Assessment of GRAS ionospheric measurements from MetOp-A end-of-life testing campaign

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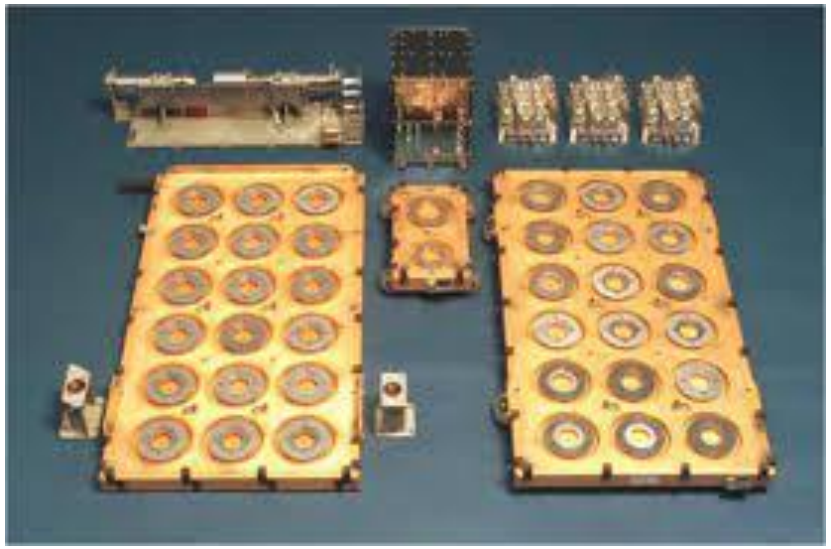
MetOp-A end of life experiment campaign

600 km extension	300 km extension
DOY 197 – 239,	DOY 175-196 and DOY 240 – 253
15 Jul – 26 Aug, 2020	23 Jun – 14 Jul, 27 Aug – 9 Sep, 2020

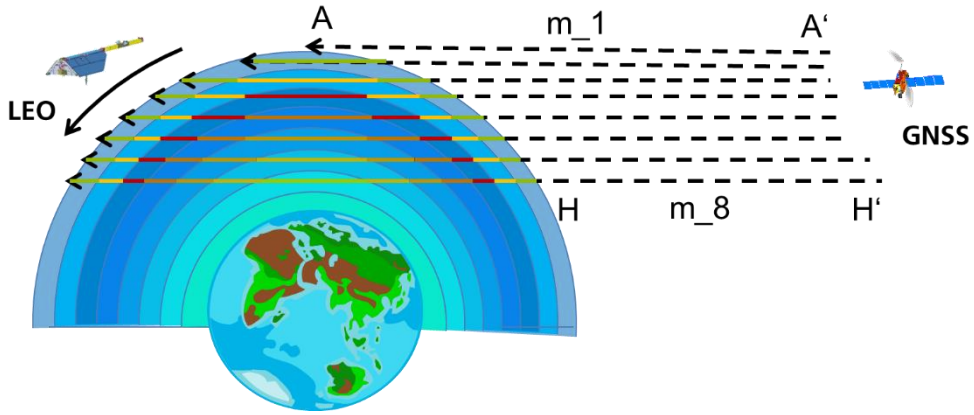
- Ionospheric measurements were truncated at 600 / 300 km height although the Met0p-A was orbiting at about 800 km altitude



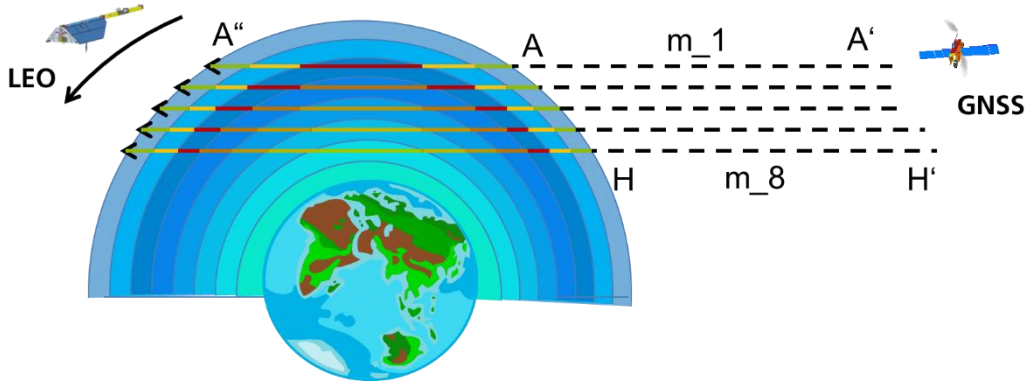
GRAS (GNSS Receiver for Atmospheric Sounding) instrument

MetOp-A life time:
Oct 2006 – Nov 2021

What are radio occultation truncated measurements?



RO geometry without data truncation



RO geometry with data truncation

Adaptive topside ionosphere/plasmasphere model technique

It is a model assisted technique where the topside ionosphere and plasmasphere above the LEO orbit height are modelled by a Chapman layer function superposing with an exponential decay function representing the plasmasphere.

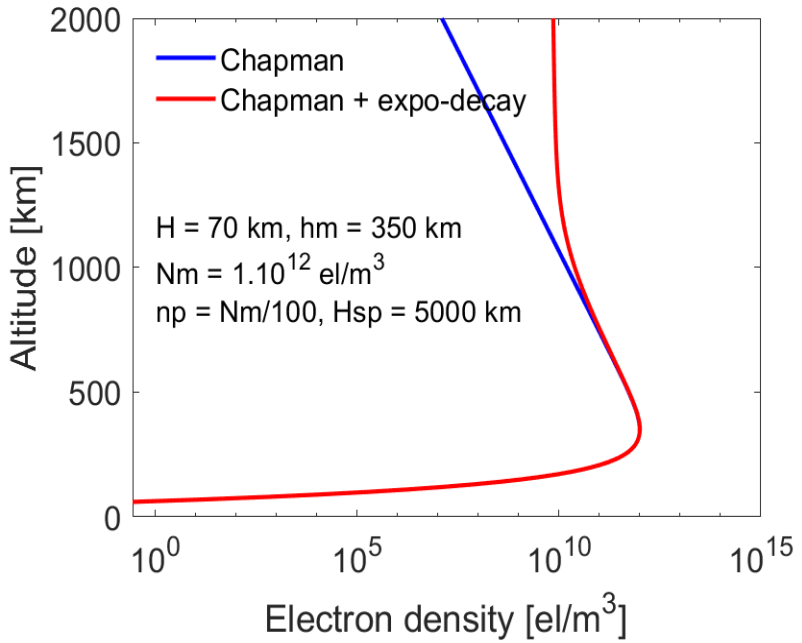
$$N_e(h) = N_{eF} + N_{eP}$$

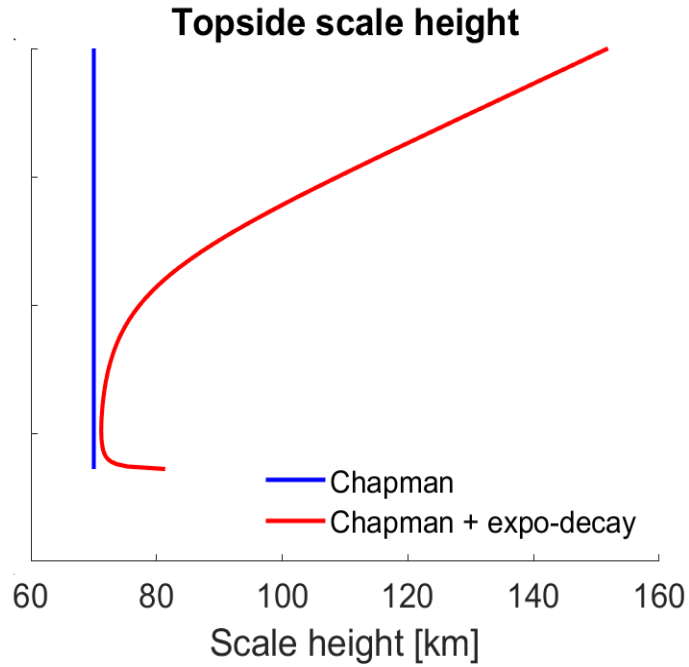
$$N_{eF} = Nm \cdot exp\left(0.5\left(1 - z - exp(-z)\right)\right)$$

