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The role of land surface processes on climate variability in the Tibetan Plateau

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The Tibetan Plateau (TP), with an average elevation of >4000 m and approximately the size of Texas, is a semi-arid environment occupied by montane grass- and shrub-lands. Over 62% of this temperature and moisture limited plateau is used for agriculture: farmlands, forests, and a majority (80%) for livestock grazing. Since the early–late 1950s, and accelerated since the 1980s, significant urban expansion and changes in agricultural and industrial practices have shaped this part of the world, resulting in a substantially altered landscape. Because of the plateau's role in the Asian Monsoon system, the water resources of most of the Asian continent and therefore the livelihoods of over 3.7 billion people, the extensive changes to the land surface in this part of the world are arguably of heightened importance to local–global resources and the climate system.

We hypothesize that land-atmosphere interactions play a major role in driving climate change on the TP. As socio-economic changes have caused a net reduction in vegetation, this has resulted in significantly reduced soil moisture which feeds back to further decrease vegetation, but also increase sensible (versus latent) heat fluxes, and hence increase temperatures. Our previous work has already demonstrated that, indeed, reported warming on the TP seems to be confined to low-lying populated regions but is absent in temperature data free of surface biases.

To quantify temperature changes on the plateau we employ long-term *in situ* temperature observations for 161 locations, and 2-meter temperatures from the European Centre for Medium-Range Weather Forecasts (ECMWF) 40+ year reanalysis (ERA-40). ERA-40 temperatures have been shown to provide a remarkably realistic depiction of temperature variability on the plateau. We next categorize the TP according to land cover type based on the Moderate Resolution Imaging Spectroradiometer (MODIS) land cover classification consisting of 16 land types at 1 km $\times$ 1 km resolution, and quantify historical vegetation changes based on the 8 km $\times$ 8 km Global Inventory Modeling and Mapping Studies (GIMMS) Normalized Difference Vegetation Index (NDVI). We assess *in situ* and reanalysis temperature trends according to land cover type and disturbed versus undisturbed regions, and quantify the corresponding warming trends related to land cover changes.

Preliminary results suggest that statistically significant vegetation decreases have occurred over the last 20 years in the central and eastern TP. Based on this geographic distribution of vegetation changes as well as the land cover type classification, we indeed find different temperature trends based on disturbed versus undisturbed regions. The seasonality of these changes plays an important role; however, vegetation changes alone do not account for observed temperature increases. Surface temperature trends are likely also affected by the reported general warming of the atmosphere in recent decades. A further complicating factor on the TP is the presence of discontinuous permafrost in certain regions, and we hypothesize that the distribution of permafrost also factors into the complex changes in vegetation, soil moisture, heat fluxes, and surface temperatures.