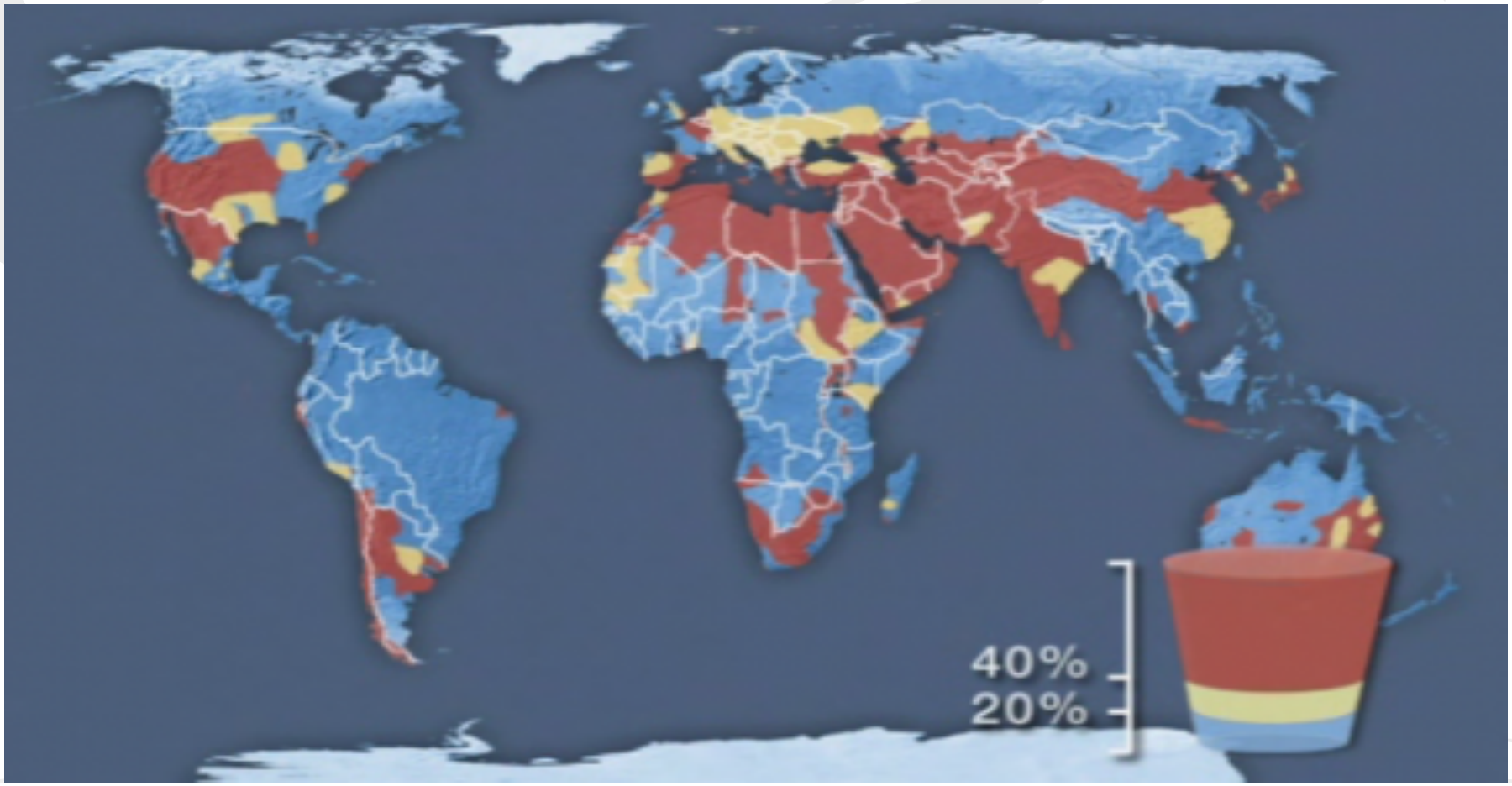
Review: A Hybrid System Model of Seasonal Snowpack Water Balance

