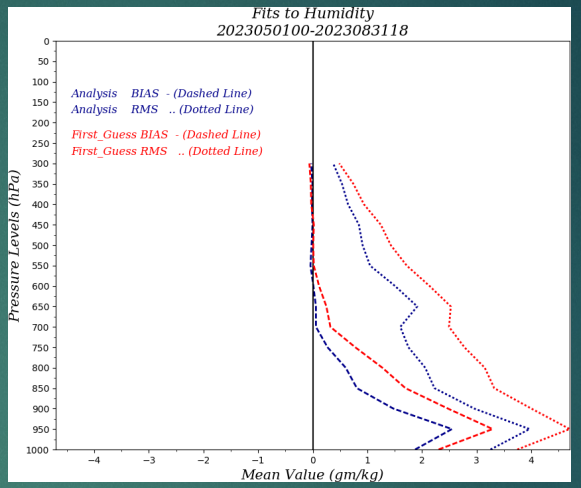
- Incorporating M2B data improved the analysis, resulting in a 20% reduction in RMSE, a 20% reduction in std, and a 55% reduction in mean bias for Channel 1.
- For Channel 4, incorporating M2B data led to a 33% reduction in both RMSE and std.

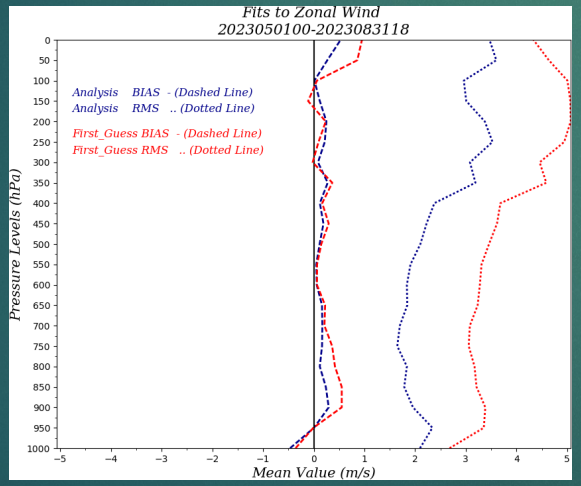
- For Channel 1, before bias correction, the distribution is skewed, indicating that the model-simulated BT is cooler than the observations. After assimilation (OMA), the distribution resembles a Gaussian curve with a peak at 0 K.
- For Channel 4, before bias correction, the distribution is skewed, indicating that the model-simulated BT is warmer than the observations. After assimilation (OMA), the distribution also resembles a Gaussian with a peak at 0 K.

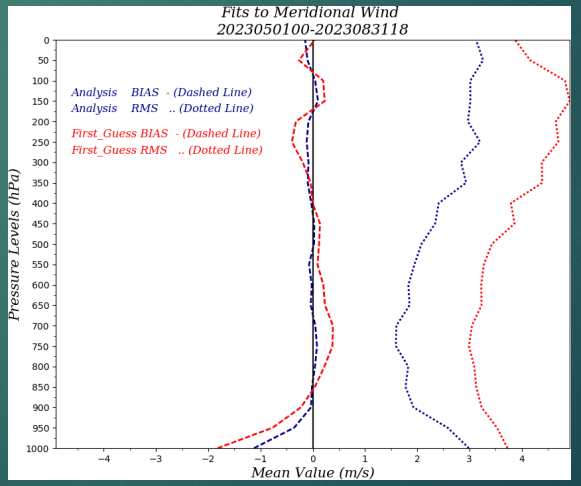
These improvements indicate that the analysis fields are adjusted closer to the observations.

Impact of Microsat-2B Radiances on Model Analysis & Background (01 May 2023 to 31 Aug 2023)



