Snow Dynamics and Modelling in Open and Forested Basins

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Study Elements

- Processes
  - Snow accumulation, structure and observation
  - Turbulent transfer to snow
  - Radiation effects on snowmelt under vegetation

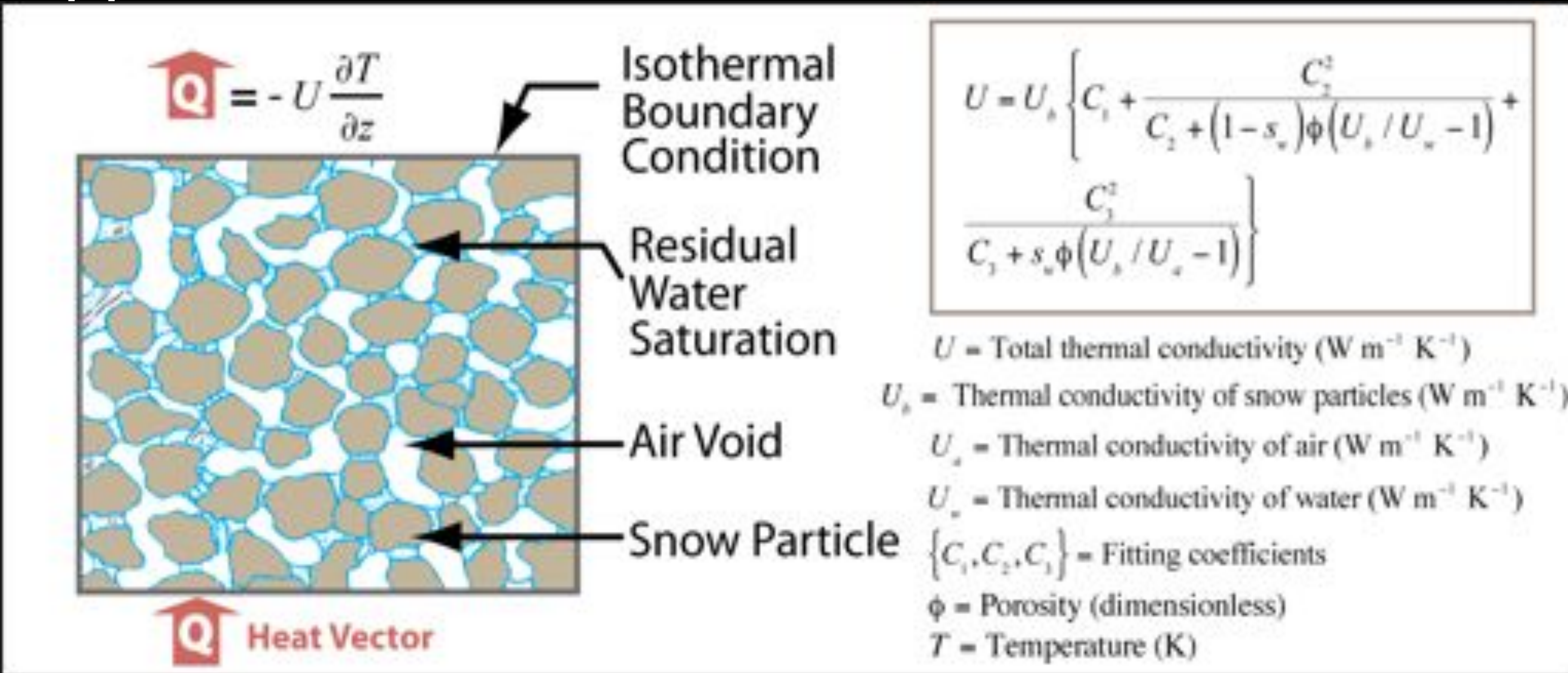
- Parameterisations
  - Blowing snow over complex terrain
  - Sub-canopy snowmelt
  - SCA Depletion,
  - Contributing area for runoff generation in snowmelt period
- Prediction
  - Wind modelling over complex terrain
  - Level of spatial complexity necessary in models
  - Regionalisation of CLASS parameters
  - Snow modelling contribution to MESH

Also see talks by Menard, Brown, Herrera, Pietroniro, Marks

Improved Snow Observations by Acoustic Sounding

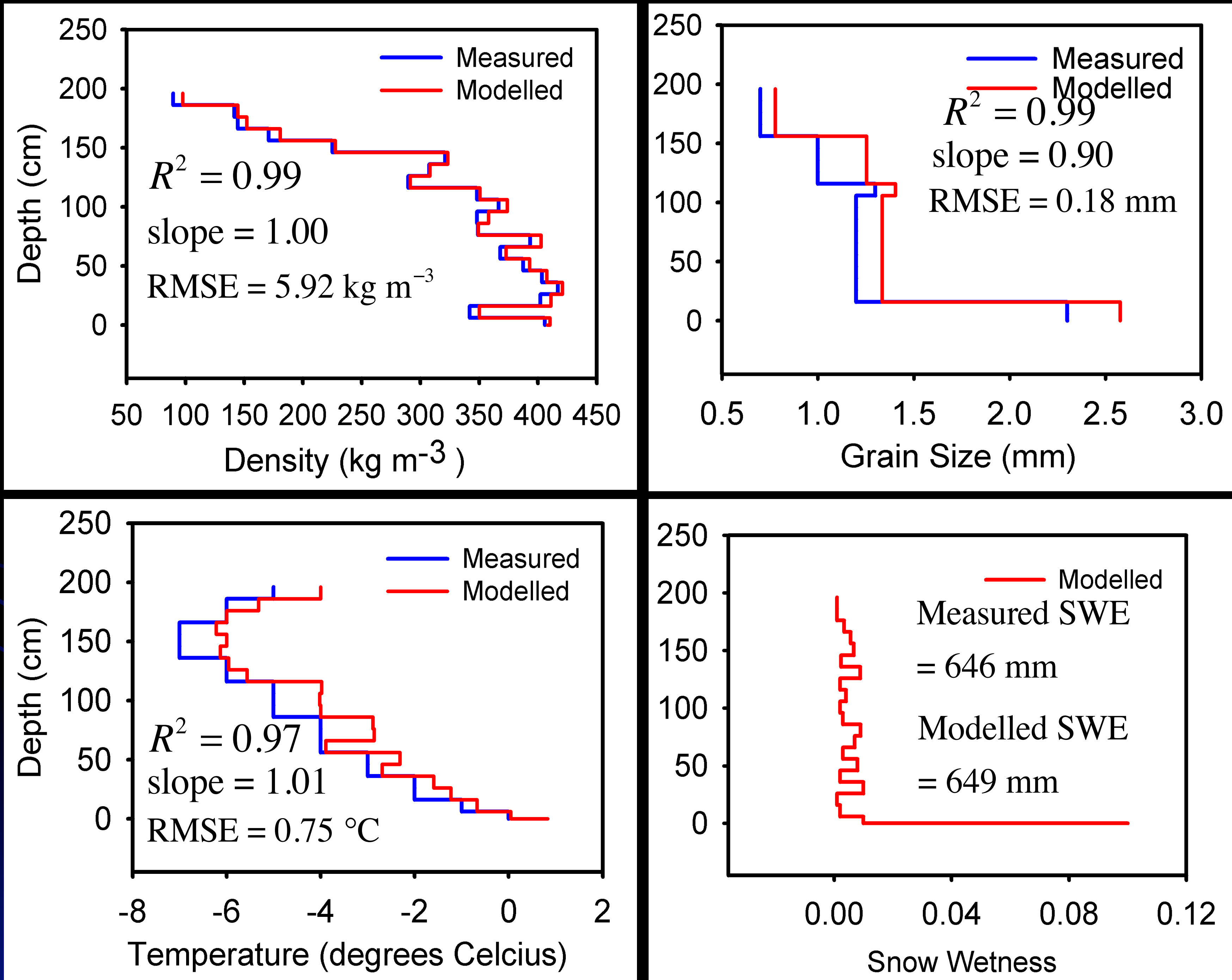
- Previous research demonstrated the possibility of determining SWE by the use of an acoustic wave.
- Experimental apparatus has been confirmed at sites in Saskatchewan, Yukon Territory, and the Rocky Mountains.

