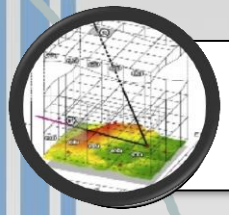
Analysis of GOES-R as a Constraint in GNSS Tropospheric Tomography

Zohreh Adavi[1] & Robert Weber[1],

[1]Department of Geodesy and Geoinformation, TU Wien, Vienna, Austria

EGU2020, May 5, 2020

Content



Introduction

Tropospheric Tomography

GOES-R

Numerical Results

Introduction

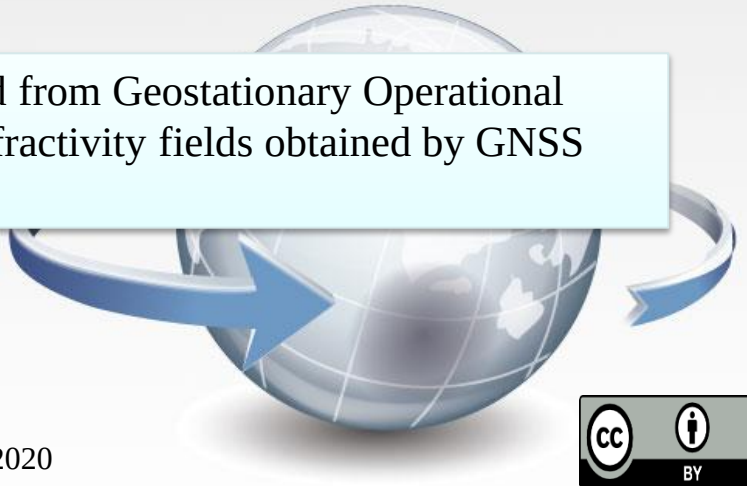
GNSS tomography is an all-weather condition remote sensing technique

Propagated signals do not pass through some of the model elements.

Reconstructed wet refractivity field suffers in terms of solution uniqueness.

Additional data sources

Combination of wet refractivity maps computed from Geostationary Operational Environmental Satellite (**GOES**) sounder and refractivity fields obtained by GNSS tomography



Tropospheric Tomography

$$\mathbf{SWD} = \mathbf{A}\mathbf{N}_w$$

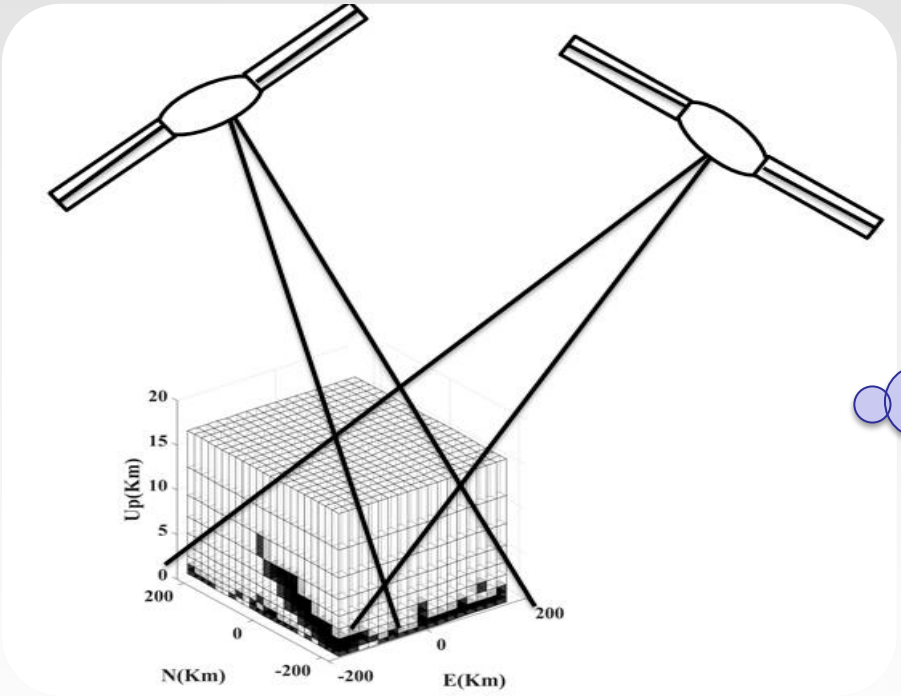
Observation Vector

Structure Matrix

$$\mathbf{A} = \begin{bmatrix} d_{11} & d_{12} & d_{13} & d_{14} & \dots & d_{1m} \\ d_{21} & d_{22} & d_{23} & d_{24} & \dots & d_{2m} \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ d_{n1} & d_{n2} & d_{n3} & d_{n4} & \dots & d_{nm} \end{bmatrix}$$

