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Assessing Upper Tropospheric Humidity During Monsoon Depression Using NCMRWF Unified Model Forecasts .

Shubha Singh¹, Anumeha Dube¹, Jhon P. George,¹ Saji Mohandas¹ & V.S. Prasad¹

¹National Center for Medium Range Weather Forecast (NCMRWF), Sector 62 , Noida 201309, India

5th June 2024 Wednesday, Stipmex.



Quick Understanding of the topic



- Relative humidity (RH) influences cloud formation and precipitation patterns.
- High RH often leads to cloud formation and potential precipitation.
- Low RH indicates drier conditions.
- Understanding RH helps predict weather and assess atmospheric moisture level critical for various phenomena.
- Water Vapor being most Potent greenhouse gas in atmosphere, significantly influencing the total atmospheric energy budget by radiation and latent heating process.
- So significantly studying RH biases for (NCUM model forecast) can enhance the accuracy of weather forecast in regions prone to convective activity or frequent extreme weather.



Relevance



- **Moisture Transport in the upper troposphere involves horizontal winds moving moisture from lower levels or distant areas.**
- **Convective systems like thunderstorms, boost Upper Tropospheric Humidity (UTH) by injecting moisture via overshooting cloud tops and detrainment.**
- **Tropical cyclones contribute to UTH through the evaporation of oceanic moisture and convective processes.**
- **The tropical tropopause layer (TTL), where deep convective injects water vapor into stratosphere, influences UTH.**
- **We assessed Upper Tropospheric humidity (UTH) using forecasts from the NCMRWF Unified Model (NCUM) during the passage of monsoon depressions and validated it through observational sources.**

