FIRST RESULTS FROM TWO-DIMENSIONAL BENDING ANGLE OPERATOR FOR AIRBORNE RADIO OCCULTATIONS

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Atmospheric River Reconnaissance (AR Recon) campaigns collect targeted observations of significant winter weather events contributing to long duration heavy precipitation and flooding on the U.S. West Coast. Airborne radio occultations (ARO) together with dropsonde observations are key datasets for studying vertical moisture structures in such frontal systems. However, in order to improve forecasts of atmospheric rivers based on ARO, an observation operator needs to be developed to allow assimilation of ARO geophysical variables into numerical weather prediction models. A two-dimensional (2-D) operator is preferred due to the nature of ARO measurements as well as significant horizontal inhomogeneities associated with atmospheric river events. This goal has been achieved by modifying the existing “state-of-the-art” spaceborne RO operator provided in the forward module of ROM SAF Radio Occultation Processing Package (ROPP). The developed operator simulates ARO bending angles using two-dimensional background information from ECMWF ERA5 fields. Since ARO measurements are characterized by significant horizontal drift of tangent points with altitude, especially in the upper levels near the aircraft, the corresponding forward modeling errors are mitigated by taking into account the tangent point drift. Observed minus Background (O-B) statistics based on observations collected during intensive operating periods sampling an impactful AR in 2021 are used to assess error properties of the ARO bending angles. Both the full bending angle from satellite to aircraft and the “partial” bending angle corresponding to the geometrically symmetrical section of the atmosphere below the aircraft have been considered in the forward modeling experiments. Simulations with the two-dimensional operator are compared with results in a spherically symmetrical atmosphere to assess the significance of horizontal gradients. The achieved error characteristics are further supported by direct comparison of ARO and dropsonde profiles in terms of refractivity. The density of ARO observations within the highly variable AR environment provides sufficient data to demonstrate a distinct advantage in using the 2-D operator for the simulations, which is anticipated to carry through to improved forecasts of AR precipitation compared to a 1-D operator.