Initial Field using GOES-R

$$SWD = (ZTD - ZHD).mf(elv) + mf_g(elv).\left[G_{NS}.\cos(\alpha) + G_{EW}.\sin(\alpha)\right]$$

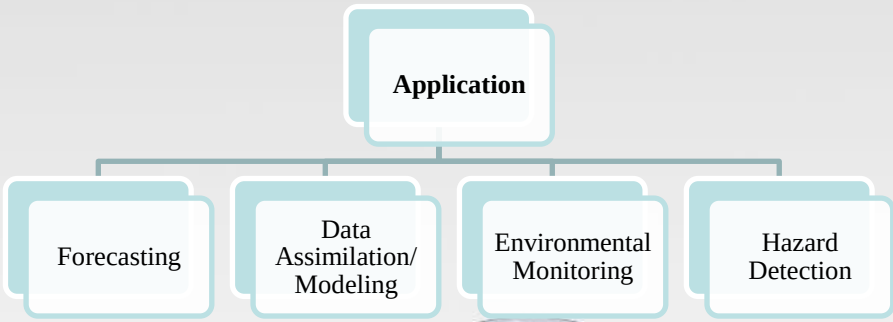


The troposphere is divided into a number of 3D elements (voxels). Then, the system of the observation equations is defined by a relation between the wet refractivity field and the distance traveled by GNSS rays through voxels.

GOES-R

Geostationary Operational Environmental Satellite-R Series (GOES-R)

Latest generation of geostationary weather satellites



GOES-R

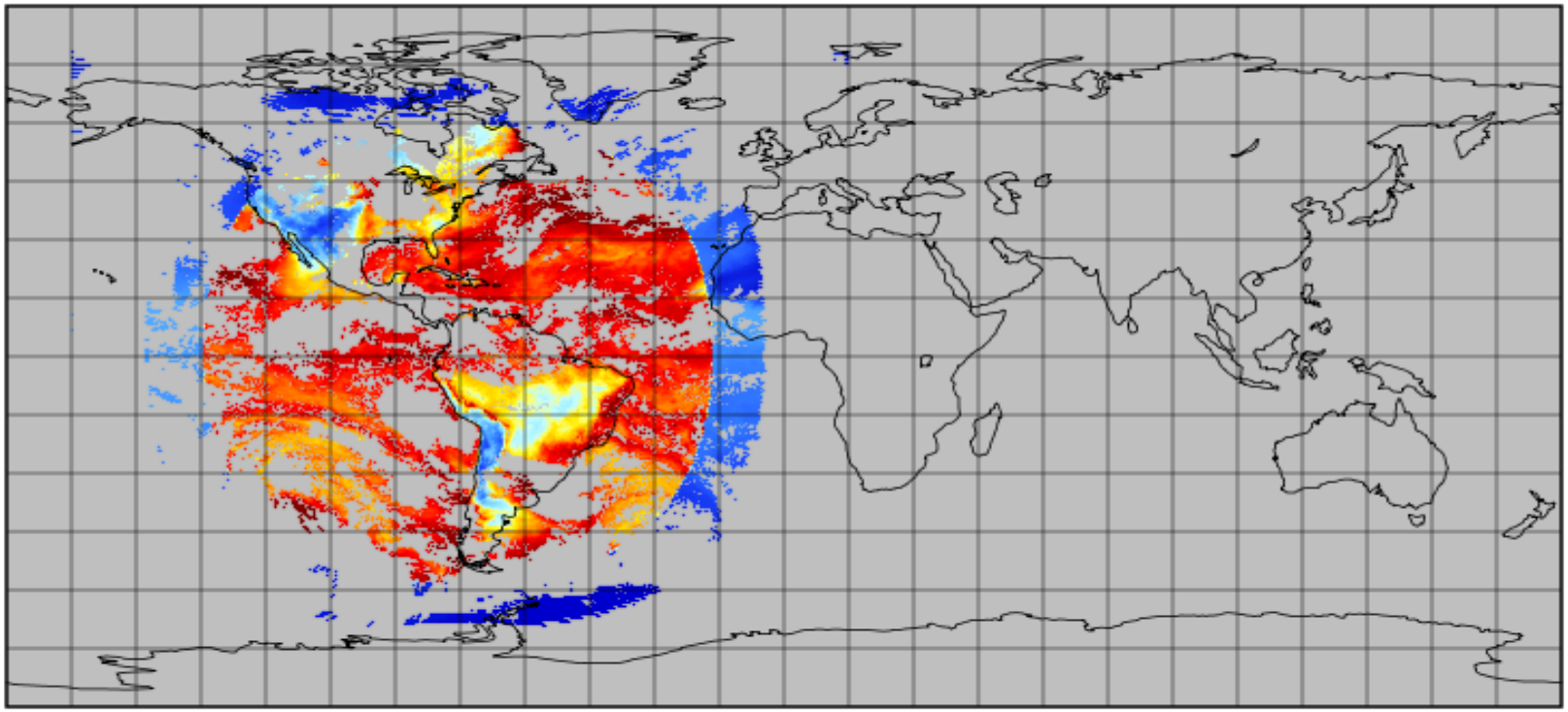
Advanced Baseline Imager (ABI)

