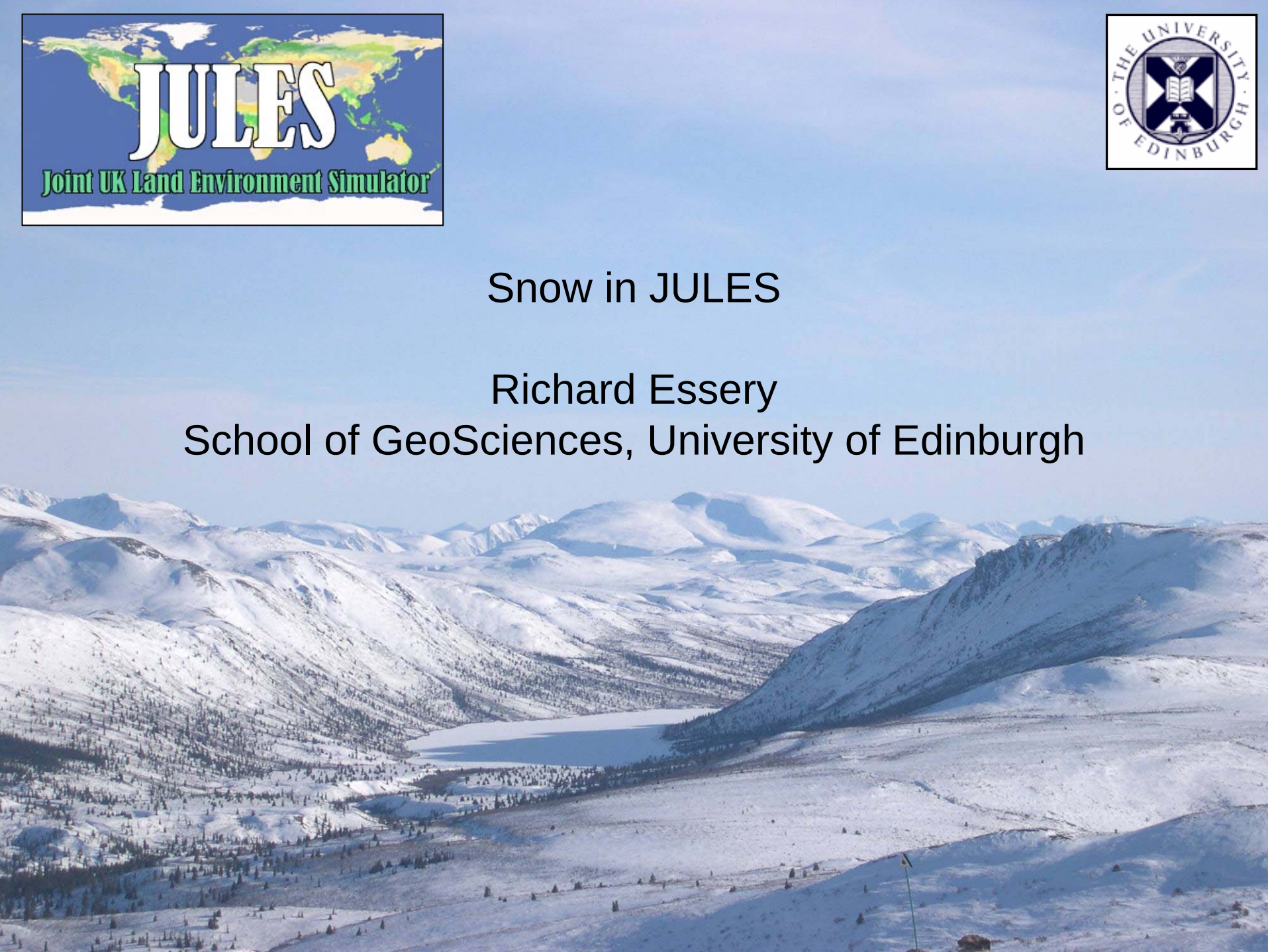


Snow in JULES

Richard Essery
School of GeoSciences, University of Edinburgh

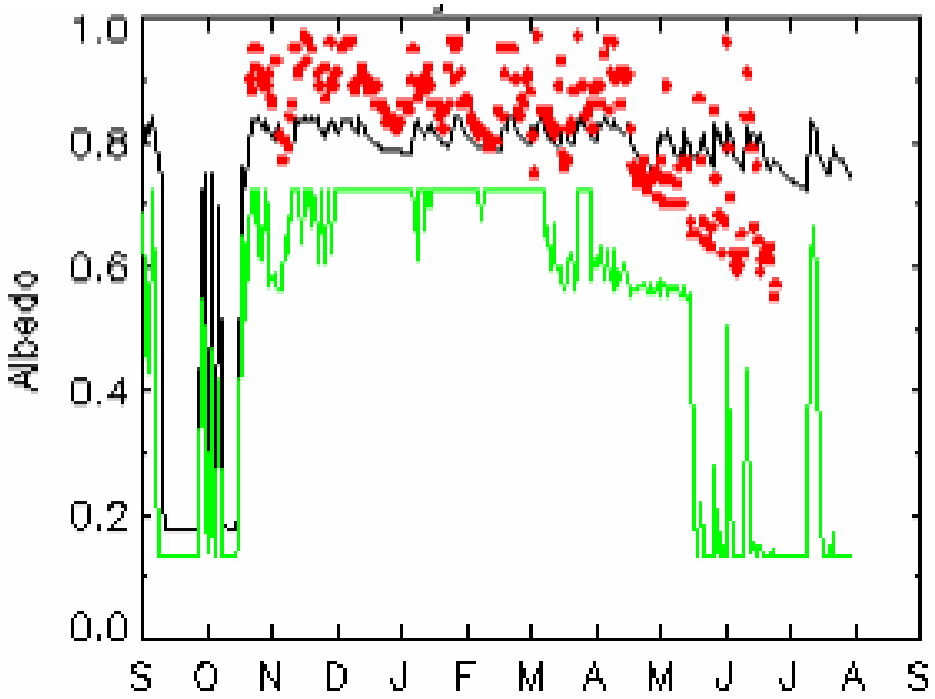
What snow does to the land surface

- Increases the albedo
- Increases the moisture availability
- Decreases the roughness
- Limits the temperature to a maximum of 0°C
- Insulates the underlying ground

