Assimilation of FORMOSAT-3/COSMIC GPS RO soundings with WRF 3DVAR and its impact on the predictions of typhoons impinging Taiwan

Shu-Ya Chen[1], Ching-Yuang Huang[1], and Ying-Hwa Kuo[2,3]

[1]Department of Atmospheric Sciences, National Central University, Jhongli, Taiwan
[2]University Corporation for Atmospheric Research, Boulder, Colorado, USA
[3]National Center for Atmospheric Research, Boulder, Colorado, USA

Abstract

With the launch of COSMIC, approximately 2,500 GPS radio occultation (RO) soundings are available on a daily basis, uniformly distributed around the globe. The GPS RO soundings are not affected by clouds and precipitation. Such observations are particularly useful for the analysis and prediction of significant weather systems, such as the tropical cyclones. The raw measurements of COSMIC are phase and amplitude of GPS radio signals. With retrieval, these raw measurements can be used to derive vertical profiles of refractivity and bending angles. To effectively assimilate these non-traditional GPS RO measurements into a weather prediction model, one needs to properly model the observables through the use of advanced observation operators. For the analysis and prediction of tropical cyclones using three-dimensional variational data assimilation systems (3DVAR), additional factors need to be considered. This includes the implementation of a bogus vortex, and the proper specification and tuning of observation and background error covariances.

In this study, we examine the impact of GPS RO soundings on the analysis and prediction of Typhoon Shan Shan that took place in September 2006, using the Weather Research and Forecasting (WRF) model and its 3DVAR system. We study the effects of (i) background error, (ii) observation errors, (iii) typhoon bogus, and (iv) observation operators on the assimilation of GPS RO soundings, and their impact on the analysis and prediction of Typhoon Shan Shan. Our study shows that the assimilation of COSMIC GPS RO soundings using the nonlocal observation operator improves the prediction of the typhoon intensity. Moreover, it is important to use the background error statistics generated by the assimilation model over the same domain, and covering the same study period, instead of adapting the background errors from other global forecasting models.