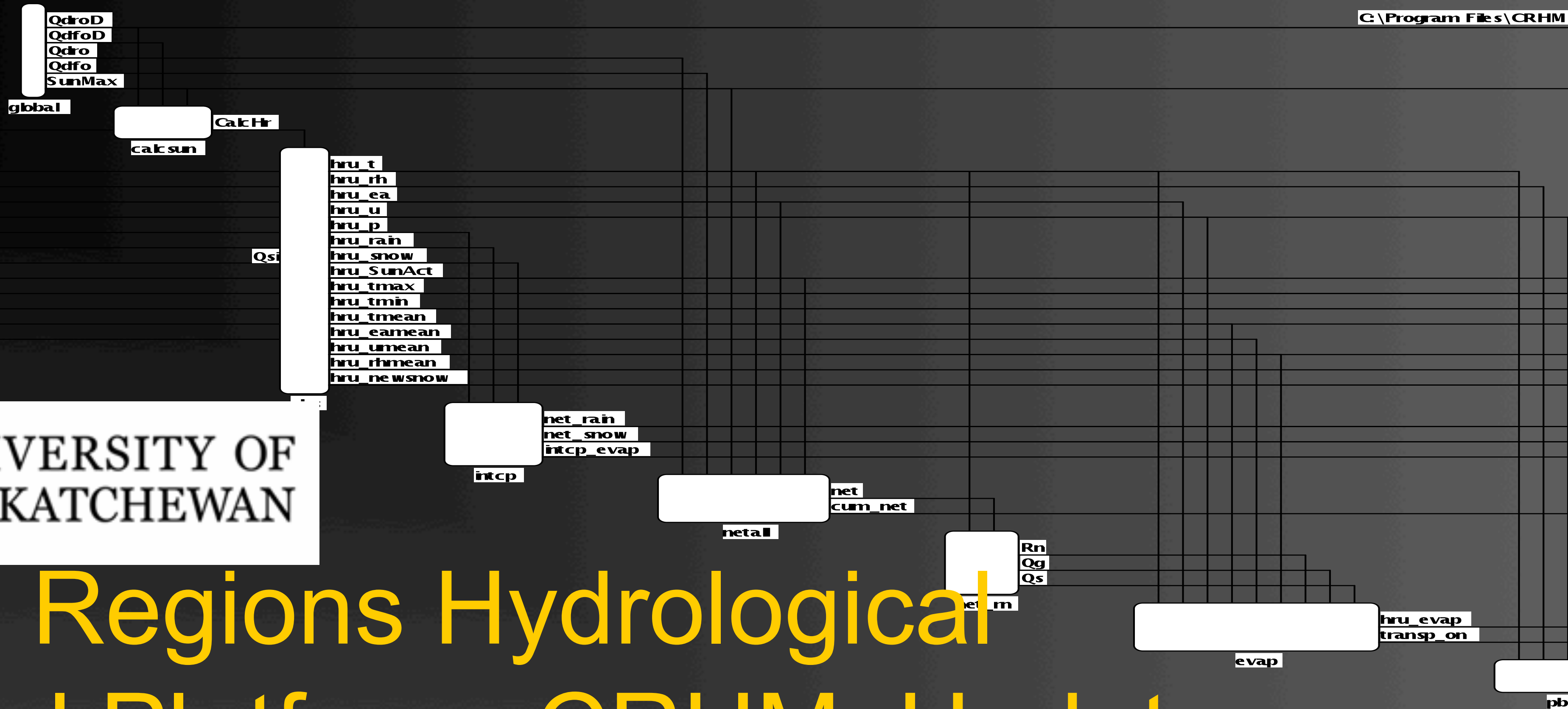

Cold Regions Hydrological Model Platform, CRHM: Update 2009

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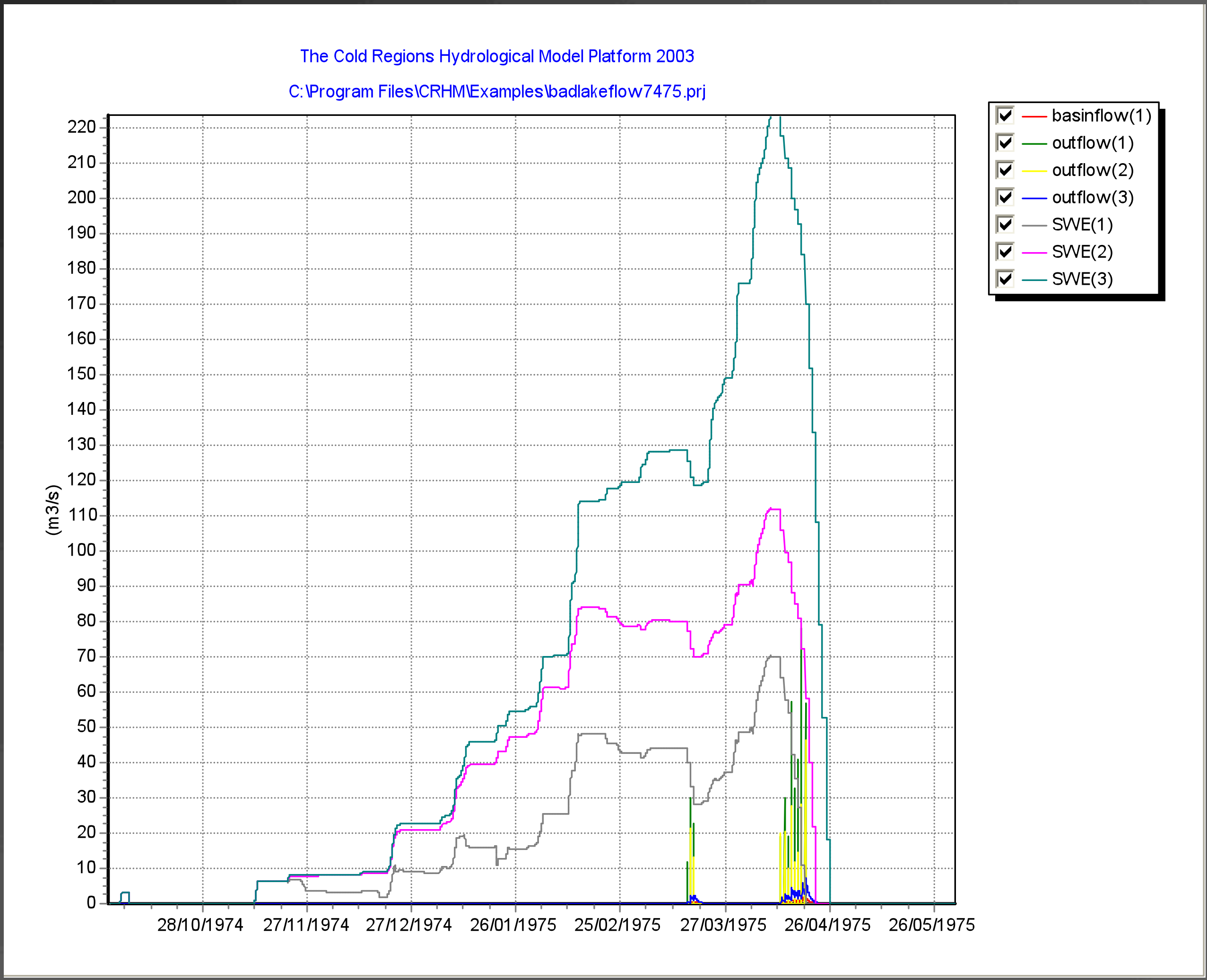
CRHM Objectives

To develop a *hydrological cycle simulation system* that:

- **is spatially distributed such that the water balance for selected surface areas can be computed;**
- **uses natural landscape/drainage units that have hydrological importance;**
- **is physically based so that the results contribute to a better understanding of basin hydrology and are robust and so that process parameters can be transferred regionally;**
- **is sensitive to the impacts of land use and climate change;**
- **Reflects landscape sequencing (e.g. catena) in natural drainage basins;**
- **does not require the presence of a stream in each land unit;**
- **is flexible: can be compiled in various forms for specific needs;**
- **is suitable for testing individual process algorithms.**
- **is easy to use for all hydrologists and useful for teaching**
- IS NOT DEPENDENT UPON CALIBRATION!

Cold Regions Hydrological Model Platform (CRHM)

