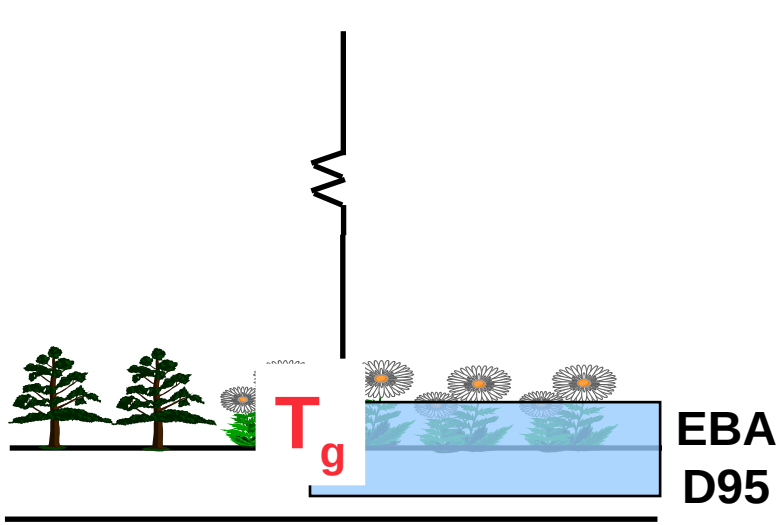
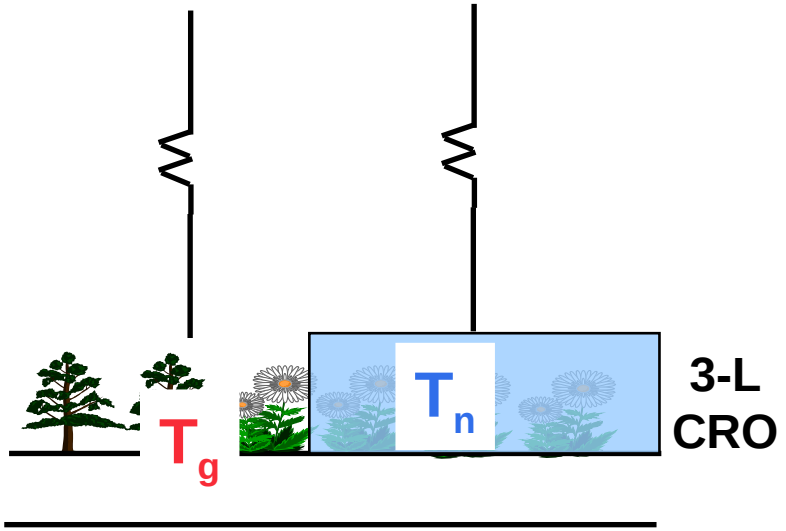
Implementation of multi-energy balance (MEB) into SURFEX

Patrick Samuelsson Stefan Gollvik
SMHI

Aaron Boone Christophe Canac
Meteo France

Current SURFEX 6.1 ISBA





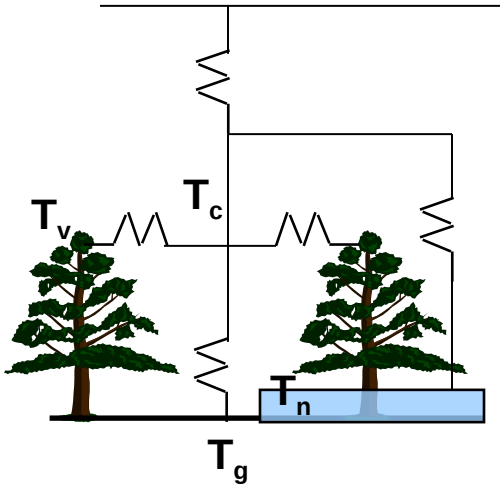
No explicit canopy vegetation energy balance (temperature)!


We want to model this!

