the Arctic Terrestrial Simulator

fine-scale simulation capability

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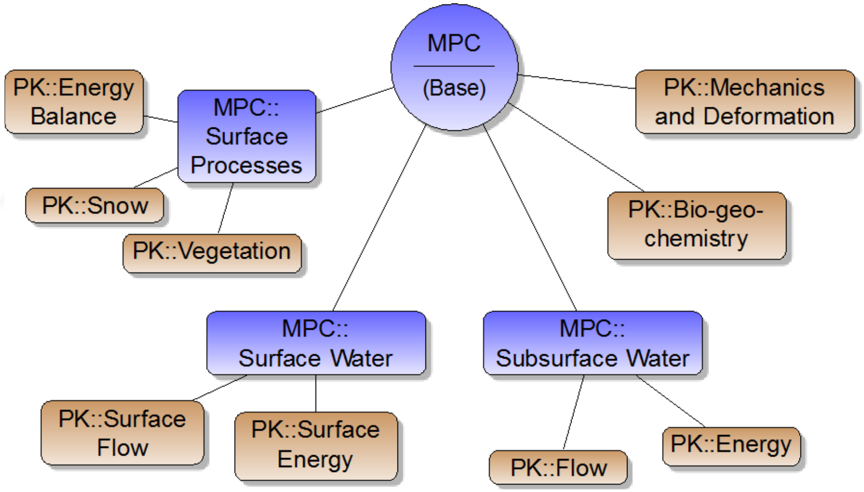
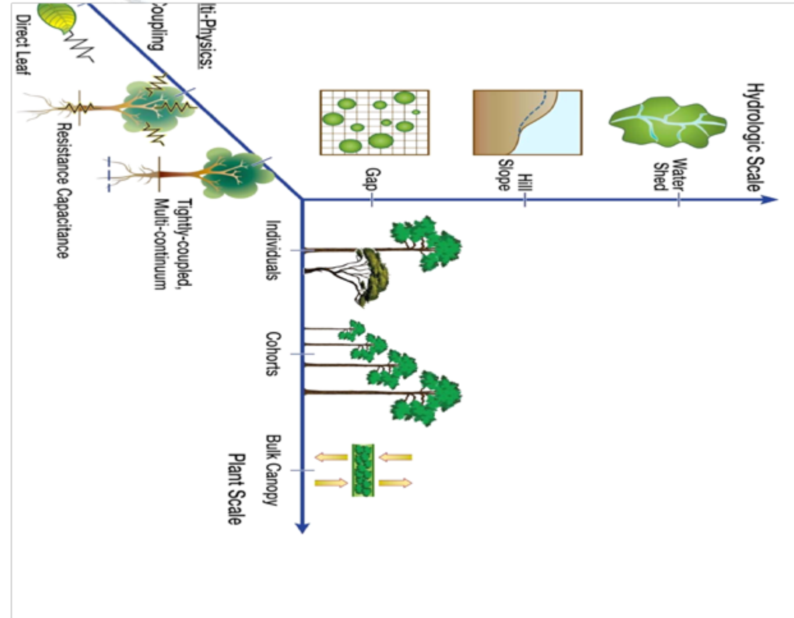
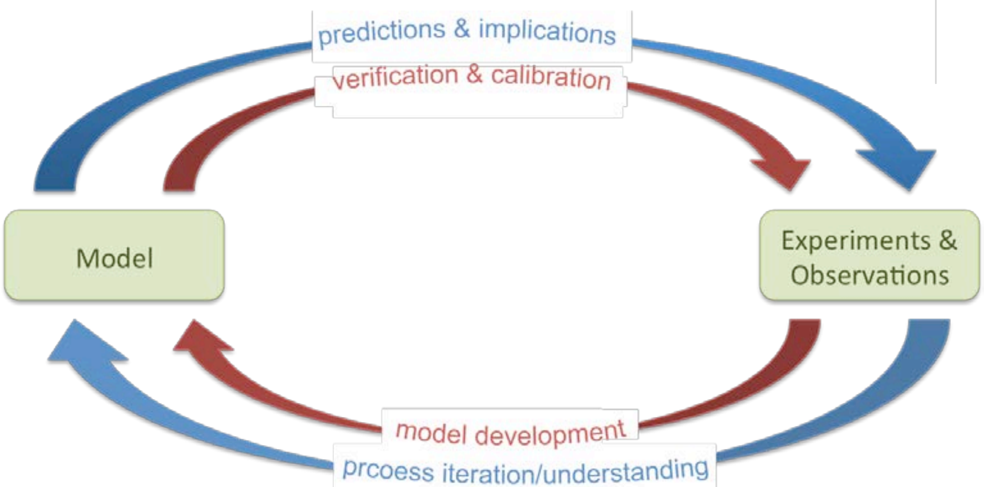
NGEE All Hands Meeting

