



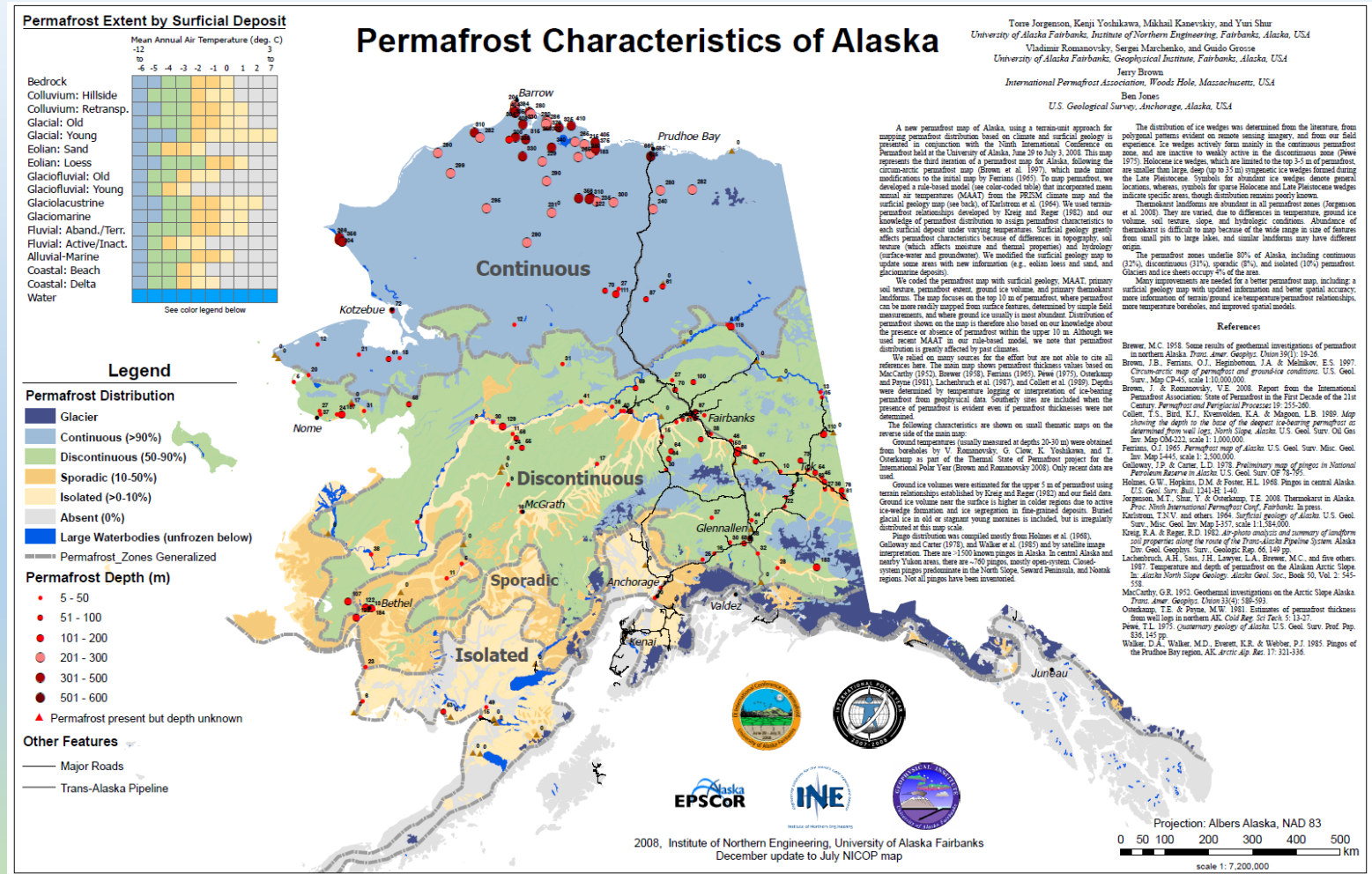
Cold regions hydrology: Developments and simulations in WaSiM

