JULES configurations or 800 ways to make a mistake

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ESM-SnowMIP participants

(Eleanor Burke for JULES

Met Office)

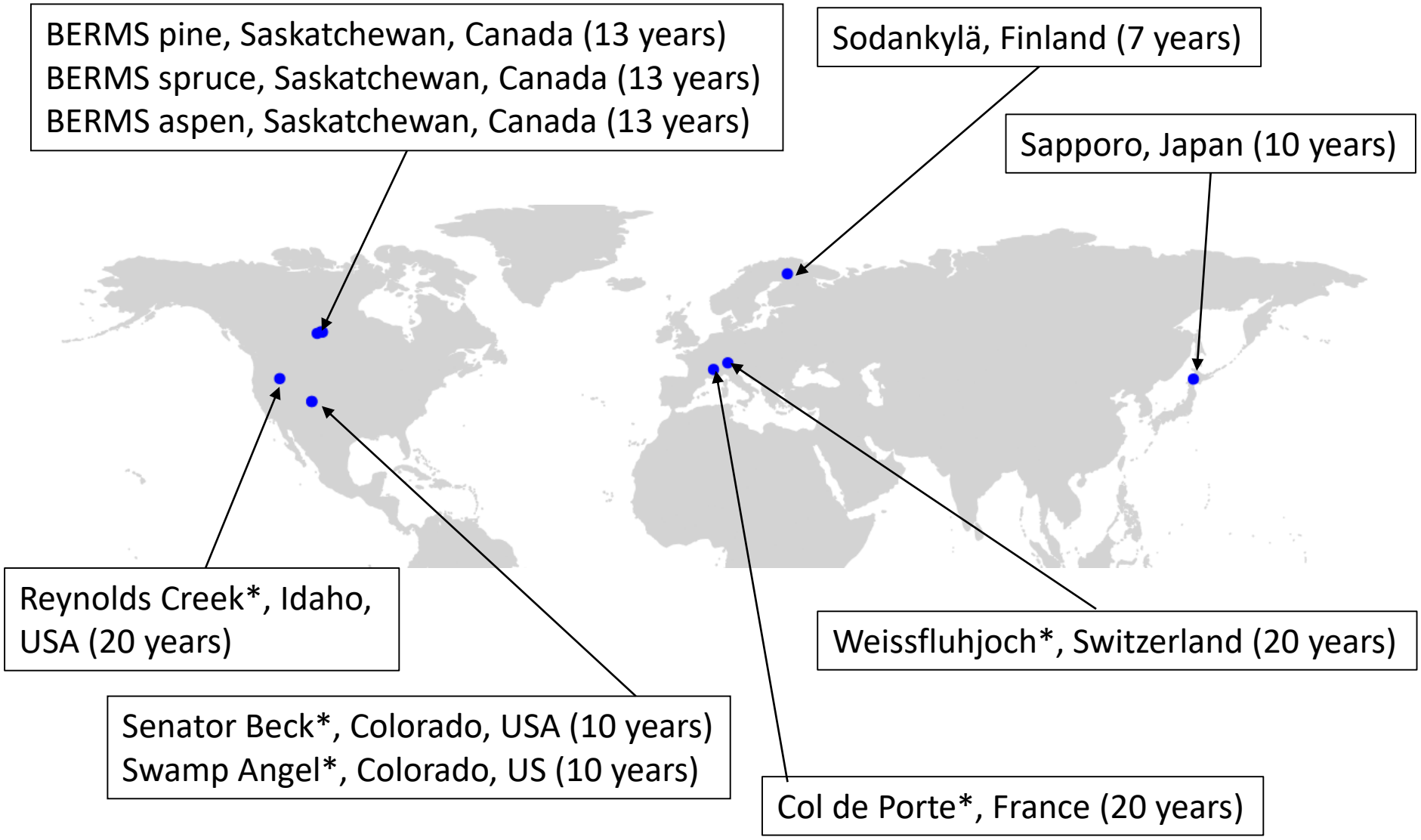
MIP (Model Intercomparison Project) hierarchy

CMIP6 endorsed 21 MIPs

ESM-SnowMIP

Earth System Model-Snow Model Intercomparison Project reference sites

* mountain sites () number of years of *in situ* data



Previous SnowMIPs

- 19-site years of in situ data from 4 sites (Etchevers et al, 2002; 2004)
- 9-site years of data from 5 sites in (Rutter et al., 2009; Essery et al., 2009)

