DEVELOPMENT OF EXCESS PHASE PROCESSING ALGORITHM FOR MULTI-RO MISSIONS AND DATA QUALITY IMPROVEMENTS AT STAR

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With recent addition of CubSATs (i.e., Spire, GeoOptics, PlanetIQ) to the GNSS RO family, more and more RO receivers with different sensing quality deployed into space to detect the atmosphere path delays of the GNSS signals. While the processing algorithms are generally similar for all missions, the sensor-dependent L1a observations and mission-specific requirements require special processing and customized interfacing software for each sensor. The comparisons between various missions are generally consistent above 8 km altitude. However, the differences are usually not negligible below 8 km. The bending angle retrieval quality in the lower atmosphere is often correlated with the open-loop technique.

Recent RO satellites (COSMIC-2, Spire and GeoOptics) can receive the GPS and GLONASS signals. While COSMIC-2 are also designed to track Galileo satellite signals, there are no actual occultation data tracking Galileo satellites yet. Spire satellites have occultation profiles from tracking the Galileo satellites. Current daily RO profiles assimilated into NWP models are far less than saturation. Inclusion of different GNSS systems in occultation can double or triple daily RO profile numbers. which can potentially improve the NWP weather forecasting skills. However, processing RO observations from receivers under new GNSS systems poses difficulties and challenges for the RO L1a to L2 data conversion. The differences in dealing with GLONASS and Galileo systems from GPS are mainly due to the signal frequency, SNR level, satellite clock system, satellite orbital accuracy, and the receiver differences. These differences can contribute to the error propagation in the RO data processing from the Precise Orbit Determination (POD) to the excess phase calculation. Including GLONASS satellites in POD may result in a different POD solution; processing occultation from Galileo signals also poses difficulty in dealing with the simulation of the open-loop phase model, signal frequency, navigation bit removal, signal smoothing/filtering, etc.

In this study, we characterize RO receivers regarding the SNR values, clock stability, number and orientation of the POD and RO antennas, satellite orbits, and the receiver open-loop model through multiple RO missions at NOAA-STAR. We compare algorithm differences in RO processing (carrier phase to bending angle) from different RO missions and quantify the difference and uncertainty in the POD, excess phase, and bending angle. We also quantify the impacts of the receiver update and decay on the bending angle time series.