Elmer coupled permafrost – model

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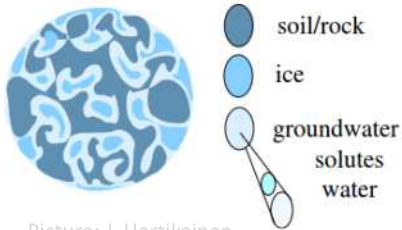[2] New Mexico Tech, Socorro, NM, USA

Posiva

Permafrost model

- **Saturated porous medium that consists of skeleton of rock or soil, ice and groundwater of water and dissolved salts :**

1. Heat transfer

2. Groundwater flow of saturated aquifer (Darcy)

3. Solute transport within groundwater
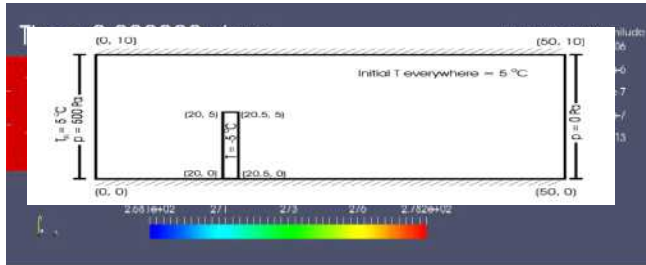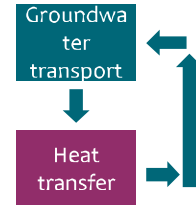
4. Deformation of bedrock (porosity)

soil/rock

ice

groundwater
solutes
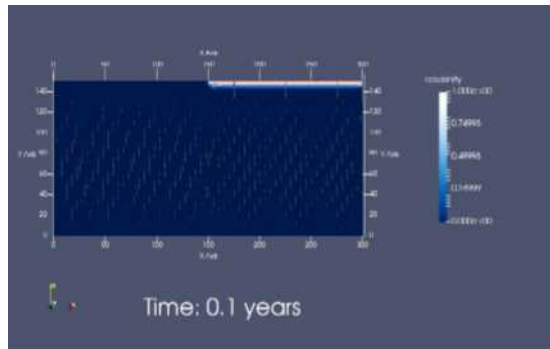water

Picture: J. Hartikainen

Permafrost model
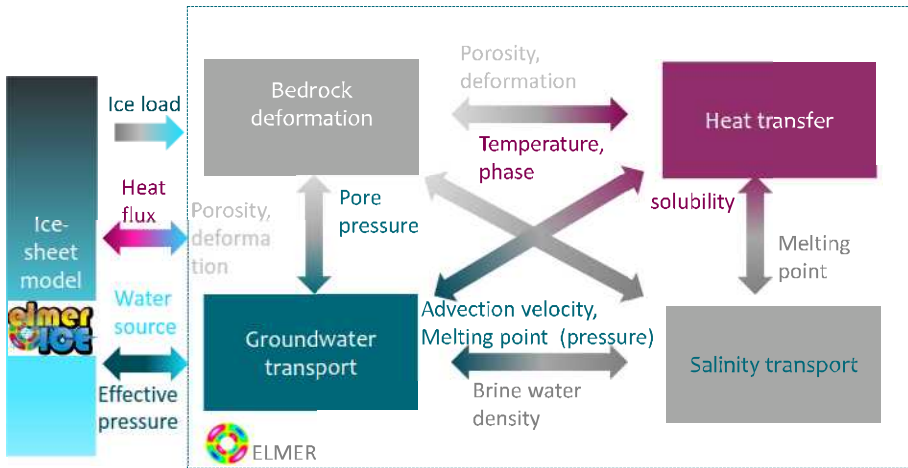
Coupled groundwater flow (after McKenzie et al., 2007)
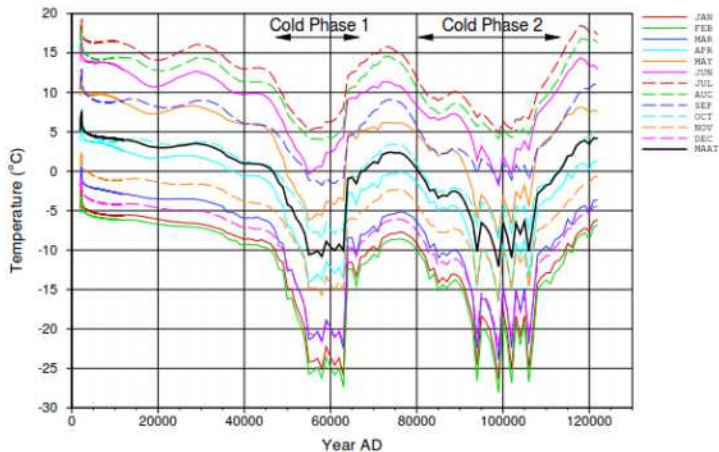
Elder Problem (Voss and Souza, 1987): salinity transport in porous medium

