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Several studies have identified a bias between the RO refractivity profiles and the weather analyses under precipitating conditions. Initially, the biases were assumed to be due to the fact that the model refractivities are usually computed with the terms of the equation relevant to temperature, pressure, and water vapour solely, missing the droplet scattering terms [Lin et al. (2010), Yang and Zou (2012, 2016), Zou et al. (2012)], which would indeed affect the RO measurements. Later, numerical simulations of the excess phase due to scattering off rain droplets were added/subtracted to actual RO excess phase profiles and showed that the actual excess phase induced by the rain-scattering term does not result in a clear statistical bias in the bending angle and refractivity retrievals [Padullés et al. (2018)]. All these studies were conducted with COSMIC data, before the polarimetric RO (PRO) experiment aboard PAZ was active.

The PAZ experiment has shown that GNSS PRO observables are sensitive and quantitatively related to precipitation [Cardellach et al. (2019), Padullés et al. (2020)]. Therefore, a new study on the biases under precipitation conditions has been conducted with PAZ GNSS PRO data. The study has shown that the biases are gradually increasing with larger polarimetric signatures, and that the relationship between the magnitude of the bias and the magnitude of the polarimetric signatures is clearer than the relationship between these biases and the rain itself. That is, GNSS PRO observables can quantify the biases at different altitudes.

Moreover, PAZ has also shown that it is extremely sensitive to frozen particles above the freezing layer, where most of the reported biases occur (around ~6 km altitude). This fact, together with the finding that the biases seem more closely related to polarimetric signatures than rain itself, has re-opened some questions, and the previously proposed hypothesis needs to be revisited with these new observations: could the biases be due to the scattering off frozen particles? Then, should comparisons with the models include an ice-scattering term? Conversely, does the ice-scattering term have little effect on the retrievals? Could the models be systematically biased when these frozen particles, mostly linked to convection, occur?

A study will be presented to shed some light on these questions combining (a) PAZ polarimetric RO data; (b) numerical simulations of the excess phase induced by frozen particles to assess how it alters the final RO retrievals; (c) co-locations between COSMIC and CloudSat cloud ice measurements; and (d) O-B comparisons with respect to different reanalysis models.

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