Ronald Daanen

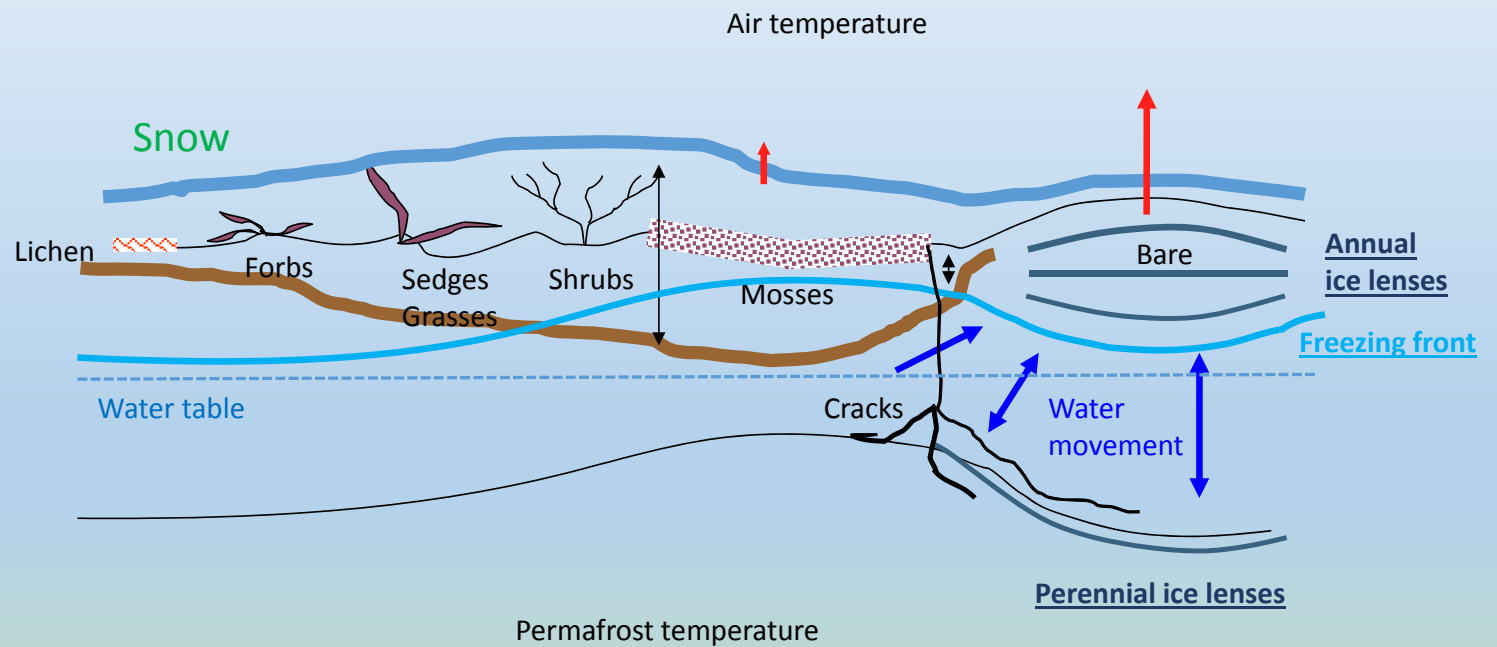
Arctic Hydrology



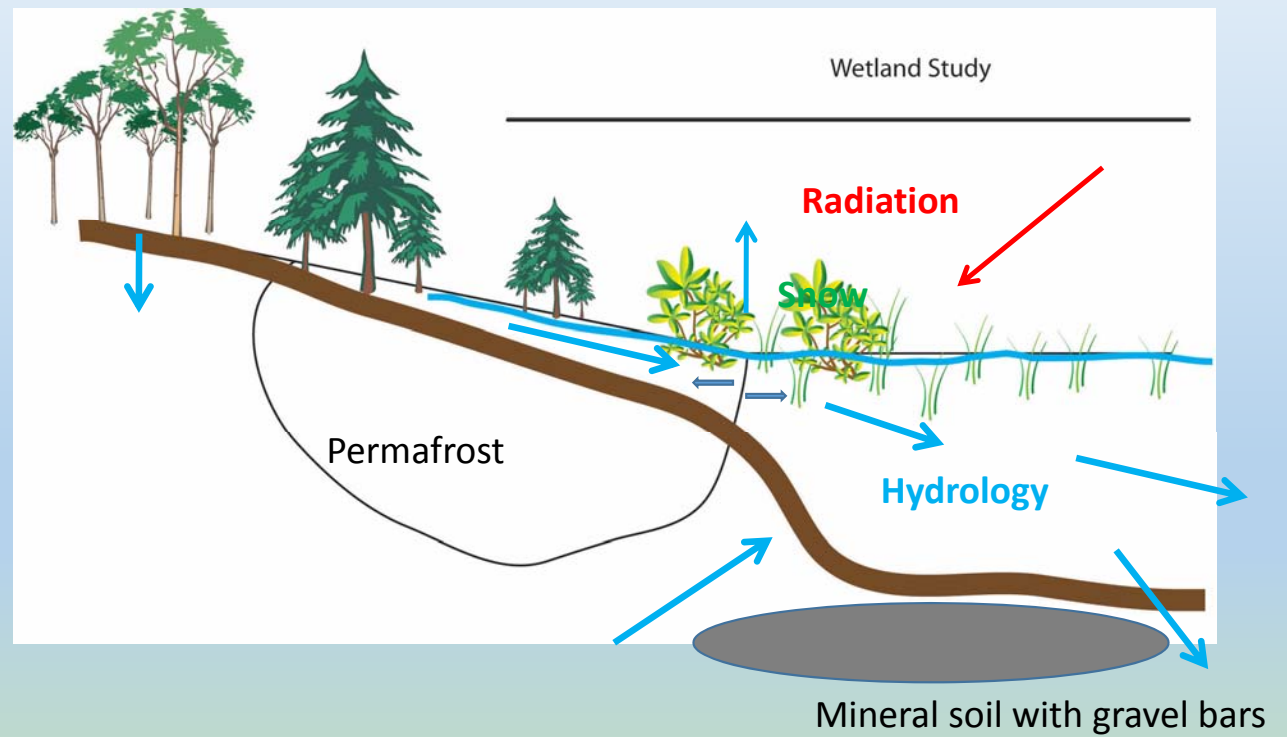
Permafrost



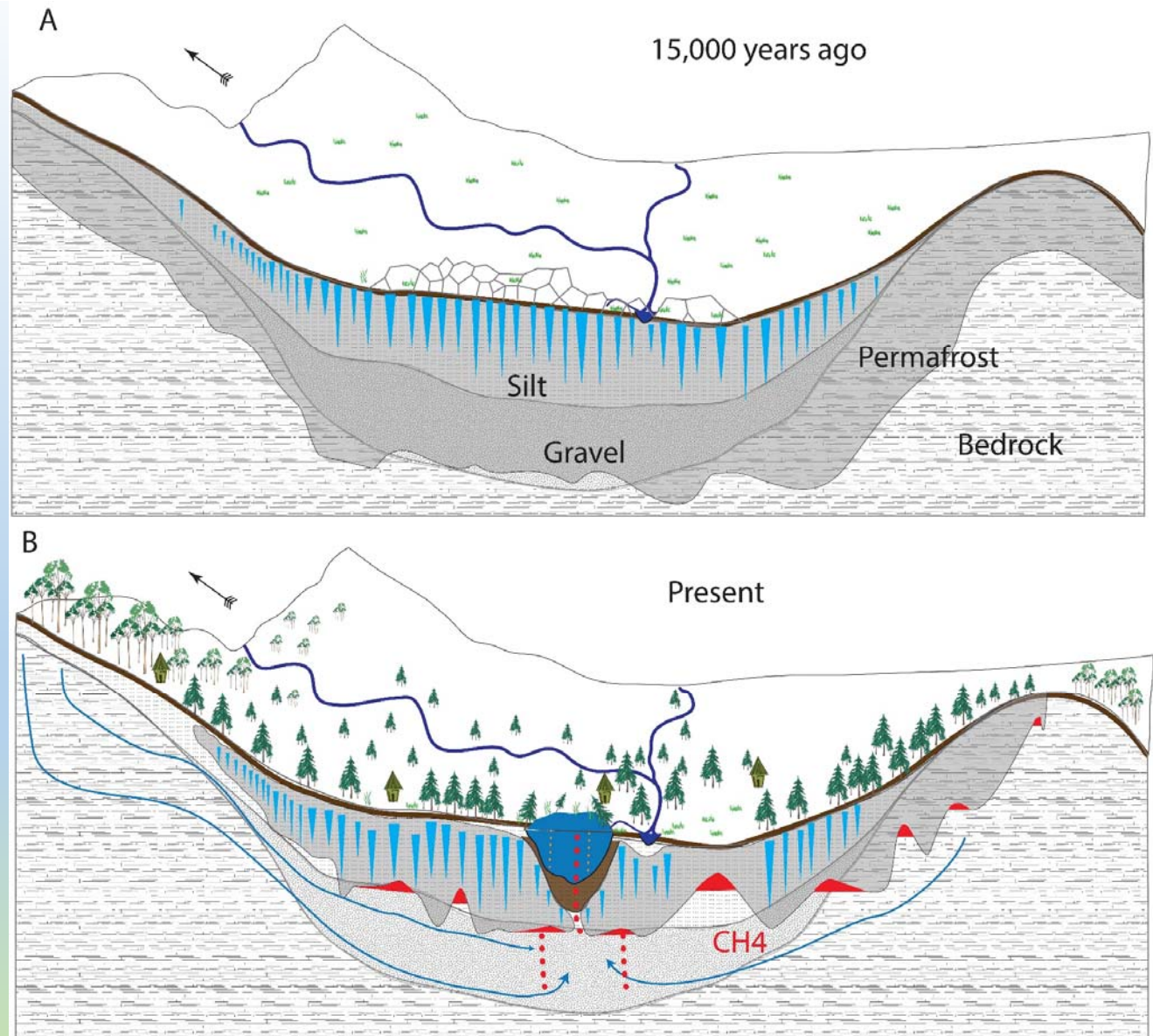
Hydrologically Active Layer



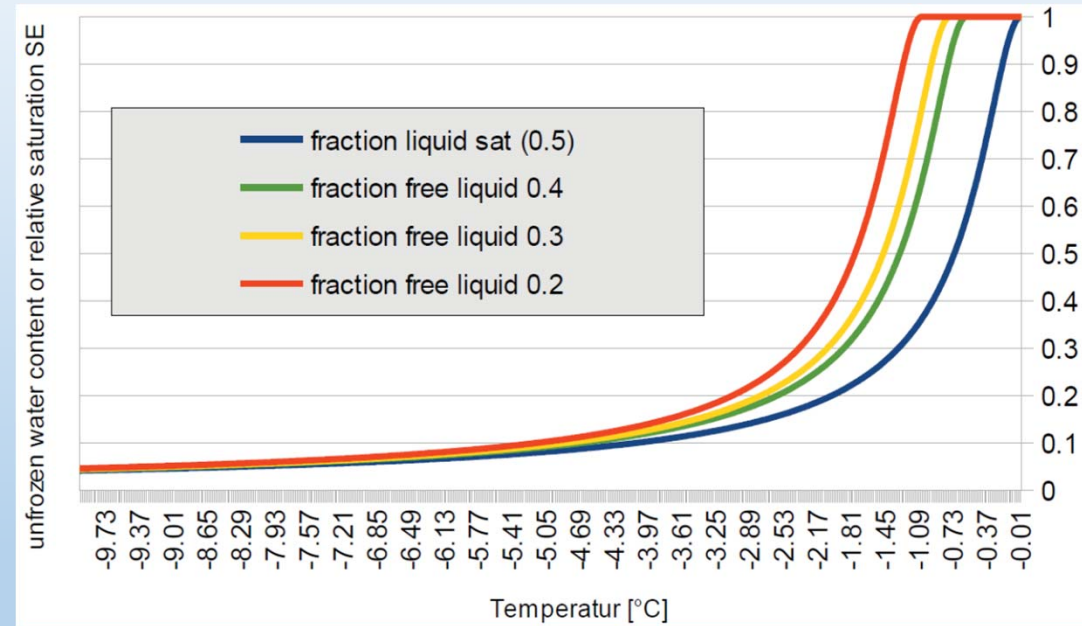
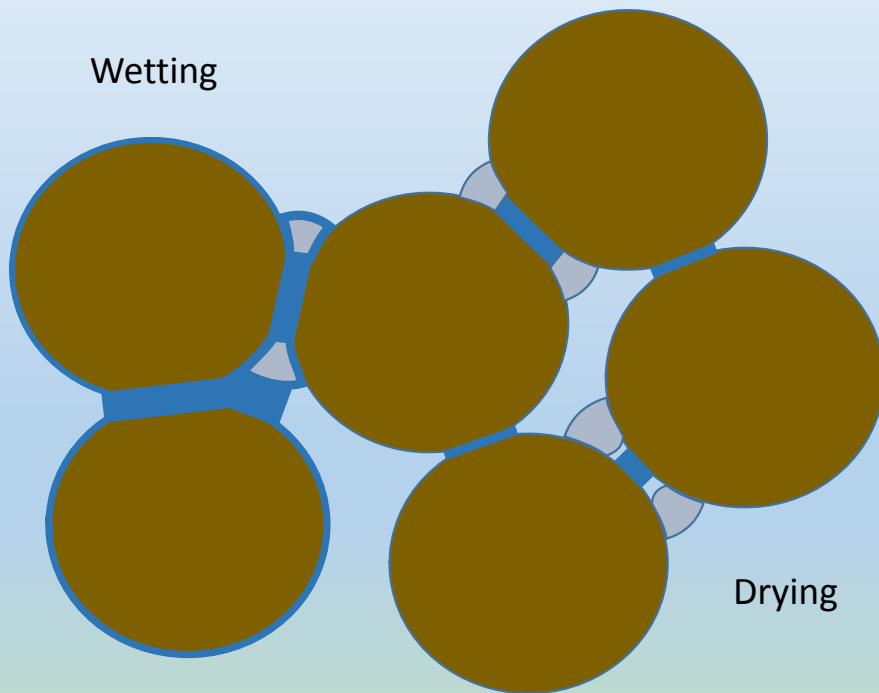
Discontinuous Permafrost



