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The impacts of physical weathering regimes on large-scale slope distributions in High Mountain Asia and the Central Andes

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Recent advances in the spatio-temporal resolution of environmental datasets and commensurate increases in computing power have expanded the scope of statistically-based topographic analyses. In this study we leverage both very-high spatial resolution topographic data from the SRTM 30m and TanDEM-X datasets alongside high-spatial resolution environmental data from multiple sensors to examine spatial and functional trends in topographic distributions around the highest peaks in the world.

At high elevations, glaciers are responsible for intense erosion in specific areas. Outside of glaciated regions, however, other cryospheric processes – namely frost cracking – are responsible for much of the physical weathering. We extend previous theoretical analyses of frost cracking on modeled data to empirical measurements of land surface temperature taken from the MODIS sensor across two mountain ranges. At lower elevations, physical weathering is strongly influenced by vegetation dynamics. We use here the SPOT NDVI dataset (1998-2014) to divide our study areas into heavily vegetated, lightly vegetated, and non-vegetated areas. As a final parameter, we include in our analysis a rainfall intensity index derived from TRMM (1998-2014).

Using these physically-based landscape divisions, we examine differences in slope distributions over very large data volumes ($\sim$hundreds of millions of points) to constrain the impact of different physical weathering regimes on landscape morphology. We find distinct environmental and climactic differences along the strike of both mountain ranges which correlate strongly with differences in slope distributions. We further posit that a functional relationship between multiple erosive regimes and landscape morphology can be derived from high resolution environmental data.