Selection and Downscaling of Climate Models for the Indus, Ganga and Brahmaputra Basins

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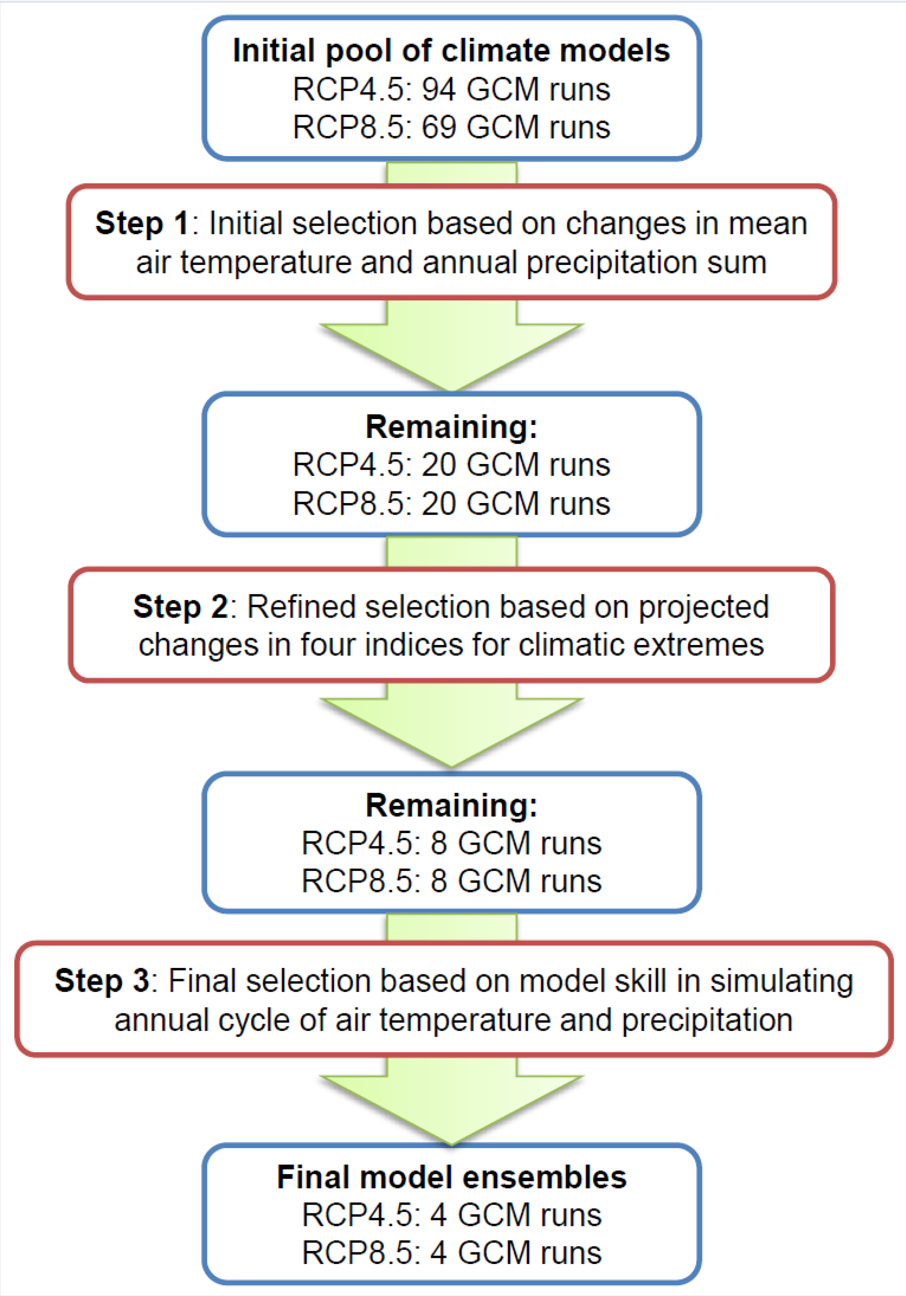
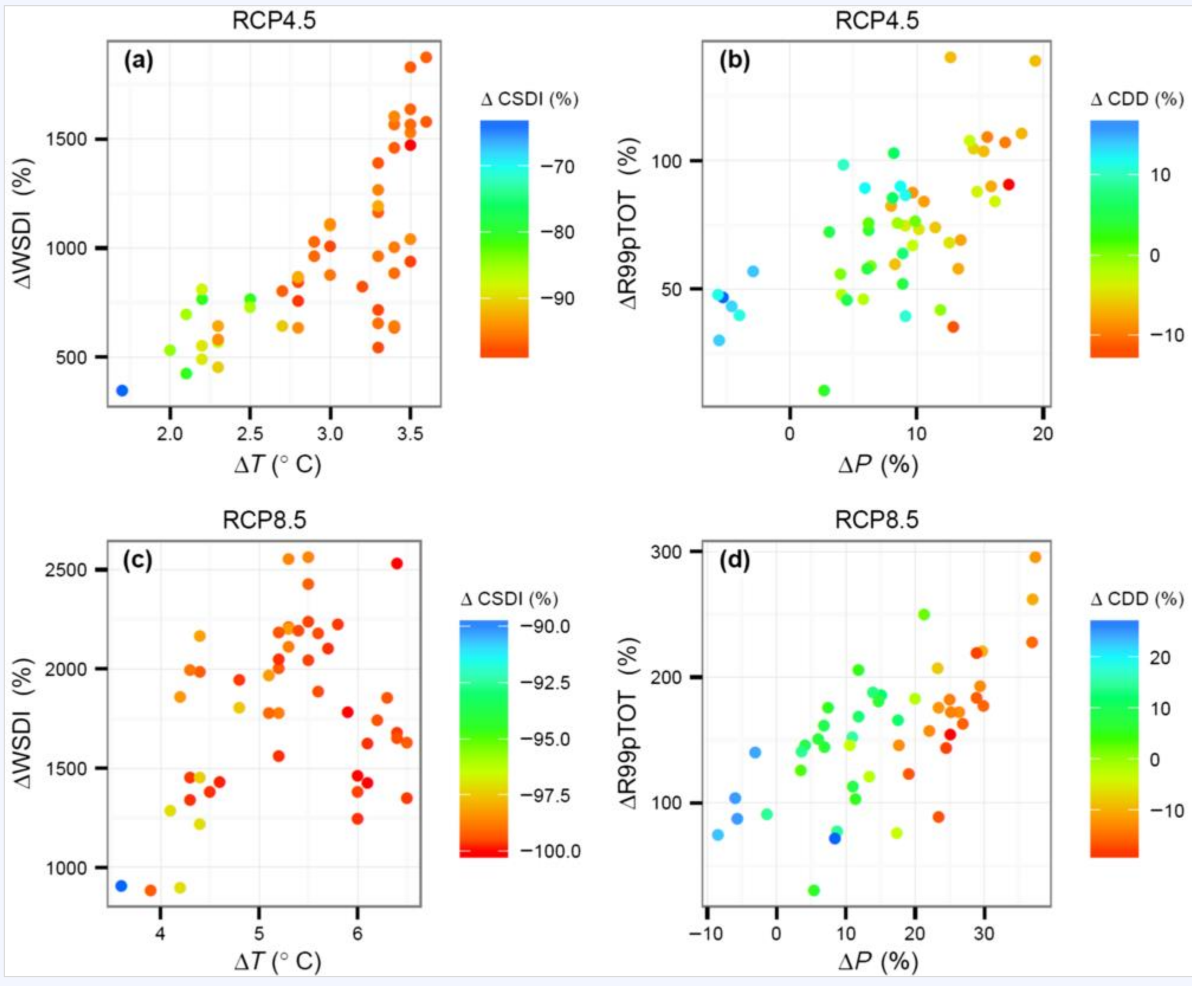
Selection of climate models



