# Space-born detection of long-term tropopause trends

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## 1. Objectives

1) Validate and evaluate radio occultation (RO) tropopause measurements using collocated radiosonde station measurements as reference data

2) Compare RO tropopause and upper troposphere / lower stratosphere (UTLS) measurements with those from reanalyses

3) Examine RO tropopause anomaly time series and apply regression methods to examine long-term tropopause behavior..

## 2. RO validation

To validate RO measurements, we compare individual RO temperature profiles from the University Corporation for Atmospheric Research (UCAR) to nearby radiosonde soundings from the Integrated Global Radiosonde Archive (IGRA). We find:

- Global mean RO – radiosonde tropopause temperature differences are generally within 0.5 K and 75 m.
- Tropopause measurements from different RO instruments are generally within 0.1 K and 41 m for the globe.
- Dissimilarly processed temperature data can differ by as much as 2 K in the zonal mean.
- Tropopause height data does not appear to be significantly affected by the processing methods examined in this study.

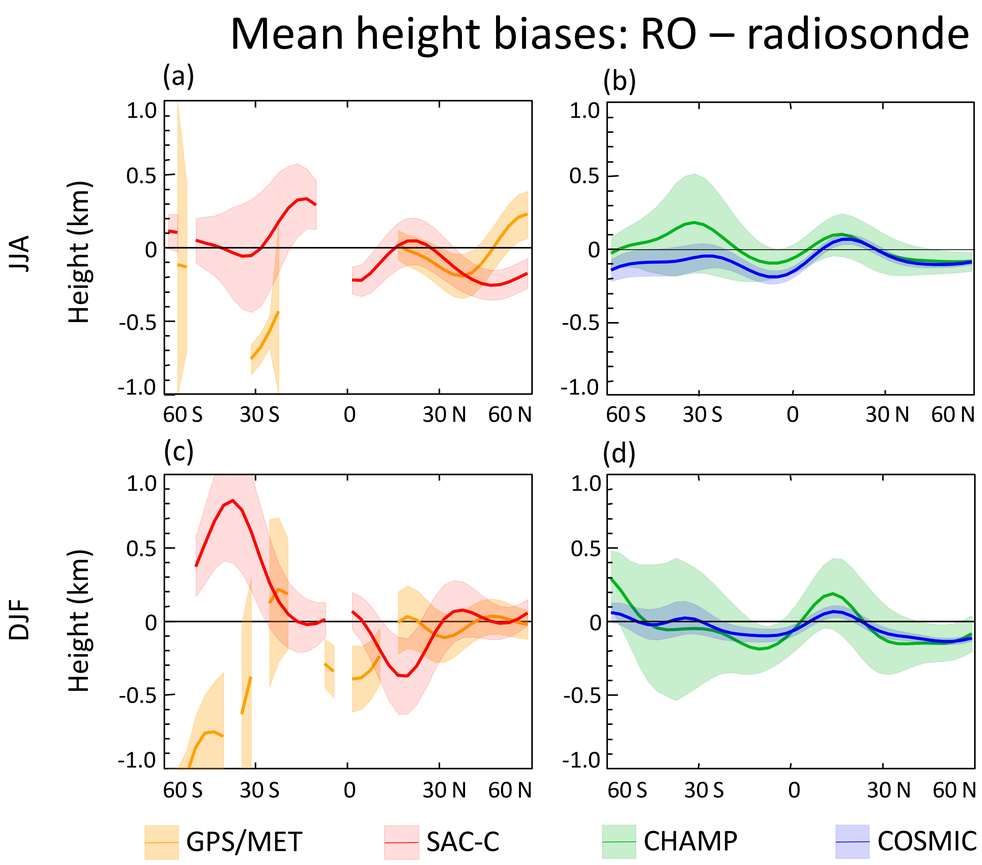


Figure 1. Zonal mean height differences between RO tropopauses and nearby radiosonde tropopauses. Differences are shown for boreal (a, b) and austral (c, d) summer. Values are Gaussian smoothed over ±30 °. Gaps represent insufficient data. Average global instrument biases are 1.06 K for GPS/MET, 0.25 K for SAC-C, 0.3 K for CHAMP, and 0.29 K for COSMIC.

