Use of the NSF LAOF GISMOS instrument in the study of developing tropical cyclones

Jennifer Haase, Brian Murphy, Paytsar Muradyan, J.L. Garrison

The GNSS Instrument System for Multistatic and Occultation Sensing (GISMOS) is a limb-sounding instrument for profiling the larger scale environment and is available on the NCAR Gulfstream-V aircraft. Its first science deployment as part of the NSF Lower Atmospheric Observing Facility was for the Pre-Depression Investigation of Cloud systems in the Tropics (PREDICT) campaign in 2010. For the first time, dense GPS radio occultation observations have been collected near developing cyclones using an airborne system, with concurrent dense sampling by dropsondes. These observations were planned to investigate the genesis phase within tropical waves and carry out assimilation tests for improving intensity forecasts. The horizontally sampling rays provide an integrated measure of moisture over a path length on the order of 100 km, and thus are very complementary to the very localized point sampling of the dropsondes. Over the 5 day period prior to the development of hurricane Karl, the retrieved GPS radio occultation profiles distinguish lateral variations in moisture associated with the structure of the developing circulation. Observations made inside the central region have more moisture in the 3.5 to 7 km height range than at larger distances, indicating preconditioning of moisture necessary for development, consistent with the dropsonde profiles. Occultation refractivity profiles are shown to agree closely with dropsonde profiles that are in close proximity. The profiles are also useful for evaluating the representativeness of the European Center for Medium-range Weather Forecasting re-analysis in the regions of tropical storms. This GPS radio occultation experiment paves the way for assimilating radio occultation data with greater confidence in the forecasting of tropical cyclones.

Spaceborne GPS radio occultation profiles from the COSMIC constellation are available operationally and have been found to provide good information on the vertical structure of the upper troposphere and lower stratosphere. This has resulted in an overall impact in numerical weather prediction for synoptic scale weather systems. Although there have been some studies using spaceborne GPS radio occultation profiles in forecasts of tropical cyclones, the satellite constellation has never been able to provide enough data in the near storm environment to demonstrate impact in these mesoscale convective environments. The deployment of GISMOS in the PREDICT experiment allowed unprecedented sampling of this environment. It is a successful example showing how the LAOF airborne instruments can provide useful data for advancing the objectives of improving forecasting by satellite missions, when those missions have not yet developed to the stage where they provide sufficient data coverage.