

# Radio occultation profile results obtained from Spire's CubeSat GNSS-RO constellation

Vladimir Irisov<sup>1</sup>, Dave Ector<sup>1</sup>, Timothy Duly<sup>1</sup>, Vu Nguyen<sup>1</sup>, Christian Rocken<sup>2</sup>, Michael Gorbunov<sup>3</sup>,  
Oleguer Nogues-Correig<sup>1</sup>, Linus Tan<sup>1</sup>, Takayuki Yuasa<sup>1</sup>

<sup>1</sup> Spire Global, Inc, 1050 Walnut St., St. 402, Boulder, CO 80302

<sup>2</sup> GPS Solutions, Inc, 1320 Pearl St, Boulder, CO 80302

<sup>3</sup> A.M.Obukhov Institute of Atmospheric Physics, Russian Academy of Sciences, Moscow, Russia

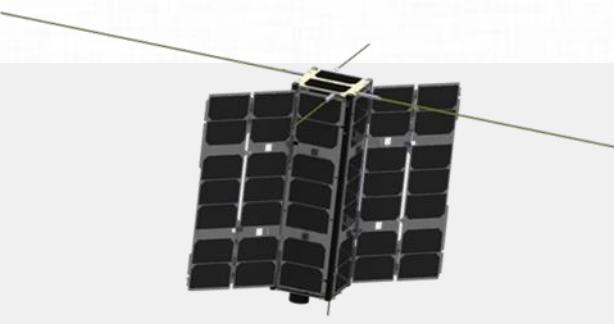
# Outline

- NOAA/NESDIS Commercial Weather Data Pilot
- RO Processing
- Statistical results
- Conclusion and Plans



