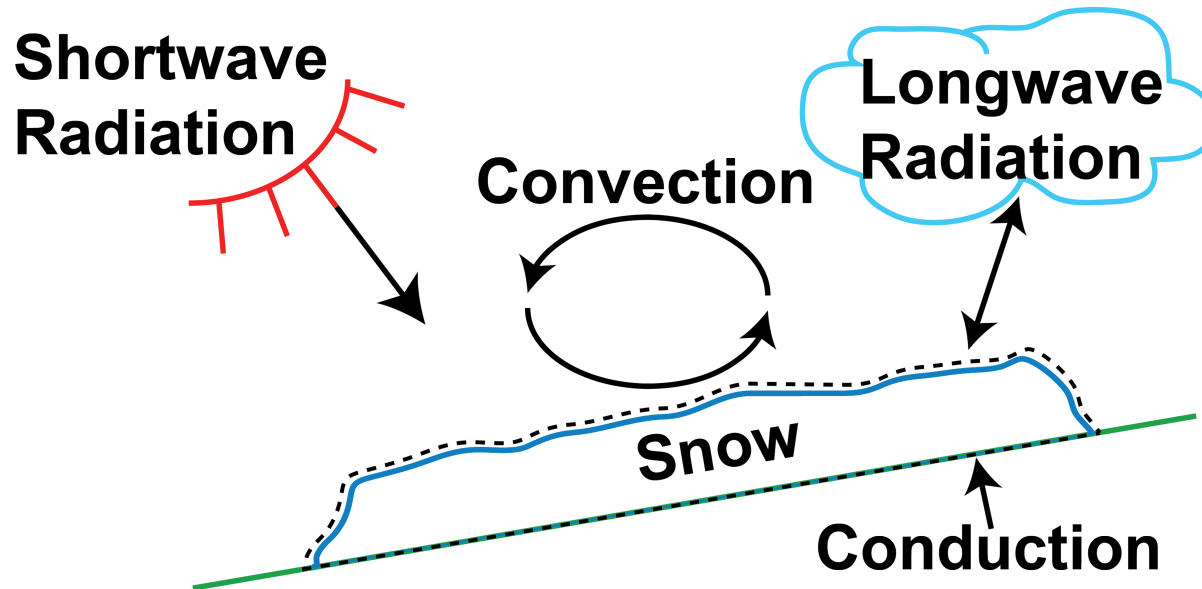
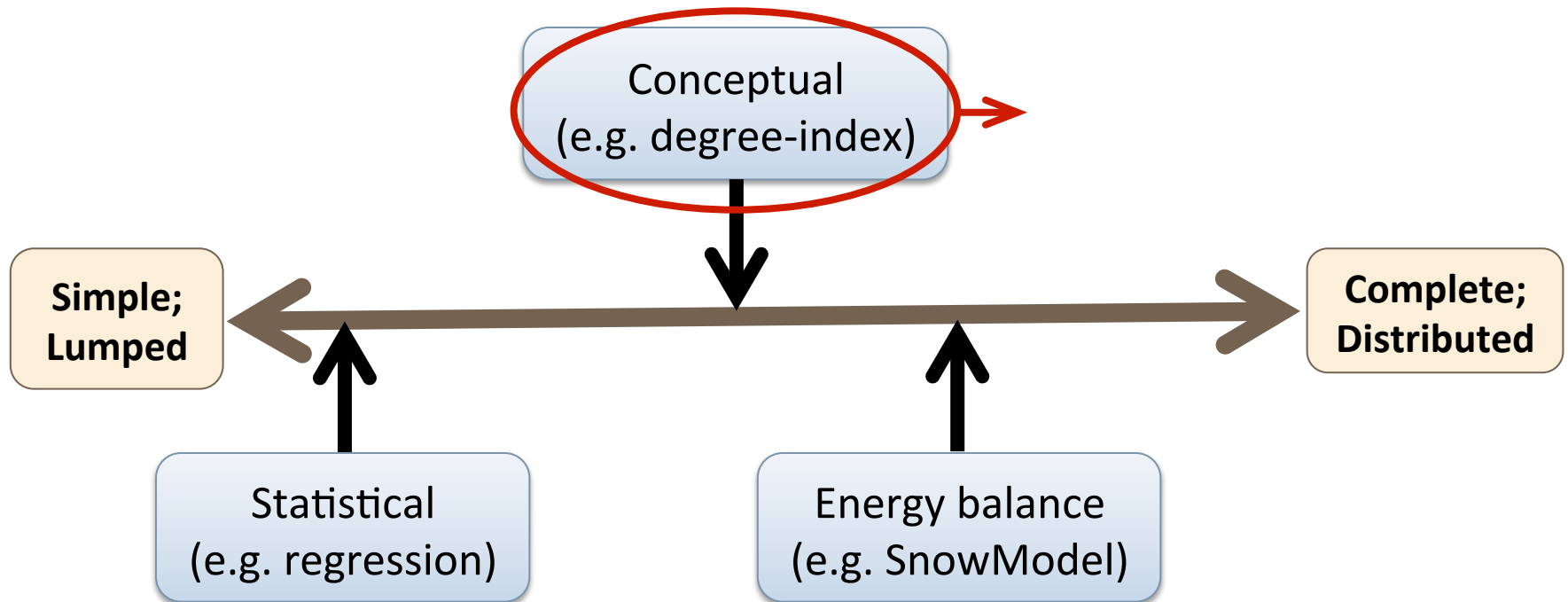