$$N_{ep} = np \cdot exp\left(-z_p\right)$$

$$z = \frac{h - hm}{Hs}$$

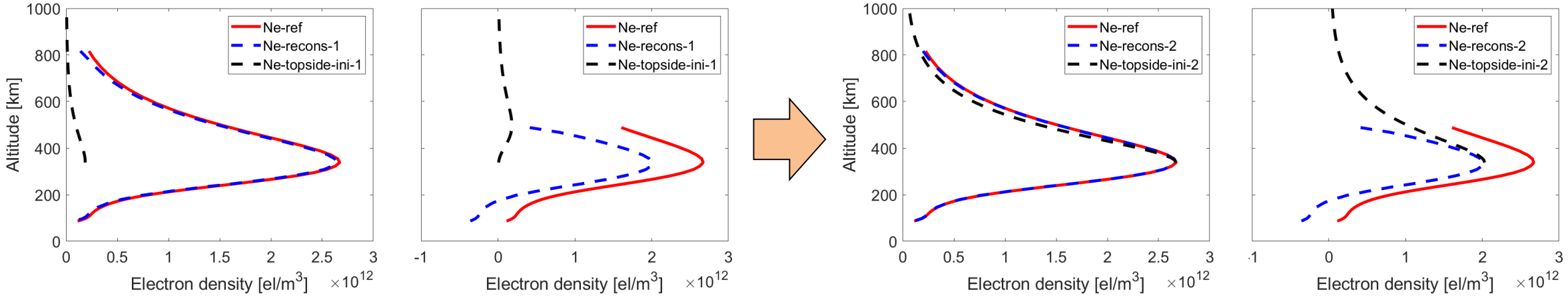
$$z_p = \frac{h - hm}{Hsp}$$



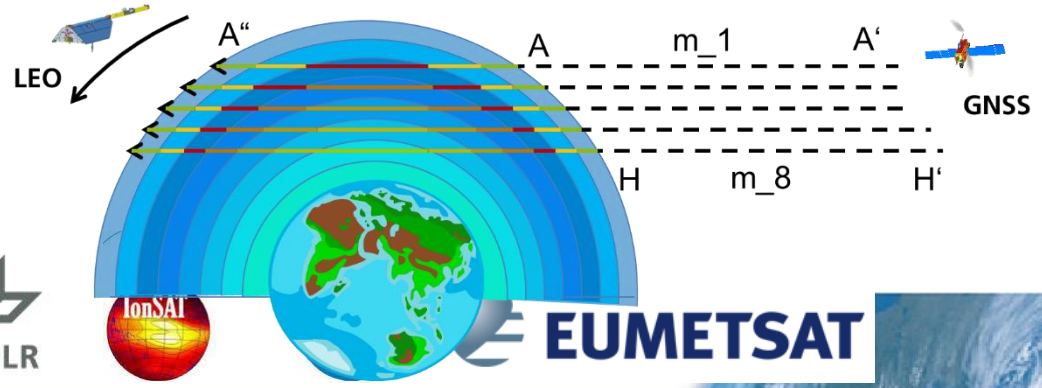


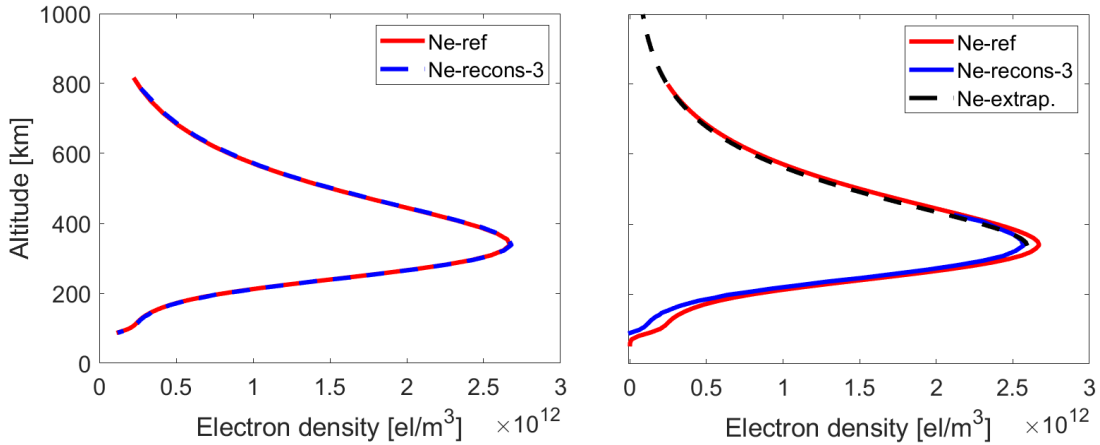
Simulation results with known reference

In each case left panel shows RO inverted profiles for a full dataset and right panel shows for a truncated dataset



Step-6: TEC correction for AA' and A"A segments is applied. Another Abel inversion is performed and an updated electron density profile is obtained.





