Quantification of Structural Uncertainty in Climate Data Records from GPS Radio Occultation

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GPS radio occultation (RO) provides observations of the Earth's atmosphere with best quality in the upper troposphere and lower stratosphere. Its properties comprise global coverage, essentially all-weather capability, good vertical resolution, long-term stability, and homogeneity making it well suited for climate monitoring. RO errors are well characterized from observational errors of single profiles to the full error description of climatologies. Especially for the establishment of an RO climate record the quantification of structural uncertainty arising from different processing schemes is of high importance. In this study we quantify the structural uncertainty of trends estimated from the RO record, which arises from current processing schemes of six international RO processing centers, DMI Copenhagen, EUM Darmstadt, GFZ Potsdam, JPL Pasadena, UCAR Boulder, and WEGC Graz. We analyze bending angle, refractivity, dry pressure, dry geopotential height, and dry temperature of monthly 5-deg zonal mean climatologies at 8 km to 30 km for the CHAMP RO record 09/2001–09/2008. Intercomparison is performed for tropical, mid-, and high latitude bands. After subtraction of the sampling error, anomaly time series and their difference to the all-center mean are computed. Statistical analysis of the respective difference time series allows quantifying the structural uncertainty of RO data stemming from different processing schemes. We find that structural uncertainty is lowest in the tropics and mid-latitudes (50°S to 50°N) from 8 km to 25 km for all inspected RO variables. In this region, the structural uncertainty in trends over 7 years is <0.03% for bending angle, refractivity, and pressure, <3 m for geopotential height of pressure levels, and <0.06 K for temperature. Larger structural uncertainty above about 25 km and at high latitudes is attributable to differences in the processing schemes, which undergo continuous improvements. Though current use of RO for reliable climate trend assessment is bound to within 50°S to 50°N, our results show that quality, consistency, and reproducibility are favorable in the UTLS for the establishment of a climate benchmark record.