COSMIC-2/FORMOSAT-7 Product Validation at NESDIS/STAR Using Satellites and Global Radiosonde Observations

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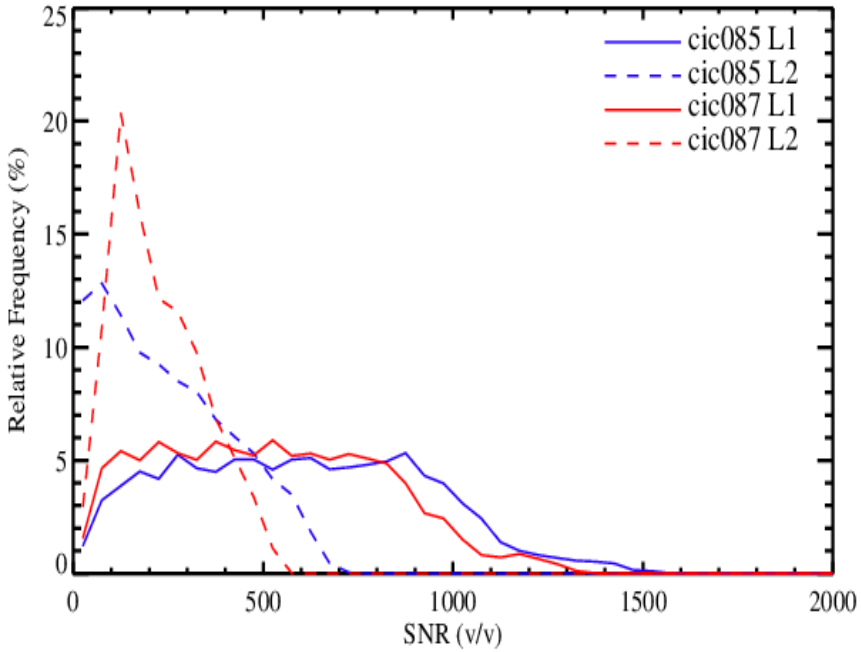
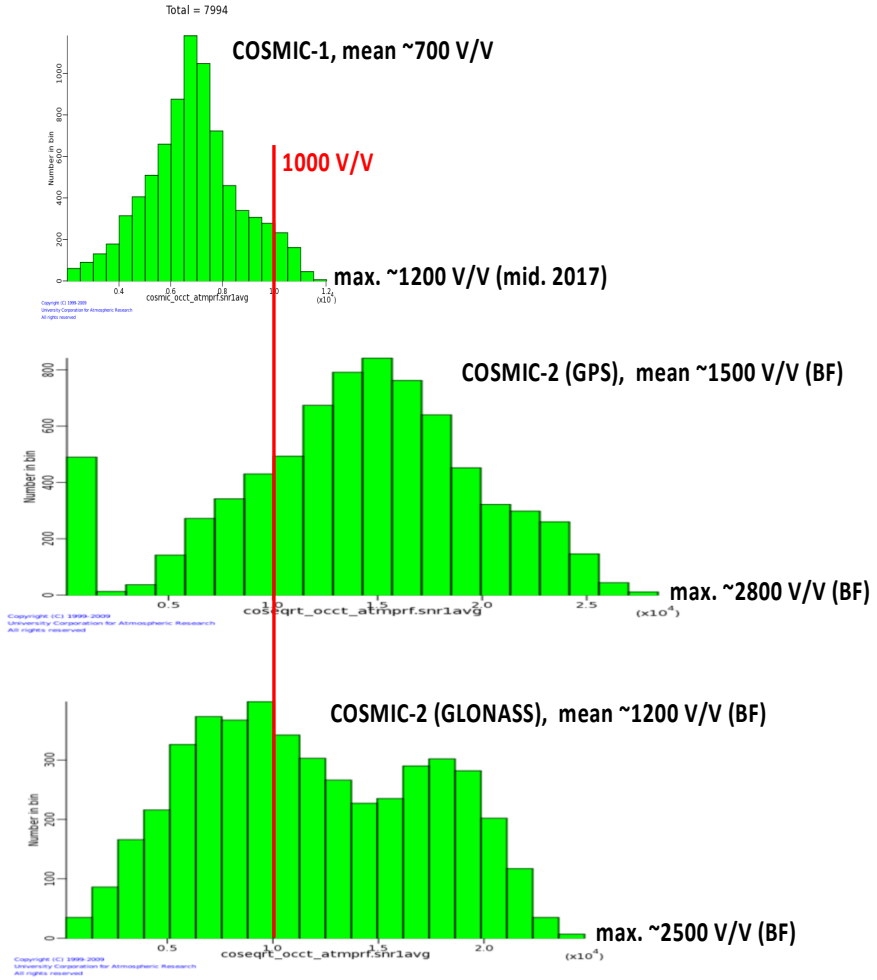
Outline

- Penetration depth
- Precision
- Long-term Stability
- RO-RAOB comparisons
- GFS/GSI O-B results
- LSW
- Conclusions
- Future Study Area

