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Impact of Spatio-Temporal Resolutions on Dynamical Downscaling of Precipitation Over CONUS

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Extremes in the water cycle, such as drought and flood, threaten the sustainability of water resources and cause significant impacts on society that will likely increase due to growing populations and a changing climate. Reducing the impact of extreme events requires preparations enabled by reliable and relevant predictions of streamflow and other hydrologic variables at seasonal time scales. Climate predictions from Global Climate Models (GCMs) can provide seasonal predictions of climate that can aid in predicting the local aspects of the hydrologic system, however the GCM spatial resolution is typically too course for application at the local level where the prediction is needed to ensure a society resilient to extremes. Therefore, a common practice is to downscale the climate predictions to finer spatial resolutions. One way of downscaling the GCM output is through dynamical downscaling using a regional climate model that can provide predictions at scales consistent with the hydrologic application. However, dynamical downscaling is computationally expensive which impedes the wide scale application, especially for running models at high resolution (<10km). There are also still many questions about the utility of dynamical downscaling and the results are dependent on model physics, model setup (e.g. boundary conditions, nudging) and as a result the overall validity of dynamically downscaling has not been fully demonstrated. Furthermore, there have been many studies that have compared models at different resolutions, however, these comparisons usually only consider a single spatial and temporal resolutions when validating the models, which does not provide a complete model evaluation.

This work leverages a recent NASA intra-agency downscaling project to better understand the validity of dynamical downscaling. As part of this project, several simulations of the NASA Unified Weather Research and Forecast (NU-WRF) model that vary in resolution and large-scale nudging were used to downscale MERRA-2 reanalysis over the continental U.S. This work utilizes these model runs to understand the impact of model resolution, nudging and domain on downscaled precipitation. This study analyzes downscaled precipitation from model runs at 4km, 12km, 24km spatial resolution at different spatio-temporal validation scales over the U.S. through the Taylor diagram and other skill metrics. The initial results indicated that dynamical downscaling at higher spatial resolution provides improved predictions at longer temporal validation scales, for some parts of the U.S. However, the increased skill is not seen at the finer temporal and spatial resolution. The impacts of these findings relative to seasonal prediction and possible ways forward will also be discussed.