For HI-AWARE, General Circulation Models (GCMs) are selected for the Indus, Ganga, and Brahmaputra river basins based on three criteria:

- The envelope of projected changes in mean precipitation and temperature
- The envelope of projected changes in precipitation and temperature extremes (heavy precipitation events, dry spells, hot spells, cold spells)
- The skill of GCMs in simulating the historical climate

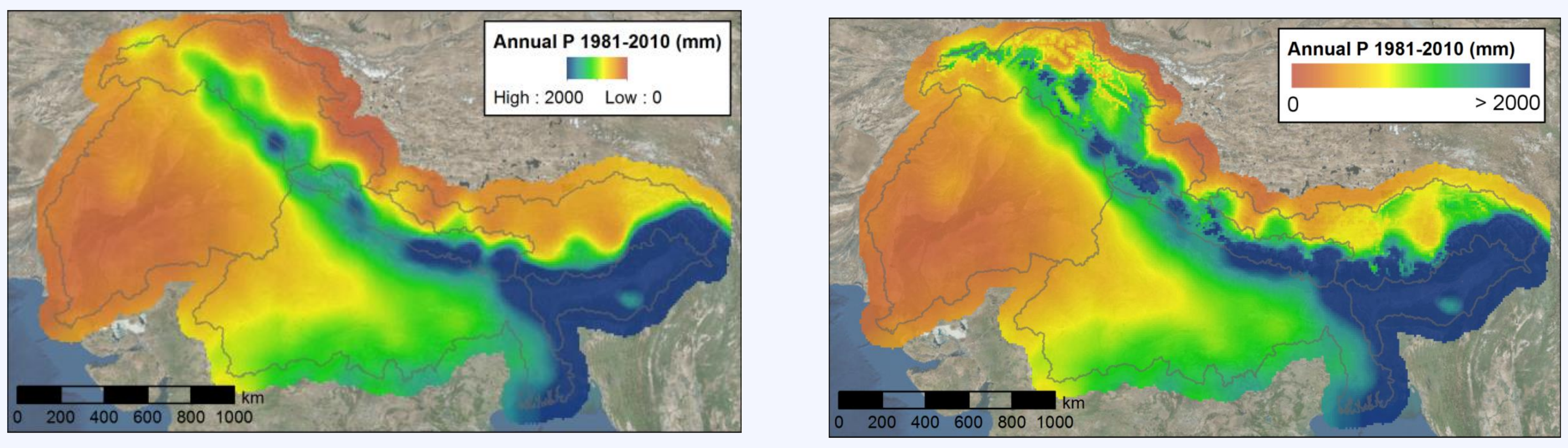
This leads to a representative ensemble of climate models, which can be used for further assessment of climate change impacts.



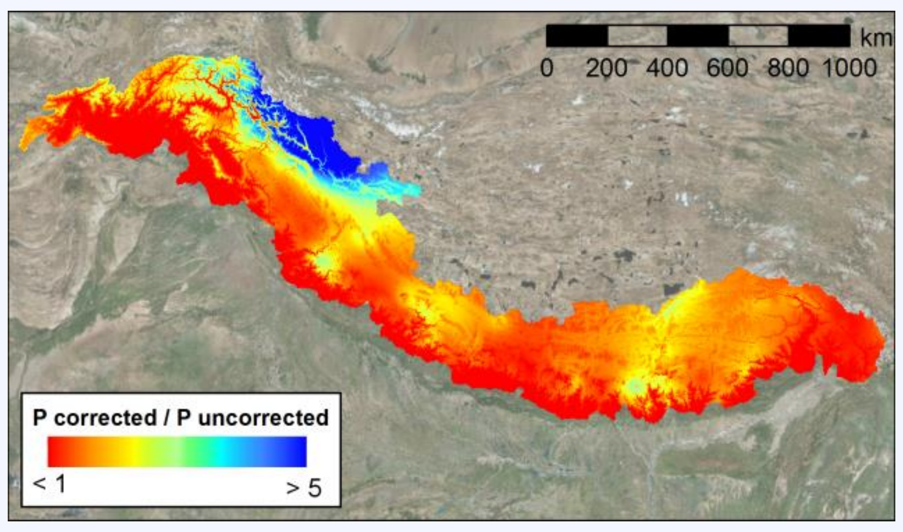
Projected changes in mean air temperature (ΔT), warm spell duration index (ΔWSDI), cold spell duration index (ΔCSDI) between 2071–2100 and 1971–2000 for RCP4.5 (a) and RCP8.5 (c). Projected changes in annual precipitation sum (ΔP), precipitation due to extremely wet days (ΔR99pTOT), consecutive dry days (ΔCDD) between 2071–2100 and 1971–2000 for RCP4.5 (b) and RCP8.5 (d). Dots represent all available climate models in the CMIP5 archive.

High-resolution historical climate dataset

Most precipitation in mountain regions occurs at high altitude. However, precipitation is hardly measured at high altitude because most gauges are installed in the valleys. Therefore existing precipitation products based on interpolated station data underestimate the actual amount of precipitation. Besides, remote-sensing derived precipitation products underestimate snowfall and thus also lead to underestimated precipitation. For HI-AWARE, available glacier mass balance and discharge data were used to improve high-altitude precipitation. This was done by inversely modeling the amount of precipitation required to sustain observed glacier mass balances and validating the updated estimates to observed discharge.



Uncorrected (left) vs corrected (right) precipitation estimates for the Indus, Ganga, and Brahmaputra basins.