Supporting Materials



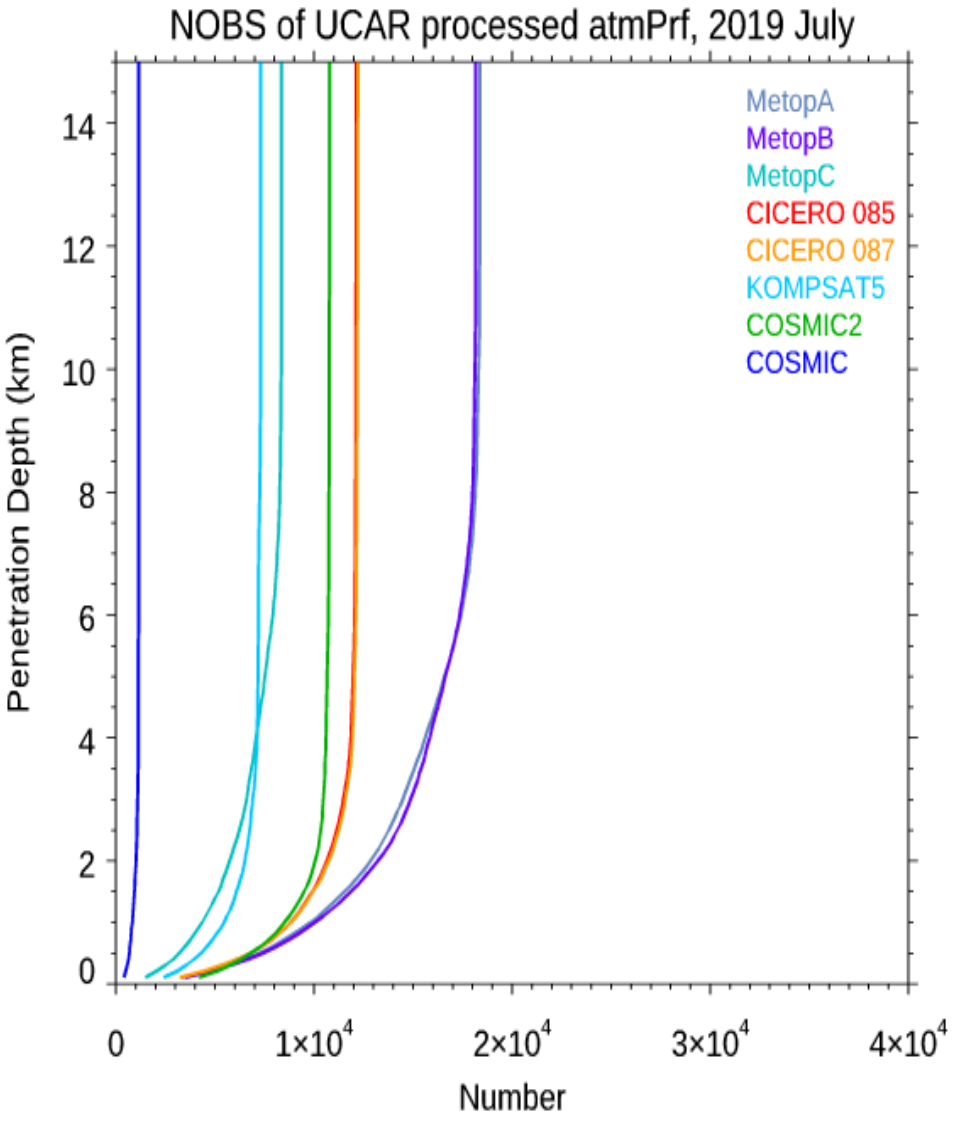
COSMIC-1 vs COSMIC-2 SNRs



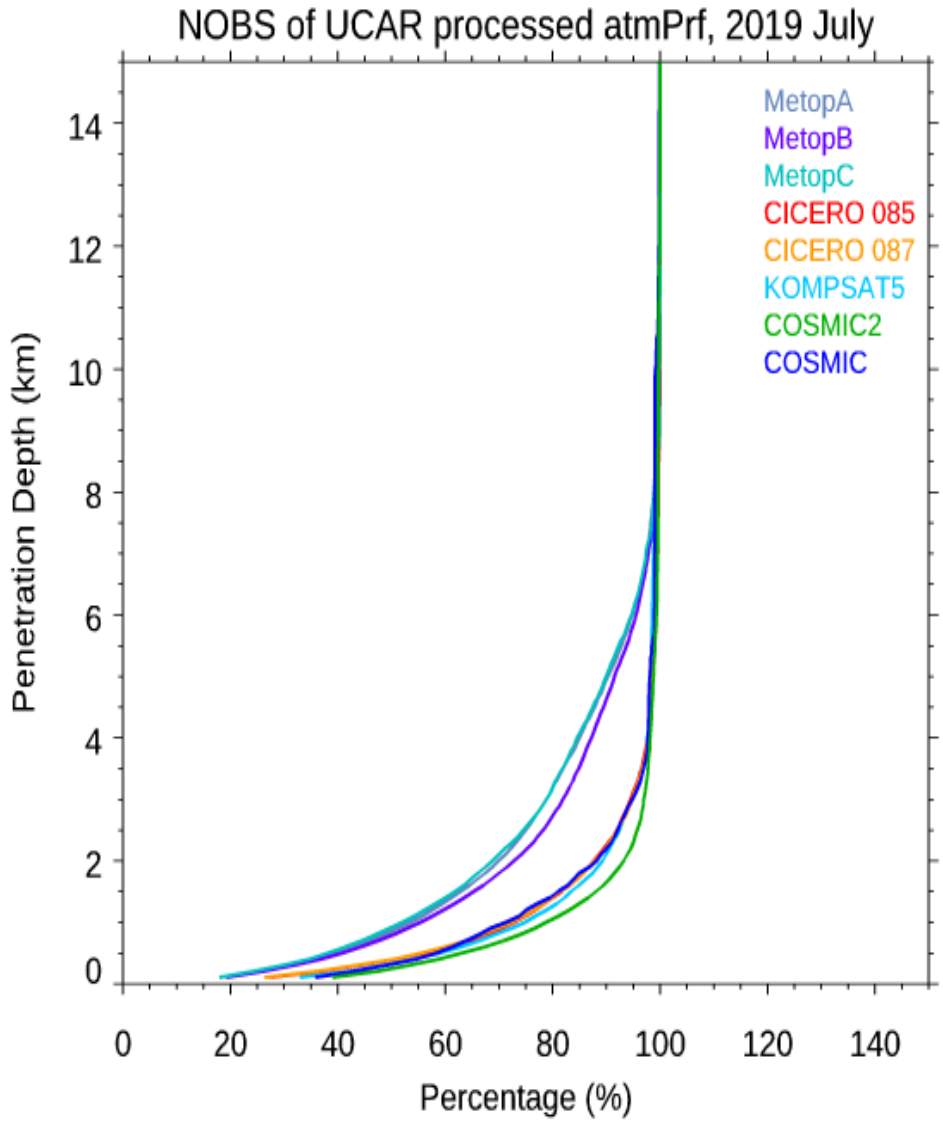
Mean v/v for KOMSAT-5 = 700
Mean v/v for SPIRE = 500

1. Penetration depth : COSMIC-1 and COSMIC-2 and other RO missions

Number of penetration



Percentage of penetration

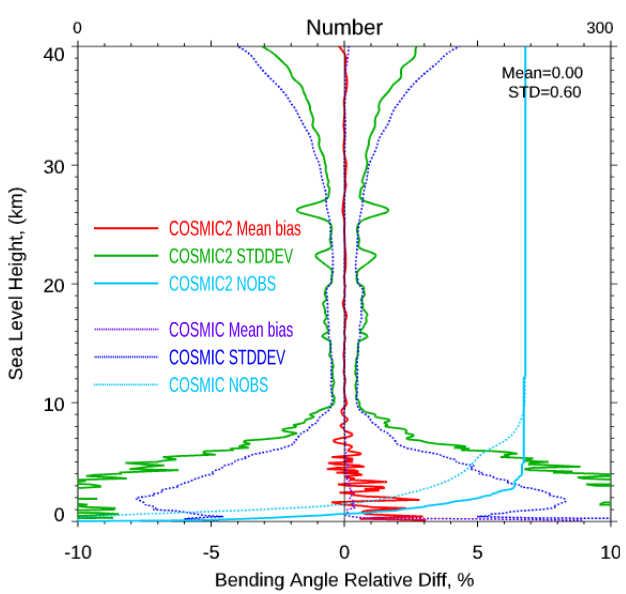


- **The lowest penetration height of 80% of the total data for different RO missions at different latitudinal zones All the data are from July 2019.**

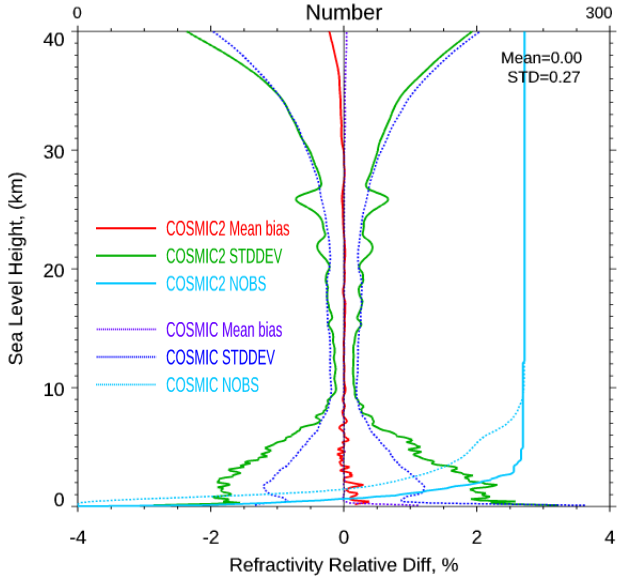
	10N-10S	10N-30N	10S-30S	30N-45N	30S-45S	45N-60N	45S-60S	60N-90N	60S-90S
Metopa	3.2	7.2	4.0	4.9	2.1	3.2	1.2	3.0	3.6
Metopb	2.6	4.5	3.7	4.0	2.0	2.6	1.3	2.6	3.6
Metopc	2.8	4.7	4.0	4.9	1.8	3.2	1.4	3.0	3.5
Cic085	1.3	0.8	1.2	2.3	0.7	1.6	0.4	1.5	2.8
Cic087	1.4	1.6	1.3	2.1	0.7	1.6	0.4	1.6	2.7
Cosmic	1.5	1.2	1.4	1.9	0.6	1.9	0.4	1.5	2.2
Cosmic2	1.2	0.5	1.1	1.8	0.6				
kompsat5	1.7	1.4	1.4	1.8	0.6	1.2	0.3	1.1	2.8

