Poster No. P07

National Aeronautics and Space Administration

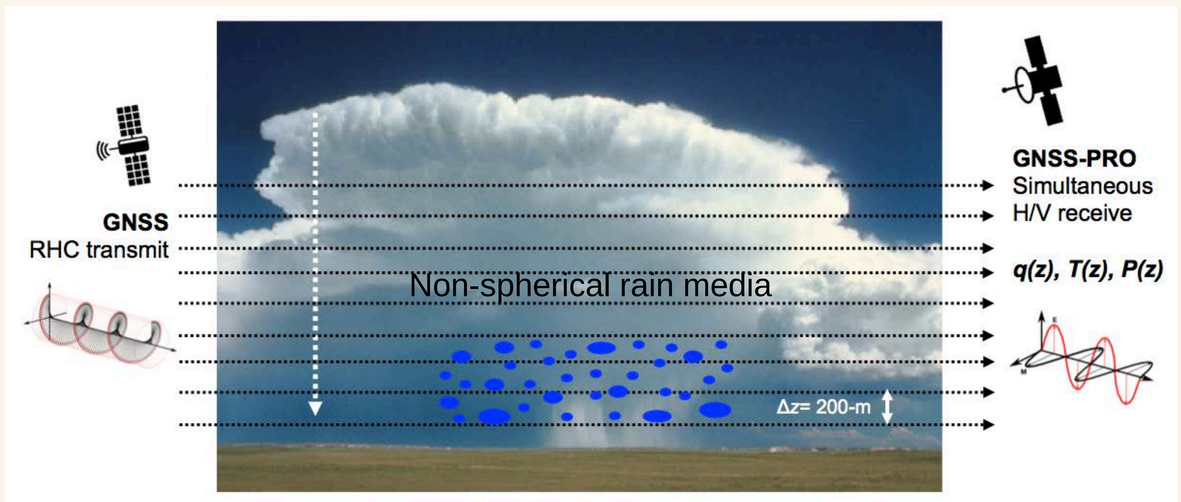
A study on the effects of heavy precipitation on Polarimetric Radio Occultation (PRO) bending angle observations

Author: [1]K.-N. Wang, [1]C. O. Ao, [1]R. Padullés, [1]F. J. Turk, [1]M. de la Torre Juarez, [2]E. Cardellach

[1] Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA [2] Institute of Space Sciences (ICE-CSIC, IEEC), Barcelona, Spain

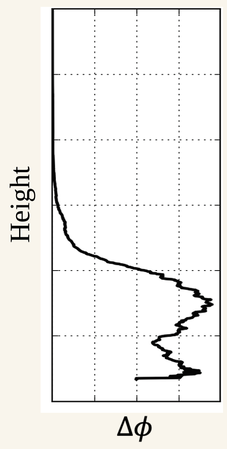
GPS Polarimetric Radio Occultation (GPS-PRO)

- GPS-PRO is an effective technique to profile **vertical moisture** and **precipitation structure *simultaneously*** *[Cardellach 2019]*.

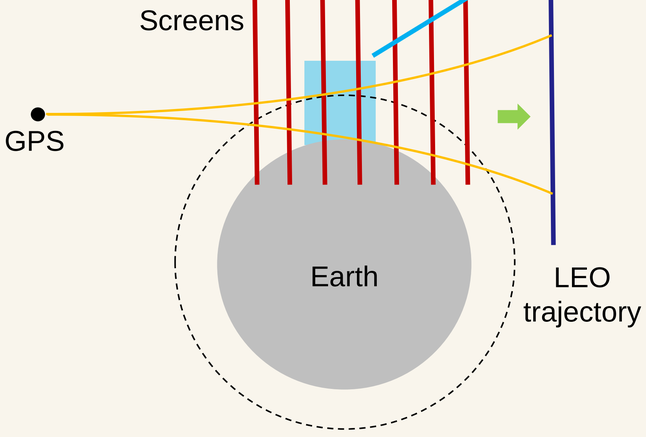


- Up to now, the PRO has been studied using polarimetric phase shift assuming geometric optics propagation through **ray tracing** techniques.
  - GPS-RO **bending angle** observations are more commonly used in data assimilation process
  - the propagation of the PRO signals is likely to suffer the **multipath effect** due to large moisture variance at lower troposphere