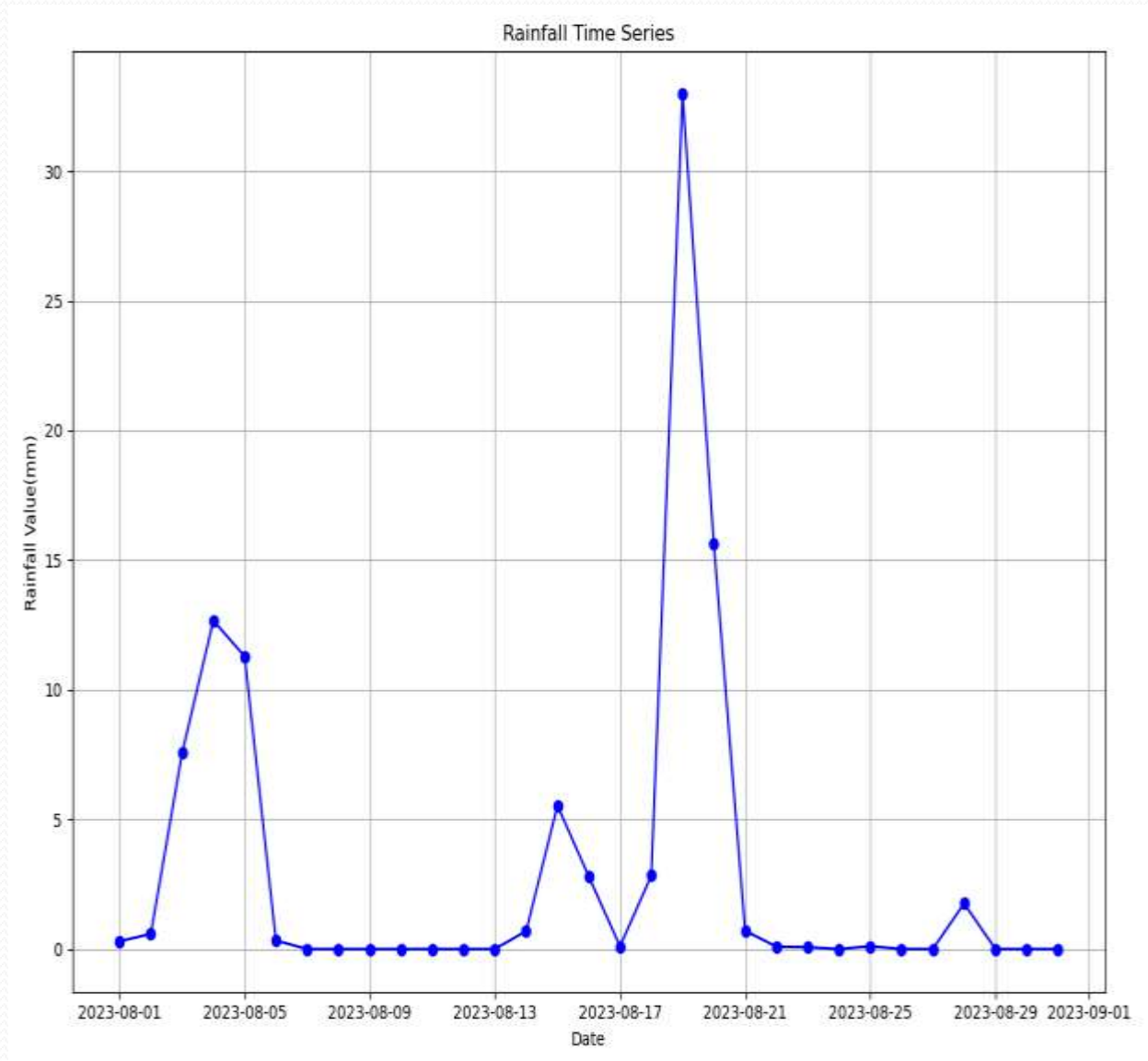


NCUM Models Brief

- The NCMRWF Unified Model (NCUM-G) has been used for numerical weather prediction since 2012.
- Based on Unified Model(UM) system, developed by the Met office-UK, Bom CSIRO-Australia, KMA-South Korea, NIWA-New Zealand and MoES/NCMRWF-India.
- The NCUM system is periodically upgraded to incorporate new scientific and technological advancement for improved global and regional NWP.
- Since 2012, the NCUM global assimilation-forecast system has undergone six major upgrades. The latest (10th June 2020) is NCUM-G: V6(Details on MCMRWF website) .
- High Resolution domains for the Indian region are configured with Unified Model(UM) seamless prediction system , adapted from the UM- Partnership for various applications collectively referred to as NCUM-R .
- The history of NCUM-R began with the implementation of the Singapore version (SINGV₂) in 2016. In 2018 the UK Met office Regional Atmosphere version was adopted , starting with first version of RAL₁, This followed by implementation of RAL₂ in October 2020.
- The latest NCUM-R is based on the UK Met Office RAL₃ and is operated since October 1, 2022.(Details on NCMRWF website)

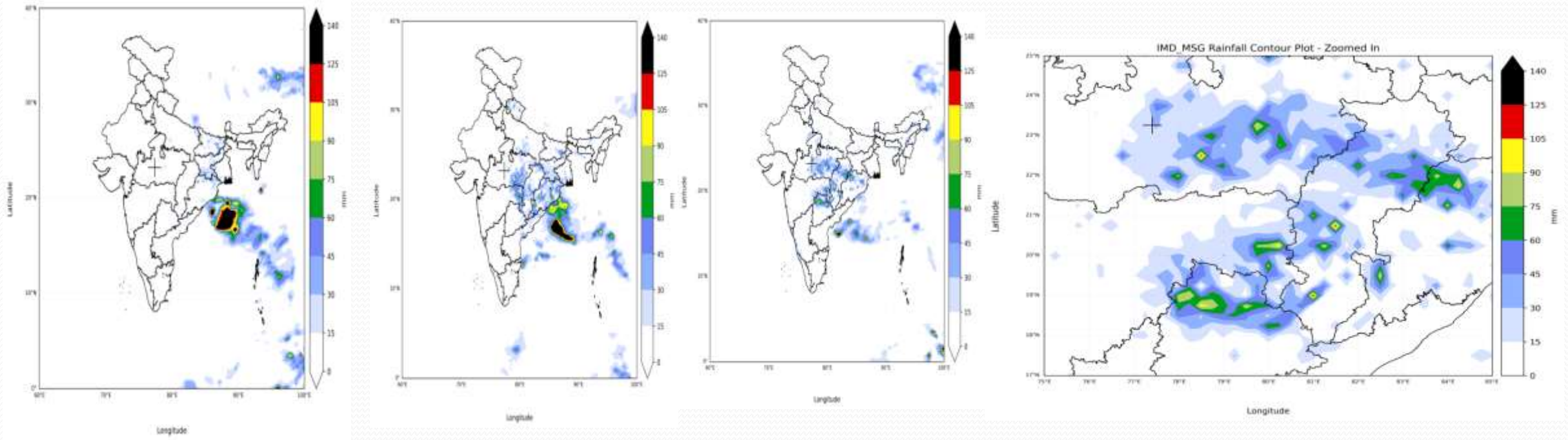
Time series plots of IMD_MSG rainfall for Bhopal August 2023

- A time series plot of the rainfall data typically shows how the amount of rainfall varies over time, often daily monthly or yearly.
- The interpretation of the rainfall time series plot for station like Bhopal from IMD_MSG provides valuable insights into the historical precipitation pattern at the location for a month.



Spatial Plots Rainfall for IMD_MSG during Monsoon Depression from 17th -19th August

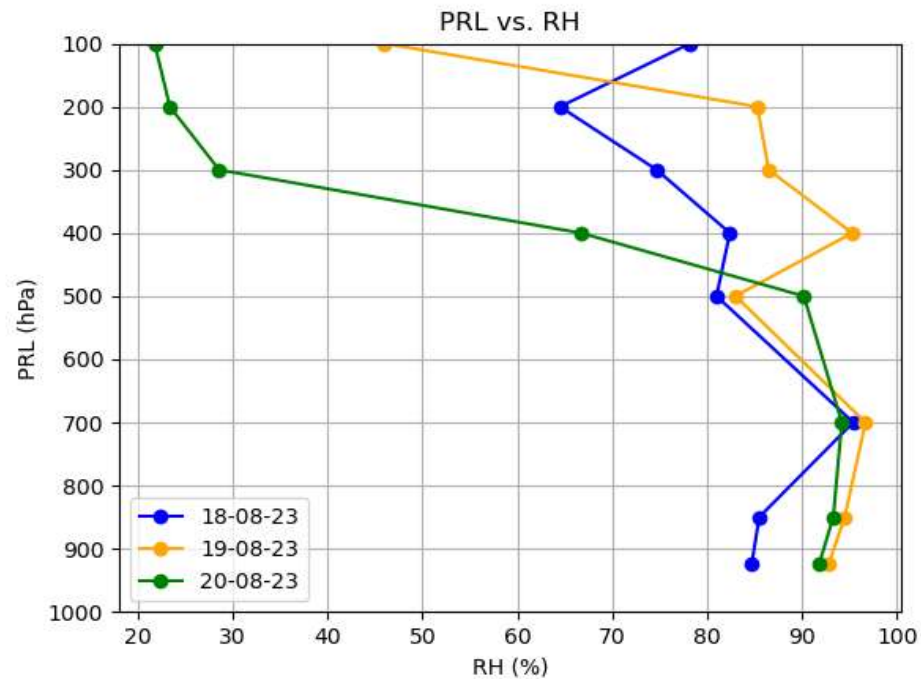
2023
These Plots show the passage of Monsoon depression and corresponding rainfall measured through IMD_MSG during the period 17th -19th August 2023 as per IMD report.



