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Distribution and intensity of extreme winter precipitation in seasonal forecasts

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I. Introduction

Global climate models have a coarse horizontal resolution that does not resolve topography well. By downscaling using regional climate models (RCMs), topography is better resolved and may allow for a better representation of precipitation over topographically varying regions, such as the western United States. An objective of the Multi-RCM Ensemble Downscaling (MRED) Project is to answer this question: **Does downscaling using RCMs provide skillful monthly and seasonal forecasts of extreme precipitation compared to the global model and the observations?**

II. Models

- **Global model:** National Center for Environmental Prediction (NCEP) Climate Forecast Systems version 1 (CFS Native)
- **Regional climate models:**
  - Two versions of the RSM
    - NCEP RSM
    - Experimental Climate Prediction Center RSM (ECPC RSM)
  - Two versions of the WRF model
    - Pacific Northwest National Lab WRF-Advanced Research WRF (PNNL WRF-ARW)
    - Illinois State Water Survey Climate WRF (ISWS CWRF)
  - Iowa State University MM5 (ISU MM5)
  - Colorado State University RAMS (CSU RAMS)
  - University of California-Los Angeles Eta (UCLA ETA)

Observations

- North American Regional Reanalysis (NARR)
- Climate Prediction Center (CPC) US Unified Precipitation (UNI)

III. Method

The NCEP CFS global model runs ten ensemble members by starting from a different initial date (November 21-25, November 29-December 3) to produce retrospective forecasts from 1982-2003. Each of the global ensemble forecasts is downscaled using each of the RCMs over the contiguous United States. The CFS is evaluated both at its native resolution (CFS Native) and interpolated to the MRED grid (CFS MRED). The horizontal resolution of the CFS Native is ~200km, the RCMs, CFS MRED and NARR are 32km and the UNI is ~28km.

From each of the models and observations, we examined daily accumulated precipitation for the months of January through April and the JFM and FMA seasons. Our focus is on **extreme precipitation**, defined as greater than **50mm/day**. We chose the central Rocky Mountains of the United States (Figure 1, red box) to assess the potential usefulness of higher resolution RCMs to answer our research question.

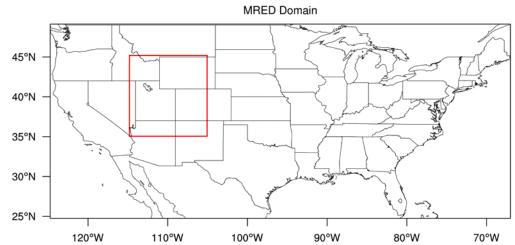

Figure 1: The MRED domain and the central Rocky Mountains analysis region (red box).

IV. Results

Sum of extreme precipitation frequency (Figure 2): We evaluated the frequency of extreme data in both the model output and after fitting gamma distributions to the output (Figure 2a). **The downscaled RCMs produce extreme precipitation (>50mm/day) too frequently while the CFS Native has generated little or no extreme precipitation (Figure 2b).**

The ISU MM5 and either or both of the RSMs tends to have higher modeled frequencies than their corresponding gamma distribution estimated frequency. This implies the gamma distribution is not able to represent the more extreme precipitation events in these models.

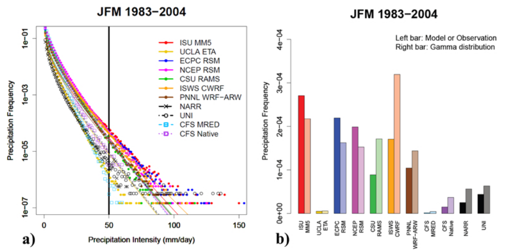

Figure 2: a) Precipitation frequency vs. intensity and the b) sum of the extreme precipitation (>50mm/day) frequency where the bars represent the modeled or observed frequency (left bar) and the estimated gamma distribution frequency (right bar).

Acknowledgments:

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IV. Results continued

Difference between the observed CDF and RCMs CDF (Figure 3): For February and FMA, several of the RCMs are closer to the UNI observed frequency compared to the CFS Native, meaning **the forecast has been aided by downscaling.** These results are similar for other time periods, except January and JFM where the impact of downscaling is less (not shown).

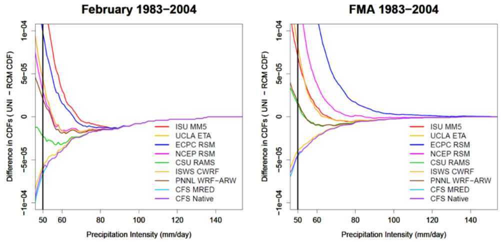

Figure 3: The difference between the observed and RCM CDFs. Plot only shows 50mm/day to 150mm/day.

CDFs (Figure 4): The CFS Native is picking up precipitation quicker in the lower intensity bins (<50mm/day) compared to UNI. **The downscaled RCMs are distributing precipitation to higher intensities which may or may not be extreme.** NARR has similar results (not shown).

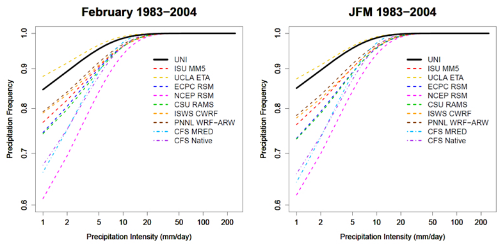

Figure 4: CDFs of the RCMs with UNI observations for precipitation intensities. Both axes are log scale and the y-axis begins at 0.6 and the x-axis ranges from 1mm/day to 250mm/day.

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