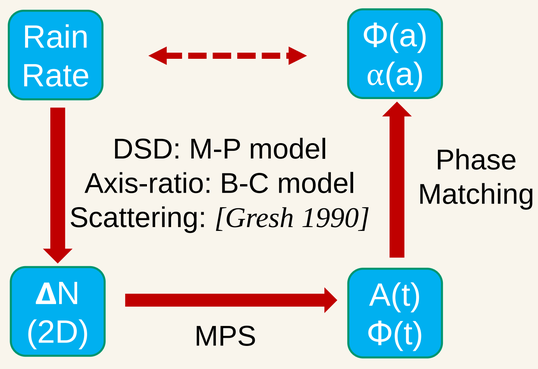
In this research, we studied the **polarimetric phase** and **bending angle difference** retrieved by the radio-holographic (RH) method for multipath effect mitigation and data assimilation purpose.



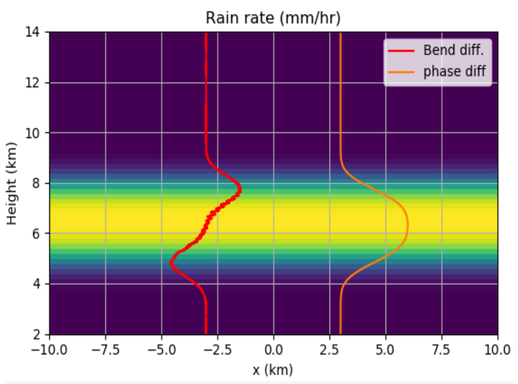
MPS Simulation and Phase Matching method

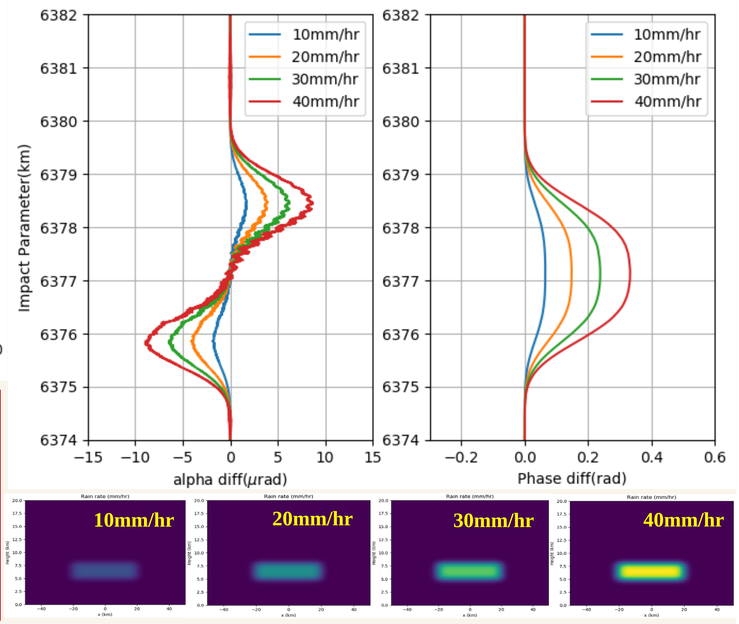


- Multiple Phase Screen (MPS) simulates the wave propagation of PRO signals through hydrometeors:



- The sensitivity tests based on MPS show that both phase and bending angle shift on impact parameter domain are **sensitive to the range, height, and strength of the precipitation** and above the statistical noise level (~2μrad).



