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Measuring gases from sub-glacial volcanoes

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More than half of Iceland‘s eruptions originate from ice-capped volcanic systems, which presents challenges for pre-eruptive geochemical monitoring. Subaerial gas measurements can be made where gases reach above the ice, such as at nunatuks or at geothermal cauldrons where heat has partly melted through the overlying ice, however these measurements are made during field-campaigns, as permanent installations would be buried by snow accumulation. Gases dissolved in melt- and ground-water can be measured where springs emerge from the ground, and further work is being done to develop this, however these measurements present their own challenges. We have explored the glacier-surface manifestations of gas emissions from Bárðarbunga volcano, covered by Vatnajökull ice cap, to test a new continuous gas-in-snow monitoring instrument. The most actively changing cauldron, characterized by near-vertical circular crevassing, was identified as the single source of surface-reaching gas emissions in June 2016. CO2, H2S, and SO2 sensors are housed within a plastic pipe which is buried in a 1 m hole drilled into the snow. This instrument measures gases contained within snow, so accumulation on top of the instrument is not a problem. Measurements are transmitted via a satellite-modem mounted on a mast high above the ice-surface. This setup allows for continuous data sampling and transmission at geothermal cauldrons throughout a substantial part of the year. Hourly values were transmitted with CO2/H2S ratios consistent with those measured by MultiGAS near the edge of the outermost crevasse. Samples collected from high-concentration air and samples drawn out of the snow on the edge of the outermost crevasse were analyzed for d13C in CO2 using a Delta Ray spectrometer. The d13C values measured both in air and in air-in-snow were consistent with values measured from gases collected at fumaroles not covered by ice from the neighboring volcanoes Grímsvötn, Kverkfjöll, and Askja.