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Using resistivity method to characterize water flow patterns in permafrost environment (Ilulissat, Greenland)

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The construction of transport infrastructure in the north inevitably affects the hydrology of the watershed it overlaps by impeding water drainage on the land. Observations of events causing the rapid degradation of northern infrastructure suggest that liquid water transport and its thermal effects have been significantly underestimated in recent years in permafrost science and engineering. The consequences of convective heat transfers at the interface between flowing water and the ground, caused by concentration and channeling of runoff and groundwater around infrastructures, are poorly known. Electrical resistivity is one of the most effective geophysical methods used to map and characterize permafrost, as it is sensitive to the state (frozen/unfrozen) of the ground, its ice content and subzero temperatures. To study the extent of permafrost degradation caused by the redirecting of water flow, electrical resistivity surveys were conducted perpendicular to a stream draining a small watershed, south of the airport of Ilulissat in Greenland. Ilulissat is located on the west coast of Greenland, north of the 69°parallel in the continuous permafrost zone. The soil of the study site consists of marine clay and silt. Permafrost temperature is between -1 °C and -3.5 °C. The first 4 meters of permafrost is ice-rich and show high resistivity values while the soil below 4 meters depth is estimated to be unfrozen due to a high porewater salinity (Foged and Ingeman-Nielsen, 2009). The water flow patterns in the ice-rich zone are easily observable through lower resistivity values recorded due to permafrost warming at these locations. At this site, electrical resistivity profiles correlated with several permafrost properties such as: soil temperatures at different depths, active layer thickness, and water content of active layer and permafrost soils. Water discharge and water temperature in the stream were measured daily during the study period and implications for heat transfers are observed.