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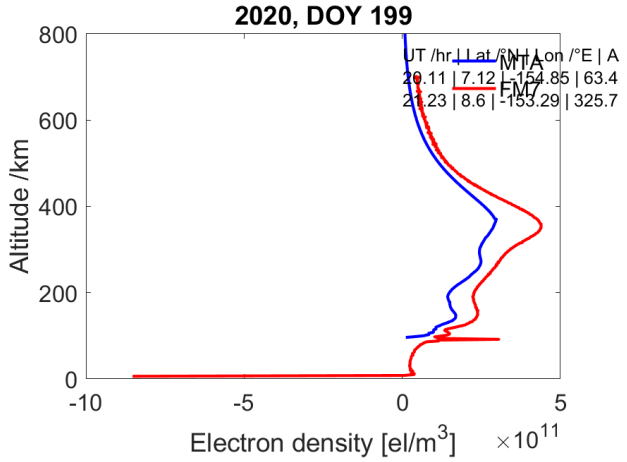
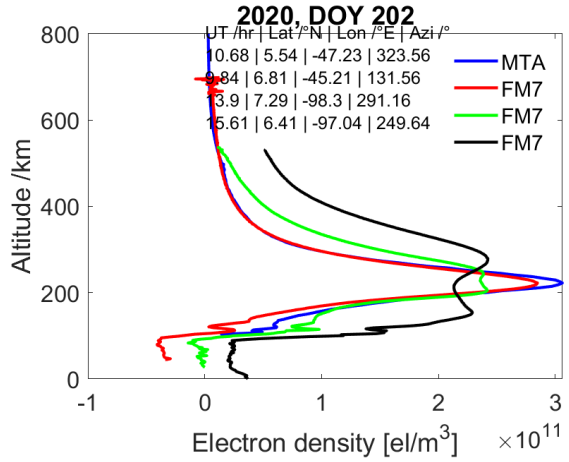
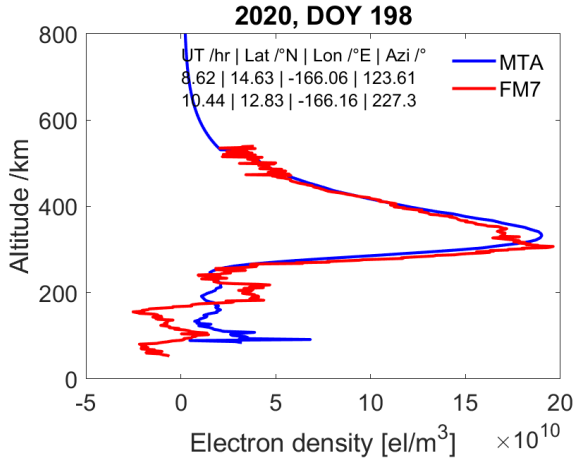
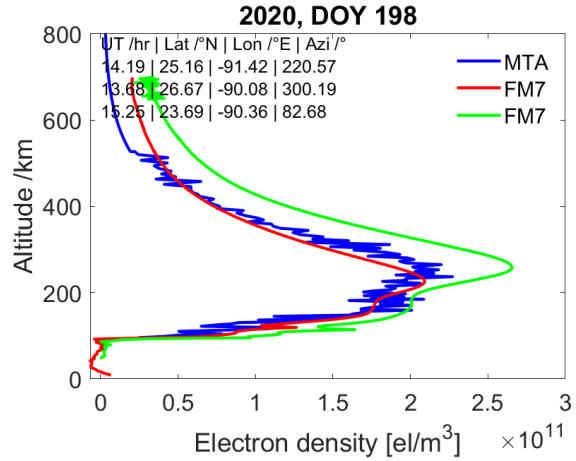
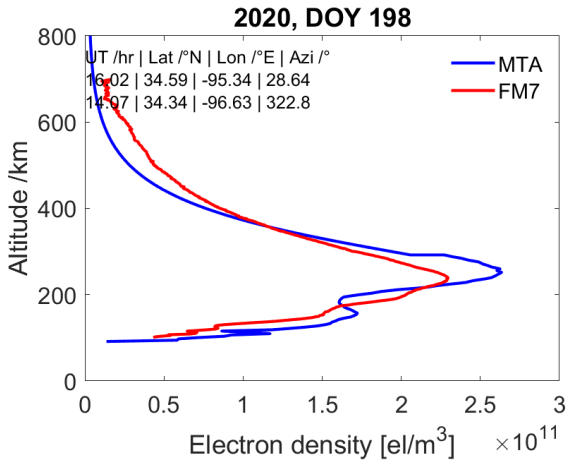
Examples of retrieved MetOp-A electron density profiles

