Snow Processes for Cold Regions Prediction: Description and Scaling

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Snow Accumulation

- Blowing Snow Redistribution – parameterise inter-basin, inter-tile, intra-tile redistribution

- Intercepted Snow Redistribution – improve description of unloading, wind redistribution

- Snow Sublimation – parameterise and evaluate model representation from blowing, intercepted, & surface snow.

Snowmelt

- Improved Methods to Estimate Short and Longwave Exchange

- Terrain Effects on Turbulent Transfer

- Forest Canopies – radiation effects

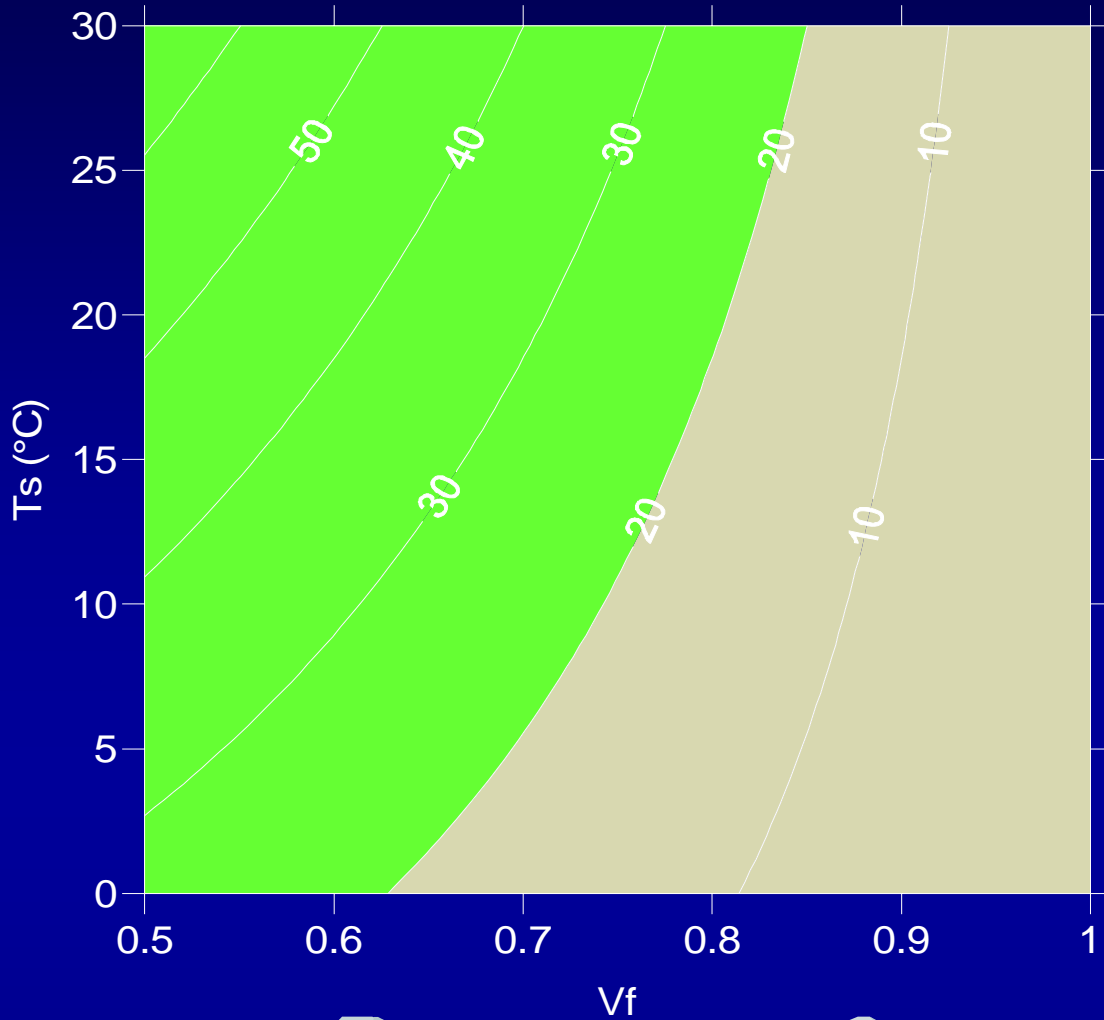- Combined Forest Canopy and Slope Effect on Energy Balance