Jackson-Black Thermal Conductivity Model Applied to Snow



- A macroscopic model that relates the effective thermal conductivity of the porous medium to the thermal conductivities of snow, water and air
- Liquid water acts as a thermal binder providing high conductivity pathway across the snowpack
- Coupled with Fourier’s Law to relate heat flux to snow thermal properties

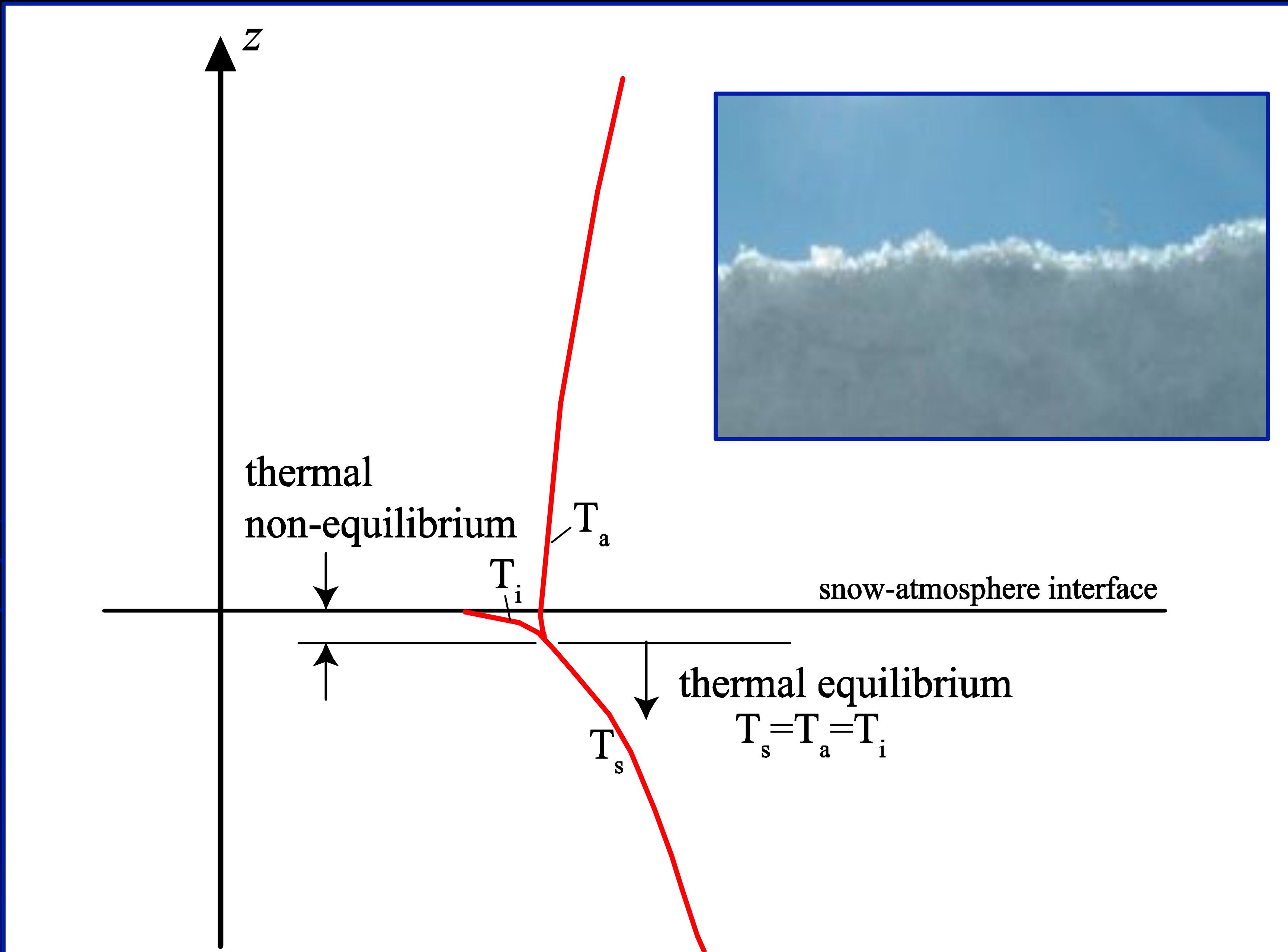
Open Woodland: CLPX Rabbit Ears Site, Buffalo Pass, Feb 2002
Virtual Test of Acoustic and Snow Thermodynamic Models



