Exploring the Precipitation Extremes over Hindu Kush Himalayas in CORDEX simulations

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THE HINDUKUSH HIMALAYAS

A UNIQUE REGION
A complex climatic regime due to its topography, poses a great challenge for modelling the climate and reproduce the observed variability.

THE THIRD POLE
Glaciers on the HKH hold the largest ice mass outside the polar region resulting in the name Third pole. Ten major Asian rivers originate in this region. Nearly 1.9 billion people living in the 10 river basins
Data and Methodology

- The present study has considered 17 members of CORDEX simulations.

- The extreme precipitation indices by Expert Team in Climate Change Detection and Indices (ETCCDI) are used to quantify the extreme precipitation characteristics over the region from reference dataset (APHRODITE) for the period 1980-2005.

- Studies based on model ranking are widely being conducted to analyze the performance of global and regional climate models [F. Jeferson de Medeiros et al., 2022; Ayodele, A.P. et al., 2022; A.A. Akinsanola et al., 2021; T. Ngo-Duc et al., 2017]

\[ \text{Taylor Skill Score (TSS)} = \frac{4(1 + PCC)^2}{\left(\frac{\sigma_{\text{Model}}}{\sigma_{\text{Observation}}} + \frac{\sigma_{\text{Observation}}}{\sigma_{\text{Model}}} \right)^2 (1 + R_0)^2} \]

<table>
<thead>
<tr>
<th>S/N</th>
<th>Extreme Indices Name</th>
<th>Definition</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>R95pTOT (Very wet days)</td>
<td>Total precipitation exceeding 95th percentile on wet days.</td>
<td>mm</td>
</tr>
<tr>
<td>2.</td>
<td>RX5day (Maximum consecutive 5-day precipitation.)</td>
<td>Maximum of consecutive 5 day rainfall in the season</td>
<td>mm</td>
</tr>
<tr>
<td>3.</td>
<td>SDII (Simple Daily Intensity Index)</td>
<td>Precipitation amount on wet days</td>
<td>mm/day</td>
</tr>
<tr>
<td>4.</td>
<td>CWD (Consecutive wet days)</td>
<td>Count the largest number of consecutive days where precipitation &gt; 1 mm</td>
<td>days</td>
</tr>
<tr>
<td>5.</td>
<td>CDD (Consecutive dry days)</td>
<td>Count the largest number of consecutive days where precipitation &lt; 1 mm</td>
<td>days</td>
</tr>
</tbody>
</table>

Index of Agreement (C. J. Willmott et al., 2012)

\[ I = \left( \frac{\sum_{i=1}^{n} |P_i - O_i|}{c \sum_{i=1}^{n} |O_i - \bar{O}|} \right)^{1/2}, \text{ when} \]

\[ \sum_{i=1}^{n} |P_i - O_i| \leq c \sum_{i=1}^{n} |O_i - \bar{O}| \]

\[ c \sum_{i=1}^{n} |P_i - O_i| = 1, \text{ when} \]

\[ \sum_{i=1}^{n} |P_i - O_i| > c \sum_{i=1}^{n} |O_i - \bar{O}| \]
Climatology and Seasonality

- Annual rainfall is predominantly contributed by the Indian summer monsoon.
- Winter precipitation is mainly contributed by the western disturbances over western Himalayas.
- The annual cycle and climatology of precipitation across the seasons over HKH sub-regions are captured reasonably well by CORDEX MME.
Extreme indices skills and statistics

- There are models showing high and low values of TSS.
- The model performance varies with the index under consideration as well as across the seasons.

Reduction in error (up to 10%) w.r.t the MME of all models. Better agreement with reference dataset.
In general, precipitation extremes portray an increasing tendency over bulk of the HKH in both near and far future (both for moderate and high emission scenarios).

Though mixed trends exist in certain cases, however, mostly they tend to be insignificant.
The extreme precipitation characteristics in CORDEX simulations over the HKH region is explored using ETCCDI indices.

Skill of models to reproduce the extreme index climatology are analyzed using Taylor Skill Score (TSS).

The skill of various models in representing extreme precipitation characteristics is significantly influenced by both the season and the index being considered.

In the ensemble of models with highest TSS values, we see up to a 10% reduction in errors compared to the MME of all models, as well as improved agreement with the reference dataset.

In general, precipitation extremes portray an increasing tendency across the HKH sub-regions in both near and far future (for moderate and high emission scenarios).

The models depict better skills in simulating extreme precipitation characteristics for annual and JJAS period compared to DJF.
References


THANK YOU