CHARACTERIZING THE RADIO OCCULTATION BENDING ANGLE UNCERTAINTY IN THE LOWER TROPOSPHERE USING END-TO-END SIMULATIONS

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Radio Occultation (RO) technique has been widely used in numerical weather forecasting because of its unbiased nature, all-weather capability, and high vertical resolution. However, recent studies show that RO bending angle observations in the lower troposphere suffer from strong fluctuation and negative biases, which could fail the quality controls (QCs) in the data assimilation (DA) process. These significant bending angle uncertainties persist even in high SNR RO missions, such as COSMIC-2. The high QC rejection rate could significantly reduce RO impacts on weather forecast skills and the capability to resolve the complex moisture structure within the lower troposphere and planetary boundary layer (PBL).

The COSMIC-2 statistics show that the bending angle retrieval is mostly negative-biased compared to the NCEP reanalysis below the altitude where a sharp humidity change is present. In contrast, the bias is gradually reduced below the top of PBL. These observation errors could be attributed to several interconnected causes: instrument noise, sampling bandwidth, open-loop tracking model bias, atmospheric turbulence, and vertical smoothing applied to the bending profile retrieval.

This study used the end-to-end multiple phase screen (MPS) simulation to better characterize the bending angle error in the moist lower troposphere. The primary observation error sources can be identified by conducting the Monte-Carlo sensitivity test to the MPS simulated bending angle and comparing it with the actual retrieval. The initial results show that the bending angle bias and uncertainty observed in the RO data can be reproduced by including realistic levels of noise and refractivity fluctuations from atmospheric turbulence. We examined how the simulated biases and uncertainty change at different SNR conditions. In addition, an observation-only bias detection method using a spectrogram approach on the impact parameter domain will also be discussed.