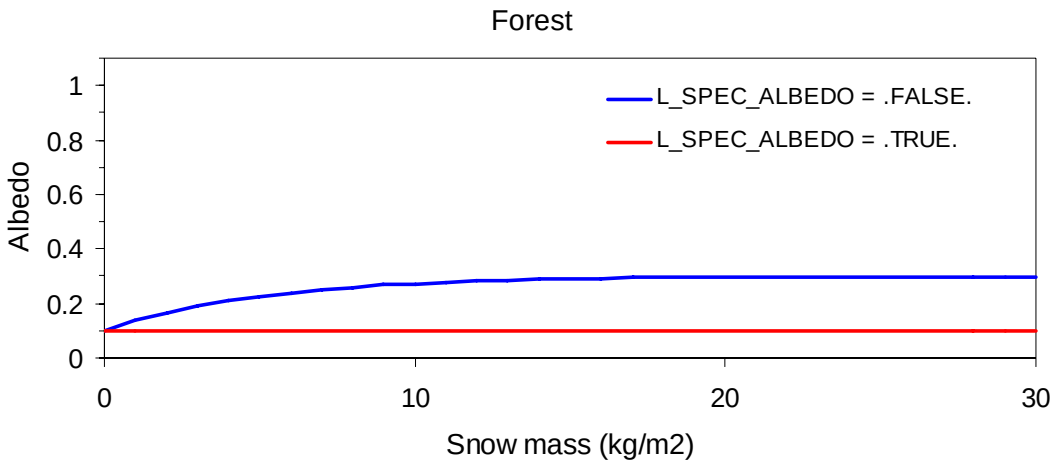
What JULES does with snow: Albedo

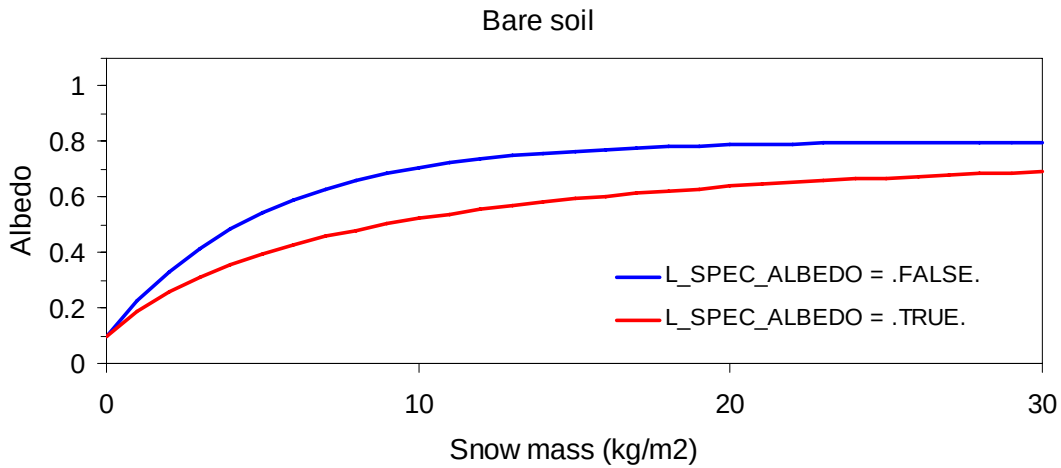
L_SPEC_ALBEDO = .FALSE. (in green):
Broadband albedo, diagnostic function of surface temperature

L_SPEC_ALBEDO = .TRUE. (in black):
Separate visible and near-infrared albedos for direct and diffuse radiation
Function of prognostic snow grain size (age and temperature history)
Soot content



What JULES does with snow: Albedo





