Multi-* modeling, analysis, and simulation of coupled processes in the Arctic soils.

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Abstract: The Arctic is a complex environment which responds to, and contributes to the global climate controls at multiple spatial and time scales. In the talk we discuss multi-component models of energy, mass flow, and deformation affecting Arctic soils: these are partial differential equations involving various nonlinear non-smooth relationships and heterogeneous data. The first challenge is to define and implement robust conservative algorithms for the approximation of solutions which must respect the low regularity of solutions expected from these complex PDE systems featuring, e.g., free boundaries associated with thawing [1, 3, 2]. The second challenge is the data: for predictive power, the models require realistic physical data, but the empirical and field data is scarce due to the vastness of the Arctic environment; moreover, the data is rarely available for coupled processes. We approach this challenge with multi-scale techniques starting with xray images of the pore-scale applying first-principles models at the pore-scale, which we post-process with computational upscaling while respecting the non-local features and randomness [4, 6, 5].
This is joint work with the co-authors of the work listed below as well as with collaborators on current projects

References:

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