2 meteorological driving datasets

- 136-site years of in situ data from 10 sites
- 300-site of bias-corrected GSWP3 data from 10 sites

(Krinner et al.,2018; Menard et al., 2019)

Evaluation data

- Snow water equivalent (all sites)
- Snow depth (all sites)
- Albedo (8 sites)
- Soil temperature (8 sites)
- Surface temperature (8 sites)

Results feature 7 sites (omitting forest sites)

Col de Porte, France

Senator Beck, Colorado, USA

Sapporo, Japan

ESM-SnowMIP models

ESM land surface schemes
BCC_AVIM
CABLE-SLI
CLASS
CLM
CoLM
CRHM
ECEARTH
HTESSEL, HTESSEL_ML
ISBA, ISBA-MEB
JULESGL7, JULESUKESM
JSBACH, JSBACH_PF
MATSIRO
ORCHIDEE-E, ORCHIDEE-I,ORCHIDEE-MICT

Hydrology / land surface models
ESCIMO
RUC
SPONSOR
SWAP
VEG3D

Snow physics models
Crocus
SNOWPACK

JULES-I (MOSES)

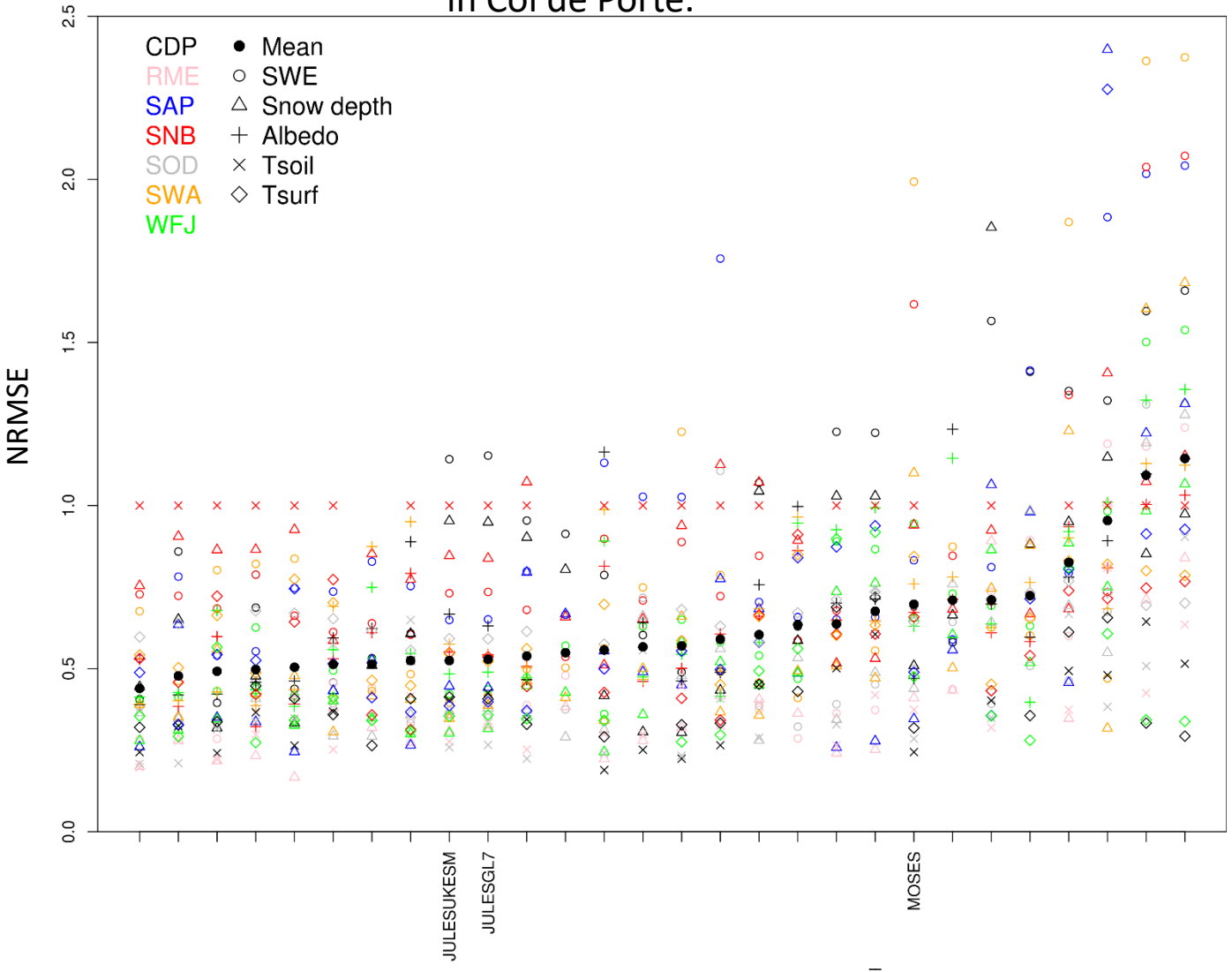
- Multi-layer snow
- Mechanical snow compaction