$$\alpha = (1 - f)\alpha_0 + f\alpha_s$$

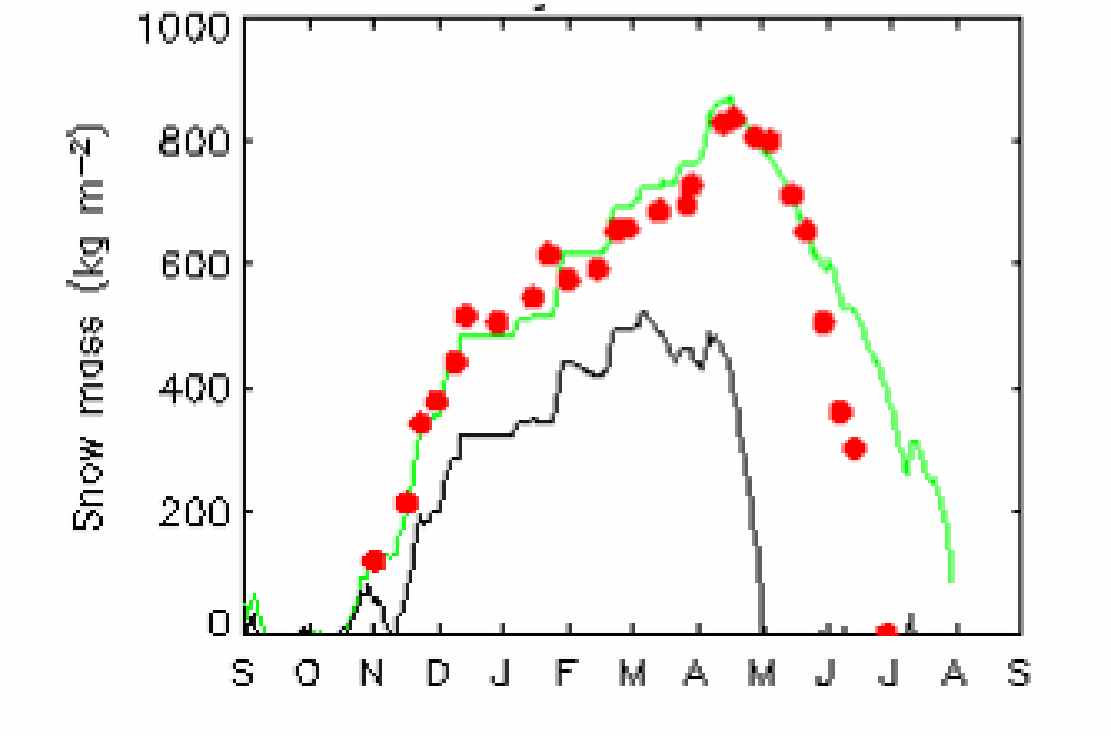
L_SPEC_ALBEDO=.FALSE.:
α_s depends on vegetation type
f does not

L_SPEC_ALBEDO=.TRUE.:
f depends on vegetation type
α_s does not

What JULES does with snow: Surface temperature

L_POINT_DATA = .FALSE. (in black):
Surface energy balance for composite snow and snow-free surfaces

L_POINT_DATA = .TRUE. (in green):
Surface energy balance for continuous snow cover