Snow - Atmosphere Exchange

- Longwave exchange at surface
- Shortwave penetration
- Windpumping through porous structure
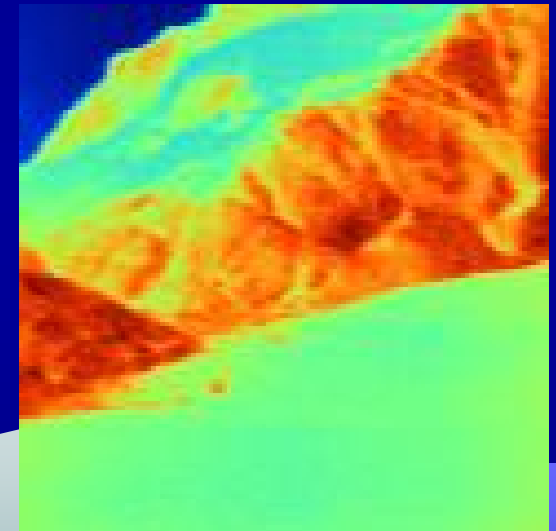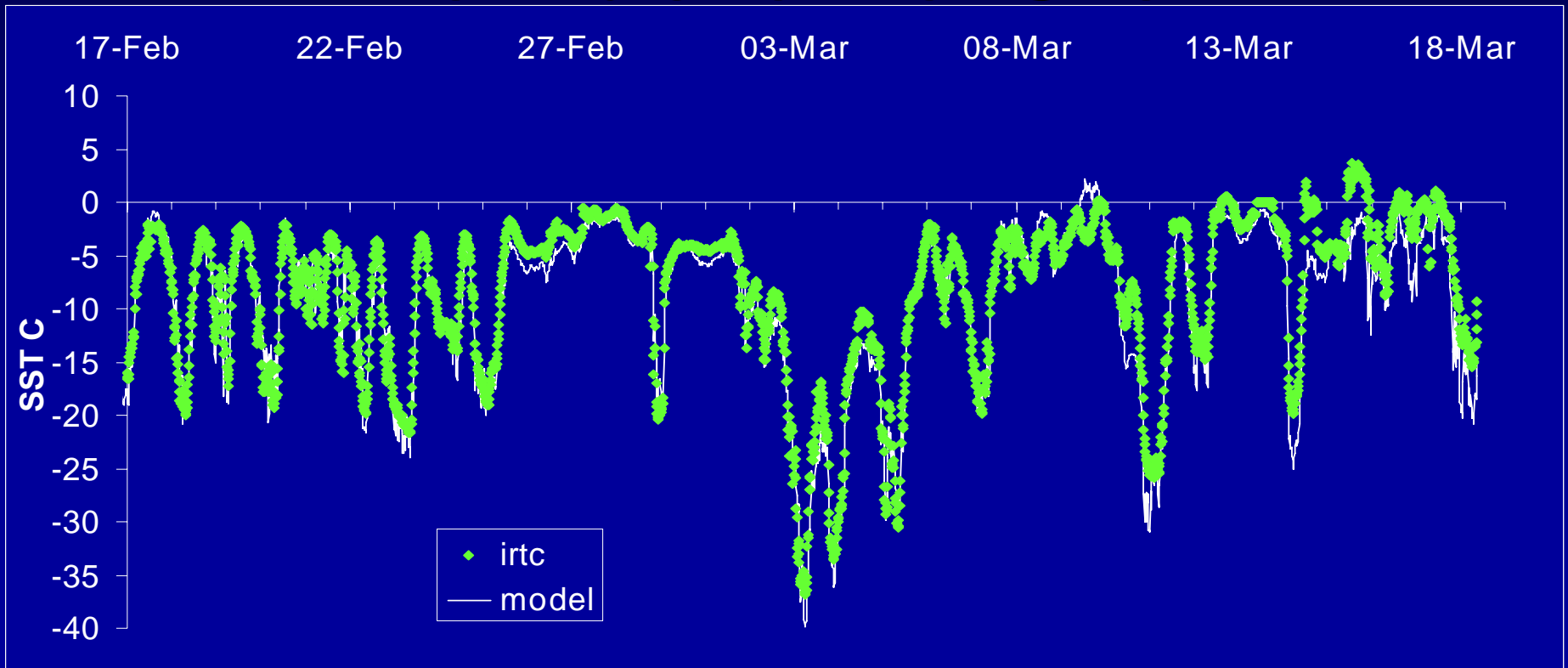
- Polythermal
- Multiphase
- Macropores

