

# METOP-C RO Evaluation for NCEP Operations



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## 1. INTRODUCTION

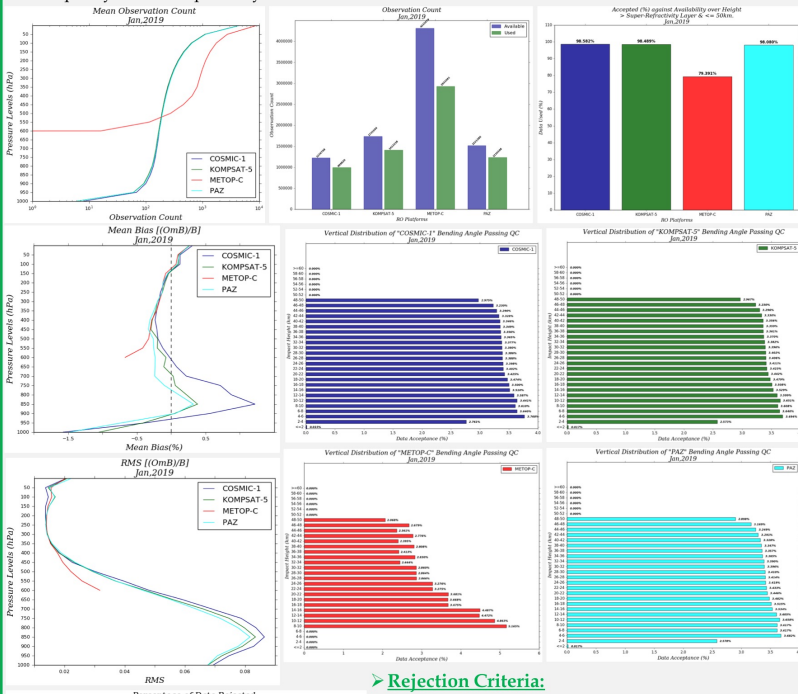
Optimal use of resources and betterment of NWP model forecasts requires regular monitoring and evaluation of assimilated dataset. This is an ongoing effort towards monitoring and assessment of **GNSS (Global Navigation Satellite System) RO (Radio Occultation) observations**. This includes observations from both existing and new GNSS-RO platforms. Assessment of the RO data currently involves only the **Bending Angle** observation. NCEP's GSI (Grid-point Statistical Interpolation) 4D-EnVar analysis scheme & GFS (Global Forecast System) is used as assimilation and forecast system for the experiments.

Observations from new GNSS-RO platforms currently under investigation are:

Platforms	GPS Sensor	Processing Center
KOMPSAT-5 [Korea Multi-Purpose Satellite-5]	IGOR [Integrated GPS Occultation Receiver]	CDAAC, UCAR
METOP-C [Meteorological Operational Polar Satellite - C]	GRAS [GNSS Receiver for Atmospheric Sounding]	ROM SAF, EUMETSAT
PAZ [SEOSAR / PAZ - Satélite Español de Observación Synthetic Aperture Radar]	IGOR + [Advanced GPS Receiver IGOR]	CDAAC, UCAR

## 3. PRE-MINIMIZATION DIAGNOSTICS (DATA ACTUALLY USED FOR ASSIMILATION)

Pre-Minimization diagnostics represent the diagnostics of the observations available for assimilation after quality control imposed by GSI.



### Rejection Criteria:

- Observations are outside the vertical boundary of the sigma levels.
- Observations are at height above 50km. above the ground.
- The  $|\text{ratio} [\text{Innovation Vector} / \text{Obs. Error}] > \text{Gross Error Parameter}$  'or'  $|\text{incremental bending angle}| > \text{a cutoff value}$ .
- Observations are close to or inside model super refractivity layer.
- Observations are below 8km.