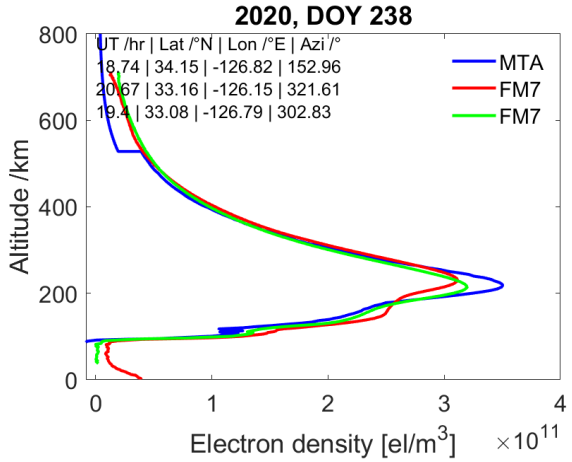


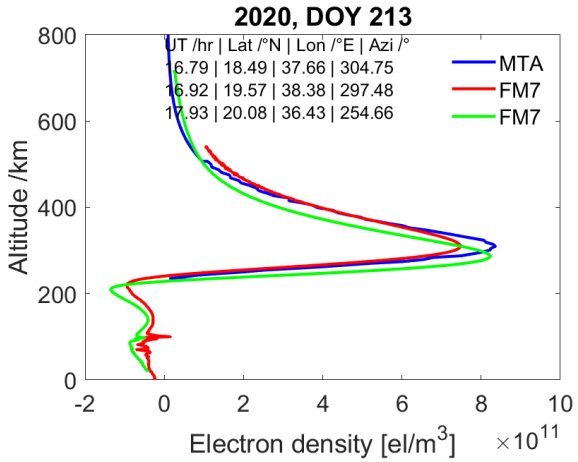


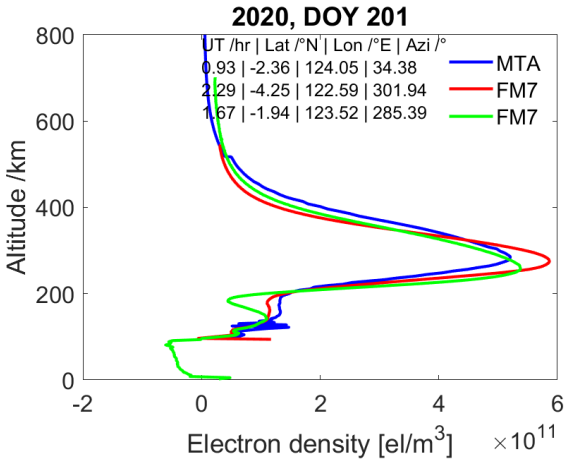




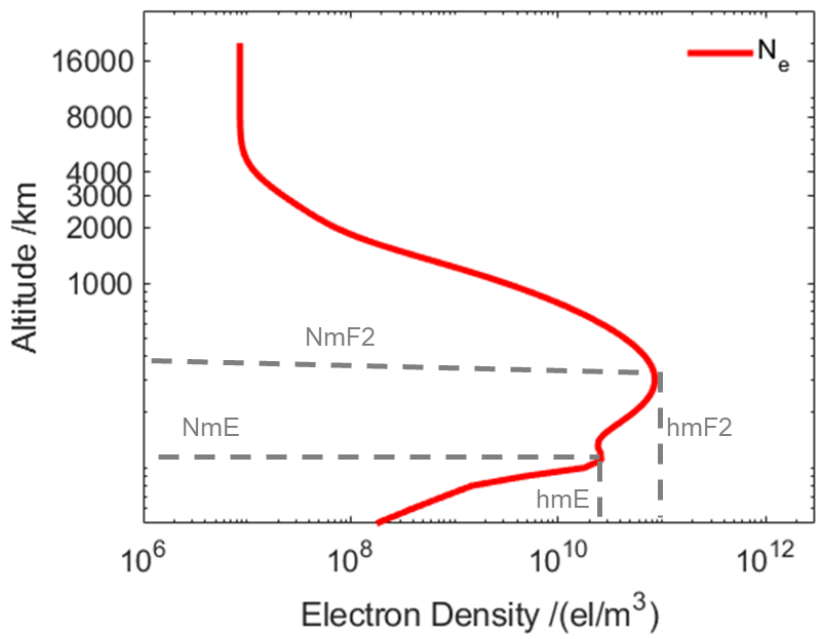








Validation of GRAS RO electron density retrievals

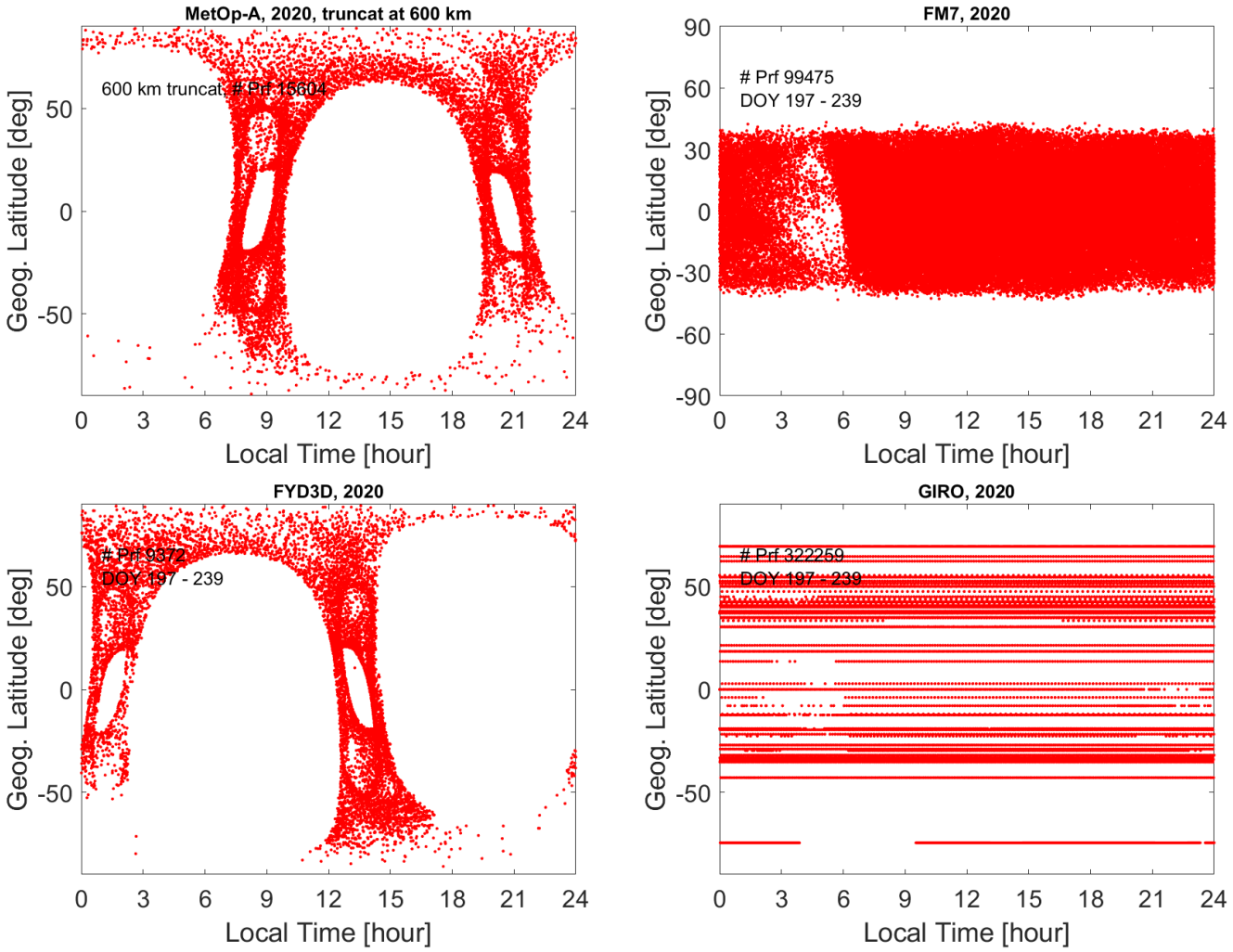


Validation strategy

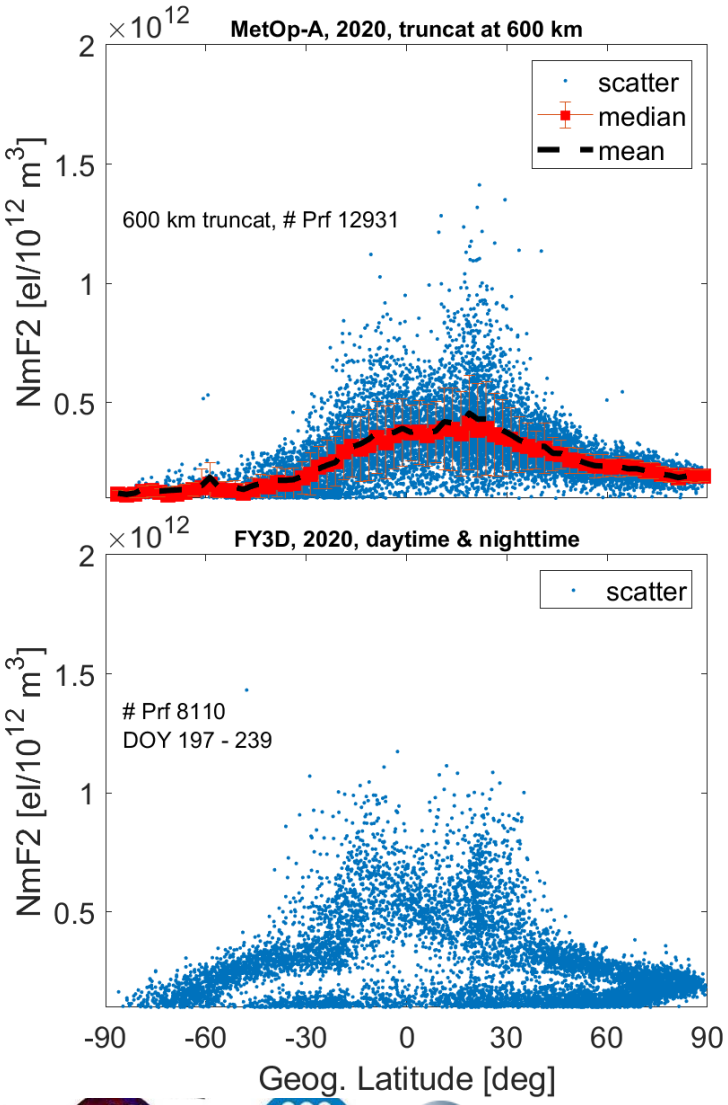
- Validations are separately done for MetOp-A Ne profiles which are retrieved from truncated RO data at 600 km and 300 km height
  - In each case profile peak parameters (e.g., NmF2, hmF2, NmE and hmE) are compared with the corresponding peak parameters from **COSMIC-2, Fengyun-3D and ionosonde data of GIRO network**
  - Comparisons between peak parameters are done using with and without co-location criteria
  - For co-located profiles, comparison is also done for full profiles (i.e., at different impact heights)