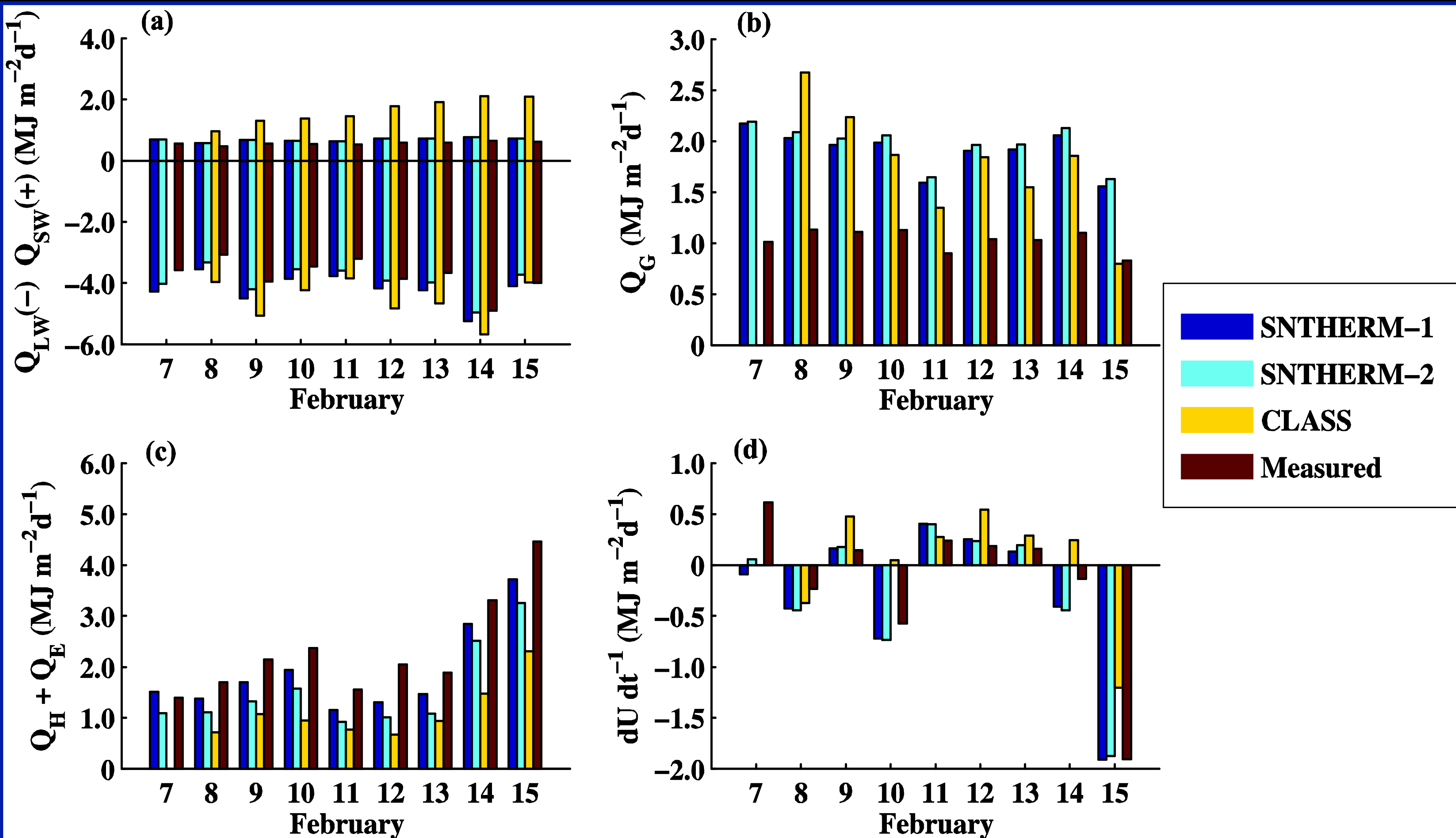
Turbulent Transfer over Snow

Conceptual model of air flow over permeable snow surface

Conceptual Model of Air-snow Temperature Profile

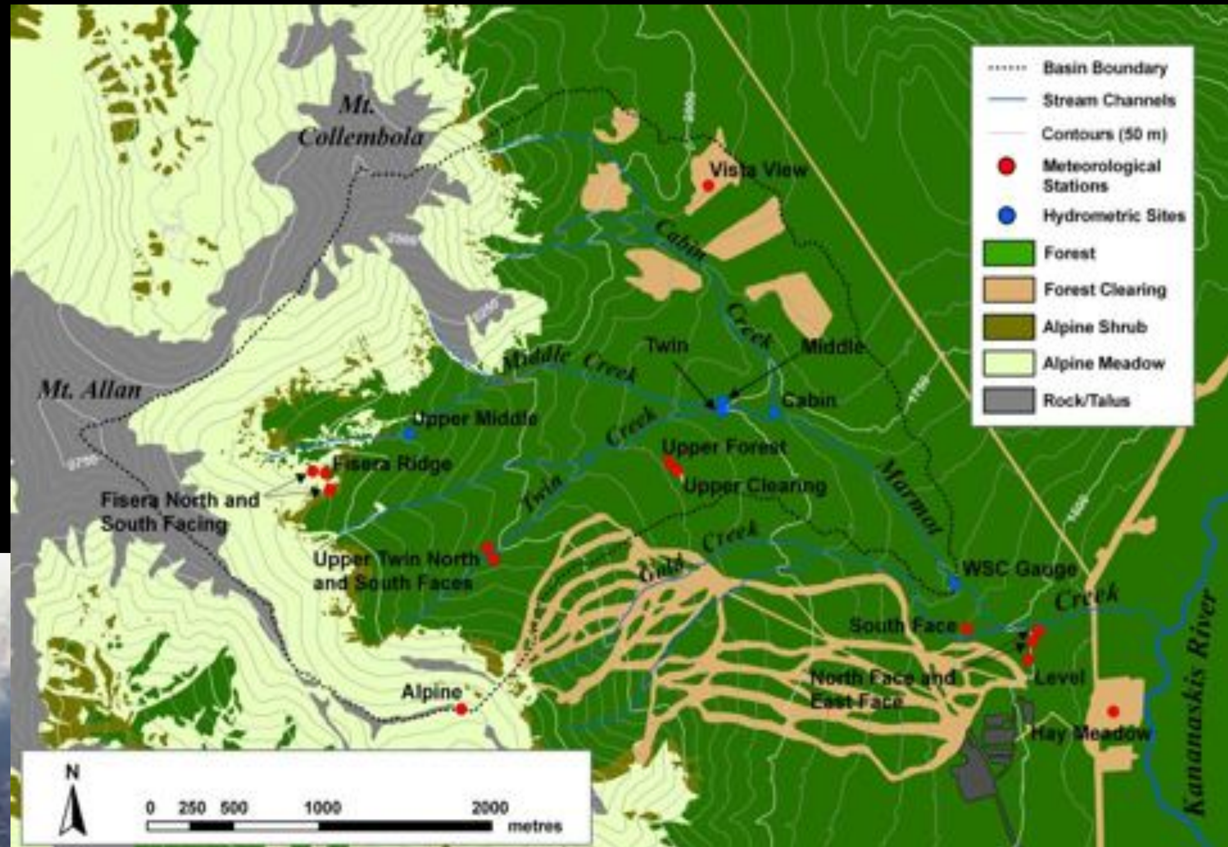


Modeling Fluxes at a Level Site

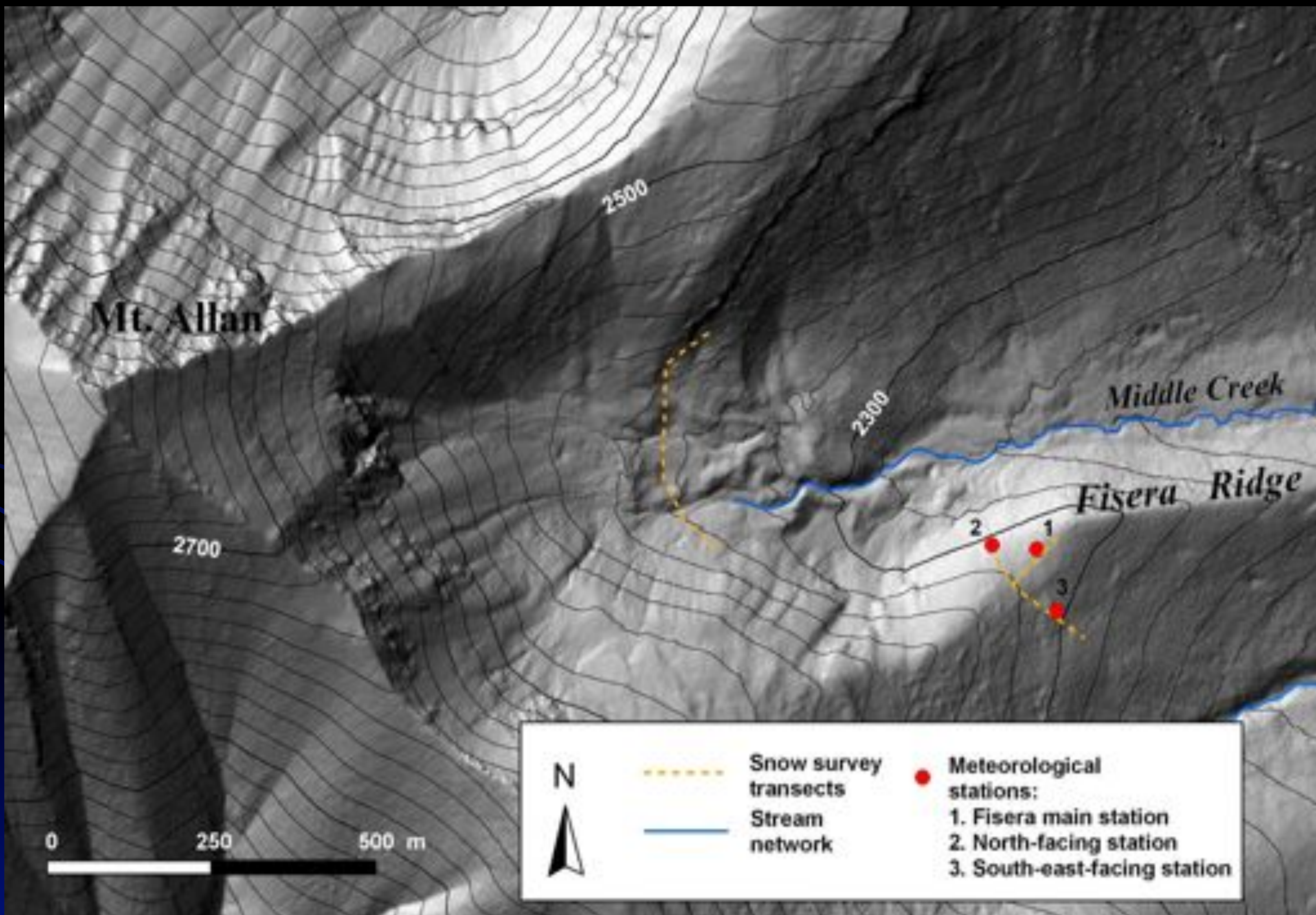


