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The surface energy balance of the Sygyktinsky glacier (Kodar ridge, Eastern Siberia) during the ablation periods of 2019 and 2020 and its sensitivity to meteorological conditions

Eduard Osipov[1] and Olga Osipova[2]
[1]Limnological Institute SB RAS, Irkutsk, Russian Federation (eduard@lin.irk.ru)
[2]V.B. Sochava Institute of Geography SB RAS, Irkutsk, Russian Federation (olga@irigs.irk.ru)

The surface energy balance (SEB) of a glacier during ablation period describes the physical process of melting and its relationship to climatic fluctuations. Unfortunately, there is little experimental data on physically substantiated processes of melting of continental Siberian glaciers. In this study, we modeled the components of the SEB of a small low altitude continental glacier located in inland Asia (Eastern Siberia, Kodar ridge, 56° 51 'N, 117° 25' E, 2561 m above sea level). The Kodar glaciers (about 40 small glaciers) have been shrinking since the end of the Little Ice Age and have experienced an accelerated area decline in the 1990s. To study the SEB components we installed two automatic weather stations (AWS) directly on the glacier and its terminal moraine during the two ablation seasons (July–August of 2019 and 2020). Such parameters as meteorological characteristics (air temperature, relative humidity, precipitation, wind speed and direction, atmospheric pressure, temperature of the upper glacier layer) as well as radiation fluxes (short-wave and long-wave radiation) were measured with a 30-minute resolution. Turbulent fluxes were estimated using the bulk aerodynamic approach. Daily ice melting was directly measured using ablation stakes and a thermometric method. As a result, we found that the net radiation was the main source of surface snow/ice melting (84–93% of total energy for melt), followed by sensible heat (5–9%) and latent heat of condensation (3–7%). The simulated ablation is in good agreement with the measured one. Albedo strongly affects the net radiation and demonstrates two clearly distinguished regimes due to the presence or absence of snow cover on the glacier. During the first half of the ablation season (July) albedo decreases almost linearly, and during the second (August) it has low background values with pronounced spikes due to short-term summer snowfalls. The net radiation and melting regime are strongly influenced by summer cloudiness, which reaches 70–80% as a result of the intensification of cyclonic processes over the Kodar region. Heat losses due to long-wave radiation were recorded only in summer of 2019 (−15 W m^{-2}), while in 2020 the net long-wave radiation was slightly above zero (3 W m^{-2}). This is explained by the more significant (10% more) cloud fraction in 2020 over the study area. Thus, almost all heat supplied to the glacial surface spends on melting snow and ice. The influence of solar radiation factors on ice melting indicates the need to take into account long-term trends in the processes of atmospheric circulation (fluctuations of cyclones and anticyclones) when explaining the acceleration in ice area reduction of the Kodar glaciers in 1990s. This study was supported by the Russian Foundation for Basic Research (project No. 19-05-00668).