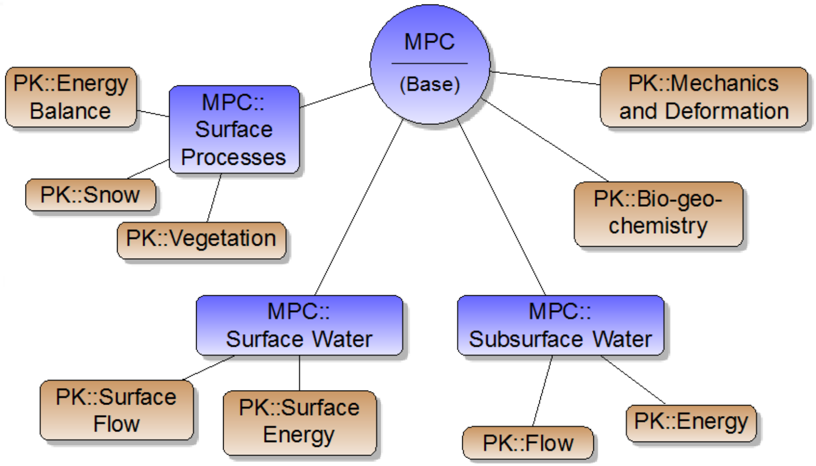
Complexity in climate simulation…



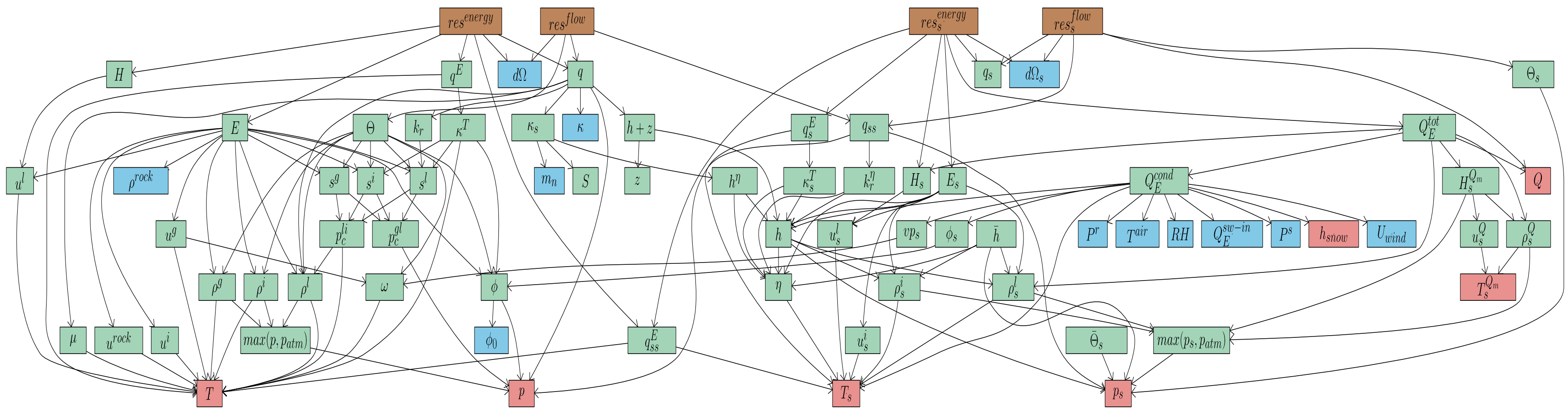




Arcos: a novel process management system



- Process models coded in individual process kernels (PKs)
- Multiprocess coordinators (MPCs) manage couplings
- Data management system allows PKs to register data needs at runtime, resulting in a dynamically configured model



- Pink: Primary variables in a process kernel or evaluator
- Green: Dependent variables in the system (e.g., relative permeability)
- Blue: Input data (e.g., precipitation)

Advantages of the ATS/Arcos approach

- Flexibility and extensibility of object oriented approach
  - Shortens the model development cycle
  - Allows process coupling strategies to be quickly tested and optimized
- Dynamically configured model
  - Enables a hierarchical testing approach that builds confidence in model implementation
  - Facilitates exploration of model structural uncertainty and hypothesis testing (what-if scenarios)
- Encapsulation of process models in process kernels facilitates interdisciplinary collaborations by allowing scientists to engage in their area of expertise

Goal is to free application scientists to focus on process representations and applications, not software

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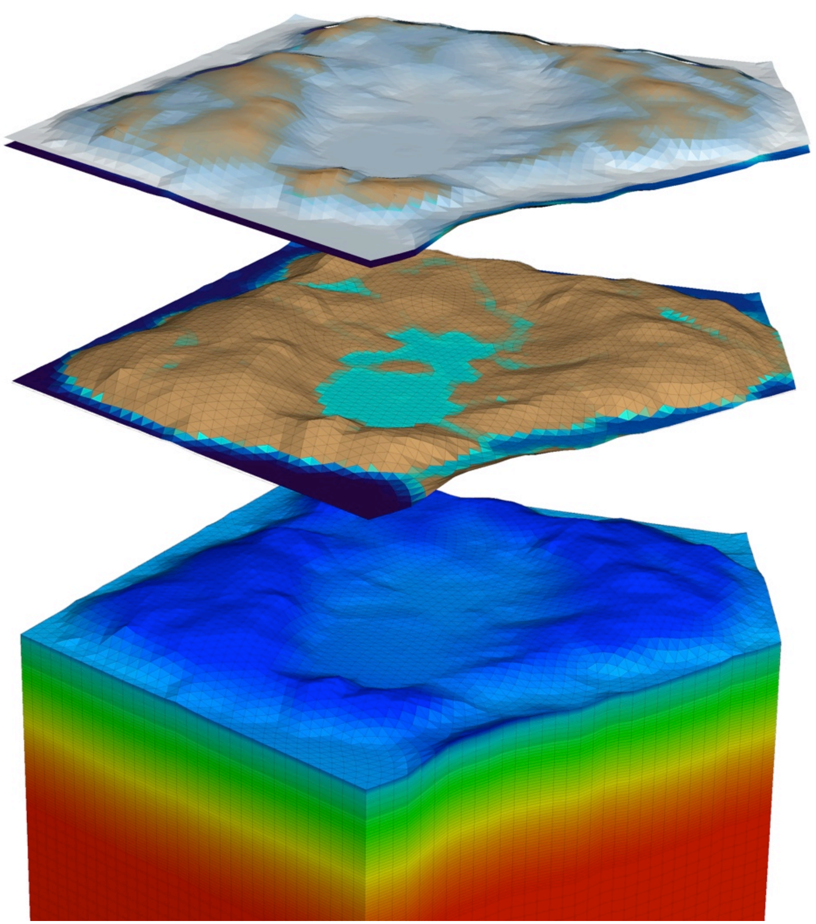
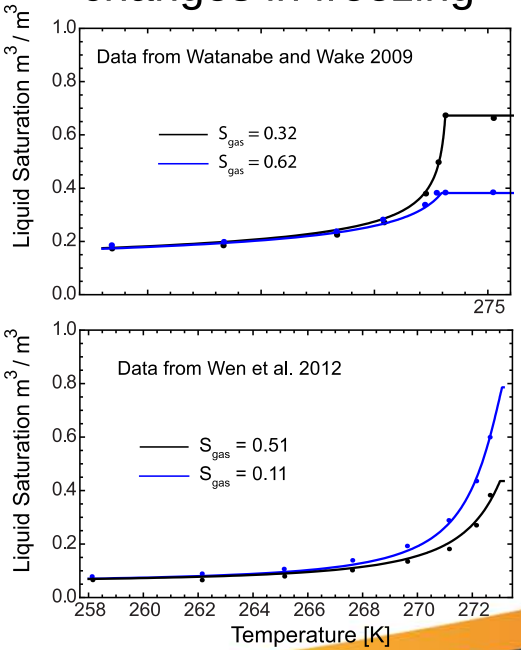


