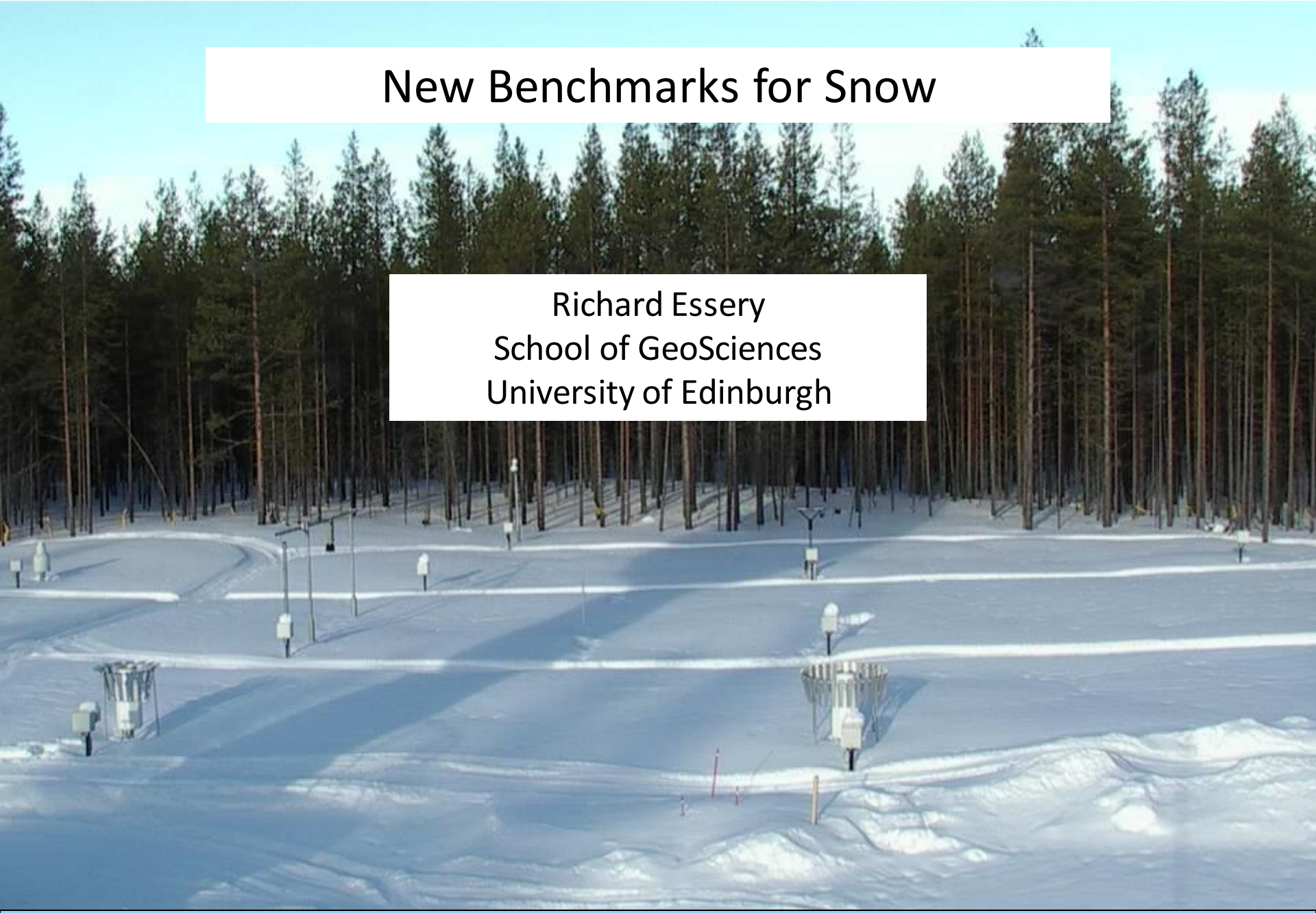
New Benchmarks for Snow



Richard Essery
School of GeoSciences
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JULES meeting, Reading, 30 June – 1 July 2015

