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Thermal characterization of two contrasting active layers in the warm permafrost region on the Qinghai-Tibet Plateau

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Permafrost degradation is evident on the Qinghai-Tibet Plateau (QTP) over the last few decades. The site-specific response of permafrost to climate warming can be very different, since it depends on not only climate but also on permafrost thermal state, surface characteristics such as vegetation and albedo, and heat transfer processes in active layers. Understanding the mechanisms governing the thermal regime of the active layer is essential to improve modeling and prediction of permafrost.

We chose two contrasting sites with different terrain elements to investigate the characteristics of weather-permafrost interaction in a warm permafrost region on the QTP. One active layer at Chumaer is characterized by a thick active layer with a large amount of deep groundwater and sparse-canopy surface, while the other one at Qumahe has a thin and nearly saturated active layer with dense vegetation. The hydraulic and thermal dynamics of the active layers have been monitored with soil-weather monitoring stations since September 2006. By comparing the key factors to the thermal regime in both active layers, the contrasting hydraulic and thermal regimes of the two active layers mainly originate from the soil-atmosphere interaction and the heat transfer within the active layers. Based on precise soil temperature and soil water content data, the heat transfer in the active layers was further characterized with an analytical method. Results demonstrate that non-conductive processes such as daily freeze-thaw cycles, infiltration, evaporation and convection significantly play an important role in the thermal regime of these sites.