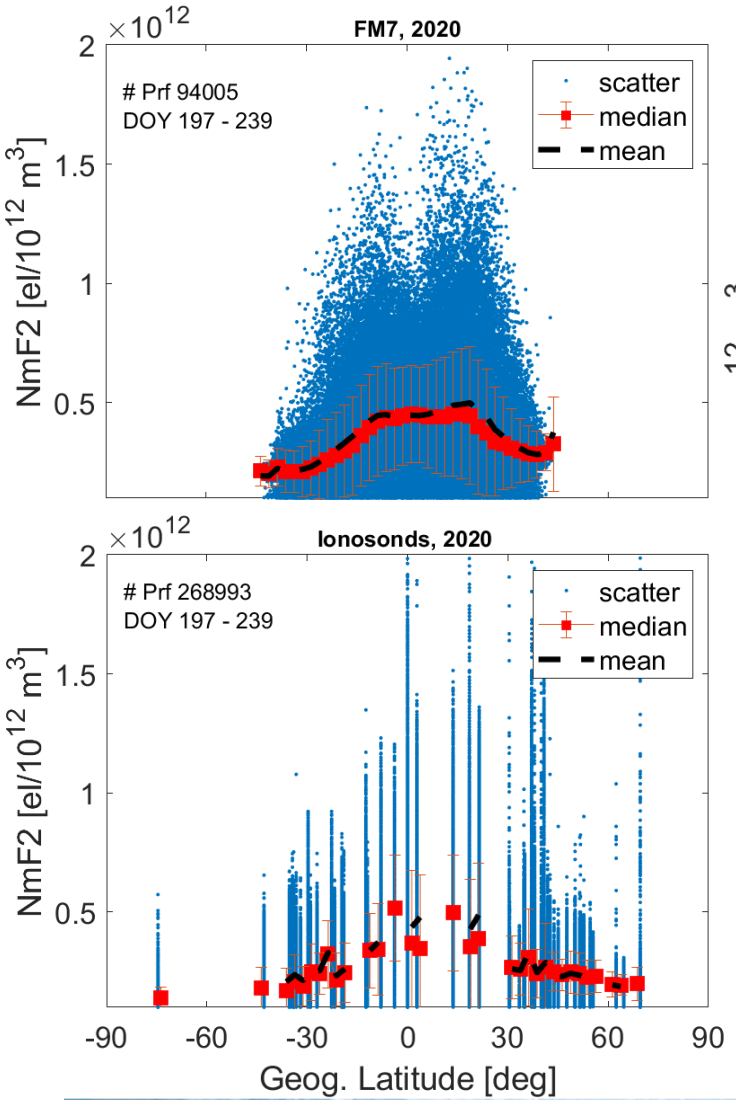
Validation of GRAS RO electron density retrievals

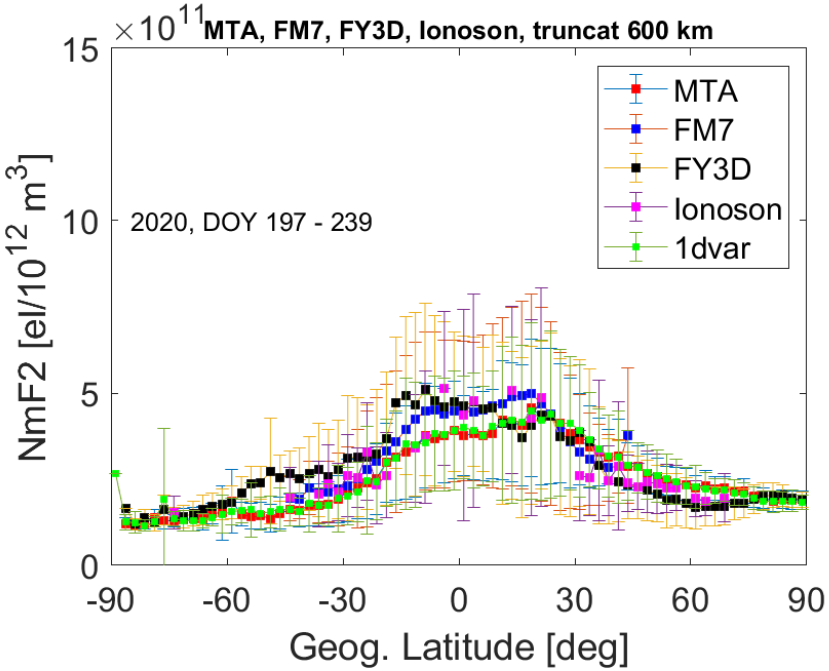
600 km extension campaign:
15 Jul – 26 Aug 2020



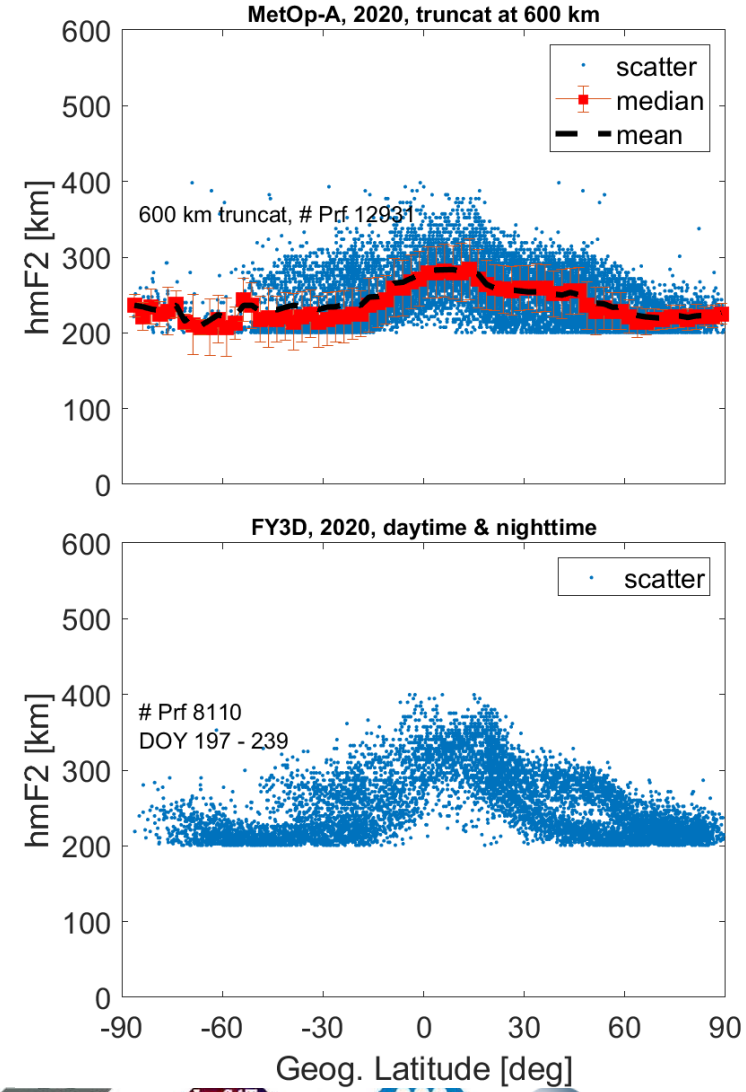
600 km experiment: peak density NmF2 comparison, no colocation

