Geometric enhancement of the absorption of incoming insolation on complex terrain

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The surface of ice sheets and ice shelves are far from flat. Rivulets, crevasses and ponds sculpt the surface of ice in an ablation zone creating surface roughness on multiple scales. These surface features reflect energy towards other portions of the surface, and cast shadows, creating a tug-of-war between the shadows which exacerbate surface roughness, and multiple reflections and absorption which acts to minimize surface features. We developed a numerical model which expands on the pioneering work of Pfeffer and Bretherton, 1987, who examined the ability of V-shaped crevasses to trap solar energy more efficiently than a flat ice surface. Our methodology extends this previous work to arbitrary, 2-dimensional surface feature geometries. Our numerical model calculates the distribution of absorbed energy for surfaces and includes multiple reflections and shadows from both direct and reflected light sources. Insolation is only part of the surface energy budget of an ice-shelf or ice-sheet, but we focus exclusively on this aspect of the surface energy flux in this study because other energy fluxes may not share the strong dependence on surface geometry associated with absorption of insolation. This may mean that meter to kilometer scale surface features in ice ablation zones evolve according to ice-sheet surface 'optics', the radiative details of complex, multiply illuminated terrain.