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Assessing Structural Uncertainty in Climate Data Records from GPS Radio Occultation

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Uncertainty quantification plays a key role in the establishment of fundamental climate data records. Requirements are long-term stability, reproducibility, global coverage, accuracy, resolution in space and time, description and validation of the products. GPS radio occultation (RO) is a promising source for atmospheric climate records with best quality in the upper troposphere and lower stratosphere (UTLS). Its properties comprise global coverage, nearly all-weather capability, good vertical resolution, long-term stability, and homogeneity. RO errors are well characterized for single profiles as well as for climatological fields.

In this study we quantify the structural uncertainty of 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 atmospheric variables based on monthly 5-deg zonal mean fields at 8 km to 30 km for the CHAMP RO record 09/2001–09/2008. Anomaly time series are computed and their difference to the all-center mean. Anomaly difference trends and the standard deviation of the all-center mean trend are used as an estimate of the structural uncertainty.

We find that structural uncertainty is lowest in the tropics and mid-latitudes 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. Although reliable climate trend assessment with RO is currently bound to within 50°S to 50°N, our results show that quality, consistency, and reproducibility are favorable in the UTLS for establishing of a climate benchmark record.