What JULES does with snow: Roughness

Reduction of surface roughness as SWE increases

$$z_0 = z_{0f} - 4 \times 10^{-4} \mathrm{SWE}$$

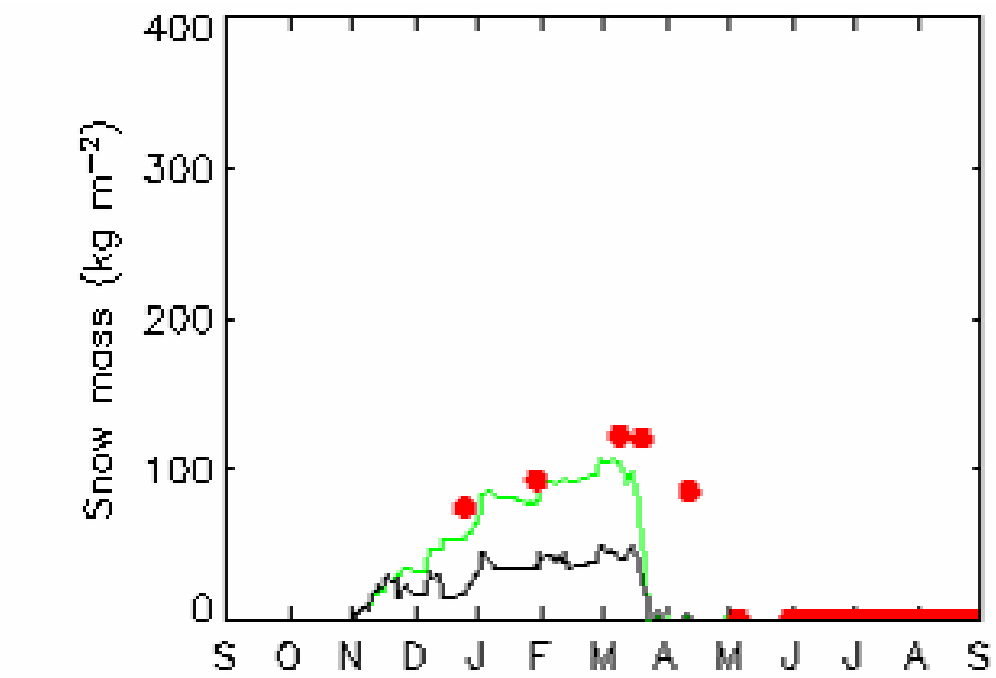
Constant snow density (250 kgm^{-3} in MOSES) and fixed relationship between roughness and vegetation height ($z_{0f} = 0.1h$)

$$\Rightarrow \quad z_0 = 0.1(h - Sd)$$

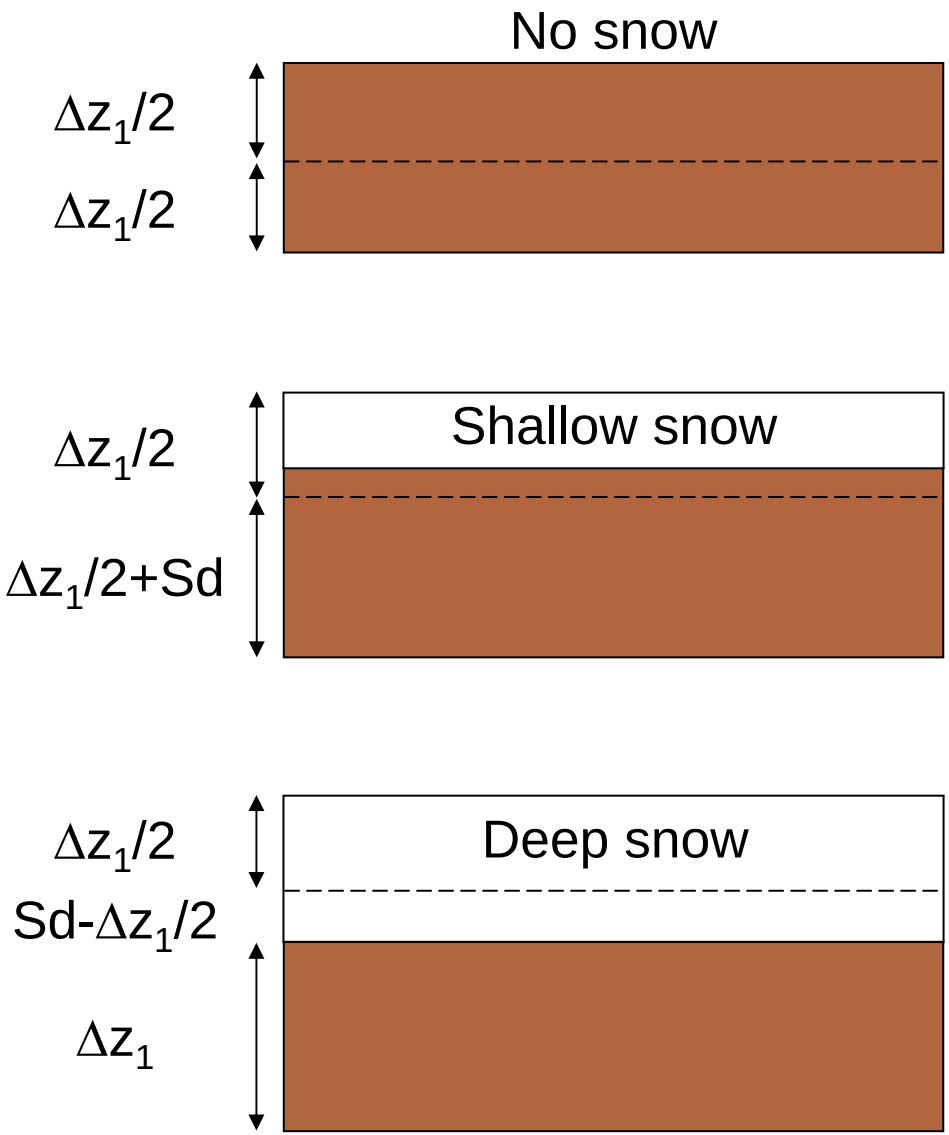
What JULES does with snow: Snow in canopies