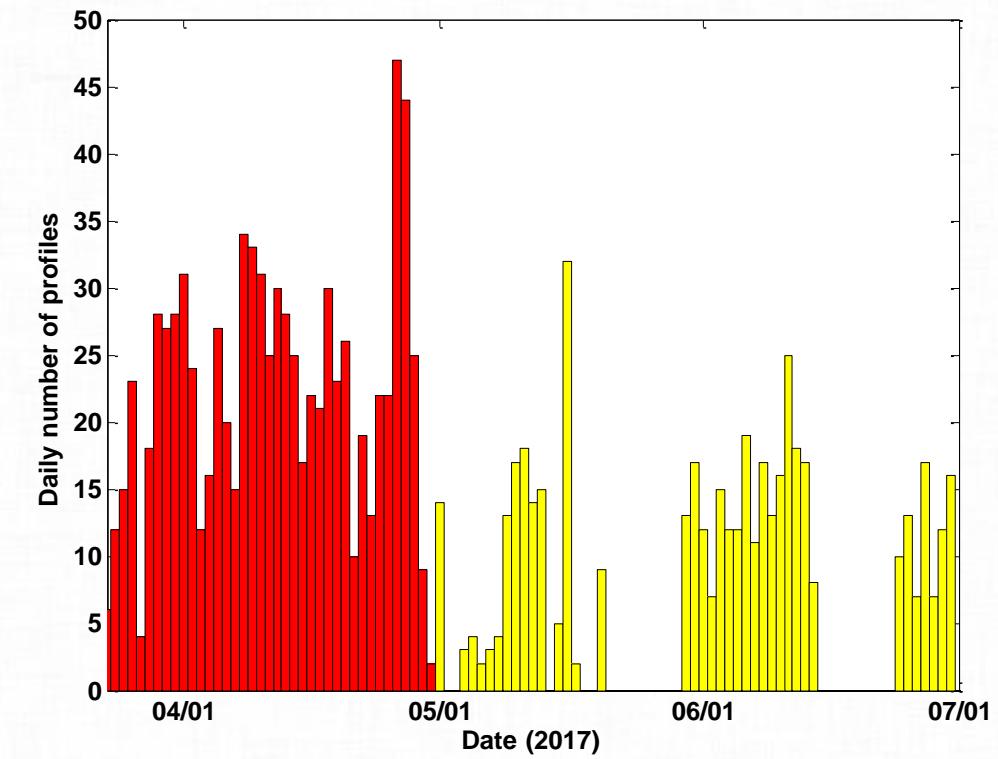
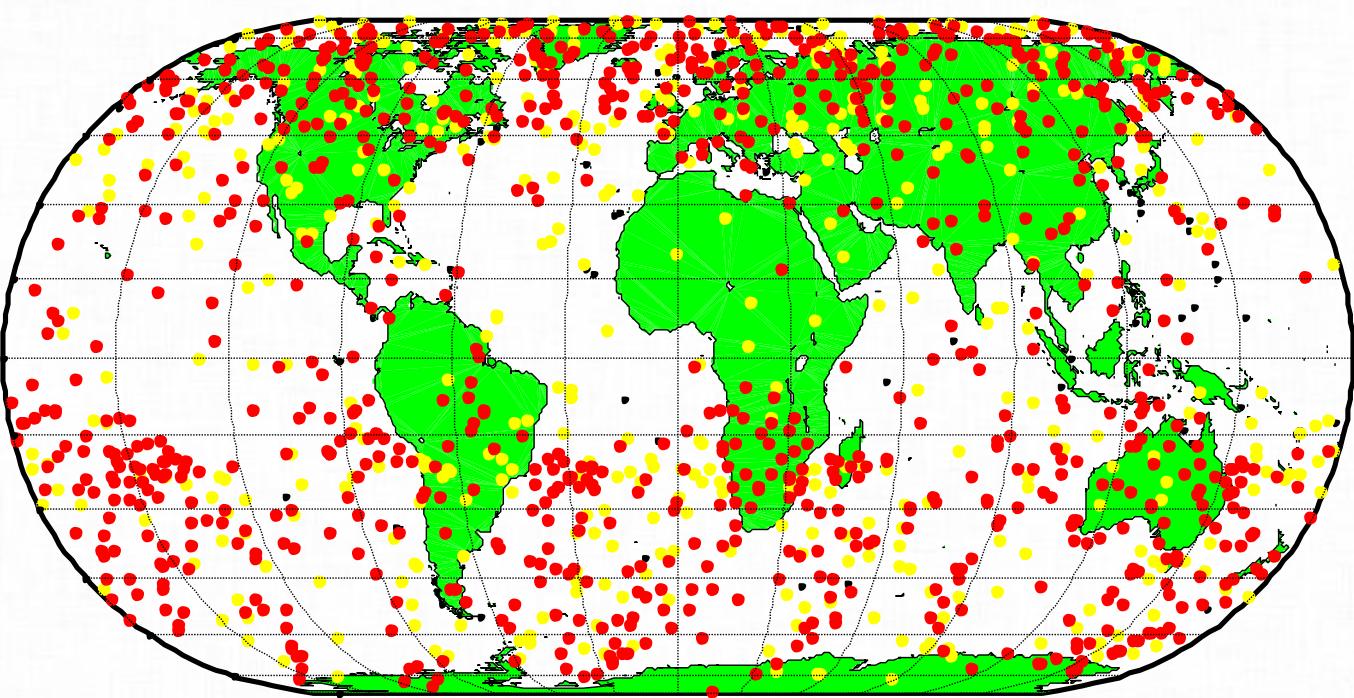
# Spire NOAA trial

- STRATOS GNSS open loop digital receiver on 3U nanosatellites.
- Advanced POD code capable to handle GNSS signals of both dual and single frequency.
- Cloud-based Spire Processing Center and full-chain RO processing software.
- Open loop profiles processed during March 23 – April 31, 2017.
- JPL helping to assess the data quality.



