

**Submission Title:**

The Impact of Assimilating Large Volumes of GNSS Radio Occultation Observations from Spire's Commercial Constellation into NASA's Global Earth Observing System

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**Abstract**

The upcoming retrospective analysis for the 21st century (R21C) reanalysis product from NASA will include the full dataset of GNSS Radio Occultation (RO) observations collected by Spire with their constellation of smallsats. The Spire RO dataset, which was purchased by NASA for its Commercial Smallsat Data Acquisition (CSDA) archive, has global coverage and includes approximately 6 thousand RO profiles per day during 2019 increasing to nearly 20 thousand in 2022-2023. This more than doubles the volume of RO profiles from all other routinely assimilated RO missions combined during 2023. The increase in the number of RO profiles available is particularly important in the extratropics as the next largest RO constellation, the state-of-the-science Formosa Satellite Mission 7 (FORMOSAT-7)/Constellation Observing System for Meteorology, Ionosphere and Climate (COSMIC-2) mission (hereafter COSMIC-2), is focused on the Tropics and only provides approximately 4 thousand RO profiles per day. The large number of observations in the Spire RO dataset have great potential to improve analyses and forecasts of the Earth's atmosphere produced by numerical weather prediction systems. Their impact is assessed through numerical experiments using NASA's Global Earth Observing System (GEOS) Atmospheric Data Assimilation System (ADAS) with and without the observations from the COSMIC-2 mission. The ability of the Spire RO observations to make up for the omission of the RO observations from COSMIC-2 is directly assessed over the tropics and the impact of Spire over the extratropics is compared to that of the available RO missions that sample over this region. Finally, the quality of the Spire RO observations is compared to that of the routinely assimilated RO missions using Forecast Sensitivity-based Observation Impact (FSOI).