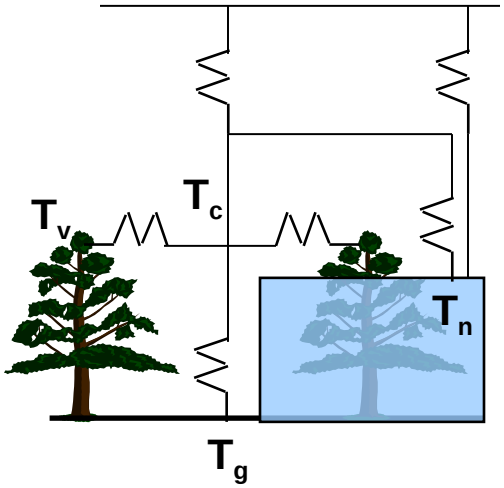
Multi-Energy Balance (MEB)

SMHI

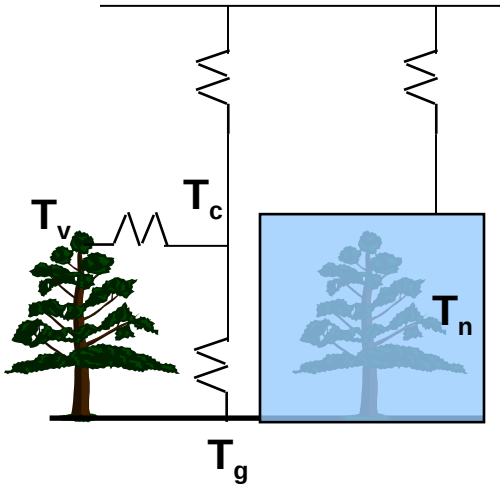
Snow well below the canopy



Snow partly buries the canopy



Snow buries the canopy



MEB is designed to work with

- snow schemes 3-L and CRO (requires separate snow energy balance)
- soil schemes 2-L & 3-L (force restore) and DIF (diffusion)