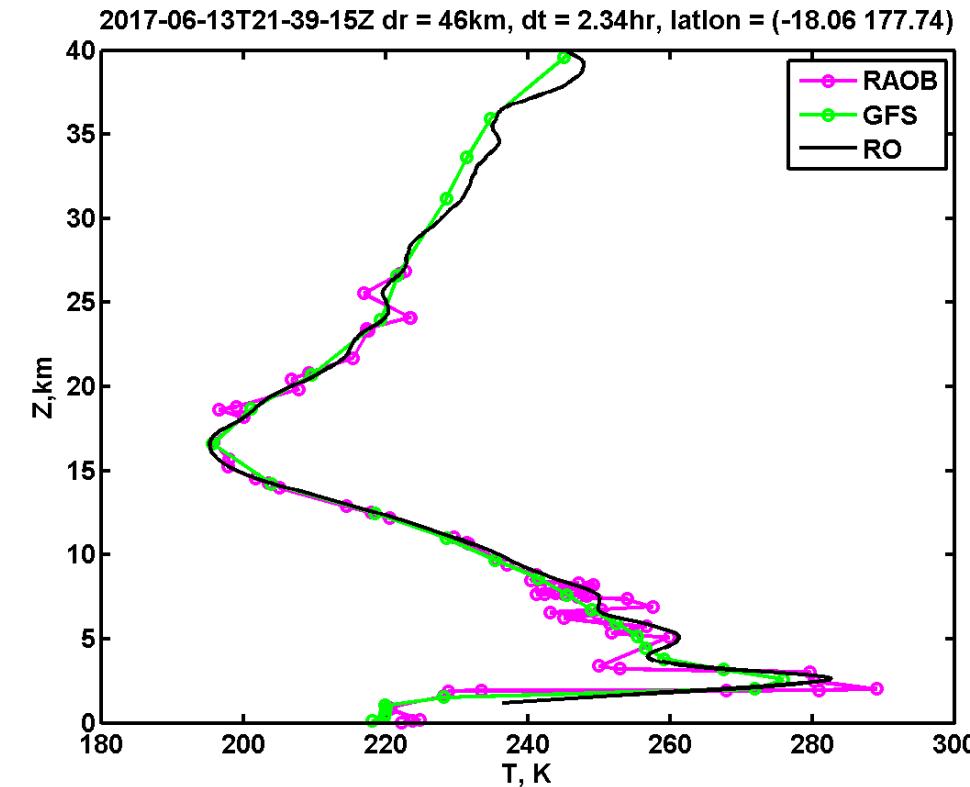
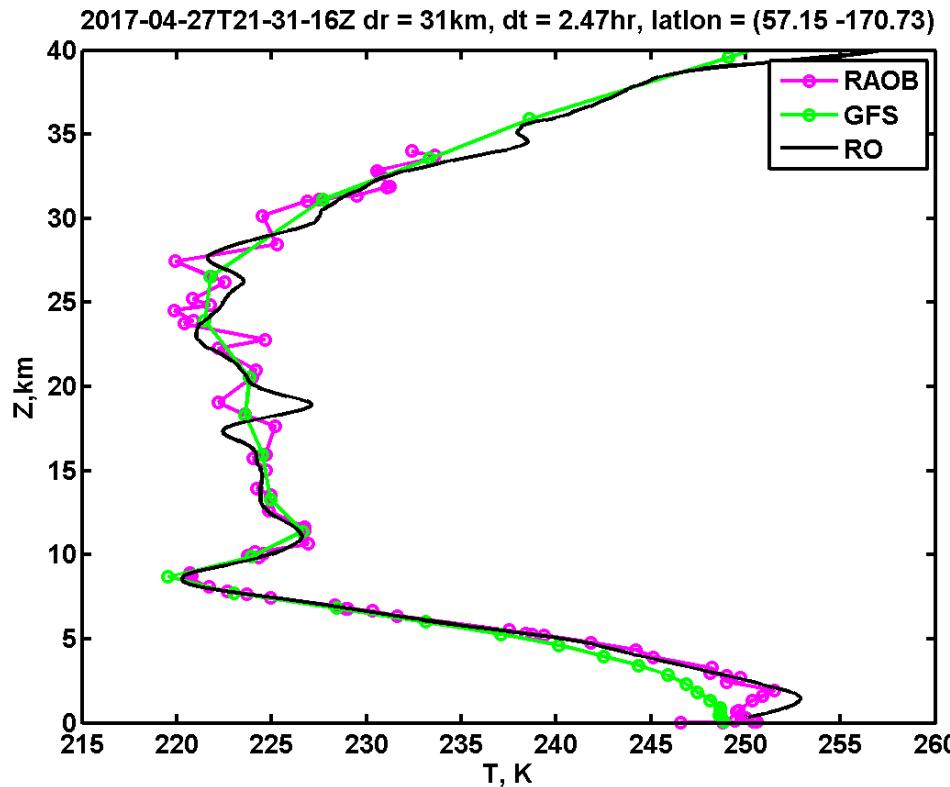
# Global and Temporal Distribution of SPIRE Profiles