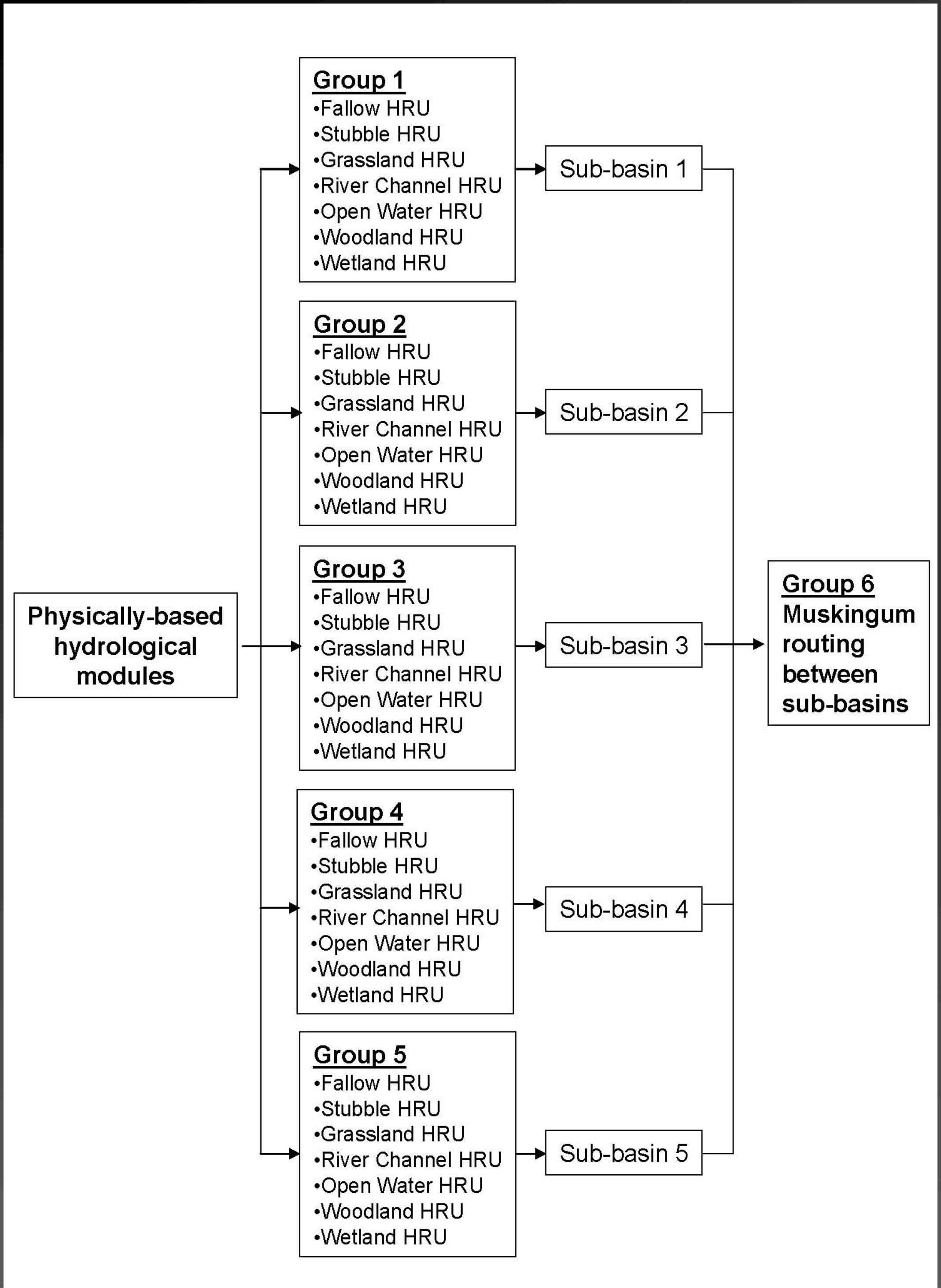
- Started in late 1990s as NWRI land use hydrology model.
- Attempted to write Canadian modules for USGS MMS
- 1999 Tom Brown developed CRHM platform in windows environment
- Development of modules from MAGS, PAMF, NERC, Quinton-CFCAS, IP3 and other research
- Multiple developers: Brown, Gray, Granger, Hedstrom, Pomeroy



