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Using large ensemble modelling to derive future changes in mountain specific climate indicators in a 2 °C and 3 °C warmer world in High Mountain Asia

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Introduction

Natural disasters in High Mountain Asia (HMA) are largely induced by precipitation and temperatures extremes. Precipitation extremes will change due to global warming, but these low frequency events are difficult to analyse using (short) observed time series. In this study we analysed large 2000 year ensembles of present day climate and of a 2 and 3 °C warmer world produced with the EC-EARTH model. We performed a regional assessment of climate indicators related to temperature and precipitation (positive degree days, accumulated precipitation, (pre and post-) monsoon precipitation), their sensitivity to temperature change and the change in return periods of extreme temperature and precipitation in a 2 and 3 °C warmer climate.

Study area

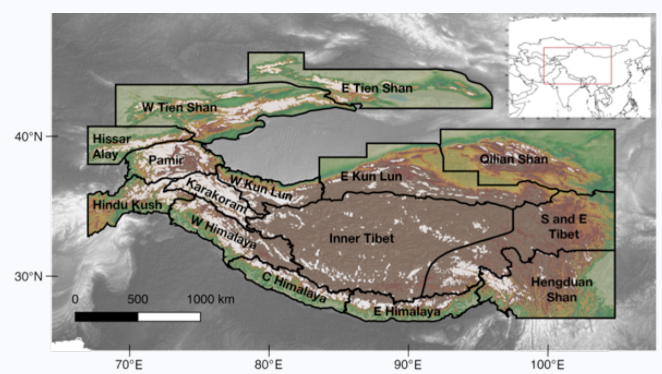

Figure 1: *Regions for analysis with its topography and glaciers (white; RGI) with S=South, E=East, W=west.*

Large ensembles

Data of 3 large ensembles are analyzed and generated with the EC-EARTH model (van der Wiel et al., 2019). Each large ensemble contains 2000 year of data, wherein extreme events are explicitly modelled:

- Present day Climate (PD)
- Pre-industrial + 2 °C warming (2C)
- Pre-industrial + 3 °C warming (3C)

Climate indicators:

- Melt days (MD);
- Accumulated precipitation (PA);
- Pre-monsoon precipitation(PpreM);
- Monsoon precipitation (PM);
- Post monsoon (PpostM) precipitation,
- Extreme (95th percentile) temperature (ET) and precipitation (EP).

Return periods (1:1, 1:10 and 1:100 years) of temperature and precipitation are also analysed in the paper. On this poster only a selection is shown. This paper is currently under review in International Journal of Climatology