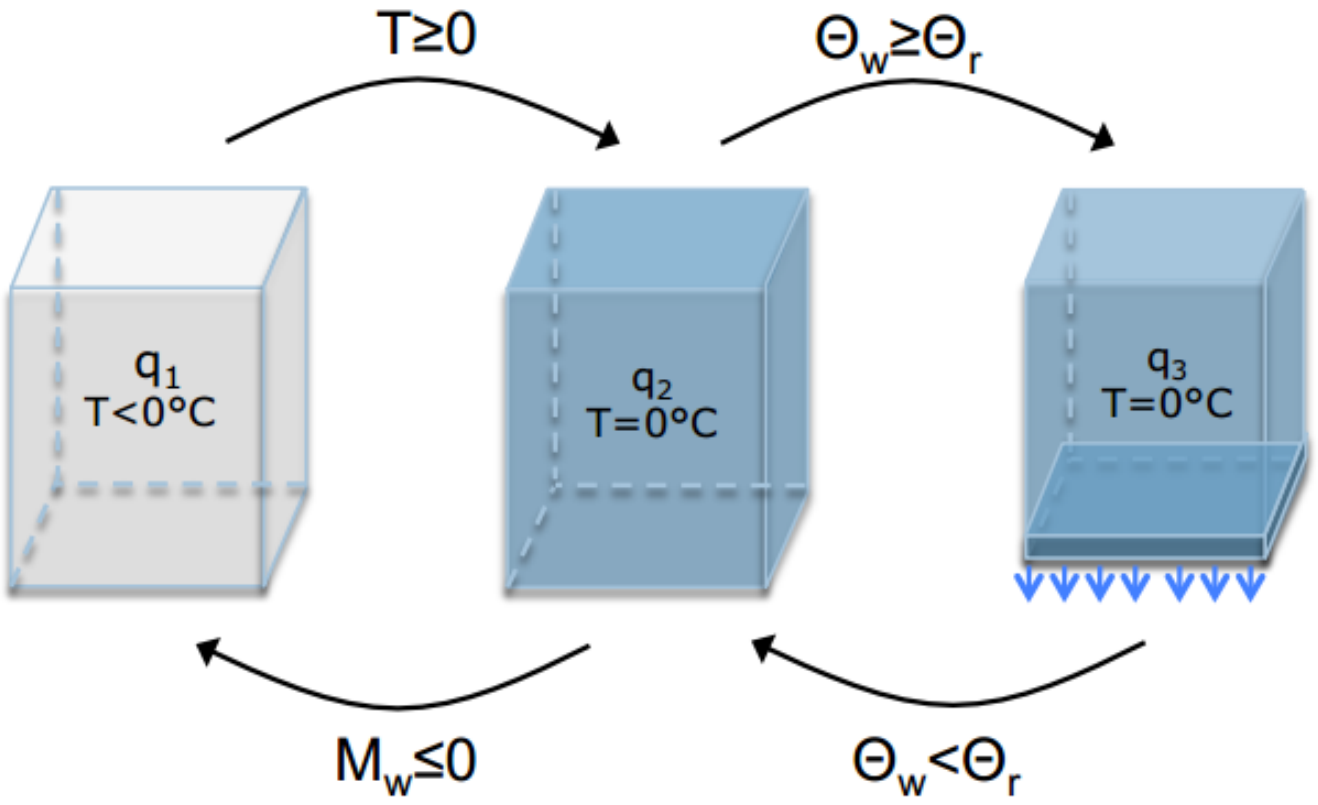
Application of hybrid modeling to natural systems

Personal Motivation

Motivation



The Discrete Model



M = 0

The Basics

$$\frac{dT}{dt} = \frac{u(t)}{M_{snow}C_{snow}}$$

$$\frac{dM_{water}}{dt} = -\frac{dM_{ice}}{dt} = \frac{u(t)}{L_f}$$

The Settling

$$\rho_{snow}(t) = \frac{A}{1 + B/t}$$

$$\frac{d\rho_{snow}(t)}{dt} = \frac{AB}{(B+t)^2}$$

$$t = \frac{\rho_{snow} B}{A - \rho_{snow}}$$

$$\frac{d\rho_{snow}(t)}{dt} = \frac{A}{B(1 + \frac{\rho_{snow}(t)}{A - \rho_{snow}(t)})^2}$$