Subsurface:

- 3-phase, Richards-like equation for hydrology
- energy conservation via advection-diffusion
- includes cryosuction, density changes in freezing



(Painter & Karra, 2013

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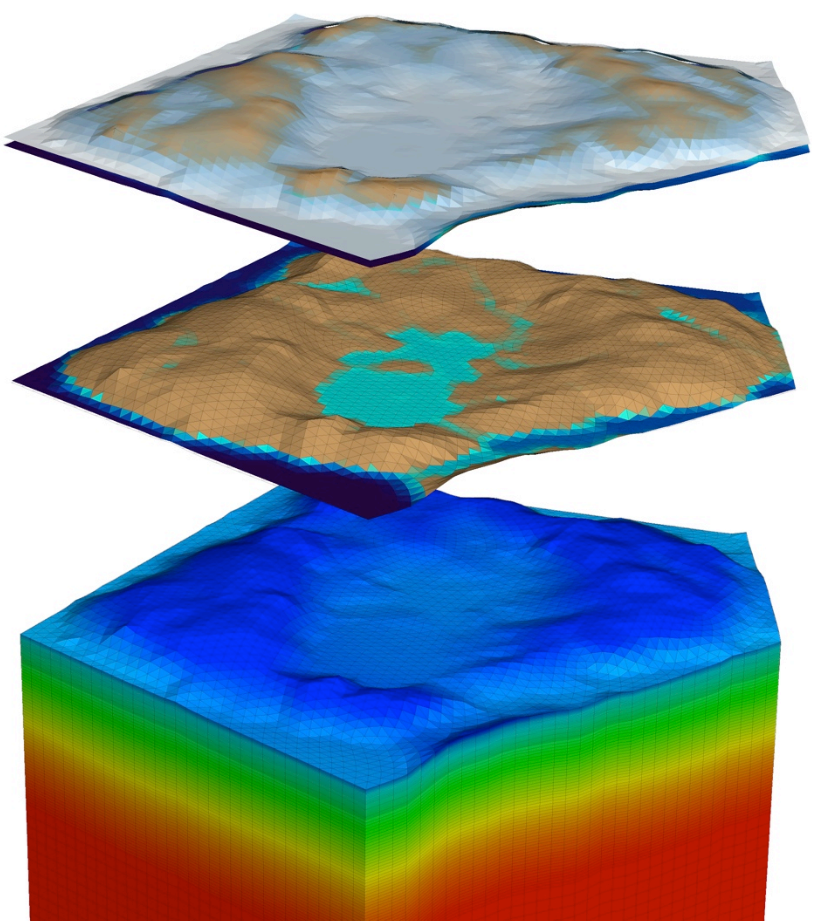
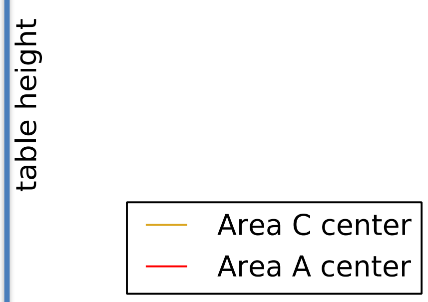


Surface:

- Overland flow (diffusion wave approximation)
- Energy equation allowing freezing of ponded water
- Coupled to subsurface with flux and pressure continuity



