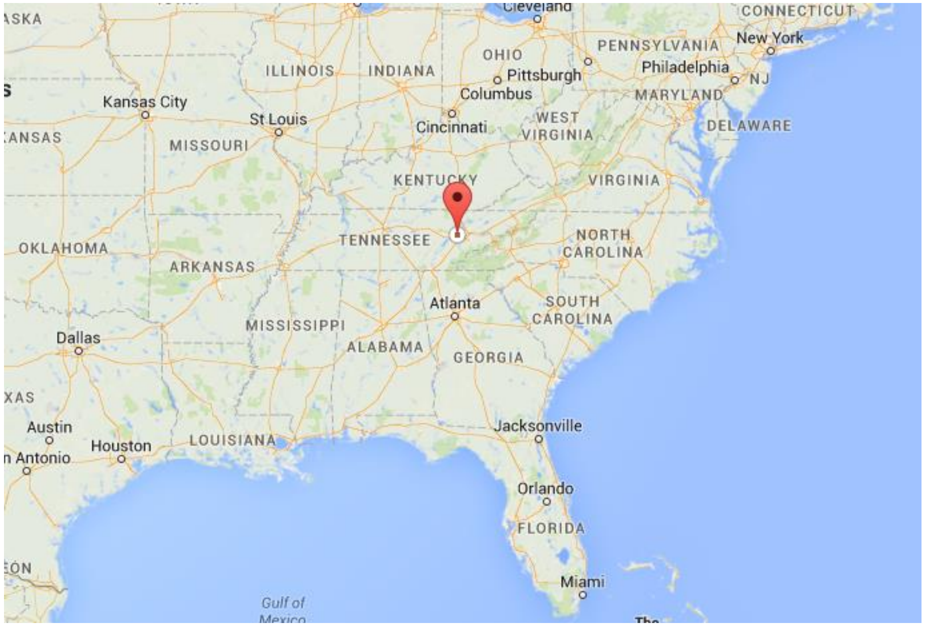
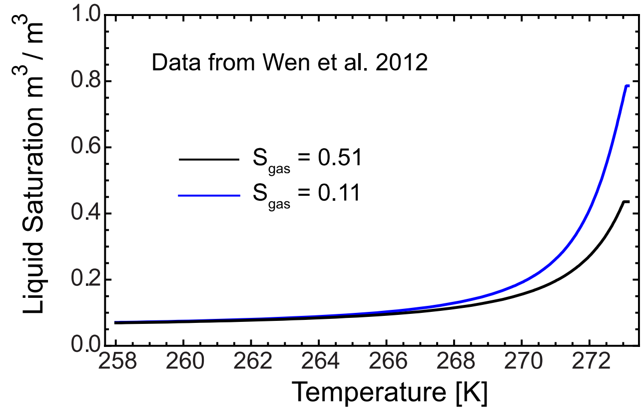
Nathan Collier

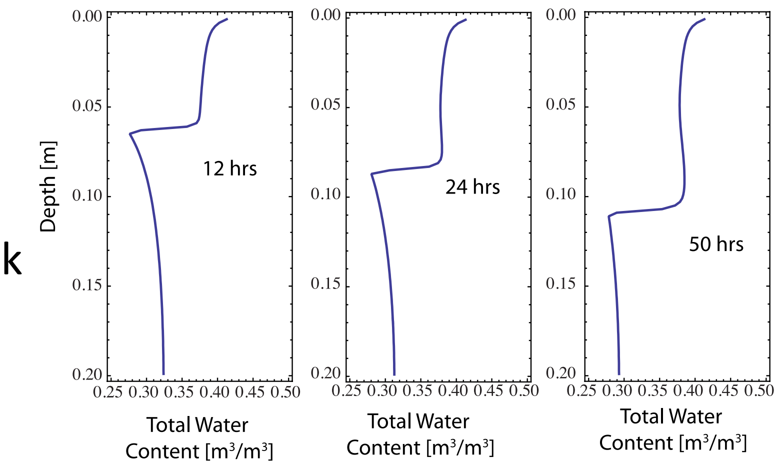
- Oak Ridge National Laboratory
  - Climate Change Science Institute
    - Next Generation Ecosystem Experiments – Arctic



Arctic Terrestrial Simulator

- Product of LANL internal project and DOE's NGEE Arctic program
- Developed by Ethan Coon (LANL) based on the modeling strategy outlined by Painter et al. (2013)
  - Subsurface heat and moisture transport in variably saturated, freezing/thawing soil
  - Surface flow with heat transport and phase change
  - Surface energy balance
  - Heat and mass transport in snow
  - Areal distribution of snow
  - Dynamic topography (in progress)
- Benchmarked against laboratory experiments
- Highly parallel code based on Trilinos framework
- Now open source. See Ethan Coon (LANL) or Scott Painter (ORNL) for details





