STAR GNSS RO PROCESSING, VALIDATION, AND MONITORING SYSTEM: VALIDATION OF THE SPIRE DATA PRODUCTS AND THEIR APPLICATIONS FOR NUMERICAL WEATHER PREDICTION AND CLIMATE STUDIES

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Global Navigation Satellite System (GNSS) Radio Occultation (RO) is becoming an essential component of National Oceanic and Atmospheric Administration (NOAA) observation systems.

NOAA has operationally assimilated the RO observations from the current NOAA mission (i.e., Constellation Observing System for Meteorology, Ionosphere, and Climate-2 (COSMIC-2)) and partners' missions (i.e., Challenging Minisatellite Payload, Korea Multi-Purpose Satellite-5 (KOMPSAT-5), Meteorological Operational satellite (MetOp) series -A/-B/-C Global Navigation Satellite System Receiver for Atmospheric Sounding (GRAS)) into the National Centers for Environmental Prediction (NCEP) numerical weather prediction (NWP) systems. NOAA is also purchasing RO Commercial Weather Data (CWD) from commercial vendors (i.e., GeoOptics, Inc. and Spire Global, Inc.) and assimilating the CWD into its NWP systems. To optimize the usage of RO data in data assimilation systems, it is necessary to quantify the accuracy and the uncertainty of the RO-derived atmospheric profiles, especially in the lower troposphere, understand the sources of uncertainty and optimize the data impacts on NWP.

In the past three years, the Center for Satellite Applications and Research (STAR) has developed capabilities as a GNSS RO processing and science center. This is to develop the ability as a national satellite center to perform NOAA operational processing and NOAA science development, support, archive, and steward for the operational processing and data quality monitoring. To better quantify how the observation uncertainty from clock error and geometry determination may propagate to bending angle and refractivity profiles, STAR has developed the GNSS RO Data Processing and Validation System. We will use this system to assess the Spire product quality. In this study, we first describe STAR RO Data Processing System, which includes: i) STAR's conversion of Spire carrier phase to excess phase, ii) bending angle inversion algorithm, and iii) one-dimension variational approach to convert refractivity to temperature and moisture profiles. We then provide the validation of the STAR's processed results for the Spire mission. We demonstrate the usefulness of Spire data for the numerical weather prediction system through data assimilation and quantify their impacts and present the potential climate and atmospheric applications using Spire data among measurements from all available RO missions.