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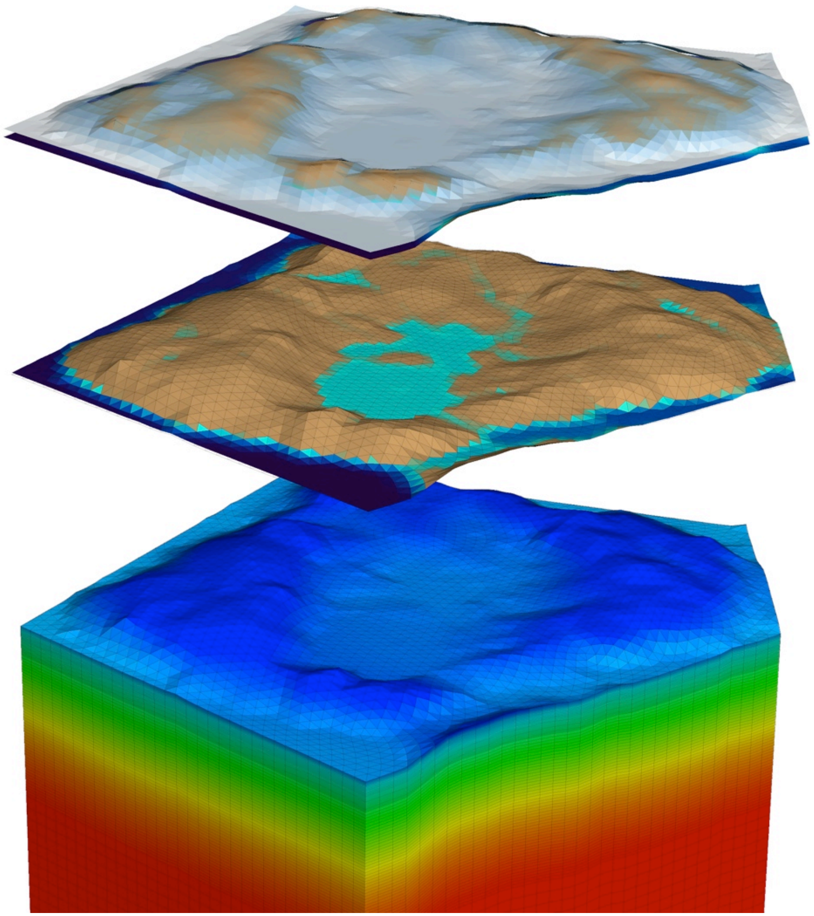
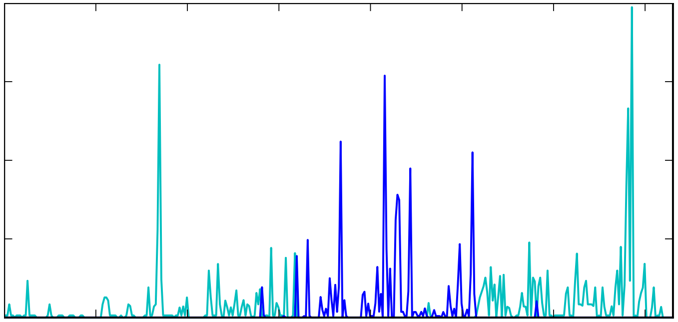


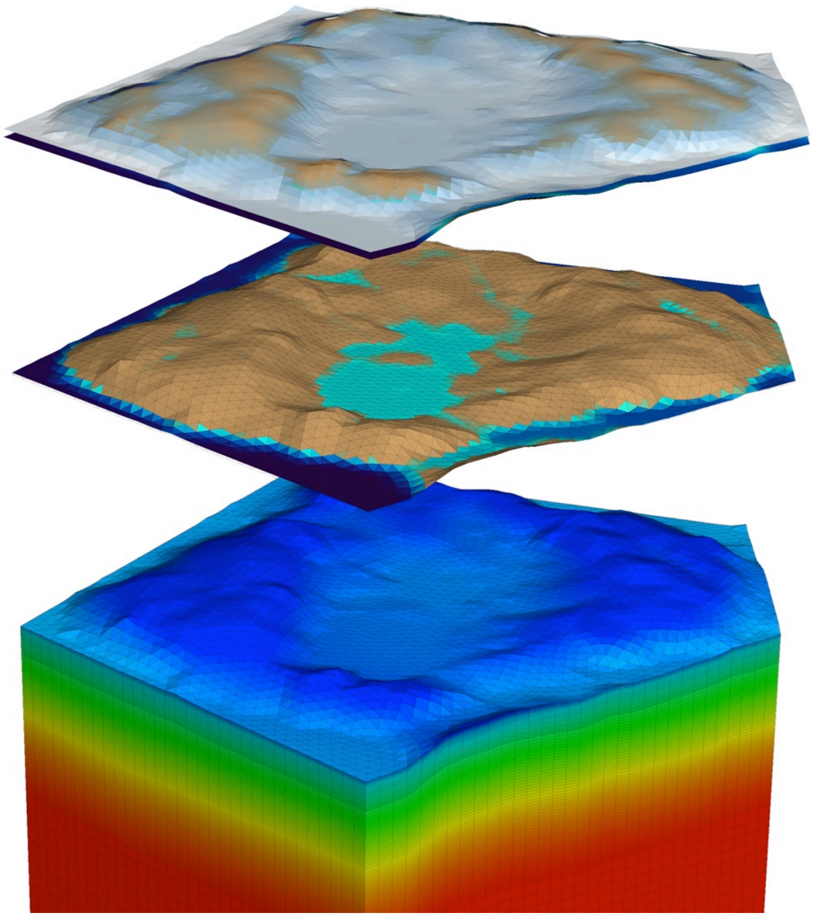
Surface energy balance:

- Balance of incoming/outgoing radiation, evaporation, sensible heat exchange, etc
- Snow model including simplified preferential distribution of incoming precipitation
- Coupled system driven by meteorological data