$K\downarrow$ $K\uparrow$ $L\downarrow$ $L\uparrow$ Q_H Q_E Precipitation

Q_A

T_s

T_i

SNOWPACK   dU/dt

Q_G

Melt
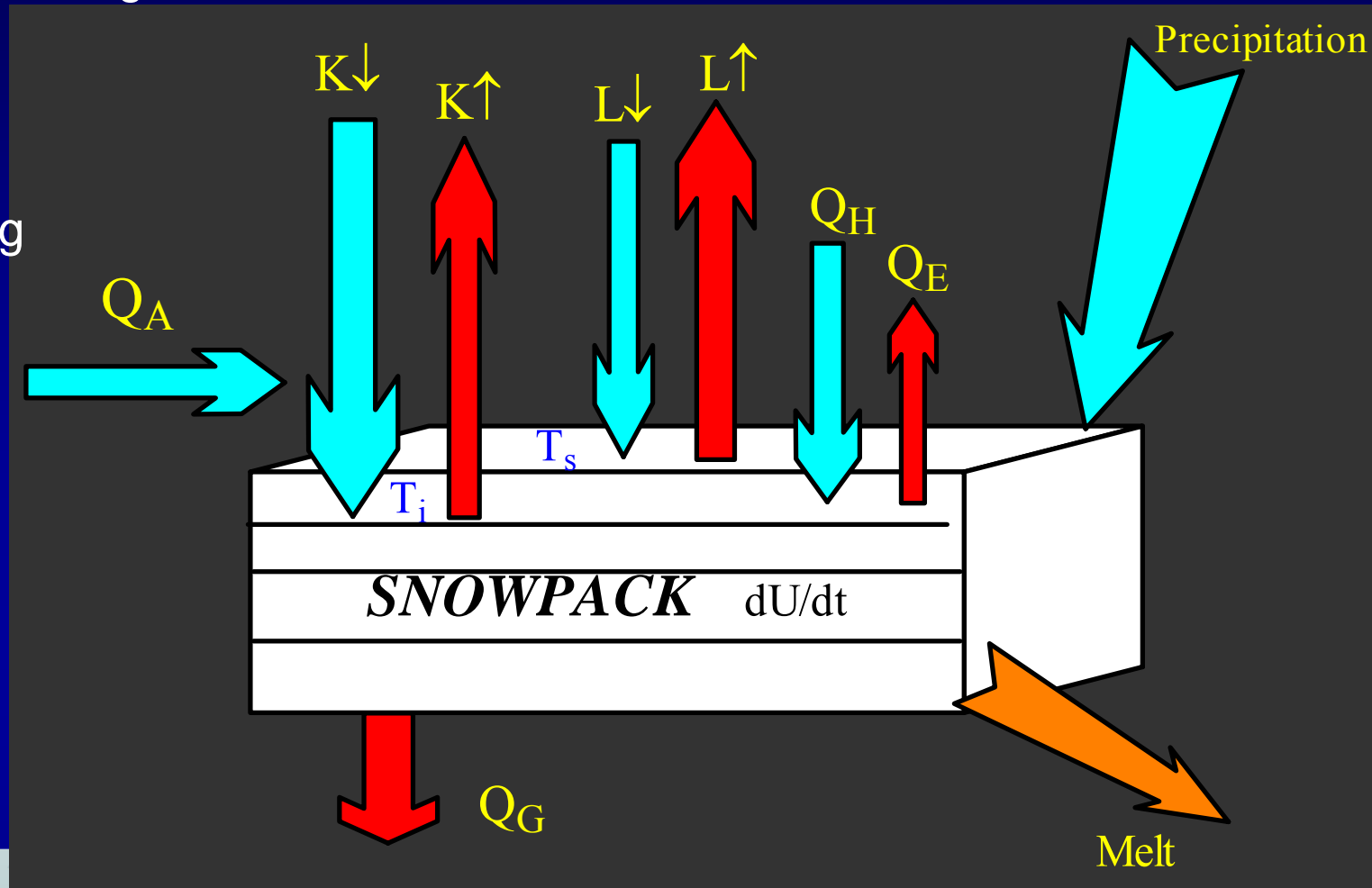
Incoming Longwave in Mountains

Percent increase in longwave irradiance due to terrain emission due to sky view factor (V_f) and surface temperature (T_s).

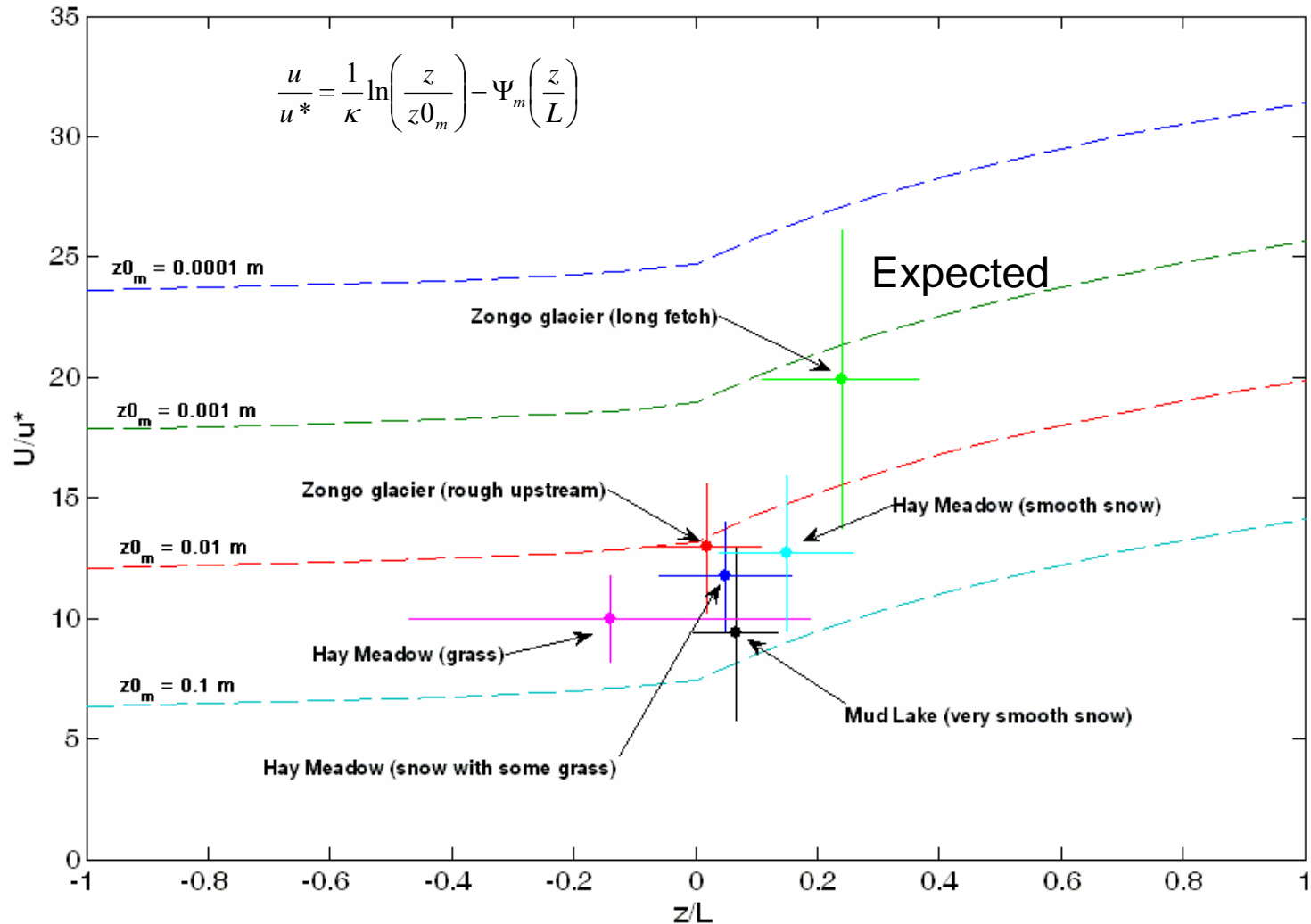Air temperature is 0°C and the clear sky emissivity is 0.65