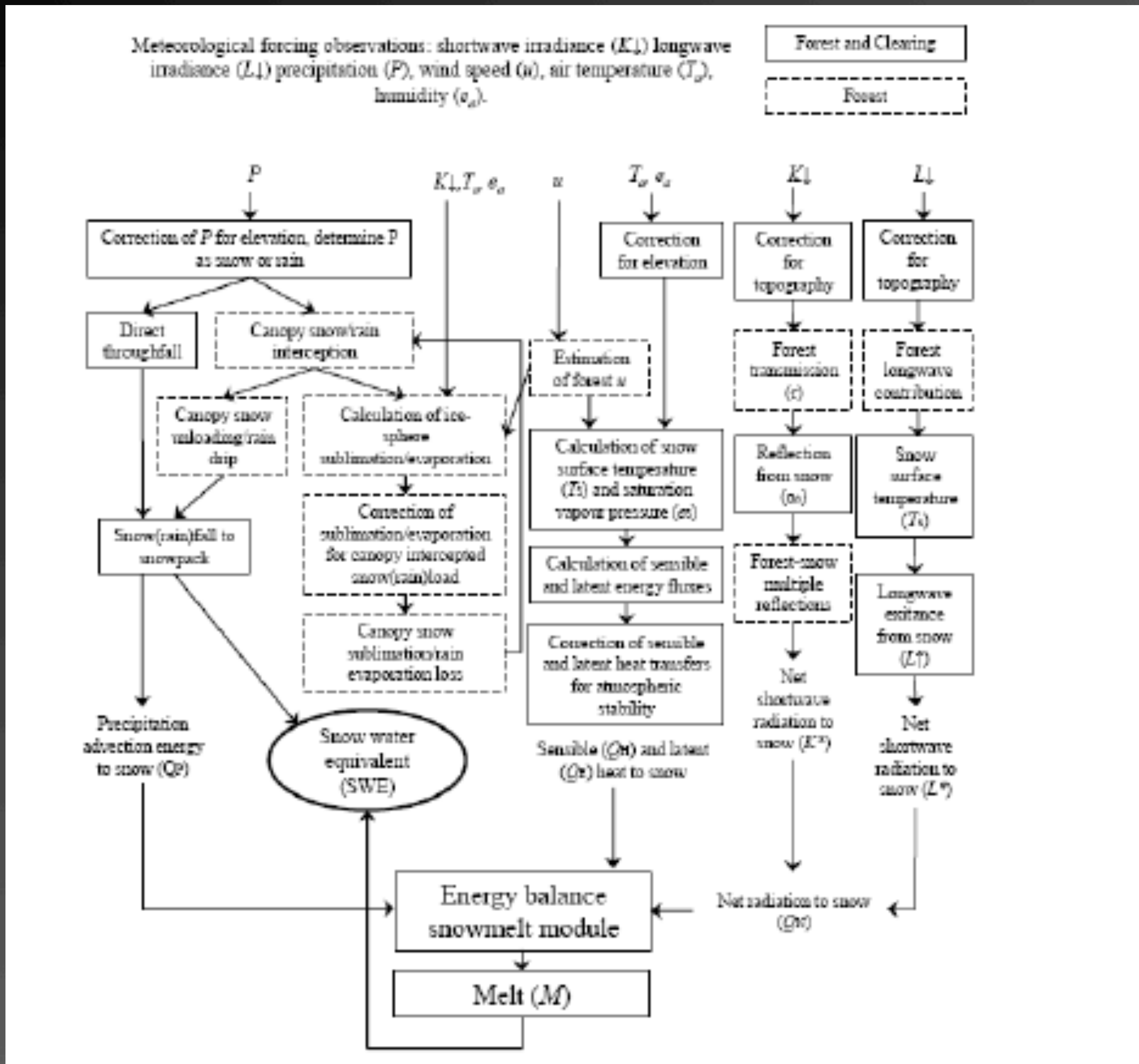
What is New?

- Using “groups” to handle sub-basins and model over large basins with Muskingum routing
- Forest modules (radiation transfer)
- Evapotranspiration – soils interaction
- Depressional storage
- Gridded operation in batch files, Excel