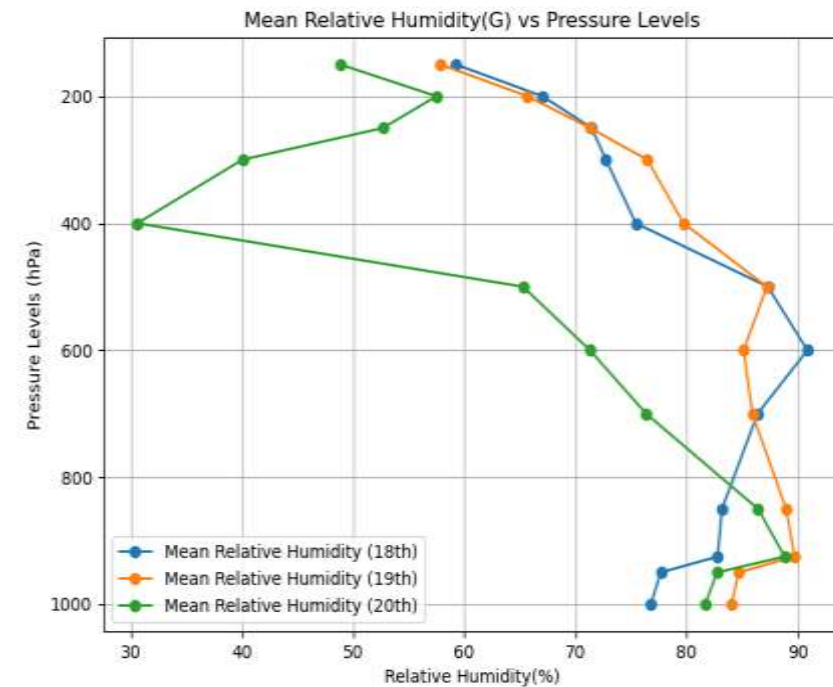
+ sign indicates Bhopal Latitude: 23.25 ° N Longitude: 77.4 °

Average Relative humidity for NCUM(G) Fcst, during Monsoon Depression and its observational Vertical Profile comparison.

Radiosonde Observation

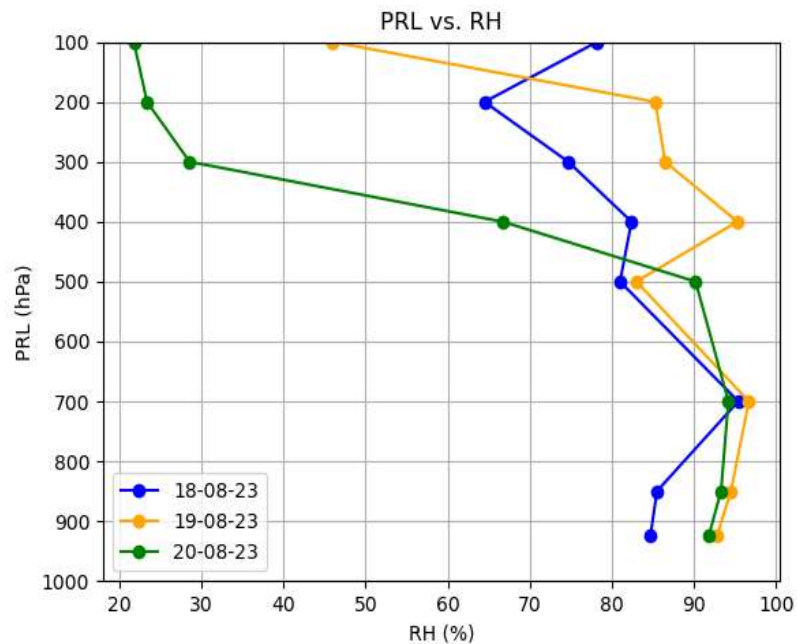


Mean RH for NCUM (G)