# My research assesses how snow/glacier model complexity impacts accuracy

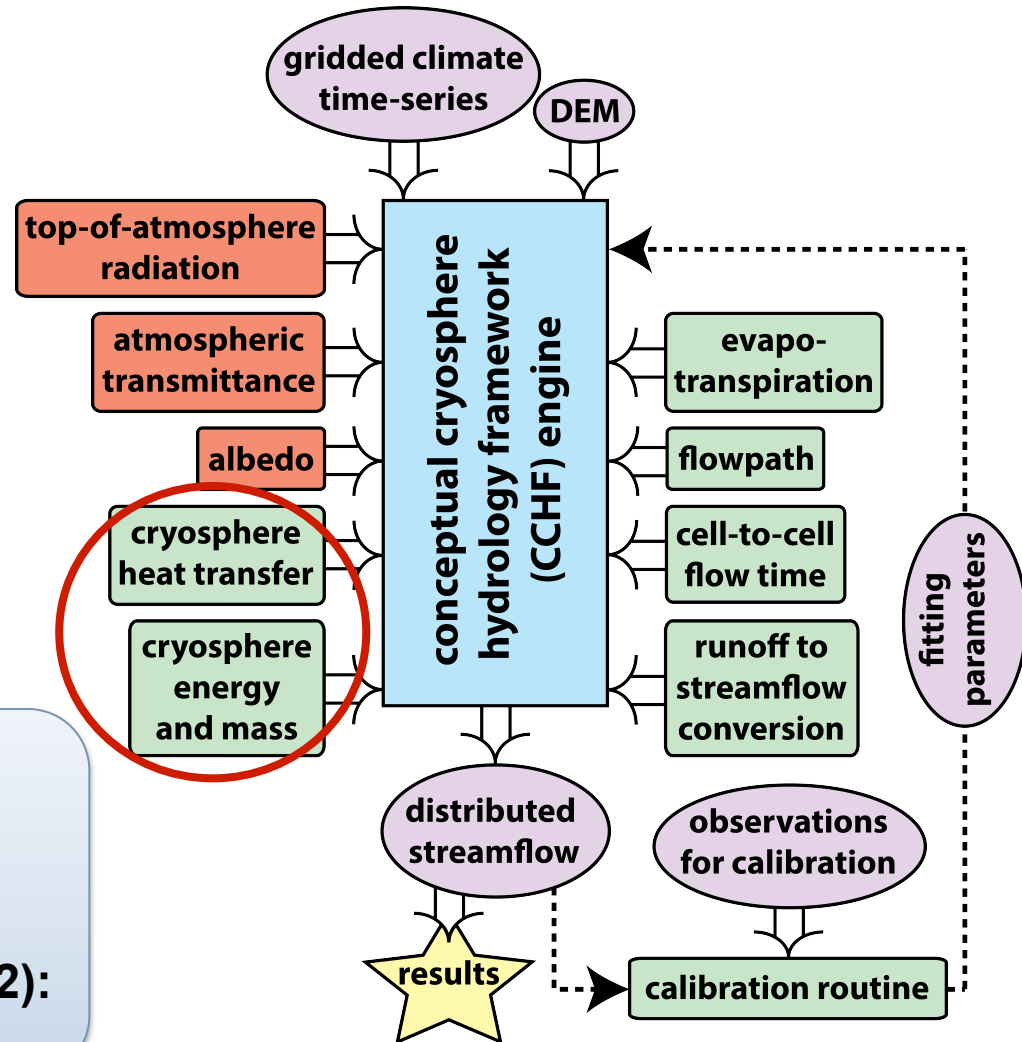


- Explicitly representing energy and mass balances requires many inputs: precip, temp, wind, humidity, soil, vegetation
- How certain are these inputs? How should this inform model complexity?