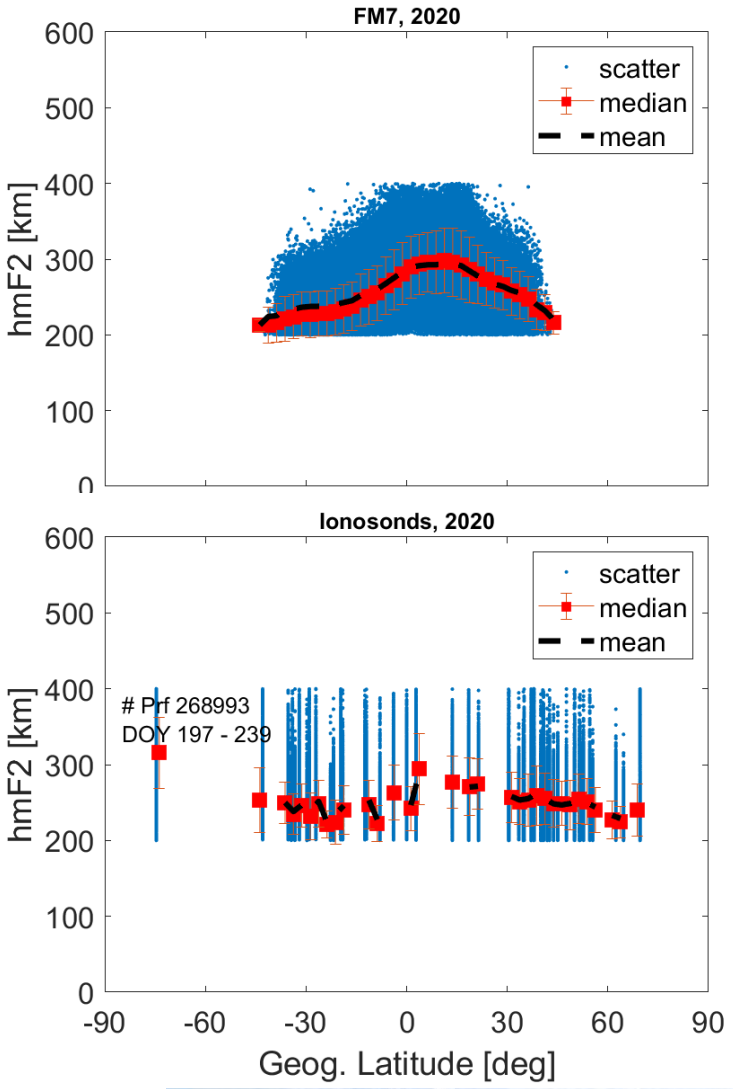


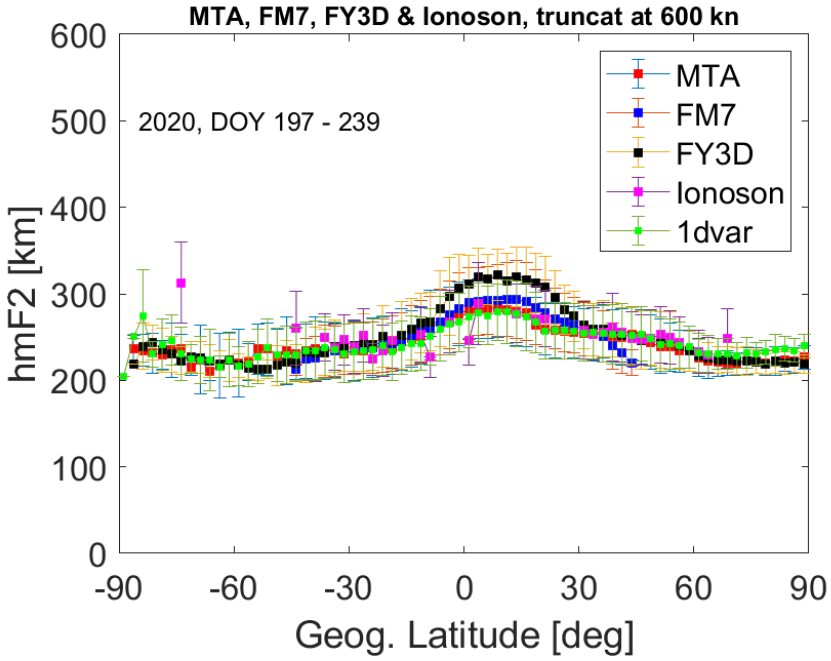




Peak density height hmF2 comparison, no colocation





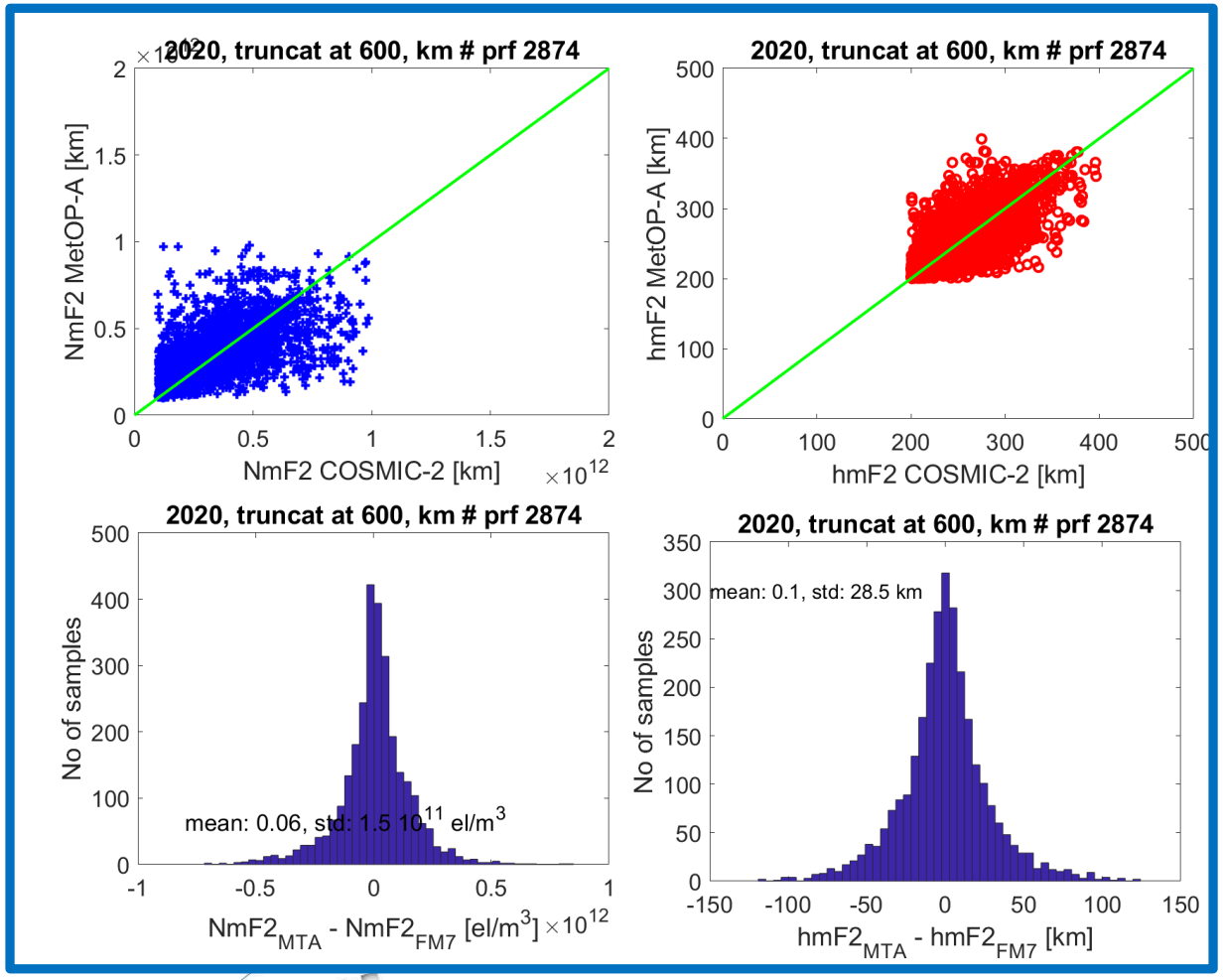


Co-location criteria

- We define that a co-located peak density pair lies within the **300 km and 2 h** of each other and may or may not track the same GPS satellite.