2. Precision : COSMIC-1 and COSMIC-2

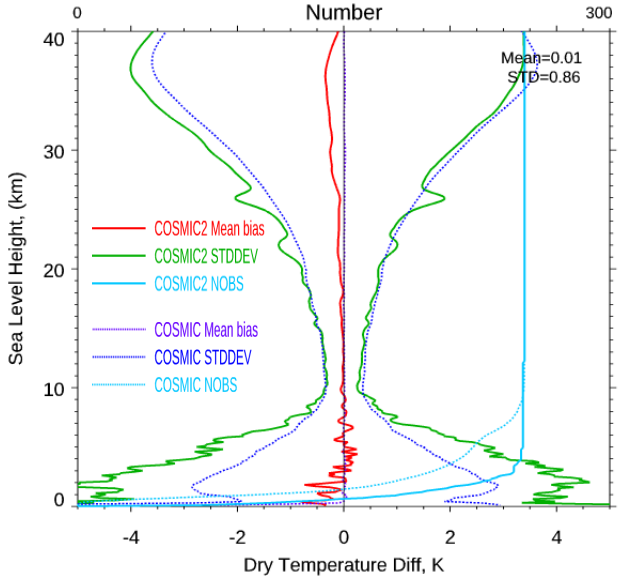
COSMIC2: 2019-07-16 to 2019-07-20, C2E1 and C2E4, in solid line
COSMIC: 2006-04-22 to 2006-10-20, FM3 and FM4, in dashed line,
COSMIC number is scaled to that of COSMIC2



Bending angle
fractional difference (%)



Refractivity
fractional difference (%)

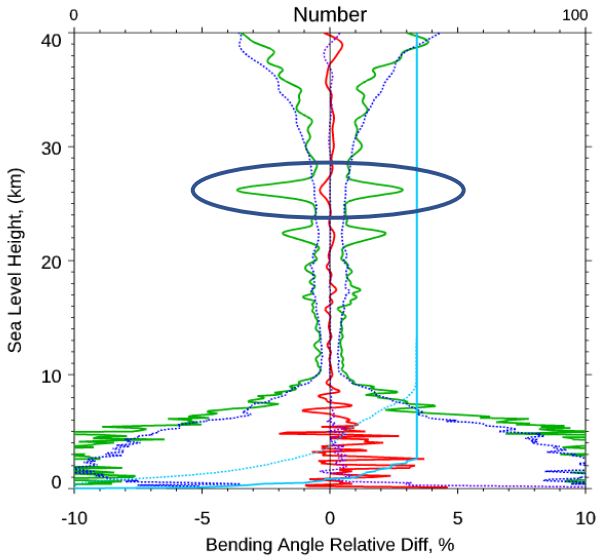


Temperature
Difference (K)

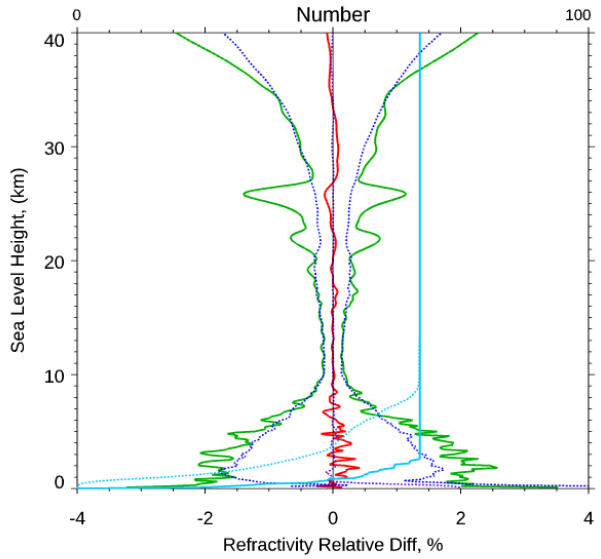
All matches are within 30 km and 30 mins
And are within 45 N and 45 S

COSMIC2: 2019-07-16 to 2019-07-20, C2E1 and C2E4, in solid line
COSMIC: 2006-04-22 to 2006-10-20, FM3 and FM4, in dashed line,
COSMIC number is scaled to that of COSMIC2

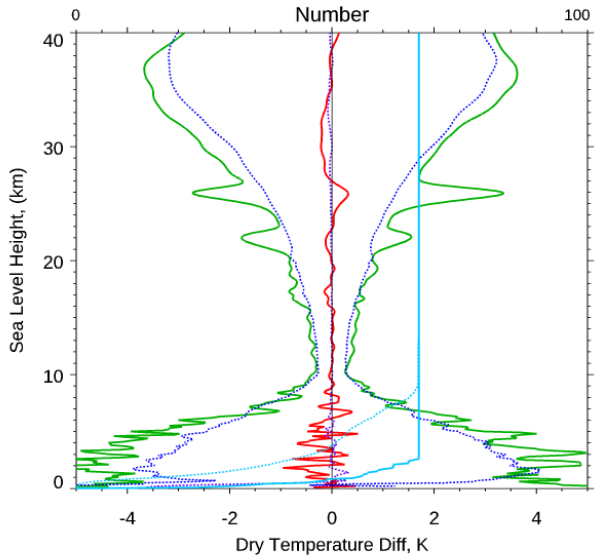
30 N to 10 N



Bending angle
fractional difference (%)



Refractivity
fractional difference (%)

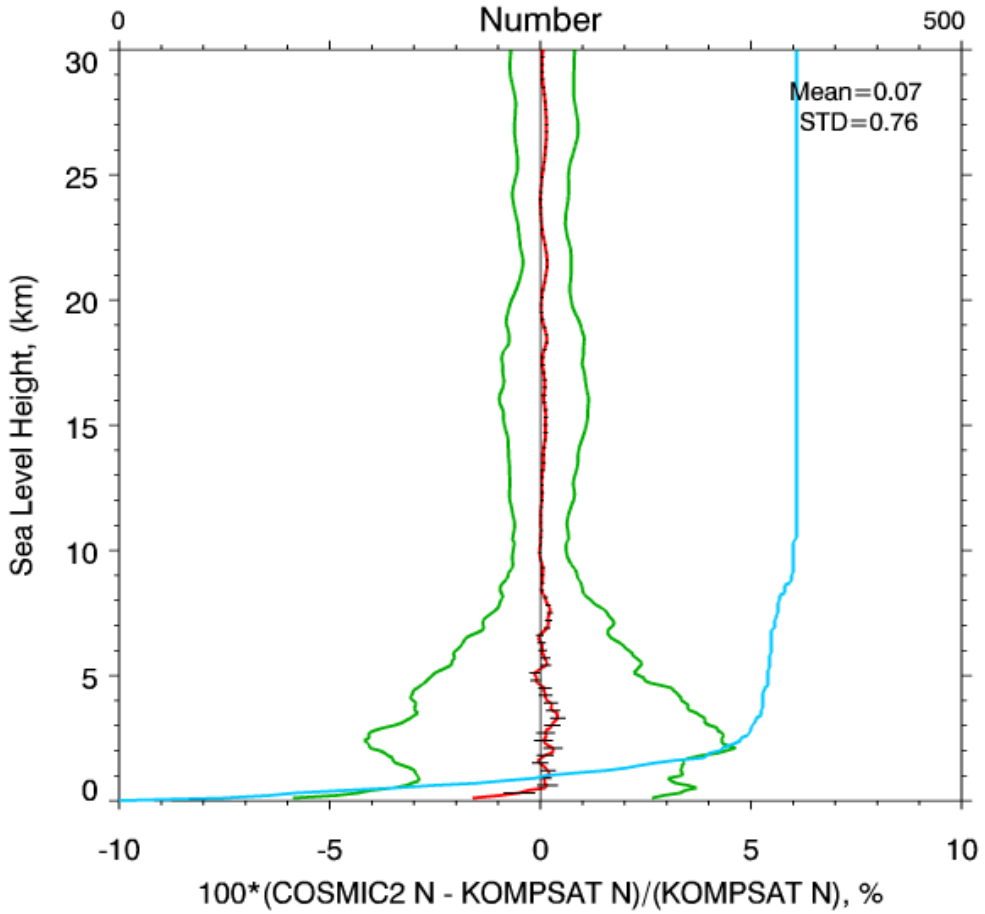


Temperature
Difference (K)