# Hydrology model spectrum: where's the optimum pt?



# The Conceptual Cryosphere Hydrology Framework (CCHF) enables intercomparison of model structures



I compare

- **Heat transfer (4):**  
SDI, ETI(H), ETI(P),  
and LST
- **Energy and mass (2):**  
Step and CC

# Assess four heat flux representations

## Simple Degree Index (SDI)

$$\text{heat} = c_1 T + c_2$$

Snow

e.g. Wang et al., 2004: GOA study

## Longwave, Shortwave, and Temperature (LST)

Shortwave Radiation

$$\text{heat} = c_1 T$$

Longwave Radiation

Snow

LST – By me. Open-source gridded model

## Enhanced Temperature Index (ETI)

Shortwave Radiation

$$\text{heat} = c_1 T + c_2$$

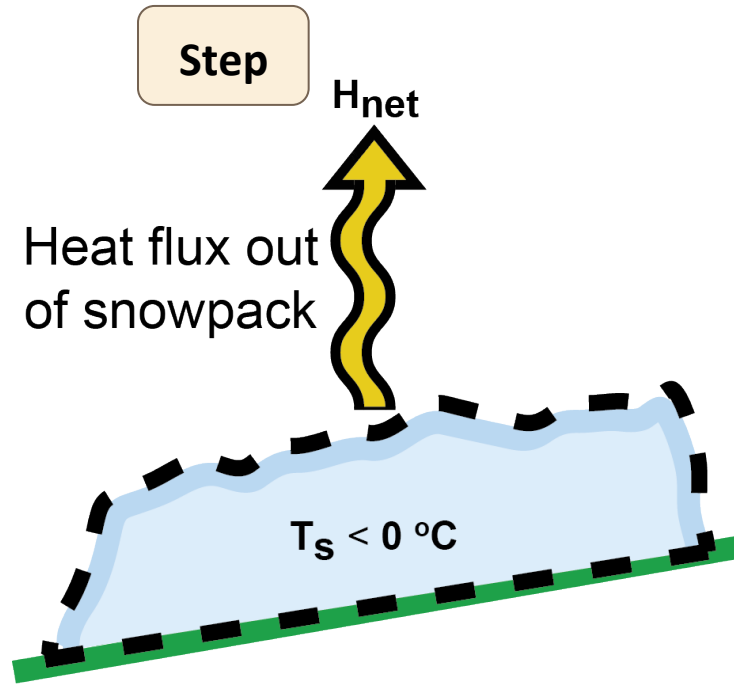
Snow

## Two existing ETI models

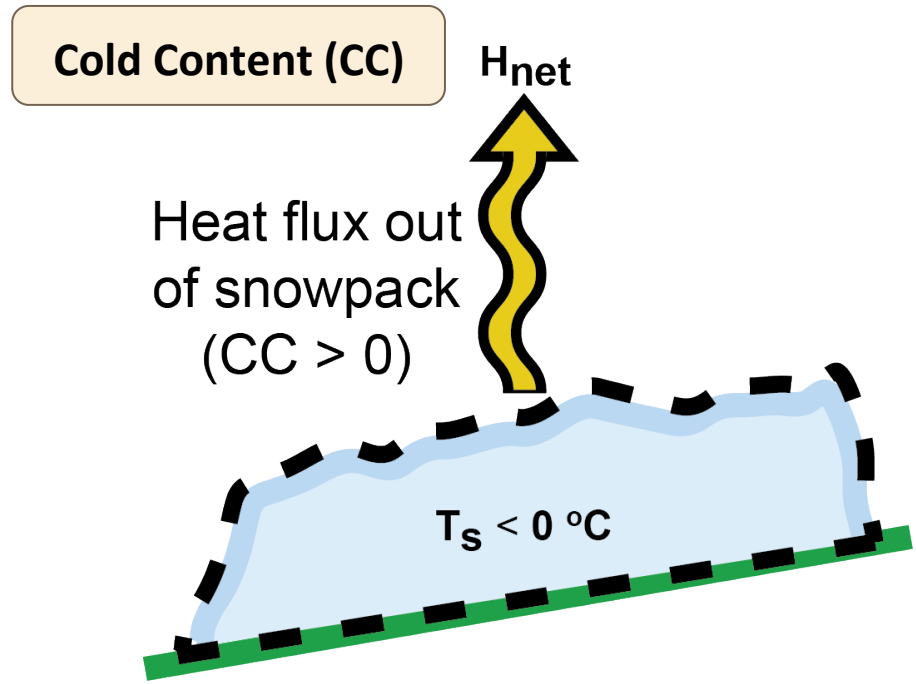
- **ETI(H)** – By Regine Hock. Open-source gridded model
- **ETI(P)** – By Francesca Pellicciotti. Only point-based



