Geophysical Research Abstracts
Vol. 13, EGU2011-10941, 2011
EGU General Assembly 2011
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Impacts of the Ey2010 tephra fall on Icelandic ice caps: interactions between substrate and glacier surface topography.

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The Ey2010 tephra fall provides a unique opportunity to assess the perturbations to snow and ice melt caused by supraglacial tephra. Observations from Eyjafjallajökull reveal varied interactions of tephra, ablation and glacier substrates which give complex responses in terms of meltwater production. Tephra resting on low-permeability ice substrates was rapidly removed by runoff. Tephra on permeable snow was more persistent, especially at thicknesses greater than several centimetres, where meltwater drained through the snow pack so the insulating effect of an undisturbed tephra cover was prolonged. Topographic evolution of tephra-snow-ice surfaces involved a process of thermal etchplanation, where rill incision set up rapid backwasting of 50-60° low-albedo ice walls, progressively removing the initial tephra-covered surface. Such etching of the ice cap surface involves the growth of a slower-melting, largely tephra free ice surface several metres below a shrinking, insulated tephra-covered surface, so that the surface area for melt first increases then decreases, and meltwater production is maximised when ice-wall areas are at a maximum. The implications for modelling melt are that three surface types with specific ablational characteristics must be parameterized and their changing area quantified.