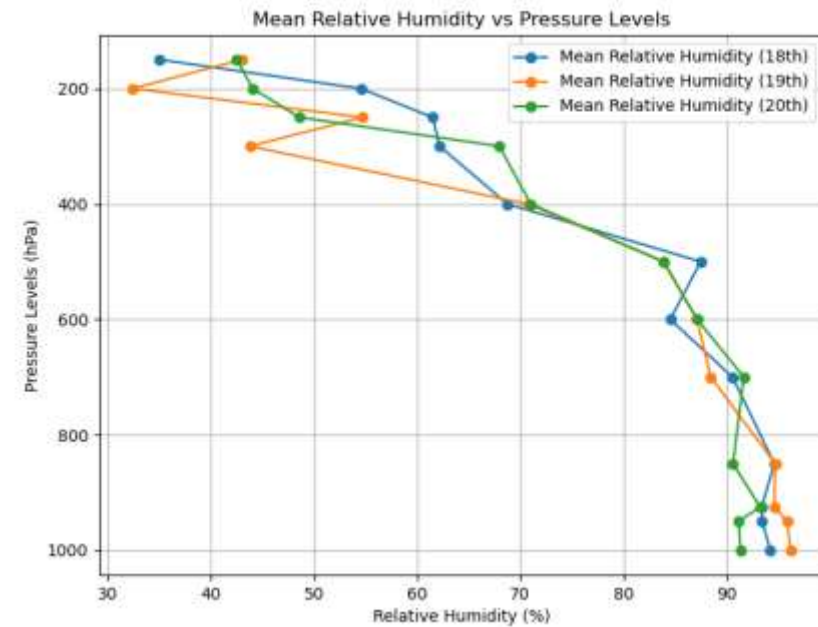


Average Relative humidity for NCUM(R) Fcst, during Monsoon Depression and its observational Vertical Profile comparison.

Radiosonde Observation

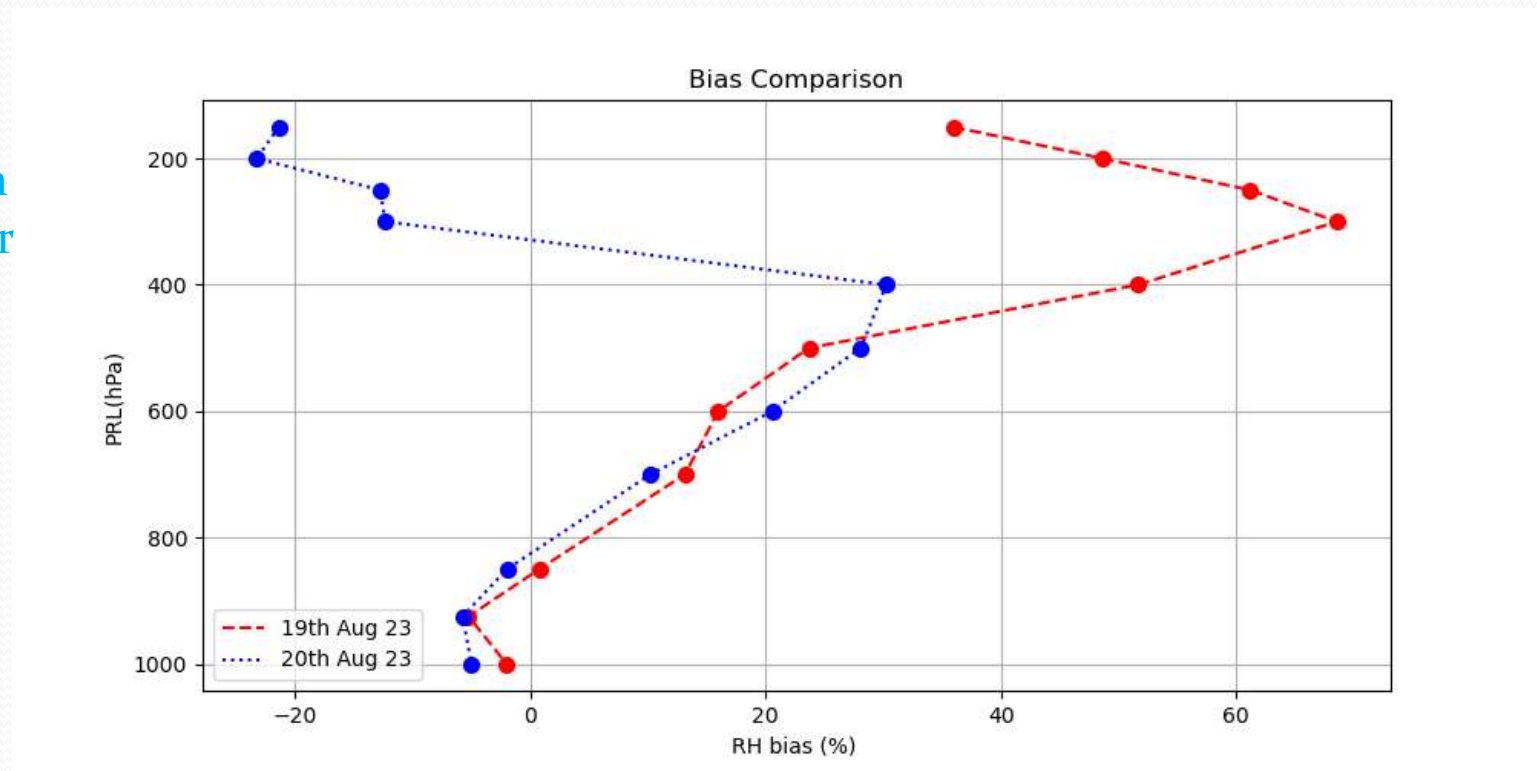


NCUM (R)