# Assess two energy and mass representations

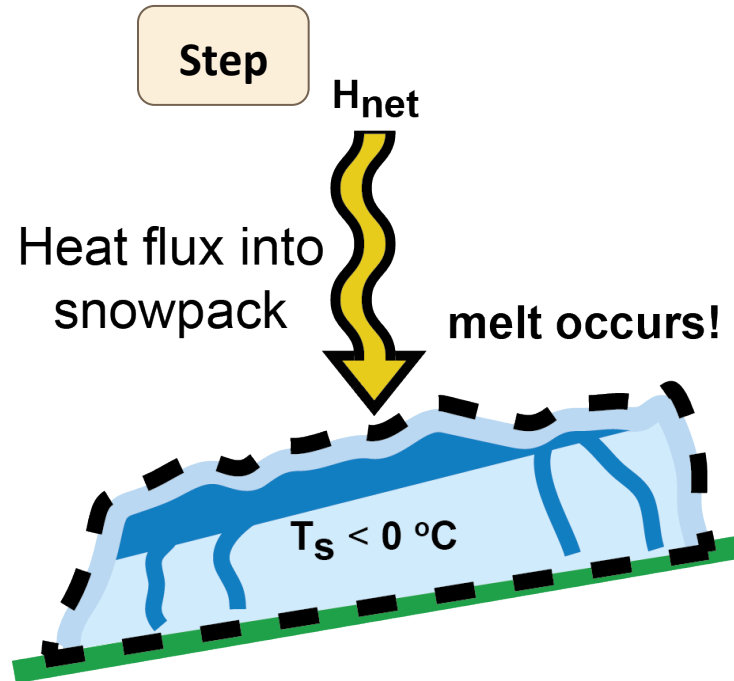


Commonly used in  
existing conceptual  
hydrology models



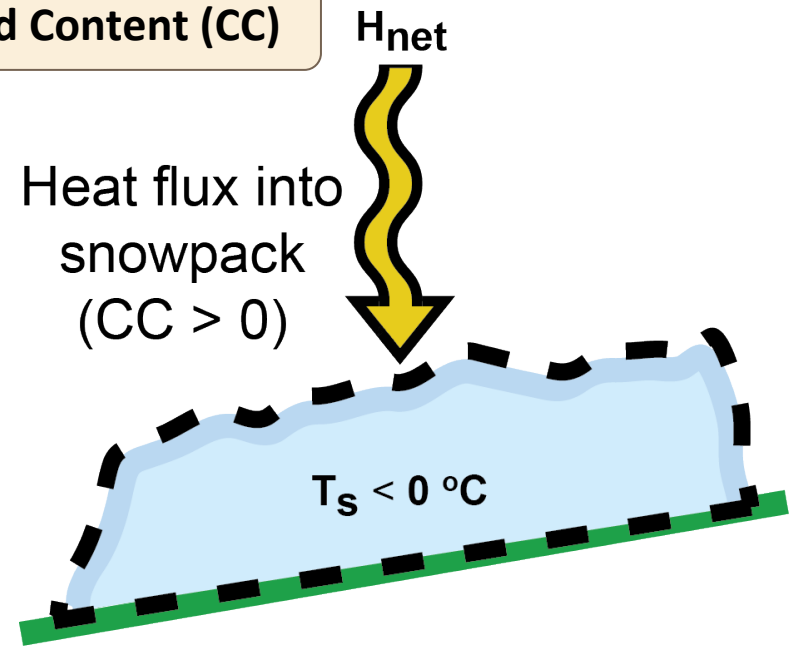
Not previously used in  
conceptual hydrology  
models