1. Aerosol Detection (Including Smoke and Dust)
2. Aerosol Optical Depth (AOD)
3. Clear Sky Masks
4. Cloud and Moisture Imagery (KPP)
5. Cloud Optical Depth
6. Cloud Particle Size Distribution
7. Cloud Top Height
8. Cloud Top Phase
9. Cloud Top Pressure
10. Cloud Top Temperature
11. Derived Motion Winds
12. Derived Stability Indices
13. Downward Shortwave Radiation: Surface
14. Fire/Hot Spot Characterization
15. Hurricane Intensity Estimation
16. Land Surface Temperature (Skin)
17. Legacy Vertical Moisture Profile
18. Legacy Vertical Temperature Profile
19. Radiances
20. Rainfall Rate/QPE
21. Reflected Shortwave Radiation: TOA
22. Sea Surface Temperature (Skin)
23. Snow Cover
24. Total Precipitable Water
25. Volcanic Ash: Detection and Height

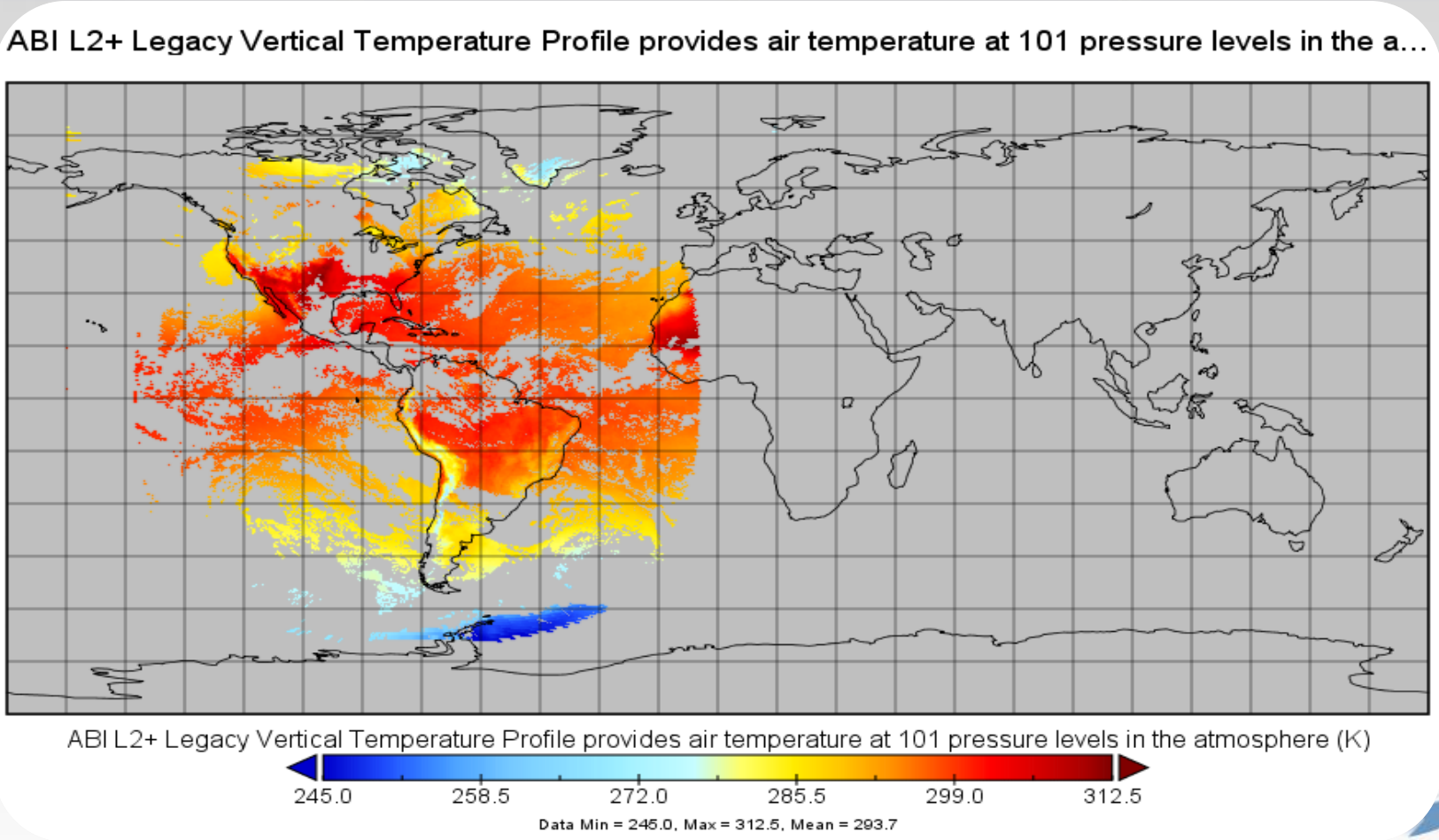
Spectral Coverage	**16 bands**
Spatial Resolution	
0.64 μm Visible	0.5 km
Other Visible/near IR	1 km
Bands (>2 μm)	2 km
Spatial Coverage	
Full Disk	4 per hour
CONUS	12 per hour
Mesoscale	Every 30 sec
Visible (reflective bands) On orbit calibration	Yes

