Evaluation of JULES multi-layer snow scheme for Norwegian snow conditions

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METHOD:

- OFFLINE runs of JULES land surface model
- SINGLE point modelling

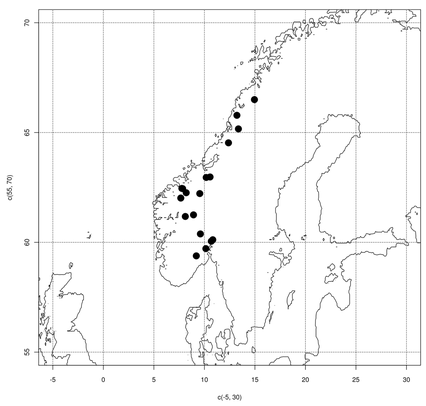
DATASET:

1. OBSERVATIONS from weather stations*
2. FORECASTS from Met Office Unified Model (MetUM)

*Hourly observations of at least precipitation and temperature.

Replace missing parameters with short-term forecasts from MetUM

18 Weather Stations in Norway



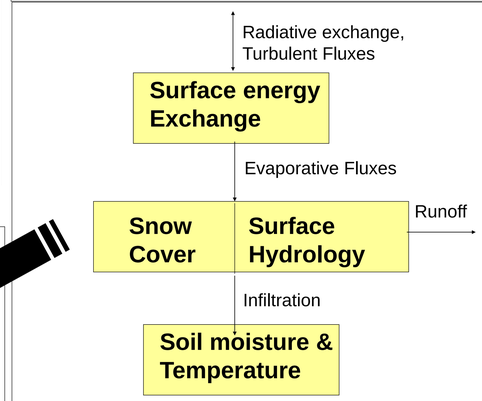
FORCING data:

Parameter	Units
Downward shortwave radiation (surface)	W m^{-2}
Downward longwave radiation (surface)	W m^{-2}
Rainfall rate (2 m)	Kg m^{-2} s^{-1}
Snowfall rate (2 m)	Kg m^{-2} s^{-1}
wind speed (10 m)	m s^{-1}
Air temperature (2 m)	K
Specific humidity (2 m)	kg kg^{-1}
Surface pressure	Pa

MULTI-LAYER Snow Model:

- We used 3 snow layers.
- Each layer has a:
  - thickness (m)
  - temperature (K)
  - density (kg m^{-3})
  - ice content (kg m^{-2})
  - liquid water content (kg m^{-2})
- Prog. snow density: Best et al (2011):eq.21.
- Prog. snow albedo: Best et al (2011): eq.37-45

JULES:
- MetUM's land surface model



Ref: Best et al. (2011), The Joint UK Land Environment Simulator (JULES), model description – Part 1: Energy and water fluxes, *Geosci. Model Dev.*, 4, 677-699, 2011

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Photo: Ketil Isaksen

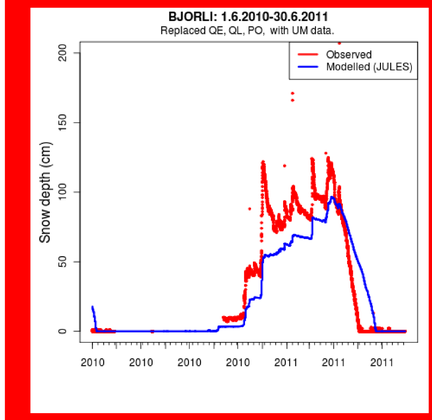
APPROACH:

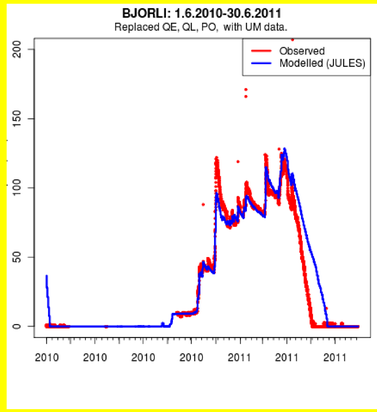
1. Use default parameter values
Fresh snow density: 250 kg m^{-3}
Fresh snow albedo: 0.98 (visible), 0.7 (NIR)

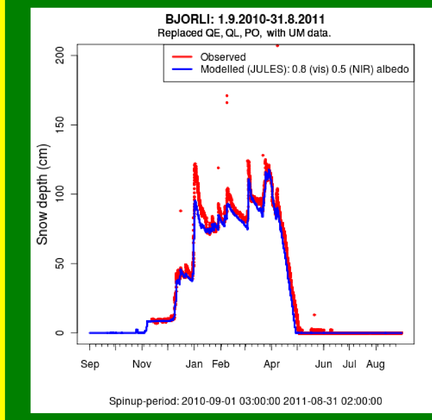
2. Modify fresh snow density
Fresh snow density: 100 kg m^{-3}
Fresh snow albedo: 0.98 (visible), 0.7 (NIR)

3. Modify snow albedo values
Fresh snow density: 100 kg m^{-3}
Fresh snow albedo: 0.8 (visible), 0.5 (NIR)

MODELED and OBSERVED Snow Depth for BJORLI Station: 2010-2011







RESULTS:

1. Use default parameter values

Modeled accumulation: POOR
Modeled snow melt: POOR

- Underestimates snow depth
- Conservative snowmelt

2. Modify fresh snow density

Modeled accumulation: GOOD
Modeled snow melt: POOR

- Conservative snowmelt

3. Modify snow albedo values

Modeled accumulation: GOOD
Modeled snow melt: GOOD

- We carried out experiments with 56 combinations of different visible and NIR albedo.
- The results indicate that it is difficult to determine which albedo values are optimal, but for all stations the default values (vis=0.98 and nir=0.7) are too high. These values represent clean snow.
- For most stations the modeled snow melt increases and therefore the modeled snow depth improves during the snowmelt season using lower albedo values, e.g. vis=0.8 and nir=0.5.
- Many stations are located near forests. Litter on the snow surface is not accounted for in the snow albedo parametrisation. This may explain why the default values were too high.