- Snow/soil composite layer
- Fixed snow density

– all are physics-based models.

Results

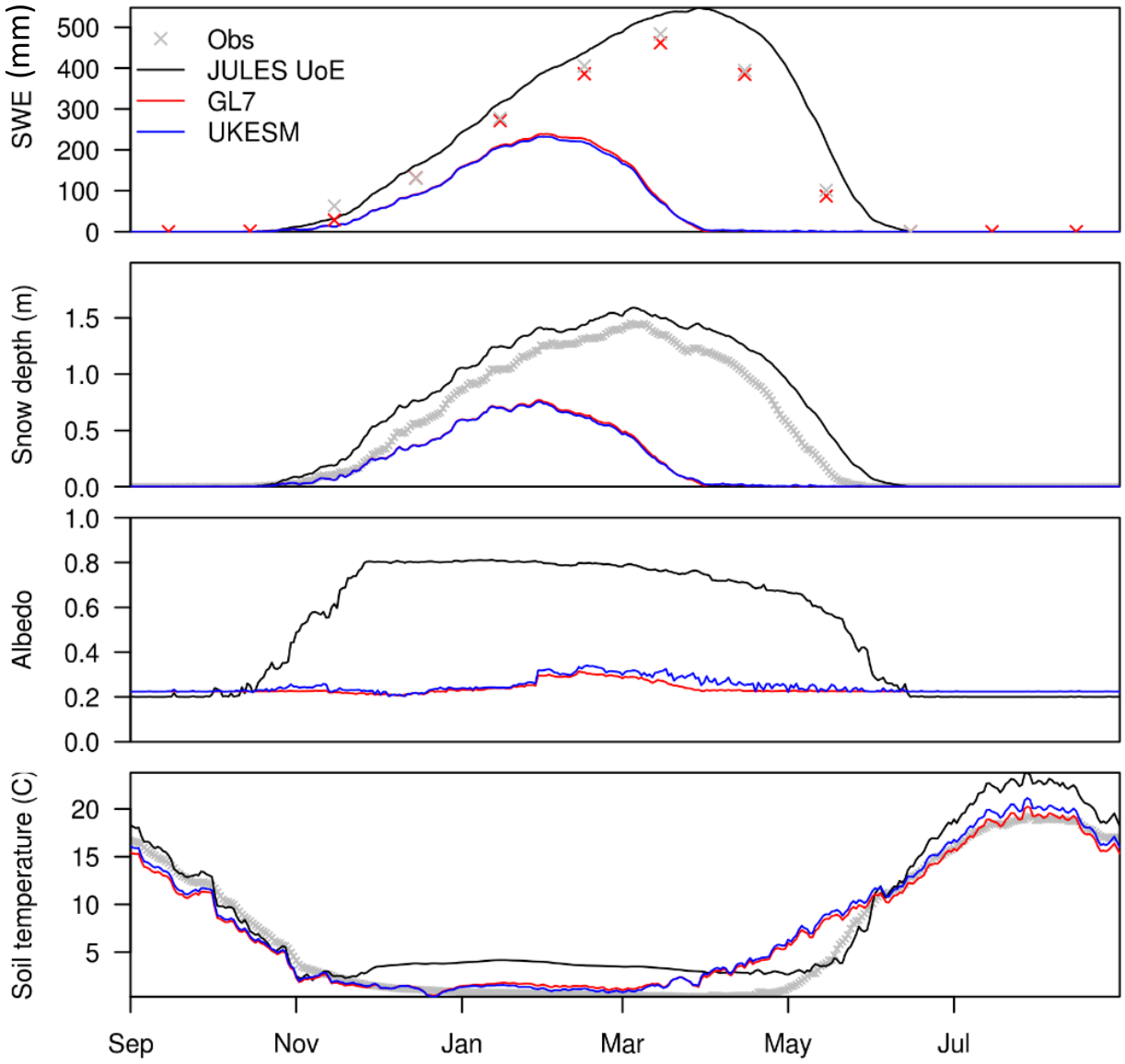
- Almost all models do well at least at one site.
- No model does well at all sites.
- Some models do well some years but not others.
- UKESM is #1 at reproducing the trend in soil temperature in Sodankyla… but one of the worst at reproducing Tsoil seasonality in Col de Porte.