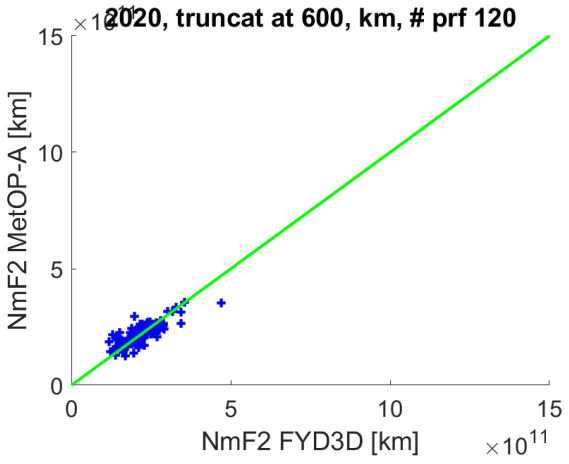
- For comparison purpose hmF2 height is restricted to 200 – 400 km

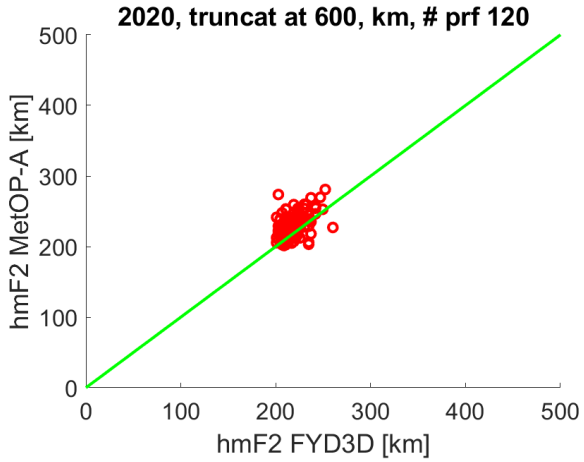
Co-located pairs of MetOp-A and COSMIC-2 profiles

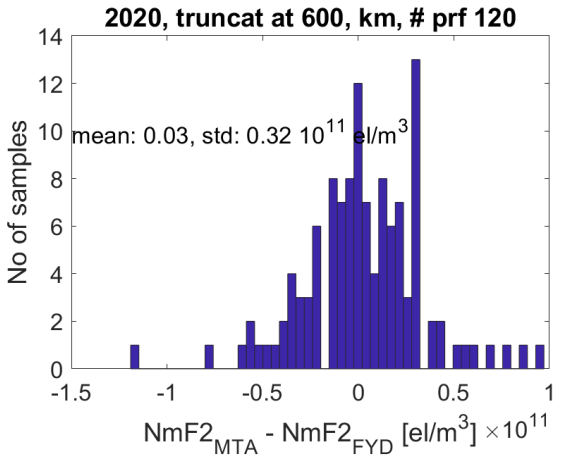


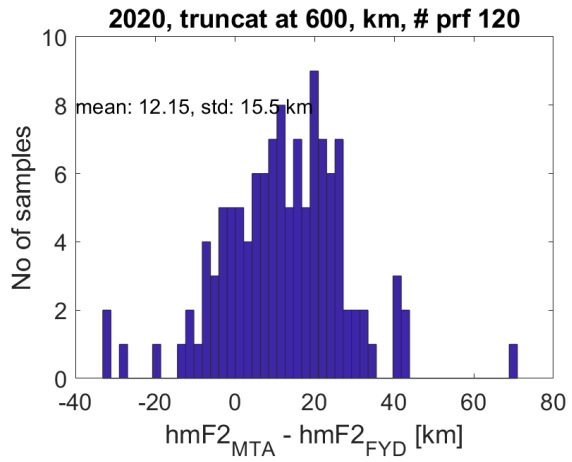
NmF2 [10^{11} el/m^3]		hmF2 [km]	
mean	STD	mean	STD
0.06 or 15%	1.5 or 56%	0.1 or 0.6%	28.5 or 11%

Co-located pairs of MetOp-A and Fengyun-3D profiles





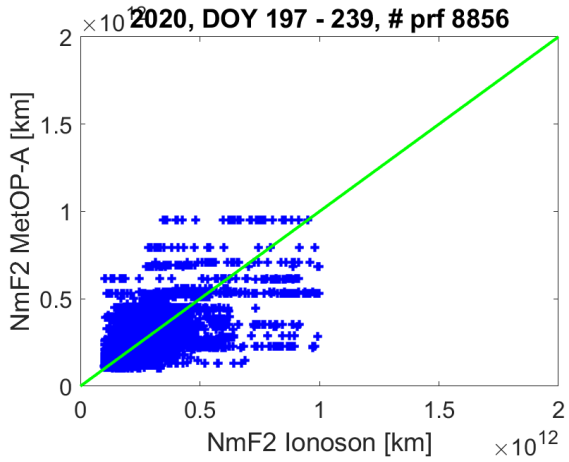


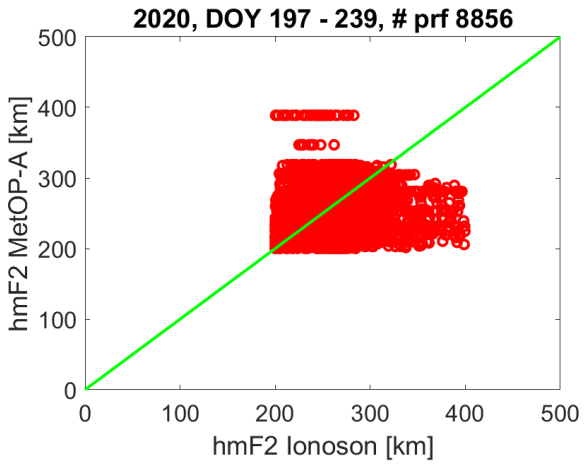


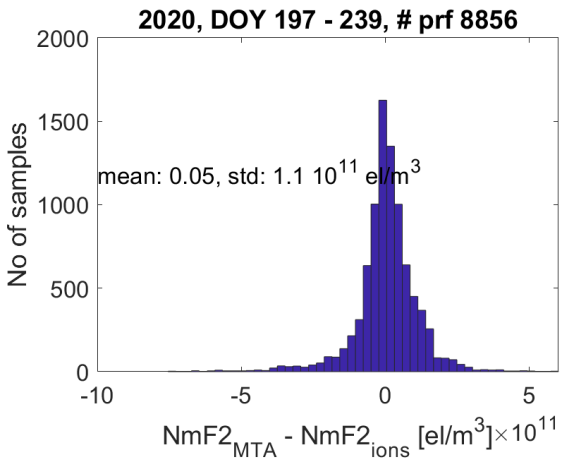
MetOp-A RO - Fengyun-3D

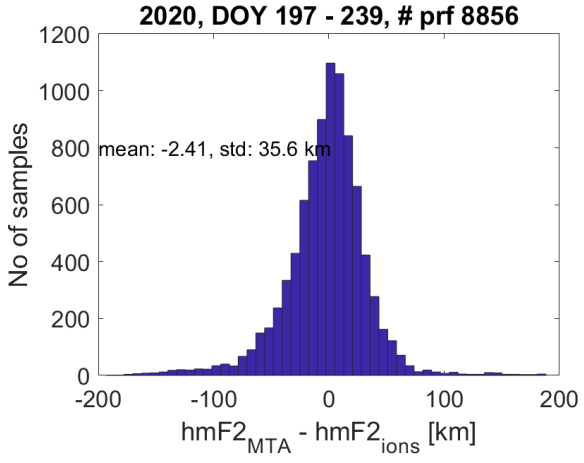
NmF2 [10^{11} el/m^3]		hmF2 [km]	
mean	STD	mean	STD
0.03 or 3%	0.32 or 16%	12 or 6%	16 or 7%