Red – NOAA trial period



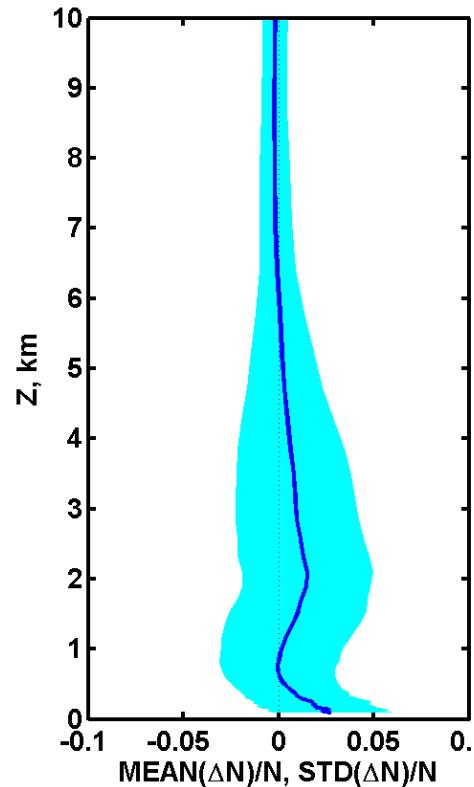
# Examples of “Dry” Temperature Profiles

RAOB selection: space distance < 50 km AND time difference < 3 hours.