User errors and bugs found in ESM-SnowMIP results

- initial conditions taken from wrong date
- bug in model use of site longitude
- LAIs taken from model's global grid, not site descriptions
- incorrect wind measurement height specified
- model SWE limited to a maximum of 1000 mm
- soil freezing bug
- canopy radiative transfer bug
- unintentional decoupling of snow surface and atmosphere
- wrong forcing file used for one site
- bug in partitioning of SW radiation into direct and diffuse
- bug in liquid water content
- assumed UTC times
- many variations in output file formats

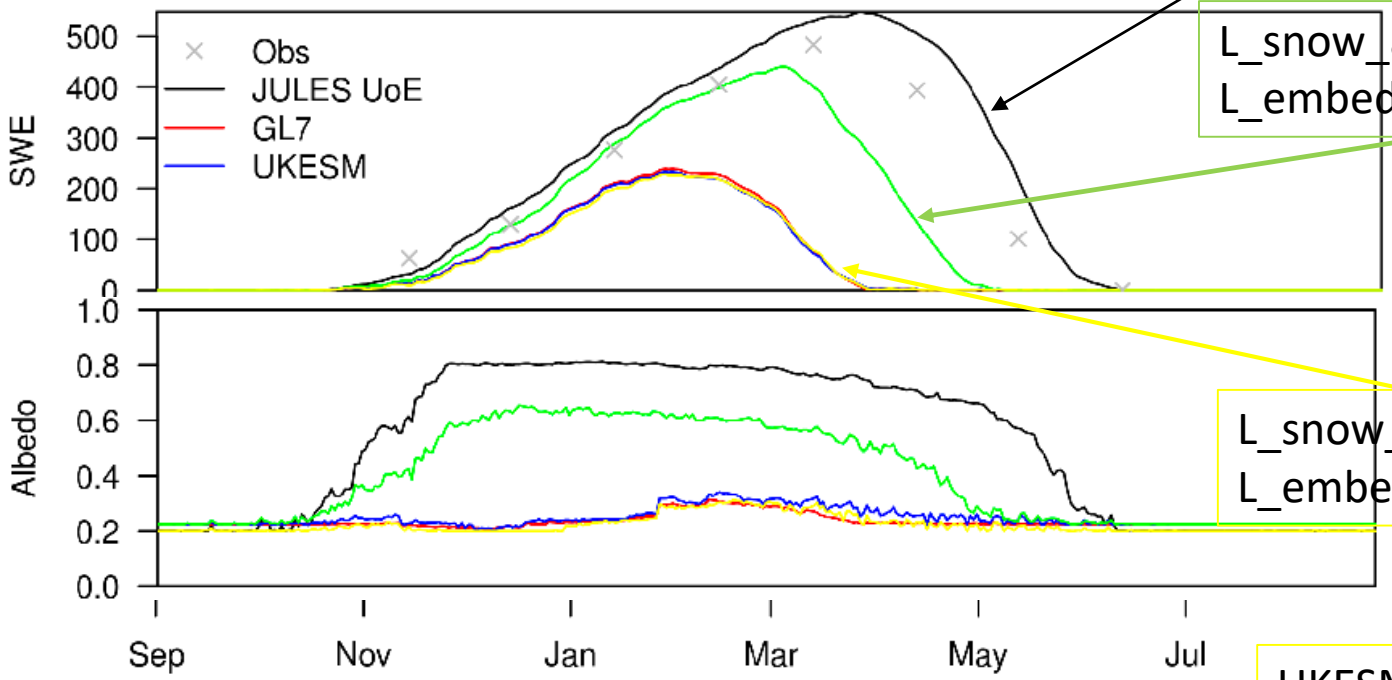
Reynolds Mountain East, Idaho, USA



20-year “climatological” average

Snow albedo scheme

Reynolds Mountain East, Idaho, USA



L_snow_albedo = TRUE
L_embedded_snow = FALSE

L_snow_albedo = FALSE
L_embedded_snow = FALSE

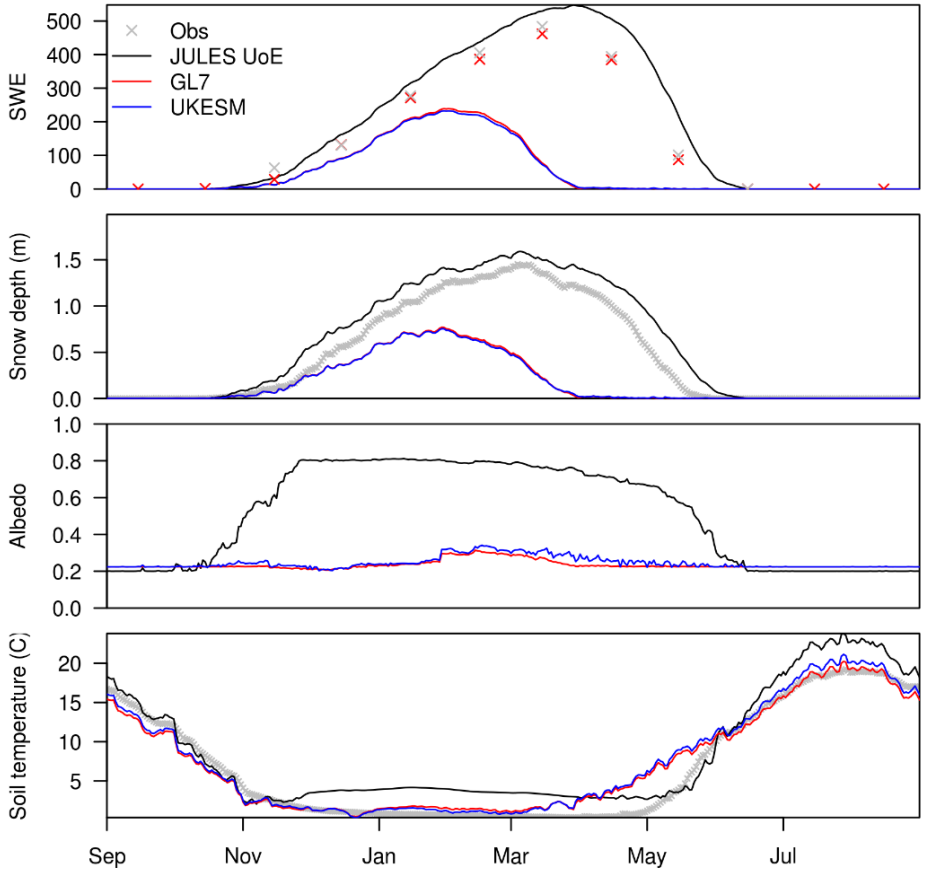
L_snow_albedo = FALSE
L_embedded_snow = TRUE