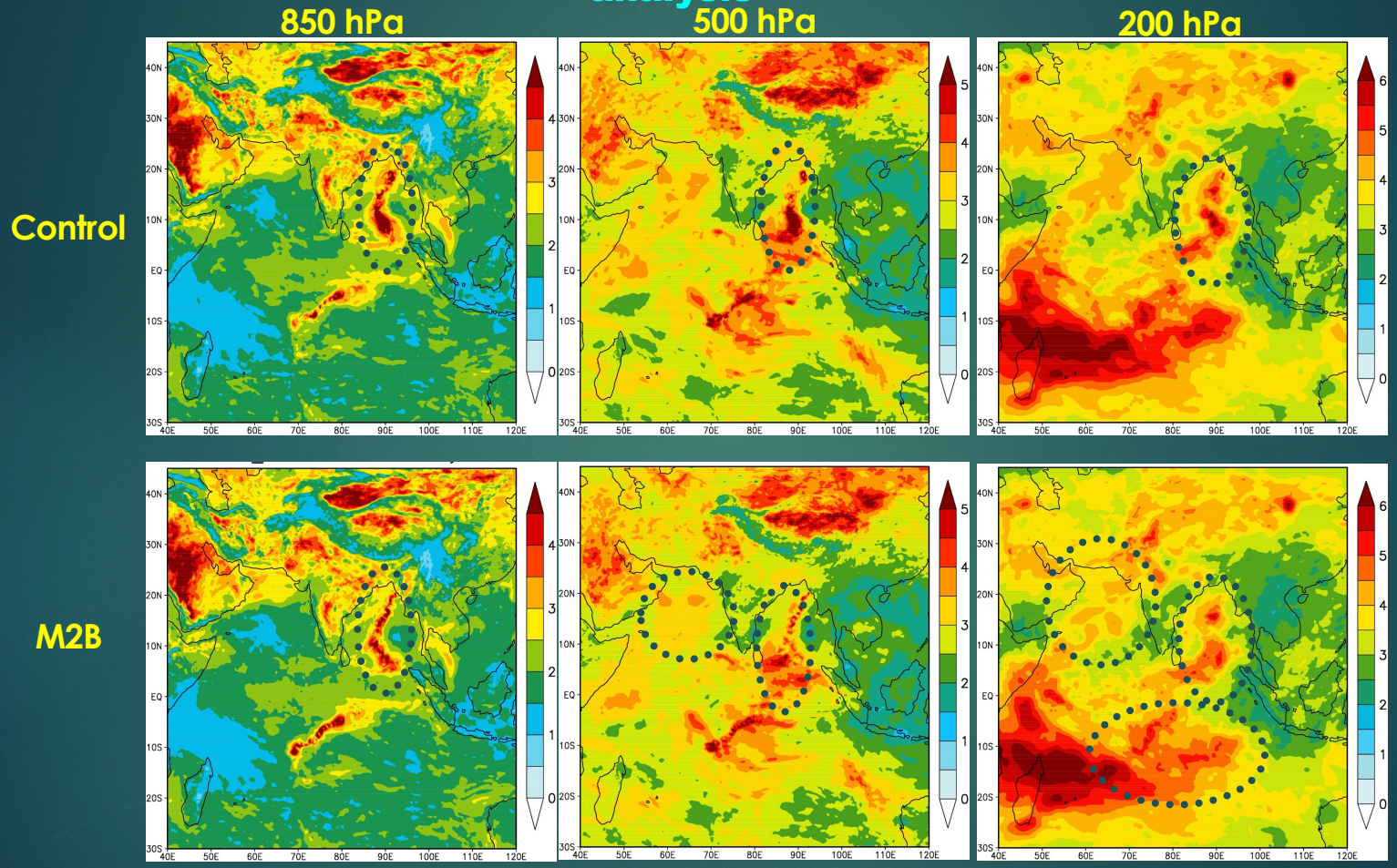






Blue: OMA
Red: OMB
Dash Line: Bias
Dotted Line: RMS

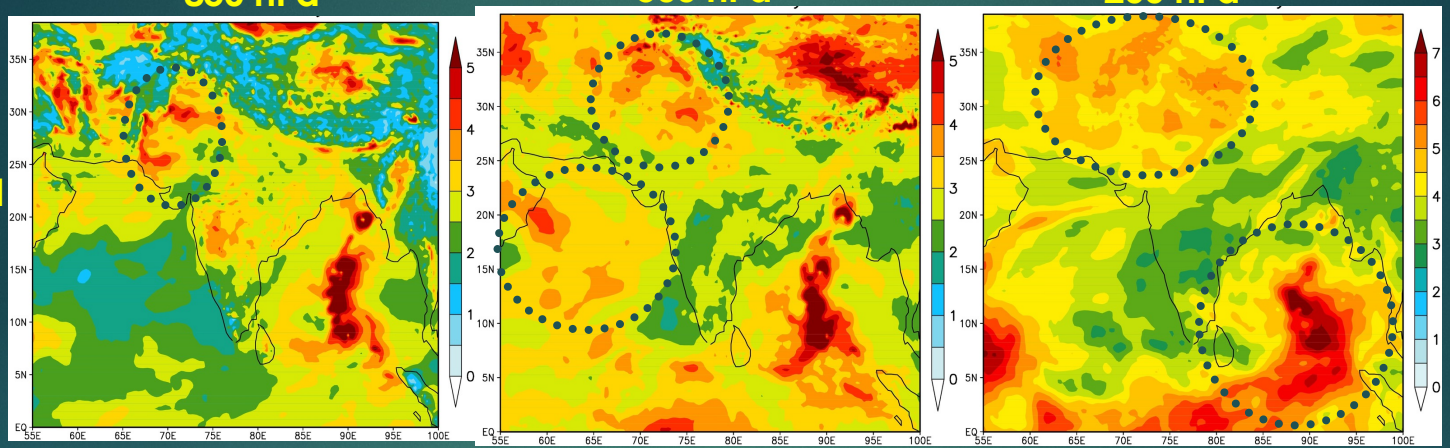
RMSE of wind magnitude at 850, 500, & 200 hPa for May 2023 from analysis