A SURFEX grid box

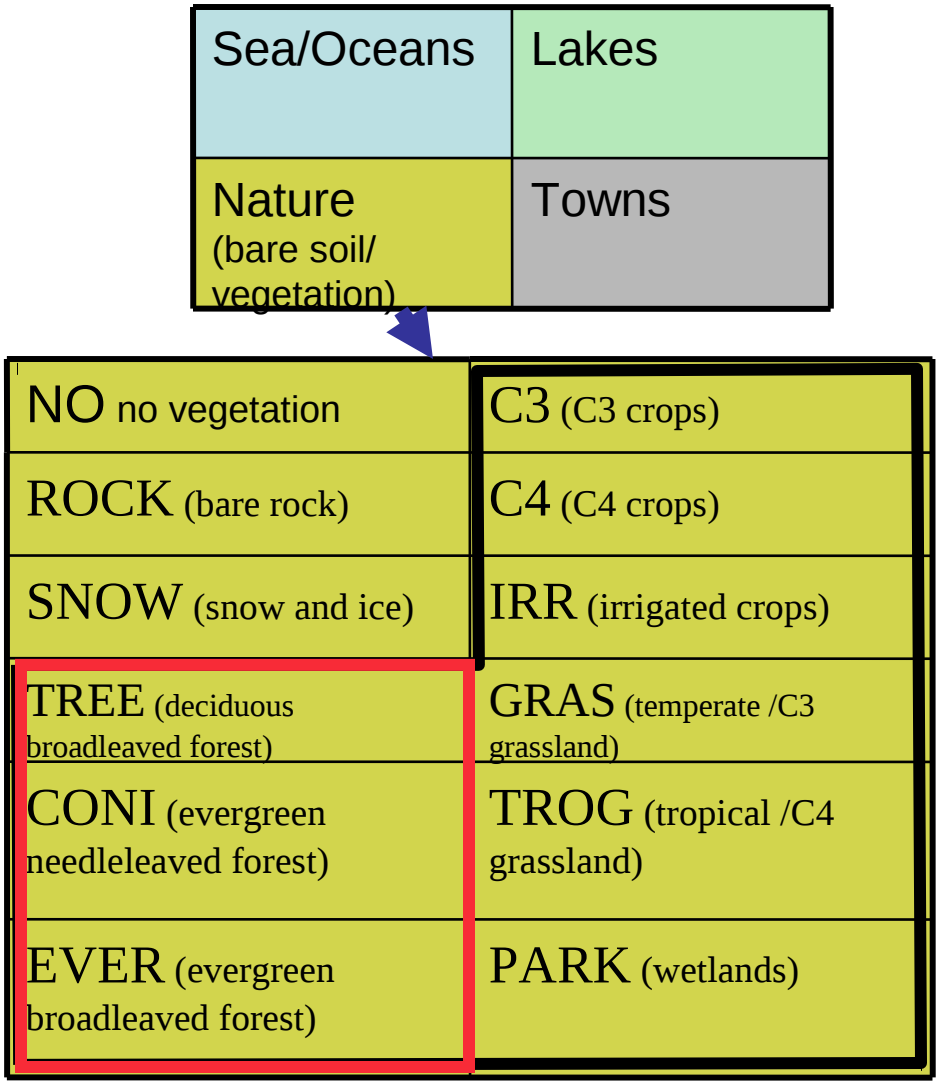
SMHI

Snow occurs separately in each tile and each patch.

Thus, for the nature tile we can have up to 12 separate prognostic snow storages.

MEB is designed to work for all vegetated patches.

A logical vector in namelist is used to decide for which patches MEB should be used.



Motivations for MEB

SMHI

- **Canopy has low heat capacity (as top soil layer) but can only exchange heat via radiation and turbulent fluxes.**
  Gives a relatively large and realistic diurnal cycle in canopy temperature.

- **Gives a more physical consistent energy exchange between soil/snow and atmosphere.**
  Replaces mulch-effect in present ISBA which parameterise presence of vegetation by decreasing heat transfer in upper soil.

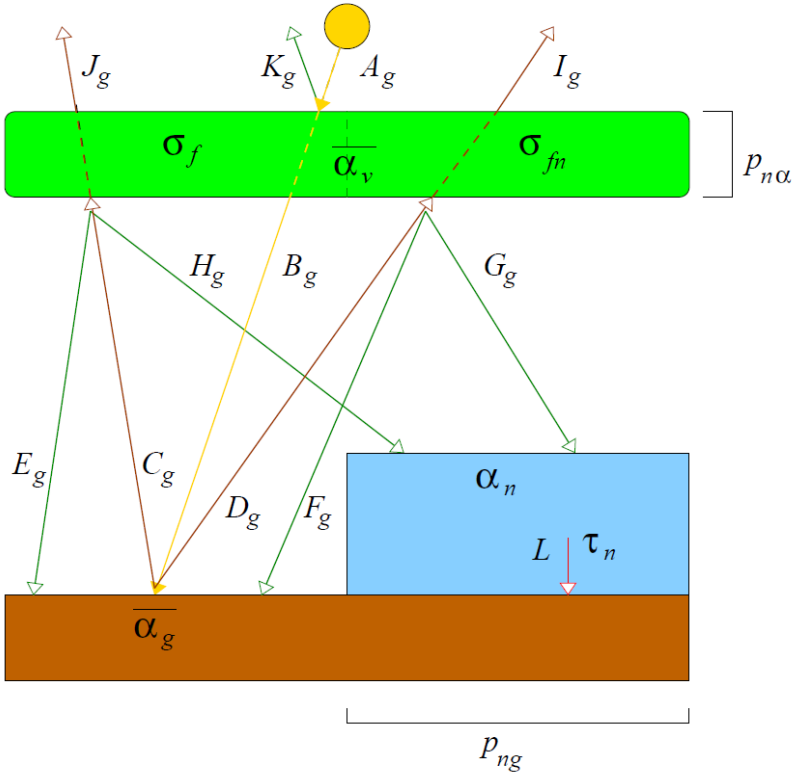
- **Tall canopy (low albedo) hides snow (high albedo).**
  Important for snow evolution in forest areas → runoff and hydrology
  See radiation exchange on next slide…