# Real world example: Ice-sheet advance
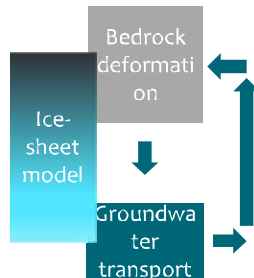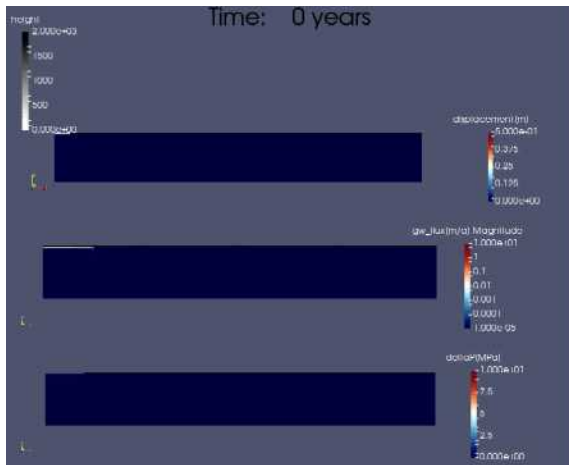
Olkiluoto: Climate forcing

- Modified RCP 4.5 for 120kyr into future

- 2 significant (slightly manually exaggerated) cold periods

Olkiluoto domain

- 7.7x5.8 km² around Eurajoki island, W-coast Finland (Botnian bay)
- Strong land uplift ongoing for several millennia to come
- Nuclear waste repository about 400 m under ground in granite rock
- Extended ~10 km below surface
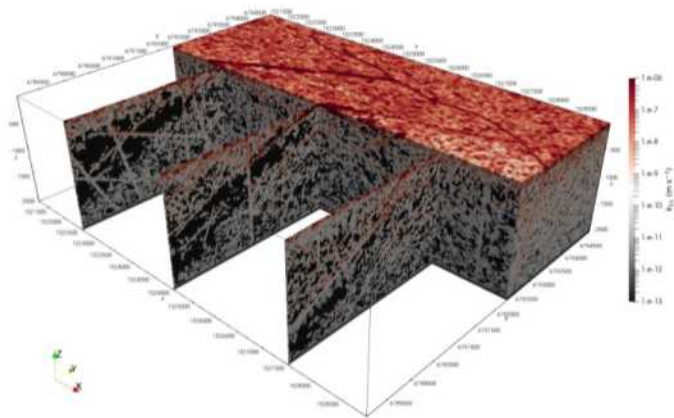- 30x30x30 m³ resolution mesh for first 2000 m
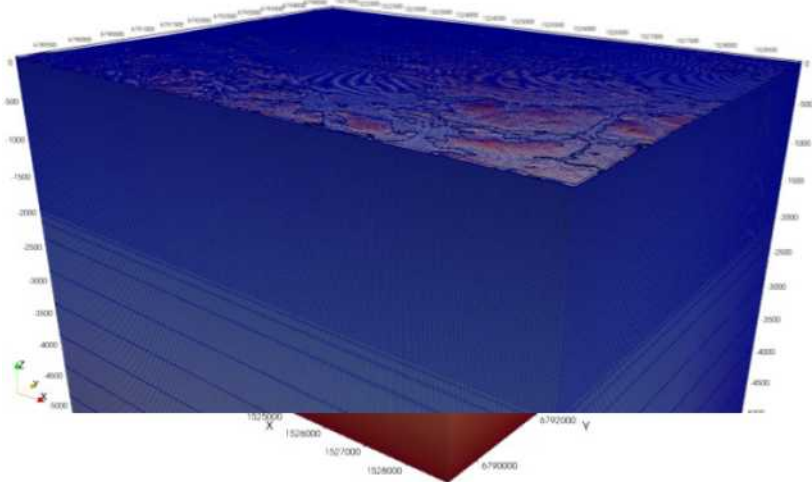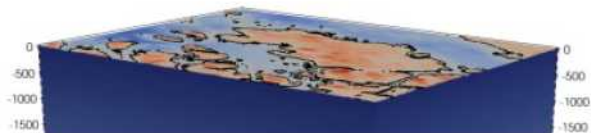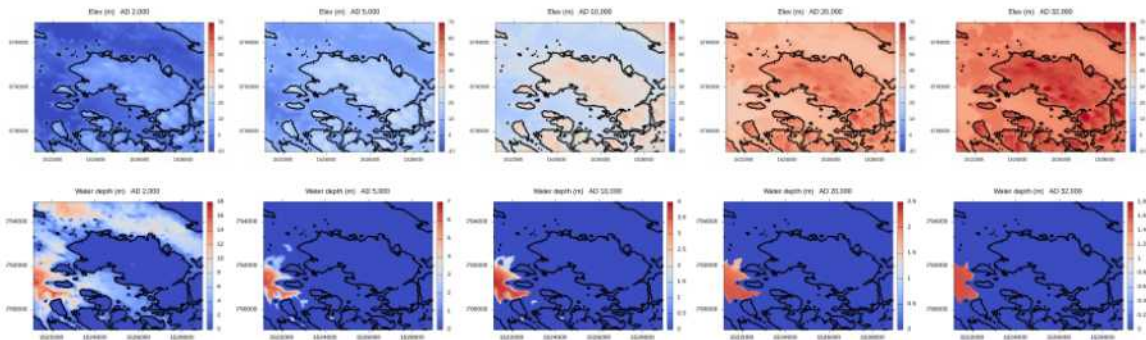
Olkiluoto: measured parameters