Using Groups to define many sub-basins

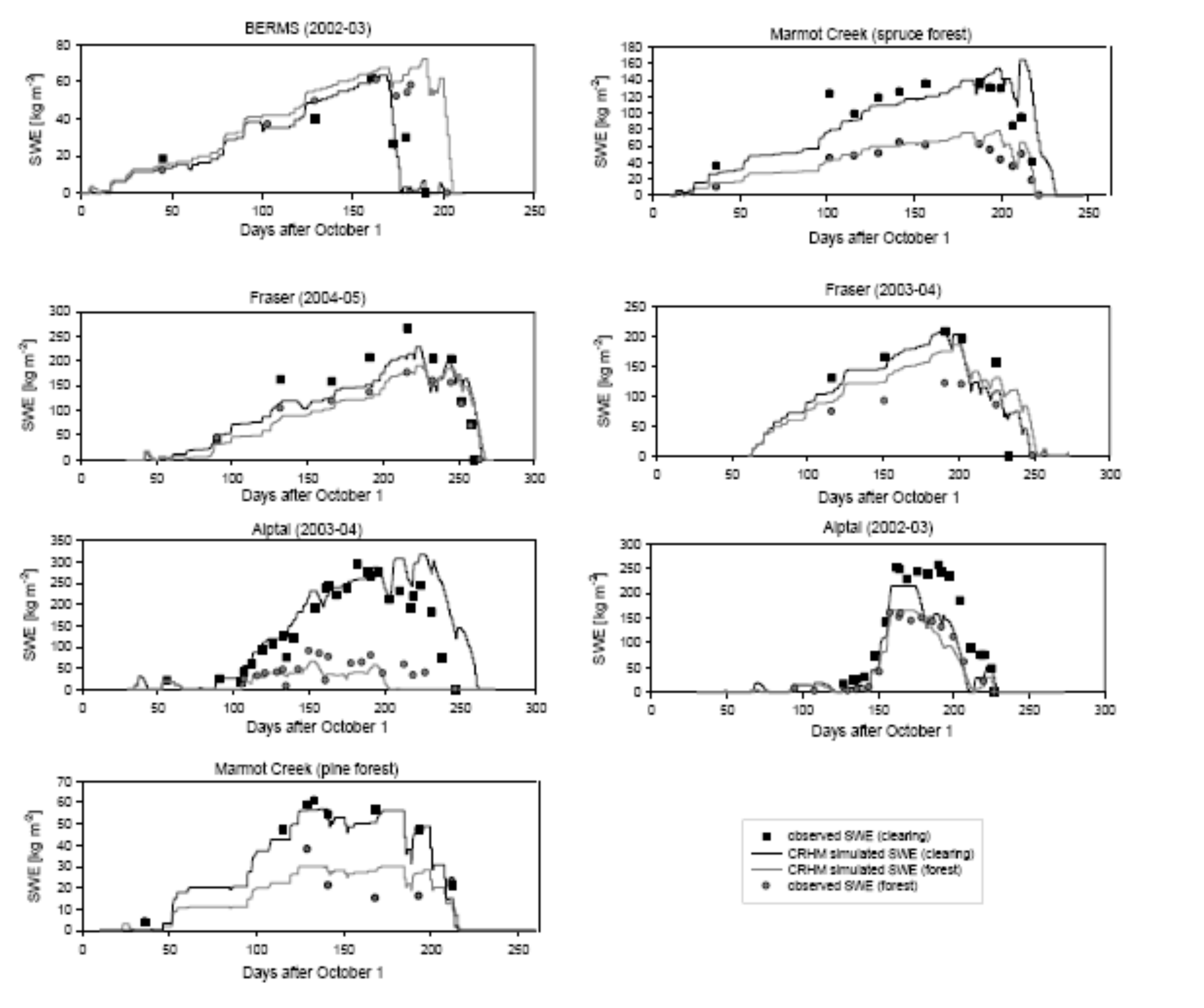


CRHM Forest

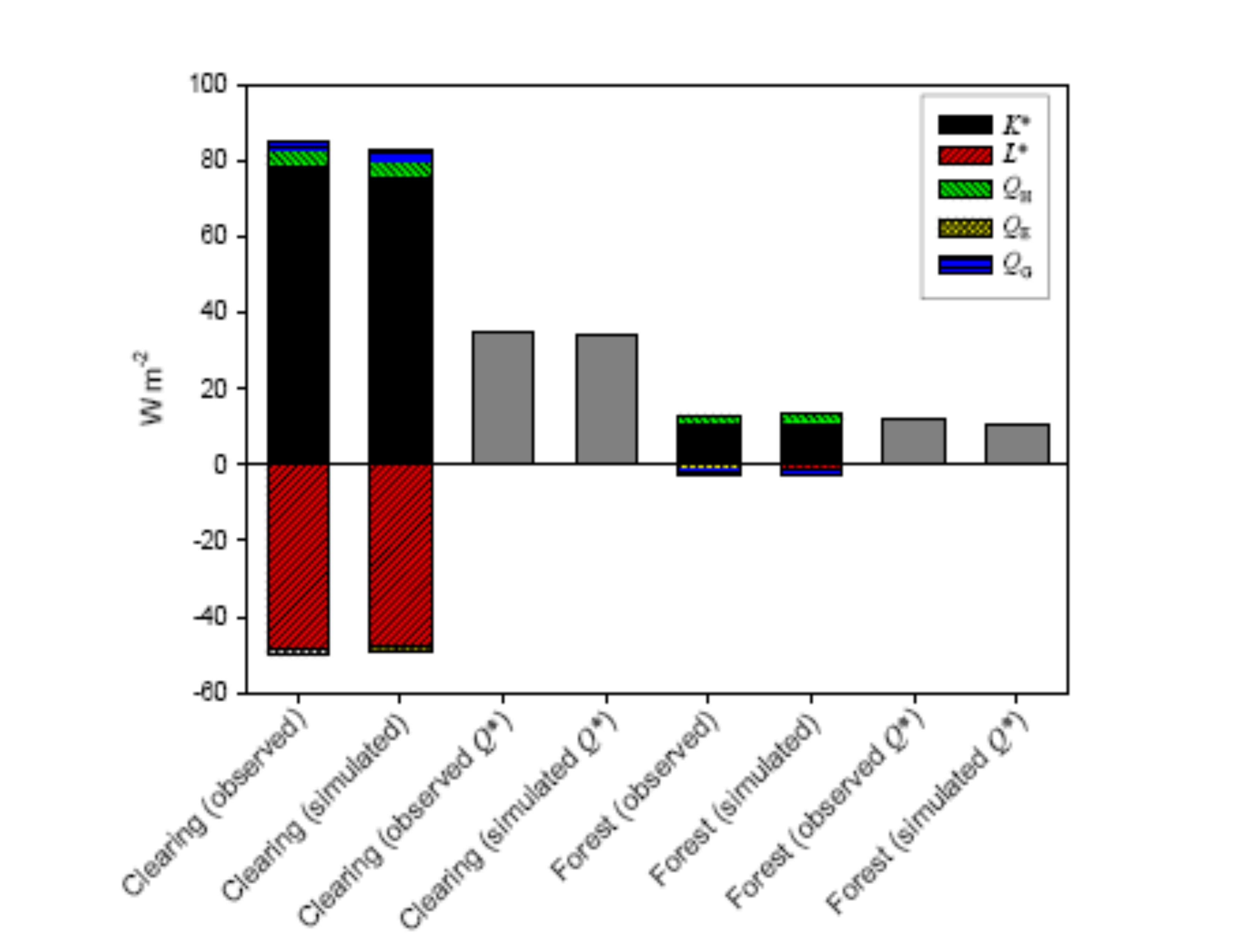


Meteorological forcing observations: shortwave irradiance (K↓) longwave irradiance (L↓) precipitation (P), wind speed (u), air temperature (Ta), humidity (ea).
Forest and Clearing
Forest
P
K↓, Ta, ea
u
Ta, ea
K↓
L↓
Correction of P for elevation, determine P as snow or rain
Correction for elevation
Correction for topography
Correction for topography
Direct throughfall
Canopy snow/rain interception
Estimation of forest u
Forest transmission (τ)
Forest longwave contribution
Canopy snow unloading/rain drip
Calculation of ice-sphere sublimation/evaporation
Calculation of snow surface temperature (Ts) and saturation vapour pressure (es)
Reflection from snow (αs)
Snow surface temperature (Ts)
Snow(rain)fall to snowpack
Correction of sublimation/evaporation for canopy intercepted snow(rain)load
Calculation of sensible and latent energy fluxes
Forest-snow multiple reflections
Longwave exitance from snow (L↑)
Canopy snow sublimation/rain evaporation loss
Correction of sensible and latent heat transfers for atmospheric stability
Net shortwave radiation to snow (K*)
Net shortwave radiation to snow (L*)
Precipitation advection energy to snow (QP)
Snow water equivalent (SWE)
Sensible (QH) and latent (QE) heat to snow
Energy balance snowmelt module
Net radiation to snow (QN)
Melt (M)