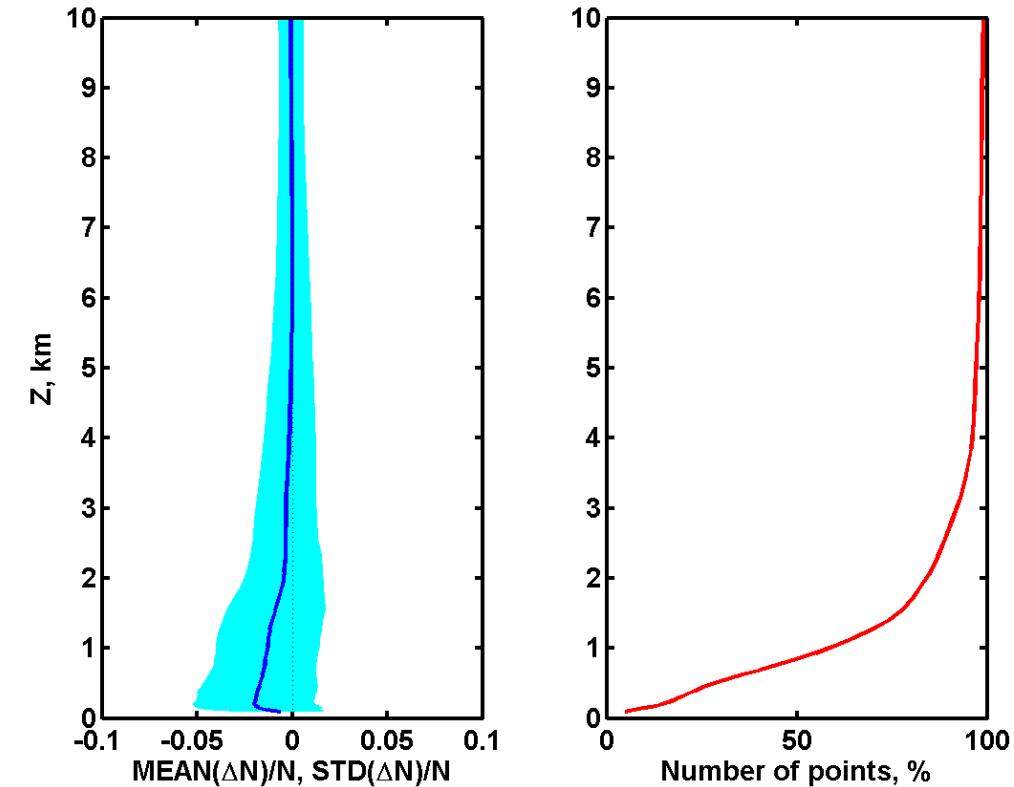


# Statistical Comparison of Refractivity Profiles vs. GFS analysis with COSMIC data

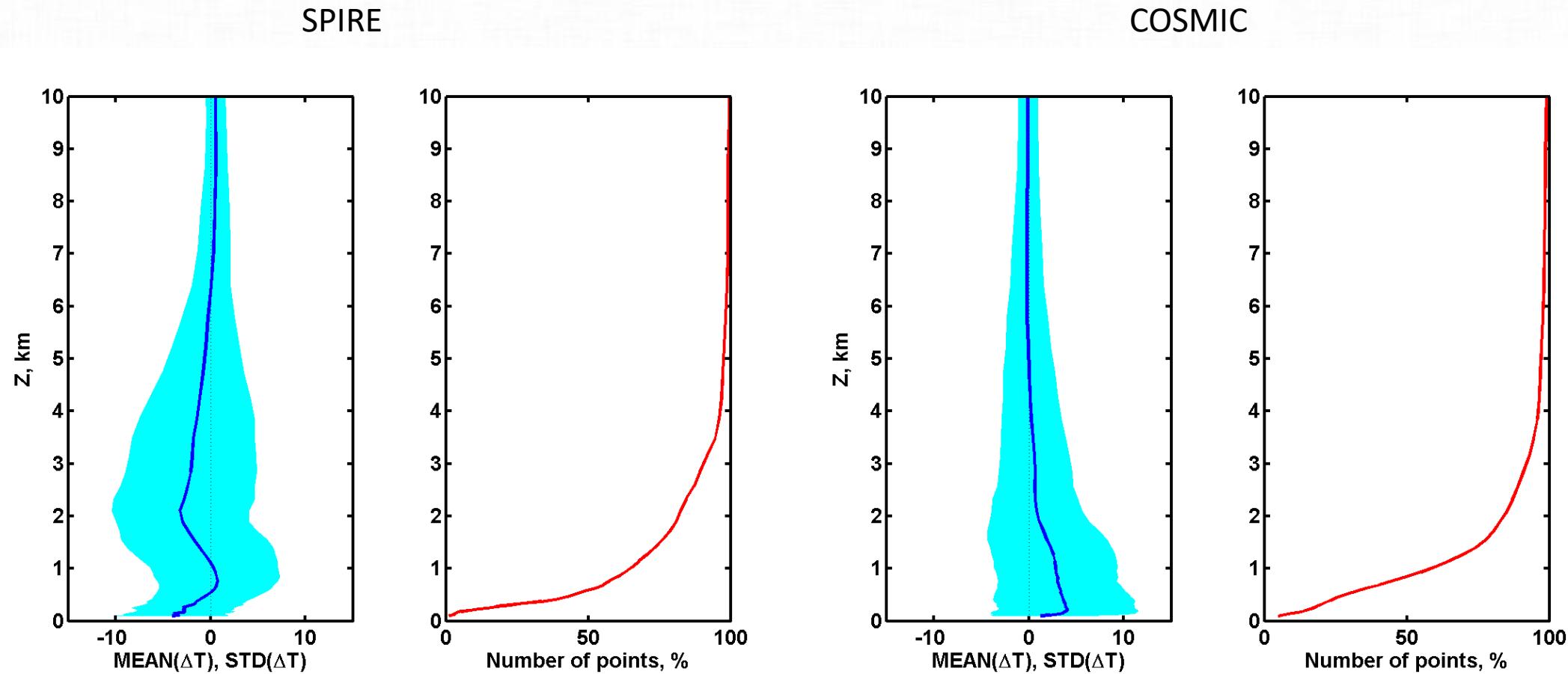
SPIRE sounding and processing (QC: 78.1%)



