Geophysical Research Abstracts
Vol. 13, EGU2011-12282-1, 2011
EGU General Assembly 2011

The 2010 jökulhlaup from Grímsvötn subglacial lake, Iceland and its effects on glacier motion

Eyjólfur Magnússon (1), Helgi Björnsson (2), Páll Einarsson (2), Dana Floricioiu (3), Florian Mueller (4), Thomas Nagler (4), Finnur Pálson (2), Matthew Roberts (5), Helmut Rott (6), and Gunnar Sigurdsson (5)

(1) Nordic Volcanological Center, Institute of Earth Sciences, University of Iceland, Reykjavík, Iceland (eyjolfm@raunvis.hi.is), (2) Institute of Earth Sciences, University of Iceland, Reykjavík, Iceland, (3) Remote Sensing Technology Institute, German Aerospace Center (DLR), Munich, Germany, (4) ENVEO IT GmbH, Innsbruck, Austria, (5) Icelandic Meteorological Office, Reykjavík, Iceland, (6) Institute of Meteorology and Geophysics, University of Innsbruck, Innsbruck, Austria

Studies of jökulhlaups (glacial outburst floods) from Grímsvötn subglacial lake, located in the centre of Vatnajökull ice cap, have since the early steps of such studies helped to advance the scientific understanding of jökulhlaups. The Grímsvötn jökulhlaups drain ∼50 km underneath the Skeiðarárjökull outlet glacier, flowing south from the ice cap. Floodwater previously drained into the river Skeiðará at the easternmost edge of the glacier, but the river has been dry since July 2009. Most of the meltwater from Skeiðarájökull now drains westwards along the terminus into the river Gígjukvísl. In October 2010, GPS measurements on the ice cover over Grímsvötn, showed that the lake level was at the same height as before the last significant jökulhlaup in November 2004. The total volume of water accumulated in the lake at that time was ∼0.7 km^3. Because of the increased likelihood of a jökulhlaup, a GPS station was mounted on Skeiðarárjökull on 19 October. The station was located 8 km from the terminus, above an over-deepened part of the glacier bed where previous studies have revealed subglacial accumulation of water during jökulhlaups and events of intense rainfall.

Seismic tremor observed at the Grímsfjall nunatak (<1 km from the lake's drainage point) gave the first indication that floodwater was seeping from Grímsvötn on 28 October. In the afternoon of 29 October increased electrical conductivity of the water in Gígjukvísl indicated that floodwater was draining from the glacier. A detectable increase in discharge was apparent by the afternoon of 31 October. The flood reached a maximum gauged discharge of 2,600 m^3 s^{-1} at 9:30 on 3 November, but the actual peak was slightly higher, as visually the discharge continued to increase until 12:30. Significant discharge due to the jökulhlaup is evident in river level data of Gígjukvísl until 10 November. The total volume of the jökulhlaup according to discharge measurements was 0.45 km^3. High values in electrical conductivity show that Grímsvötn was still leaking at the beginning of January 2011.

A time series of TerraSAR-X images was acquired between August amd December 2010. By applying a SAR amplitude image correlation technique a time-series of ice motion maps can be generated showing the average surface velocity before, over the period including the jökulhlaup and after it, providing additional insight in the dynamic respond of a glacier to the jökulhlaup. Processing of the data-set is currently ongoing.

The motion of the GPS station was strongly affected by the passage of the jökulhlaup. Water began to accumulate beneath the station in the evening of 30 October. Uplift corresponding to a total of 3 m and a maximum uplift rate of 2 m d^{-1} (during the night of 31 October) continued until ∼6:00 on 3 November, few hours before the peak flow in Gígjukvísl. In the evening of 30 October the horizontal motion of the station increased from 0.3 m d^{-1} to 4.0 m d^{-1} in the early morning of 31 October and it remained >2.5 m d^{-1} during the period of water accumulation. By the early morning of 3 November the station remained at roughly constant height for ∼6 hours and, during that time the horizontal velocity decreased to 1.1 m d^{-1}. Then the station started subsiding, at ∼1 m d^{-1} during the first hours but later at much slower rate. The GPS data shows clear sign of subsidence until 10 November approximating the time when floodwater discharge had dropped below a detectable value in Gígjukvísl. During the subsidence period the horizontal velocity declined slowly from 1.1 m d^{-1} to 0.34 m d^{-1}.

Pervious observation derived from interferometric SAR data have revealed an 8-10 km^2 area of ice uplift during a jökulhlaup and a winter rainfall event in the vicinity of the GPS station. Assuming the same area of uplift for the 2010 jökulhlaup we may expect that between 5-10% of the total flood volume had accumulated at the base of the glacier near the GPS station, signifying the importance of subglacial water storage during jökulhlaups from Grímsvötn and its effect on floodwater discharge.