- Kinematic porposity
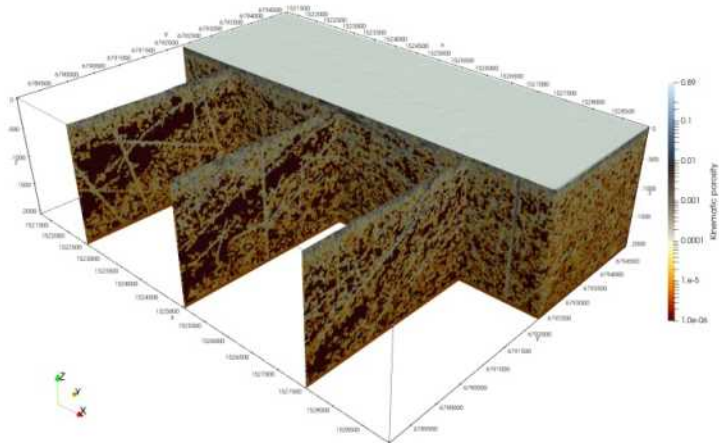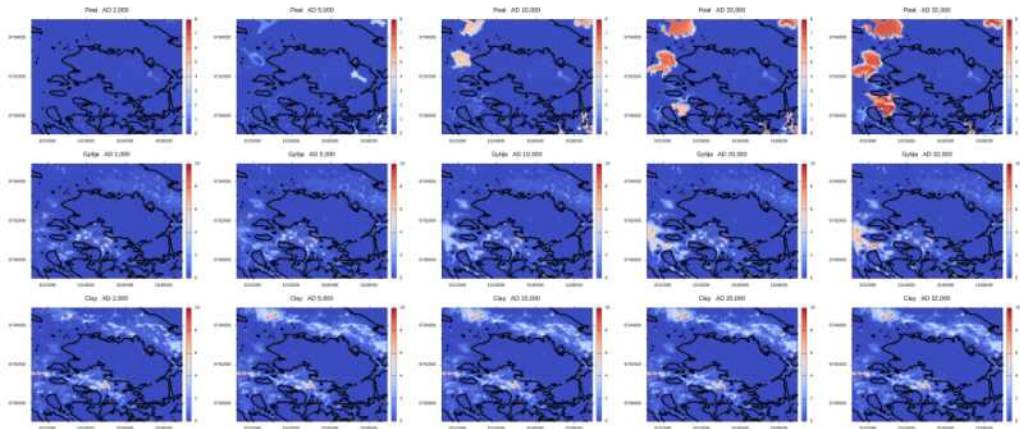
Olkiluoto: measured parameters

- Hydr. conductivity

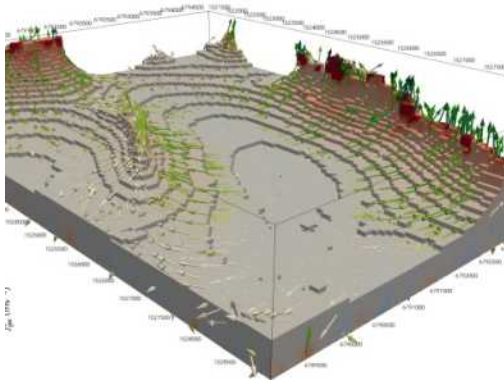# Olkiluoto: external input

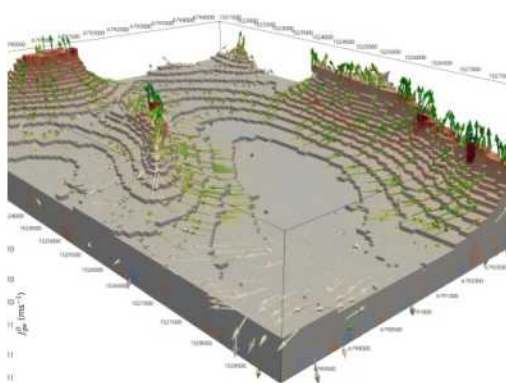- Land-uplift

Olkiluoto: external input

- Soil-evolution

These are preliminary results!

Olkiluoto: Groundwater flow

Before Freezing

During Freezing

Olkiluoto: permafrost thickness

AD 61,721