Work in progress…

http://software.lanl.gov/ats

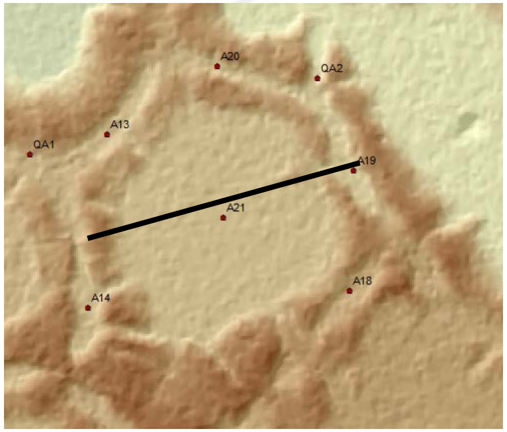


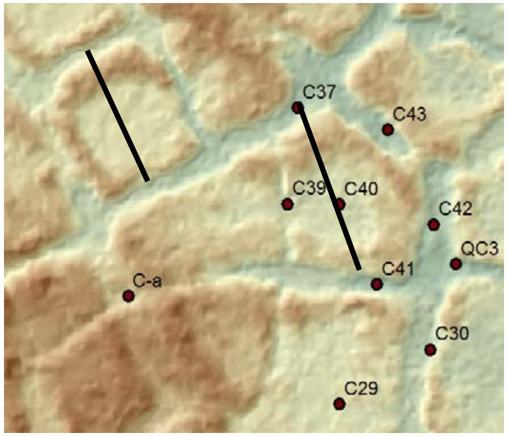
Processes currently being added or developed include:

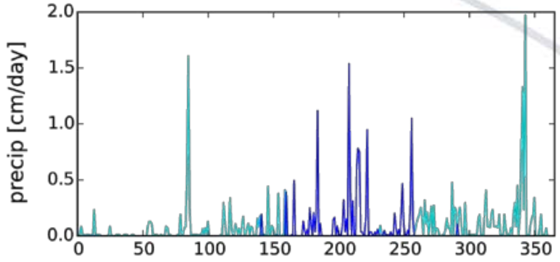
- Deformation, especially for subsidence in permafrost degradation and frost heave
- Biogeochemistry, including vegetation model and carbon cycle
- Vegetation succession through CLM-ED
- Fire

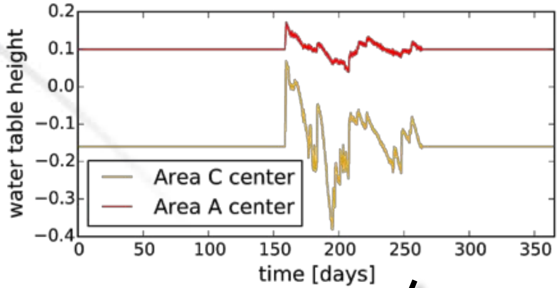
A powerful, flexible, easily extended, multiphysics tool for simulation of climate systems.