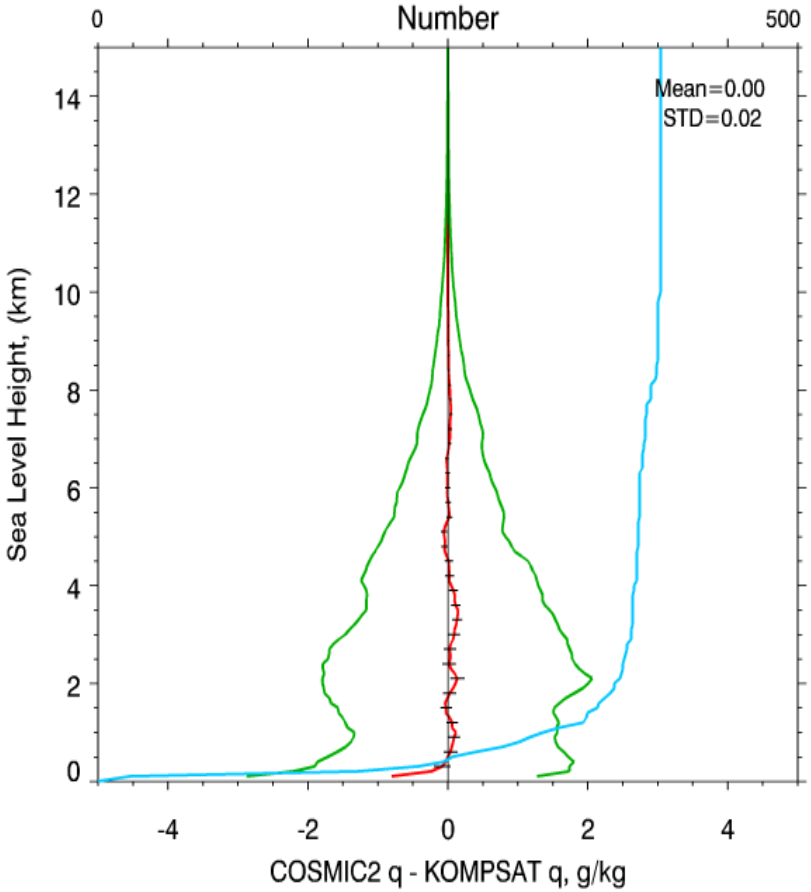
All matches are within 30 km and 30 mins
And are within 45 N and 45 S

3. Checking the long term stability: comparisons between C2 and KOMSAT-5 (within 300 km and 2 hours)

Fractional refractivity differences UCAR KOMSAT-5 vs. UCAR C2

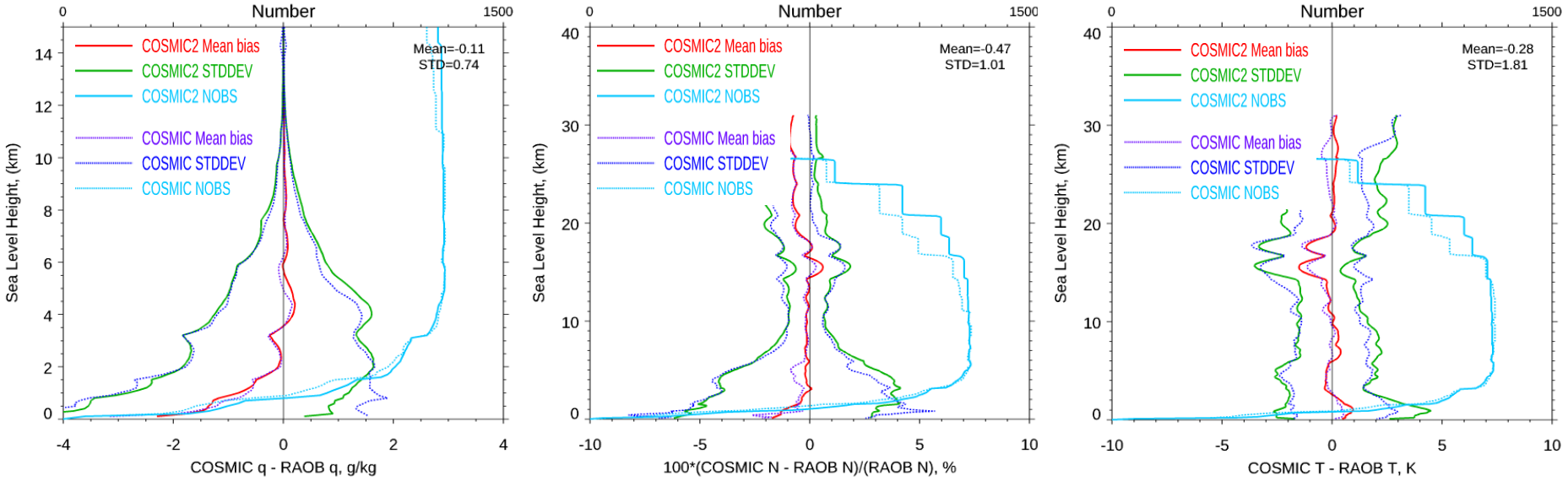


Specific humidity KOMSAT-5 vs. COSMIC-2



4. COSMIC-2/COSMIC vs. RAOB

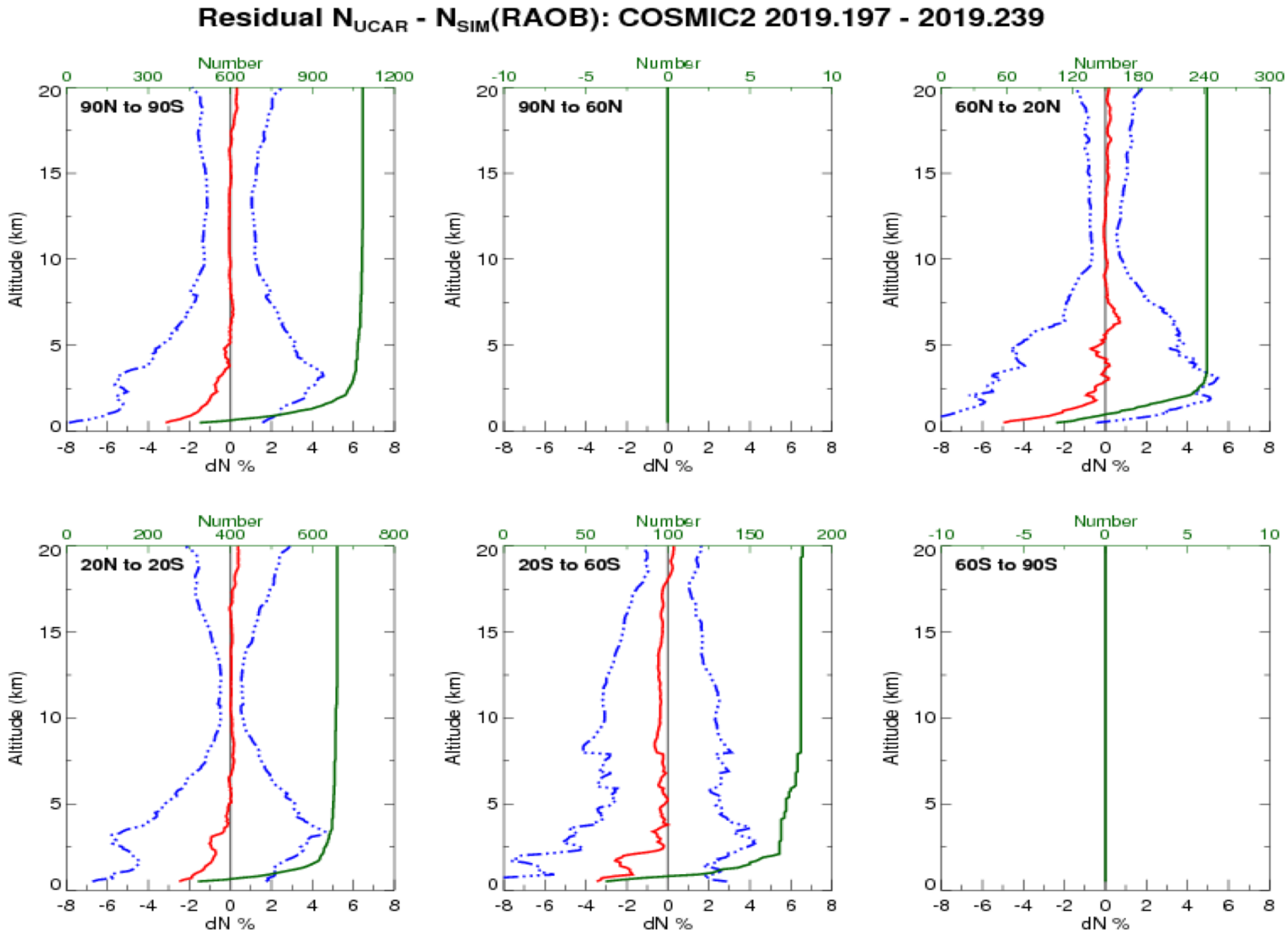
COSMIC2: Oct 2019, in solid line
COSMIC: all Oct from 2010 to 2019, in dashed line
number is scaled to those of COSMIC2