Co-located pairs of MetOp-A and ionosonde data







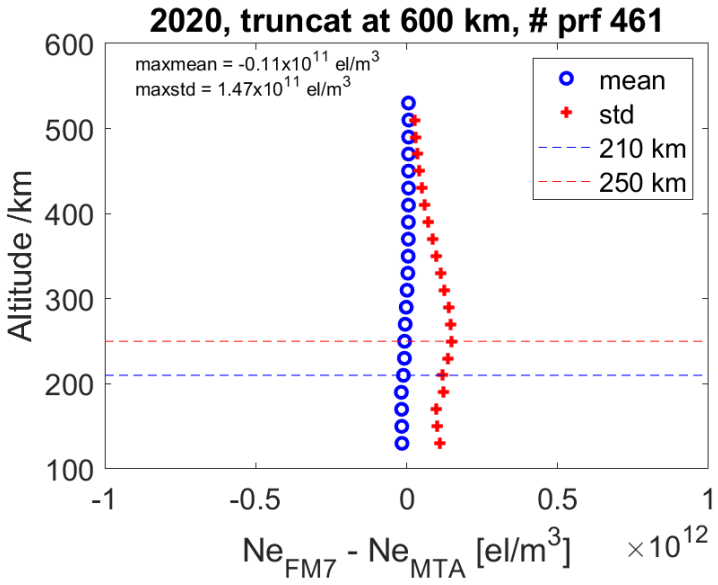


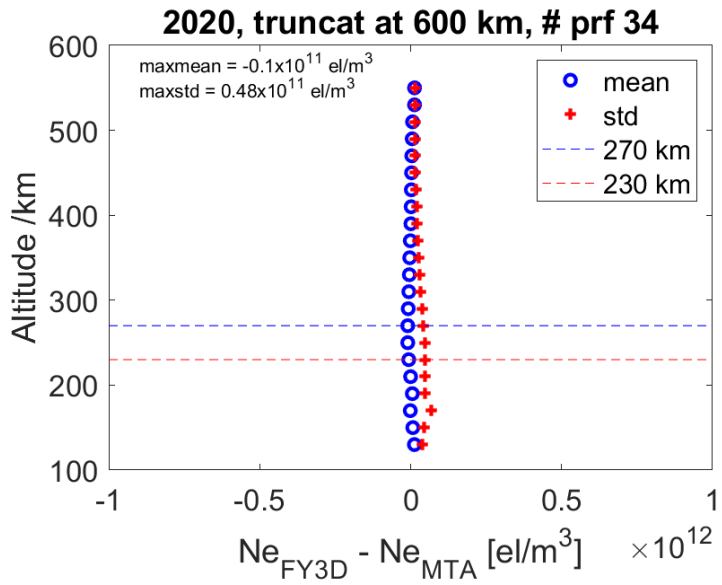
MetOp-A RO - Ionosonde

NmF2 [10^{11} el/m^3]		hmF2 [km]	
mean	STD	mean	STD
0.05 or 9%	1.1 or 41%	-2.4 or 0.03%	36 or 13%

Mean and STD differences between co-located Ne profiles

	MetOp-A data truncated at 600 km Ne [10^{11} el/m^3]	
	mean	STD
COSMIC-2 - MetOp-A	-0.11	1.47
Fengyun-3D - MetOp-A	-0.1	0.48





Summary

- Investigation shows that the developed approach can successfully retrieve the electron density values from the truncated MetOp-A data.

- We have found that the accuracy of the retrieved electron density profile is comparable to the electron density retrieved from COSMIC-2 mission.

Acknowledgement:

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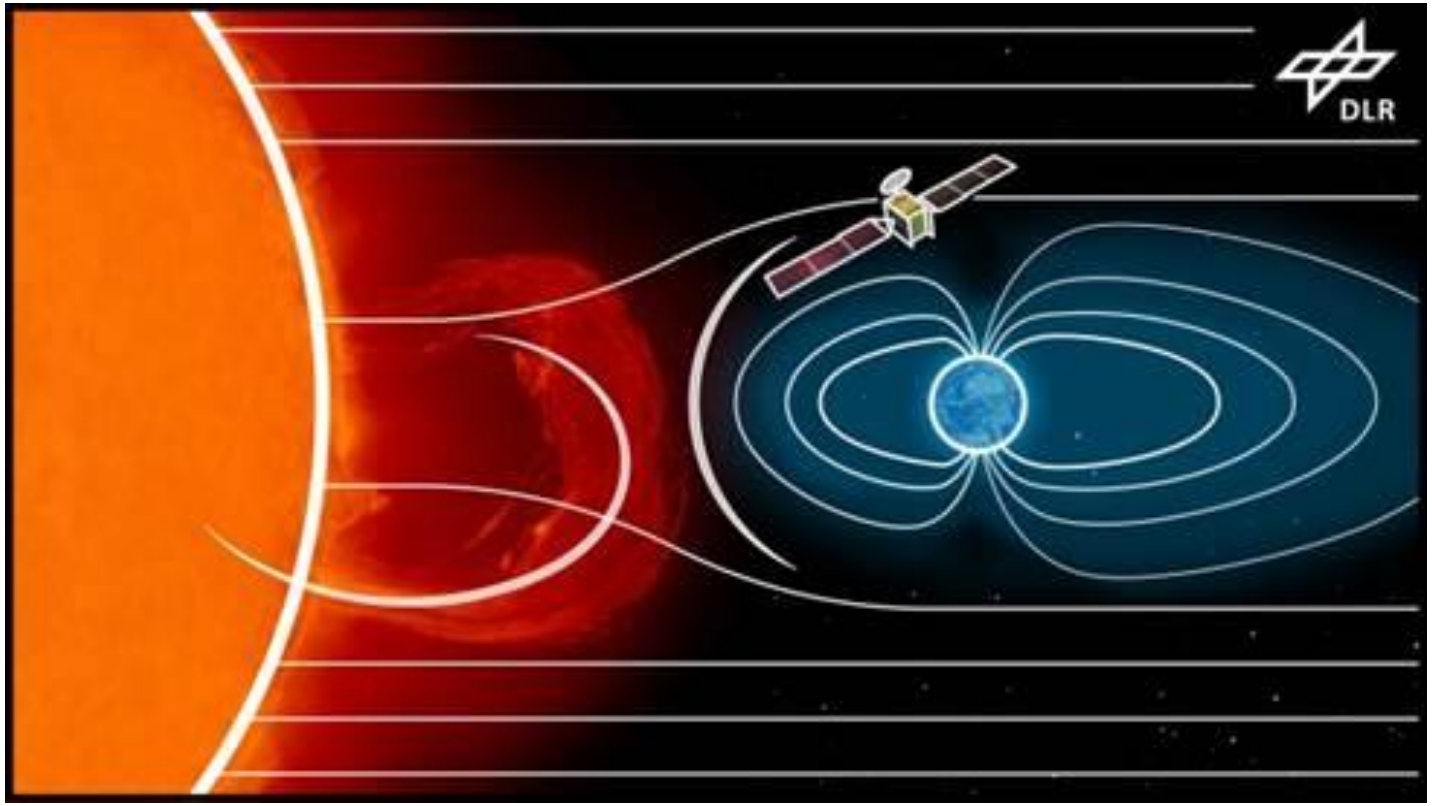
Thank you!



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