Spatial distribution of surface temperatures, from ground-based and ASTER derived measurements on debris-covered glaciers. Study case of Miage Glacier, Mont Blanc Massif, Italy

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ASTER-derived surface temperatures of Miage Glacier debris-covered ablation area (TIR data, acquisition time 10:40 a.m. of 01-08-2005, in the frame of GLIMS project), were compared with simultaneous ground measurements by thermistors at 21 sites spread along the whole glacier tongue (from 1800 to 2400 m a.s.l); the relationships between surface temperature, elevation and debris thickness were analyzed as well. The ground- and remotely-sensed temperatures correlate well over continuously debris-covered areas (r = 0.8), while on partially debris-covered ice (i.e.: crevassed areas, ice cliffs and water ponds), the correlation is weaker (r = 0.5 over the whole glacier tongue). Using debris thickness vs surface temperature relationships (r = 0.8), calculated for different elevation bands (100 m), a map representing the spatial distribution of debris cover on Miage glacier was derived from ASTER data at 90 m resolution. The debris thickness map agrees well with the values and spatial pattern from field measurements, supporting the performed analysis and the use of surface temperature as a proxy for debris distribution.

Over <1 day, surface temperature is influenced by surface meteorological conditions, shading, roughness and elevation; over periods >1 week, debris thickness is the primary control. Both ground and remotely sensed temperature data predict well the debris thickness at the terminus and its upstream decrease.