Improving the Value of Radio Occultation Data for Monitoring Climate in the UTLS

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During the past decade we have worked on establishing the Global Navigation Satellite System (GNSS) Radio Occultation (RO) as a new data source for climate monitoring. The technique has the potential to deliver climate benchmark measurements of the upper troposphere and lower stratosphere (UTLS), since RO data can be traced (in principle) to the international standard for the second. RO climatologies from different satellites show an amazing consistency (better than 0.1 K) and the value of RO data for climate monitoring is therefore increasingly recognized by the scientific community. In order to fully exploit the potential of RO it is important to understand (and if possible, remove) small residual systematic errors that might be common to all data sets.

Data processed from different centers show differences due to structural uncertainty, which is still small at bending angle level, but increase through the retrieval chain. The retrieval step from bending angle to refractivity is a major source for structural uncertainty, since it requires background information at high altitudes, where individual RO profiles are too noisy. When data and background are combined by statistical optimization, the observations are inversely weighted with the measurement error. A bias in the background profile will result in a bias in the retrieved profile down to an altitude that depends on the noise of the data. An unbiased high altitude background - or data with low noise up to high altitudes - would therefore be highly beneficial. High altitude background information could, however, become (largely) obsolete in climate applications, when averages over many RO profiles are used. Average refractivity profiles can then be obtained by averaging many bending angle profiles in a domain and then inverting this average bending angle profile to a single refractivity profile (instead of averaging refractivity profiles, which have been obtained by inverting individual bending angle profiles). We tested different implementations of the Average Profile Inversion (API) approach at the Danish Meteorological Institute (DMI) and the Wegener Center for Climate and Global Change (WEGC) and successfully validated them against independent data.

Another potential source for systematic errors is the ionospheric correction, which is usually applied as an approximation to first order. We identified small ionospheric residuals during high solar activity – together with a potential way to remove them.

Key words: Climate, UTLS, Radio Occultation