Evaluation, Intercomparison and Benchmarking

Best et al., 2015. The plumbing of land surface models: benchmarking model performance. *J. Hydrometeor*, **16**, http://dx.doi.org/10.1175/JHM-D-14-0158.1

- Evaluation – compare model outputs with observations
- (Inter)comparison – compare models with each other
- Benchmarking – compare model performance with an *a priori* standard

Widlowski et al., 2013. The fourth radiation transfer model intercomparison (RAMI-IV): Proficiency testing of canopy reflectance models with ISO-13528. *J. Geopys. Res*., **16**. http://onlinelibrary.wiley.com/doi/10.1002/jgrd.50497/full

Driving Data: Challenges in Snowy Environments

- incoming shortwave radiation
- Incoming longwave radiation

} burial / frosting of radiometers

- snowfall rate — gauge undercatch / blocking
- rainfall rate — partitioning total precipitation
- air temperature — solar heating
- specific humidity — relative humidity usually measured
- wind speed — icing of anemometers
- air pressure

Evaluation Data for Snow Simulations

- snow depth
- snow mass

} manual or automatic measurements

- reflected SW radiation / albedo
- emitted LW radiation / surface temperature
- snow temperature profile
- soil temperature profile
- snow grain size / specific surface area
- snow liquid water content
- turbulent fluxes

SnowMIP and SnowMIP2

● **SnowMIP** (Etchevers et al. 2004)

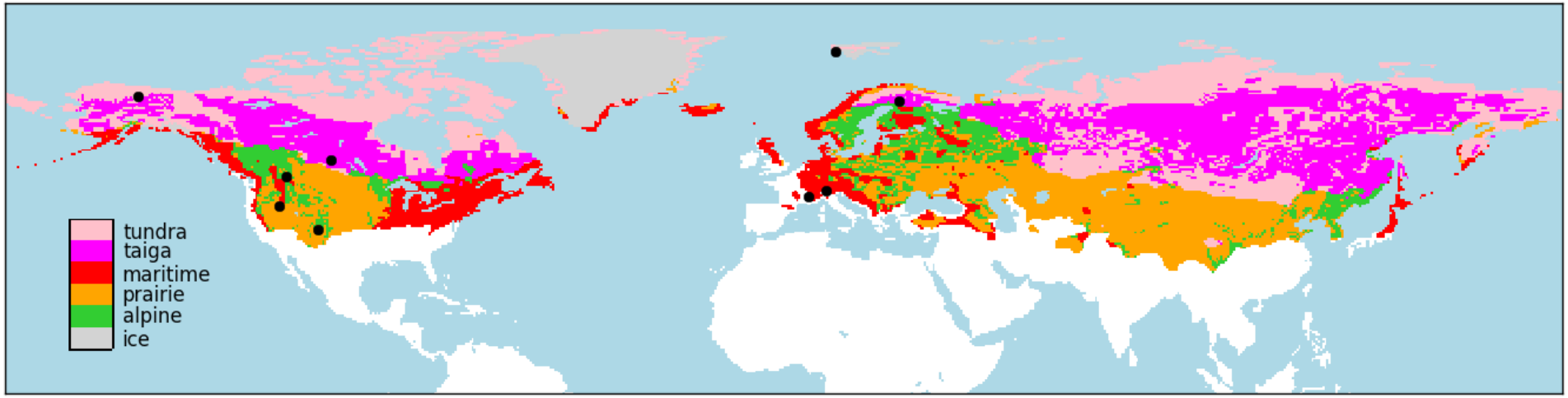
Col de Porte	(45.3ºN, 5.8ºE)
Goose Bay	(53.3ºN, 60.4ºW)
Sleepers River	(44.5ºN, 72.2ºW)
Weissfluhjoch	(46.8ºN, 9.8ºE)

● **SnowMIP2** (Essery et al. 2009)

Alptal	(47.3ºN, 8.7ºE)
BERMS	(53.6ºN, 104.4ºW)
Fraser	(39.5ºN, 105.5ºW)
Hitsujigaoka	(42.6ºN, 141.2ºE)
Hyytiälä	(61.5ºN, 24.2ºE)

