Geophysical Research Abstracts
Vol. 14, EGU2012-14422, 2012
EGU General Assembly 2012

Latitudinal variations in modeled insolation driven snow surface ablation

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Net absorbed insolation is partially dependent on and positively correlated with surface roughness, which changes through an ablation season. Understanding the feedback between absorbed insolation and surface ablation is important for understanding the spatial and temporal variations in surface ablation or melting. To investigate this feedback we developed a numerical model to determine the absorption of insolation on an arbitrary two-dimensional surface, and used the absorbed radiation to ablate that surface. The model is used to investigate how surface topography evolves over an ablation season. Results from numerical simulations reveal that the evolution of surface features throughout an ablation season is strongly latitudinally dependent. At high latitudes, the aspect ratio of surface features decreases through the ablation season, reducing surface topography. At low latitudes, sinusoidal periodic surfaces grow in amplitude as the surface ablates. This surface evolves into a series of peaks and valleys, resembling penitentes, features observed in high alpine snow-packs in the tropics and sub-tropics. Further investigation of the modeled latitudinal range at which periodic surfaces grow in amplitude as well as their surface orientations matches observational data on penitentes. In both high and low latitudes, topographic complexity significantly increases the fraction of absorbed insolation relative to a flat surface. For example, simulations for ablation in Greenland show that the inclusion of complex features enhances absorption by 15 percent, or for a typical ablation season, 8 W m^{-2}.