DEVIATIONS FROM A HYDROSTATIC ATMOSPHERE IN RADIO OCCULTATION DATA

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Motivation

- NRL study to estimate radio occultation measurement impact on their 3DVar model
- For flexibility use radio occultation measurement simulator: EGOPS
- For simplicity start with an external 1DVar model to derive T, WV

1DVar Retrieval

- 1DVar Retrieval or Optimal Estimation Method
- Iterative to account for non linear problem
- Levenberg-Marquardt algorithm to find minimum in cost function
- Simultaneous retrieval of temperature-, H2O profile, reference pressure

1DVar / Forward Model Setup

Species	Height [km]	Sampling dz [km]	A priori Error
Temperature	$00 \leq z \leq 30$	0.5	3 K-5 K
	$30 \leq z \leq 40$	1.0	5 K-7 K
	$40 \leq z \leq 60$	2.5	7 K-11 K
	$60 \leq z \leq 100$	10.0	11 K-20 K
Water Vapor	$00 \leq z \leq 20$	0.5	40 %
Pressure	Lowest	–	1 %

Height [km]	Sampling dz [km]	Error [μrad]
$00 \leq z \leq 25$	0.25	4.0
$25 \leq z \leq 40$	0.50	2.8
$40 \leq z \leq 60$	1.00	2.0

