Implementation of multi-energy balance (MEB) into SURFEX

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No explicit canopy vegetation energy balance (temperature)!
We want to model this!
Multi-Energy Balance (MEB)

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

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

- 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.
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” ($\varepsilon \sim 0.98$)
Evaluation of MEB

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
Evaluation of MEB

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

Low SW absorption by snow and low turbulent energy transfer
Evaluation of MEB

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

Data via SRNWP Data Exchange Programme (see Andras’ talk Tuesday)
Problems with quality of precipitation data (needs correction against daily SYNOP)
Evaluation of MEB

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

July

Sensible heat flux

January

April - May

Latent heat flux
Multi-energy balance (MEB) parameterisation has been implemented in a test version based on SURFEX 6.1 code (isba.f90 and below).

Work done, and more needed, to implement new physiographic data and variables in SURFEX code structure (above isba.f90).

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. Not yet compatible with Canopy model.

Extensive 0D testing with forcing from tower observations has just started. Will go on for a few months more. GOOD data is needed!

MEB will be part of SURFEX X.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...
THANKS!