# Assess two energy and mass representations



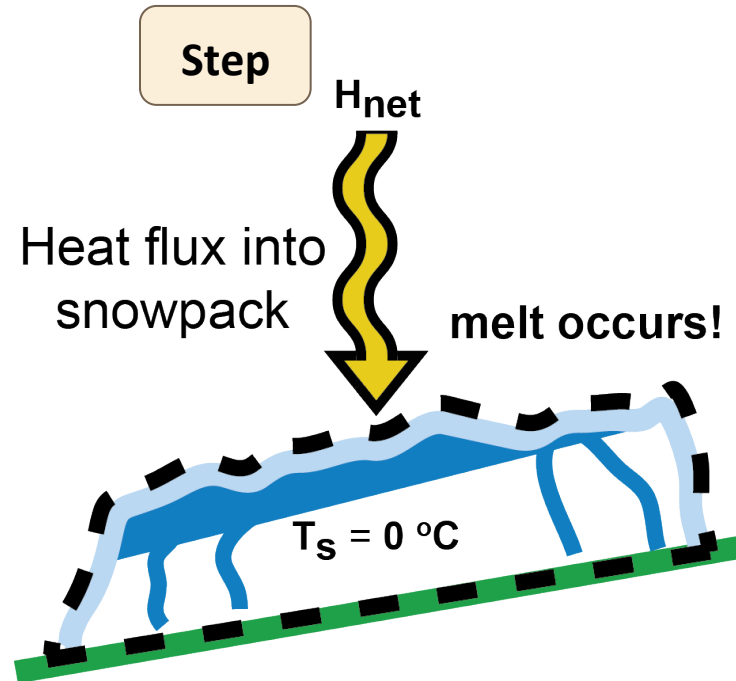
Commonly used in  
existing conceptual  
hydrology models