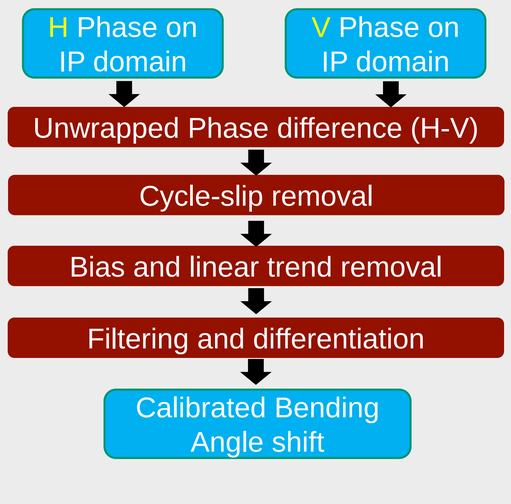


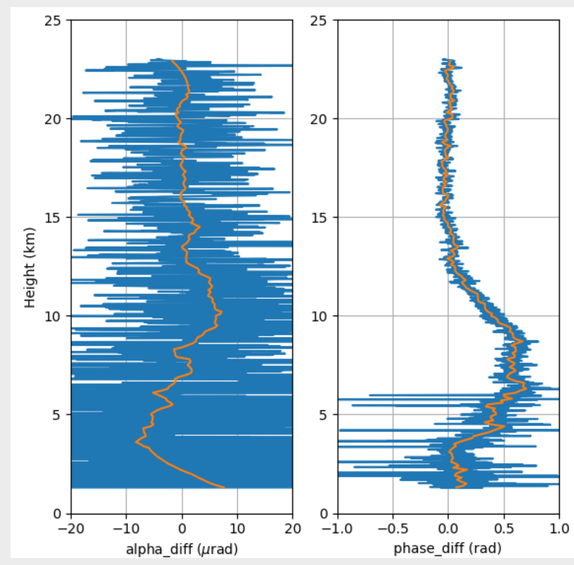
The research described in this paper was carried out at the Jet Propulsion Laboratory (JPL), California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

National Aeronautics and Space Administration
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

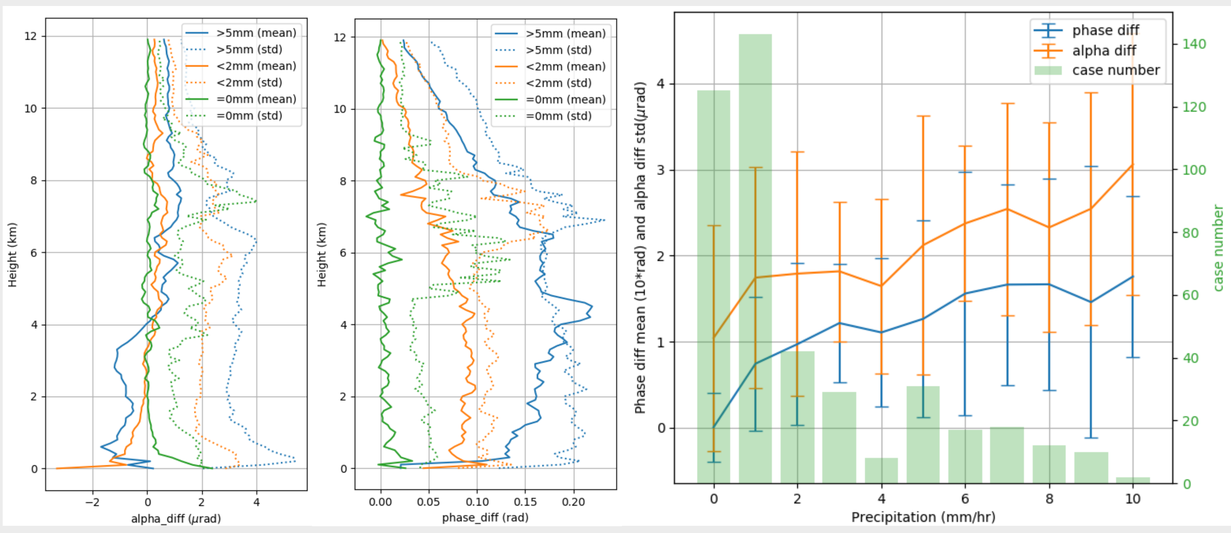
Actual PRO data and statistics

- The phase and bending angle shift due to precipitation are shown after calibrating the phase difference *[Padullés 2019]* on the impact parameter domain (20180620_0658paz_g56, 6.26 mm/hr)