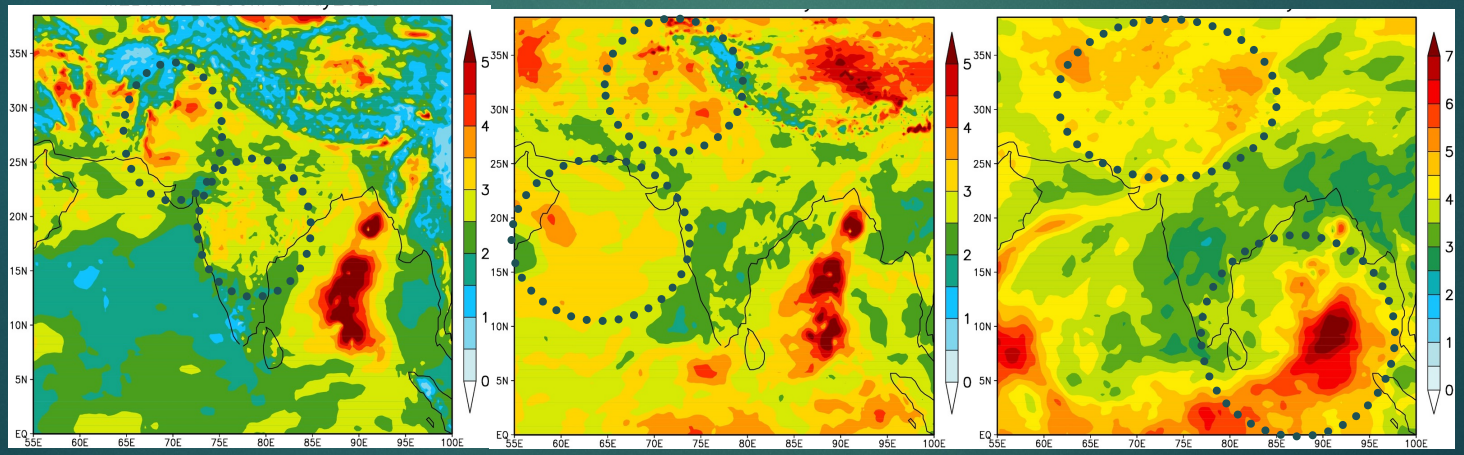
RMSE of wind magnitude at 850, 500, & 200 hPa for May 2023 from day 1 forecasts