Vertical Moisture Profile

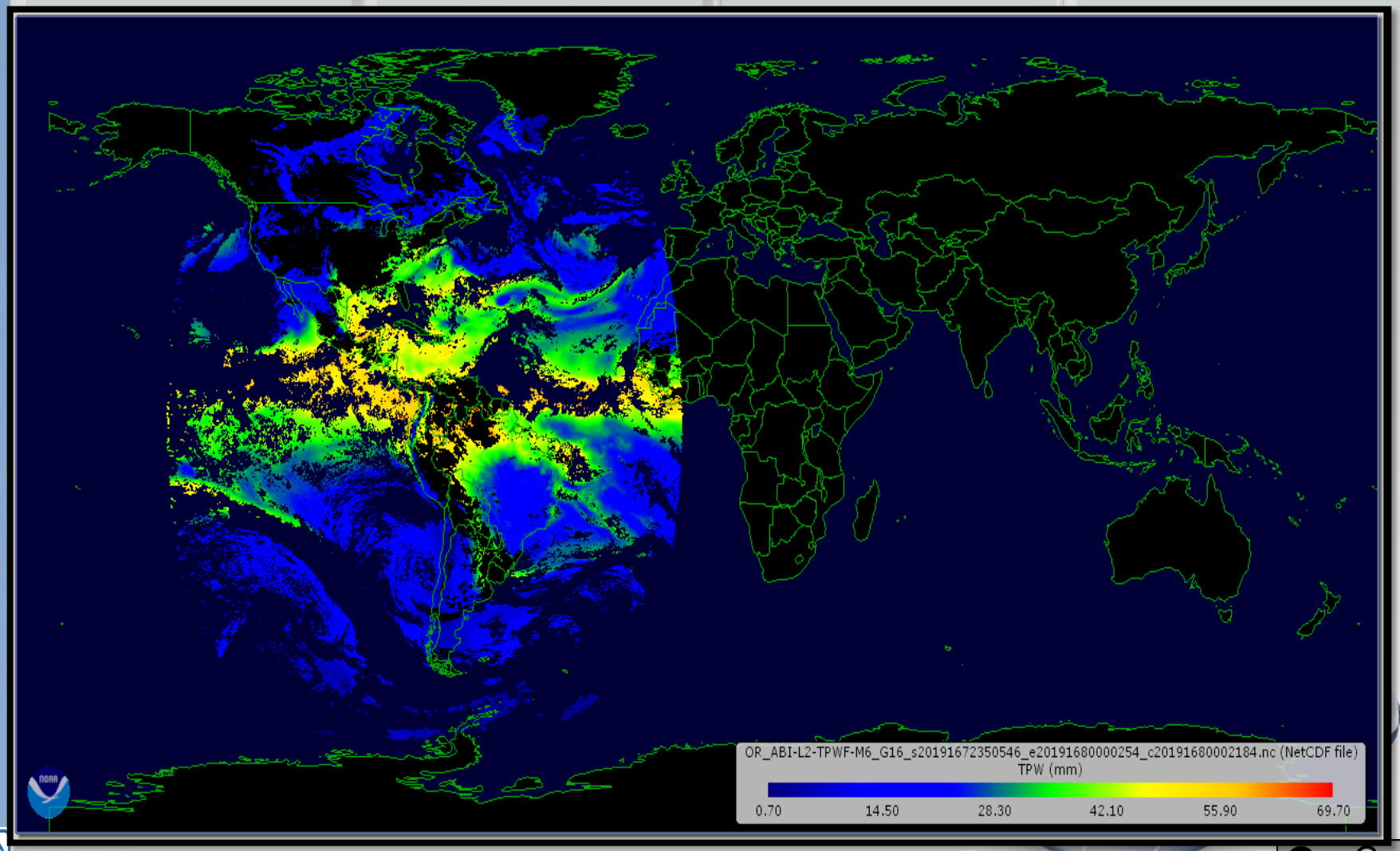
ABI L2+ Legacy Vertical Moisture Profile provides relative humidity at 101 pressure levels in the atmos...