Results published in Staten, P. W., and T. Reichler (2008), Use of radio occultation for long-term tropopause studies: uncertainties, biases, and instabilities, *J. Geophys. Res.*, *(In Press)*.

RO and radiosonde data was provided by NCAR, GFZ Potsdam, and NOAA. NCEP/NCAR Reanalysis data provided by the NOAA/OAR/ESRL PSD. This work was supported by NASA Headquarters under NASA Earth and Space Science Fellowship Program – Grant 08-Earth08R-3 and by NSF Grant ATM 0532280.

## 3. Preliminary comparison with reanalyses

We evaluate RO and reanalysis data by creating global tropopause pressure and temperature maps, and comparing these with reanalyses. Preliminary inspection of measurements from the Constellation Observing System for Meteorology, Ionosphere and Climate (COSMIC) and the NCEP / NCAR Reanalysis (NNR) leads to the following observations:

- COSMIC – NNR tropopause differences are generally strong near the poles, where the lapse rate tropopause definition breaks down.
- COSMIC tropopause temperatures are generally cooler than those from NNR, although temperatures in the UTLS region (not shown) show no such global bias. The relative warmth of the NNR tropopause may be due to smoothing during data assimilation.
- Pressure differences vary substantially between seasons.

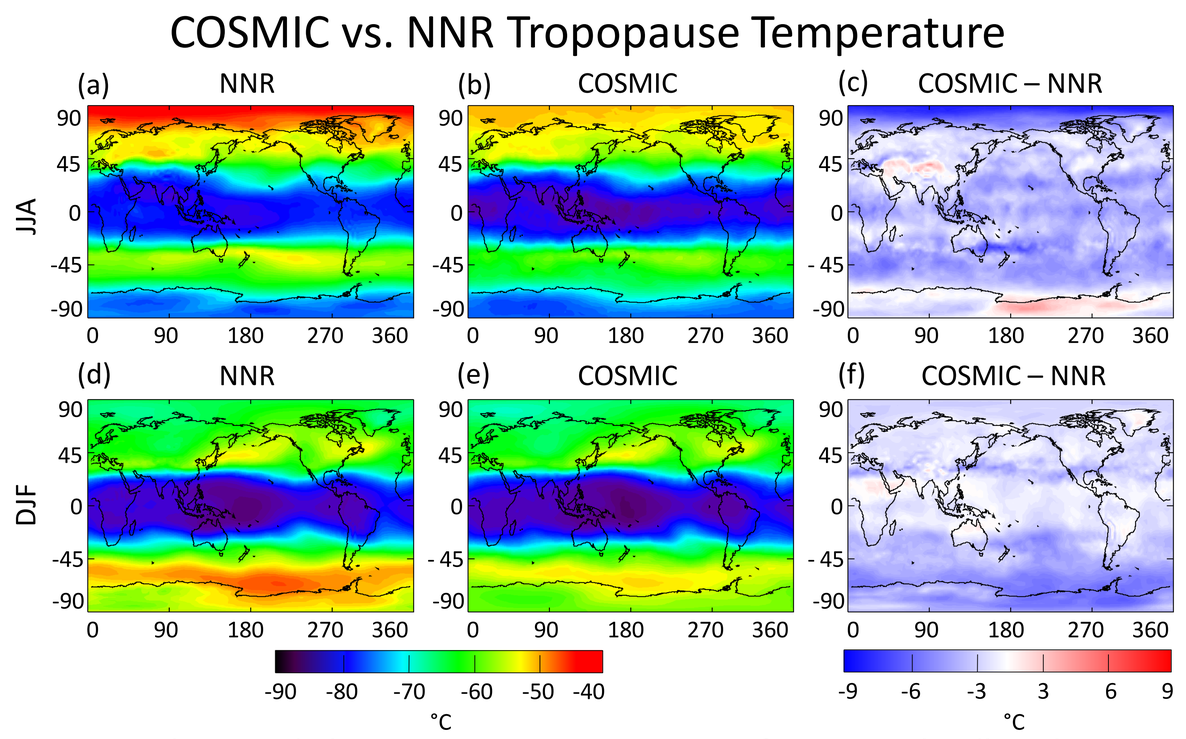


Figure 2. Seasonal mean daily tropopause temperatures from NNR (a, d) and COSMIC (b, e), as well as the difference between the two (c, f) for JJA (a, b, c) and DJF (d, e, f).