SNTHERM-2 has local roughness lengths

Marmot Creek Research Basin



Alpine Snow Accumulation, Ablation and Runoff Contributing Area



Fisera Ridge, Mt Allan Cirque

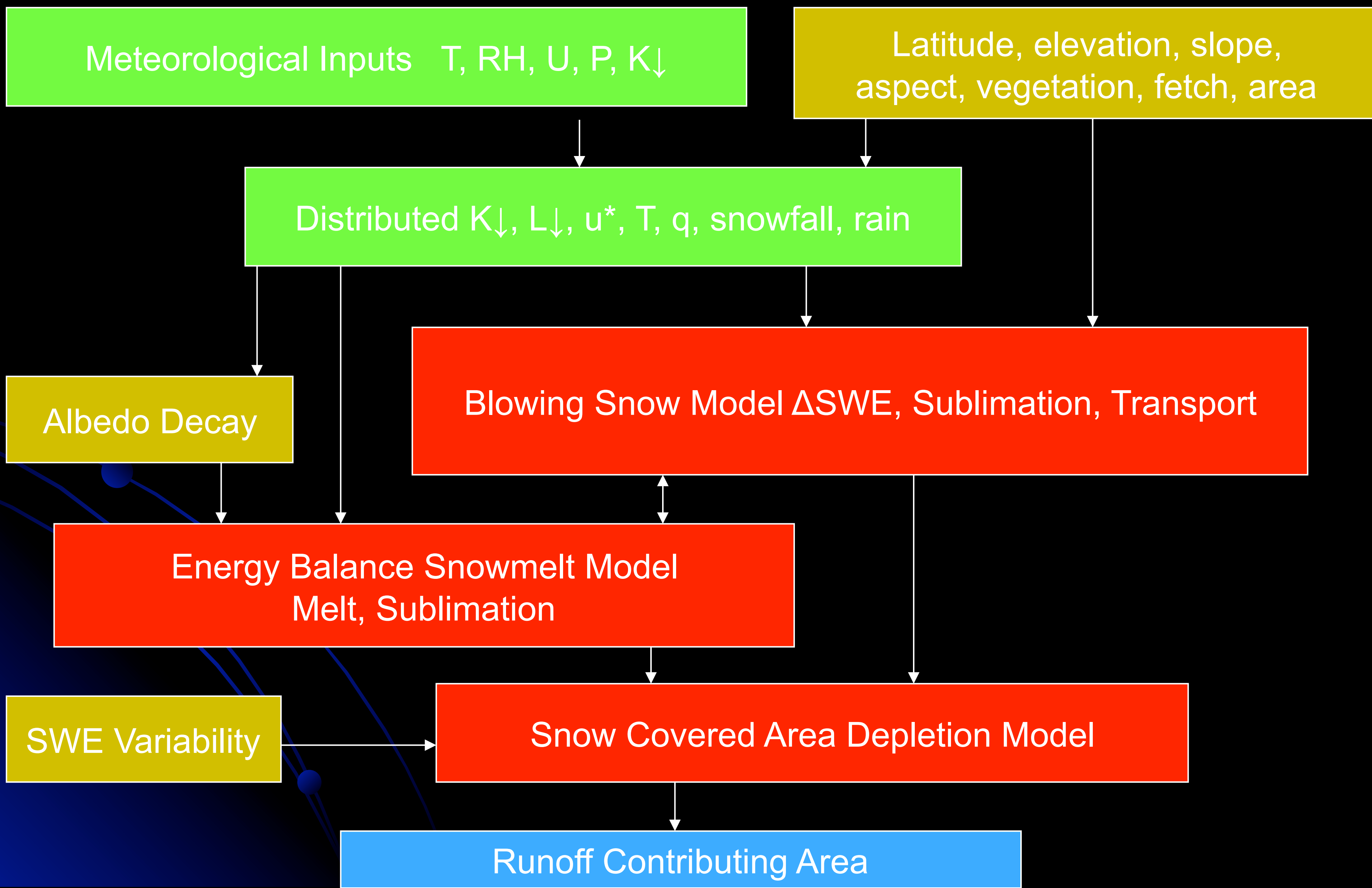
- 2318 m
- Ridge above treeline
- Windblown
- U, T, RH
- Precip
- Radiation
- Snowdepth
- Camera
- 2 outlier stations