Vertical Temperature Profile

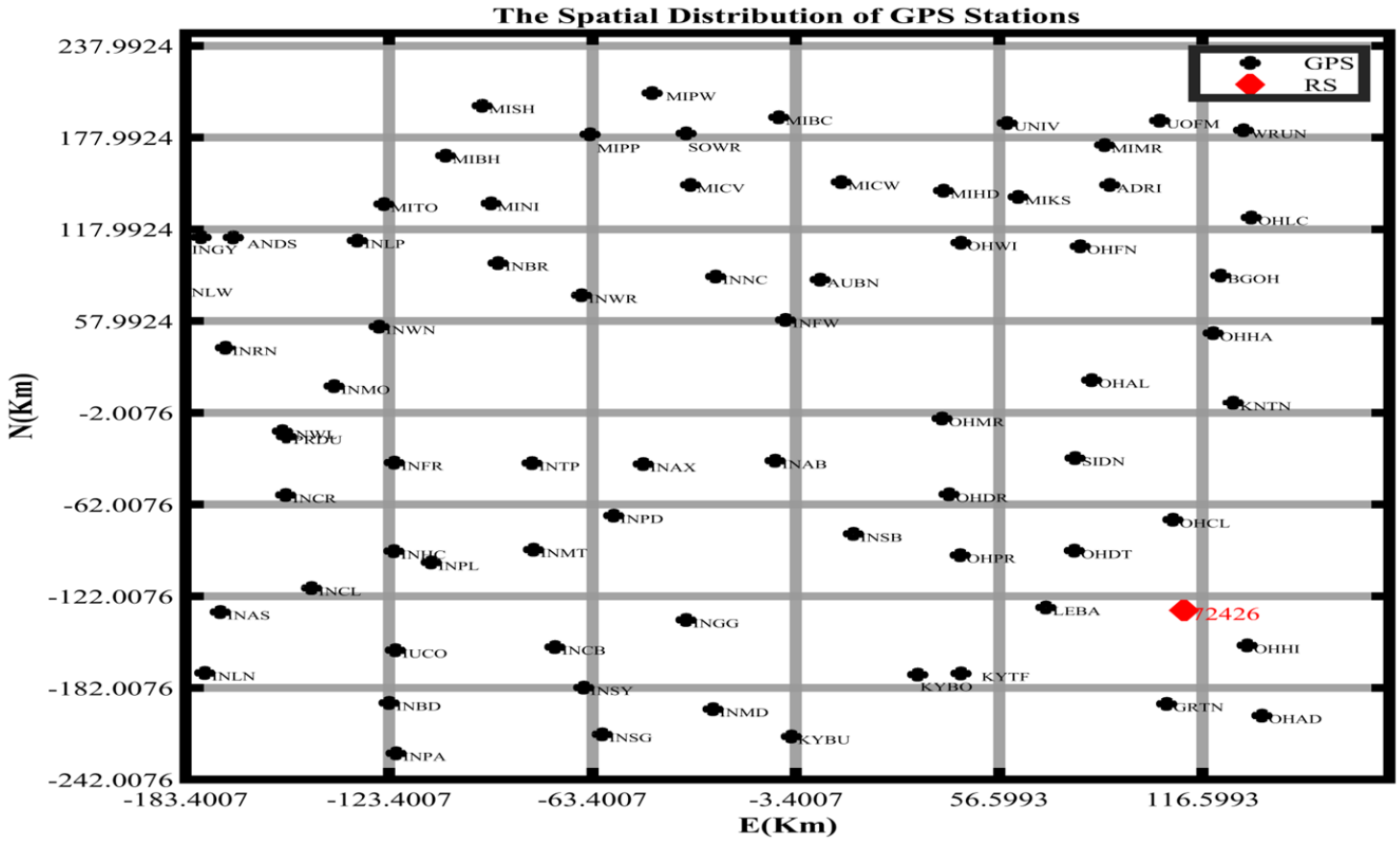


Total Precipitation



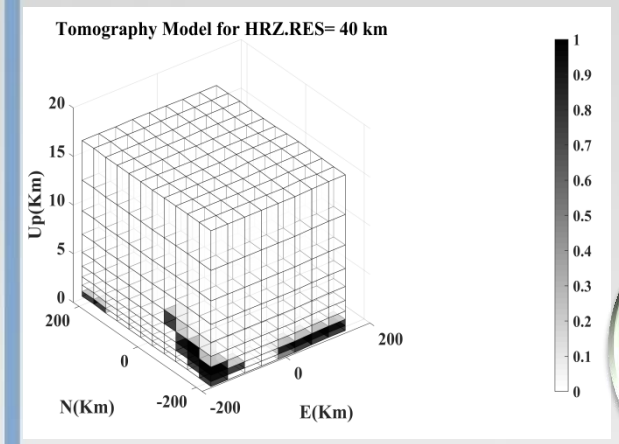
Case Study

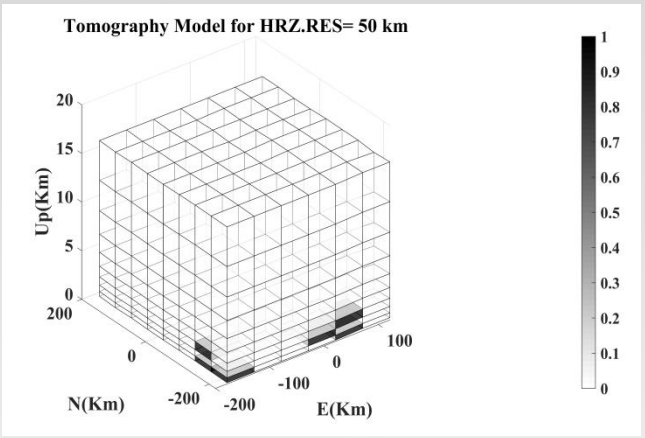
The area of interest ranges from 38.4˚ to 42.8 ˚ in latitude, 87.2 ˚ W to 83 ˚ W in longitude, and mostly located in the north America. The GNSS network in this study contains 72 stations and it is a part of the united states CORS Network.