850 hPa | 500 hPa | 200 hPa

Control

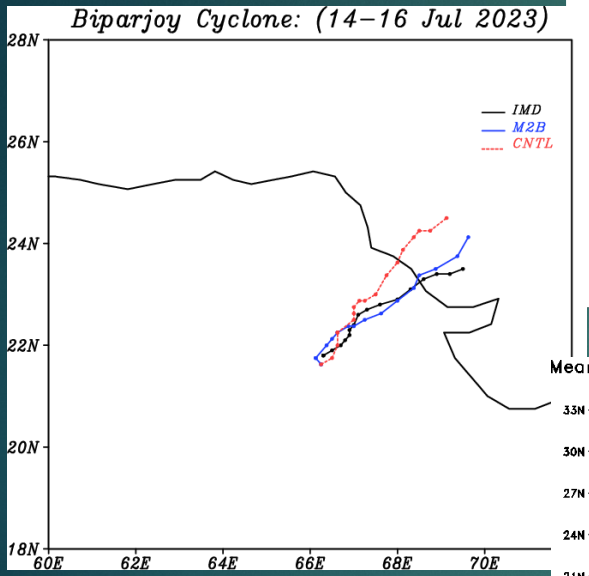


M2B

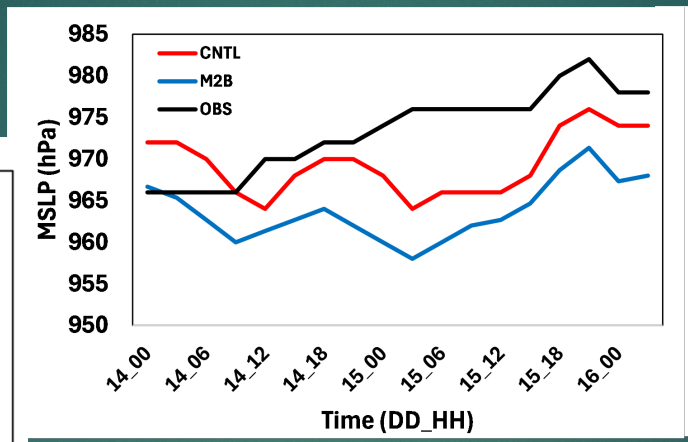


Case Study

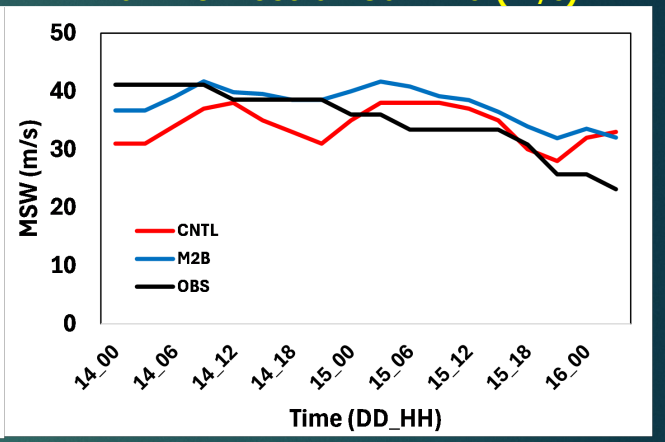
Biparjoy: (14-16 Jun 2023)



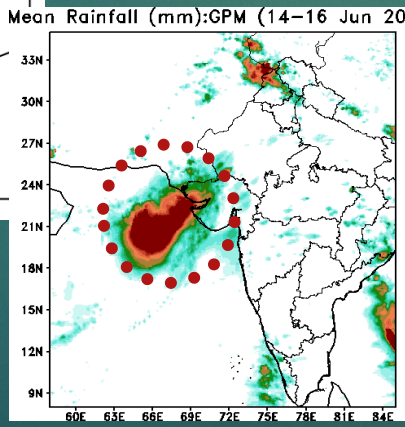
Mean Sea Level Pressure (hPa)



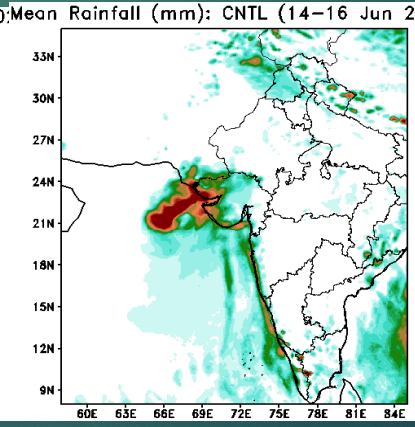
Maximum Sustained Wind (m/s)



