A Study on Airborne Radio Occultations and their Impact on Hurricane Karl (2010)

Global Positioning System (GPS) radio occultation (RO) data have been considered as one of the highest quality observations due to their high vertical resolution and their nearly all-weather characteristics. However, space-borne RO data are sparse for applications related to mesoscale weather systems. Thus GPS receivers have been placed on airplanes in past field campaigns, such as PREDICT in 2010, to collect more RO observations over a targeted region (Montgomery et al. 2012, Haase et al. 2014). An airborne GPS receiver can not only provide a higher density of observations, but also provide occultation observations to the sides of the aircraft, which complement observations from dropsondes. This study evaluates the impact of assimilating airborne GPS RO data on Hurricane Karl (2010) simulations. Two different forms of the assimilation operator, local refractivity and non-local excess phase, are used. An excess phase operator for the assimilation of space-borne GPS RO data was modified to accommodate the unique geometry of the airborne GPS RO data and was implemented into the Weather Research and Forecasting (WRF) model data assimilation (DA) system. Several numerical experiments were conducted to assess the impact of a) the assimilation of observations with and without airborne GPS RO data, b) the assimilation of local refractivity versus non-local excess phase, and c) the assimilation of drifting versus non-drifting perigee points on the simulations of Hurricane Karl. Results indicate that the assimilation of airborne RO observations improved the model initial conditions (analyses). The use of excess phase, being a more representative quantity of the impact area, resulted in a better improvement on the analysis than local refractivity. Later development of the simulated hurricanes indicates that the forecasts were sensitive to the positioning of the assimilated RO observations. The simulated track and central minimum sea level pressures were closer to the observed when the drifting of the tangent points was considered during assimilation, especially when the excess phase operator was used.