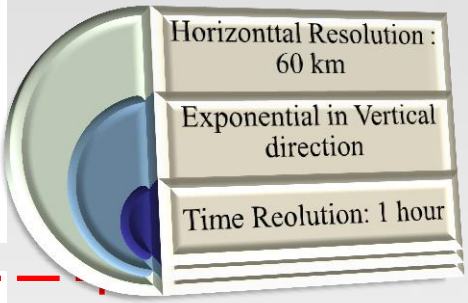


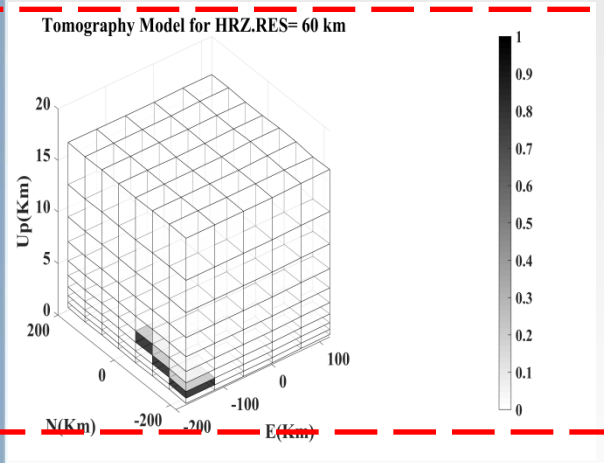
Tomography Model

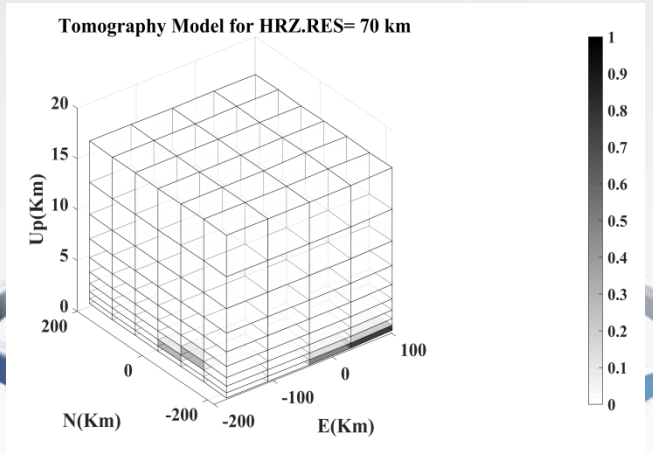
The concept of model space resolution matrix has been used to select an optimal horizontal resolution of the tomography model between 40 km and 70 km.