North Face, South Face

North Face windswept

South Face
deposition zone

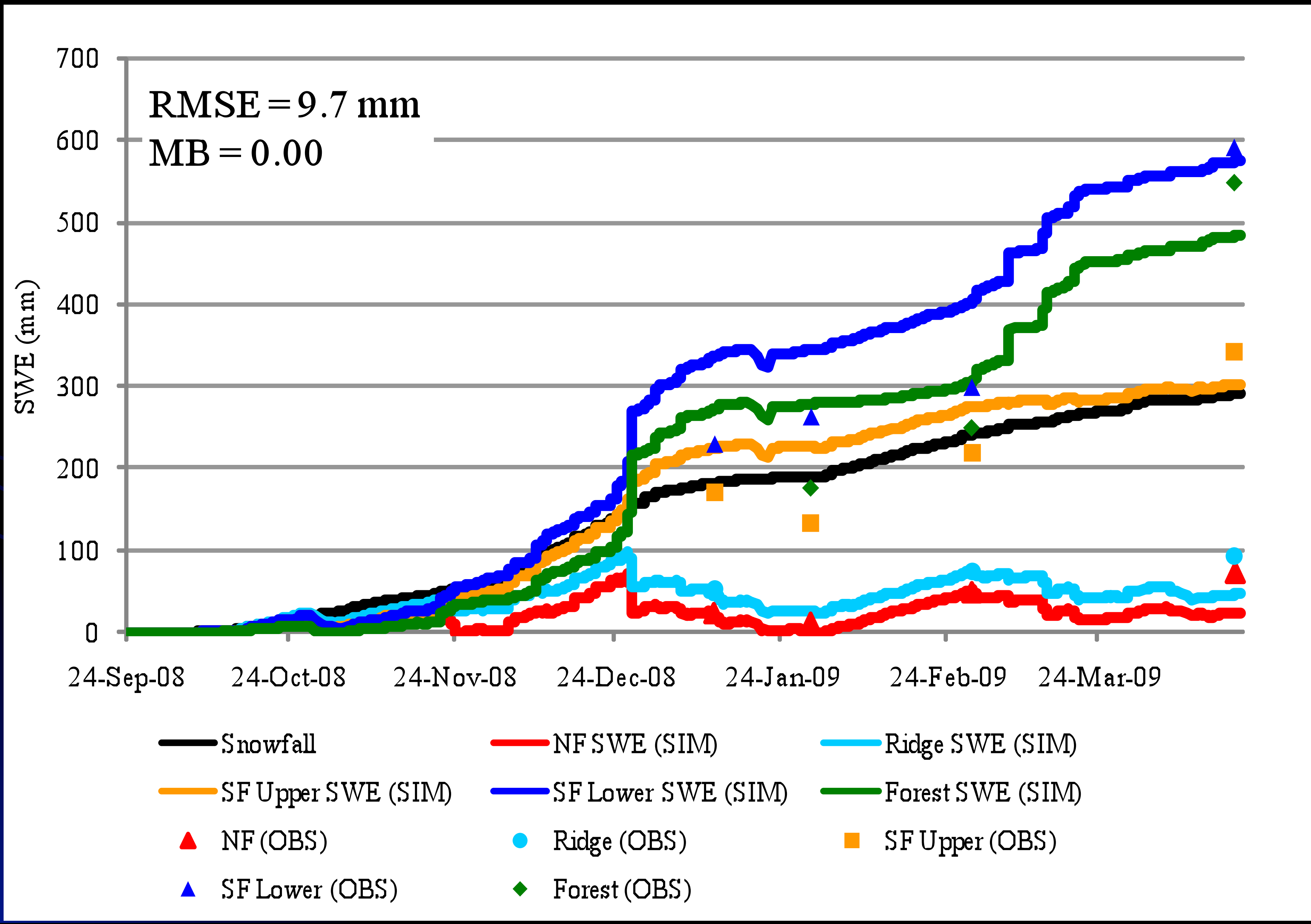
Snow Hydrology Modelling in Alpine Basins



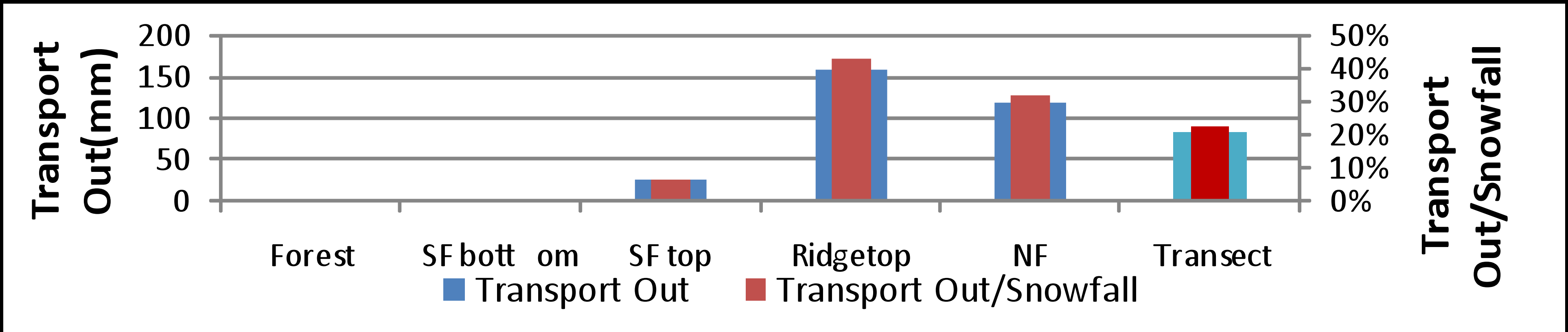
Blowing snow flow parameterisation

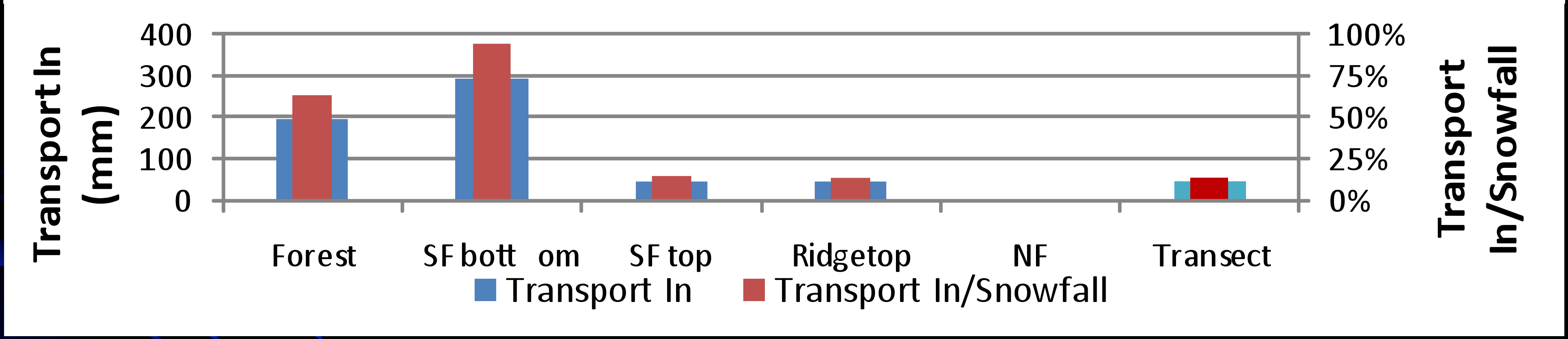
- Dominant windflow: north to south
- Flow over ridgetop and into forest

