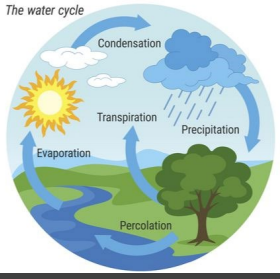
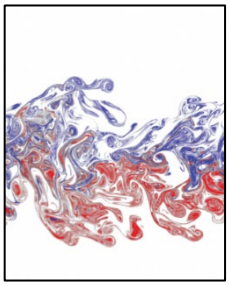
Boase Seminar Series in Hydrology and Water Resources Engineering

Department of Civil, Environmental and Architectural Engineering





Numerical Simulation of Partially Frozen Soils to Understand Aufeis Formation in Polar Regions

Mr. Alexi Lainis
Denver Water
Denver, CO

Abstract: Aufeis (also known as icings) are large sheet-like masses of layered ice that form in river channels in artic environments, where permafrost is present at shallow depths and an upper active layer is frozen part of the year. Aufeis are important sources of water for arctic river ecosystems because they melt late into the summer, providing a source of water to rivers when other water resources are reduced. The aim of this research is to use numerical simulations to evaluate a conceptual model of subsurface hydrogeothermal conditions that can lead to the formation of aufeis in the Kuparuk aufeis field on the North Slope of Alaska. Above the permafrost, ~15m of the shallow subsurface remains unfrozen all year long (also known as a talik). Groundwater in this talik is forced to the surface through unfrozen gaps in the active layer when it encounters a fully frozen subsurface downstream. We developed a 2-D heterogeneous vertical profile model to show that subsurface water can flow to the land surface through subvertical high permeability pathways during winter months when the lower permeability soils near the land surface are frozen. The water that exits the subsurface would then freeze on the surface, contributing to aufeis formation throughout the winter. We have performed sensitivity analyses on subsurface properties and surface temperature forgings. We show that certain parameter sets produce a contiguous unfrozen pathway through which groundwater can flow, reducing the quantity of water that is available to exit at the surface and form aufeis; while other parameter sets lead to conditions consistent with the conceptual model. An understanding of the processes that lead to the formation of aufeis is necessary to be able to predict how rising temperature may affect aufeis formation and the availability of water in Arctic river ecosystems.

Speaker Bio: Alexi Lainis graduated from the Hydrology, Water Resources & Environmental Fluid Mechanics master's program at CU Boulder in December 2021. His advisor was Professor Roseanna Neupauer. Alexi's thesis research focused on the groundwater modeling of partially frozen soils to understand Aufeis formation. His other research interests include water modeling, glaciology, snow hydrology and reservoir sedimentation. Previously he received his BS in Civil Engineering at CU Boulder in 2019. Currently he is working for Denver Water in the water modeling supply group.