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Article

Spatial distribution of thermal properties on debris-covered glaciers in the Himalayas derived from ASTER data

Ryohei SUZUKI, Koji FUJITA and Yutaka AGETA
Graduate School of Environmental Studies, Nagoya University, Nagoya 464–8601, Japan

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Abstract

The present study investigates thermal resistances on debris-covered glaciers around Mt. Everest and in the Lunana region of Bhutan, using satellite images taken by ASTER and NCEP/NCAR reanalysis data. The thermal resistance is defined as the thickness divided by the thermal conductivity of a debris layer, and is an important index to the evolution of glacial lakes through the melting process. This index is obtained from surface temperature and heat balance on the debris layers. Since the net radiation is a dominant energy source on the Himalayan glaciers, thermal resistances are calculated by neglecting turbulent heat flux in heat balance. We evaluate errors of thermal resistances using field meteorological data and multitemporal ASTER data. The result shows that above errors are unlikely to affect the spatial pattern of thermal resistances. About half of 25 target glaciers without moraine-dammed lakes have larger thermal resistances than 7 glaciers with the lakes. Spatial distribution of thermal resistances shows the large increases toward glacier termini on the glaciers without lakes, whereas relatively small and uniform values on those with lakes. These results imply that the difference in magnitudes and distribution of thermal resistances on debris-covered glaciers are related to different evolutionary stages of the glacial lakes in the Himalayas. The present study demonstrates the possibility that ASTER data provide thermal resistance distribution over many glaciers for glacial lake studies without simultaneous field observations.