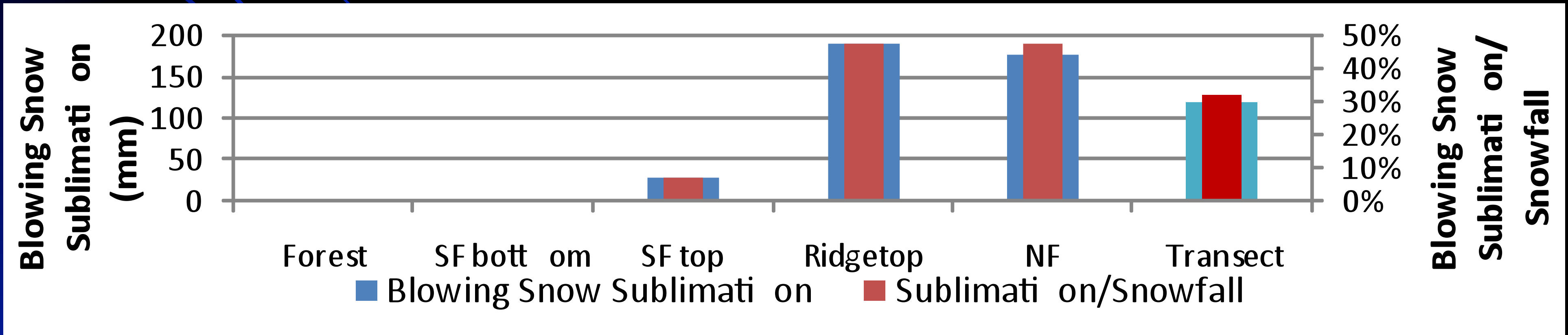
Landscape Units: 2008-2009



Simulation Summary: 2008/2009





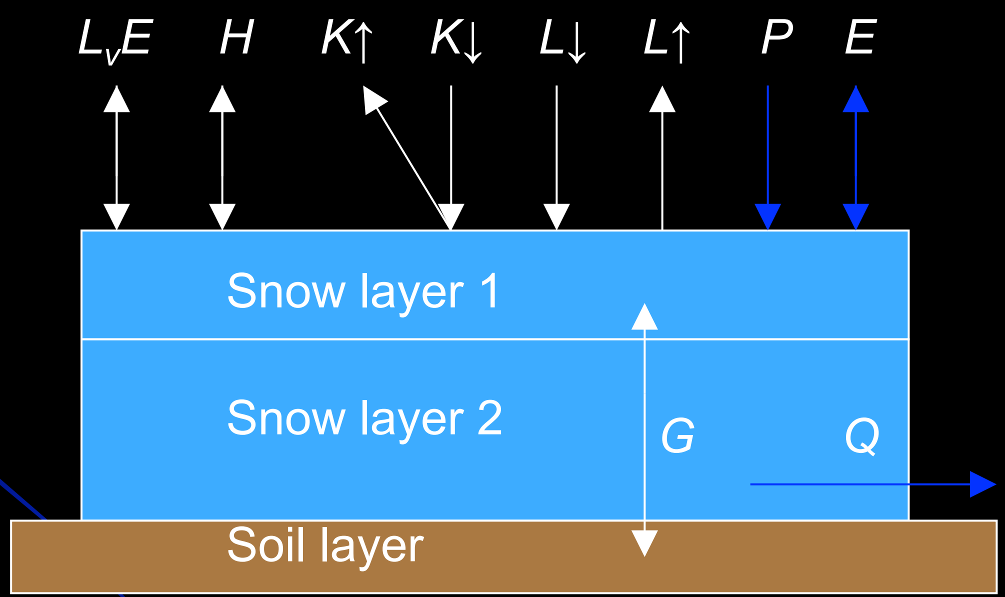


Runoff Contributing Area

- Runoff from snow delivering meltwater to base of snowpack
  - No runoff from cold snowpacks
  - No runoff from non-snowcovered area
- Marsh and Pomeroy (1996) showed that runoff contributing area was due to snow redistribution and differences in internal energetics and snow hydrology with depth.