Permafrost Change

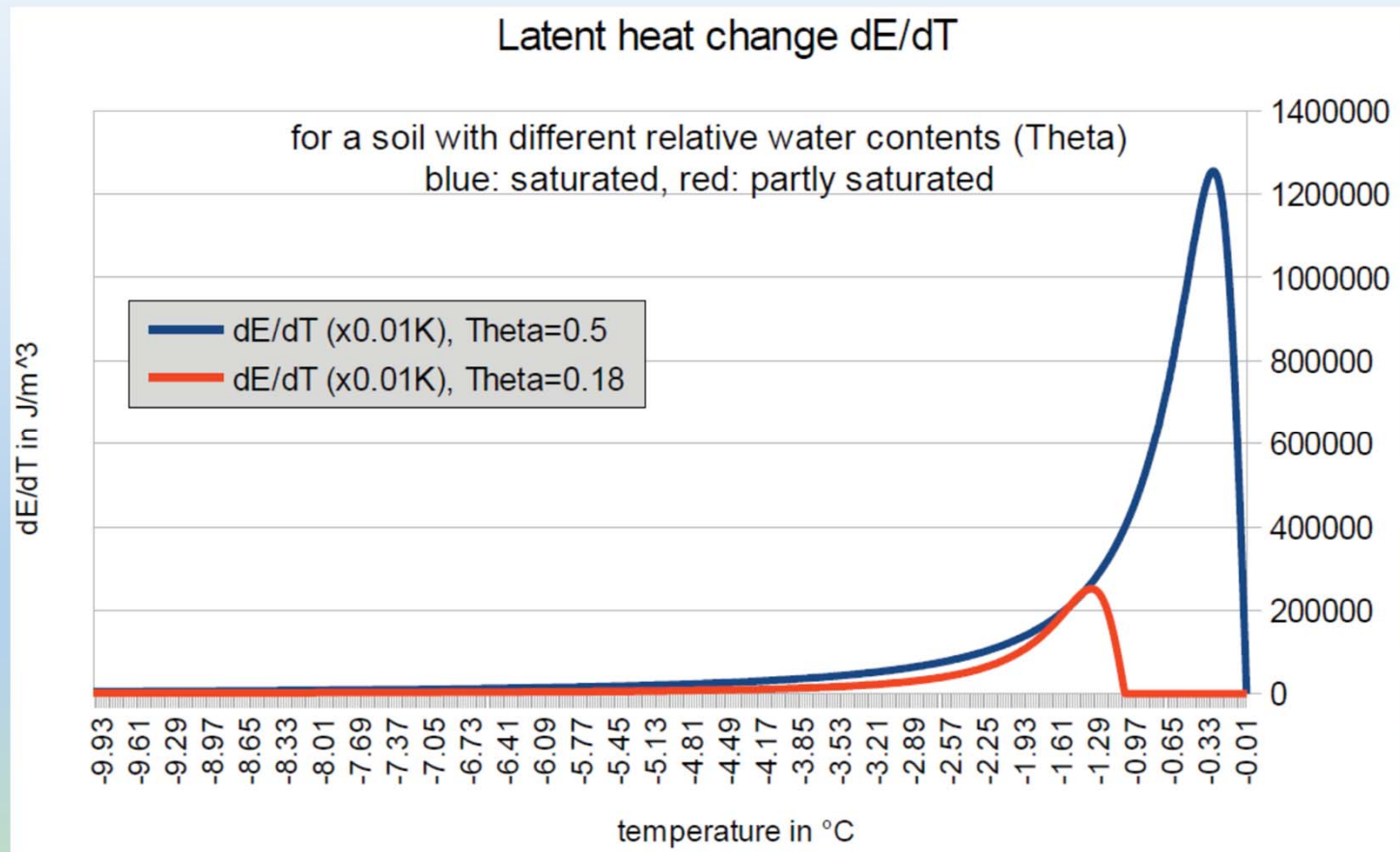


Soil Freezing and Thawing



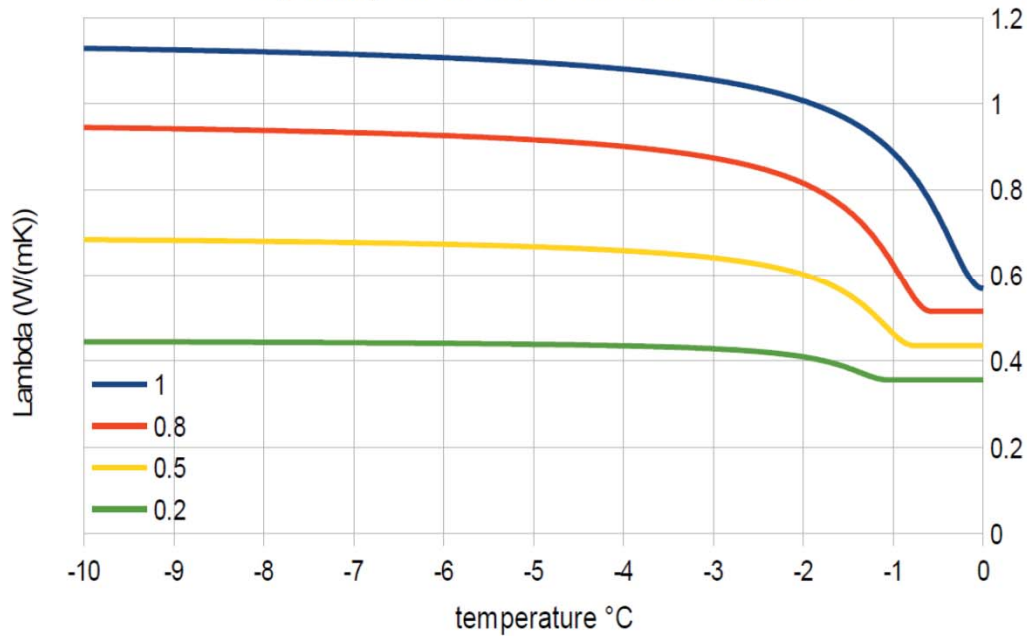
Richard's equation with Van Genuchten's moisture characteristics

