

The Impact of Doppler Wind Lidar Measurements on High-Impact Weather Forecasting: Regional OSSE and Data Assimilation Studies

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Abstract

Wind profiles are essential for operational weather forecasting on all scales and at all latitudes. However, tropospheric winds are the number one unmet measurement objective for improving weather forecasts. In recent years, ground-based and airborne Doppler wind lidar (DWL) wind profiles have been used in field programs and various applications to obtain the necessary wind measurements. These measurements offer the opportunity to examine the impact of wind profiles on numerical weather prediction (NWP). In addition, satellite-based DWL missions are also being planned. Observing System Simulation Experiments (OSSEs) have been conducted to evaluate the impact of future space-based satellite global wind measurements on NWP. While many previous studies have emphasized global NWP systems, in this chapter we provide an overview and summary of recent studies with both data assimilation and OSSEs to demonstrate the value of DWL wind measurements in improving severe weather system forecasts in regional NWP, especially for systems with large societal impacts due to the damage they may cause (e.g., high-impact weather systems). Specifically, we give an overview of previous studies that have examined the impacts of ground-based and airborne DWL on the numerical predictions of mesoscale convective systems and hurricanes. The regional OSSE concept is introduced. Recent results with regional OSSEs using the mesoscale community Weather Research and Forecasting (WRF) model and the NCEP Hurricane WRF (HWRF) model are presented. The potential configuration (e.g., resolution vs. accuracy) for future satellite-based DWL is evaluated. It is found that fairly good forecast impacts can be obtained from high-resolution observations with larger errors compared with accurate observations at a coarser resolution. Finally, the relative impact of ocean-surface wind measurements and 3-dimensional profiles is compared. The advantages of 3-D wind measurements are evident.

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