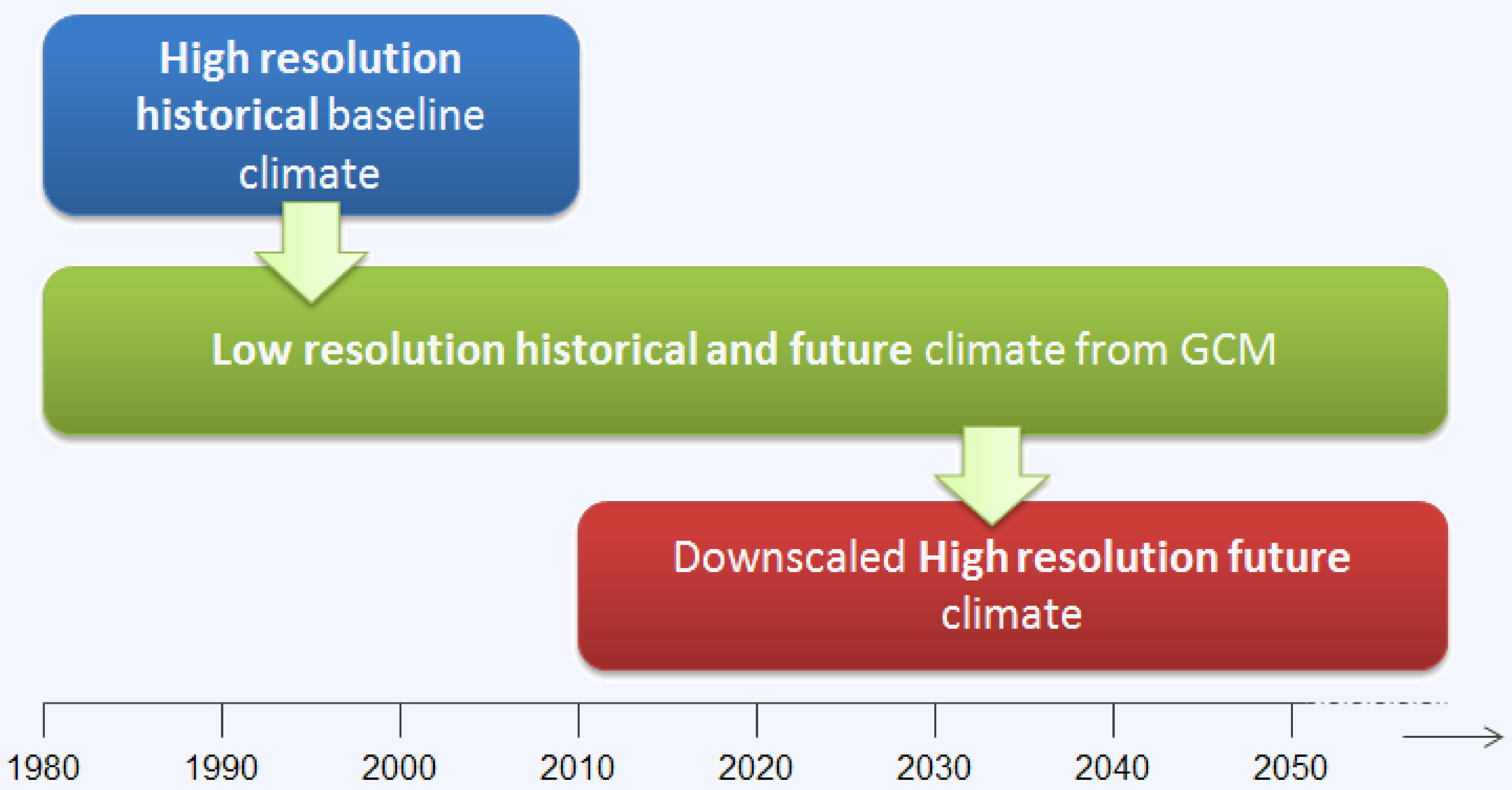


Fraction of corrected over uncorrected precipitation estimates for the upstream basins. Corrected precipitation is up to 5 times higher than uncorrected precipitation in the upper Indus basin.

The high-resolution historical climate dataset contains daily gridded precipitation and air temperature data for 1981-2010 at 5x5 km resolution for the upstream basins and 10x10 km for the total basins.

Empirical-statistical downscaling of GCMs

To bridge the scale gap between GCMs and the required resolution of input data for hydrological models and tailored climate data, the raw GCM data of the selected GCMs are downscaled using the Quantile Mapping method, which has proven its robustness in mountainous climates [*Themessl et al., 2011*]. In Quantile Mapping, correction factors are determined between the high-resolution historical climate dataset and the raw historical GCM data. These factors are used to downscale the raw future GCM data up to 2100 to the same resolution as the high-resolution historical climate dataset.



References

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