CRHM SWE Tests -



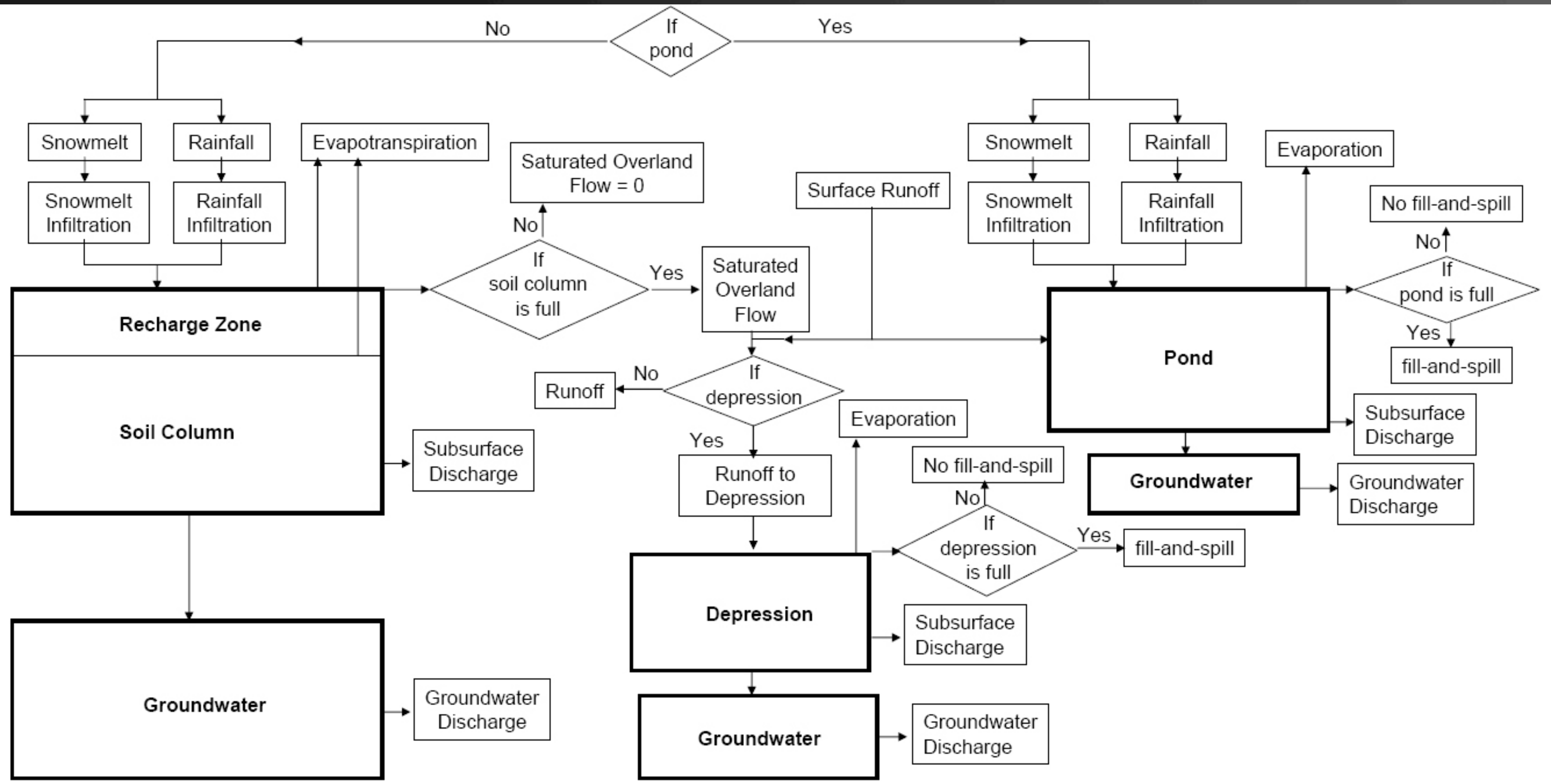
CRHM Energetics Tests



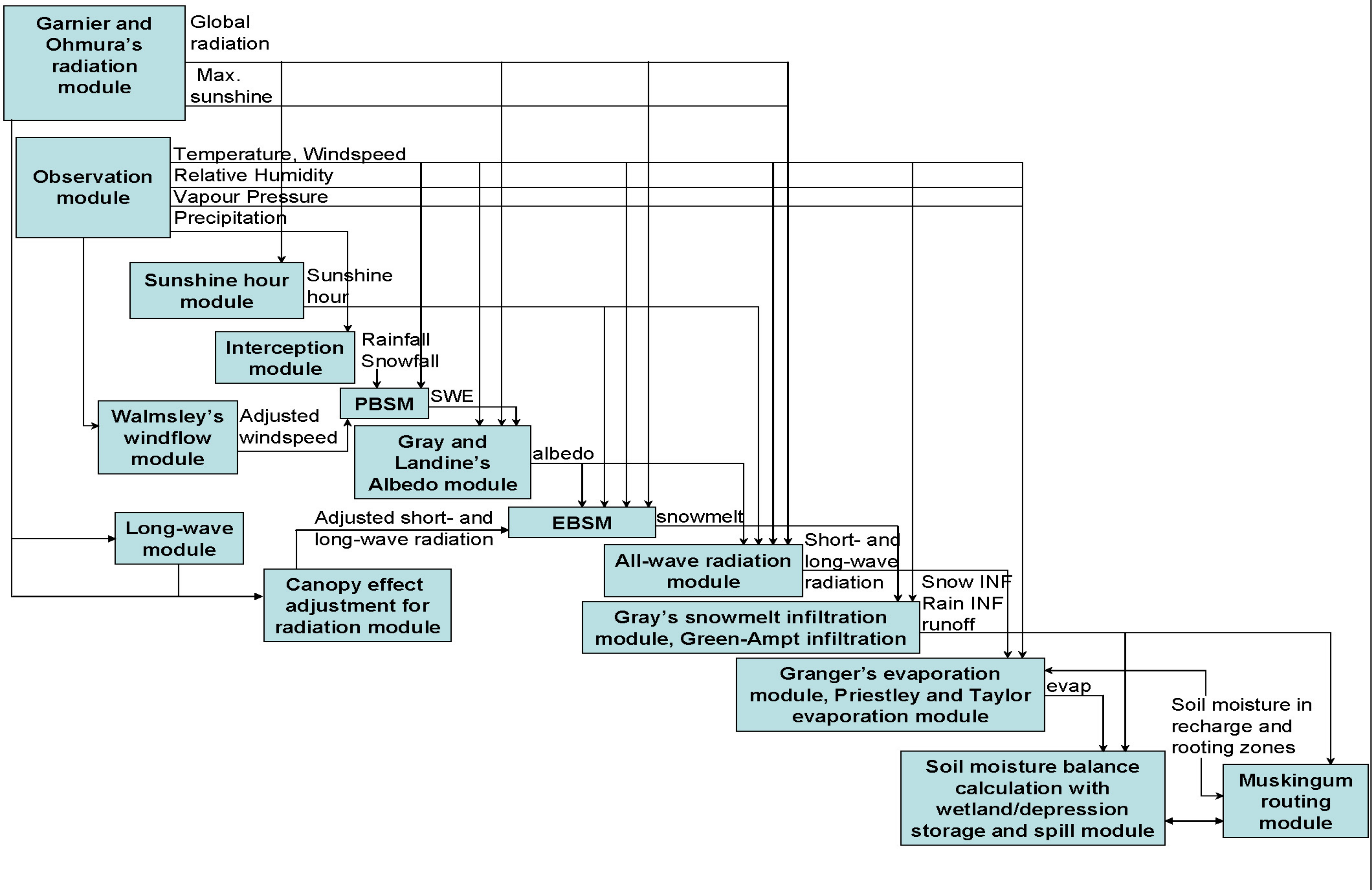
Soil

-
  - Depressional storage
    - sub-HRU
    - can form subsurface runoff or ground water recharge or fill and spill.
    - transfer of flows between HRUs
  - Pond storage
    - all of HRU water covered.
    - parameterization of maximum pond storage.
    - possible to: (i) leak to subsurface flow or groundwater recharge (ii) fill and spill.
  - Interflow between HRU
    - subsurface flow can enter downhill HRU as surface or subsurface flow.

