

C43E-09 A Graph Neural Network Emulator of a Finite Element Ice Flow Model



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15:10 - 16:40



eLightning Theater 2, Hall D - South (Exhibition Level, South, MC)

Abstract

Emulators of ice flow models have shown promise for speeding up simulations of glaciers and ice sheets. Existing ice flow emulators have relied primarily on convolutional neural networks (CNN's), which assume that model inputs and outputs are discretized on a uniform computational grid. However, many existing finite element-based ice sheet models such as the Ice-Sheet and Sea-level System model (ISSM) benefit from their ability to use unstructured computational meshes. Unstructured meshes allow for greater flexibility and computational efficiency in many modeling scenarios.

In this work, we present an emulator of a higher order, finite element ice flow model based on a graph neural network (GNN) architecture. In this architecture, an unstructured finite element mesh is represented as a graph, with inputs and outputs of the ice flow model represented as variables on graph nodes and edges. An advantage of this approach is that the ice flow emulator can interface directly with a standard finite element-based ice sheet model by mapping between the finite element mesh and a graph suitable for the GNN emulator. We test the ability of the GNN to predict velocity fields on complex mountain glacier geometries and show how the emulated velocity can be used to solve for mass continuity using a standard finite element approach.

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