**Cold Content (CC)**

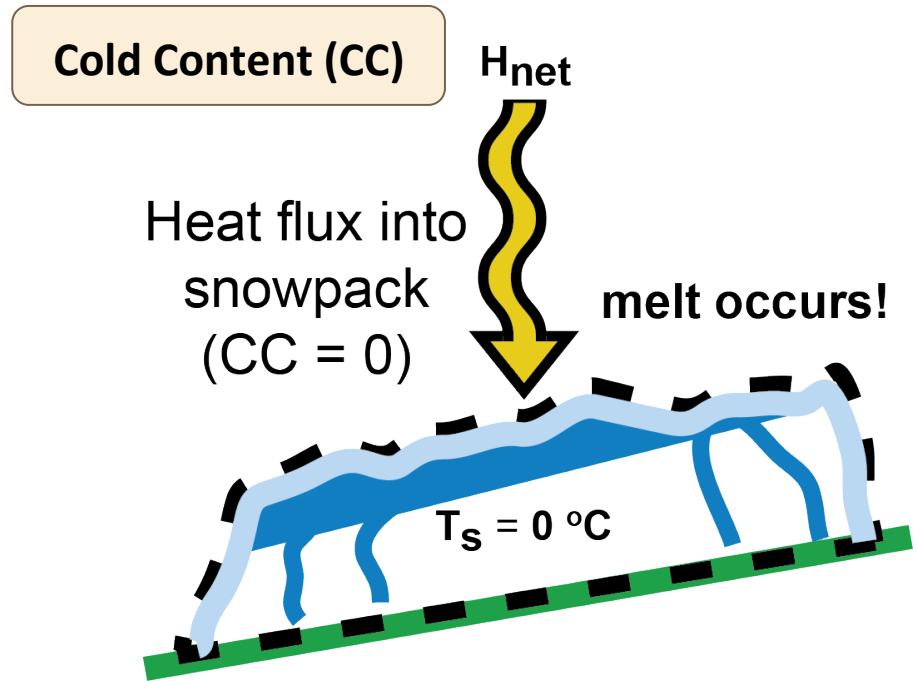


Not previously used in  
conceptual hydrology  
models

# Assess two energy and mass representations

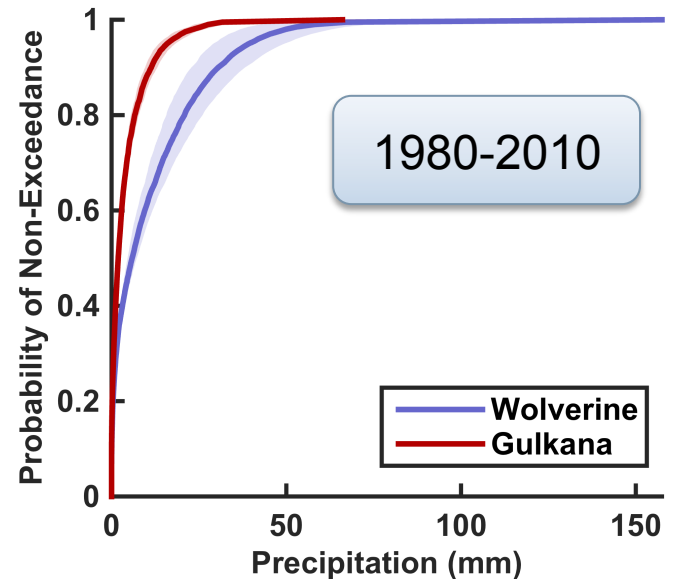
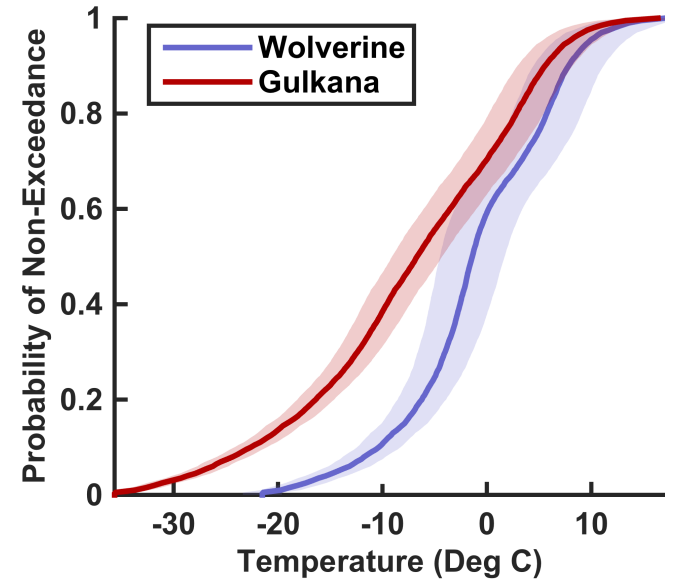
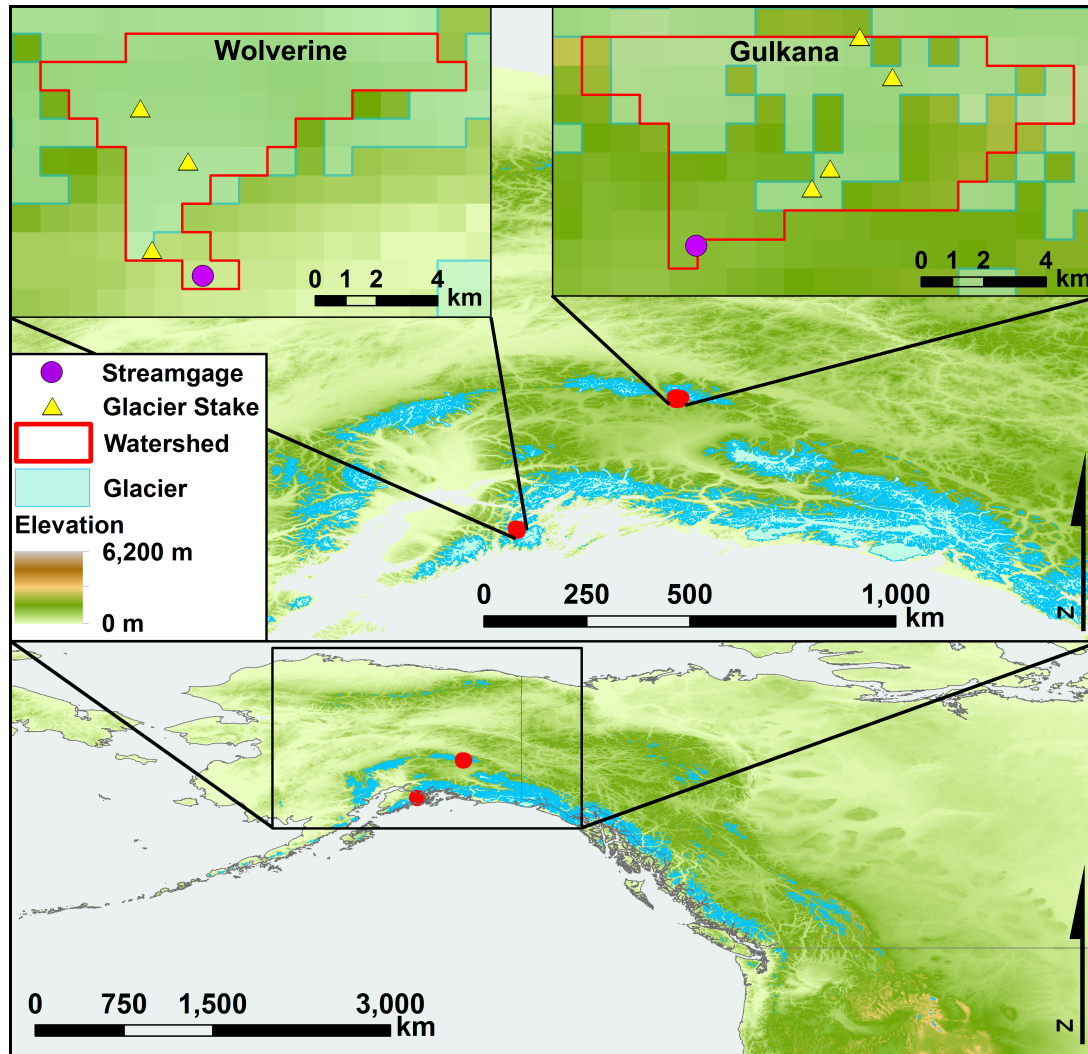