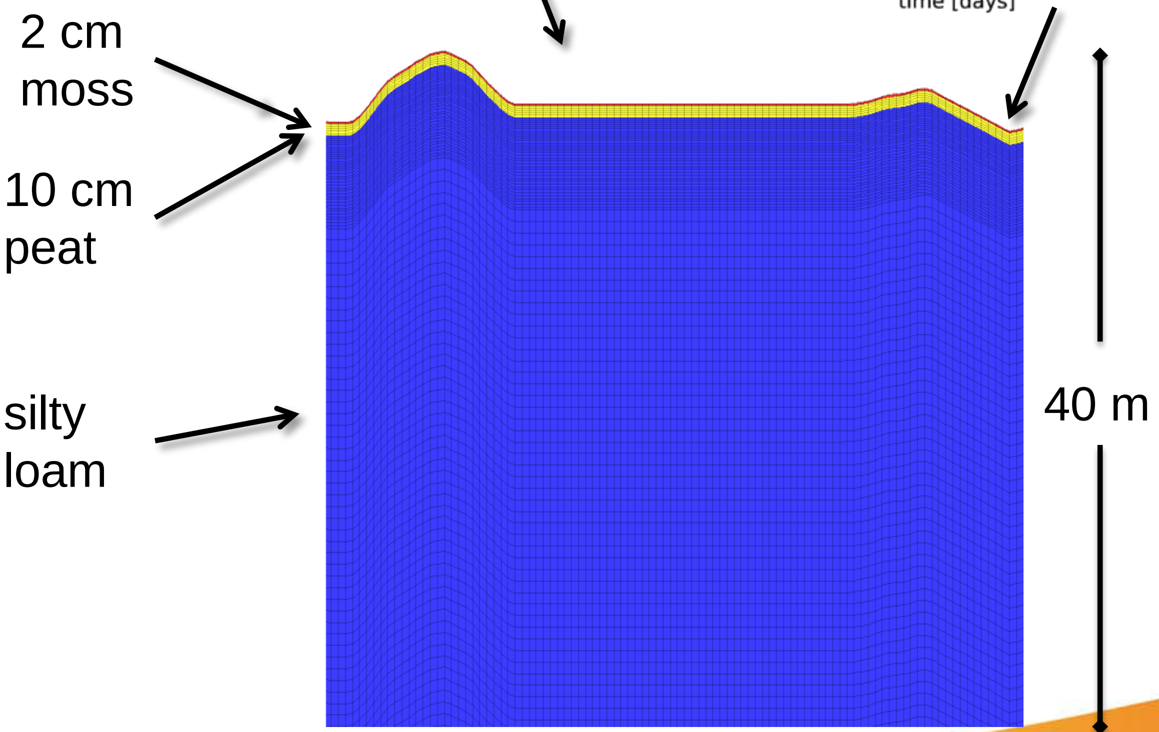
Numerical experiment setup





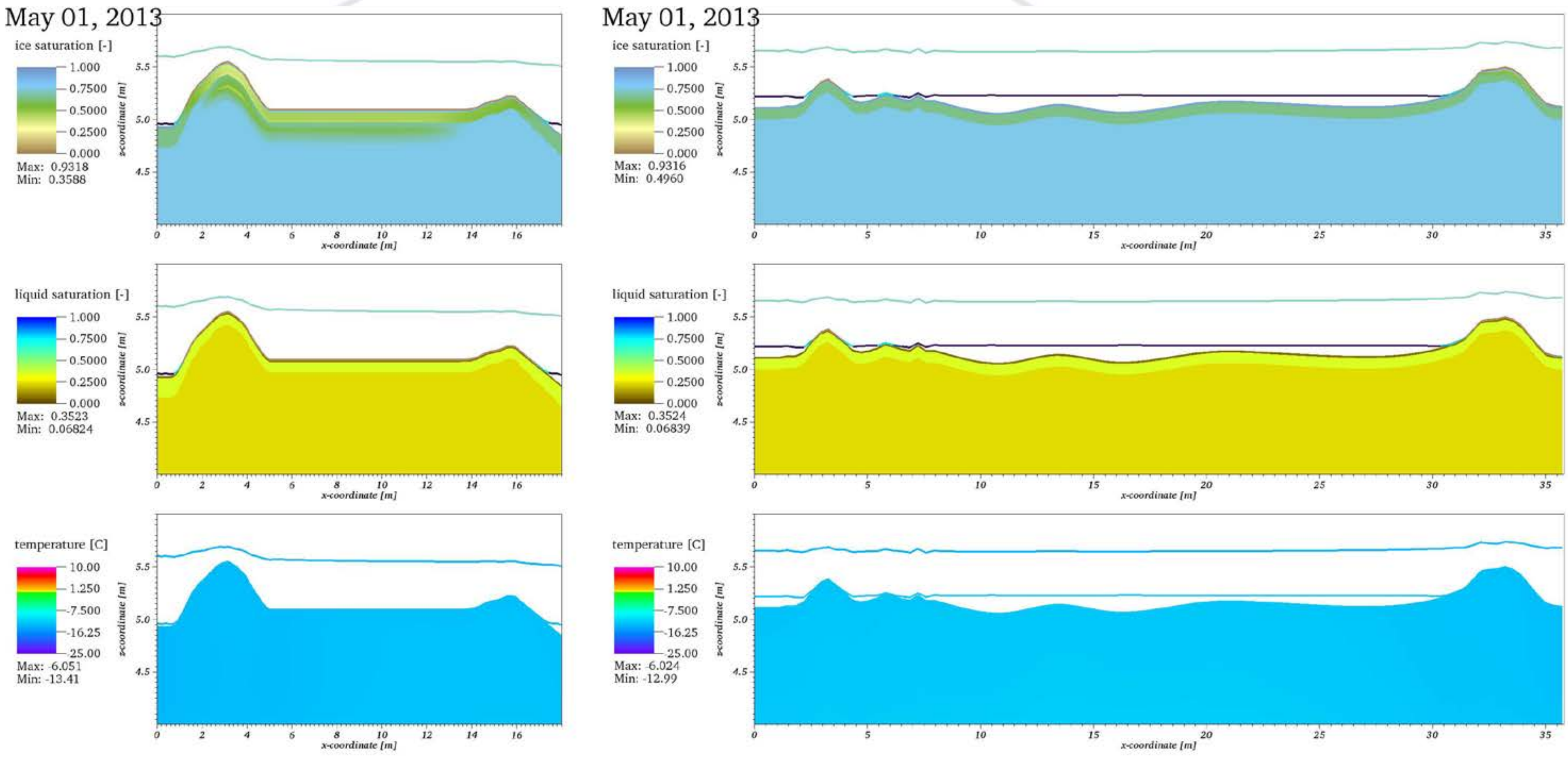






Active Layer in the current climate

Los Alamos NATIONAL LABORATORY EST. 1943



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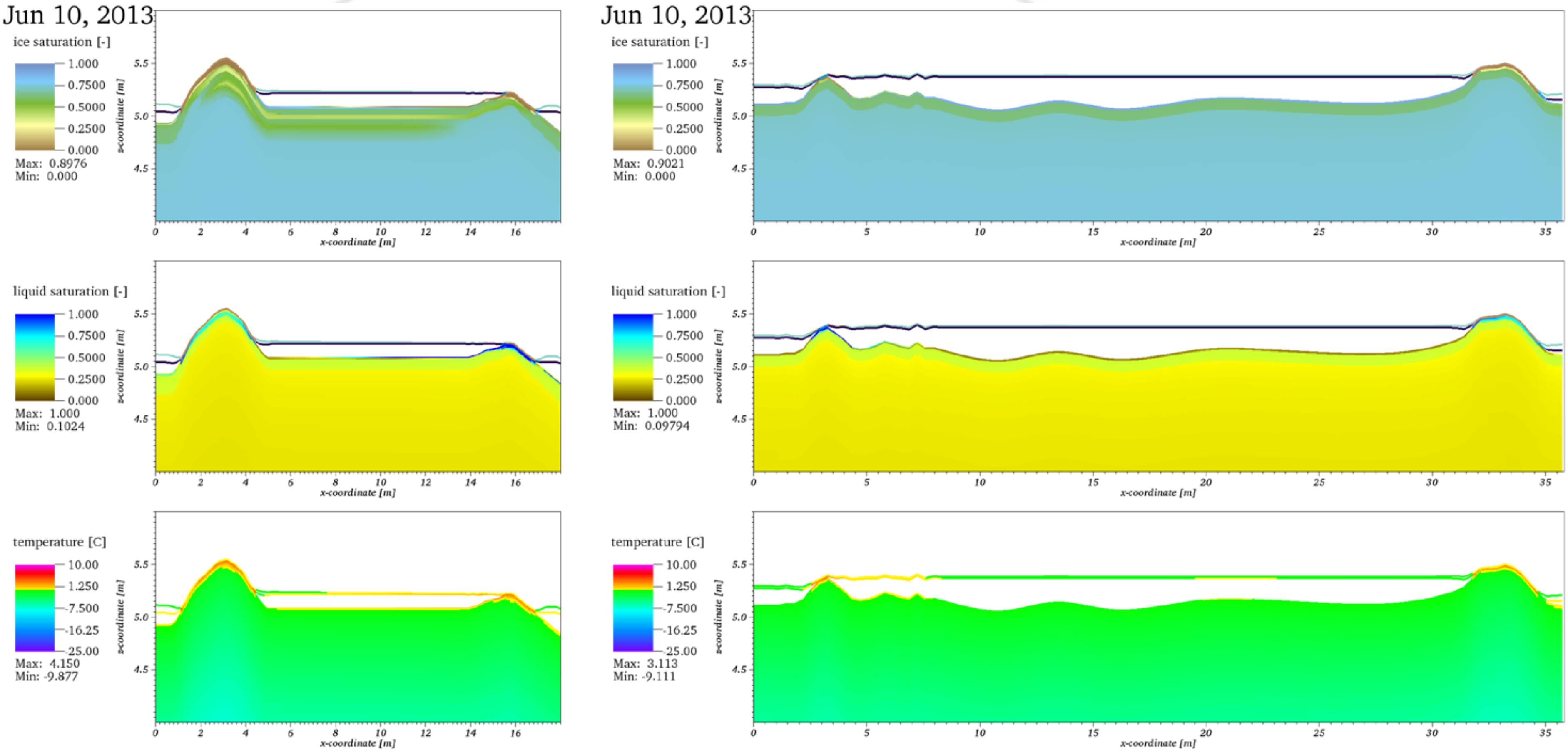