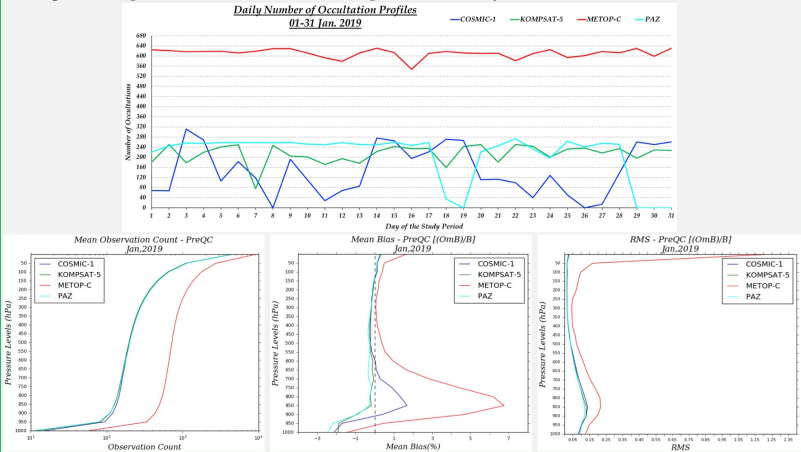
## 2. PRE-QUALITY CONTROL DIAGNOSTICS (DATA AVAILABLE FOR ASSIMILATION)

Pre-Quality Control diagnostics represent the diagnostics of full set of observations as available for operational use.

The observations (O) [here 'Bending Angle'] are evaluated against background information (B) from NCEP's operational 6hr-forecasts.

Bias & RMS diagnostics presented here are **normalized against the model background**.

Diagnostics represents the mean value for the period of January-2019.



## 4. FORECAST SCORE-CARD

Forecast verification of METOP-C involves its assimilation and forecast in cyclic mode, in two phases - **Winter & Summer Cycle**. Winter cycle is presented here.

Diagnostics from the winter cycle covers the period **01-31 January, 2019**.

**RMV Verification Scorecard**

Start Date: 20190101, End Date: 20190131

Height	Temp	Wind	Pressure	Humidity	Cloud
Surface	RMSE	RMSE	RMSE	RMSE	RMSE
850hPa	RMSE	RMSE	RMSE	RMSE	RMSE
700hPa	RMSE	RMSE	RMSE	RMSE	RMSE
500hPa	RMSE	RMSE	RMSE	RMSE	RMSE
300hPa	RMSE	RMSE	RMSE	RMSE	RMSE
200hPa	RMSE	RMSE	RMSE	RMSE	RMSE
100hPa	RMSE	RMSE	RMSE	RMSE	RMSE
50hPa	RMSE	RMSE	RMSE	RMSE	RMSE
20hPa	RMSE	RMSE	RMSE	RMSE	RMSE
10hPa	RMSE	RMSE	RMSE	RMSE	RMSE
5hPa	RMSE	RMSE	RMSE	RMSE	RMSE
2hPa	RMSE	RMSE	RMSE	RMSE	RMSE
1hPa	RMSE	RMSE	RMSE	RMSE	RMSE

## 5. SUMMARY

Daily occultation profiles and Mean Observation Count of METOP-C is higher compared to COSMIC-1, KOMPSAT-5 (only setting profiles) & PAZ.

Pre-quality control diagnostics shows comparatively higher bias and RMS of METOP-C bending angle over levels below 600hPa or 8 km. impact height.

All METOP-C bending angle observations below 8km. impact height are rejected by GSI.

Post-quality control / Pre-minimization diagnostics shows Bias and RMS characteristics of METOP-C above 600hPa similar to the other GNSS-RO platforms.

Significant improvement in Temperature and Vector Wind forecast RMSE is observed over Tropics and Northern Hemisphere at higher atmospheric levels.

Forecast deterioration is observed for temperature forecasts close to the surface over Northern Hemisphere.

Temperature forecasts have higher Bias close to surface and at higher atmospheric levels over Northern Hemisphere and North American region.

## 6. CURRENT STATUS

- The evaluation of METOP-C is ongoing and a summer cycle is needed for proper assessment.
- The necessary steps for inclusion of the METOP-C bending angle in real-time assimilation suite of operational runs are in progress.

## 7. ACKNOWLEDGEMENT

- We thank ROM SAF, EUMETSAT for providing the processed METOP-C GNSS-RO observations.
- We are thankful to CDAAC, UCAR for providing the processed KOMPSAT-5 and PAZ GNSS-RO data.