Latent Heat Release

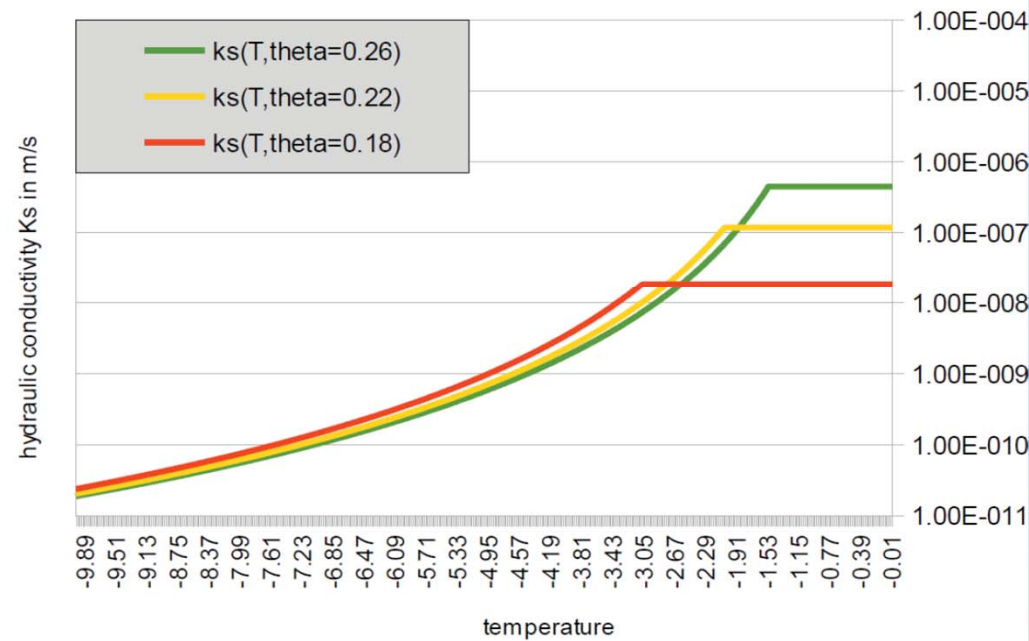


Changes in Conductivity

effective thermal conductivity
depending on total water content and temperature

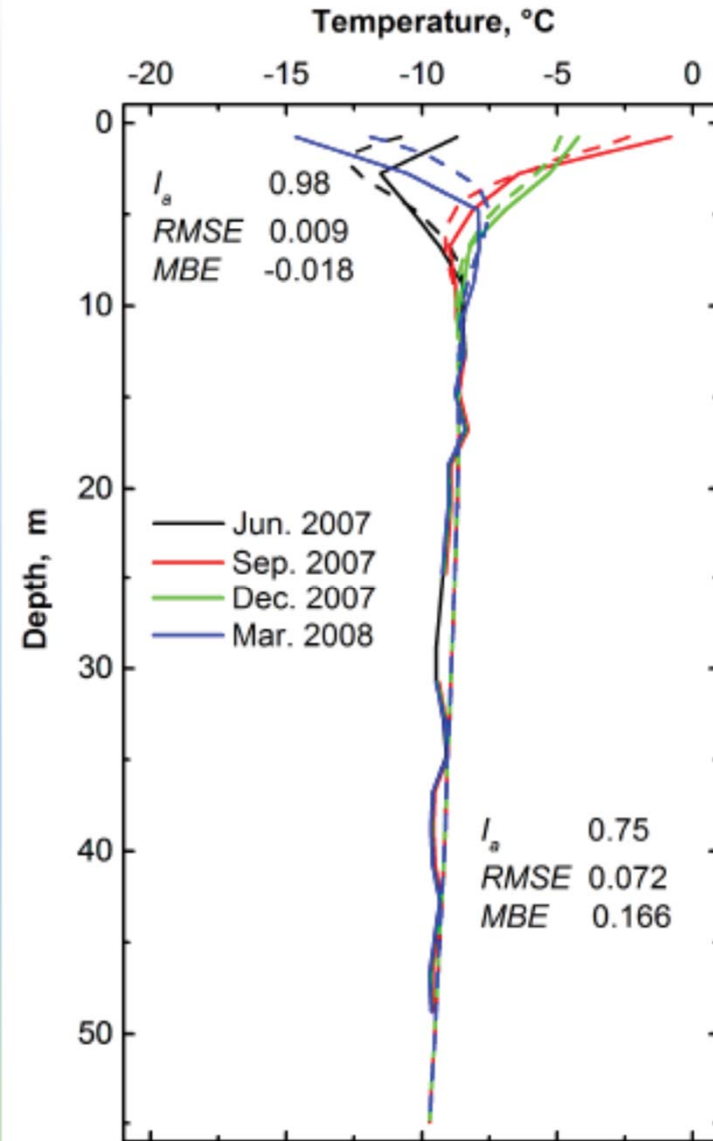


temperature dependent hydraulic conductivity

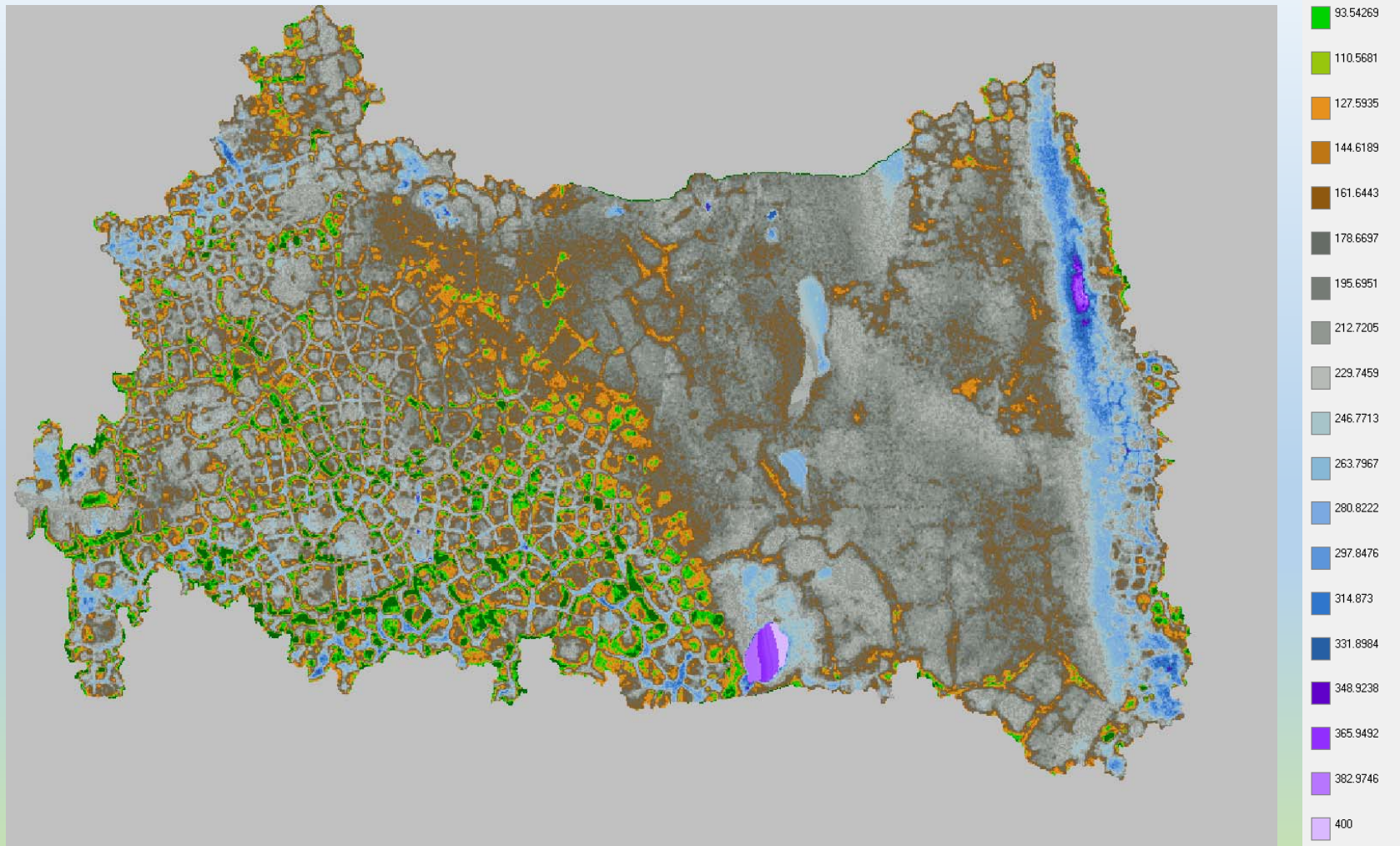


Permafrost Temperatures

