Sensitivity Study of WRF Downscaled Data for the Northeast Corridor

Luis E. Ortiz, M.S.
City College of New York

Bereket Lebassi, Ph.D
Lawrence Livermore National Laboratory

Jorge González, Ph.D
City College of New York

Introduction

Understanding the effects of low resolution forcing such as Land-cover and topography on climate is an integral of predicting conditions in the future of the Northeast Corridor, an important economic region in the US. Current work by the CUERG Research Group involves developing a set of high resolution (4km) data sets by using the WRF model to dynamically downscale output from Global Circulation Models (GCMs) for the 2013-2100 time period. This model output will be fed into hydrological and energy production models which will then be used to develop policy guidelines for the region.

Before conducting simulations for the future, the model must be validated using data from the present (2000-2010). This study focuses on studying the sensitivity of the cumulus parametrization schemes employed by WRF in order to optimize the model before running a full-decade validation run. Output will be compared to both PRISM and station data to determine the best scheme for the region.

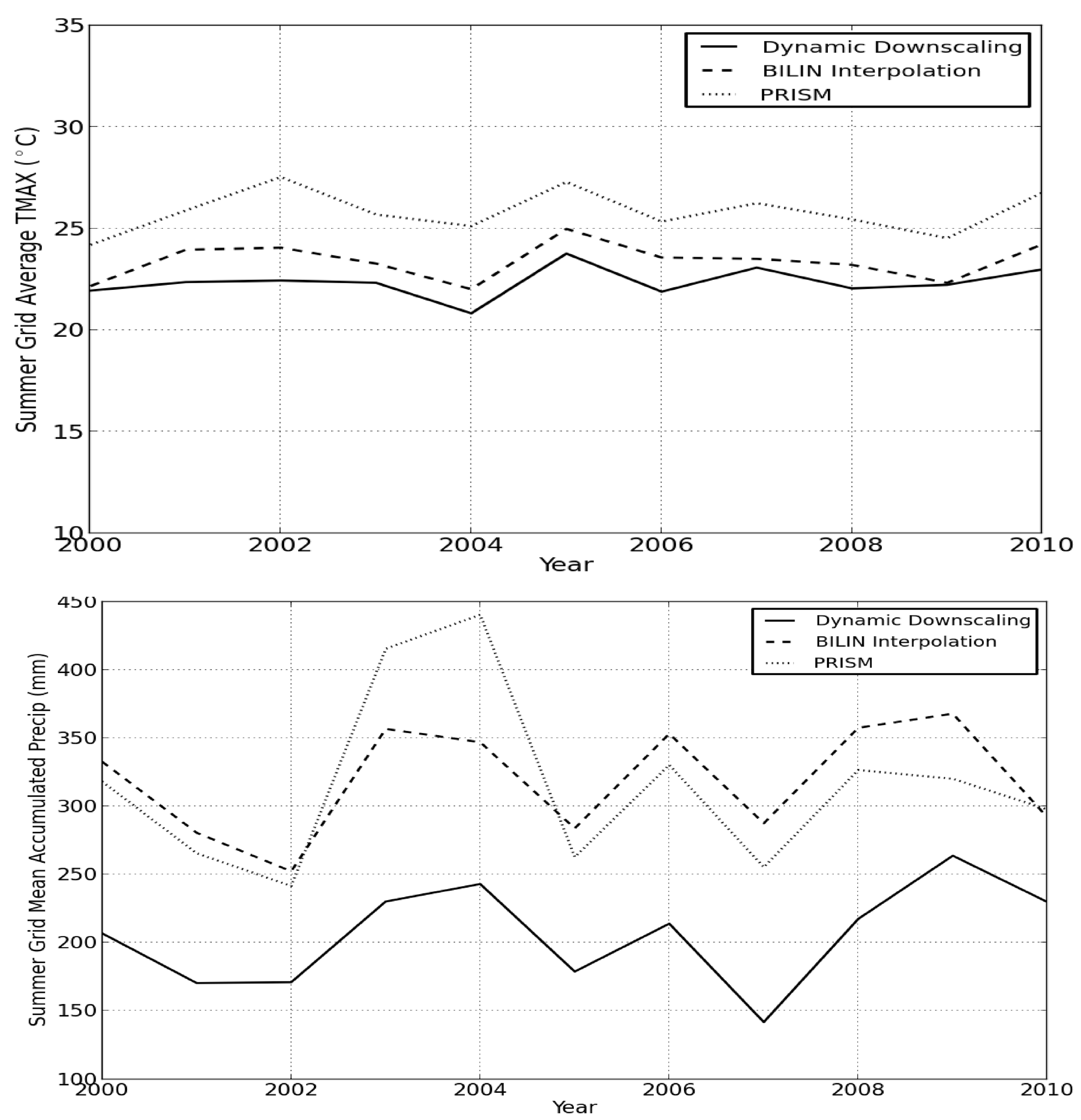

Fig. 2: Spatially averaged precipitation for PRISM, WRF downscaling, and statistical downscaling. WRF exhibits considerably lower precipitation,but follows the same trends nonetheless

Objectives

The objectives for this research project are summarized as follows:

- Study the effects of different cumulus parametrization schemes on dynamically downscaled precipitation.
- Compare results with station data, and PRISM [1], and original NCEP [2] forcing.
- Choose the cumulus parametrization scheme that best presents the NE precipitation.

Methodology

To optimize the dynamic downscaling output, we take a look at cumulus parametrization schemes employed in WRF. From previous runs, the driest month has been chosen (Aug-2003) to perform sensitivity studies to these parameterizations. Four different parametrization schemes were studied: Old Kain-Fritsch [3], Kain Fritsch [4], Grell-Devenyi [5], and Grell-3. WRF runs for these four schemes were performed for the selected year. In order to ascertain how well the different runs do, they are compared to both station data and PRISM output. Finally, the NCEP forcing is examined to see if any deficiencies in the output are due to the original model or introduced by the downscaling.