CAN_MODEL = 3 (in black):
All snow sits on top of vegetation

CAN_MODEL = 4 (in green).:
Snowfall partitioned into interception by canopy and throughfall to ground



What JULES does with snow: Insulation



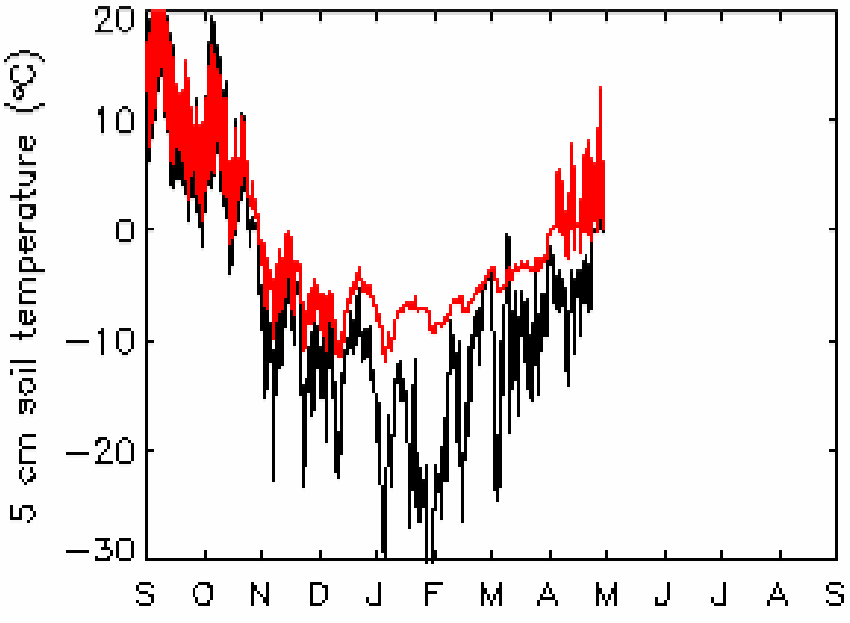
Fixed thermal conductivity
(0.265 $Wm^{-1}K^{-1}$ in MOSES)

