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THERMAL EFFECTS FROM GROUNDWATER FLOW - A CASE STUDY FROM A SUBARCTIC FEN WITHIN THE SPORADIC PERMAFROST ZONE OF TAVVAVUOMA, SWEDEN

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The ground thermal regime and associated heat fluxes are the determining factors for permafrost distributions. On a large scale, permafrost is thus controlled by climatic factors; however, at local scales, especially in marginal permafrost areas, factors such as ground thermal properties, hydrology, and snow cover are important. Groundwater can transport heat in both lateral and vertical directions but its influence on ground temperatures at local scales in permafrost environments is not well studied due to the complexity of processes involved and the remoteness of potential study sites. In this study we combine field observations from a subarctic fen located within the sporadic permafrost zone with numerical simulations using the Arctic Terrestrial Simulator (ATS). At the Tavvavuoma study site in northern Sweden, ground temperature profiles and groundwater levels were observed in boreholes every 15 minutes over the summer of 2013. These observations were simulated using the ATS down to 2 m depth across a gradient of permafrost conditions both within and surrounding the fen. Two-dimensional scenarios representing the fen under various groundwater fluxes were developed to quantify the influence of groundwater flows on the ground temperature/heat flux. Our modeling results show that heat transported by groundwater from lakes surrounding the fen is on the same order of magnitude as the vertical heat flux from the ground surface.

The results suggest that heat transported by groundwater flows has a significant impact on the ground temperature distributions in the fen. As sporadic permafrost environments often contain substantial portions of unfrozen ground with active groundwater flow paths (such as fens) this heat transport mechanism is extremely important for permafrost dynamics in these environments.