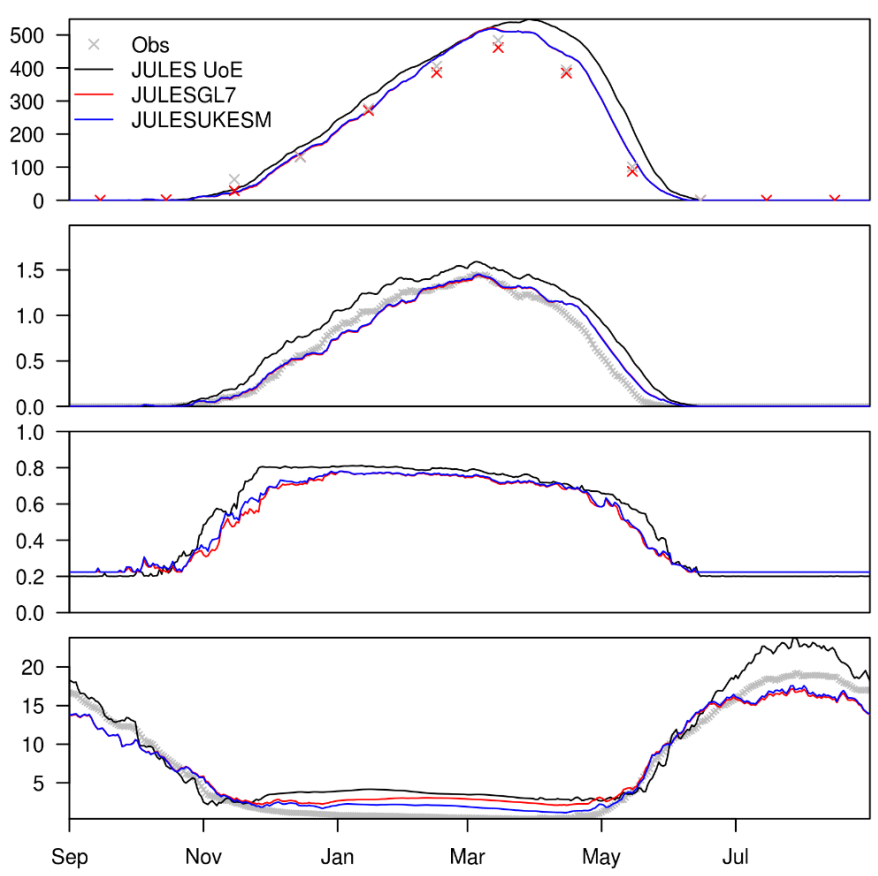
UKESM /GL7 conf.

```
l_embedded_snow=.true.
l_mask_snow_orog=.true.
!!l_niso_direct=.false.
l_sea_alb_var_chl=.true.
l_snow_albedo=.false.
l_spec_alb_bs=.true.
l_spec_albedo=.true.
```

… ~70 emails …. 4 submissions… 1 unwelcome “feature” (not bug?) …. And a couple of edits on the website later…

“Known bug” when calculating the solar zenith angle (l_cosz = TRUE).
Longitude should = 0 when forcing data are local time.





The good news is:

UKESM and GL7 are indeed the “best” configurations for snow studies.

… So what is the problem?

- Issues – perhaps – arise for site-specific simulations?
  - Local time vs UTC
  - Choice of PFT
  - Canopy height
- Was the snow albedo scheme too tuned or calibrated?