Commonly used in  
existing conceptual  
hydrology models



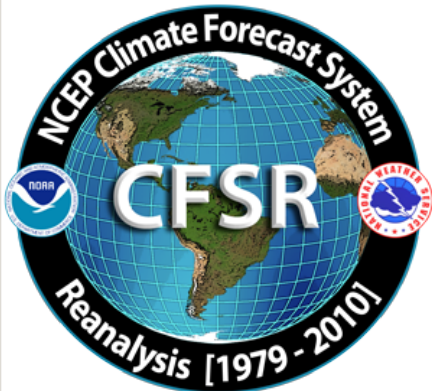
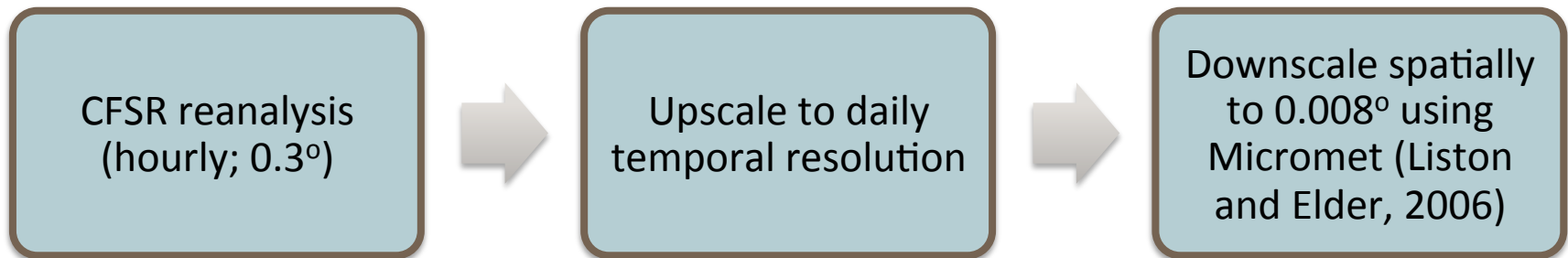
Not previously used in  
conceptual hydrology  
models

# Implement for USGS study glaciers with different climates



## CFSR used as climate forcing

- CFSR captures regional climate variations for Alaska better than MERRA or NARR (Wang et al., 2011 and Lader, 2014)



# Three types of observations used in assessment

- Models calibrated in two stages
  - Cryosphere processes
    - MODIS snow covered area images
    - Glacier stake measurements
  - Streamflow processes
    - USGS streamgauge