Heat capacity of snow neglected

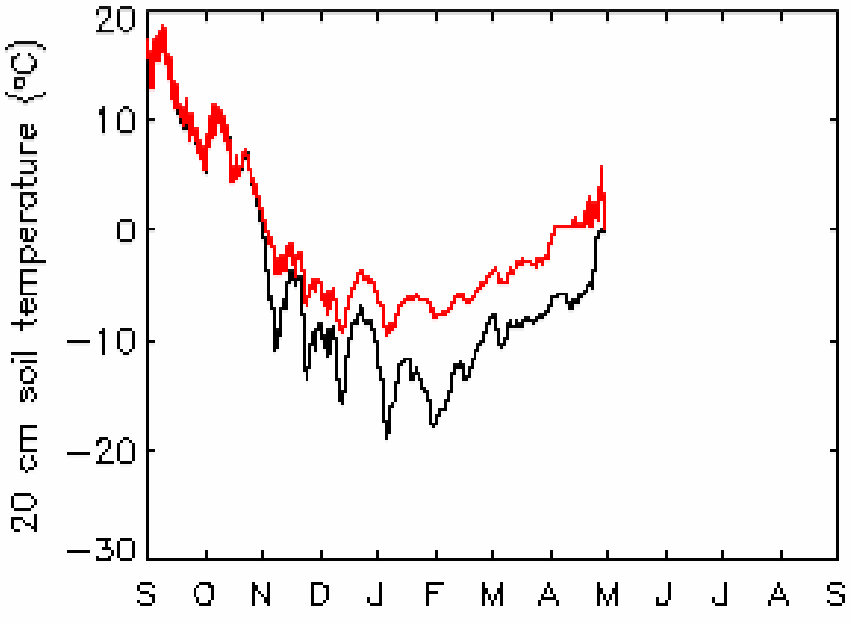
What JULES does with snow: Insulation

Observations in red, JULES in black

Soil layer 1

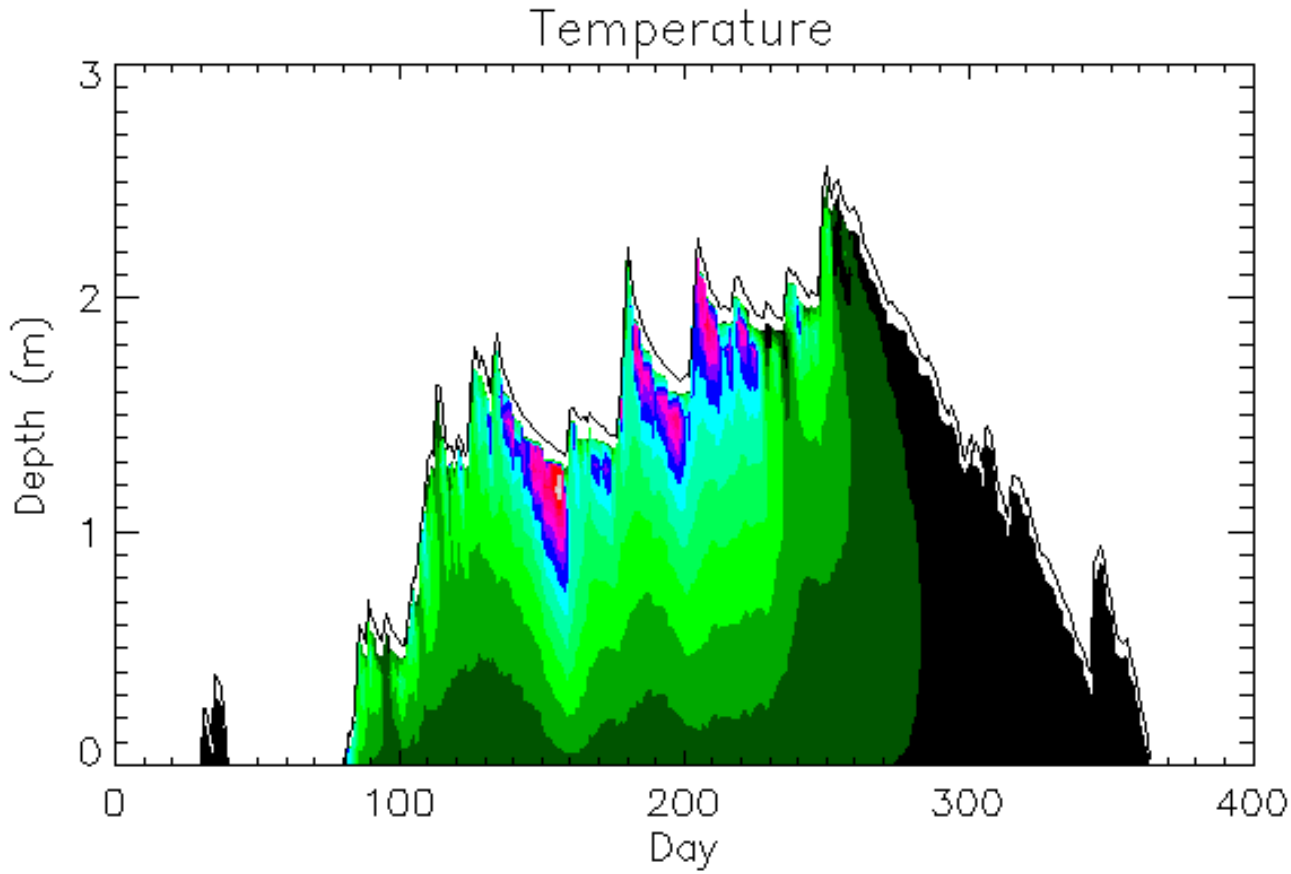


Soil layer 2