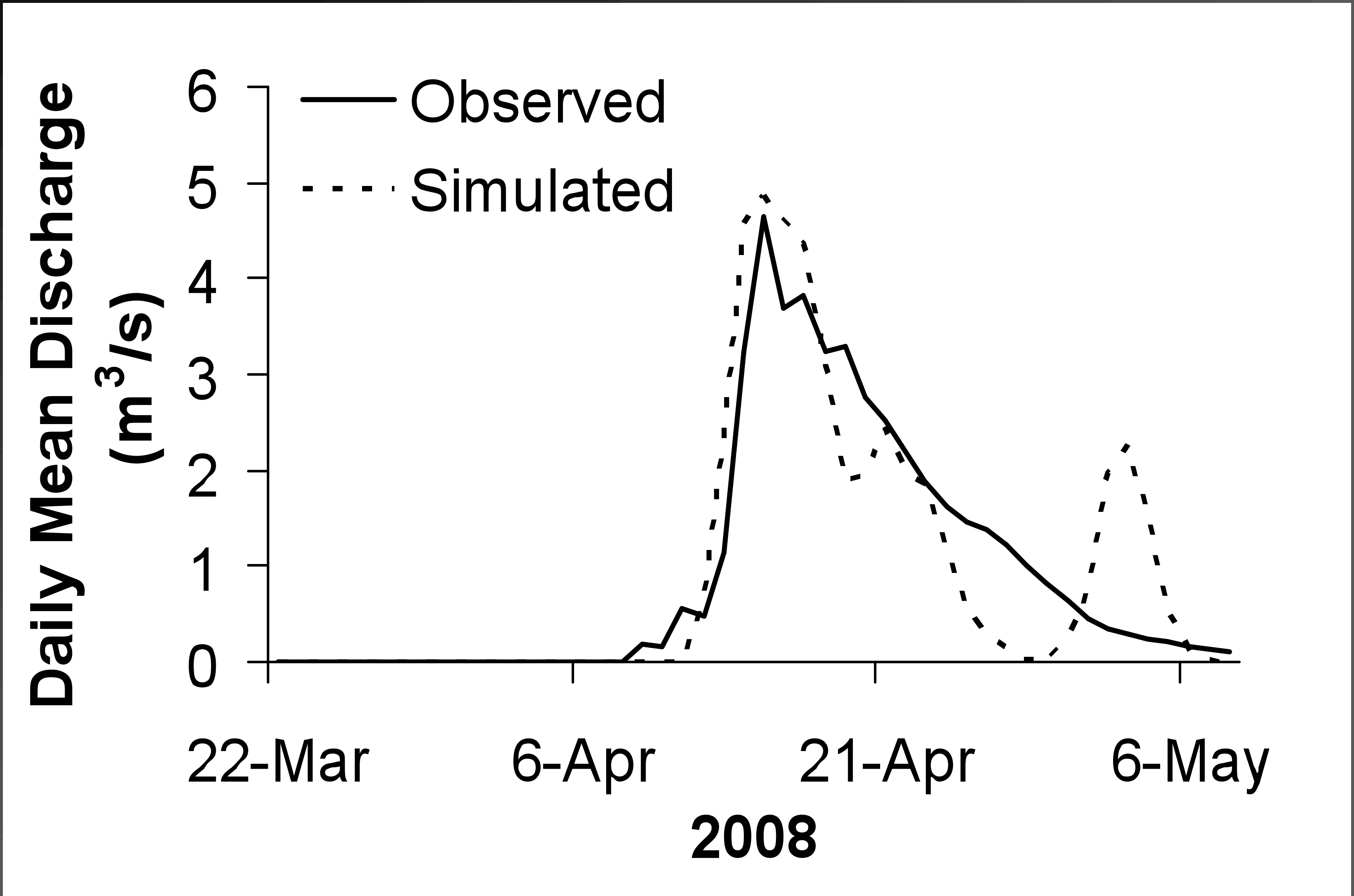
“Soil”: permits dryland or pond water balance and accounts for sub-HRU depressional storage



Smith Creek, Saskatchewan



Smith Creek: good data year



Now to model operation……..