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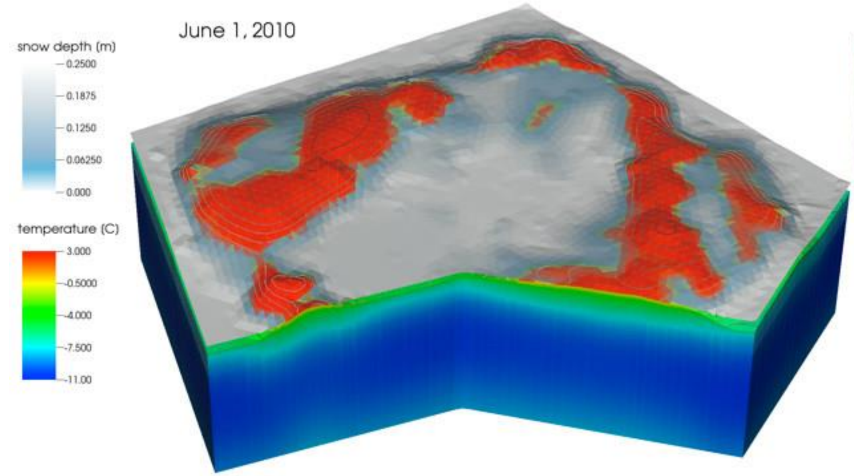
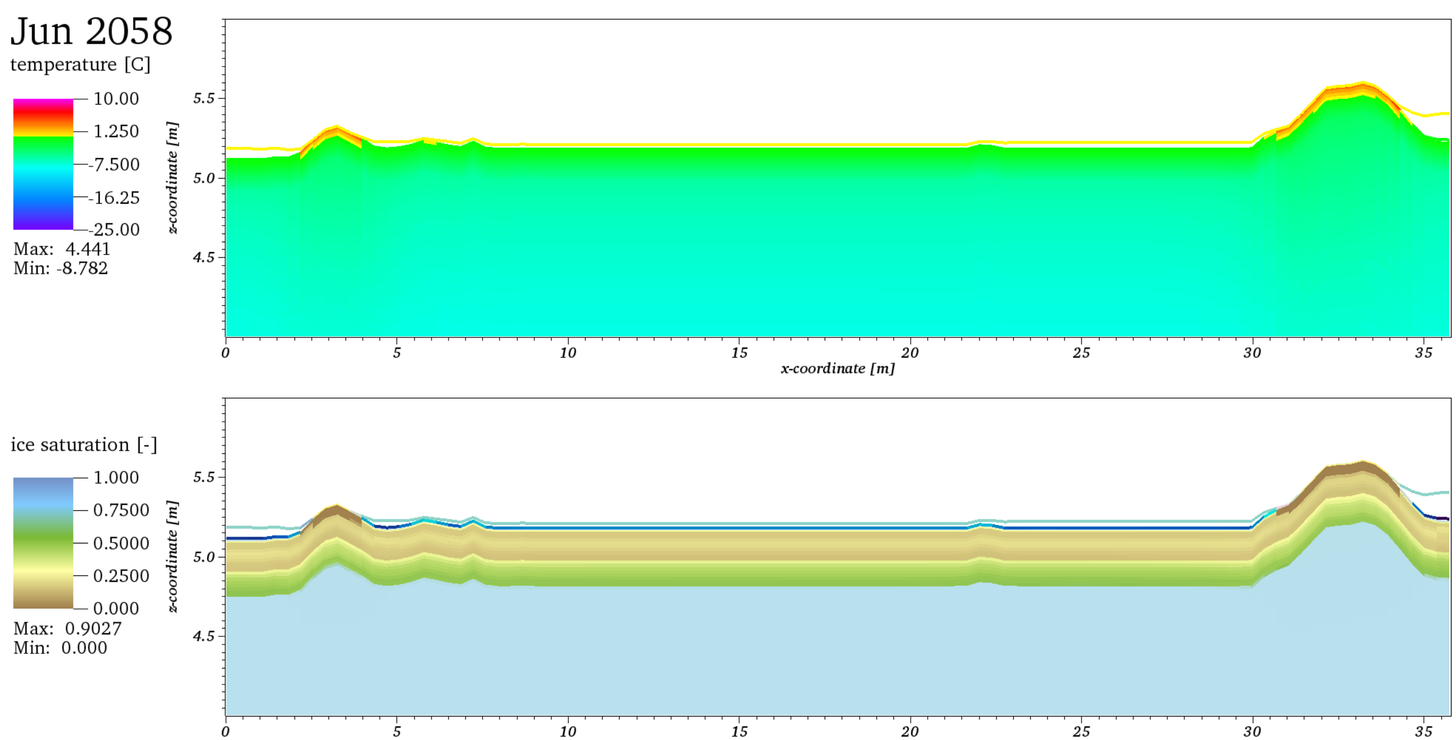
Example Simulations