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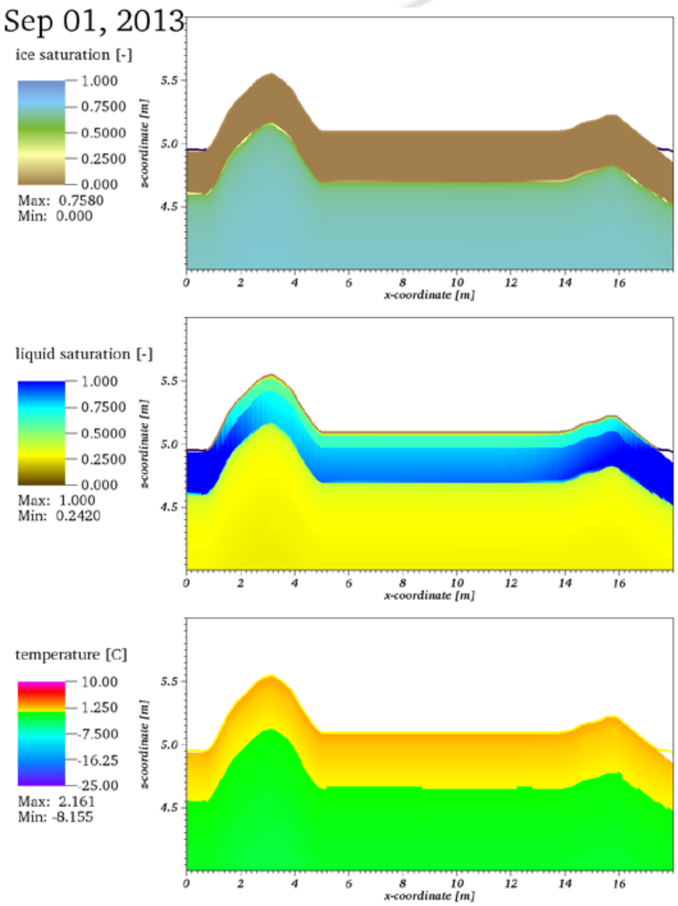