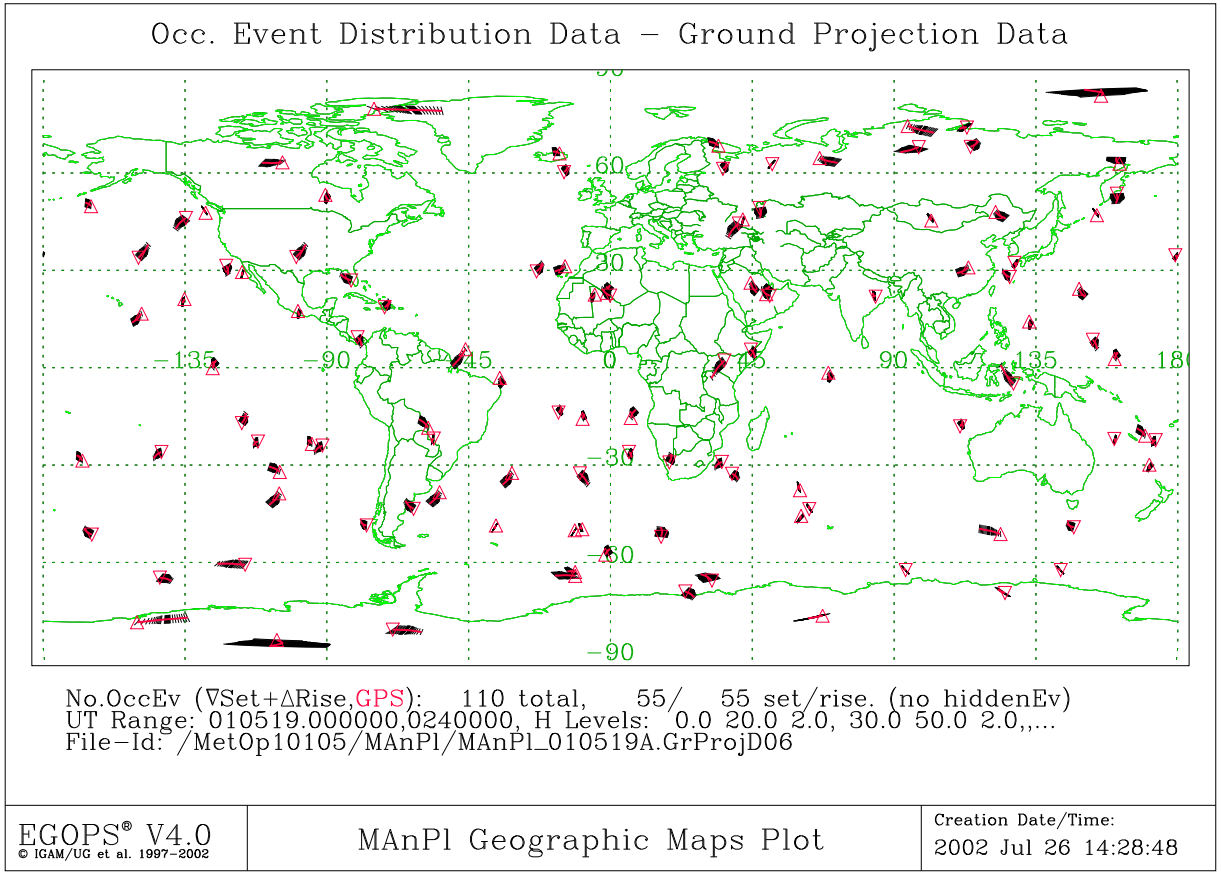
EGOPS Setup

- Atmosphere:
  - Date: 05/19/01
  - Field: ECMWF, Time 6h, Vertical 60 levels, Horizontal T511 (0.351°)
- Instrument:
  - MetOp-1 Satellite:
    - Orbit altitude: 835 km
    - Orbit inclination 98.7°
  - Viewing directions: forward, backward
  - Viewing constellation: GPS
  - Number of Occultation:
    - Total: 550
    - Study: 110

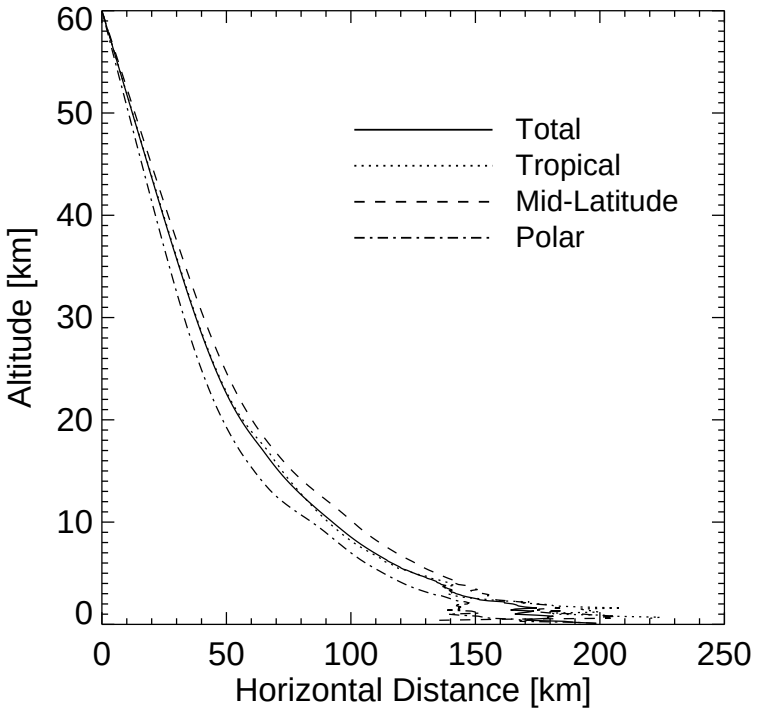
EGOPS Program

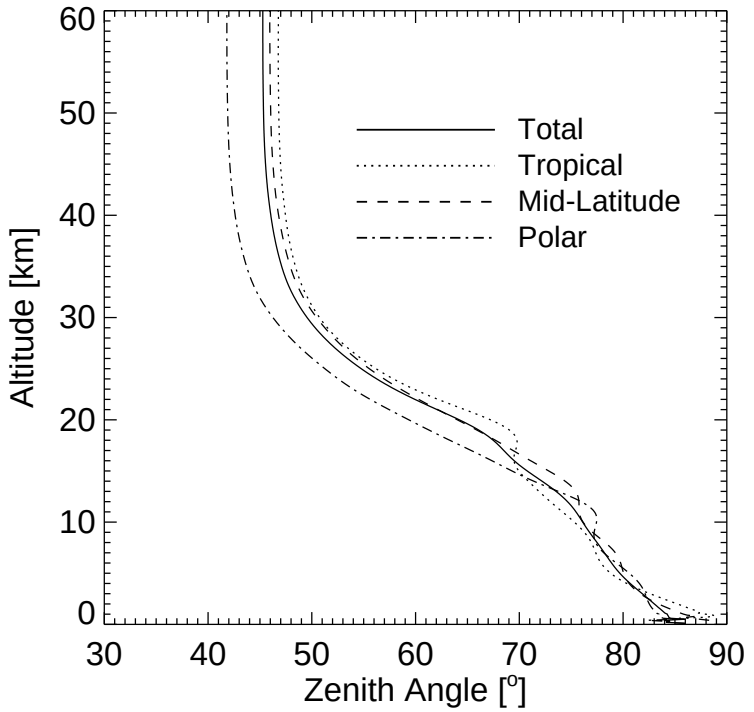
- Fortran Core, IDL Interface
- Runs interactively
- Project Manager
- Simulation split up in 4 tasks:
  - Mission Analysis/Planning
  - Forward Modeling
  - Observation System Modeling
  - Occultation Data Inversion/Retrieval
- Visualize/Validate Procedures

