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Advances in the simulation of groundwater flow and permafrost thaw

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The presence of permafrost affects the movement and storage of groundwater in cold regions. There are three primary pathways by which groundwater flows in permafrost terrain: 1) above permafrost through the active zone (or supra-permafrost aquifers), 2) below permafrost (i.e. sub-permafrost aquifers), and 3) through taliks, perennially unfrozen vertical or horizontal 'holes' in permafrost. With thawing of permafrost, these pathways can become larger and more connected, increasing both the storage and flux of groundwater through the arctic waterscape. Already there is extensive evidence of this hydrologic change, such as increasing flow in arctic rivers, the disappearance or emergence of lakes, and increased carbon export.
An important new tool for understanding and predicting these hydrologic changes are groundwater models that incorporate dynamic freezing and thawing processes (e.g., variable permeability as a function of ice content, latent heat effects, etc.). This presentation will provide an overview of the current status of these types of models. A particular challenge is that the parameterization and coupling of surface boundary conditions to the model domain is complex and often poorly implemented. We propose to use a parametric modeling approach with the US Geological Survey's SUTRA model to evaluate model outcomes as a result of different boundary configurations. The presented simulation results will improve our understanding of the model sensitivity to boundary condition design, and will improve our conceptualization of permafrost - groundwater models.