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Comparison on micrometeorology and surface energy fluxes between debris-free and debris-covered glaciers in the southeast Tibetan Plateau

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The knowledge of meteorology and energy fluxes on the debris-free and debris-covered glacier is important for understanding how different glaciers behaviors heterogeneous to regional climate change. Based on the observations during 2016 ablation season at the debris-free Parlung No.4 Glacier and the debris-covered 24K Glacier in southeast Tibetan Plateau, a comparative analysis was made to shed light on the micrometeorology and surface energy fluxes and to gain knowledge about the influencing factors controlling melting process at different type glaciers. The meteorological correlations showed that the variables including air temperature, relative humidity and incoming longwave radiation (L_{in}) display a regionally synchronous pattern, but there are notable differences in precipitation, incoming shortwave radiation (S_{in}) and wind speed between two glaciers. The most striking is the difference in precipitation, with 5 times larger in the 24K Glacier. The energy fluxes between two glaciers display contrasting pattern due to different surface conditions and monsoonal precipitation. More S_{in} was absorbed due to lower debris albedo (0.05) In spite of same amount of total S_{in} and more L_{in} (W/m^2 larger) was supplied from warm and humidity air at the 24K Glacier. However, such excess energy supply was mainly used to warm the debris temperature, leading to the increase of energy output by outgoing longwave radiation and turbulent heat fluxes, rather than glacier melting. These energy outputs are very sensitive to the debris thickness in which is less than 10 cm and the amount of S_{in}, leading to significant spatial change of underneath ice melting magnitude. At the debris-free surface at AWS of Parlung No.4 Glacier, surface melting is mainly supplied by net shortwave radiation and turbulent sensible heat fluxes (H_{se}). Comparing with energy fluxes in 2009, the reduced melting energy in 2016 on the debris-free Parlung No.4 Glacier is attributed to the decrease of S_{in} and H_{se} by the increase of monsoonal clouds and weaken katabatic wind speed.