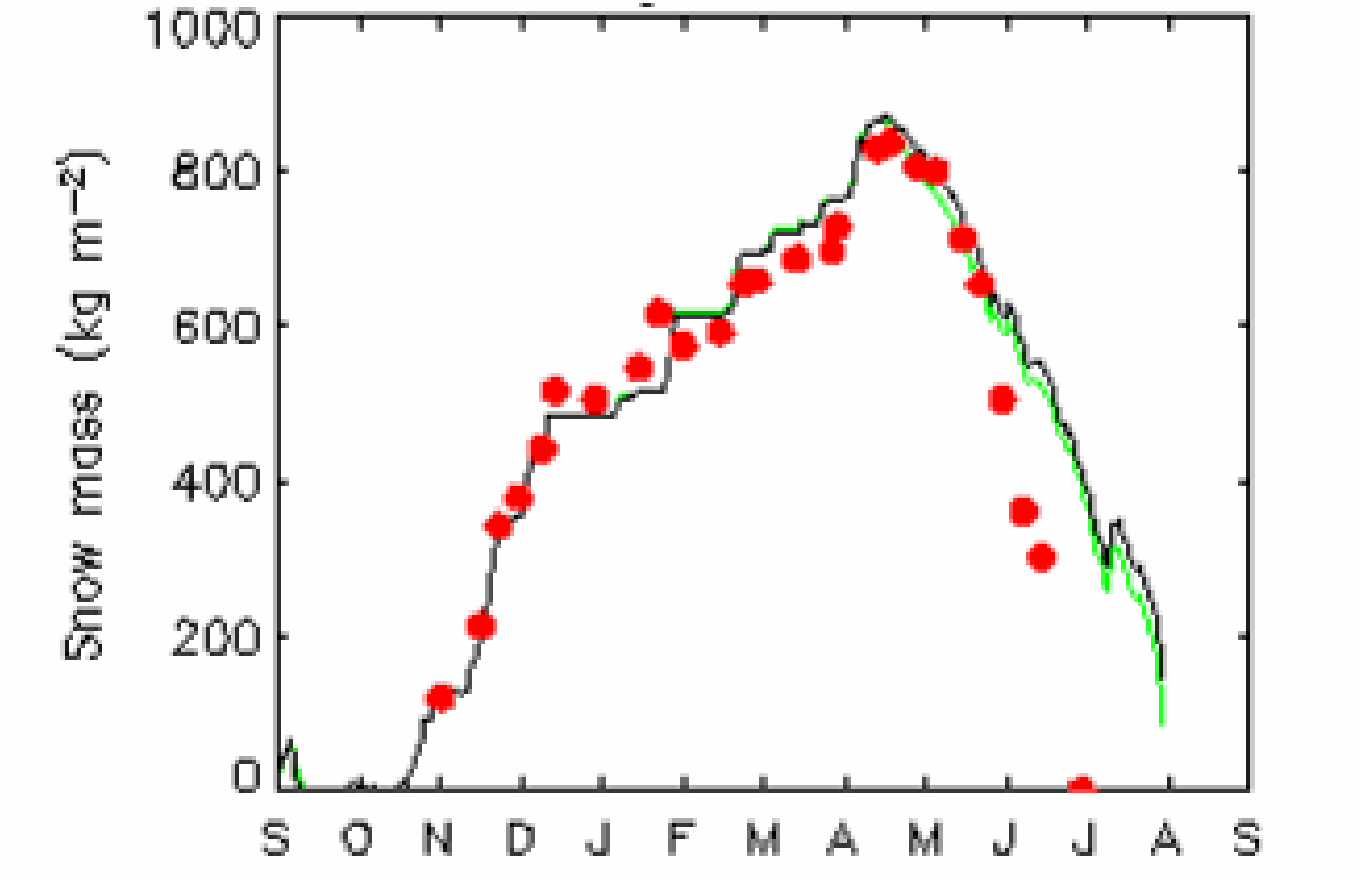
New snow module

- Multiple layers (user specified)
- Variable density, thermal conductivity and heat capacity of snow
- Retention and refreezing of liquid water in snow



