Arctic soil patterns analogous to fluid instabilities

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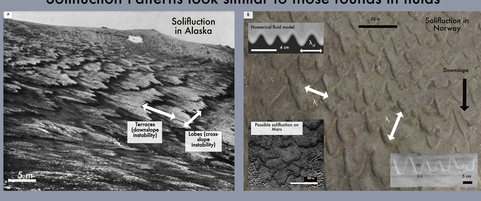
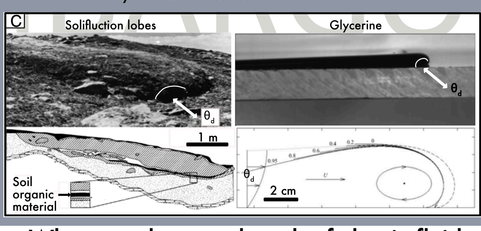
Solifluction Patterns look similar to those founds in fluids



Dynamics at the front are also similar

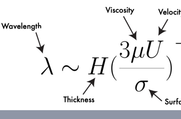


What sets the wavelength of classic fluid instabilities?

1. At a fluid front, cohesion/surface tension holds back flow, causing it to thicken

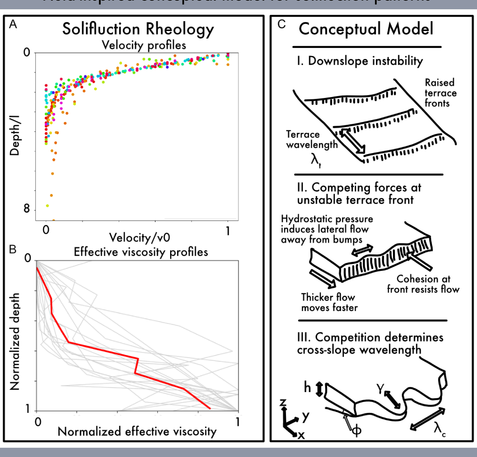
2. Thicker flow moves faster

3. Small variations in thickness lead to growth of "fingers" with wavelength (λ). This is called a "contact line instability."



$$\lambda \sim H\left(\frac{3\mu U}{\sigma}\right)^{-1/3} \quad \text{(Eqn. 2)}$$

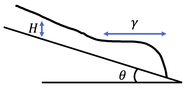
Fluid-inspired conceptual model for solifluction patterns



Theory: Solifluction wavelength scaling analysis

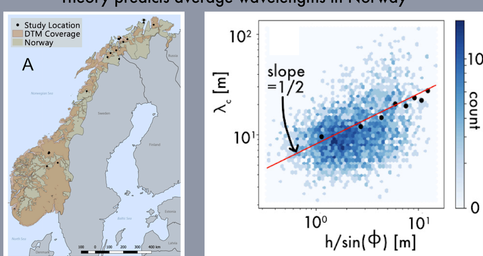
Assume:

- Soil flows like laminar fluid
- Hydrostatic component important (topographic bumps)
- Instead of surface tension, effective viscosity increases toward front of lobe with characteristic length γ

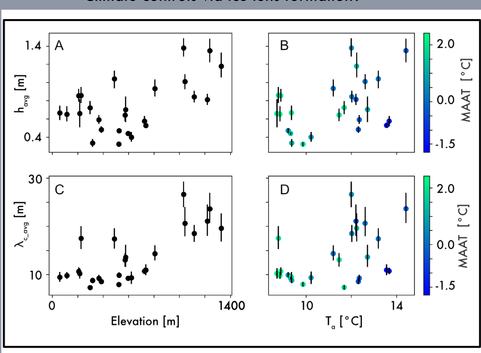


$$\lambda \sim \left(\frac{H\gamma}{\sin\theta}\right)^{1/2}$$

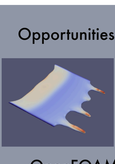
Theory predicts average wavelengths in Norway

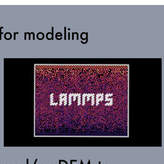


Climate controls via ice lens formation?



Opportunities for modeling





OpenFOAM and/or DEM to constrain complex rheology

How to incorporate into Landlab?

For more info (in press):