RH bias for Model(Global) Fcst & observation for 19th 20th Aug 2023

Obvious moist bias were found in middle and upper troposphere for 19th August 2024

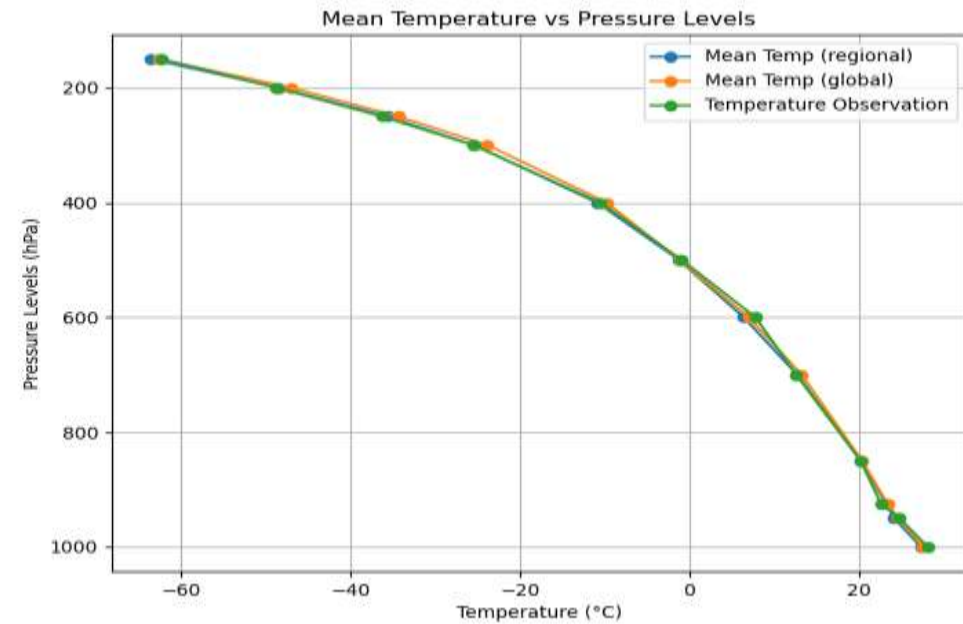
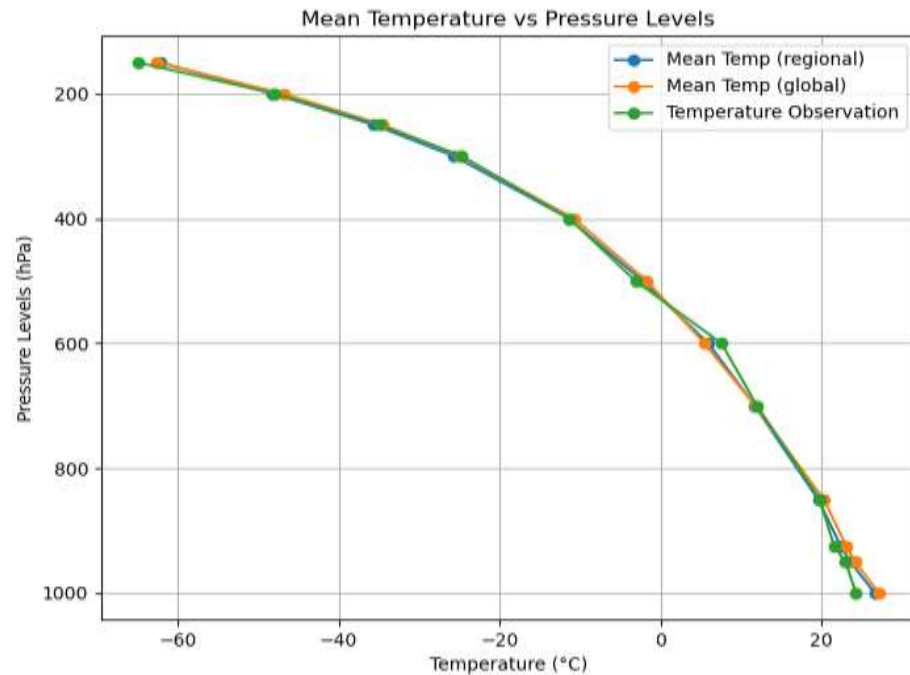


Mean Temperature Fcst Vertical Profiles with Pressure level for 19th & 20th August 2023