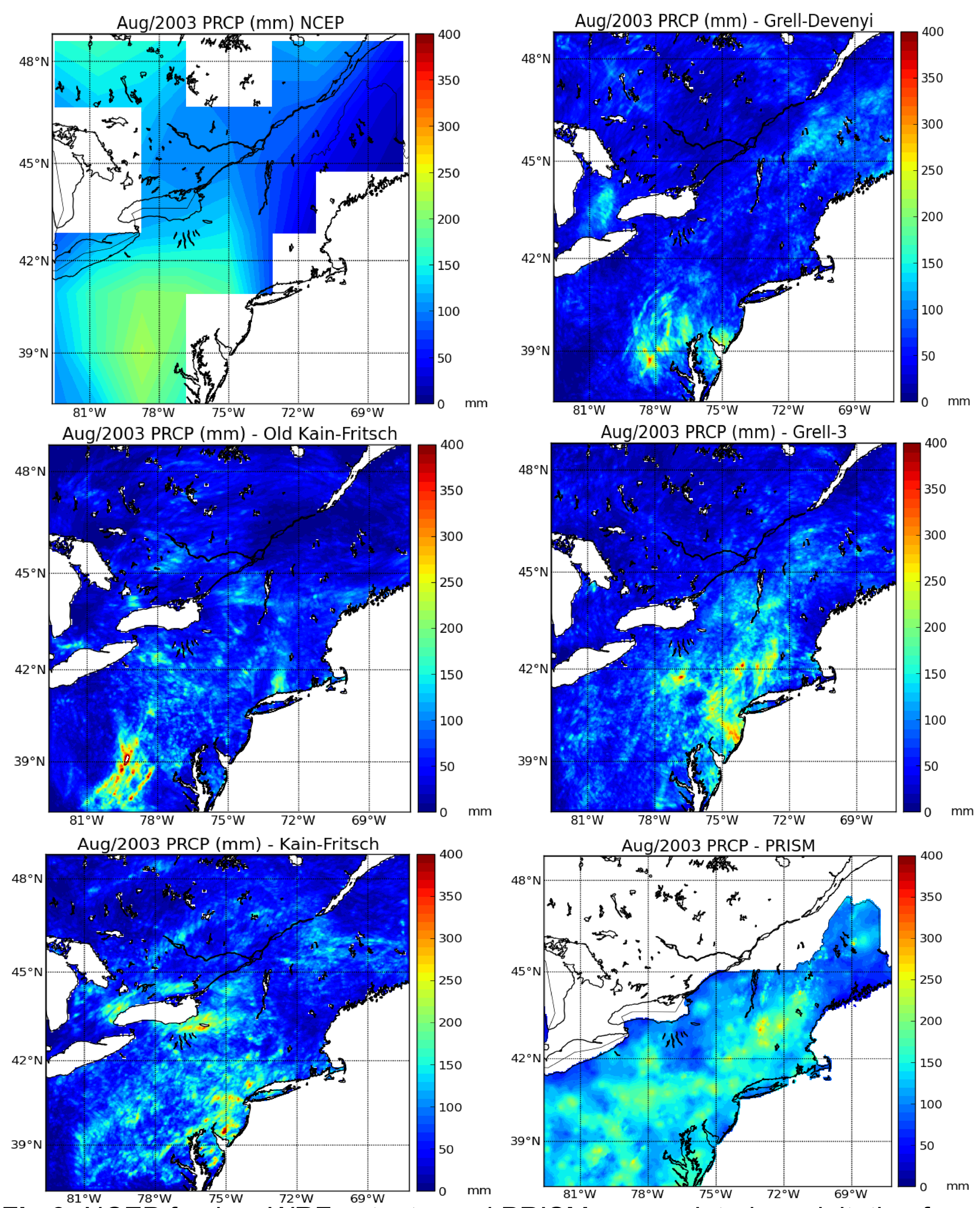

Fig 3: NCEP forcing, WRF outputs, and PRISM accumulated precipitation for Aug-2003

Results and Analysis

While still obtaining dry conditions overall compared both to the NCEP forcing as well to PRISM, performance can be obtained from choosing a cumulus parametrization scheme as shown in **Figs. 3**. From the data obtained, it seems that the two schemes which perform best are Kain-Fritsch and Grell-3. However, Grell-3 shows marked improvement in the northern latitudes, while ain-Fritsch gives a strong signal over the Great Lakes, which is to be expected. Seeing as PRISM and the station data compare favorably, to each other, difference plots are shown (**Fig. 5**), which confirm that Kain-Fritsch and Grell-3 do indeed offer the best performance for the domain. However, when taking into account the northern latitudes,Grell-3 emerges a winner, nearly matching spatial average of PRISM. Now optimized for cumulus parameterization, the 10-year run is repeated. **Fig. 6** shows the Root Mean Square Errors associated with the new 10-year run, showing a marked improvement on precipitation and very small error for maximum daily temperatures.