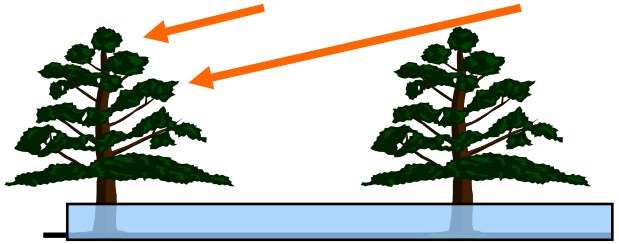
- **Enables interception of snow on canopy.**
  Most important in low-latitude mountain areas where evaporation from intercepted snow can be ~30% of annual snow fall.

Radiation in MEB

SMHI

Short-wave radiation uses two reflections





Low sun angle:

SW radiation is absorbed mainly by the dark trees →

Trees warm up →

Gives

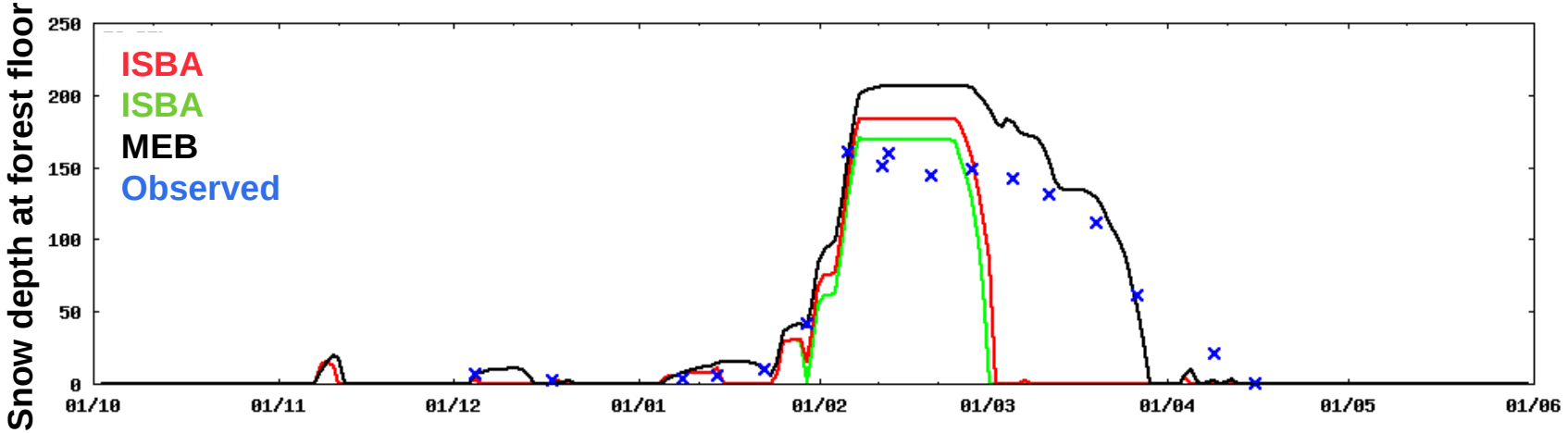
- Sensible heat to atmosphere
- LW radiation to surface which is absorbed by the “black snow” (ε~0.98)