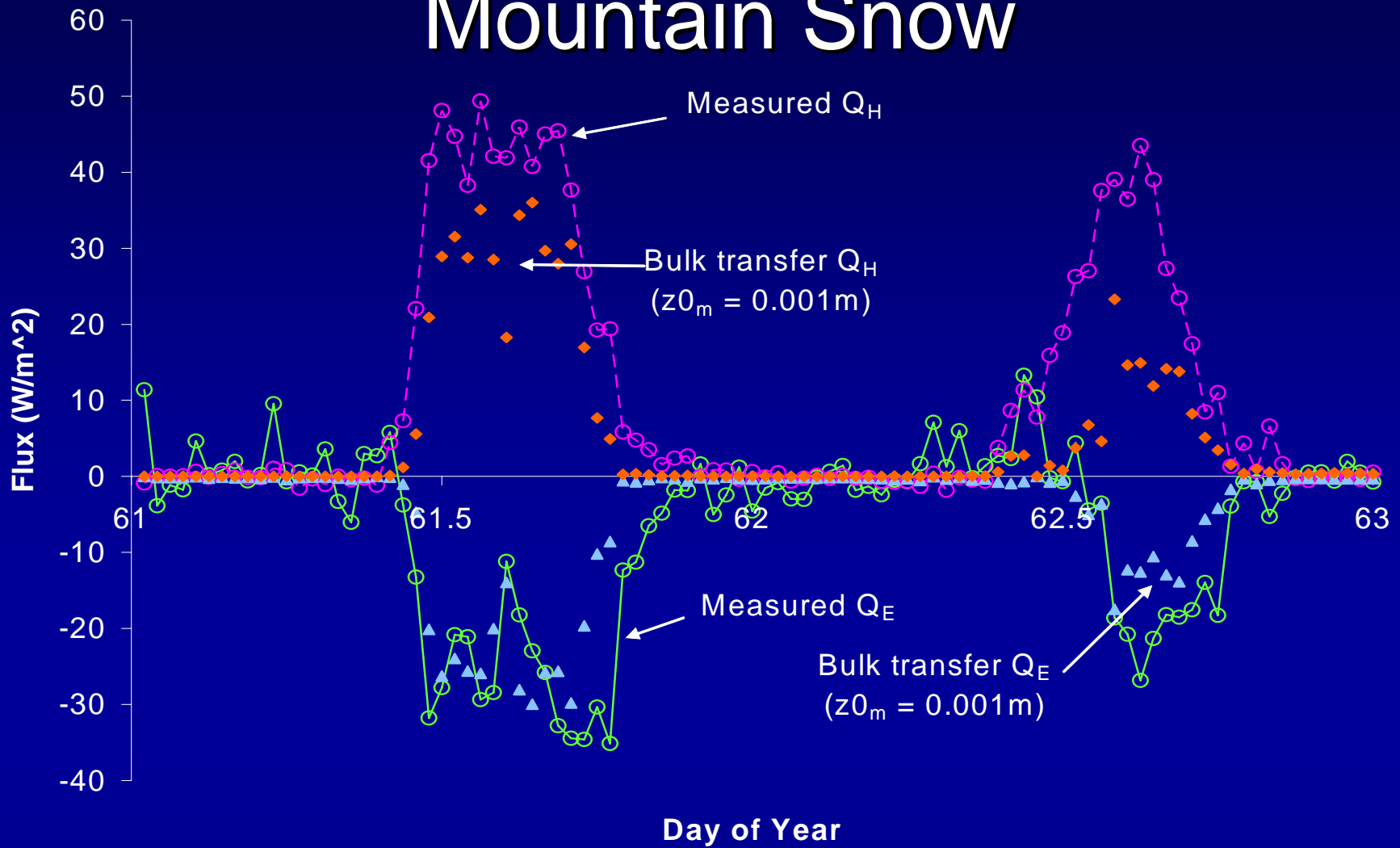# Psychrometric Outgoing Longwave Formulation for Snow