Only 1 or 2 years at most sites

ESM-SnowMIP



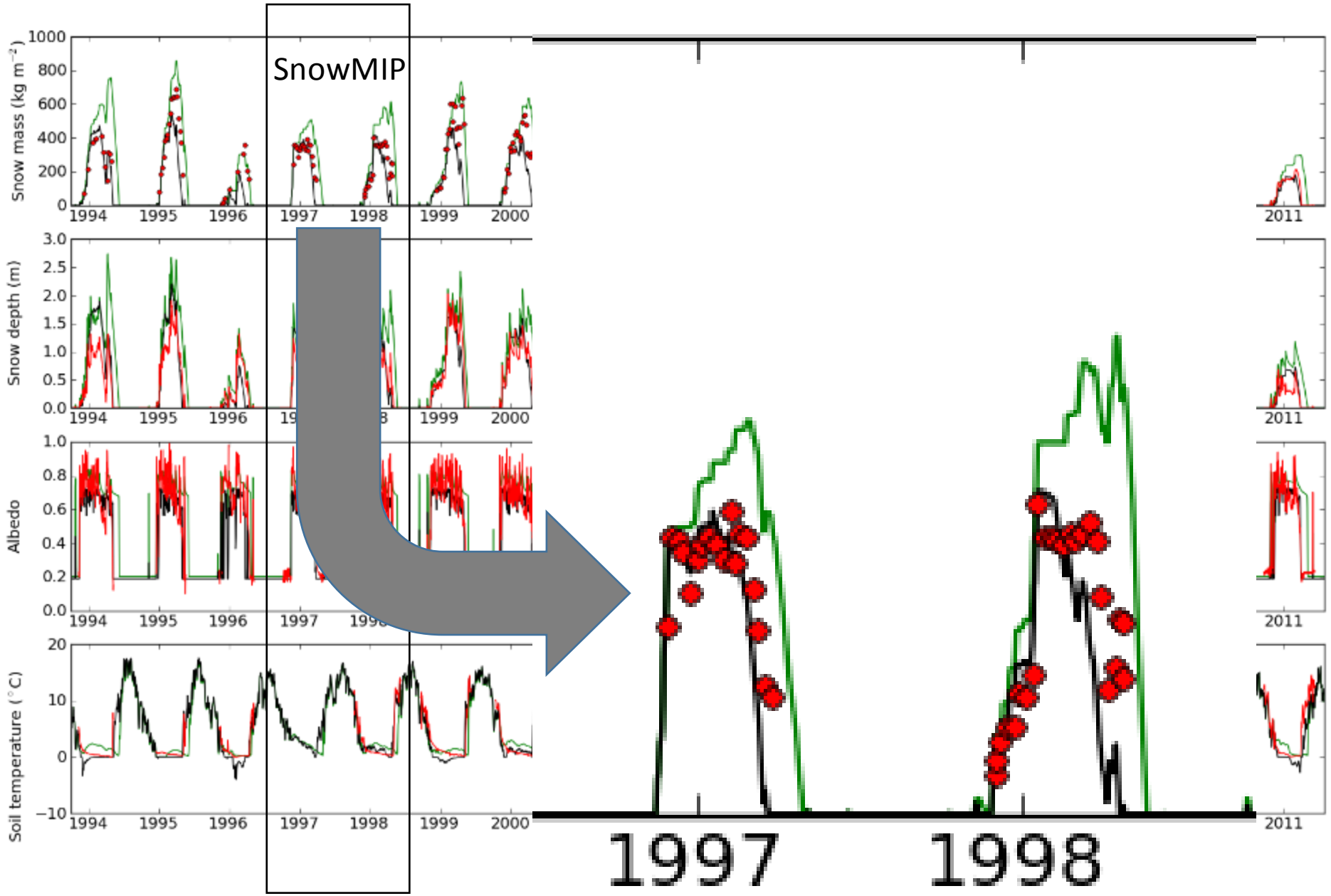
Global coupled, global offline and site simulations

