Airborne GNSS radio occultation retrievals using a radio-holographic method

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The airborne radio occultation (RO) technique precisely measures the refraction (bending) of radio signals from Global Navigation Satellite System (GNSS) satellites that are setting or rising behind the Earth's limb relative to a receiver on board an aircraft. Airborne RO offers high-resolution, dense sounding measurements over a target region in all-weather conditions, which is very attractive for regional atmospheric process studies. In February 2008, airborne RO soundings were collected during the HIAPER Experimental Flight Tests (HEFT08) field campaign supported by the National Science Foundation. A retrieval system based on geometric optics (GO) has been developed and has been successfully used to retrieve the first set of airborne RO refractivity profiles. In the moist lower troposphere, the large variations in water vapor result in multi-path propagation, which leads to significant challenges in GO retrievals. The radio holographic (RH) method is thus necessary to recover the fine vertical structure of the atmosphere. Because the airborne GPS RO receiver is inside the atmosphere, the widely used RH algorithms, such as the canonical transform (CT) and full spectrum inversion (FSI) developed for space-borne RO retrieval cannot be directly applied due to the different occultation geometry. In this study, the FSI method has been adapted for the airborne RO geometry and the atmospheric bending effect near the airborne RO receiver has been incorporated. The new FSI retrieval algorithm will be evaluated through simulation studies given different airborne RO geometry (e.g., circular or non-circular GPS and/or airplane trajectories). Preliminary results of the FSI bending angle retrieval from the HEFT08 airborne RO measurements will be presented and compared with the GO retrieval as well as the near-coincident radiosonde sounding. Extending the airborne RO measurements into the lower troposphere with the combination of open-loop tracking and FSI retrievals will significantly improve the capability for targeted observations in moist convecting systems.