Snow albedo scheme

- Effects of LAI on albedo have been tuned to ancillary files
- "The
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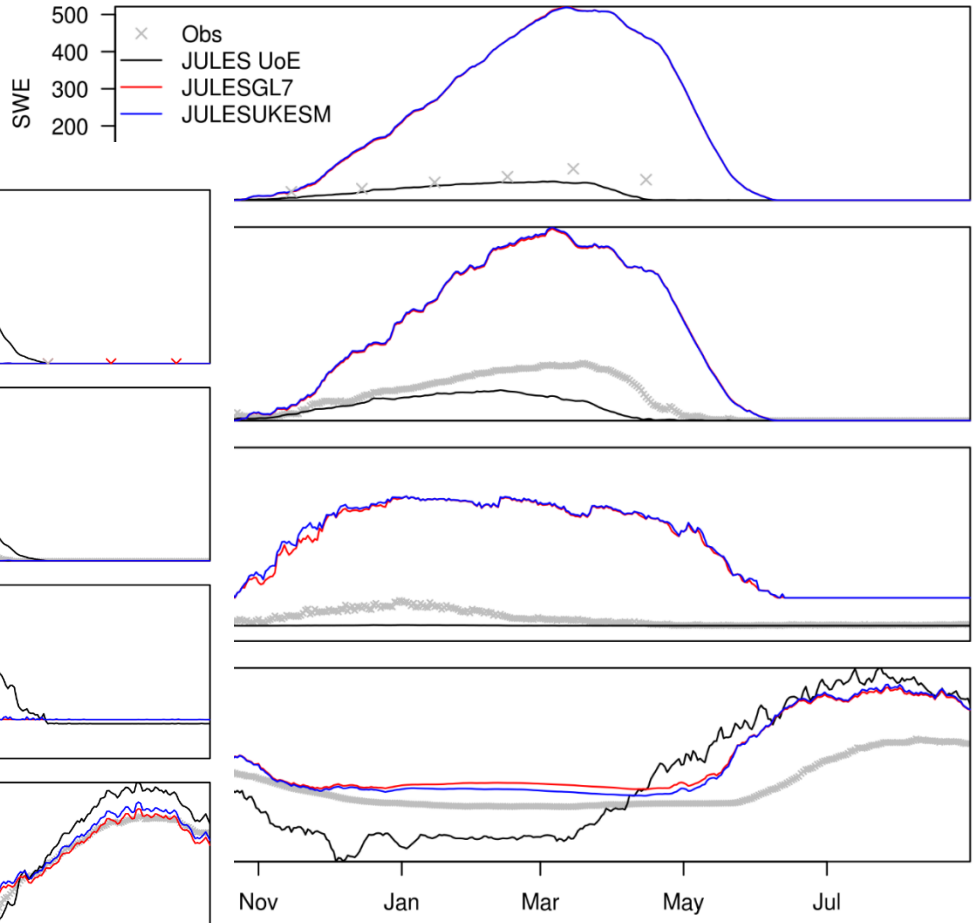
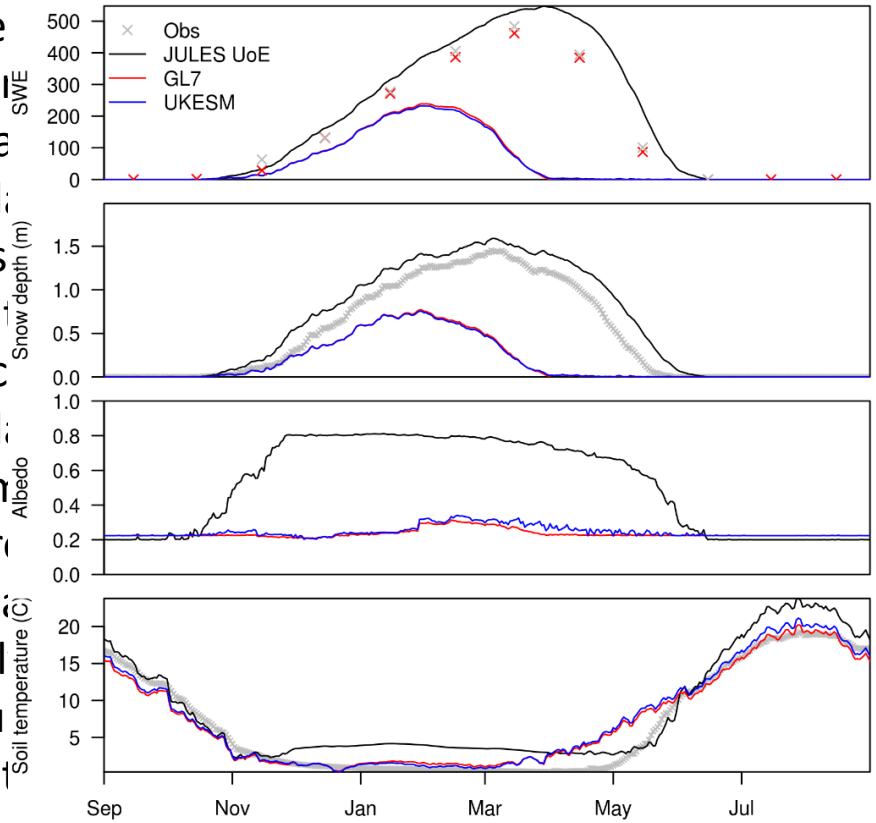
Boreal forest, Old Aspen, Saskatchewan, Canada





Final thoughts on JULES in ESM-SnowMIP…

- Information available to “users” is often not up-to-date, sometimes erroneous.
- Is there a risk that science configurations will have the opposite effect of Loobos?
- The best way to use JULES is still to know people who know about “known bugs”…

So … is JULES really a “community” model?