Mechanistic land surface modeling in an Amu Darya headwater catchment

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We apply a mechanistic land surface model to the newly established COPE research catchment ‘Kyzylsu’ in the headwaters of the Amu Darya river basin in Tajikistan. To study the concomitant responses of the cryosphere and biosphere to the region’s relatively dry climate, we apply our model at 100m spatial and hourly temporal resolution. We force the model with statistically-downscaled and bias-corrected ERA5-Land reanalysis data for the period 2010 to 2022. For model setup and independent validation, we leverage extensive in-situ observations, and complement those with spatial datasets on glacier mass balance, snow cover, and vegetation indices.

We analyze the biosphere-cryosphere-hydrosphere interactions in this high-elevation catchment, focusing on the spatial and seasonal distribution of transpiration, evaporation and sublimation. We disentangle the moisture and energy sources determining those mass fluxes, in relation to inter-annual precipitation, snow cover seasonality, glacier melt and vegetation phenology. We find that high elevation sublimation and evaporation from the snowpack play a considerable role in the water balance of the Kyzylsu catchment. As part of a larger study, we contrast these insights with those from a heavily monsoon-influenced catchment on the Southeastern Tibetan Plateau, where we applied the same modeling framework.