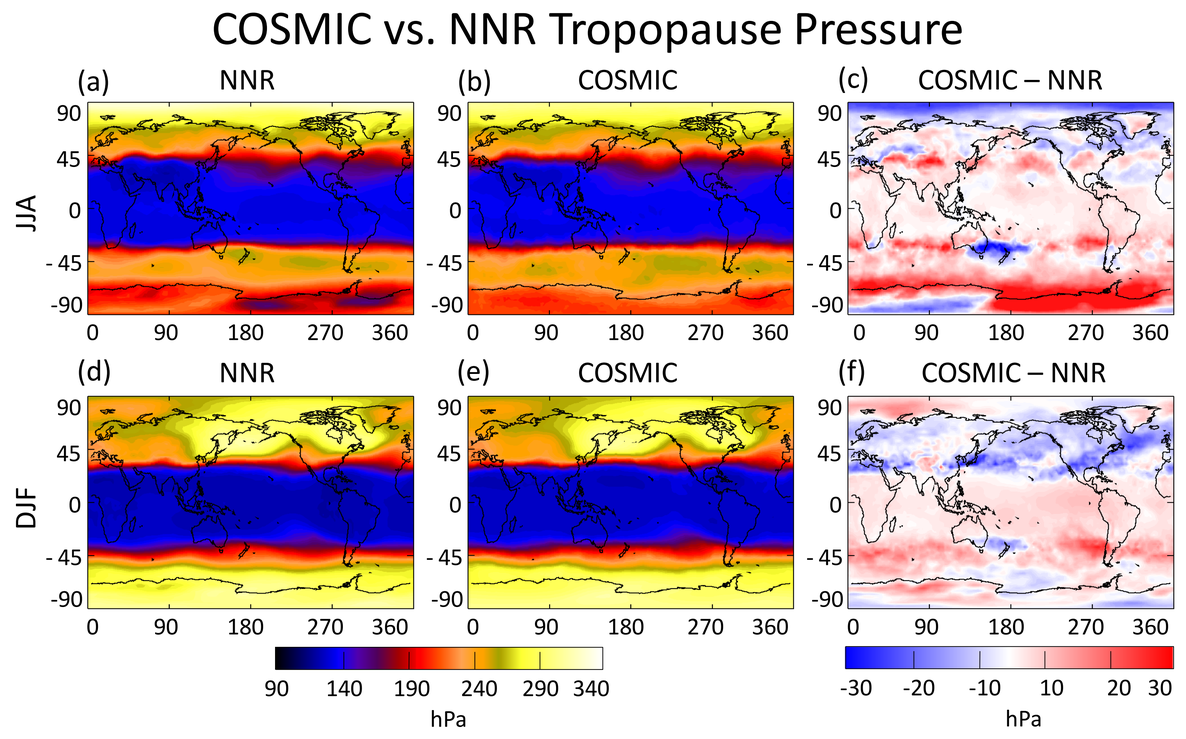


Figure 3. Seasonal mean daily tropopause pressures from NNR (a, d) and COSMIC (b, e), as well as the difference between the two (c, f) for JJA (a, b, c) and DJF (d, e, f).

## 4. Future Research

The capability of RO in measuring the UTLS region and the lapse rate tropopause raises several key questions:

- How effectively can we use RO to validate reanalysis tropopause data? How do reanalyses perform in data-void regions?
- Are measured trends in radiosonde and reanalysis tropopause data present in the current RO dataset? How will the long-term tropopause behavior in the different datasets compare?
- What confidence can we place on inferences based on RO tropopause measurements?