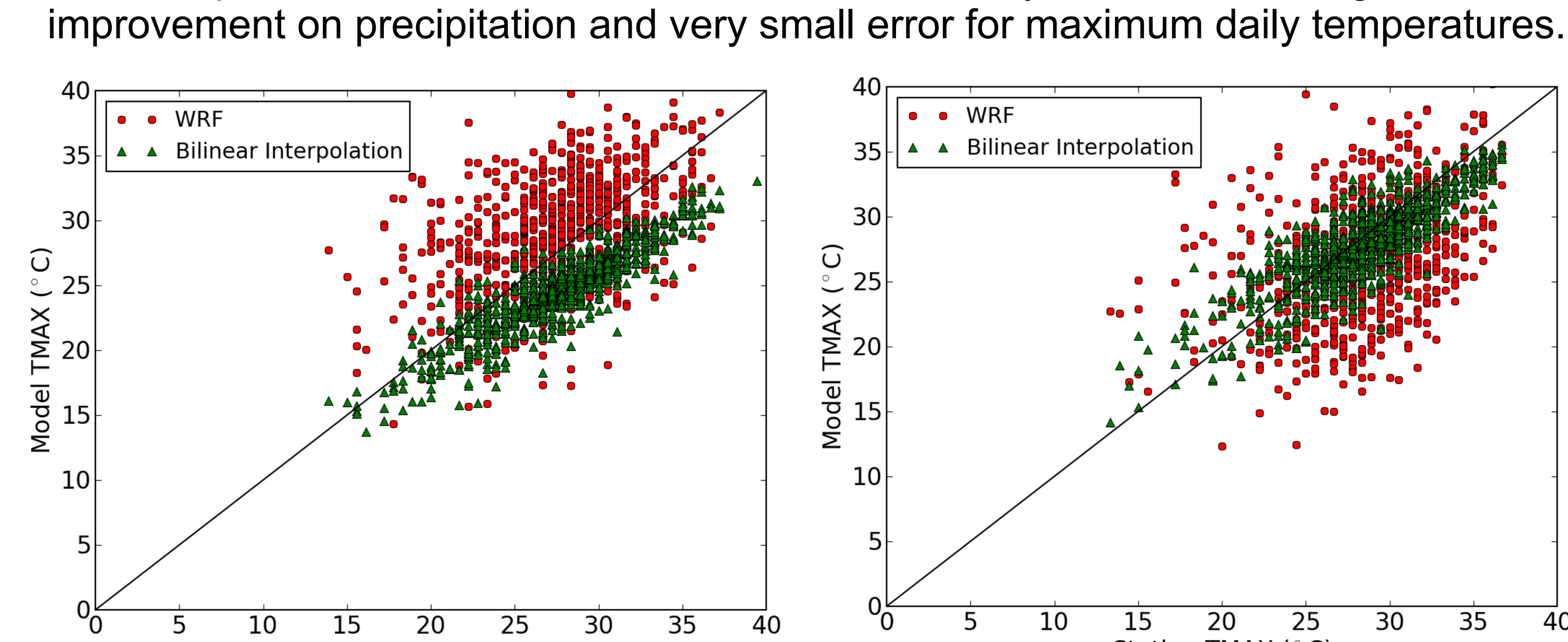

Fig 4: Comparison of model output for for two HCN stations: New York City (left), and Chambersburg, PA (right).