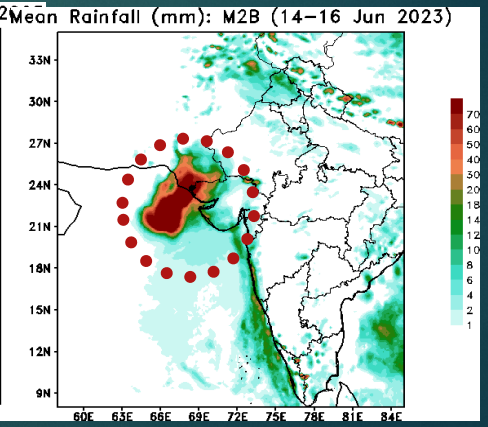
GPM



CNTL

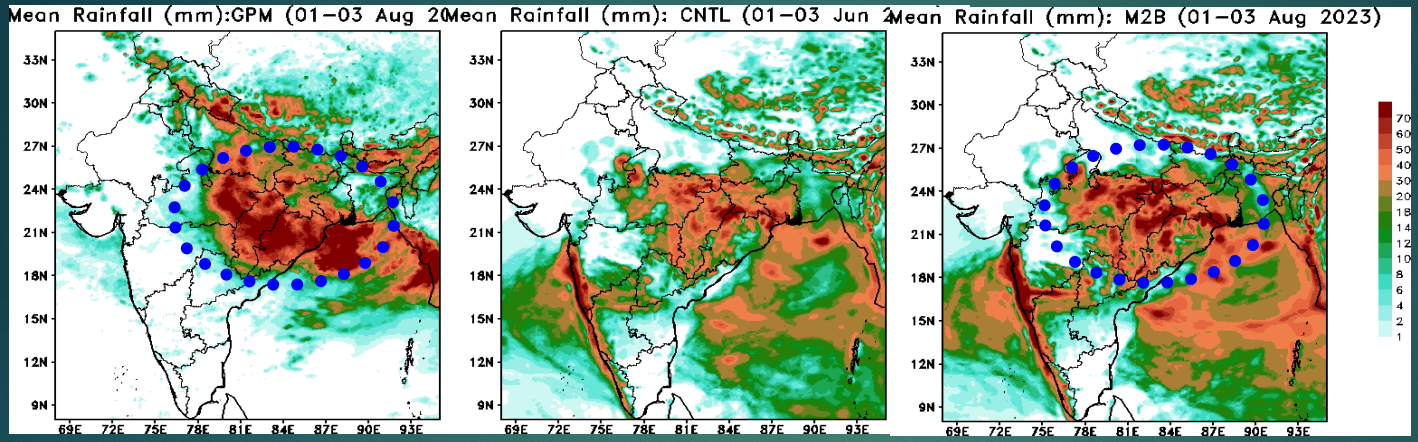


M2B



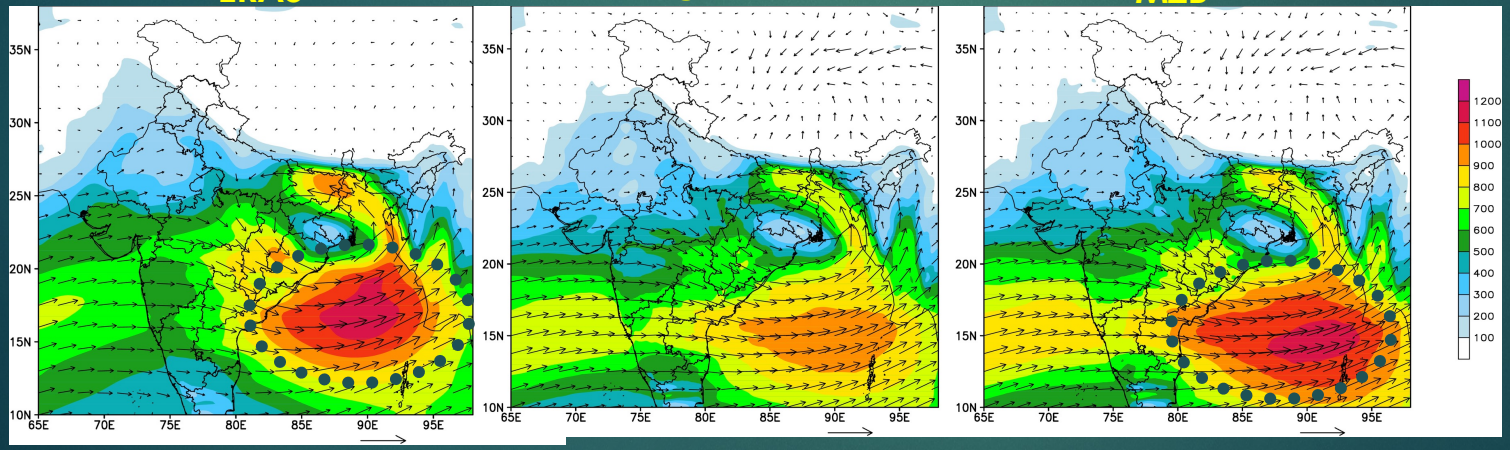
Monsoon Depression: (01-03 Aug 2023)