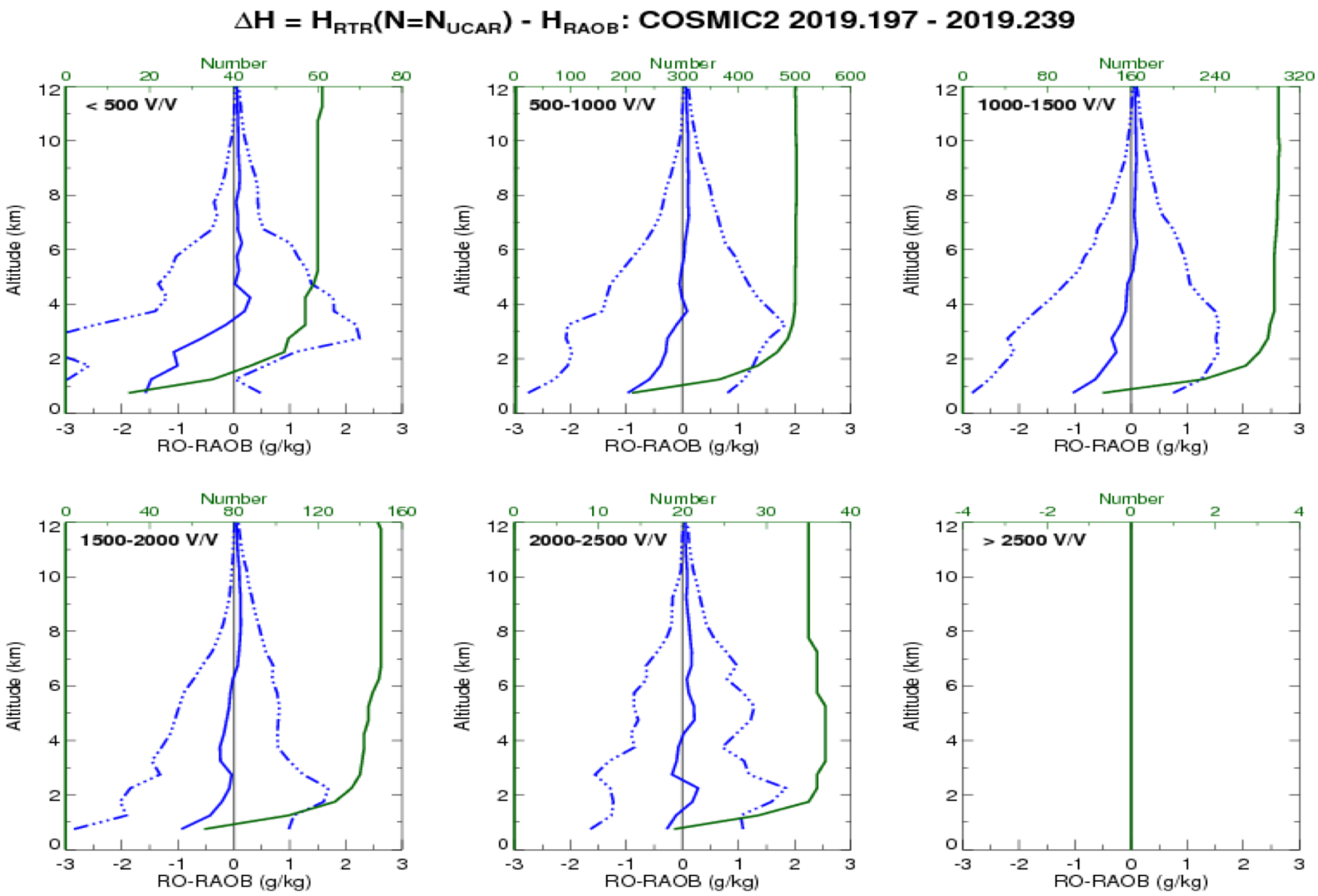
COSMIC-2 vs. RAOB RS41
Within 300 km and 2 hours
Within 45 N and 45 S

UCAR COSMIC2 N – RAOB N

N_{UCAR}



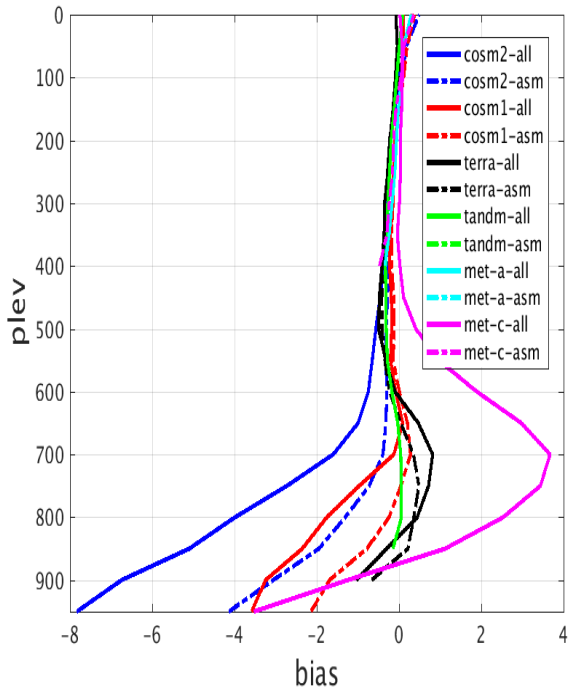
UCAR COSMIC 2 W – RAOB W



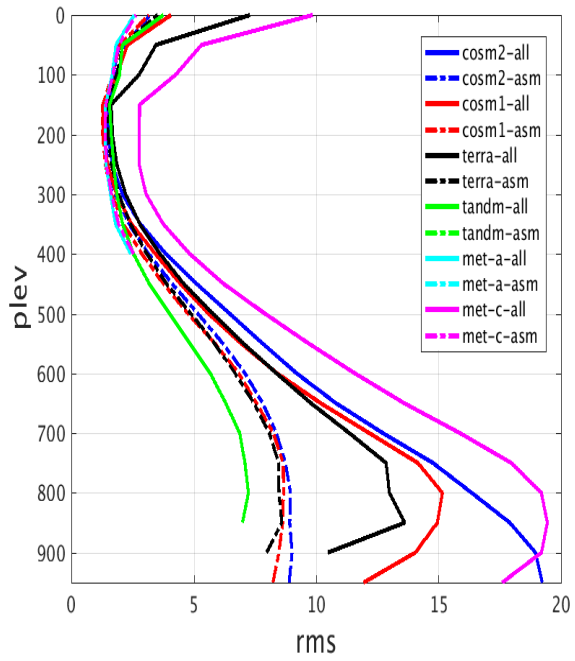
5. COSMIC-2/COSMIC vs. GFS-6 hr forecast