COSMIC sounding and processing (QC: 80.1%)



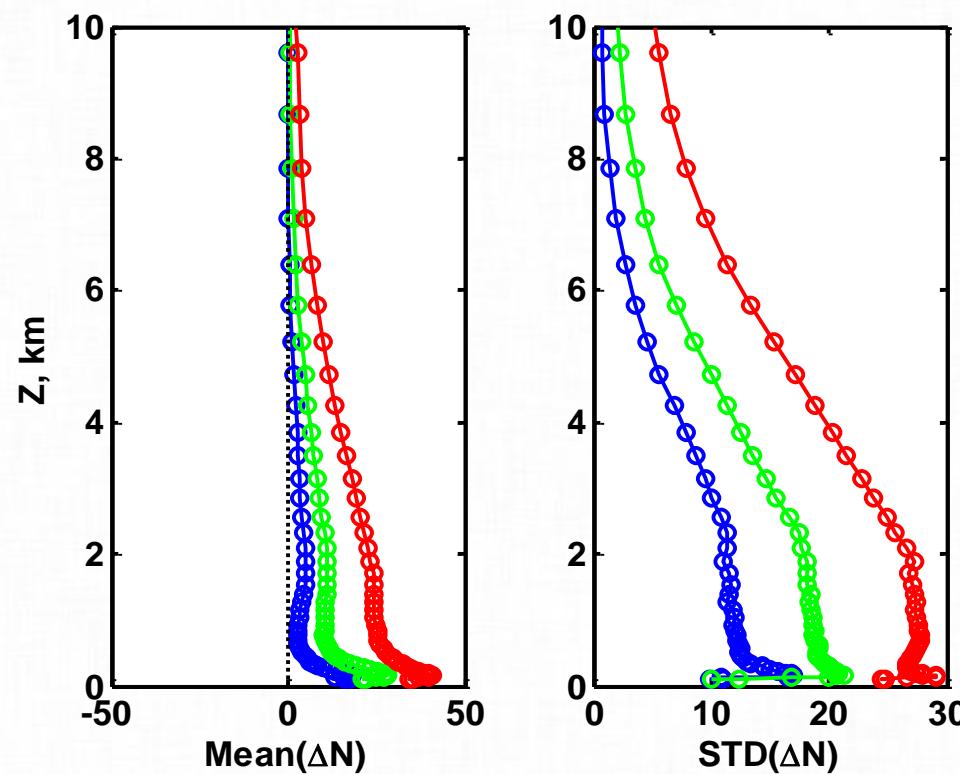
# Statistical Comparison of “Dry” Temperature Profiles vs. GFS analysis with COSMIC data



# Effect of the Added Noise to I and Q RO signals

Bias and STD of refractivity (N-units) for the three levels of the noise:

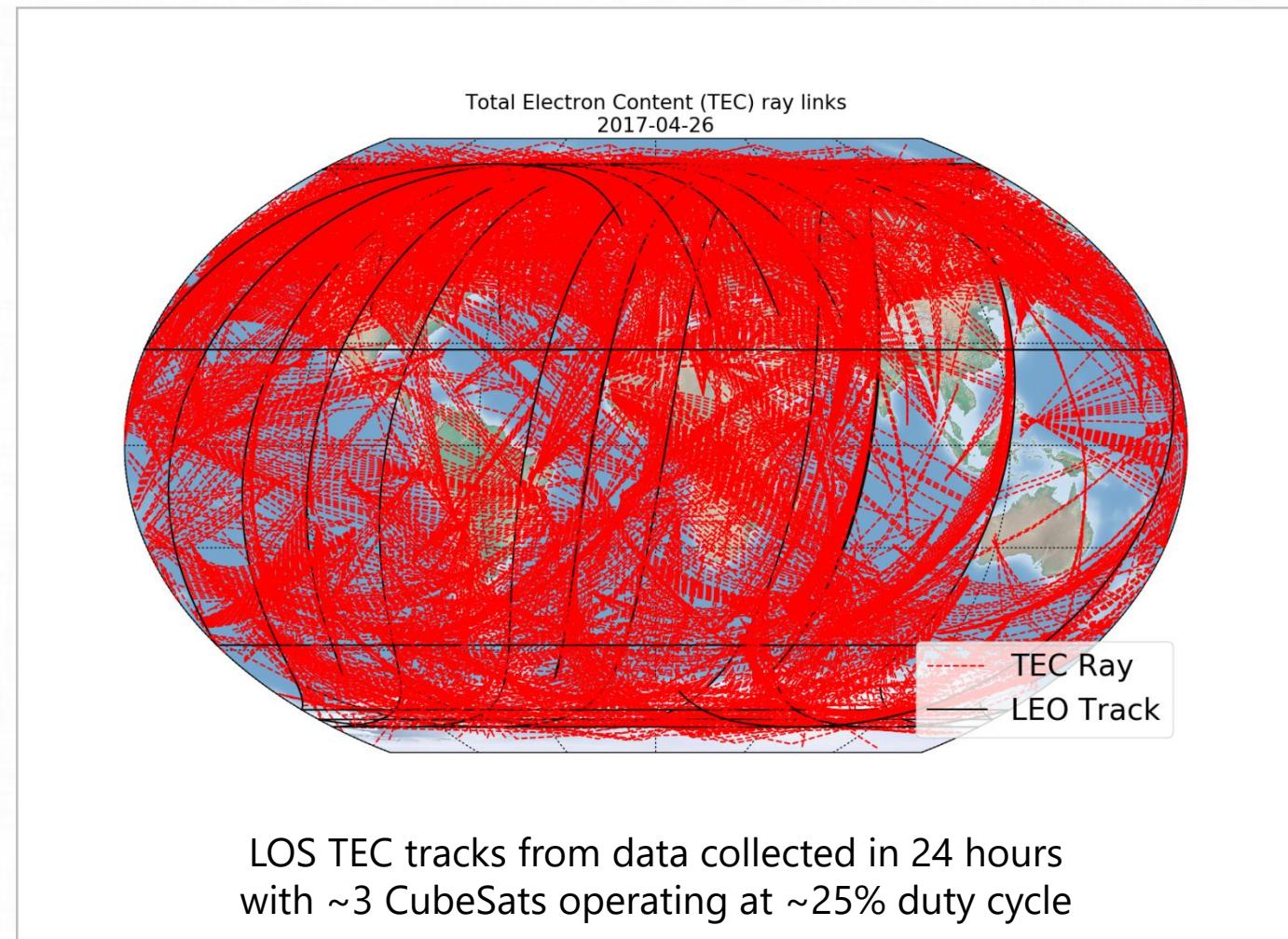
blue – no added noise, green –  $+1^*\sigma$ , red –  $+2^*\sigma$



- Added noise results in positive refractivity bias and increased STD.
- Added noise results in lower correlation between RO and GFS refractivity profiles for MSL altitudes above 0.4 km.

# Ionospheric Data

- In addition to retrieving and processing a number of high quality vertical atmospheric profiles, Spire also collected a wealth of information about the ionosphere during NOAA Trial.
- For more information, see Poster #5: *“Recent ionosphere collection results from a 3U CubeSat GNSS-RO constellation”*



## Conclusion and Plans

- Spire delivered data for NOAA trial.
- Open loop RO profiles were processed between March 23 and June 30, 2017.
- Statistical quality of RO profiles is comparable with that of COSMIC.
- New version 3.0 can track up to 12 dual-frequency POD satellites and 2 open loop RO satellites.
- Spire plans to participate in the second round of NOAA trial – expected early 2018. We expect up to 10 RO dedicated satellites (depends on launch schedule).
- Our objective: 6 months -- 2500 profiles/day, 12 months -- 5000 profiles/day.