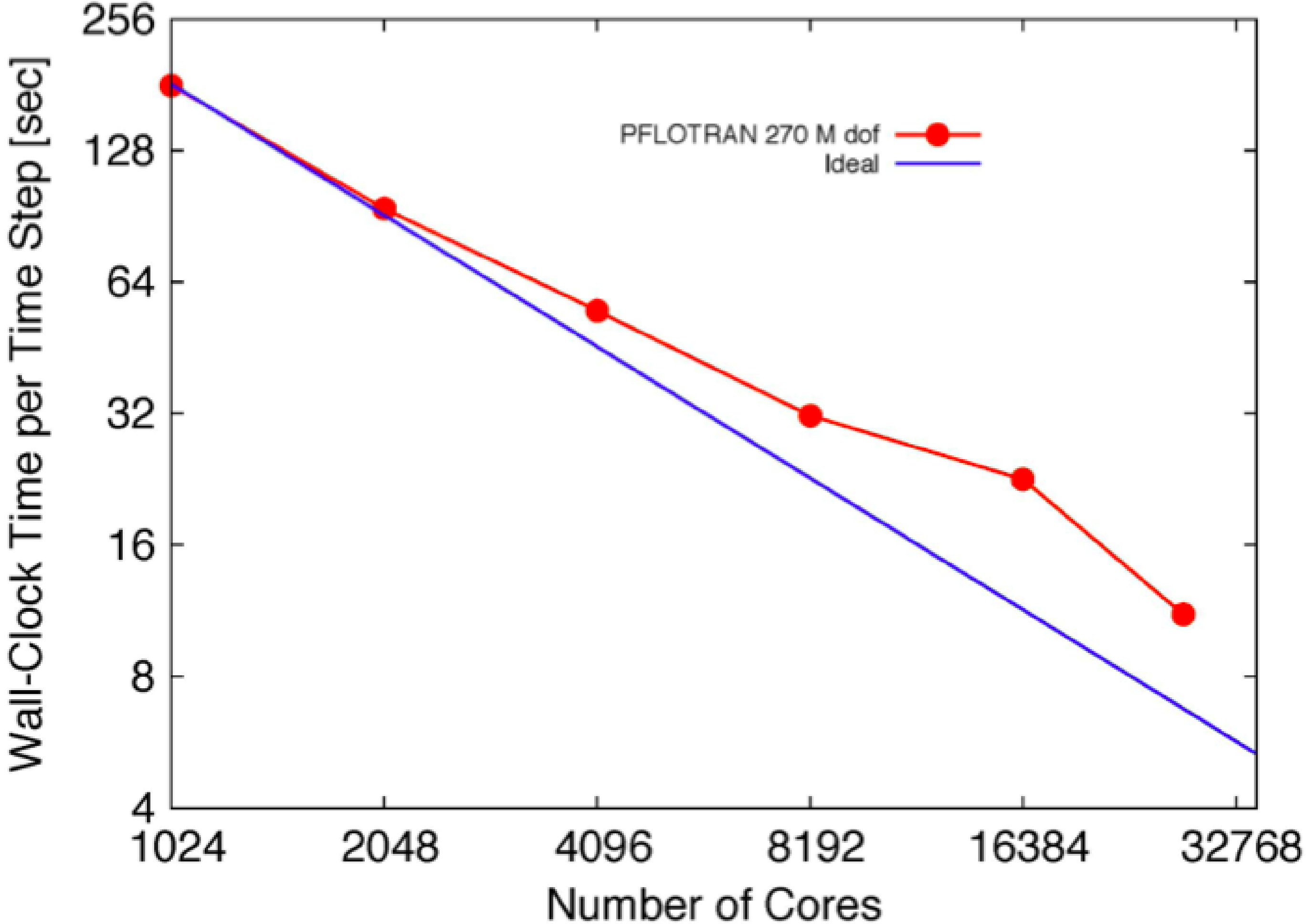
Ethan Coon (LANL)