Results

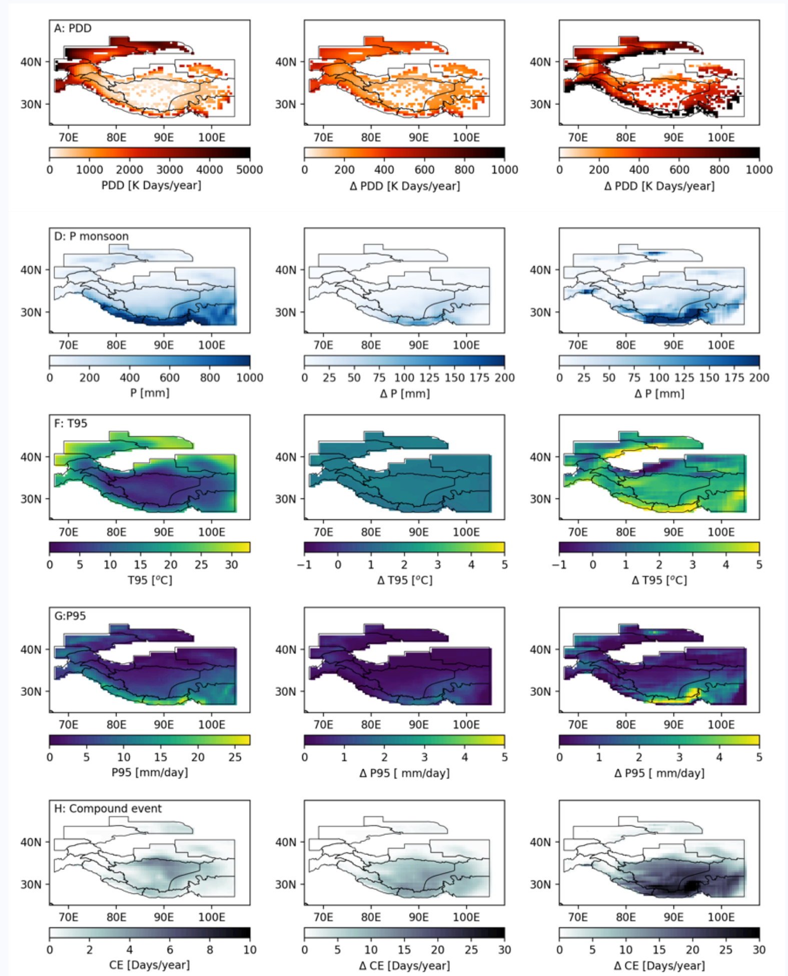

Figure 2: *Selection of present day average climate indicators (left panels) and the difference in a 2 °C (middle panels) and 3 °C warmer world (right panels).*

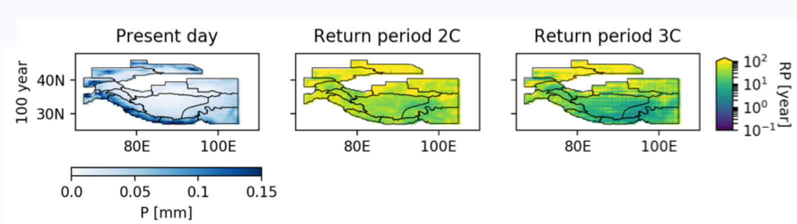

Figure 3: *Current precipitation intensity for a 1:100 year event (left), and the change in return period in a 2C (middle) and 3C (right) warmer world.*

Climate indicators

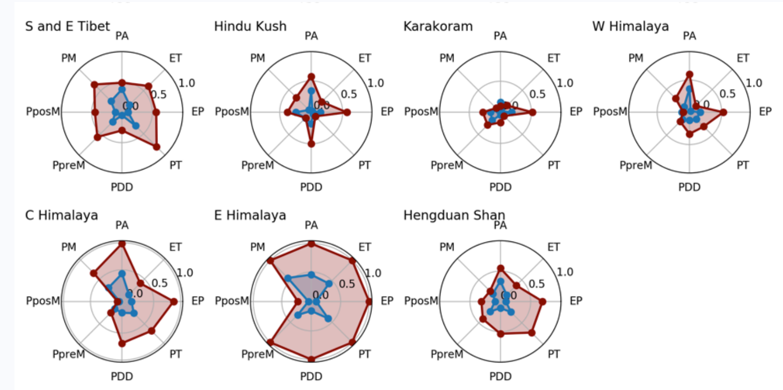

Figure 4: *Regional summary of the change in climate indicators in a 2C (blue) and a 3C warmer world (red) compared to present day, normalized by the 3 degrees warmer world. For selected regions only. Each climate indicator is normalized by the maximum regional value: a value of 1 for a specific region and climate indicator means this climate indicator changed the most in that region compared to the other regions.*

Conclusions

- In general, the 2 °C warmer world shows a homogeneous response of changes in climate indicators and return periods, while distinct differences between regions are present in a 3° C warmer world and changes do not longer follow a general trend.
- Differences between wet and dry seasons are amplified in monsoon-dominated regions by a dryer winter and wetter monsoon period in the future compared to present-day climate.
- The most affected regions are located in monsoon-dominated regions, with Central Himalayas the most affected region of all.
- Extreme temperature and precipitation are projected to increase the most in the Himalayas, southern part of Tien Shan and western regions. Compound events however are projected to increase most in monsoon-dominated areas, since temperature and precipitation extremes coincide.
- The increase in weather extremes will exacerbate natural hazards with large possible impacts for mountain communities. The results of this study could provide important guidance for formulating climate change adaptation strategies in HMA.

References: PNJ Bonekamp, N Wanders, K van der Wiel, AF Lutz, WW Immerzeel, Using large ensemble modelling to derive future changes in mountain specific climate indicators in a 2 °C and 3 °C warmer world in High Mountain Asia, International Journal of Climatology (under review)

van der Wiel, K., Wanders, N., Selten, F. M. and Bierkens, M. F. P.: Added value of large ensemble simulations for assessing extreme river discharge in a 2 ◦ C warmer world, Geophys. Res. Lett., (46), 2093–2102, doi:10.1029/2019GL081967, 2019.