$$T_s = T_a + \frac{\varepsilon\left(LW\downarrow - \sigma T_a^4\right) + L\left[Q_a - Q_{\text{sat}}(T_a, P_s)\right]\rho/r_a}{\varepsilon\sigma T_a^3 + (c_p + L\Delta)\rho/r_a}$$
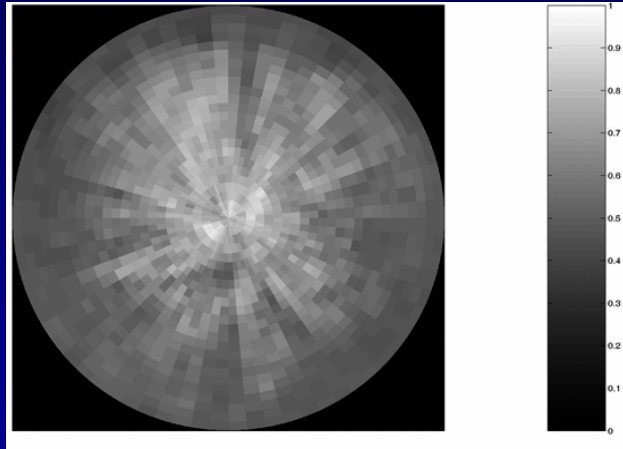
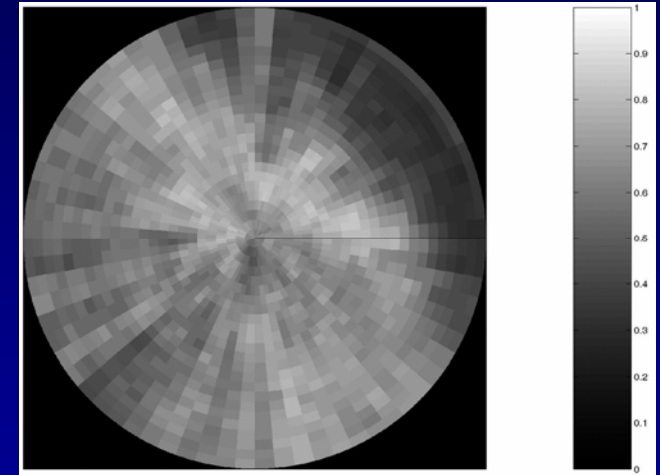# Roughness & Stability over Mountain Snow

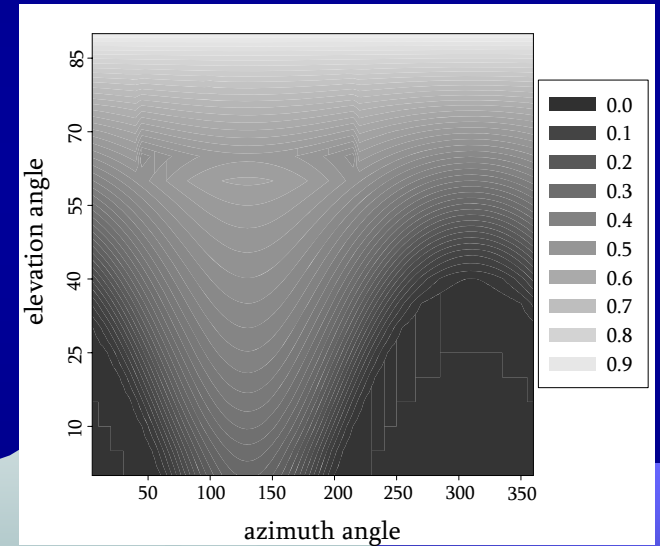# Problems with Bulk Transfer over Mountain Snow
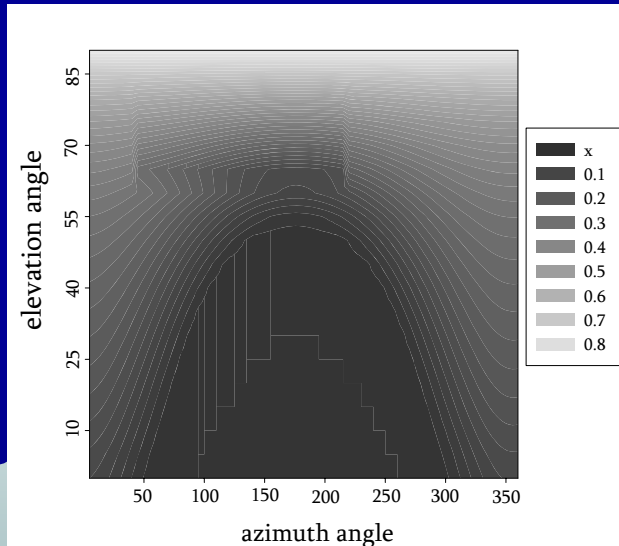
Slope Forest Transmissivity
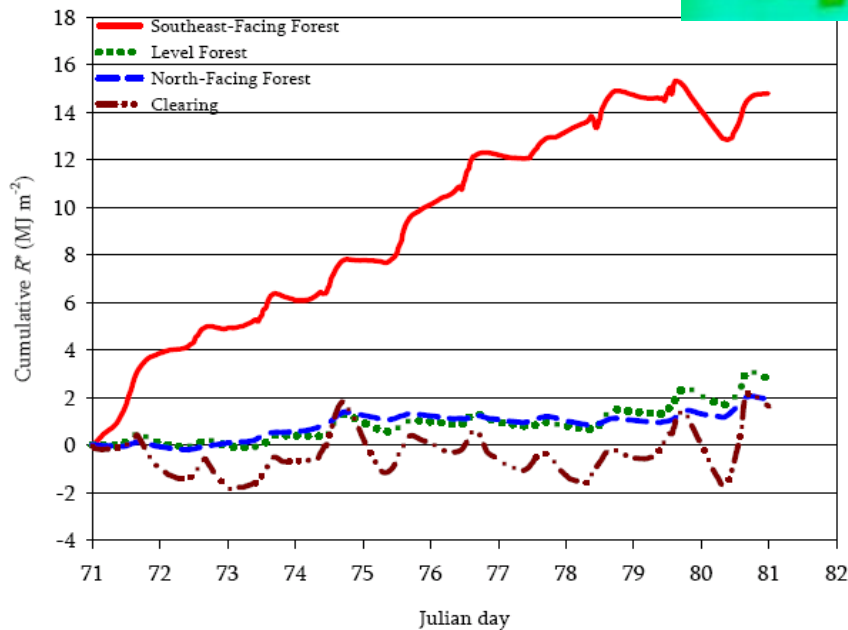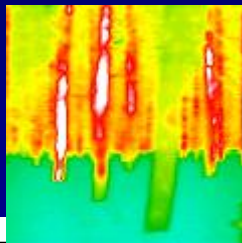

