Assessment of Downscaling Ability of a RCM to Reproduce Temperature and Precipitation Extremes over United States

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1. Introduction
- Regional Climate Models (RCMs) are a useful tool to develop high-resolution climate scenarios at higher temporal and spatial scales by allowing greater topographic complexity and finer-scale atmospheric dynamics, and thereby representing a more adequate tool for generating climate change information required for many impact and adaptation studies.

2. Objective
- Assessment of dynamical downscaling ability of the RCM when driven by GCM data to reproduce the observed statistics of extremes.
- Assess the impact of systematic bias correction approach on climate extremes in comparison to bias correction in the driving data.
- Sensitivity of simulated extremes to model resolution.

3. Methodology
- **Observed data**
  - NCEP Climate Forecast System Reanalysis (CFSR) hourly 2m-temperature (resolution: 0.5° x 0.5°) and precipitation (resolution: 0.3° x 0.3°) data for 1995-2005.
- **Model data**
  - Hourly temperature and precipitation for 1995-2005 derived from:
    1. NRCM simulations driven by CCSM at 36-km grid (NRCM36)
    2. NRCM simulations driven by CCSM at 36-km grid with bias corrected driving CCSM data (NRCM36_BBC); BBC: Boundary bias correction
    3. NRCM simulations at 12-km (NRCM12)

4. Evaluation of Temperature Extremes
- **Extreme indices**
  - Name | Type | Definition (unit) | Notes
  - Tx90 | Intensity | 90th percentile of T_{max} (K) | Includes analysis of NARCCAP simulations to better understand the dynamical downscaling ability and impact of resolution.
  - Tn10 | Intensity | 10th percentile of T_{min} (K) |
  - WD | Frequency | Days with precipitation ≥ 1mm (days) |
  - CDD | Duration | Maximum number of consecutive dry days (days) |

- **Systematic bias correction**
  For Tn10 and Tx90, we subtract the respective mean systematic bias on each simulated daily value of the period 1995-2005. For precipitation, a multiplication factor is calculated and applied on the daily value so that the two distributions have the same average value. We remove the systematic bias from NRCM36 and NRCM36_BBC and the result is known as NRCM36_SBC and NRCM36_BSBC, respectively.

5. Evaluation of Precipitation Extremes
- **Extreme indices**
  - Name | Type | Definition (unit) | Notes
  - DX90 | Intensity | 90th percentile of D (mm) |
  - DX10 | Intensity | 10th percentile of D (mm) |
  - WD in DJF | Frequency | Days with precipitation ≥ 1mm (days) |
  - WD in JJA | Frequency |

6. Summary and Conclusion
- Dynamical downscaling ability of the RCM to reproduce the observed extremes is assessed in this study.
- Although for the majority of cases model performance is better with SBC than BBC, the impacts vary by region and extreme index. Application of both corrections does not show much improvement except for wet days.
- Low sensitivity of simulated extremes to model resolution.

7. Further Work
- Explore more effective systematic bias correction techniques for precipitation.
- Include analysis of NARCCAP simulations to better understand the dynamical downscaling ability and impact of resolution.