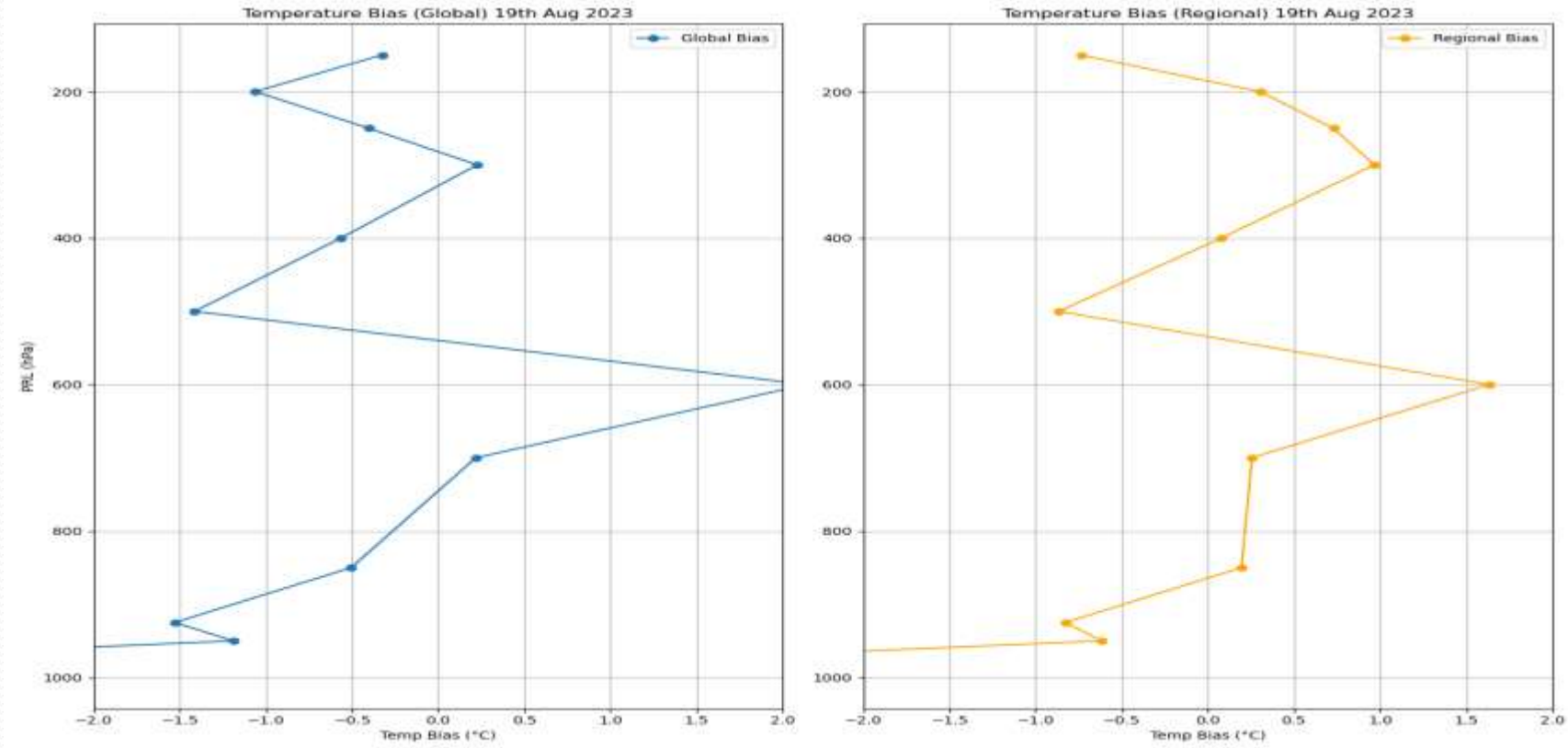
Mean Temperature Profiles with vertical Pressure levels are quite comparable for NCUM(G), NCUM(R) & Observation.