Observation Map: 05/19/01

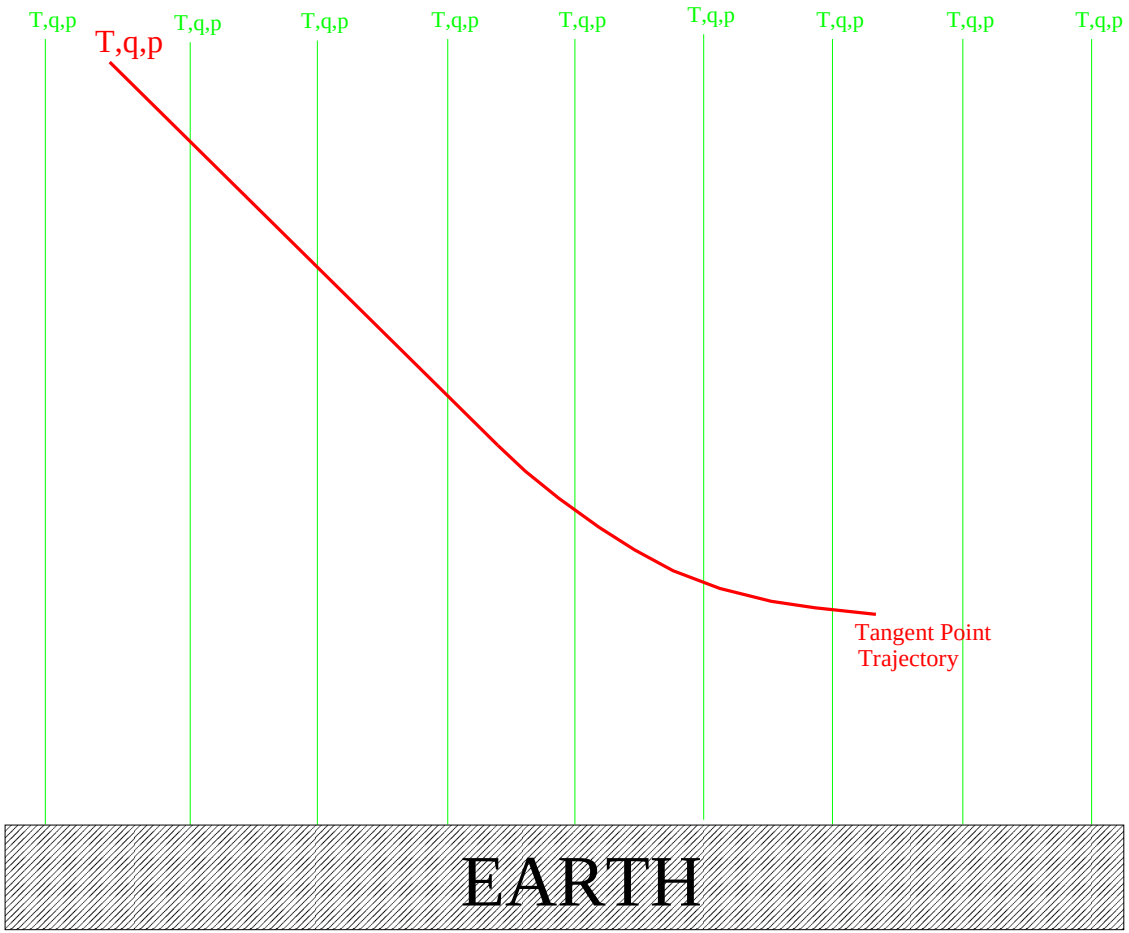


Horizontal Distance, Zenith Angle

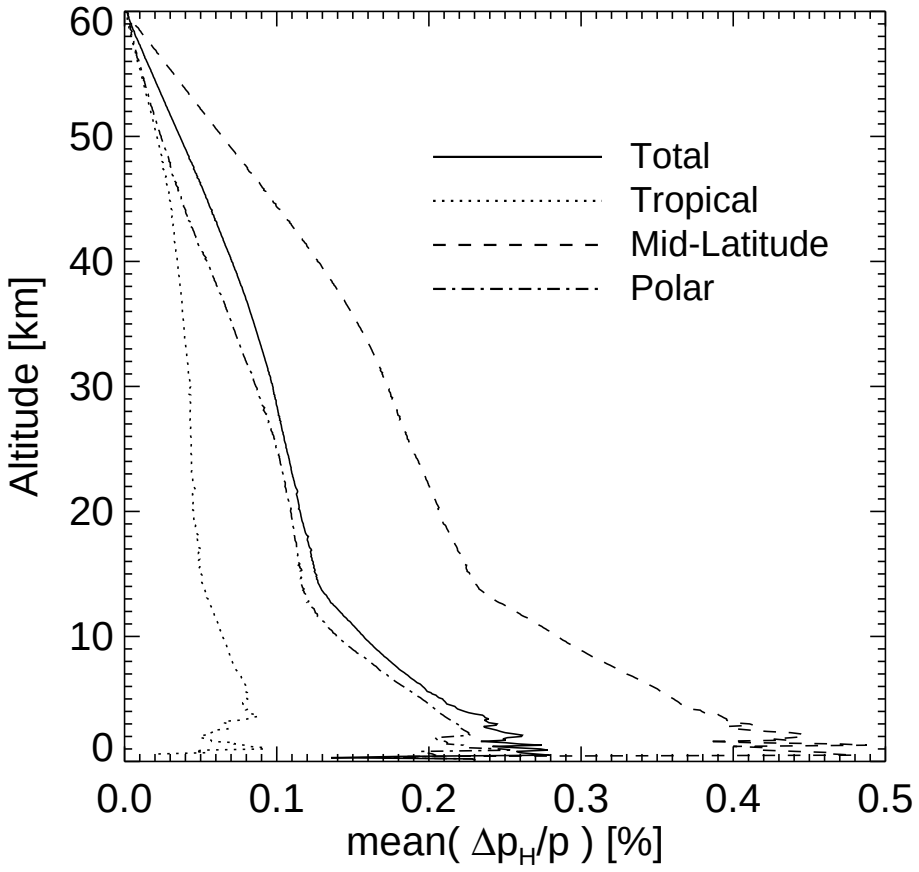




Tangent Point Trajectory



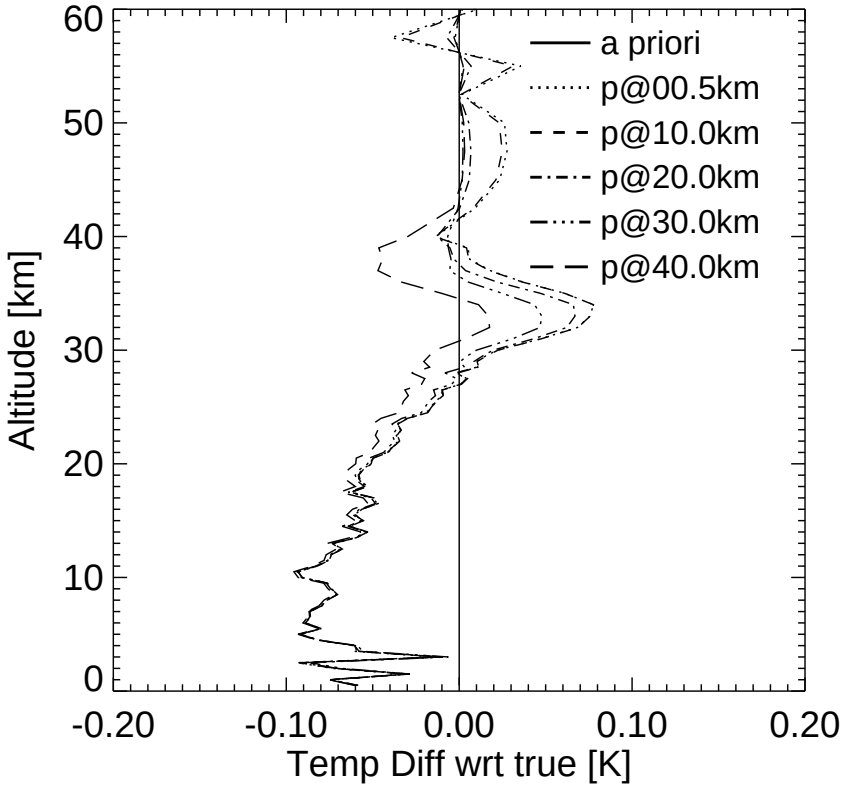
Average Deviation from Hydrostatic

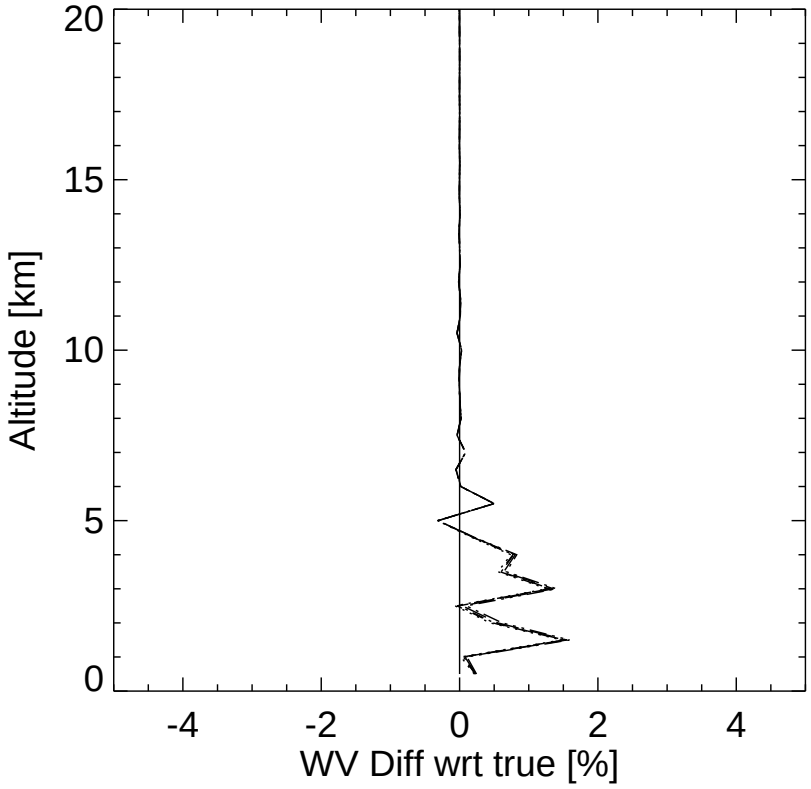


Maximum Deviation from Hydrostatic