North Face Forest

South Face Forest

τ a function of
LAI,
Foliage inclination
Crown coverage
Slope,
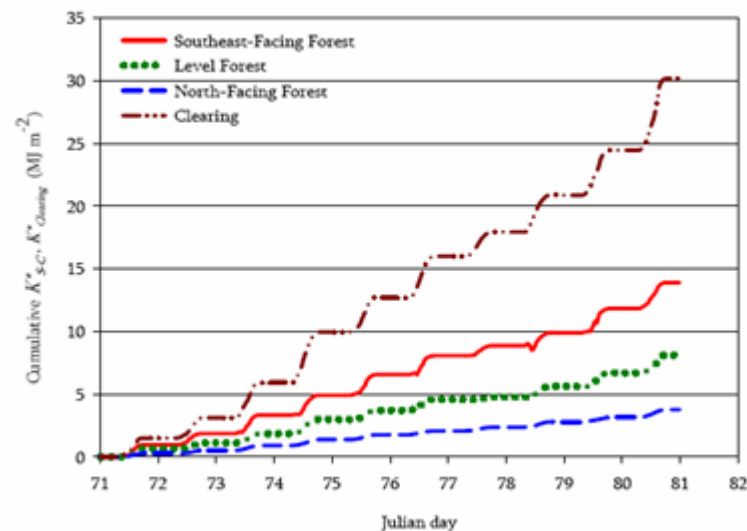Aspect,
Solar azimuth,
Solar elevation