extra-tropics north' [30, 45] Oct. 2020

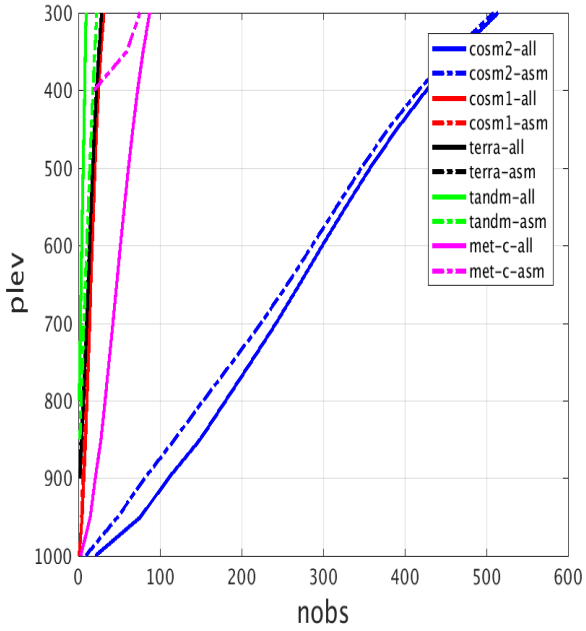
Bias



RMS



Obs Number

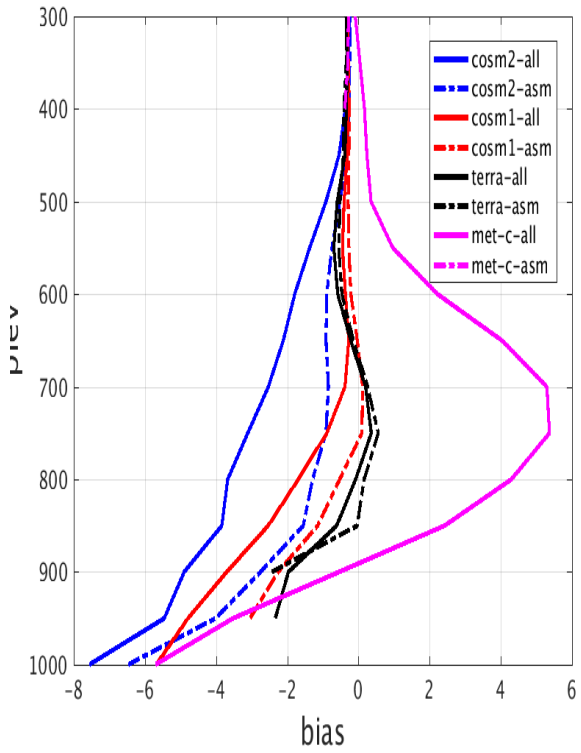


Rejection Criteria:

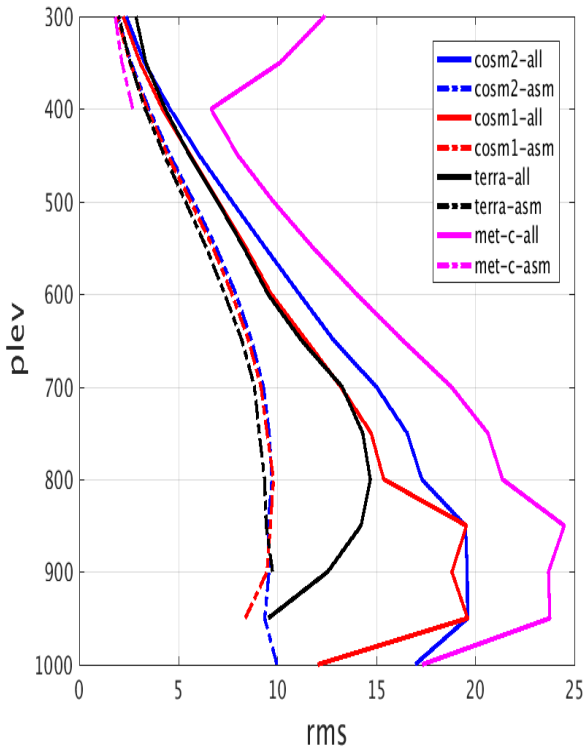
1. Observation is outside the vertical boundary of the sigma levels.
2. Observation is at a height above 50 km. from the ground.
3. [incremental bending angle > a cutoff value].
4. Observation close to or inside model SR(Super Refractivity) layer.
5. Observations below 8km. are rejected.

extra-tropics south' [-30, -10]