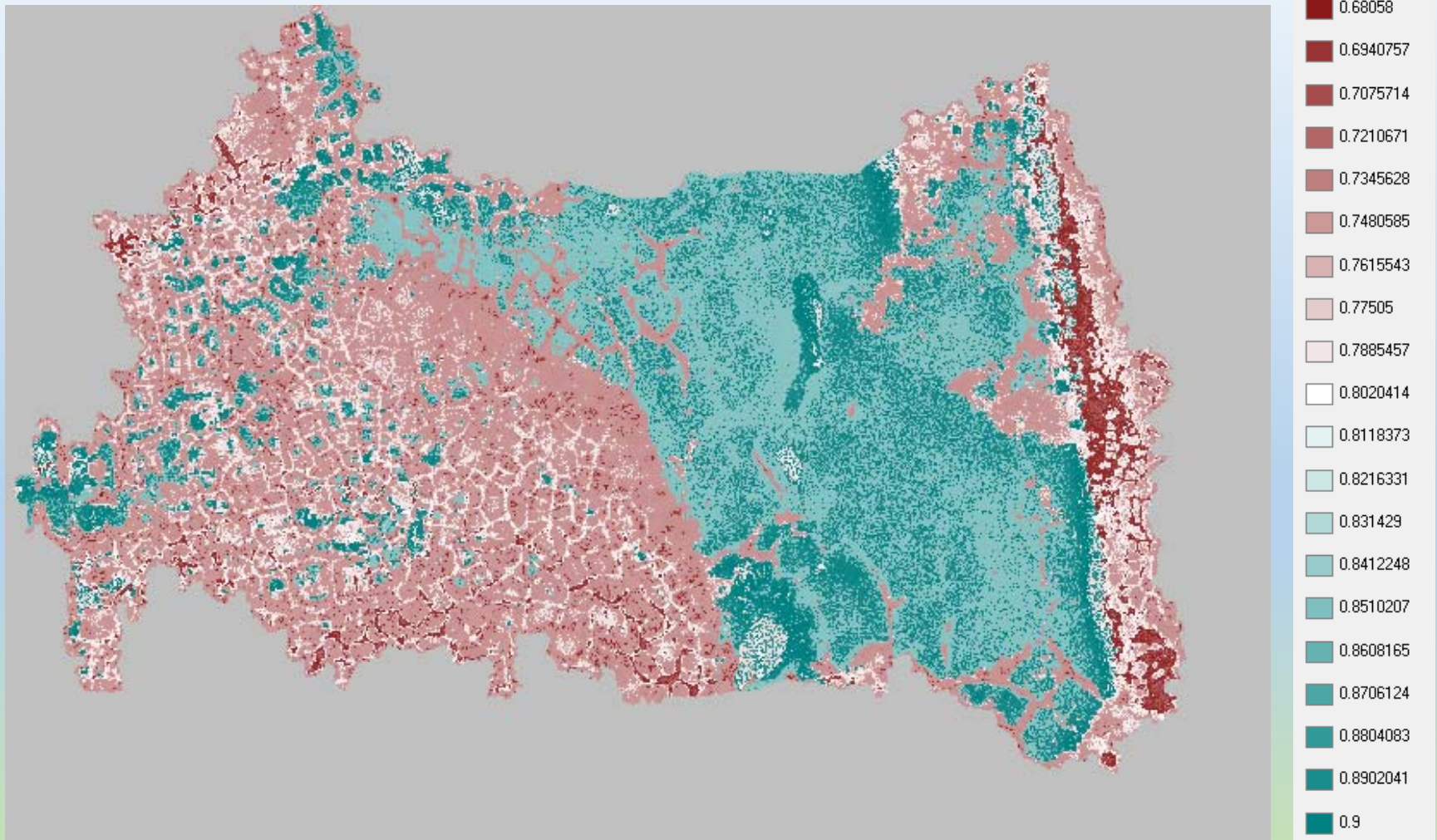
- Air temperatures
 - N-factors
 - Snow
- Bottom boundary grid
 - Temperatures
 - Heat flux
- Initial temperature conditions
 - Linear
 - Spin up



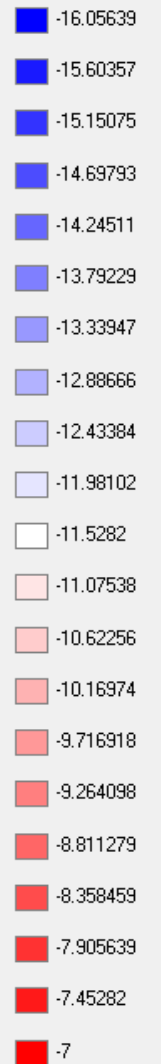
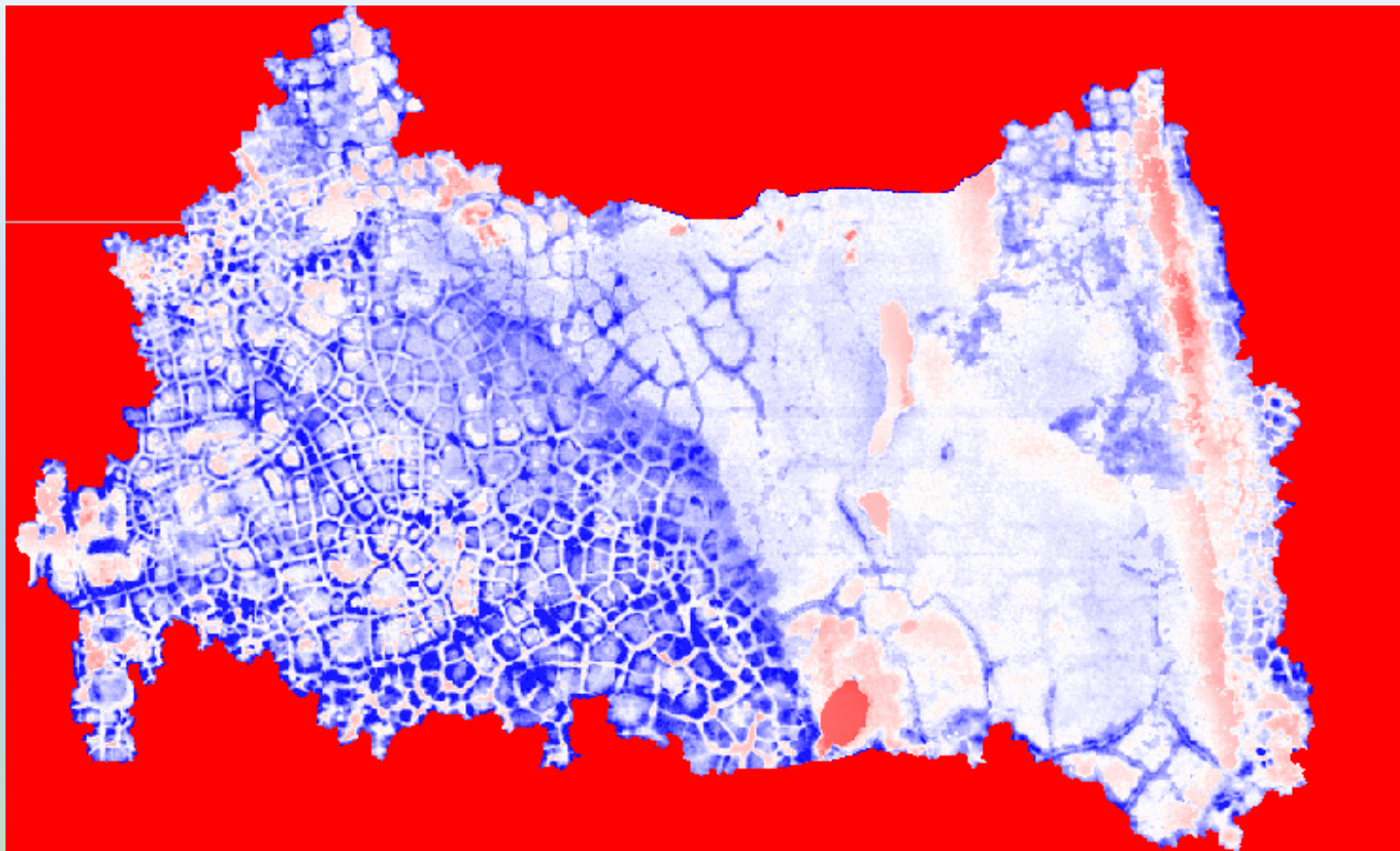
Barrow Watershed Snow Distribution



