Sensing Heavy Precipitation with Polarimetric Radio Occultations aboard the PAZ satellite: A new view of precipitation and water vapor

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Polarimetric Radio Occultations (PRO)

- New measurement technique being tested for the first time aboard the Spanish PAZ satellite.
- Observable: Differential phase shift between H and V components of the received GNSS signal ($\Delta \Phi_{H-V}$).
- Asymmetric horizontally oriented falling hydrometeors induce a larger phase shift to the H component (basics of Polarimetric Weather Radar).
- Like standard Radio Occultations, it also provides vertical profiles of pressure, temperature and water vapor.
- Sensitivity to the whole vertical precipitating structure, including frozen particles and ice in addition to rain.
- First space based observing technique able to provide joint thermodynamic and precipitation information, simultaneously.
- Useful for the study of the thermodynamic processes underlying heavy precipitation, globally (ocean/land, regardless of cloud coverage).

On Orbit Calibration and Validation

- Calibration and validation using GPM constellation products (IMERG) show sensitivity to precipitation intensity
- Vertical structure of $\Delta \Phi$ exhibits good agreement with precipitation climatologies
- Lower layers ($\Delta \Phi_{h<5\text{km}}$): Heavy precipitation is distributed following well known patterns
- Higher layers ($\Delta \Phi_{h>10\text{km}}$): Good correlation with deep convection

Sensitivity of PRO Observations to Frozen Particles

- GPM and CloudSat observations are used to simulate the effect of rain and frozen particles to $\Delta \Phi$
- Simulations using only rain cannot explain PAZ observations. Frozen particles need to be included.

All the PRO observations are linked to a precipitation measurement (R) from the IMERG product. R and $\Delta \Phi$ are compared for all available observations. $\Delta \Phi$ is evaluated between 0 and 10 km. The heavier the precipitation, the larger the $\Delta \Phi$.

Dots: Top percentile of PAZ observations evaluated between the different height levels indicated in the legend (different colors) Background: accumulated precipitation from GPM for the same months