Radiation to Snowmelt on 25° Forest Slopes, Marmot Creek Research Basin, Alberta
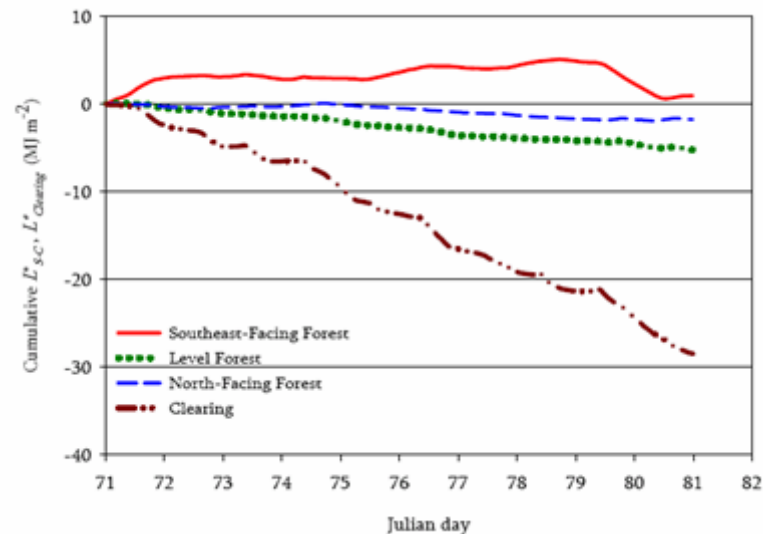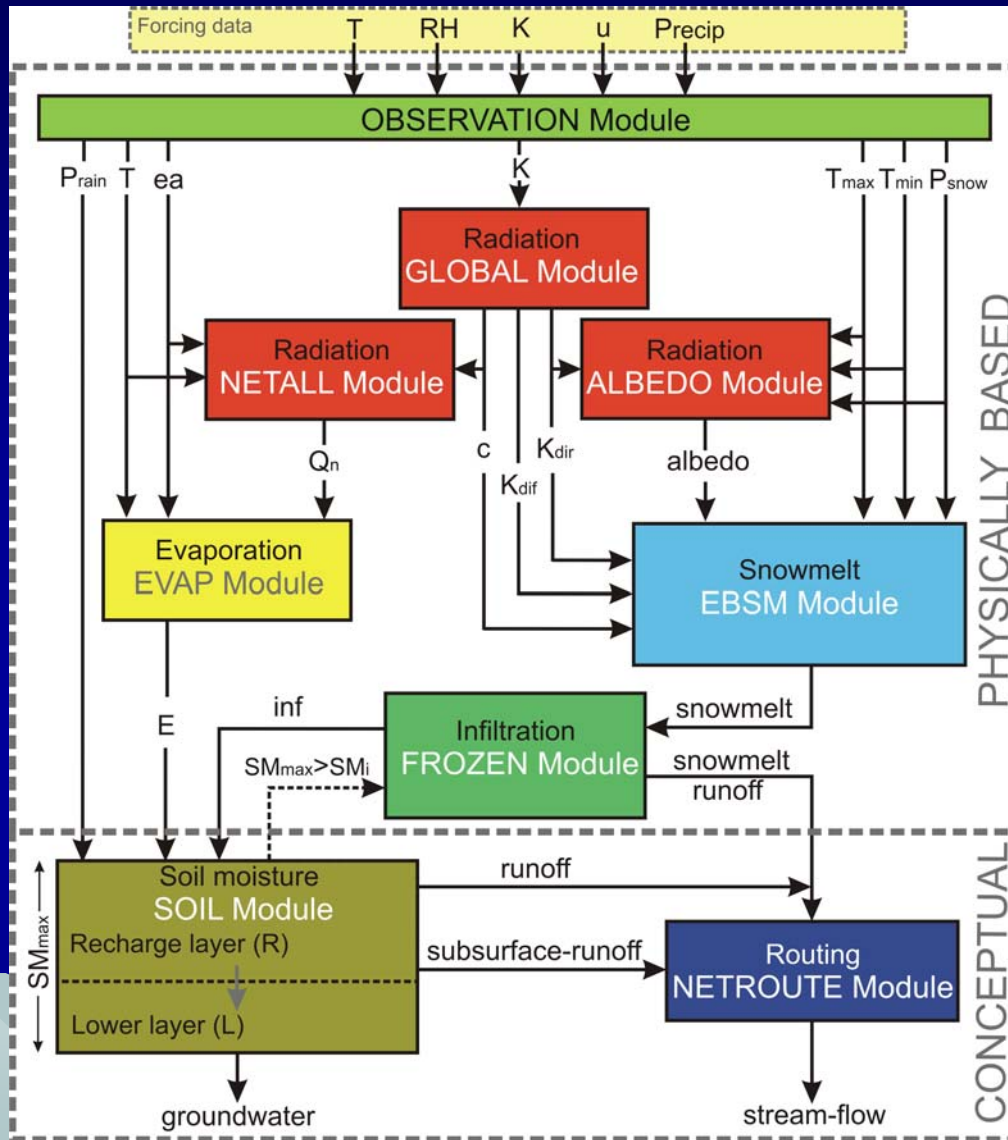
Net Allwave Radiation