19th August 2023

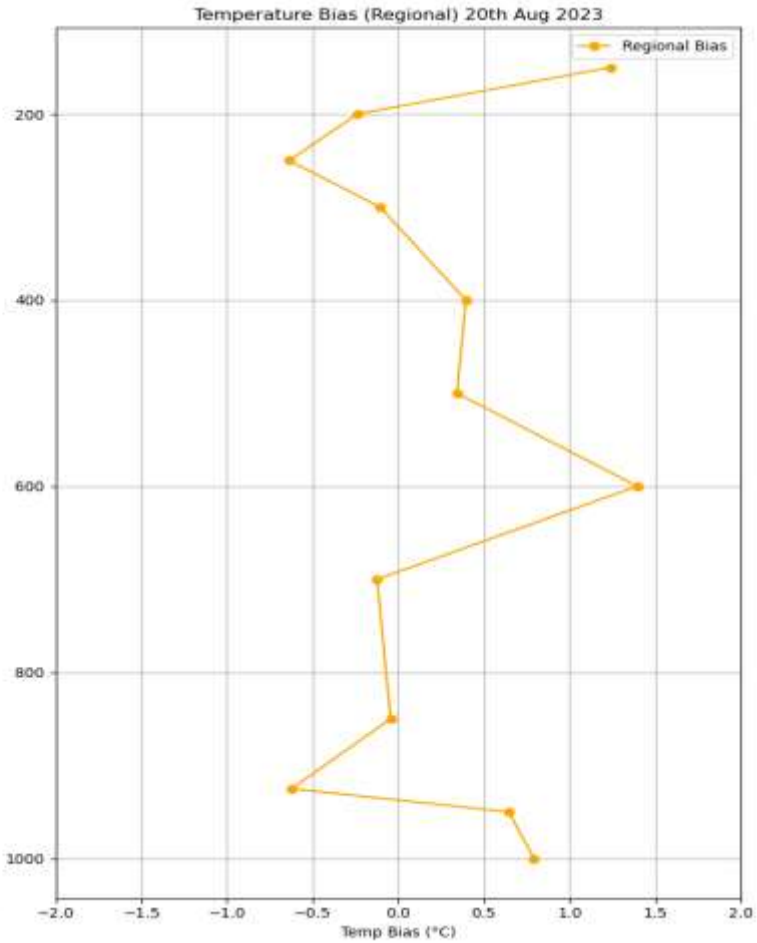
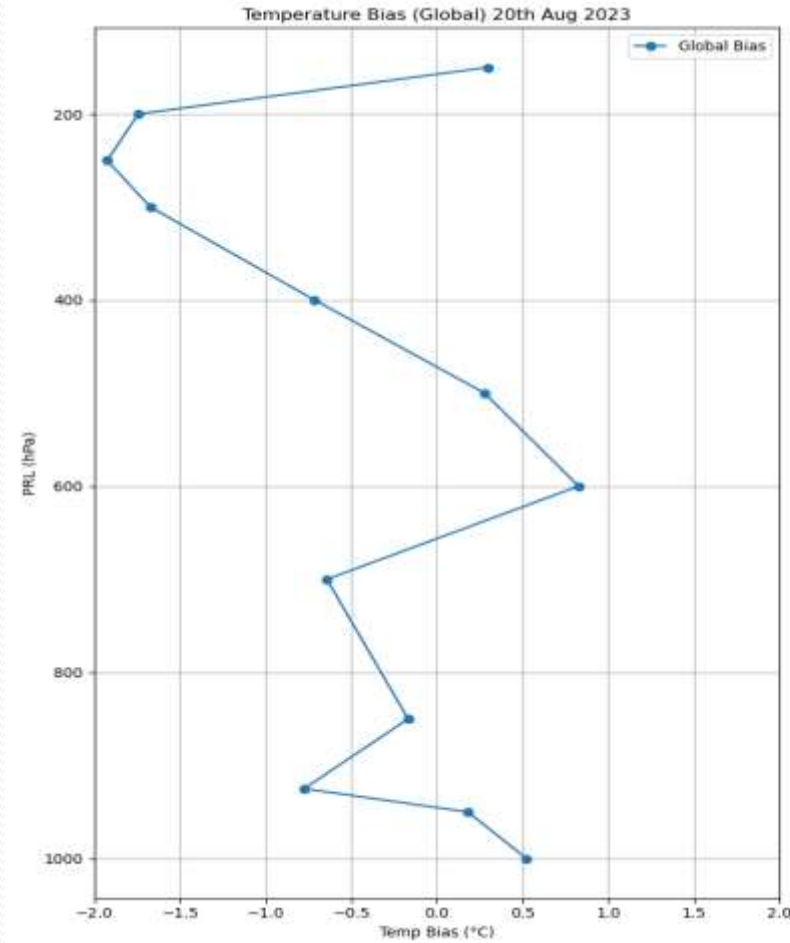
20th August 2023



Vertical Temperature Fcst, Bias for NCUM(G) NCUM(R) for 19th August 2023



Vertical Temperature Fcst, Bias for NCUM(G) NCUM(R) for 20th August 2023

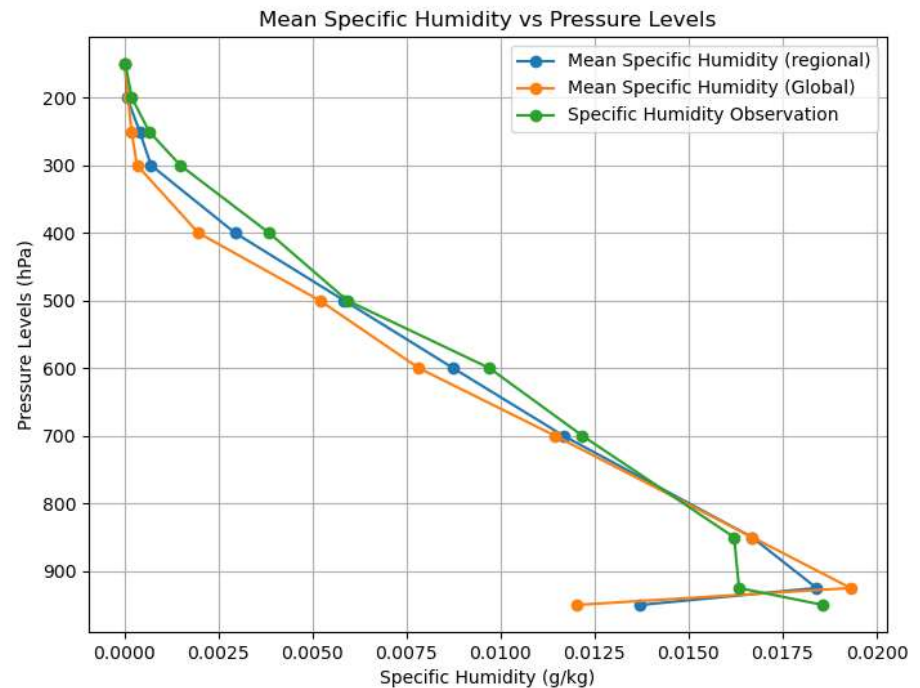
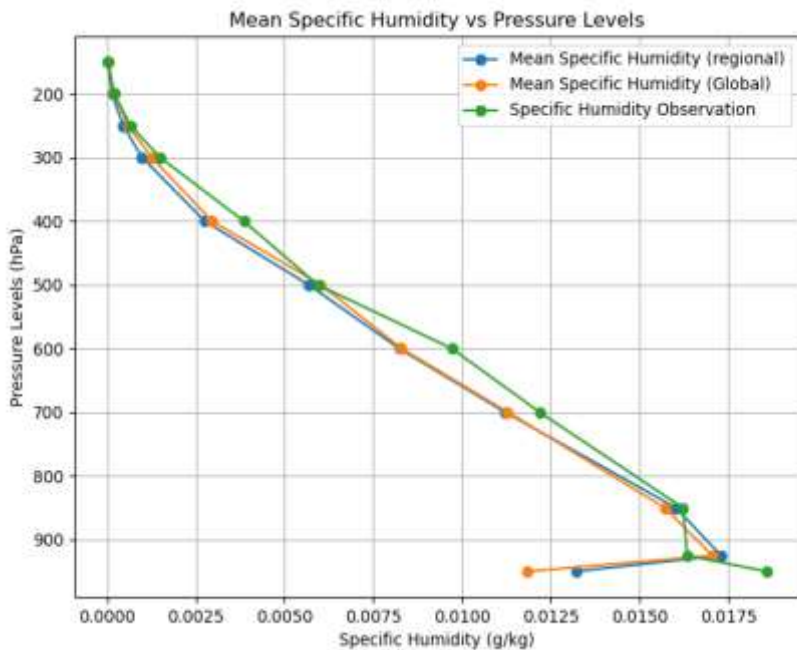


