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Late Cenozoic Climate Change and Potential Impacts on Denudation at Different Orogens

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Reconstructions of uplift and denudation histories of orogens are often made under the assumption of modern climate gradients. Quantifying the potential palaeoclimate-induced signal in erosion rates calculated from geological archives, such as cosmogenic radionuclides, allows for a more refined interpretation of these archives and thus leads to a better understanding of the evolution of orogens. Using GCM's (general circulation models) on the basis of proxy- and model-based reconstruction to quantify past changes in climate presents an alternative approach to a pure proxy-based approach, which delivers only patchy reconstructions in terrestrial regions that are of interest to Earth surface scientists. We analyse output from palaeoclimate simulations conducted with ECHAM5-wiso at a T159 (ca. 80x80km) resolution for the following time periods: pre-industrial (PI, pre-1850), Mid-Holocene (MH, ca. 6ka), Last Glacial Maximum (LGM, ca. 21ka) and Pliocene (PLIO, ca. 3ka). We use two approaches to quantify differences in denudation-relevant climate change. First, we apply a linear discriminant analysis to the output for different study regions (e.g. Himalaya, SE Alaska, Cascadia, and Central Andes) to quantify the regional differences in climate over time. For this analysis, we fine-tune our selection of climate variables for the analysis to factors that are regionally of importance to denudation. The results describe the differences in denudation-relevant climate change over time. Our second approach involves clustering of simulation output to map the extent of different climate-related 'erosional regimes', i.e. areas dominated by specific erosional processes, at different times. These regimes are described numerically by multivariate probability density functions and the clustering involves categorisation by statistical distance. LGM and PLIO experience widespread cooling and reduced precipitation, and warming and enhanced precipitation respectively. While LGM and PLIO show the largest differences from a PI climate on a global scale, regional magnitudes of changes, and thus potential impact on denudation, deviate from the global trend in some cases. For example, precipitation in the eastern Himalayas is significantly enhanced during the LGM. Some regions, such as Cascadia during the LGM, experience a significant shift to an entirely different erosional process domain.