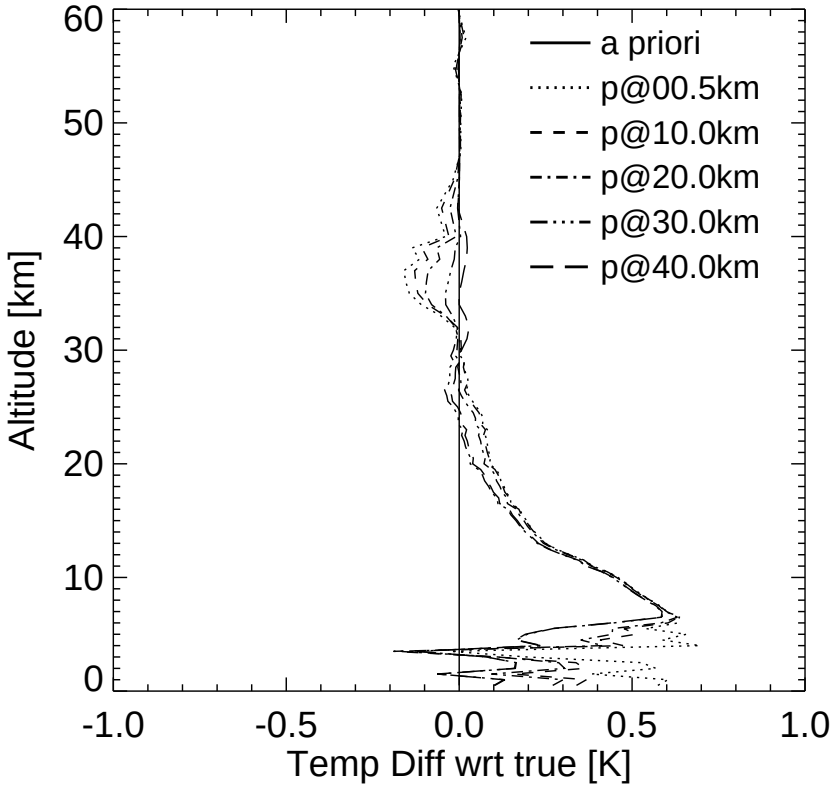
Deviation [%]	Total # of Occ [1]	Latitude Band		
		Tropical	Mid-Lat	Polar
$0.0 \geq max\left(\frac{\Delta p_{\mathrm{H}}}{p}\right) < 0.1$	36	28	3	5
$0.1 \geq max\left(\frac{\Delta p_{\mathrm{H}}}{p}\right) < 0.2$	30	12	9	9
$0.2 \geq max\left(\frac{\Delta p_{\mathrm{H}}}{p}\right) < 0.3$	17	3	9	5