Vertical Profiles of Mean specific humidity Fcst, 19th and 20th August 2023 .

The profiles of mean specific humidity there is a exponential decrease of mixing ratio with Pressure levels was consistent between observation and simulations.

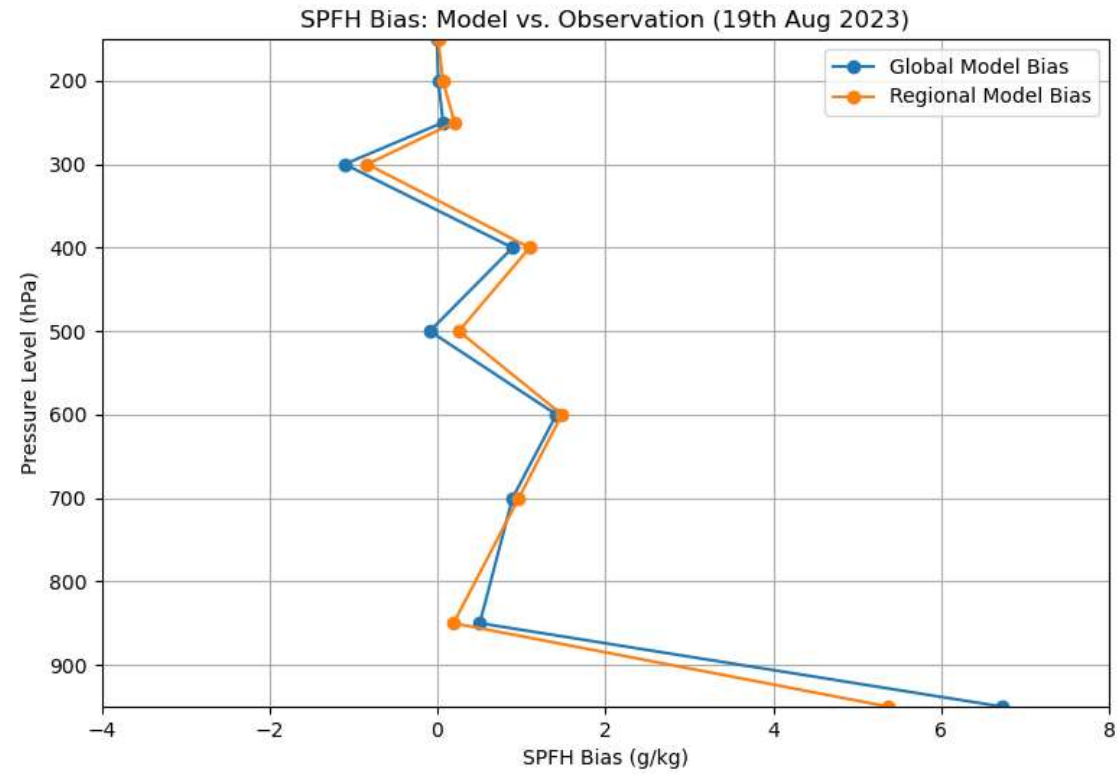
19 th August 2023

20th August 2023



Vertical Specific Humidity bias for NCUM(R) NCUM(G) for 19th August 2023.

Model moist bias can be seen in middle and upper troposphere. .



Conclusions & Further Study

- Apart from bias comparison MAD (Mean absolute difference) and Relative error for the specific humidity will be further calculated for more appropriate conclusions for considering it as the main factor for moist or wet model bias.
- In this work, we have took one station, further we will proceed for other stations also to have more detail investigation.
- Furthermore we will also compute the moist bias with NCUM analysis as well as with taking the satellite data for (UTH) for INSAT 3DR which can be downloaded from MOSDAC(<https://mosdac.gov.in>).
- CAPE Index will be computed for Instability in Atmosphere which in turn will suggest how strongly the air parcel is accelerated upward.
- As computing CAPE will allow to judge how the convective systems contribute to increased Upper Tropospheric Humidity (UTH) by injecting moisture through over shooting cloud tops and Detrainment in the upper troposphere & lower stratosphere.



THANK YOU