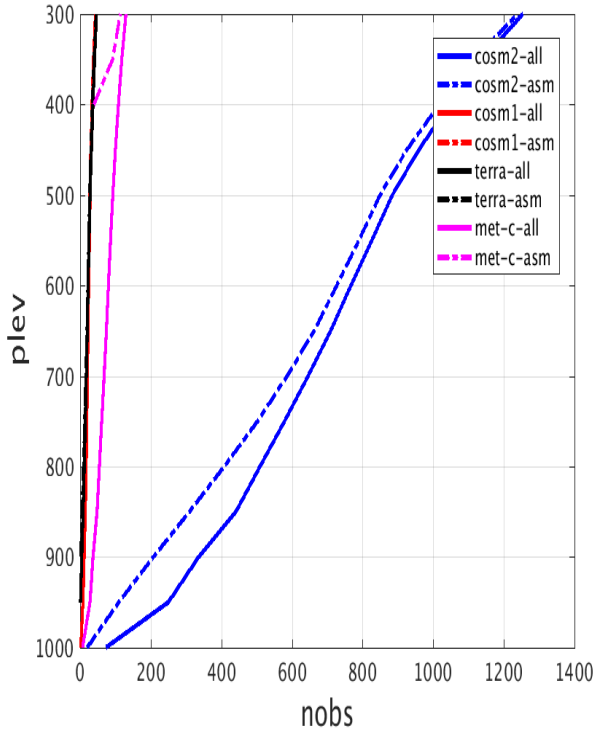
Bias



RMS



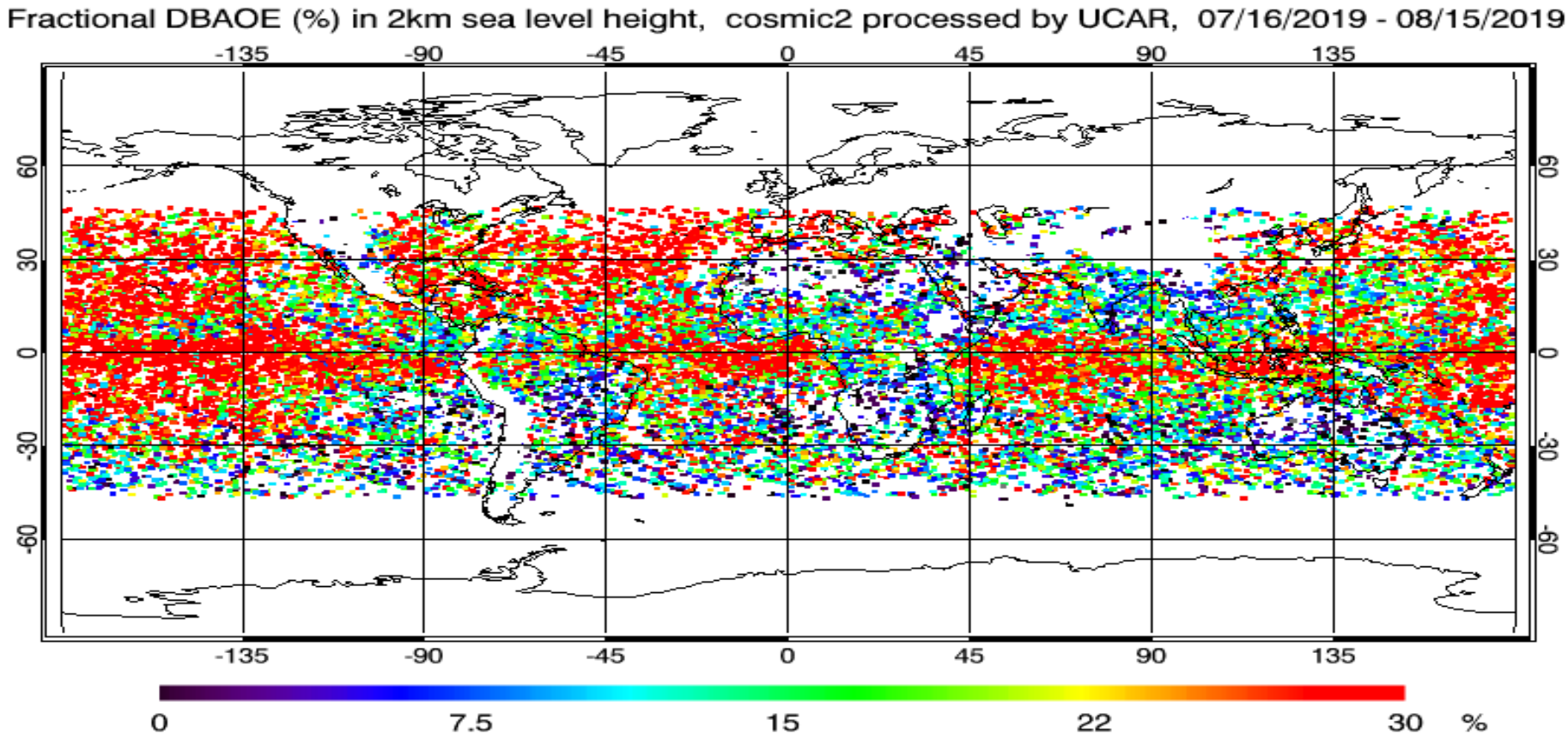
Obs Number



6. Estimate of observation uncertainty Fractional DBAOE comparisons

Fractional DBAOE is defined as 100% x LSW/2 / bending angle

COSMIC2

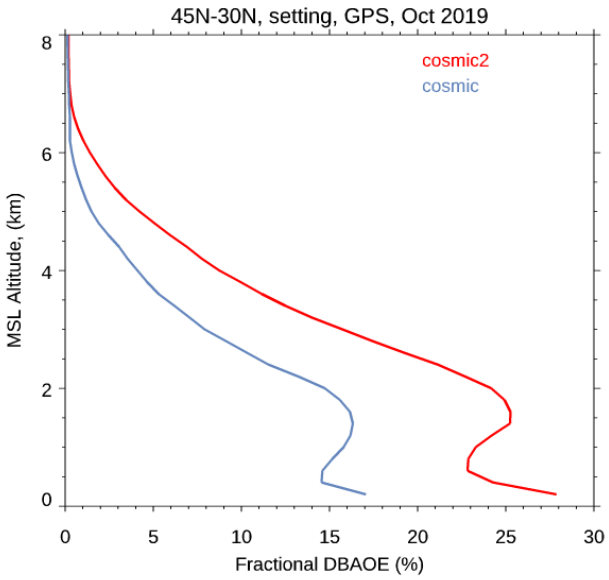


Fractional DBAOE comparisons

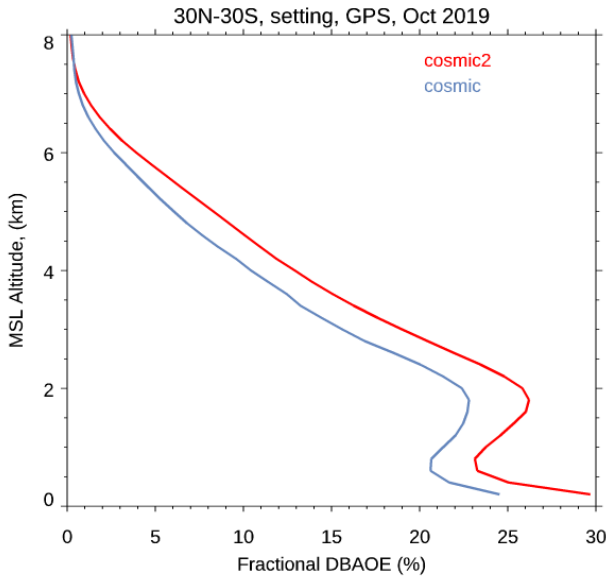
Fractional DBAOE is defined as 100% x LSW/2 / bending angle

Mean Fractional DBAOE, Oct 2019

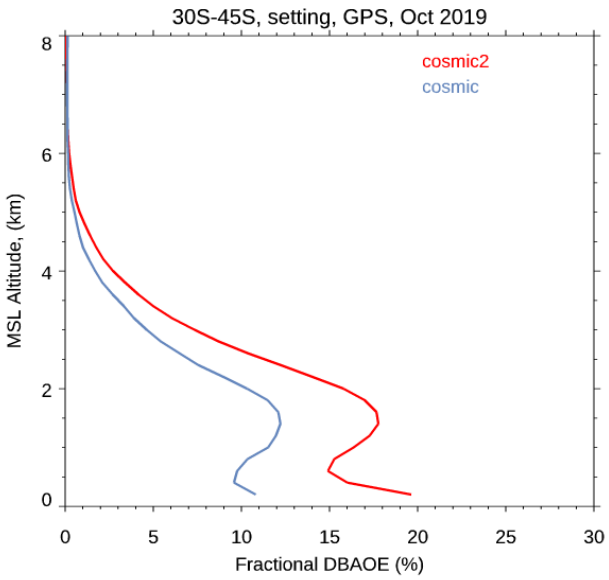
45N-30N



30N-30S



30S-45S



Fractional DBAOE comparisons 30N – 30S

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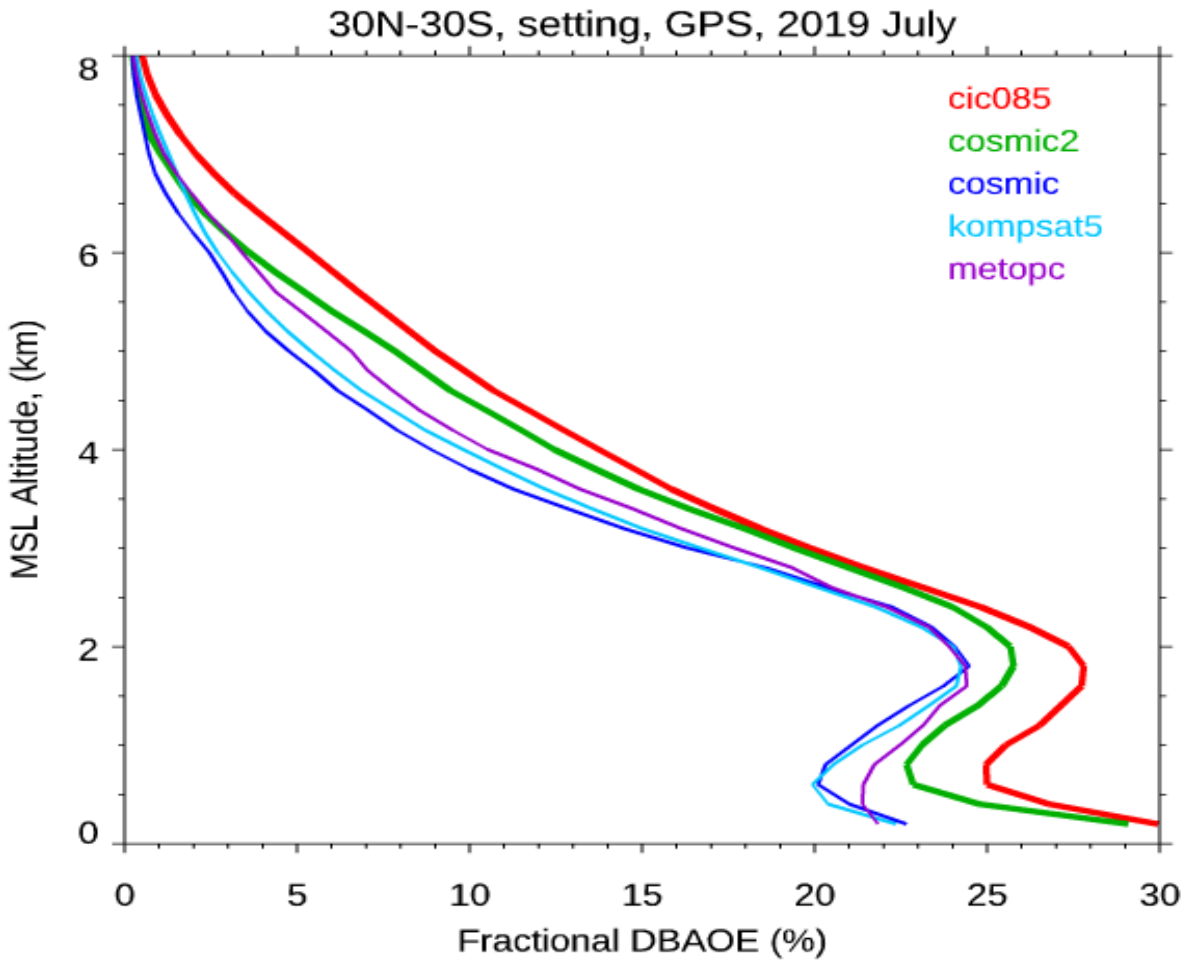