New snow module

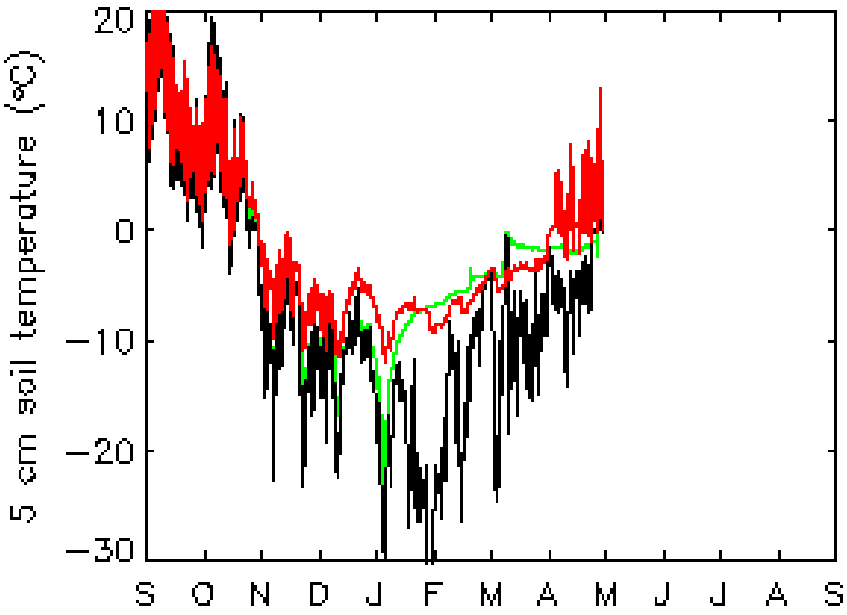
Observations in red, JULES in black, new snow module in green



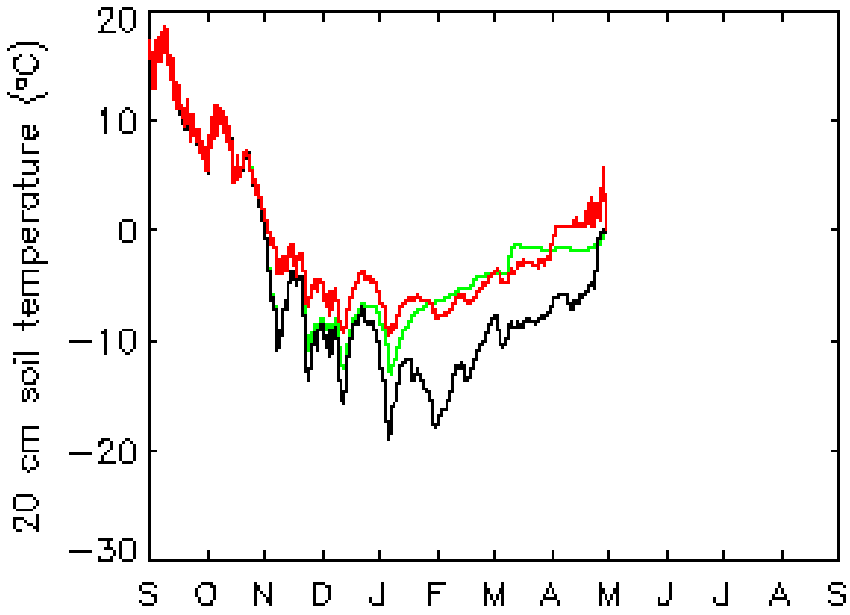
New snow module

Observations in red, JULES in black, new snow module in green

Soil layer 1



Soil layer 2



Summary

For point simulations:
Set L_POINT_DATA = .TRUE. (JULES 2)

For dense coniferous forests:
Set CAN_MODEL = 4 (and SnowCanPFT = 1 in JULES 2)

For sparse canopies:
Wait for the dual-source surface module (JULES x.x)

For snow and soil temperature profiles:
Use the new snow module (JULES 2.1?)

For examples of model performance with various options:
Come to the poster session