4D-dynamical high altitude initialization of GPS radio occultation bending angles

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The quality of retrieved Global Navigation Satellite System (GNSS) radio occultation (RO) atmospheric profiles suffers at high altitudes from a low signal-to-noise ratio. Noise in bending angle profiles at high altitudes is transferred to refractivity from top downward through Abel transform integration and then further transferred to other atmospheric profiles through the hydrostatic integral. To reduce the effect of downward error propagation into the lower stratosphere, it is important to carefully initialize bending angles at high altitudes. The statistical optimization approach is a commonly used method to smooth the noise of bending angles. This method combines observed and background bending angles to determine optimal profiles, in the sense of optimal estimation by inverse error covariance weighting.

In this context, this presentation focuses on the dynamical estimation of the background bending angle error covariance matrix, in support of the optimal estimation, and assesses its impact on retrieval performance. Current optimization algorithms generally assume the standard deviation of the background bending angle profiles to be about 15 % or 20 %, applying this ad-hoc estimate in a global static manner. Similarly, global static values are applied for vertical error correlation. However, bending angle errors vary with altitude, geographic location (especially latitude), and season, so that the global static assumption is significantly violated.

We introduce a 4D-dynamical (space- and time-varying) background bending angle error model and evaluate its utility in terms of retrieved refractivity and temperature performance in the lower stratosphere within 15 to 35 km. The model is based on error covariances estimated from ECWMF analysis and short-range forecast fields and tested within the End-to-end Generic Occultation Performance Simulation and Processing System (EGOPS) framework of WEGC against the current statistical optimization implementations of WEGC's OPS and GRAS-SAF's ROPP processing chains. Both quasi-realistically simulated data from EGOPS as well as real data from CHAMP, COSMIC, GRACE, and MetOp satellites are part of the ensemble of our test data. The results illustrate the value of a dynamical modelling of background bending angle errors.