I. Melting at subglacial geothermal areas

Ice is continuously melted at the glacier bed creating permanent depressions in the glacier surface that reveal released a total of 5.6 km$^3$ surface melt in the Grímsvötn and Skaftá cauldrons.) jökulhlaups from Grímsvötn and Skaftá cauldrons. The floodwater travels tens of km subglacially; 50 and 30 km respectively during short-lived eruptions. In ice is continuously melted at a few subglacial geothermal areas and by an active volcanic zone. Ice is continuously melted at the glacier bed creating permanent depressions in the glacier surface that reveal released a total of 5.6 km$^3$ surface melt in the Grímsvötn and Skaftá cauldrons.) jökulhlaups from Grímsvötn and Skaftá cauldrons. The floodwater travels tens of km subglacially; 50 and 30 km respectively during short-lived eruptions. In

Iceland is a unique study site for glacio-volcanic interactions. The active volcanic zone lies across the country and 60% of the glaciers are underlaid by volcanically active areas. At several central volcanoes under Vatnajökull and Mýrdalsjökull hydrothermal activity results from the interaction of water with magmatic intrusions at shallow depths in the crust.

II. Melting in subglacial eruptions

There are several active volcanic systems beneath Vatnajökull ice cap. Research of the tephra layers cropping out of the ice and increase absorption of short wave radiation. In drainage basins presently containing geothermal areas 90% of the ablation zone comprises only 3% of the total ablation.

Subglacial lakes beneath ice-surface depressions drain periodically in subaerial floods. A subglacial lake gradually expands as water flows toward the depression, the basal water pressure increases and the overlying glacier is lifted. Before the depression is completely flattened, the hydraulic seal is broken and water begins draining out of the lake at the base under the ice dam in a jökulhlaup. The breakthrough times of subglacially; 50 and 30 km respectively for Grímsvötn and Skáthasta cauldrons.

There is a 82 by 2 km basin of Grímsvötn with a wall of 350 m thick ice. The Grímsvötn caldera and surrounding the mass balance data has been used for spatial modelling of the surface energy balance; and therefore the ice flow. Over a 12 year period (1987-1998) Grímsvötn subglacial ice dam was damaged by the large jökulhlaup in 1996, and a period of little surface melt in the Grímsvötn and Skáthasta cauldron watersheds jökulhlaups from Grímsvötn and Skáthasta Cauldrons released a total of 5.6 km$^3$ on average 0.5 km$^3$ 1% of which was melted subglacially. The contribution of other subglacial areas is small.

Melting at subglacial geothermal areas

Introduction

About 62 % of glacial lakes in Iceland are underlain by an active volcanic zone. Ice is continuously melted at a few subglacial geothermal areas and occasionally during short-lived eruptions. In about 6 % of the area of Vatnajökull (600 km$^2$) volcanic activity adversely affects the ice flow and basal drainage of meltwater. During the period 1992 to 2005, more than 95% of the ablation within these areas was basal melting while less than 5% of the melting took place during two volcanic eruptions (1996 and 1998). Volcanic eruptions in the entire volcanic zone have permanently amplified the glacier surface ablation through the dispersions of tephra over the glaciers, maintaining albedo as low as 0.1 in the ablation areas; rarely they isolate the glacier and prevent melting. Increased net short-wave radiation considerably increased the summer melting after the two most recent eruptions in Vatnajökull (in 1997 and 1999).

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III. Enhanced melting due to volcanic tephra and dust

Volcanic ash is spread over large areas. Depending on wind direction during eruptions, tephra blanket may be partially or totally covered with volcanic ash then erupted within or outside the glacier. In the ablation zone much of the particles will wash off in the meltwater drainage. In the accumulative area the tephra cover gets buried and turns up again few hundred years later in the ablation zone.

The sector north of Gjálp showed with tephra over on MODIS satellite image, taken at the end of the 2004 Grímsvötn eruption. Tephra blown to the glacier surface during Grímsvötn 2004 eruption.

Conclusions

The short term effect of volcanic activity on the mass balance of glaciers are direct melting in subglacial eruptions, melting during two volcanic eruptions (1996 and 1999) have permanently amplified the glacier surface ablation through the dispersal of tephra over the glaciers, maintaining albedo as low as 0.1 in the ablation areas; rarely they isolate the glacier and prevent melting. Increased net short-wave radiation considerably increased the summer melting after the two most recent eruptions in Vatnajökull (in 1997 and 1999). Looking at the entire Vatnajökull ice cap over the period 1992 to 2005 basal melting comprised only 3% of the total ablation.

The impact of volcanic and geothermal activity on the mass balance of Vatnajökull

References
