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# MODELLING CLIMATE CHANGE OVER HIGH ASIA – METHODS, SCOPES, LIMITATIONS AND PROJECTIONS

# MODELLIERUNG DES KLIMAWANDELS IN HOCHASIEN – METHODEN, ANWENDUNGSBEREICHE, EINSCHRÄNKUNGEN UND PROJEKTIONEN

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## SUMMARY

Global warming causes distributional changes in the system dynamics of high mountains, altering highland-foreland processes and resource fluxes, essential for the functioning of social and economic systems within and beyond impacted high-mountain regions. This holds particularly true for the extreme mountain systems of High Asia, being the headwaters of major Asian rivers and indispensable resource areas for millions of people. Climate projections for perceiving future changes in climate-determined environmental processes ideally require modeling approaches capable of representing the complexity and heterogeneity of mountainous topo-climates at commensurate spatiotemporal scales. Against this background, we assess current pathways in global climate modeling and evaluate basic principles of dynamical and statistical downscaling, their limitations and application scopes. Transient climate changes over High Asia are exemplified by global 4dPDF large-ensemble and high-resolution (~60 km) simulations for the 1951-2010 period conducted with and without anthropogenic forcings and three climate change scenarios at 1.5, 2.0, and 4.0 K global warming levels relative to the preindustrial period. Modelling results reveal distinct Elevation Dependent Warming (EDW) rates over High Asia, often exceeding the respective global averages by far. Abruptly increasing warming levels at higher reaches, which are particularly simulated in wet months for both, past and projected climates indicate positive snow-albedo feedback suggesting amplified future changes of hydrometeorological processes over the Earth's Third Pole.

**Keywords:** global climate modeling, ensemble simulations, dynamical downscaling, statistical downscaling, elevation dependent warming, High Asia

## ZUSAMMENFASSUNG

Die globale Erwärmung ist mit räumlichen Änderungen in der Systemdynamik von Hochgebirgsregionen verbunden und verändert Hochland-Tiefland Prozesse sowie Ressourcen-