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GNSS Clock Error Impacts on Radio Occultation Retrievals

Jan Weiss, Sergey Sokolovskiy, Bill Schreiner, and Yoke Yoon
University Corporation for Atmospheric Research, Boulder, United States (weissj@ucar.edu)

We assess the impacts of GPS and GLONASS clock errors on radio occultation retrieval of bending angle, refractivity, and temperature from low Earth orbit. The major contributing factor is the interpretation of GNSS clock offsets sampled at 30 sec or longer intervals. Using 1 Hz GNSS clock estimates as truth we apply several interpolation and fitting schemes to evaluate how they affect the accuracy of atmospheric retrieval products. The results are organized by GPS and GLONASS space vehicle and the GNSS clock interpolation/fitting scheme. We find that bending angle error is roughly similar for all current GPS transmitters (about 0.7 mcrad) but note some differences related to the type of atomic oscillator onboard the transmitter satellite. GLONASS bending angle errors show more variation over the constellation and are approximately two times larger than GPS. An investigation of the transmitter clock spectra reveals this is due to more power in periods between 2-10 sec. Retrieved refractivity and temperature products show clear differences between GNSS satellite generations, and indicate that GNSS clocks sampled at intervals smaller than 5 sec significantly improve accuracy, particularly for GLONASS. We conclude by summarizing the tested GNSS clock estimation and application strategies in the context of current and future radio occultation missions.