Examining the Impact of Airborne Radio Occultation Observations on Short Term Precipitation Forecasts of an Atmospheric River Using MPAS-JEDI

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ABSTRACT

Atmospheric River Reconnaissance (AR Recon) campaigns are aimed at collecting targeted observations of significant winter weather events associated with long duration heavy precipitation and flooding on the U.S. West Coast. Ten United States Air Force WC-130J weather reconnaissance aircraft are now equipped with Global Navigation Satellite System (GNSS) Airborne Radio Occultation (ARO) technology to provide additional observations of the broader AR environment on AR Recon dropsonde flights. Two aircraft collected 189 ARO profiles on two consecutive days from 18 to 20 February 2023 in an AR that made landfall 22 February 2023 and brought heavy precipitation to the Pacific Northwest. This study for the first time investigates the potential impact of assimilating WC-130 ARO observations on AR analysis and prediction. Instead of traditional refractivity assimilation, emphasis is placed on ARO bending angle data for a more precise representation of atmospheric structure variations along the observation path. Employing the Model for Prediction Across Scales – Atmosphere - Joint Effort for Data assimilation Integration (MPAS-JEDI) with a global quasi-uniform 60 km grid, two sets of experiments are conducted using different assimilation algorithms (Local Ensemble Transform Kalman Filter (LETKF) and Three-Dimensional Ensemble-Variational (3DEnVar)). The experiments use the Radio Occultation Processing Package (ROPP 2D) bending angle observations operator in the Unified Forward Operator of JEDI. Each set includes a control experiment assimilating global conventional data and an ARO experiment assimilating ARO observations in addition to the control data. These preliminary results show that assimilating the additional ARO profiles was able to correct the moisture, temperature, and wind fields, and reduce the error in forecasting integrated vapor transport at landfall. This resulted in the reduction of precipitation overestimation over the mountainous terrain in Washington and Idaho, bringing the forecasts into closer agreement with observations. The WC-130 aircraft typically fly over the AR when it is closer to landfall than other AR Recon aircraft in the central Pacific, so the results will also be useful in the future for assessing targeted observation strategies at different lead times. Several challenges remain for future work and will be discussed. We are continuing to investigate the characteristics of ARO observation errors, relative to spaceborne GNSS RO. In addition, we are investigating the impact that altitude of the model top may have on GNSS RO errors for both Spaceborne and airborne RO. These should to be addressed to determine whether they can further improve results from ARO assimilation.