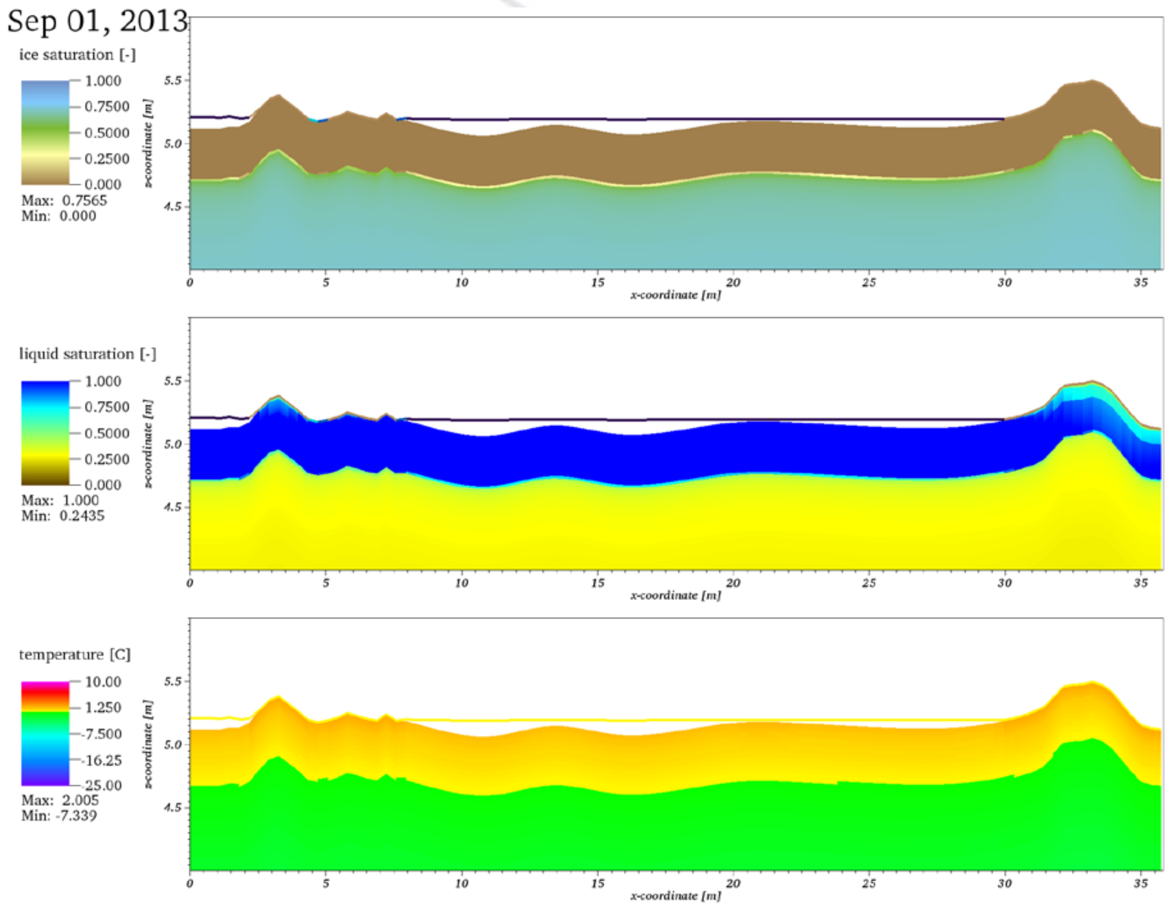

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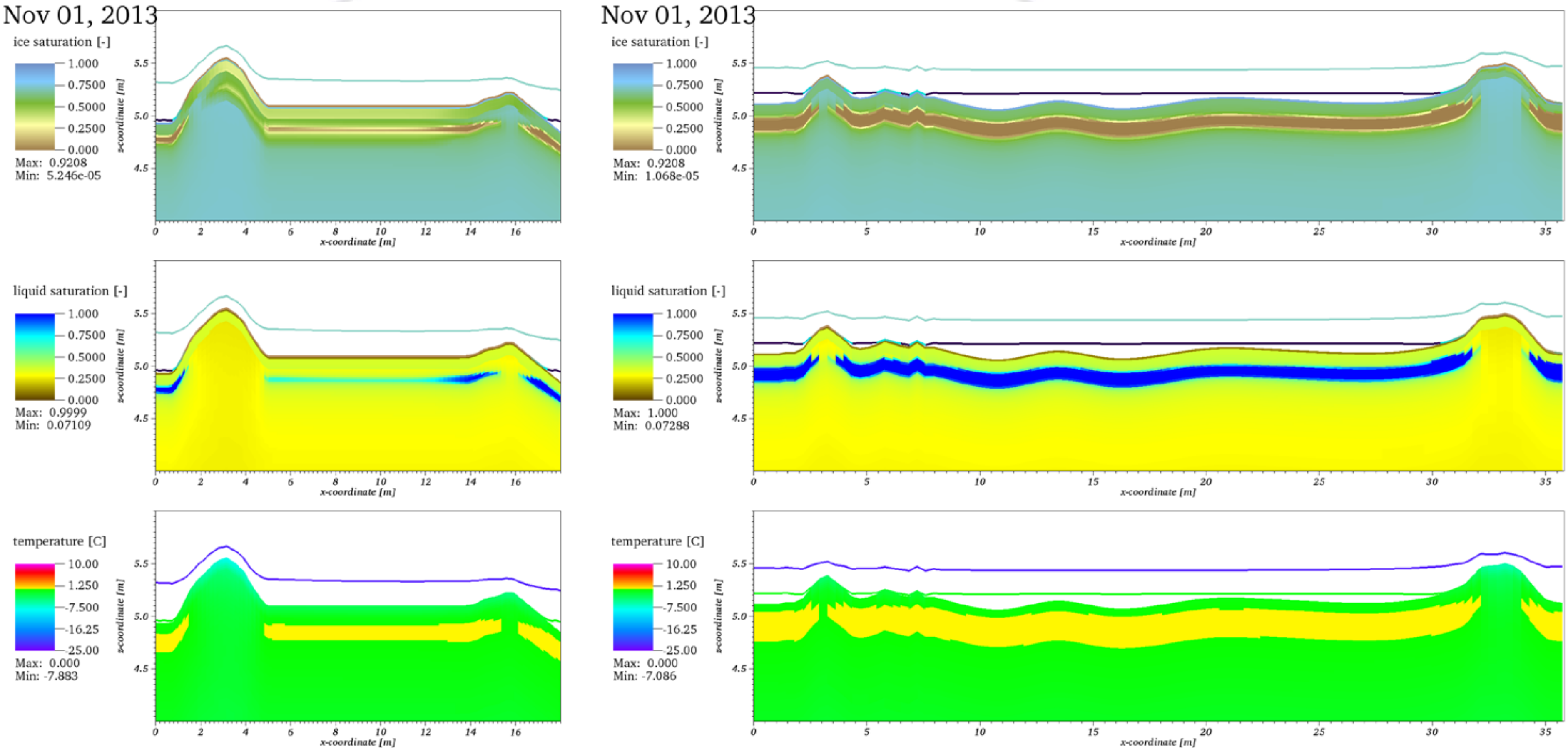

Active Layer in the current climate