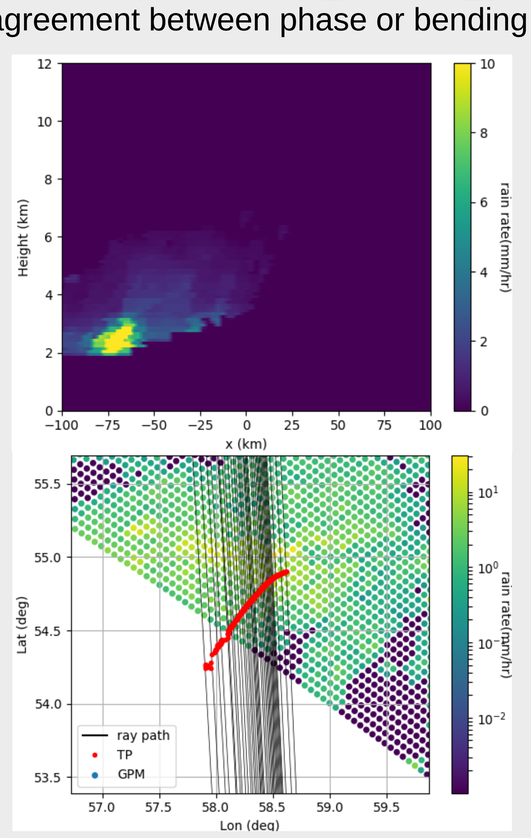


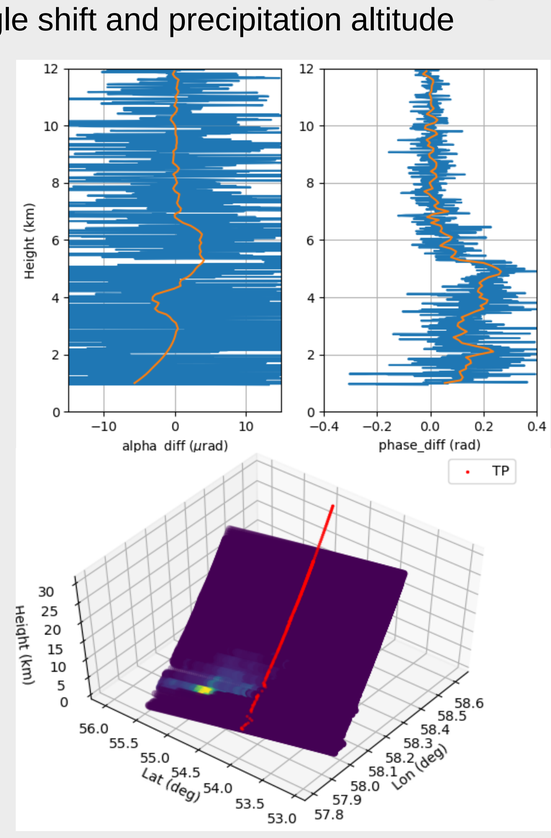


- Statistical results show that the **mean phase shift** and the **bending angle shift variance** is sensitive to different level of precipitations.



- Case study (20180525_0220paz_g57) with GPM collocation also shows good agreement between phase or bending angle shift and precipitation altitude





Reference

- Cardellach, E., Oliveras, S., Rius, A., Tomás, S., Ao, C. O., Franklin, G. W., et al. (2019). Sensing heavy precipitation with GNSS polarimetric radio occultations. *Geophysical Research Letters*, 46, 1024– 1031.
- Padullés, R., Ao, C. O., Turk, F. J., de la Torre Juárez, M., Iijima, B., Wang K.-N., and Cardellach, E.,. Calibration and Validation of the Polarimetric Radio Occultation and Heavy Precipitation experiment Aboard the PAZ Satellite. Submitted to *Atmospheric Measurement Techniques*
- Gresh, D. L., 1990: Voyager radio occultation by the Uranian rings: Structure, dynamics, and particle sizes. Ph.D. dissertation, Stanford University, 202 pp.