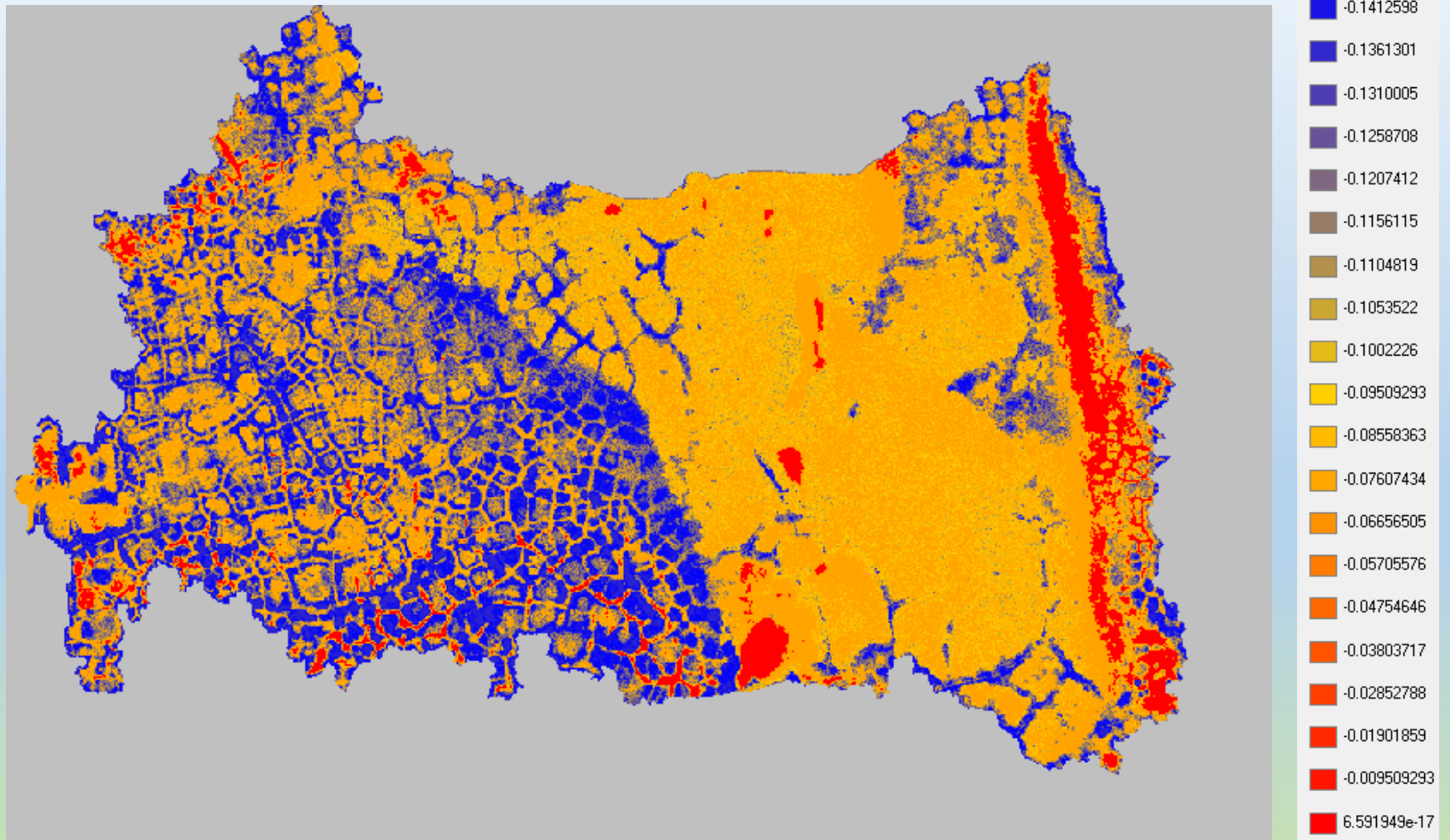
Barrow Soil Moisture



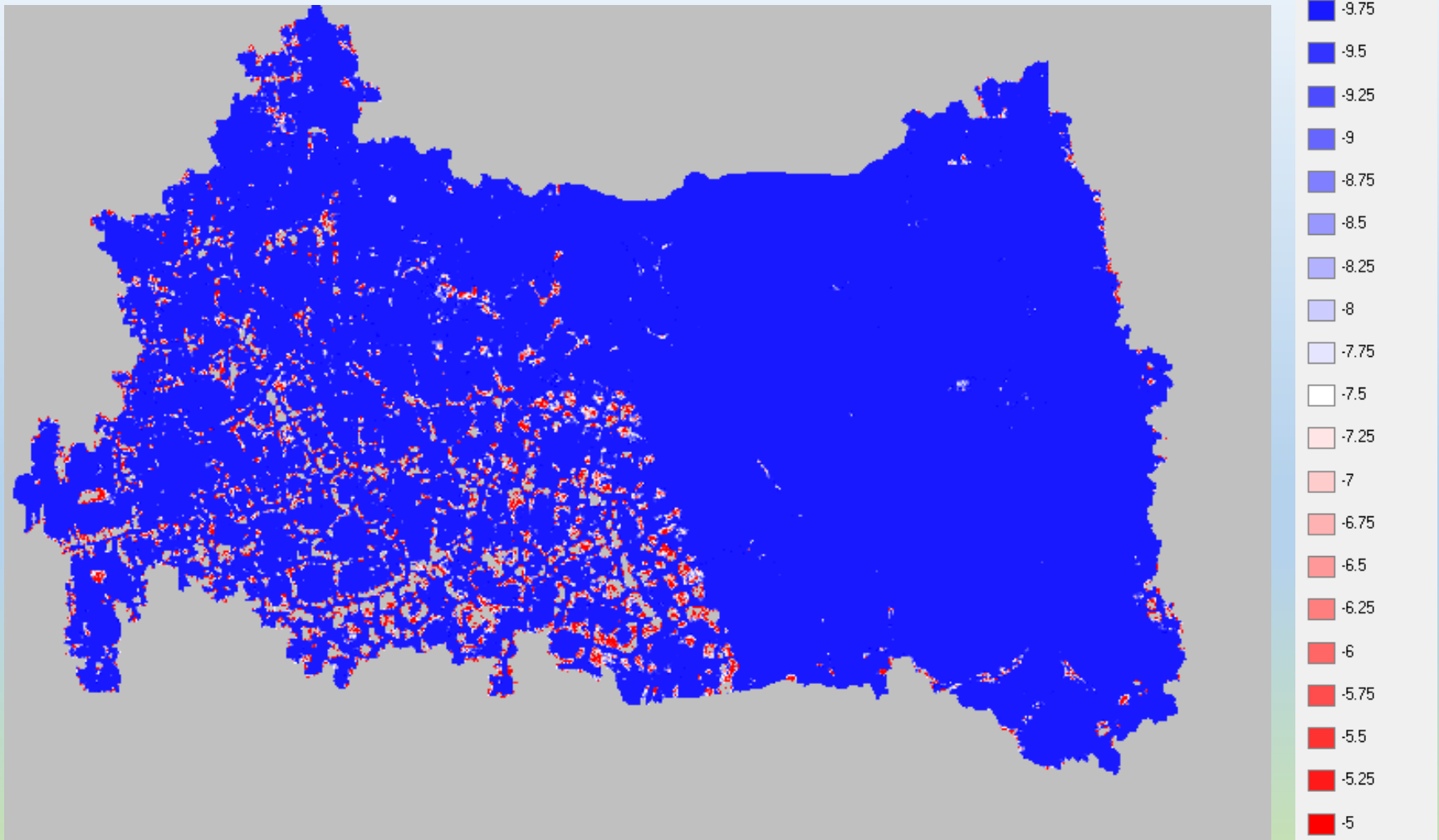
Barrow Temperature Grids



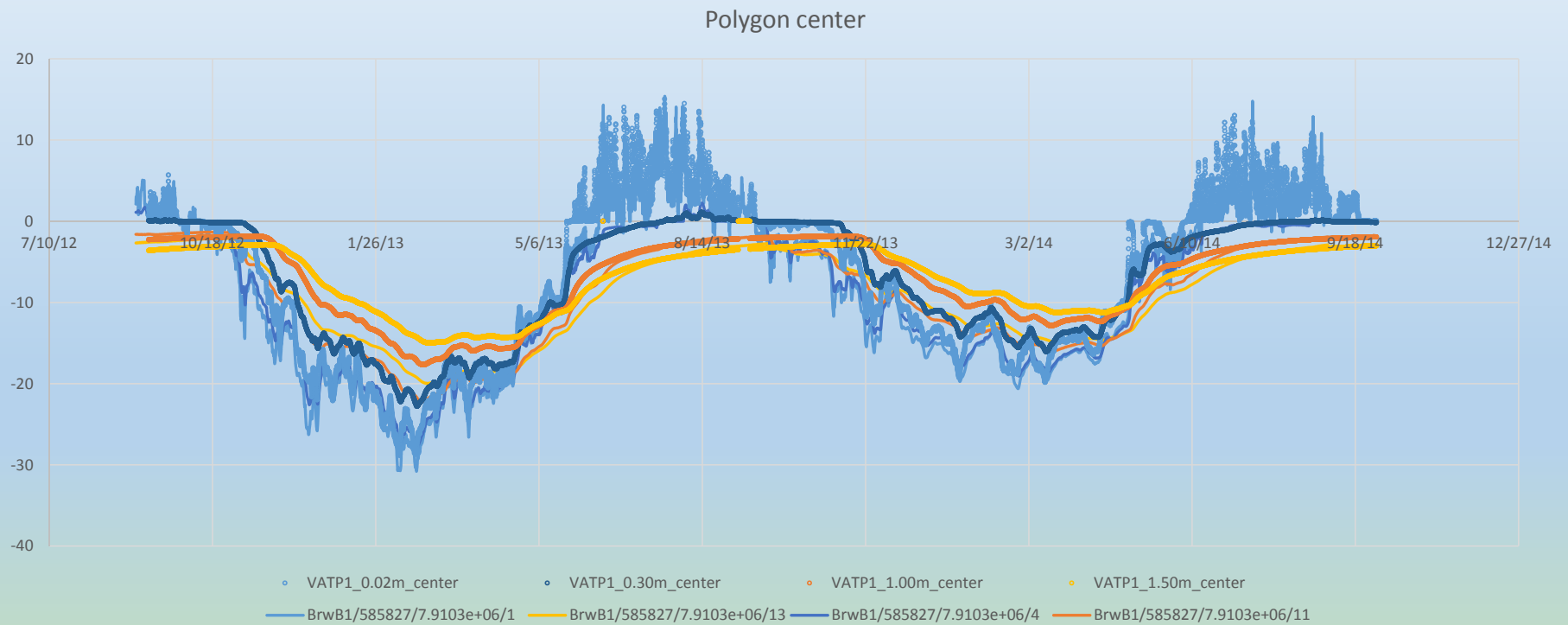