$0.3 \geq max\left(\frac{\Delta p_{\mathrm{H}}}{p}\right) < 0.4$	9	2	3	4
$0.4 \geq max\left(\frac{\Delta p_{\mathrm{H}}}{p}\right) < 0.5$	3	0	3	0
$0.5 \geq max\left(\frac{\Delta p_{\mathrm{H}}}{p}\right) < 0.6$	5	0	2	3
$0.6 \geq max\left(\frac{\Delta p_{\mathrm{H}}}{p}\right) < 0.7$	2	0	2	0
$0.7 \geq max\left(\frac{\Delta p_{\mathrm{H}}}{p}\right) < 0.8$	3	0	3	0
$0.8 \geq max\left(\frac{\Delta p_{\mathrm{H}}}{p}\right) < 0.9$	0	0	0	0
$0.9 \geq max\left(\frac{\Delta p_{\mathrm{H}}}{p}\right) < 1.0$	0	0	0	0
$max\left(\frac{\Delta p_{\mathrm{H}}}{p}\right) \geq 1.0$	5	0	4	1

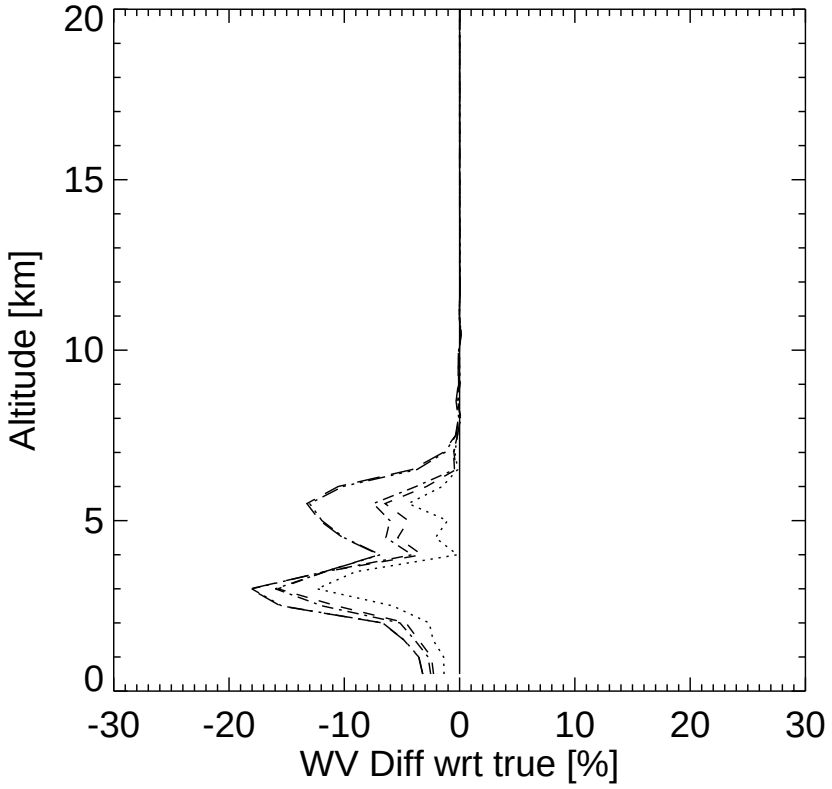
1DVar: Moderate Deviation from Hydrostatic



