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The data collected by the Radio Occultation (RO) technique has been widely used in weather forecasting applications because of its unbiased nature and high vertical resolutions. But due to the complex moisture structure below 5 km and strong gradient at the top of the planetary boundary layer (PBL), it has been challenging to observe the lower troposphere with RO measurements. Equipped with a JPL-developed TGRS RO receiver, the COSMIC-2 mission aims to resolve the lower troposphere better and decrease the penetration height by enhancing the Signal to Noise Ratio (SNR) with the beamforming technique. However, recent studies show that more than 80% of COSMIC-2 observations under 2km failed the quality control (QC) of the data assimilation (DA) process due to sizeable bending angle biases. The high QC rejection rate could significantly reduce COSMIC-2's impacts in weather forecasting.

In this research, we seek to better characterize the bending angle uncertainty of COSMIC-2 in the lower troposphere and investigate the cause of the bending angle biases. These biases are identified by comparing the bending angle retrieval with the ones calculated from NCEP reanalysis. A newly-developed forward operator is used to compute the bending under ducting conditions efficiently. The spectrogram analysis is applied to the COSMIC-2 data to characterize the impact parameter domain's energy distribution. The statistics show that the bending angle retrieval is mostly biased negatively at the altitude where a sharp refractivity change is present. In contrast, the bias is gradually diminished below the refractivity gradient peak. The observed negative bias is analyzed and quantified through end-to-end simulations in the moist lower-troposphere with different SNRs and complex atmospheric conditions. We will present the simulation results and discuss the potential cause of error in bending angle observations.
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