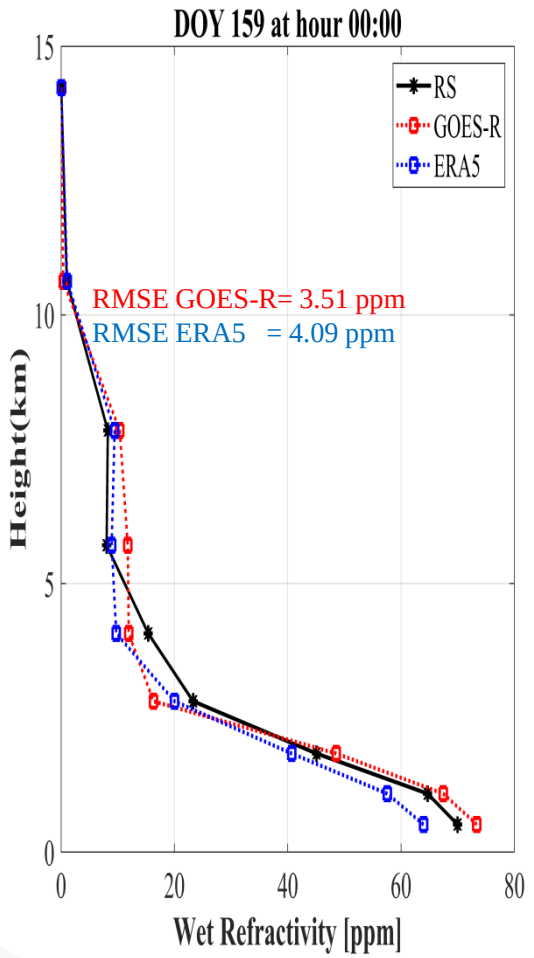


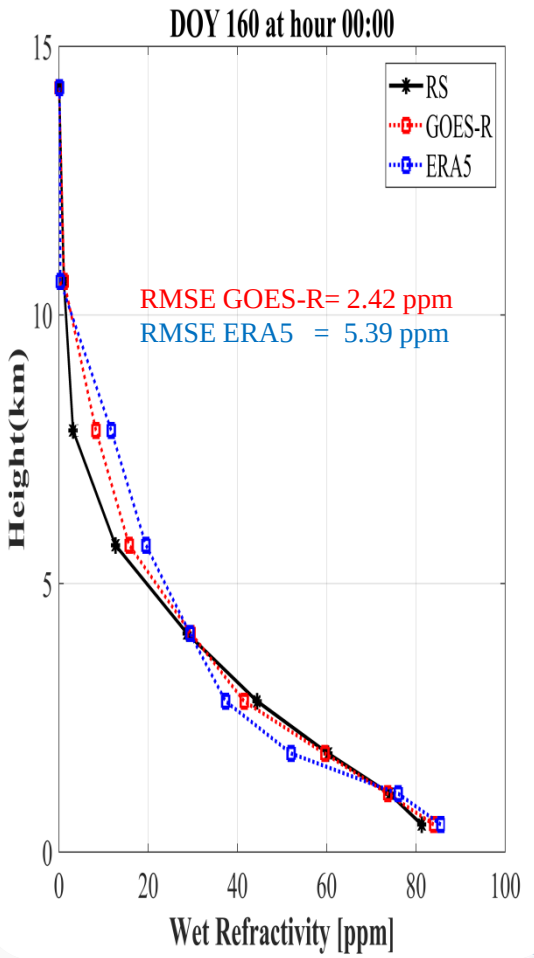


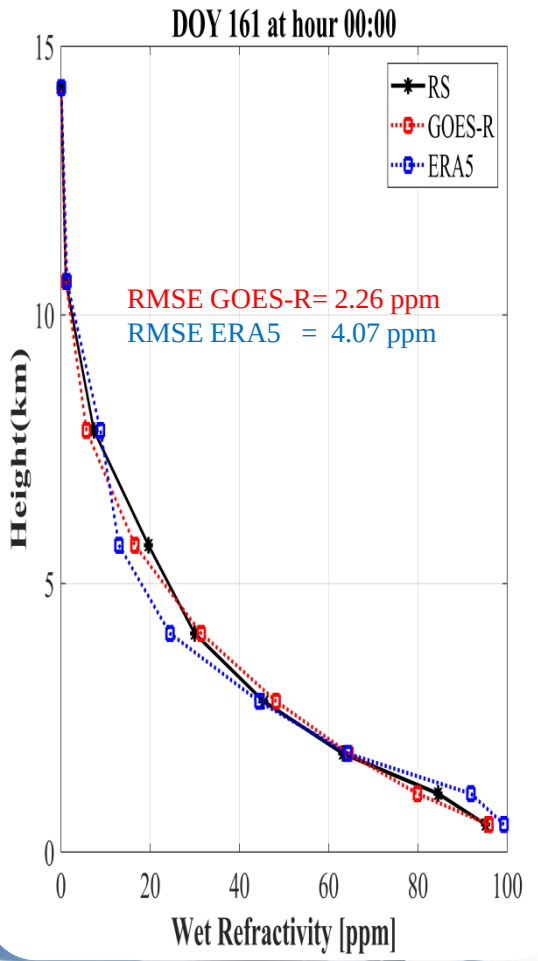




Reconstructed Profile







Summary

- ✓ The average RMSE in GOES-R is about 2.73 ppm and for ERA5 is 4.95 ppm.
- ✓ The consistency of GOES-R with RS profile is improved in comparison to ERA.
- ✓ According to the obtained results applying GOES-R to the tomography observation equation can lead to a better solution in comparison to ERA5 model.
- ✓ The time span will be increased in the next study.


Many Thanks for you attention