Conclusions

We are sure

1. COSMIC-2 penetration depth is slightly better (~0.2 – 0.5 km) than COSMIC

2. Stability : COSMIC-2 (launched in 2019/06) data is very consistent with KOMSAT-5 (launched in 2011)

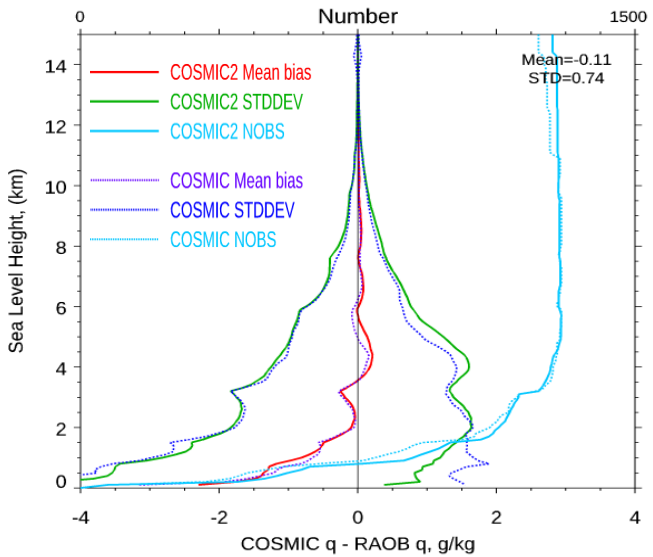
3. Accuracy : C2 vs. RS41 has a similar biases and std as those from COSMIC

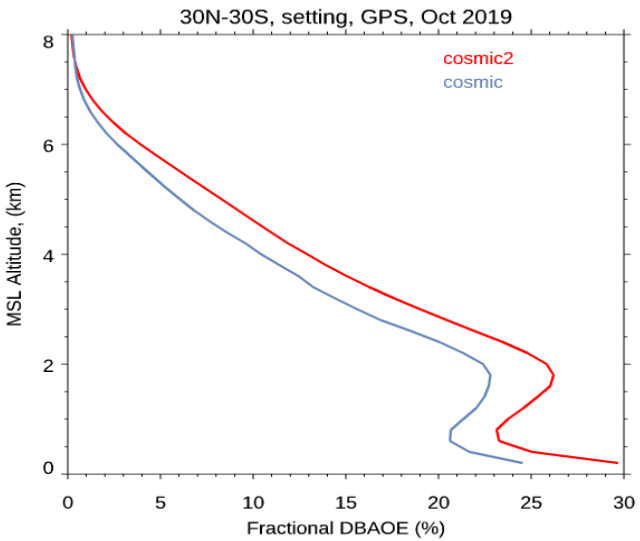
4. O-B results show that C2 seems has slightly larger uncertainty (O-B)/B before and after comparing to Similar comparisons for C1.

We are mostly sure that

1. COSMIC-2 observation uncertainty below 10 km seems 10%-30% larger comparing to COSMIC

2. The LSW for COSMIC-2 is larger than that from COSMIC-1.





Future Study Area

1. Conduct studies to demonstrate whenever the deeper COSMIC-2 penetration help for PBL H detection (penetration depth for other RO missions is only slightly higher)

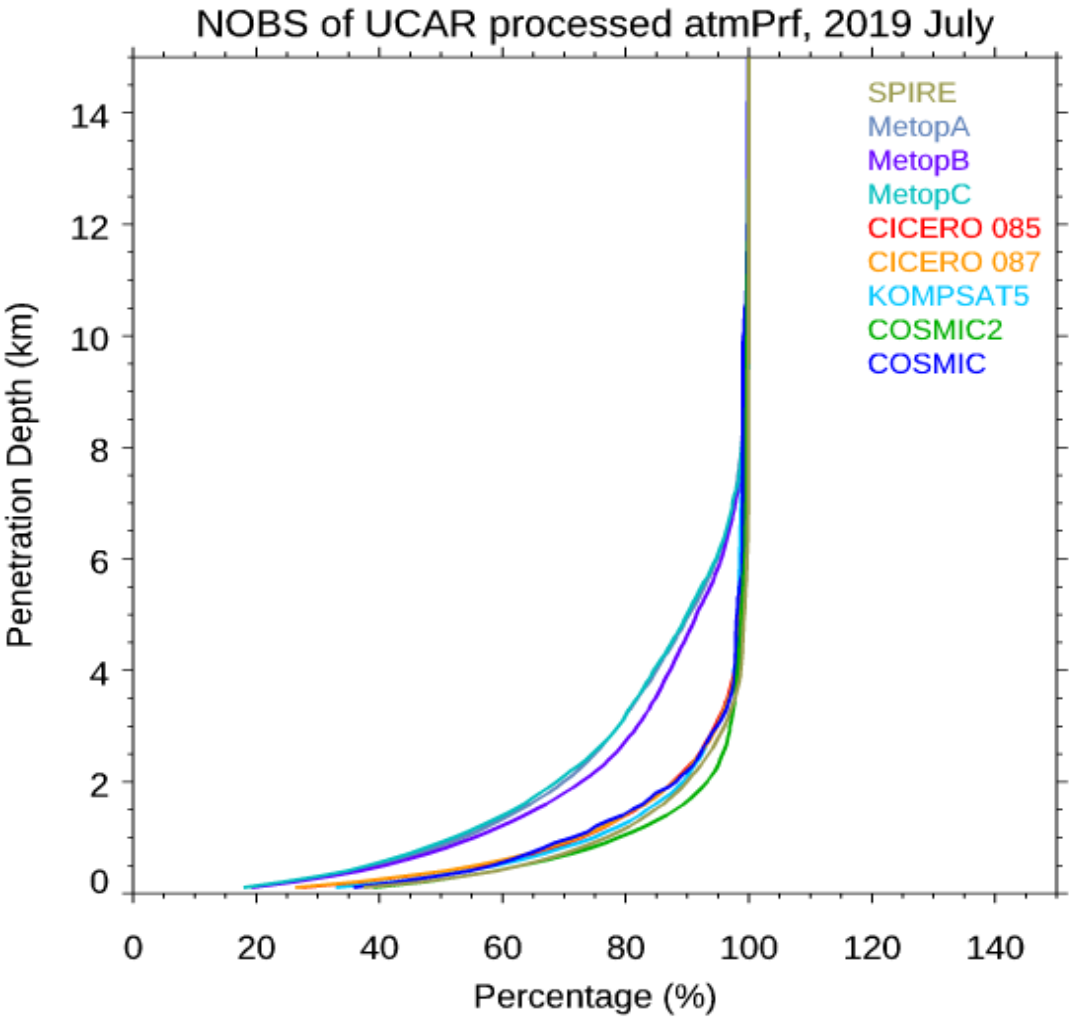
2. Studies to show how SNR will affect the bias and uncertainty especially in the lower tropical troposphere

3. Continue to quantify the SNR related biases comparing to RAOB, IR, and MW data

4. Develop the optimal method to methods to correct COSMIC-2 observation biases and working with JCSDA, EMC, and CWB to ensure the optimal usage of RO data from COSMIC-2 (CWDP and other all available RO missions).

5. Continue to process and re-process COSMIC-2 and other RO data and improve the STAR RO ICVS long term monitoring functions for RO data

Summary



Summary

	10N-10S	10N-30N	10S-30S	30N-45N	30S-45S	45N-60N	45S-60S	60N-90N	60S-90S
Metopa	3.2	7.2	4.0	4.9	2.1	3.2	1.2	3.0	3.6
Metopb	2.6	4.5	3.7	4.0	2.0	2.6	1.3	2.6	3.6
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Cosmic	1.5	1.2	1.4	1.9	0.6	1.9	0.4	1.5	2.2
Cosmic2	1.2	0.5	1.1	1.8	0.6				
spire	1.1	2.2	1.1	2.1	0.5	1.3	0.3	1.2	2.7
kompsat5	1.7	1.4	1.4	1.8	0.6	1.2	0.3	1.1	2.8