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Year-round high-resolution geoelectrical monitoring to improve the understanding of deglaciated soil evolution in the High Arctic

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High Arctic regions are experiencing an accelerated rise in temperatures, about three times more than the global average. As a result, the glacier coverage over these landscapes is reducing, uncovering soils which start their development by sustaining emergent microbial communities. These new systems will have a significant impact on the global carbon budget, thus monitoring and understanding their evolution becomes a necessity.

Geoelectrical methods have emerged as a fast, cost-effective and minimally invasive way of imaging soil moisture dynamics in the shallow subsurface. BGS PRIME technology is designed to facilitate low-power remote geoelectrical tomography by using an array of sensor electrodes. We are using such technology to monitor the year-round variability of soil electrical resistivity in 4D on a glacier forefield in the vicinity of Ny-Alesund, Svalbard. Until now, such assessment of soil properties was confined to the summer period due to harsh Arctic winter conditions making site access very difficult.

Two PRIME systems were deployed during the summer of 2021 on Midtre Lovénbreen glacier forefield, which exhibits a soil chronosequence extending from the youngest soils near the glacier snout up to soils of approximately 120 years old. The two geophysical systems are monitoring electrical resistivity within the top 2m of soil of approximately 5 and 60 years of age respectively, recording soil moisture and freeze-thaw dynamics within the active layer above the permafrost.

We present early results, a timeseries of 3D soil electrical resistivity models, that captured several precipitation events during the summer and the progression of the freezing front when soil temperatures dropped below 0 °C in October 2021. These results reveal differences in the hydrodynamic activity between the 5- and 60-year-old sites determined by soil properties and their location on the glacier forefield. In addition, soil cores were sampled from the vicinity of the PRIME systems. These were subsequently subjected to laboratory tests to describe the changes in

electrical resistivity as a function of moisture content and during successive freeze-thaw cycles. Furthermore, we are working towards an integrated analysis and a more comprehensive model of soil evolution at our sites by combining geoelectrical measurements with point measurements of environmental parameters and microbiological activity.