Evaluation of MEB

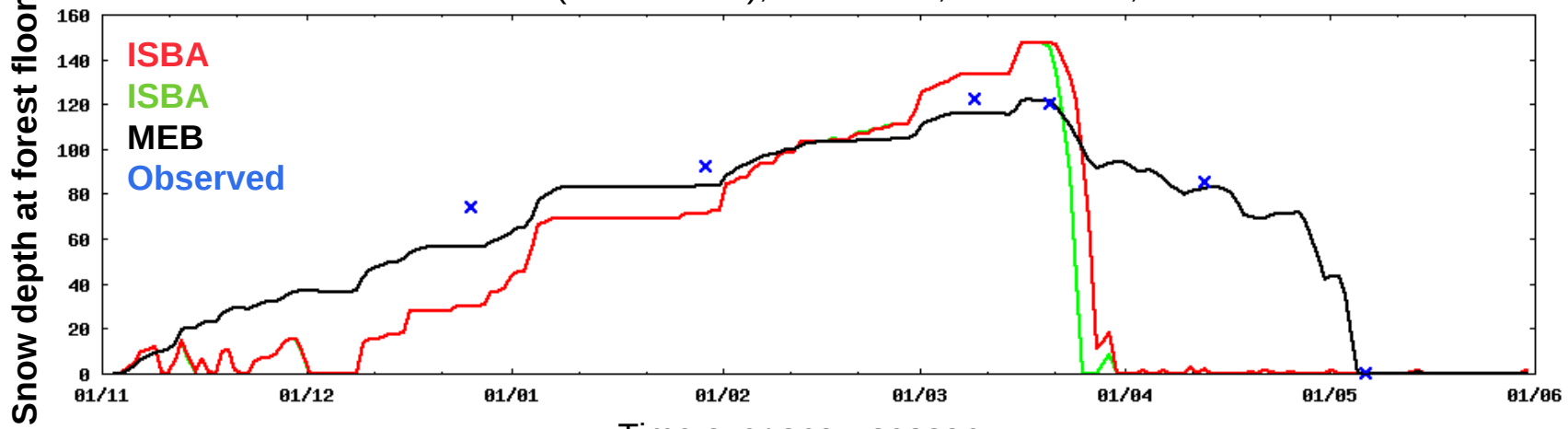
SMHI

Two SnowMIP2 forest sites where snow interception matters

Alptal (Switzerland), 1185 masl, trees: 25 m, LAI 4.2



Fraser (US Rockies), 2820 masl, trees: 27 m, LAI 5



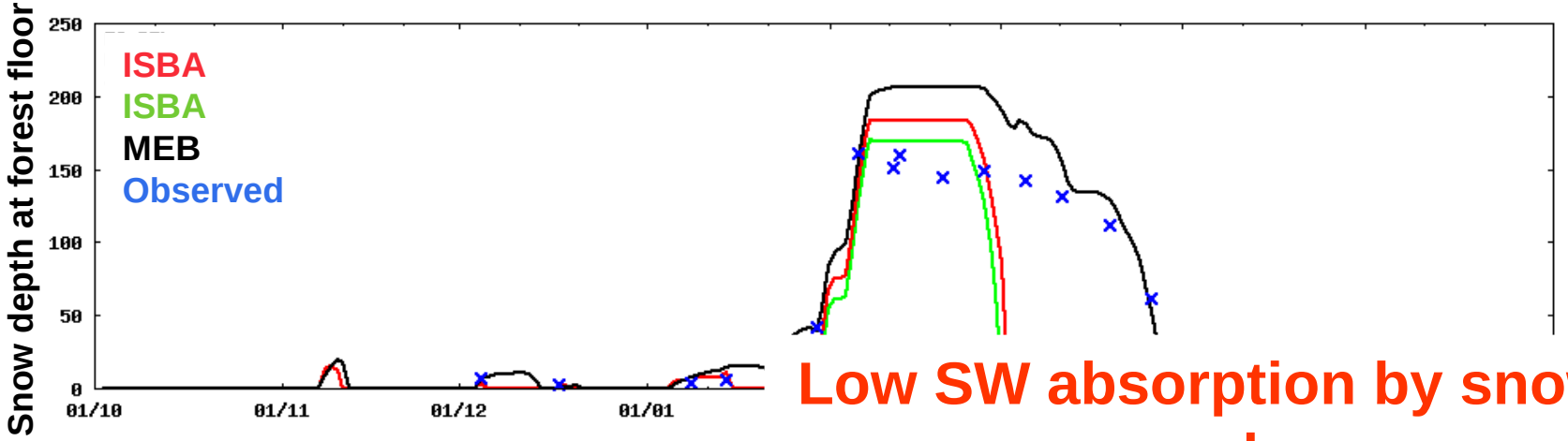
Time over snow season

Evaluation of MEB

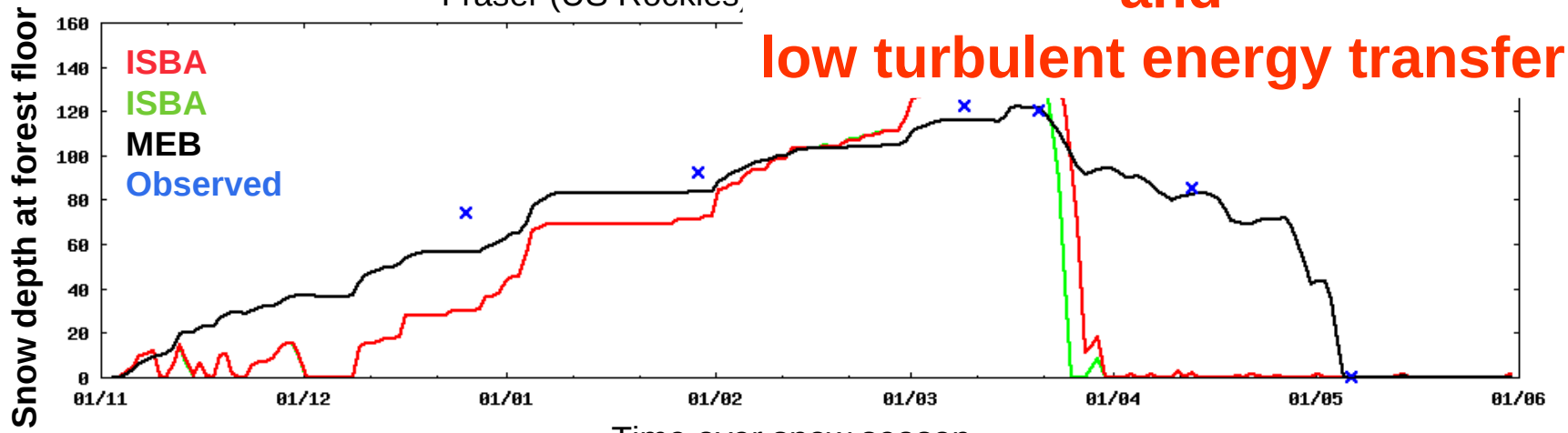
SMHI

Two SnowMIP2 forest sites where snow interception matters

Alptal (Switzerland), 1185 masl, trees: 25 m, LAI 4.2



Fraser (US Rockies)



Low SW absorption by snow and low turbulent energy transfer

Time over snow season

Evaluation of MEB

SMHI

Sodankylä (Finland), 179 masl, trees: 12 m, LAI 1.2

Data via SRNWP Data Exchange Programme
Problems with quality of precipitation data (may need correction against manual observations)

Tests gave excess snowmelt due to too strong turbulent heat fluxes

Modified MEB version on its way from Aaron

Current status and future

SMHI

- **Multi-energy balance (MEB) parameterisation is implemented in a test version based on SURFEX 6.1 code.**

- **MEB is designed for all vegetated patches (forest to grass) but will probably be used mostly for forest patches. Will also become accessible from TEB. Work will be done to make it compatible with Canopy model.**

- **Extensive 0D testing with forcing from tower observations is ongoing. Will go on for a few months more. GOOD data is needed!**
  A 1D test along a longitude line has been performed.

- **MEB will probably officially be part of SURFEX 7.X**

- **MEB in forest has been used for many years in SMHI regional climate model RCA and is now part of latest HIRLAM release. Thus "snow people" within HARMONIE has decided to head for SURFEX with MEB (forest) + 3-L snow + force-restore/DIF soil…**

- **We welcome any users interested in SURFEX – MEB applications!**


THANKS!