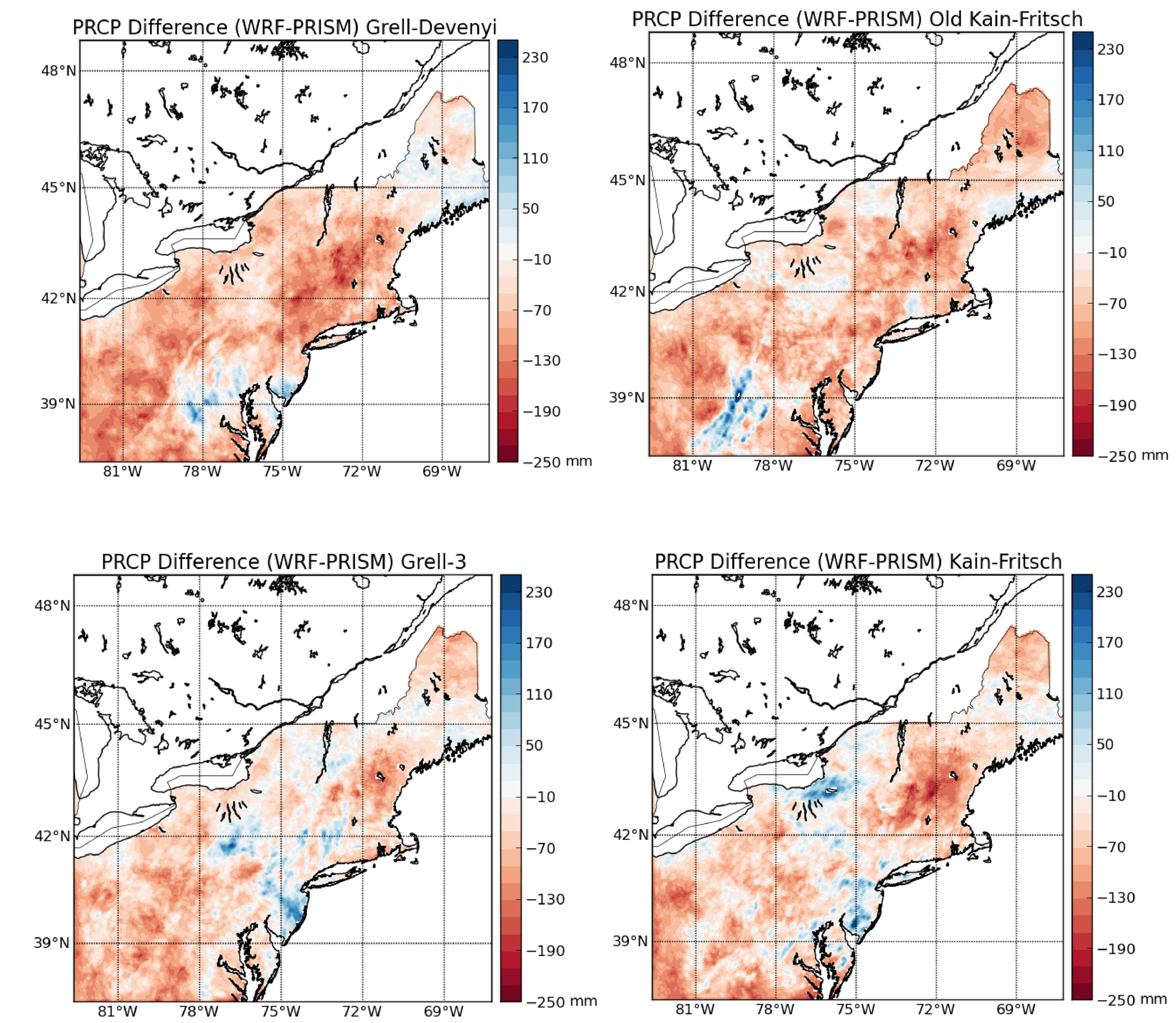

Fig. 5: Error plots between the WRF output and PRISM. Grell-3 and Kain-Fritsch show the least dry conditions.

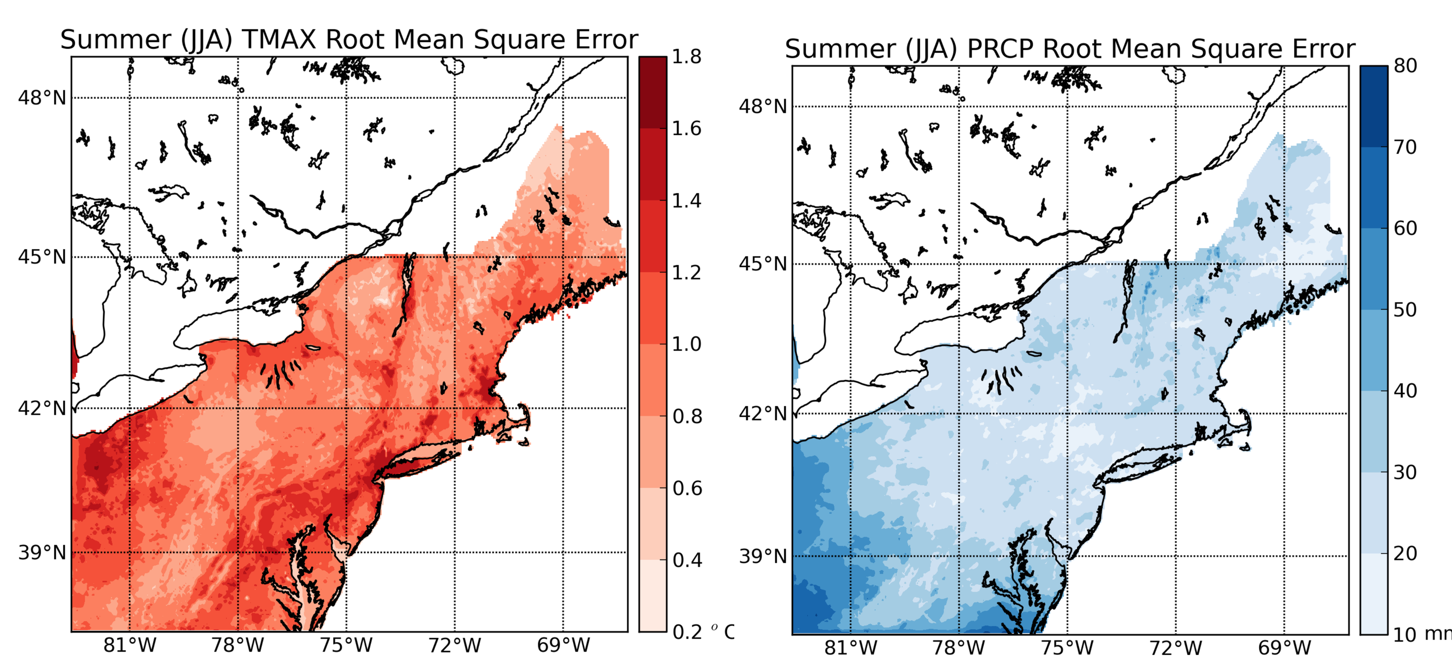

Fig. 6: Root mean square error for Maximum temperatures (left), and accumulated precipitation (right) the 2000-2010 Summer period using the optimized run

Future Work

With the optimized run 10 year validation run completed, work is being performed on moving towards GCMs. With this purpose, another 10 year validation run will be undertaking using output from CCSM 3 as boundary conditions for WRF. After assessing the downscaling results, efforts will move towards downscaling GCM output for the future period (2013-2010) with a focus on Summertime events.

References

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