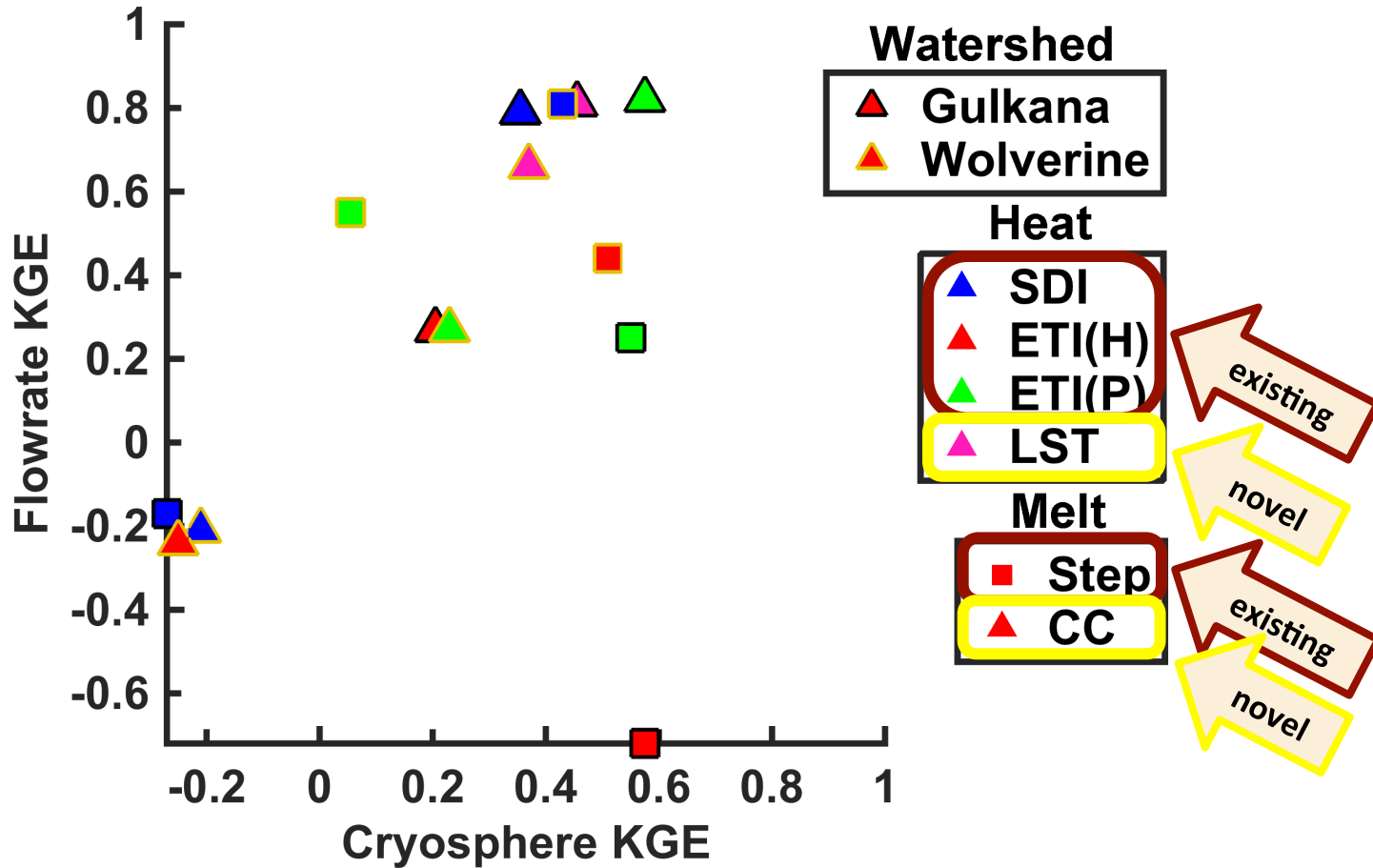


(USGS Benchmark Glaciers)

- **Calibrate:** each watershed; July 2000 – June 2010; hybrid optimization routine I developed
- **Validate:** apply to opposite watershed; same time period

$$KGE = 1 - \sqrt{(r - 1)^2 + (\alpha - 1)^2 + (\beta - 1)^2}$$

## LST<sub>CC</sub> model more robust than existing conceptual cryosphere models



$$\text{KGE} = 1 - \sqrt{(r - 1)^2 + (\alpha - 1)^2 + (\beta - 1)^2}$$