GPM | CNTL | M2B



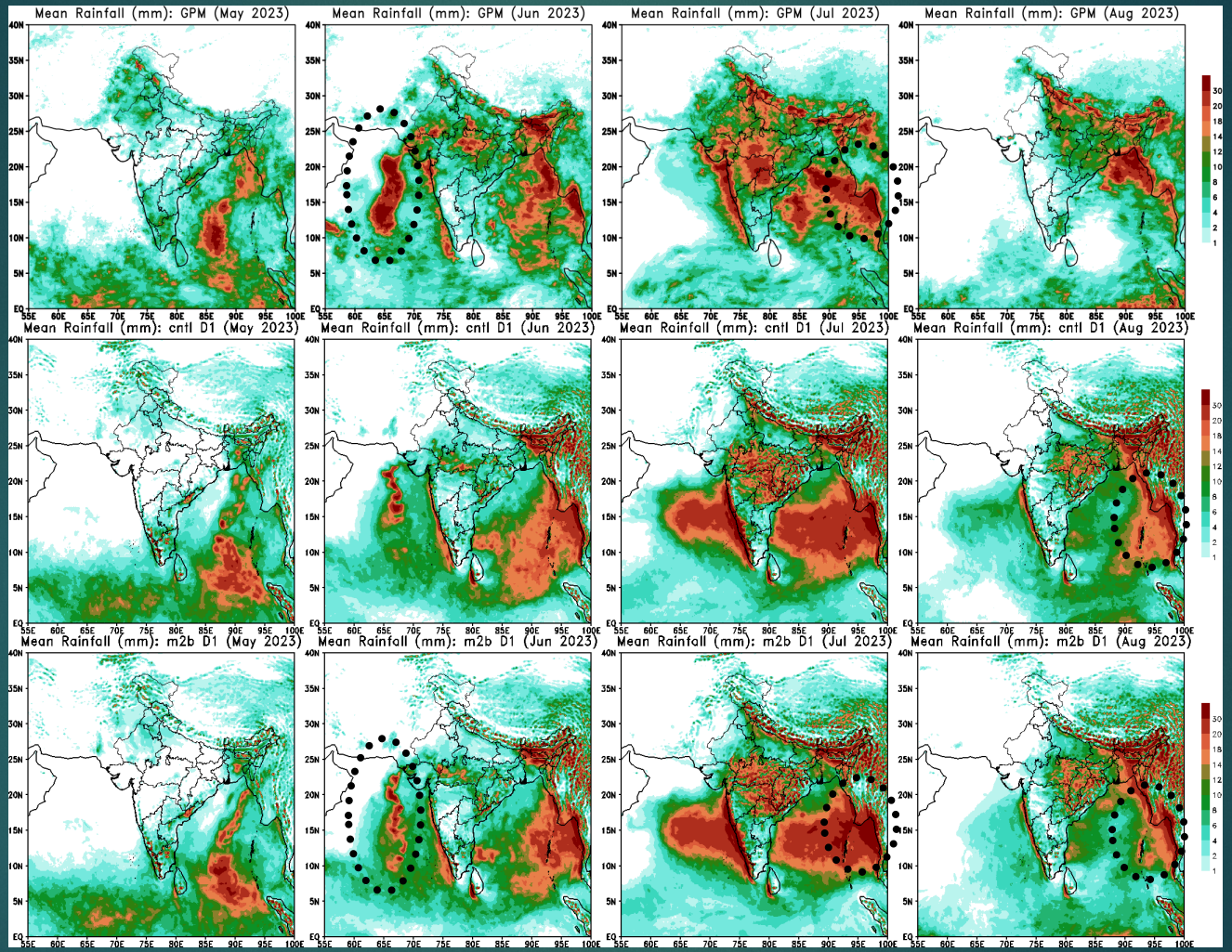
Rainfall (mm)

ERA5 | CNTL | M2B



Vertical Integrated Moisture Transport (VIMT)

Mean Rainfall from Day 1 forecasts



GPM IMERG

CNTL

M2B

Summary

- Assimilation of M2B radiances improved analysis and short-range forecasts over the Indian Ocean
- Assimilation of M2B radiance leads to notable reduction in bias, RMSE, and standard deviation in observation minus background (O-B) and analysis (O-A) statistics
- Case studies (Cyclone Biparjoy & Monsoon Depression) showed better rainfall intensity prediction
- Consistent improvement in wind fields at 850, 500, and 200 hPa in both analysis and short-range forecasts
- Radiances from Microsat-2B kind of satellites are valuable for improving NWP over the Indian Ocean region

Thank You