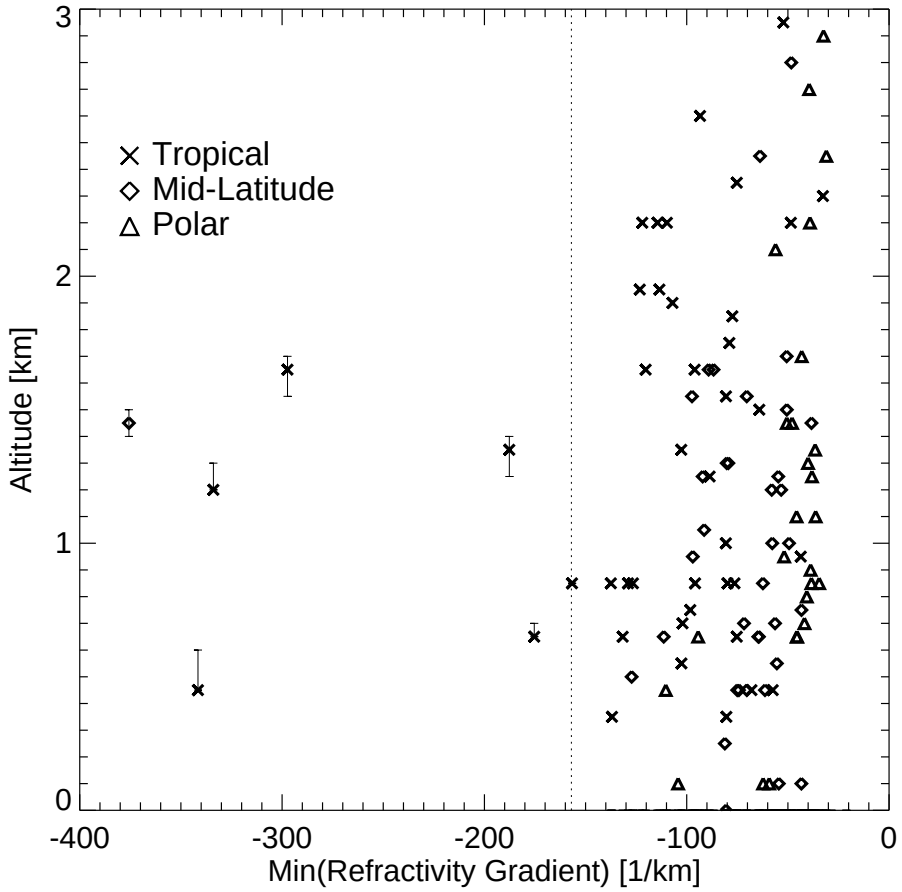


1DVar: Severe Deviation from Hydrostatic





Critical Refraction Occurrence



Conclusion

- Average Horizontal Distance: 180 km (0 - 60 km)
- Average Zenith Angle: 45° (60 km) to 85° (0 km)
- Average Deviation from Hydrostatic: 0.1 % - 0.2 %
- Retrieval Error, moderate case (≈90 %): 0.1 K, 1.5 %
- Retrieval Error, severe case (≈4 %): 0.5 K, 10 %
- Critical Refraction: 5 % affected, vertical range up to 200 m