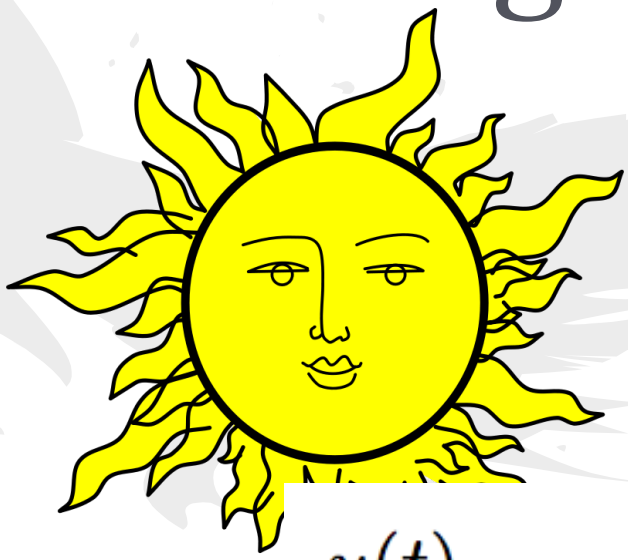
The Melting Sponge

$$\theta_{snow} = \frac{V_{water}}{V_{total}} = \frac{M_{water}/\rho_{water}}{M_{snow}/\rho_{snow}}$$

$$M_{water} = \theta_r \rho_{water} \frac{M_{ice}}{\rho_{snow} - \theta_r \rho_{water}}$$

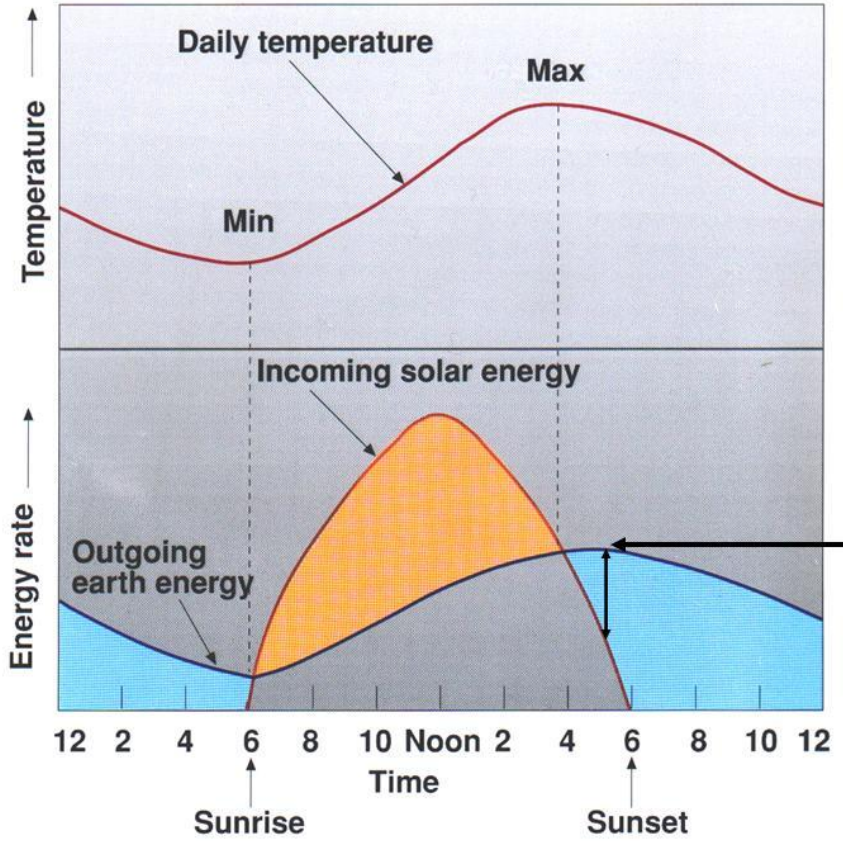
$$\frac{dM_{water}}{dt} = \theta_r \rho_{water} \left[\frac{\frac{dM_{water}}{dt}(\rho_{snow} - \theta_r \rho_{water}) - M_{ice}\frac{d\rho_{snow}}{dt}}{(\rho_{snow} - \theta_r \rho_{water})^2} \right]$$

Modeling Issues



$$u(t)_{solar} = a \sin 2\pi t$$

kJ / m / day



http://courses.knox.edu/envs150/overheads/dailytvariation.JPG


Lake effect snow
heading south-east
NASA's Earth Observatory

Questions