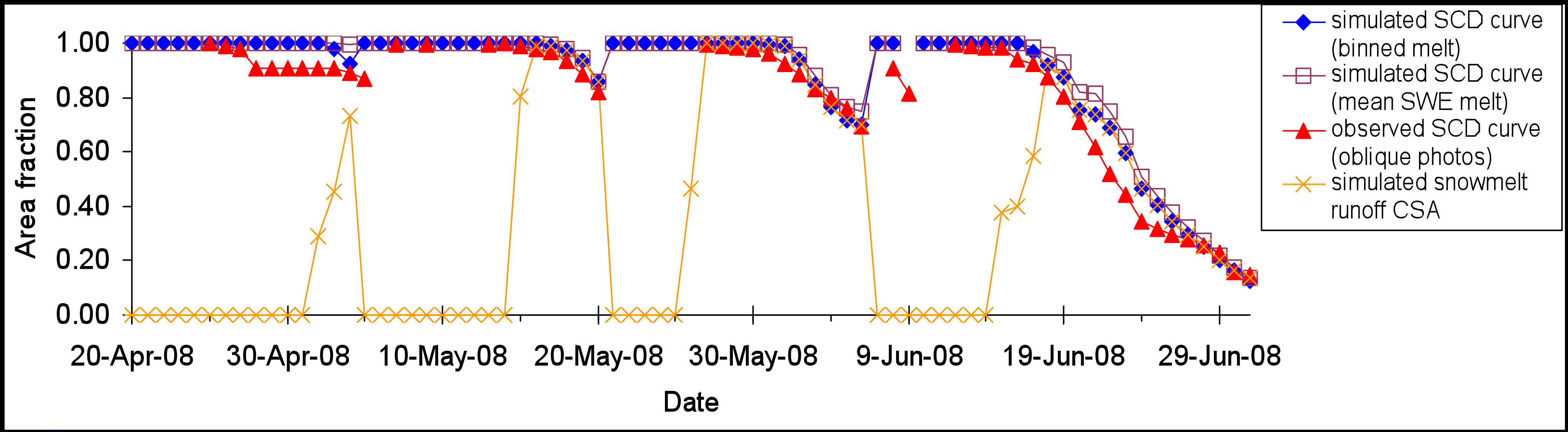
CRHM Alpine Snowmelt Modeling

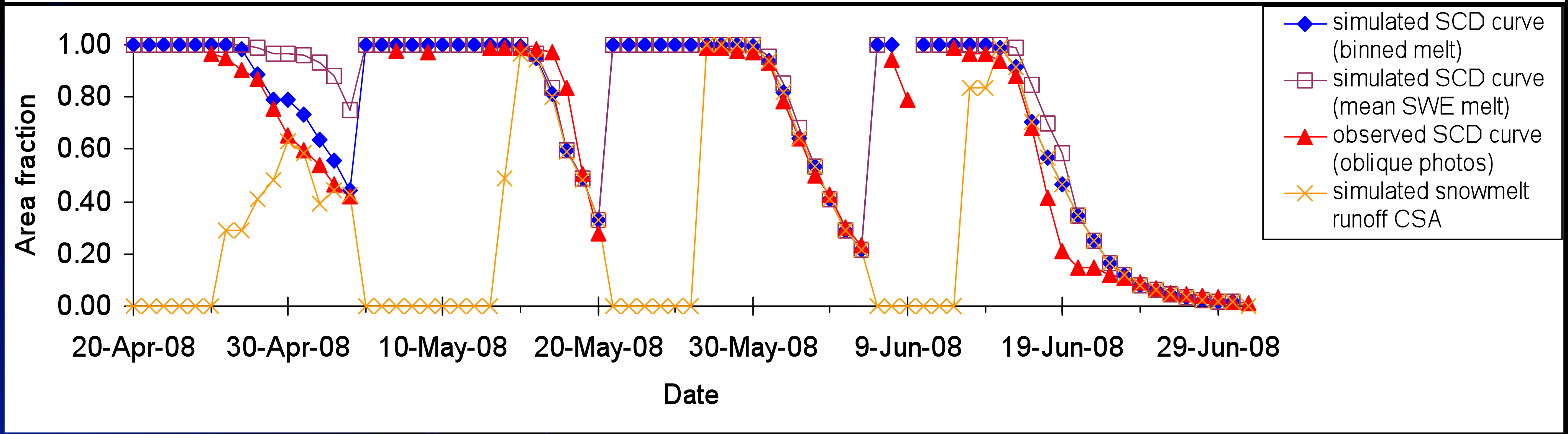
- *Snobal* mass and energy balance routine after Marks et al. (1999) incorporated into CRHM.
- Corrections for direct and diffuse shortwave and longwave radiation to slopes, including terrain emission



- Snowcovered area estimated from observed SWE frequency distribution

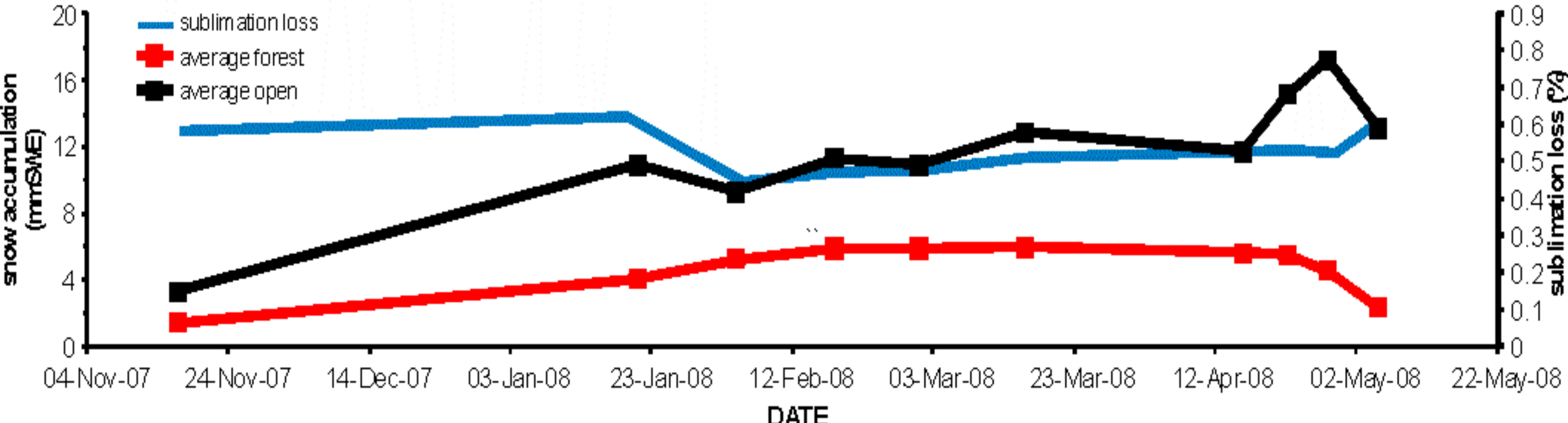
Snowcovered Area Depletion and Runoff Contributing Area