Barrow Thaw Depth



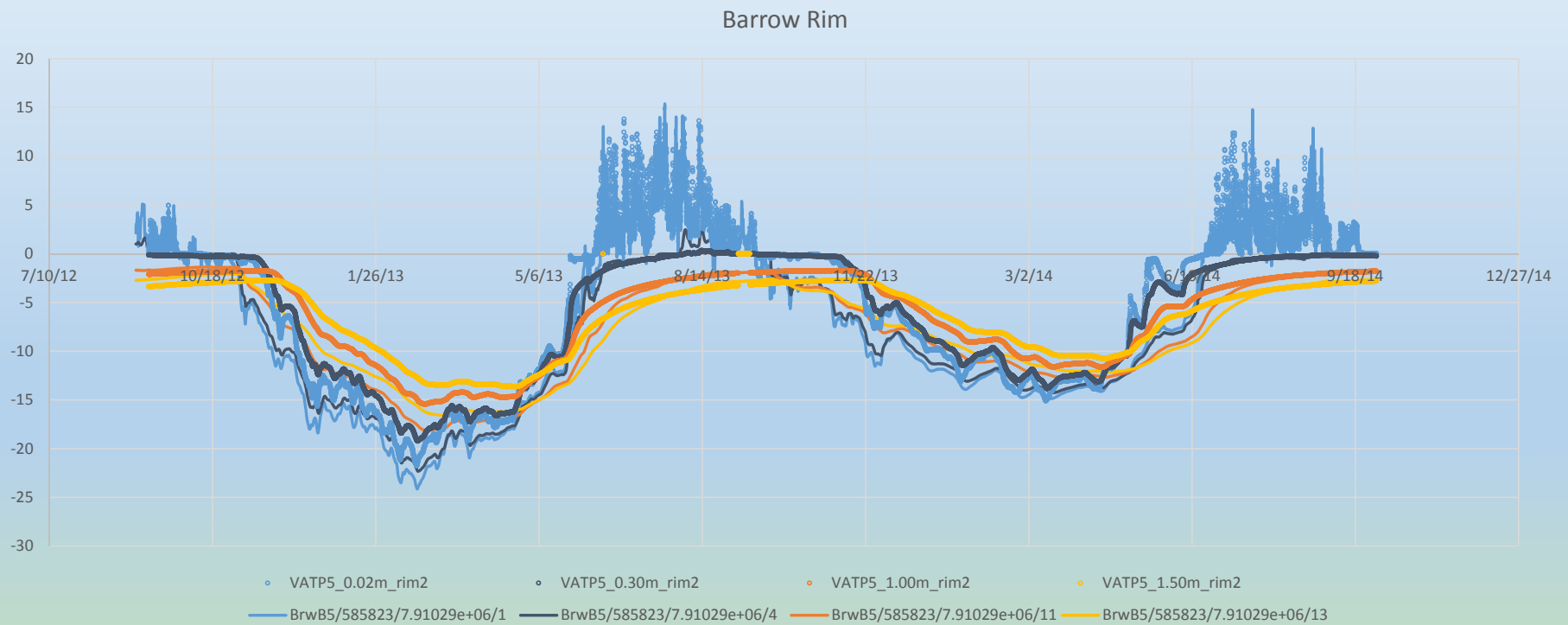
Barrow Snow Temperature



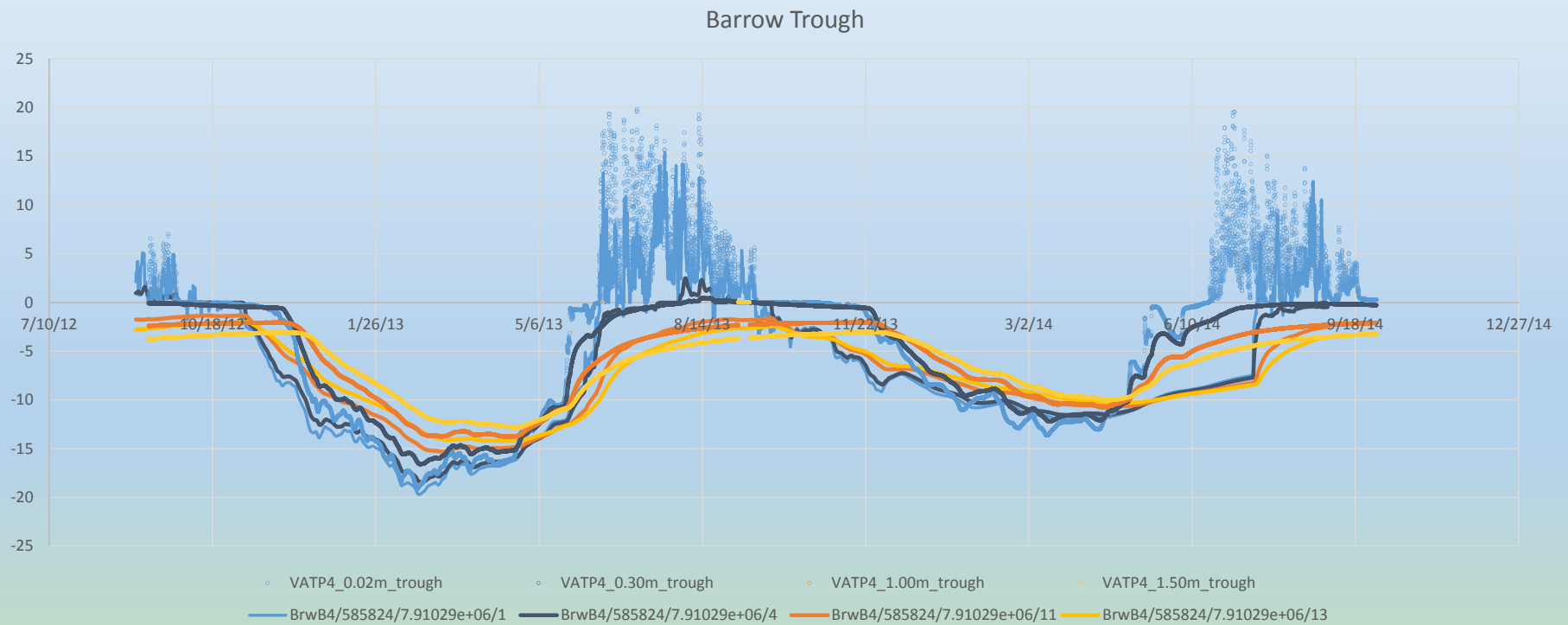
Soil Temperature Time Series: Polygon Center



