IMPLEMENTATION OF THE SUPER-REFRACTION CORRECTION FOR GNSS RO DATA AT THE STAR

S. Kireev (1), Y. Chen (2), S.-P. Ho (2), and Y. He (1)

(1) Global Science and Technology, Inc.
(2) NOAA/STAR

With high vertical resolution and all-weather sensing capability, the RO-derived atmospheric variables are applied widely for weather forecasting and detecting long-term climate signals. However, the super-refraction (SR) phenomenon, caused by sharp gradients of temperature and moisture in the Planetary Boundary Layer (PBL), is frequently observed in subtropical regions over oceans. SR results in systematic underestimating of the RO refractivity in and below PBL. It leads to the negative bias of RO retrieved water vapor compared to in-situ RAOB data and atmospheric profiles derived from microwave and infrared sounders. The NOAA/STAR RO inversion algorithm to convert refractivity into atmospheric pressure, temperature, and moisture profiles is recently enhanced with the ability to process SR cases. Under SR conditions, the refractivity should be corrected before using it in the retrieval. This is a challenging problem because a) in RO measurements, there is no information about the refraction index in the SR layer; b) the infinite number of corrected refractivity profiles satisfy the given bending angle; c) identification of the SR conditions can only be done from the bending angle or refractivity profile in the processing of actual data; d) the proper choice of correction is an ambiguous and arguable issue. We present how these challenges are met in the STAR RO-SR retrieval algorithm. To build a family of SR-corrected refractivity profiles, we implemented the approach proposed by F. Xie. We use RAOB data from the VOCALS campaign as references to simulate the SR refractivity. Then we apply the refractivity correction and retrieve the atmospheric variables for each family member. We use Global Forecasting System 6 hours forecast as the first guess for retrieval. The particular water vapor profile, which provides the minimal deviation of Total Precipitable Water from the first guess, is picked as the final retrieval. To validate the results, moisture profiles are compared with VOCALS RAOB data (123 pairs of SR cases total). After statistical averaging, the bias of humidity, retrieved from corrected refractivity, is about -0.3 g/kg for altitudes below 1.5 km, while it is in the range from -2 to -1 g/kg for retrievals from non-corrected refractivity. We will present the algorithm application to actual COSMIC observations, collocated with the VOCALS data. Results show that the STAR RO-SR algorithm significantly reduces the negative bias of moisture in PBL.