# Evaluation of TAMDAR Data Impact on 4-km CONUS WRF-Based RTFDDA Simulations and Warm-Season Convection Prediction

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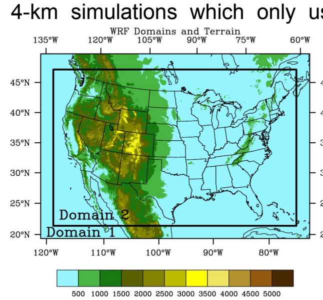
## 1. Introduction

TAMDAR (Tropospheric Airborne Meteorological Data Reporting), established by AirDat LLC, provides much-needed measurements of humidity, pressure, temperature, winds as well as icing and turbulence at low levels (below 7500 m) during the ascents, descents and cruises of regional aircrafts. The TAMDAR data have been successfully assimilated in the operational, WRF-based NCAR-AirDat RTFDDA (Real Time, Four Dimensional, Data Assimilation) analysis and forecasting system. This work presents the impact analysis of the TAMDAR data on RTFDDA simulations over the CONUS domain at 12-km and 4-km resolution.

Observations show that warm-season convection over the CONUS exhibits organized rainfall episodes characterized as coherently propagating signals over spatial scales of 1000 - 3000 km and time scales of 1 - 3 days. However, these episodes of warm-season rainfall are poorly represented by both Eta and WRF models. Using the archived, operational RTFDDA simulations over the CONUS, this work also examines how the RTFDDA system, which incorporates all the available observations including the TAMDAR data, represents the coherent episodes of warm-season rainfall. Comparisons will be made between the 12-km simulations which use both the cumulus parameterization and the microphysics scheme and the 4-km simulations which only use the microphysics scheme.




RTFDDA model domain with one nest (Domain 1: 12 km; Domain 2: 4 km). Both domains do not extend considerably to the data-void oceanic areas as including these data sparse areas might cause the data assimilation cycles of RTFDDA degraded dramatically.

## 2. Experimental Design

TAMDAR Data Impact: Two parallel runs with and without assimilating the TAMDAR data were conducted for August 1 through August 6, 2009.

Warm-Season Precipitation: Archived model simulations from the operational runs for the entire month of August 2009 were used.

## 3. Impacts of TAMDAR Data on RTFDDA Simulations

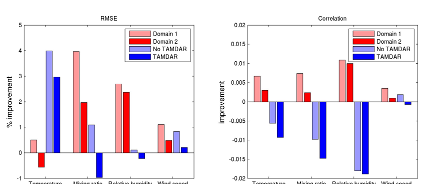
(Using percentage improvement of RMSE and correlation improvement)

$\%improvement = 100\% \times (RMSE_{noTAMDAR} - RMSE_{TAMDAR})/RMSE_{noTAMDAR}$ Due to the TAMDAR data

$\%improvement = 100\% \times (RMSE_{Domain1} - RMSE_{Domain2})/RMSE_{Domain1}$ Due to the resolution increase

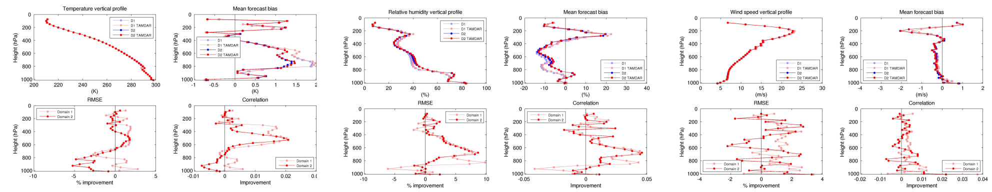
$improvement = Correlation_{TAMDAR} - Correlation_{noTAMDAR}$ Due to the TAMDAR data

$improvement = Correlation_{Domain2} - Correlation_{Domain1}$ Due to the resolution increase




Percentage improvements for RMSE and correlation improvement. Red bars indicate improvements due to the TAMDAR data (Domain 1: light red; Domain 2: dark red) while blue bars indicate improvements due to using higher resolution (without TAMDAR data: light blue; with TAMDAR data: dark blue).

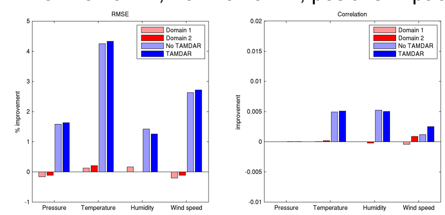
For temperature, resolution increase has larger positive impacts in RMSE than assimilating the TAMDAR data; for mixing ratio and relative humidity, assimilating the TAMDAR data improves the model simulations noticeably.




1). For temperature, positive improvement for RMSE and correlation due to the assimilation of the TAMDAR data can be seen in the 400 hPa through 600 hPa layer.

2). For relative humidity, assimilating the TAMDAR data adds moisture in the 500 hPa to 850 hPa levels resulting in reduced model dry biases and improvement for RMSE and correlation.

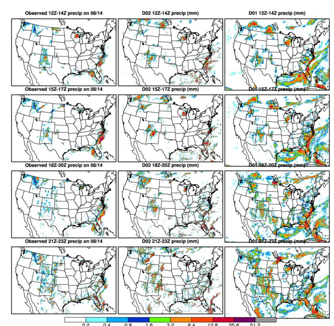
3). For wind speed, assimilating TAMDAR data results in positive improvement throughout the layer for Domain 1; For Domain 2, positive impact is noted for two layers: 200-400 hPa and 600-800 hPa.

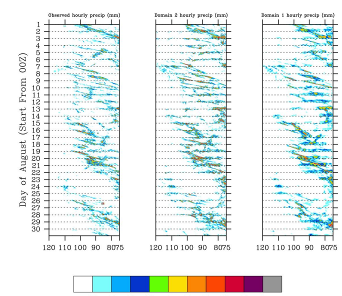



Percentage improvement for RMSE and correlation for surface pressure, 2-m temperature and relative humidity, 10-m wind speed.

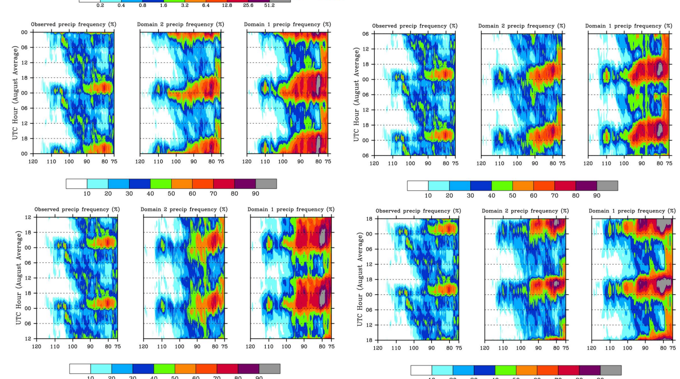
At surface, increasing horizontal resolution has significantly larger positive impacts on the simulated surface variables than assimilating the TAMDAR data.

## 4. Model Performance in Predicting Warm-Season Precipitation






The 12-km domain and 4-km domain simulated rainfall bands are located roughly in the same place as the observed; however, in terms of rainfall intensity, horizontal extent and temporal evolution, the 4-km simulations are much closer to the observations.




The diurnal cycles in the 4-km simulations are closer to the observations when compared to the 12-km simulations. It appears that for the model runs that are started in late afternoon and at night (i.e., 00Z and 06Z), the model fields are better adjusted at the time when the convections kick off than for the runs that are started in early morning and during daytime (i.e., 12Z and 18Z).