Soil Temperature Time Series: Polygon Rim

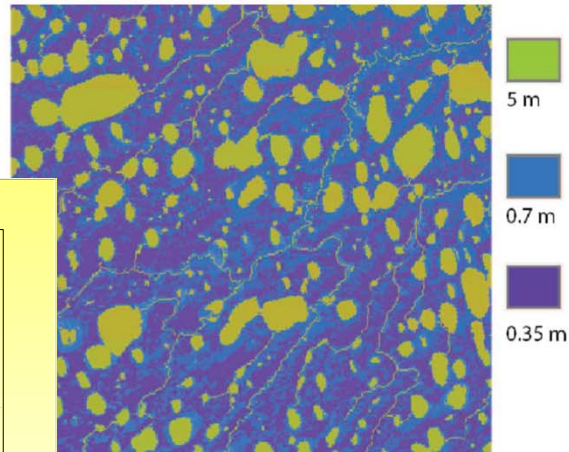


Soil Temperature Time Series: Polygon Trough

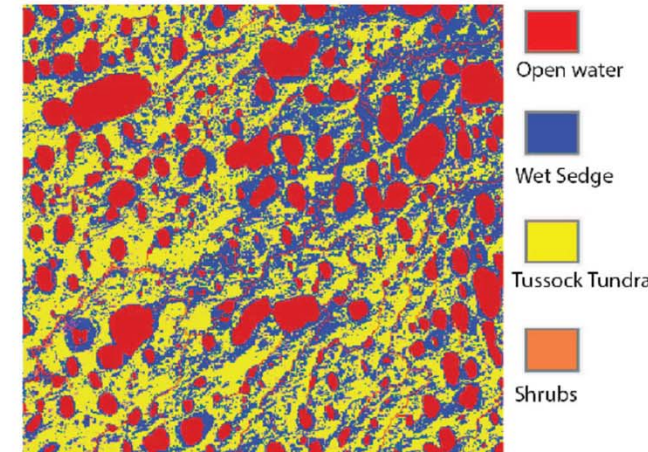


Large Arctic Watersheds with Lakes

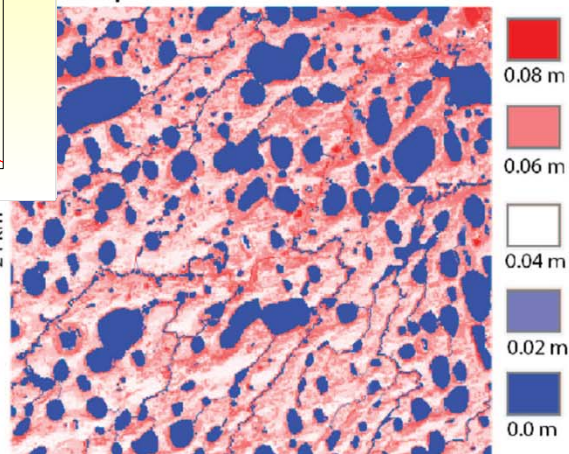
Thaw Depth



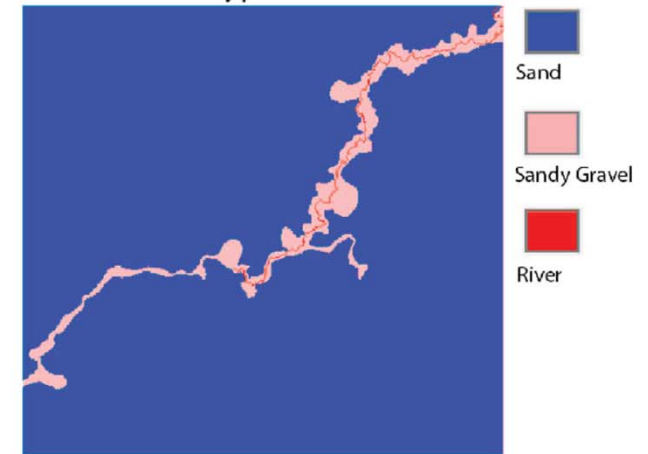
Vegetation



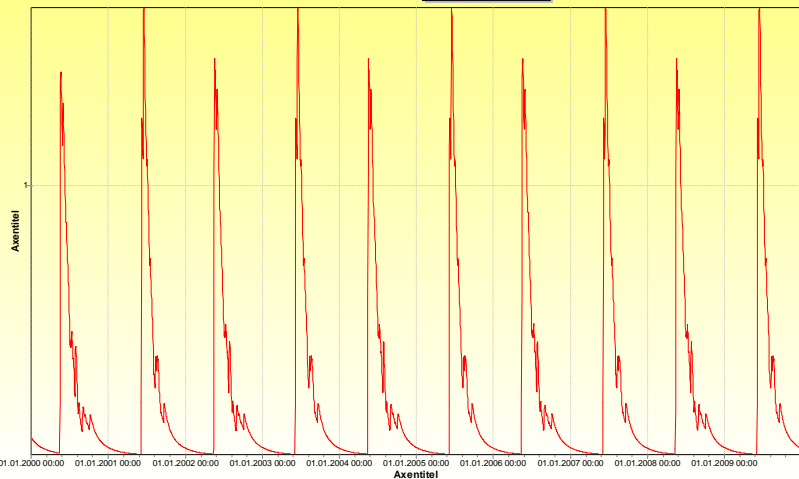
Depth to Groundwater Table



Soil Type and River

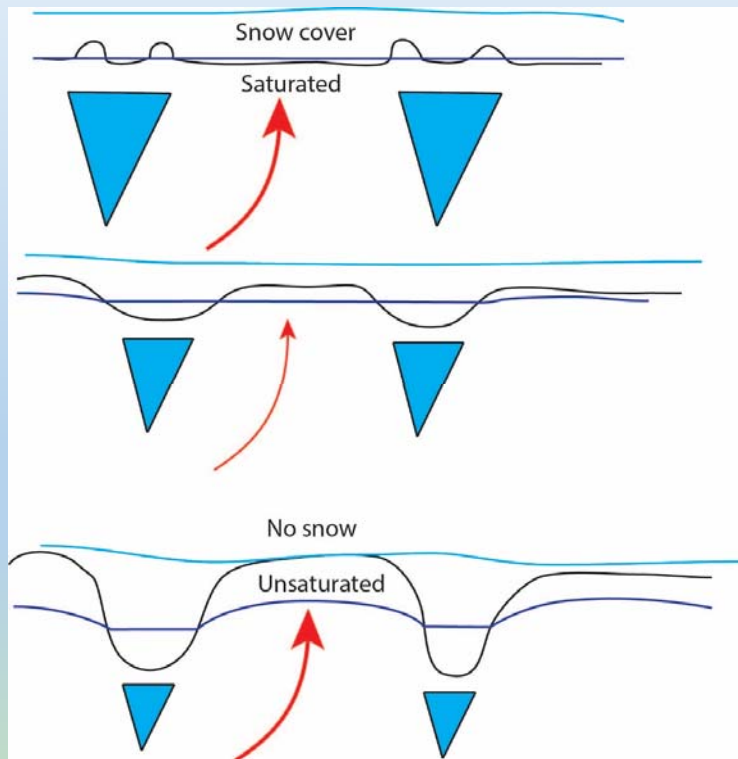


WaSIM-ETH Results

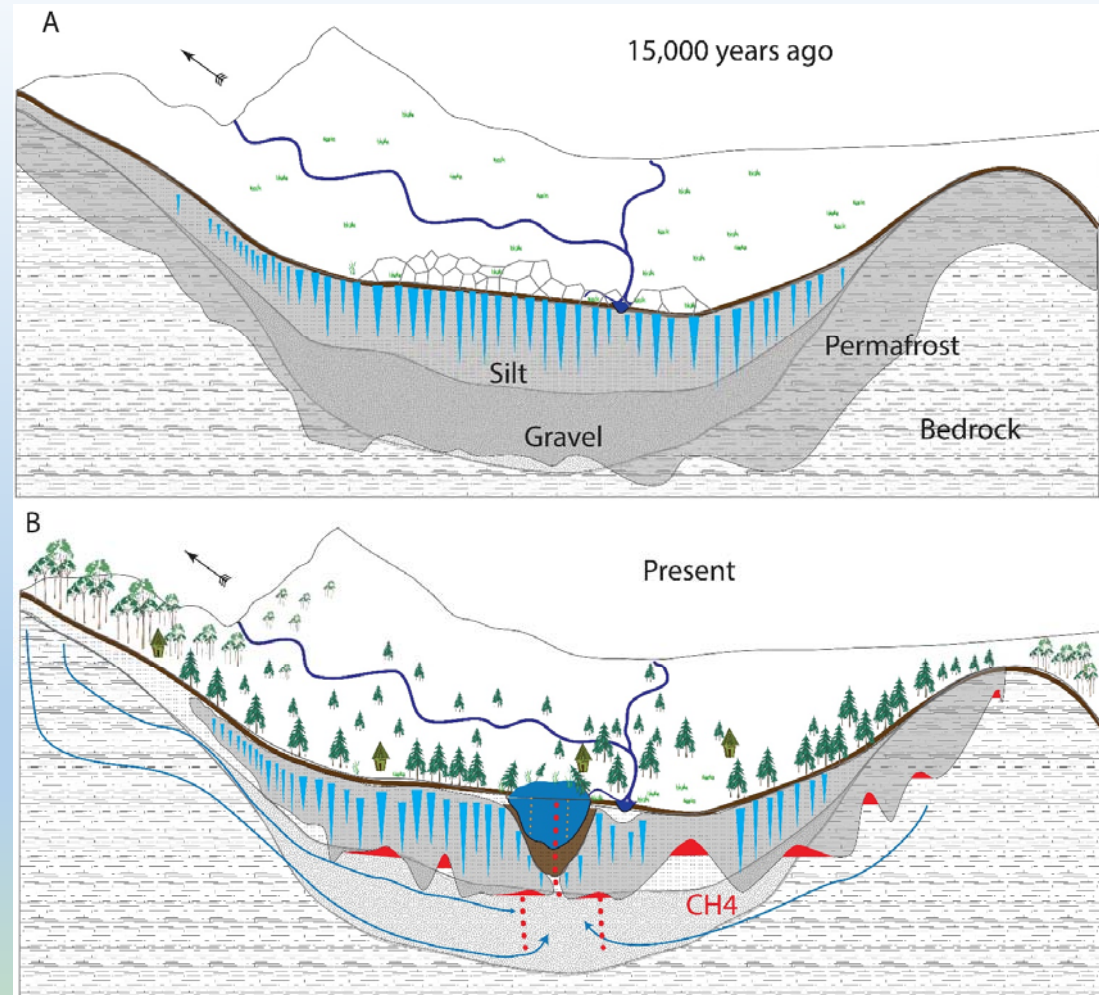


Surface routing efficiency

New Developments



Collapsing ground



Two aquifer systems in permafrost

Questions?