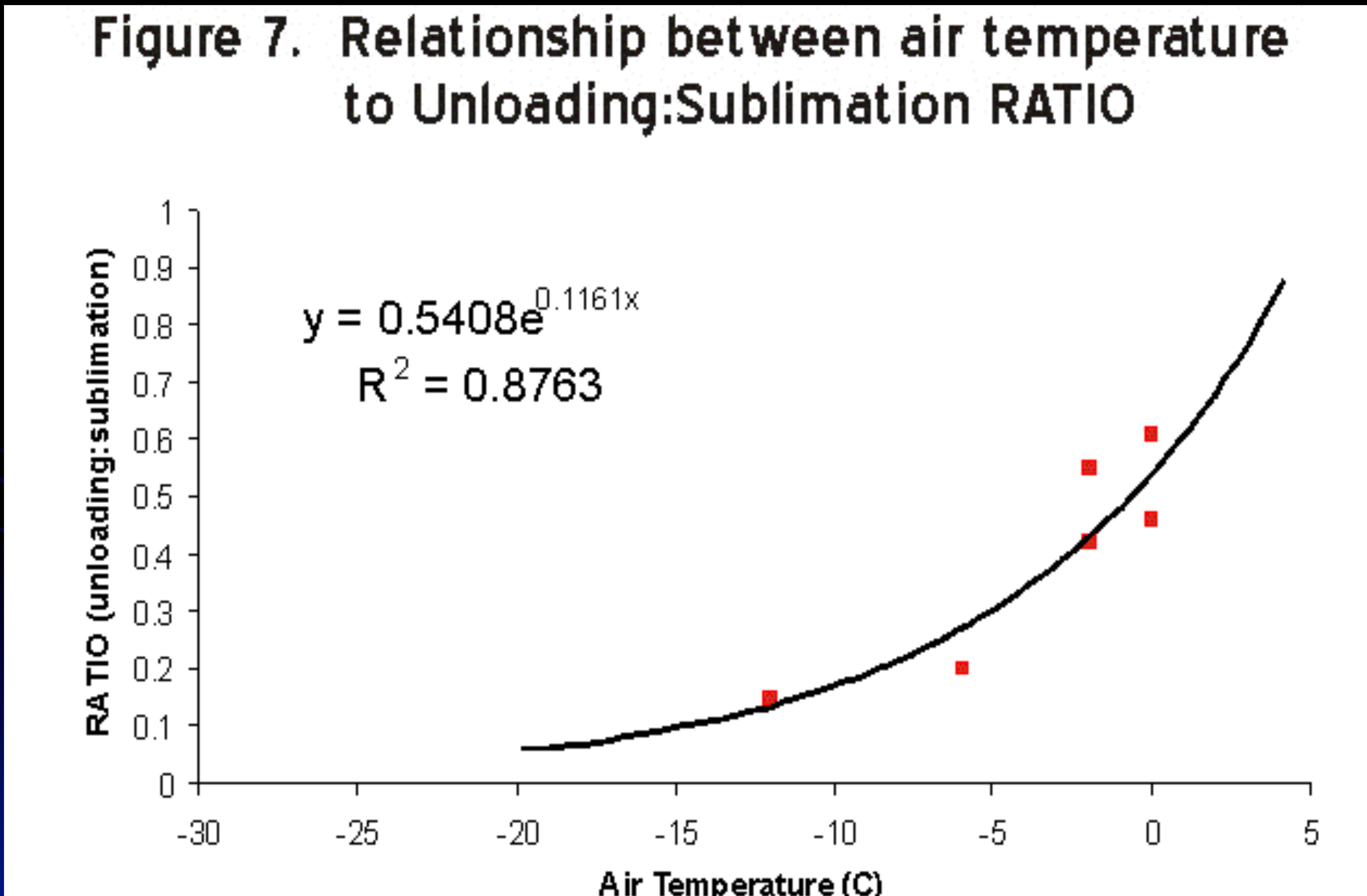


Forest Snow Interception, Sublimation, Unloading

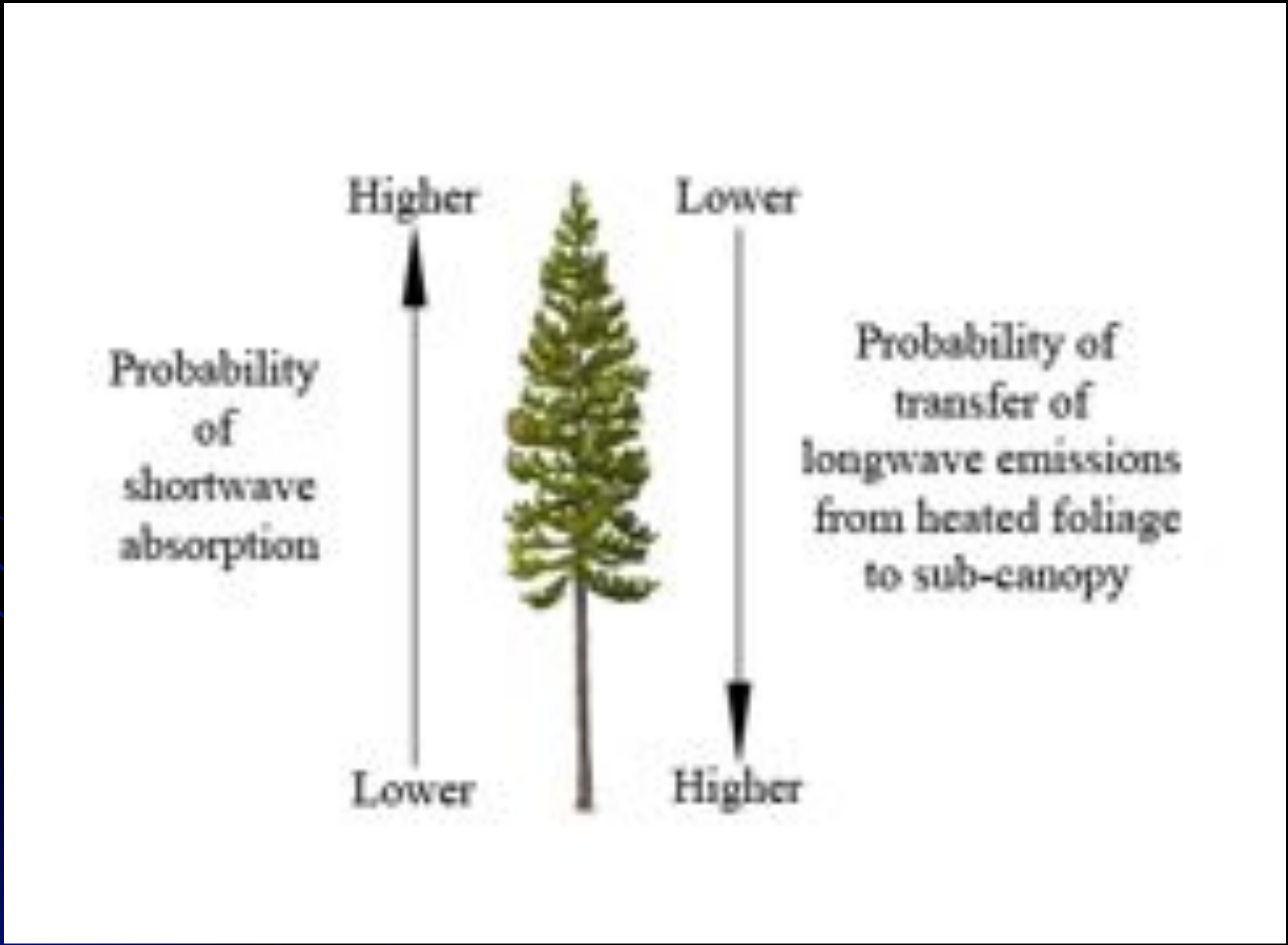
Figure 1. Marmot Creek Research Basin: Forest snow accumulation



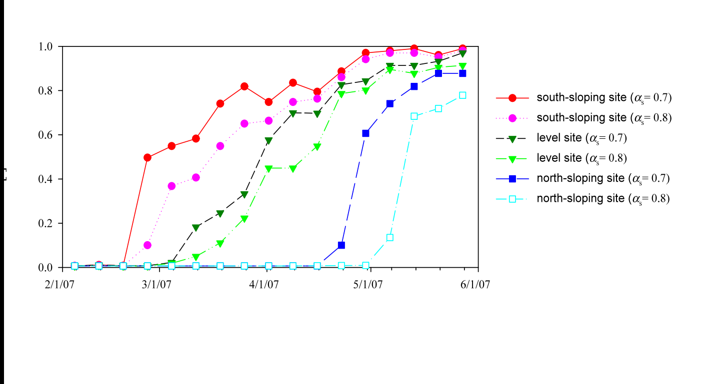
Ratio of Unloading to Sublimation Shows Promise for Modelling



Forest Snowmelt Modelling



Canopy Skyview Factor for Maximum Melt Energy a Function of Slope, Aspect, Albedo and Solar Elevation



Modelling

- CRHM: blowing snow, alpine and forest melt on slopes
- MESH: blowing snow, melt testing

- Coming: snow unloading, better turbulent transfer parameterisation, parameterisation transfer from CRHM to MESH

Thanks