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The bimodal structure of the elevation-dependent warming in the Tibetan Plateau/Himalayas simulated by CMIP5 models

Elisa Palazzi, Luca Filippi, and Jost von Hardenberg
ISAC-CNR, Torino, Italy (e.palazzi@isac.cnr.it)

We use the output of thirty global climate models participating in the Coupled Model Intercomparison Project phase 5 (CMIP5) to investigate the elevation-dependent warming signal in the Tibetan Plateau/Himalaya mountains.

We find enhanced warming with elevation particularly for the minimum temperature during the cold season. This signal is captured by all individual models (at their own spatial resolution) as well as by their multi-model ensemble mean in the historical period and in projections for the 21st century. In particular, future projections under a high emission scenario (RCP 8.5) show a larger signal of enhanced warming with elevation compared to the past.
We also find that enhanced warming correlates more with temperature (minimum, maximum, and mean) - a proxy for the elevation - than with elevation. Interestingly, minimum temperatures during the cold season show two clearly distinct regimes: regions above the freezing level of water show a much stronger warming than regions below freezing temperature, suggesting that the phase of water plays a key role. This bimodal response is very robust and it is captured by the multi-model ensemble as well as by all individual models.

The mechanisms for enhanced rates of winter minimum temperature increase in the Himalayas/Tibetan Plateau as a function of elevation are investigated and they do not appear to be influenced by a reduced snow cover. Previous model studies in the area suggested that elevation-dependent warming in this region may occur in response to increases in water vapour in high greenhouse gas emission scenario projections. We investigate this hypothesis and check if the correlation between warming rates and columnar integrated water vapour also exhibits the bimodal regime mentioned above.