PFLOTRAN

http://www.pflotran.org/

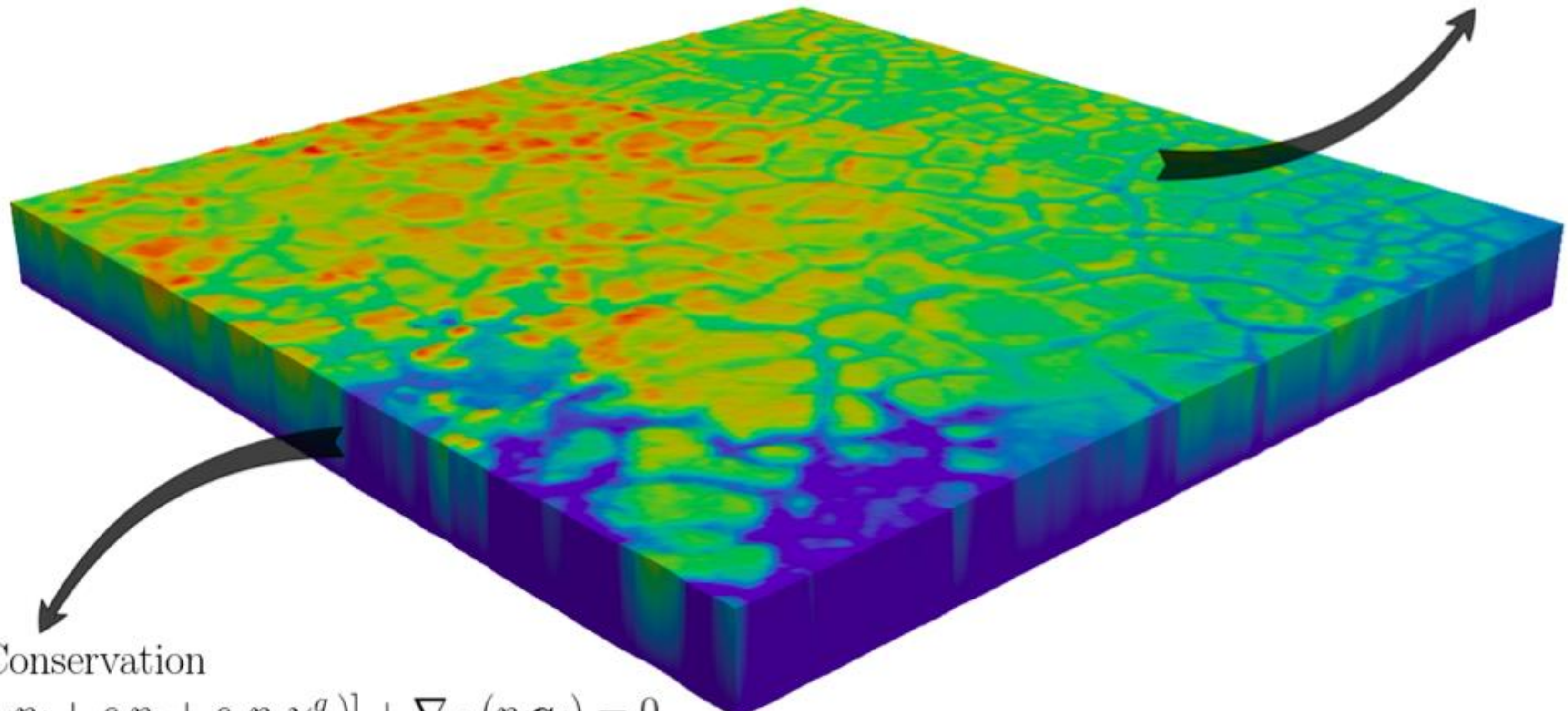


Mass Conservation

$$\frac{\partial h}{\partial t} + \nabla \cdot \mathbf{q}_m = Q_{\text{rain}} - Q_{\text{infil}}$$

Energy Conservation

$$\frac{\partial}{\partial t}\left[\rho_\ell c_\ell (h - z_0) T_s\right] + \nabla \cdot \left(\mathbf{q}_m \rho_\ell c_\ell (h - z_0) T_s - \kappa_\ell \nabla T_s (h - z_0)\right) = Q_{\text{ex}} - Q_{\text{atm}}$$



Mass Conservation

$$\frac{\partial}{\partial t}\left[\varphi\left(s_\ell \eta_\ell + s_i \eta_i + s_g \eta_g \chi_w^g\right)\right] + \nabla \cdot (\eta_\ell \mathbf{q}_\ell) = 0$$

Energy Conservation

$$\frac{\partial}{\partial t}\left[\varphi\left(s_\ell \eta_\ell U_\ell + s_g \eta_g U_g + s_i \eta_i U_i\right) + (1 - \varphi)\rho_s c_s T\right] + \nabla \cdot \left(\eta_\ell \mathbf{q}_\ell H_\ell - \kappa \nabla T\right) = 0$$