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Jökulhlaups in Iceland – SAR contribution to flowpath prediction

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Glaciers atop active volcanoes represent a constant potential danger for adjacent inhabited regions and infrastructure. Besides the usual volcanic hazards (lava flows, pyroclastic clouds, tephra falls, etc.), the volcano-ice interaction leads to enormous meltwater torrents [icelandic: jökulhlaup], devastating large areas in the surroundings of the affected glacier. In Iceland, several active central volcanoes, crater chains and fissures are covered by glacier ice.

The Katla central volcano is among the most active and dangerous subglacial volcanoes in Iceland. The volcanic system comprises an approx. 100 km^2 large caldera, with an adjacent SW-NE trending fissure swarm. The caldera is covered by Mýrdalsjökull, the fourth largest Icelandic glacier (586 km^2). The average eruption frequency of Katla is twice per century, with the last major eruption dating back to 1918. The maximum meltwater discharge of the jökulhlaup accompanying this eruption has been estimated to 300.000 m^3/s.

Due to the ice cover, meltwater produced by an eruption propagates as a floodwave subglacially from the eruption site to the glacier terminus, devastating large areas in the vicinity of the glacier. Mýrdalsjökull is surrounded by huge sandur plains, indicating the massive impacts of such meltwater torrents. Hazard zonation of periglacial areas endangered by Katla induced jökulhlaups has been conducted on the basis of the hydraulic potential at the glacier base so far, whereas the largely unknown pre-existing subglacial drainage system was not taken into account.

We analysed a total amount of 30 SAR images, with special focus on linear depressions in the glacier surface which are indicators of the subglacial tunnel system for meltwater drainage. The time series comprises images of five different SAR sensors (ERS-1, ERS-2, JERS-1/SAR, RADARSAT and ENVISAT-ASAR) covering a time period of 12 years and starting in 1994. More than 100 km of the subglacial drainage system could be identified under the Mýrdalsjökull in the SAR time series, where the location and the size of the drainage system is persistent over the whole period of investigation. It has been found, that the tunnel systems can transcend water divides and therefore connect different drainage basins. According to the results, a new hazard zonation of areas endangered by a jökulhlaup accompanying a subglacial eruption seems necessary.