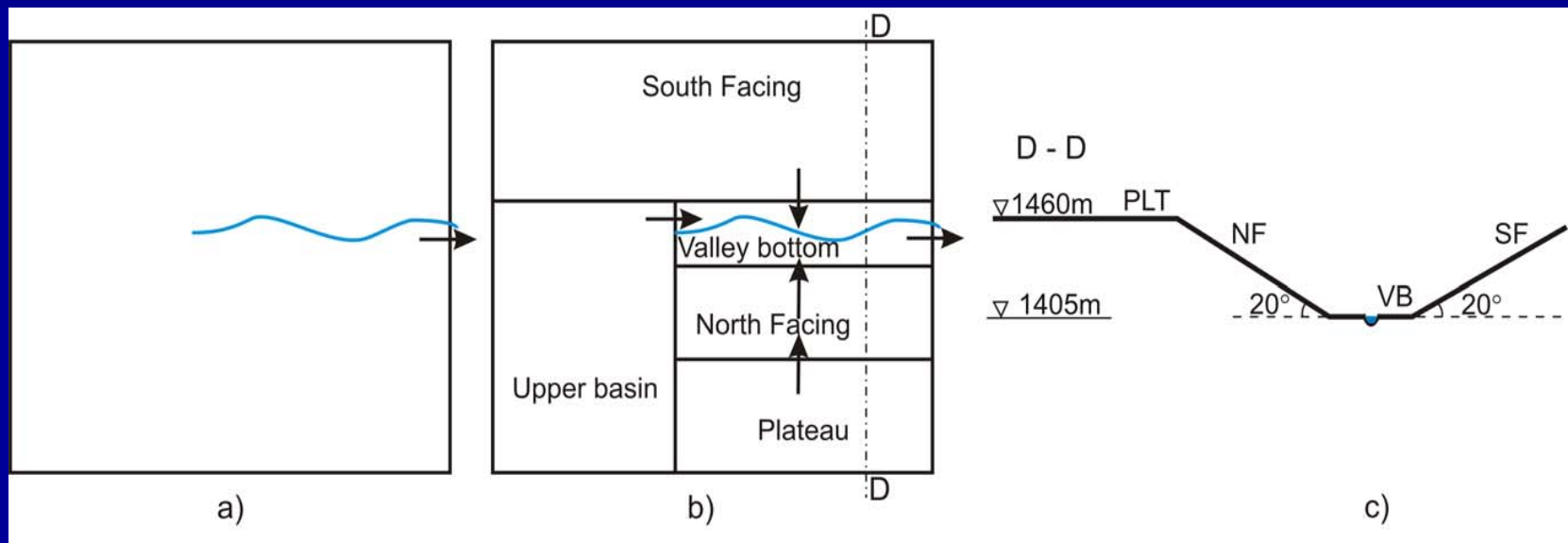Net Shortwave Radiation

Net Longwave Radiation

Cold Region Hydrological Model CRHM
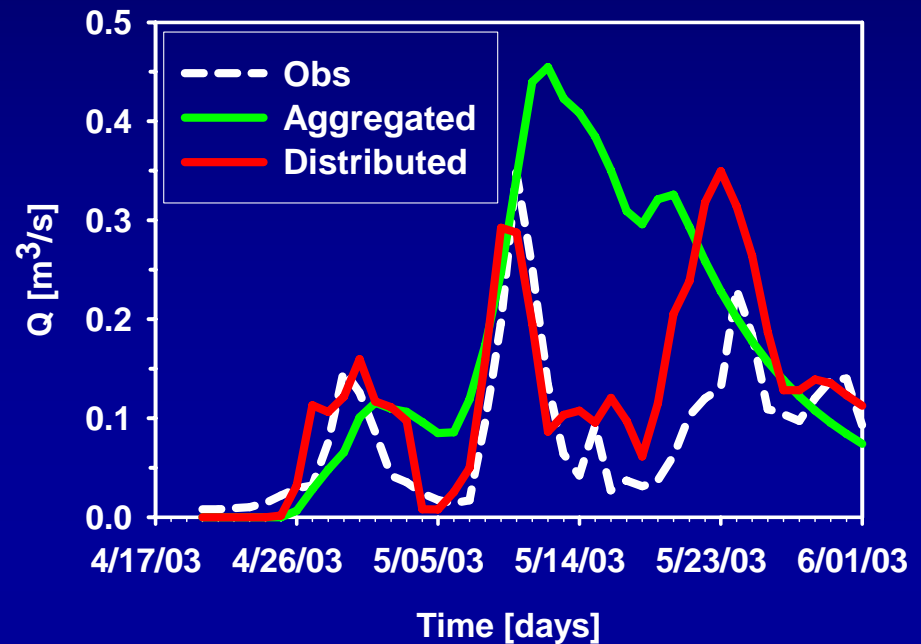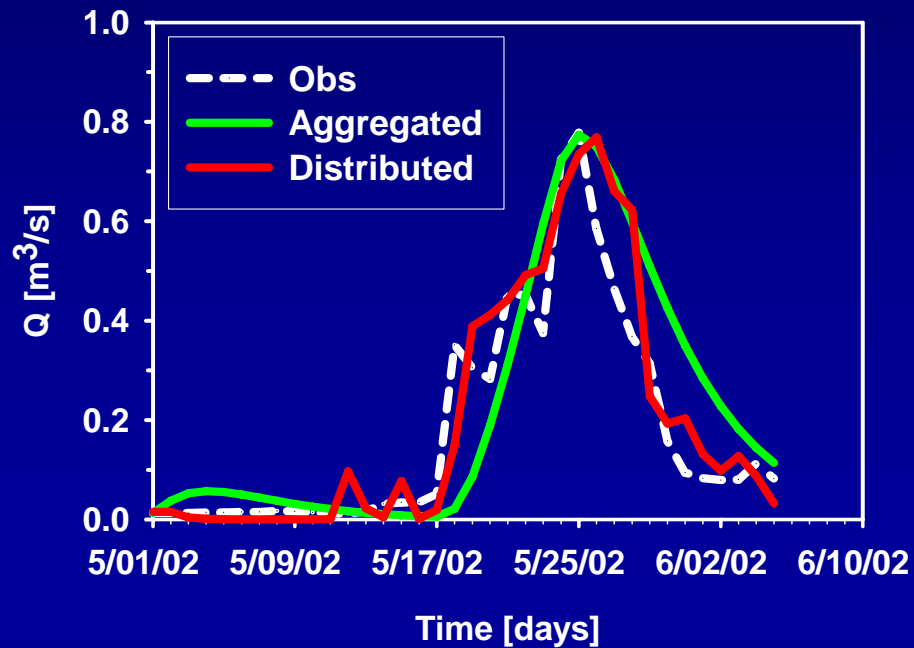
Modelling Approach

Aggregated vs. Distributed

Granger Creek Discharge

2002

2003

Next Steps

- Snow Unloading Study
- Blowing snow parameterisation for CLASS
- 3-D Blowing Snow – unsteady flow
- Multi-layer snow – atmosphere model
- Snow-atmosphere exchange parameterisation
- Complex Terrain Forest Melt Model
- Sub-grid distributions of accumulation, energy, melt for complex terrain
- CRHM basin modelling and interface to MESH