RADIAL ASYMMETRY CORRECTION ASSESSMENT BY END-TO-END SIMULATIONS AND ANALYSIS OF RO DATA

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The retrieval of atmospheric profiles from radio occultation (RO) measurements assumes local spherical symmetry of the atmosphere about the (mean) tangent-point location of RO events, for instance in the Abel integral used in refractivity retrieval and the hydrostatic integral used in pressure retrieval. However, since the real atmosphere is not exactly spherically stratified, and also since tangent-point trajectories are not vertical but rather 3D curves, the symmetry assumption in retrieval algorithms introduces errors when the retrieved profiles are interpreted (or used) as in-situ measurements.

We find that longitudinally horizontal gradients are small, in general, and that the main contribution to statistical biases from horizontal variations comes from the RO signal ray-paths in the latitudinal direction. A residual error correction based on estimating the along-ray asymmetry and accounting for the obliqueness of the tangent-point trajectory hence seems a valuable algorithmic feature.

Based on Syndergaard et al. (2005), who published a refractivity mapping operator for assimilation of RO data for numerical weather prediction purposes, we investigated the application of this mapping operator for such a residual error correction within Wegener Center's new Reference Occultation Processing System (rOPS). We used ray-traced bending angle profiles under suitable simulation conditions (orbit geometry, (a)symmetric atmosphere) for end-to-end simulations through ECMWF analysis fields. Additionally, we used real RO bending angle data as input to the assessment. Based on the ECMWF fields and the mapping operator, and retrieving refractivity and (dry-)atmospheric profiles of pressure and temperature assuming spherical symmetry, we analyzed the error correction statistically. We find highest bias correction potential in the mid-latitude and polar regions, where salient latitudinal refractivity gradients occur. The correction clearly enables improved accuracy across the stratosphere and into the upper troposphere, while its effect at the lowest altitudes is difficult to assess.