- Bayelva, Svalbard
- BERMS, Saskatchewan
- Col de Porte, France
- Imnavait Creek, Alaska
- Marmot Creek, Alberta
- Reynolds Creek, Idaho
- Sodankylä, Finland
- Swamp Angel, Colorado
- Weissfluhjoch, Switzerland

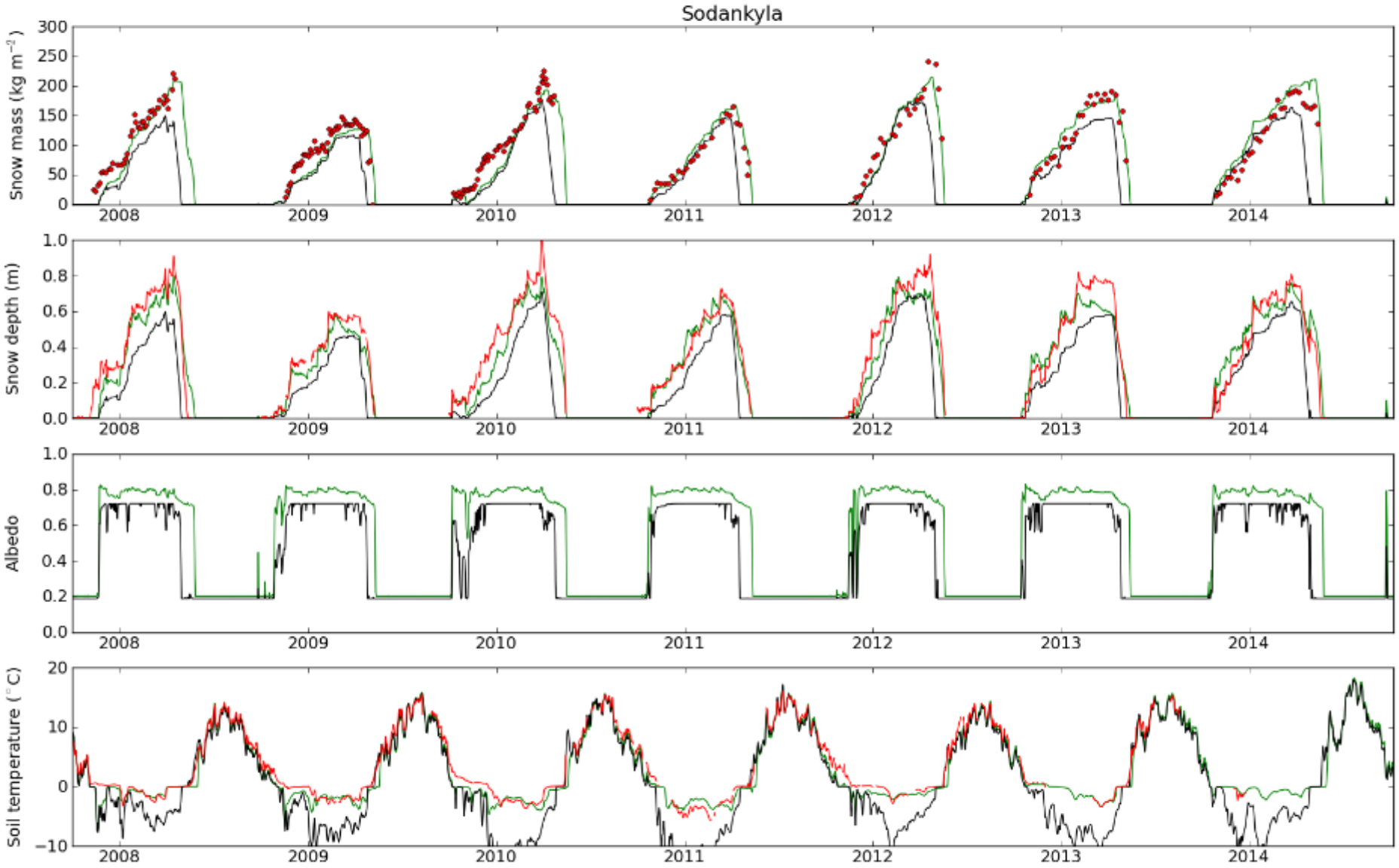
7 – 25 years at each site

http://www.climate-cryosphere.org/activities/targeted/esm-snowmip

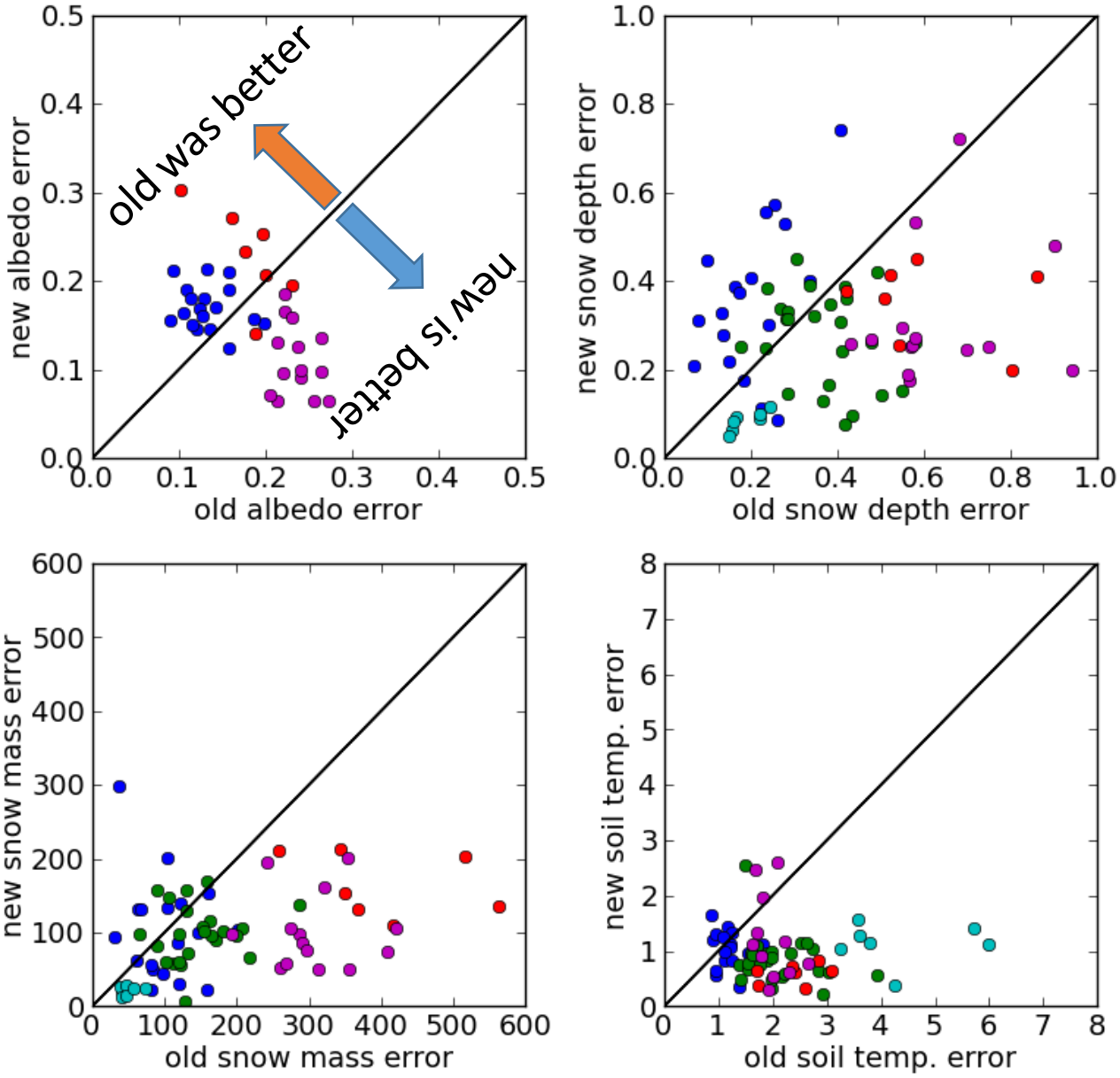
Mid-latitude Mountain Site



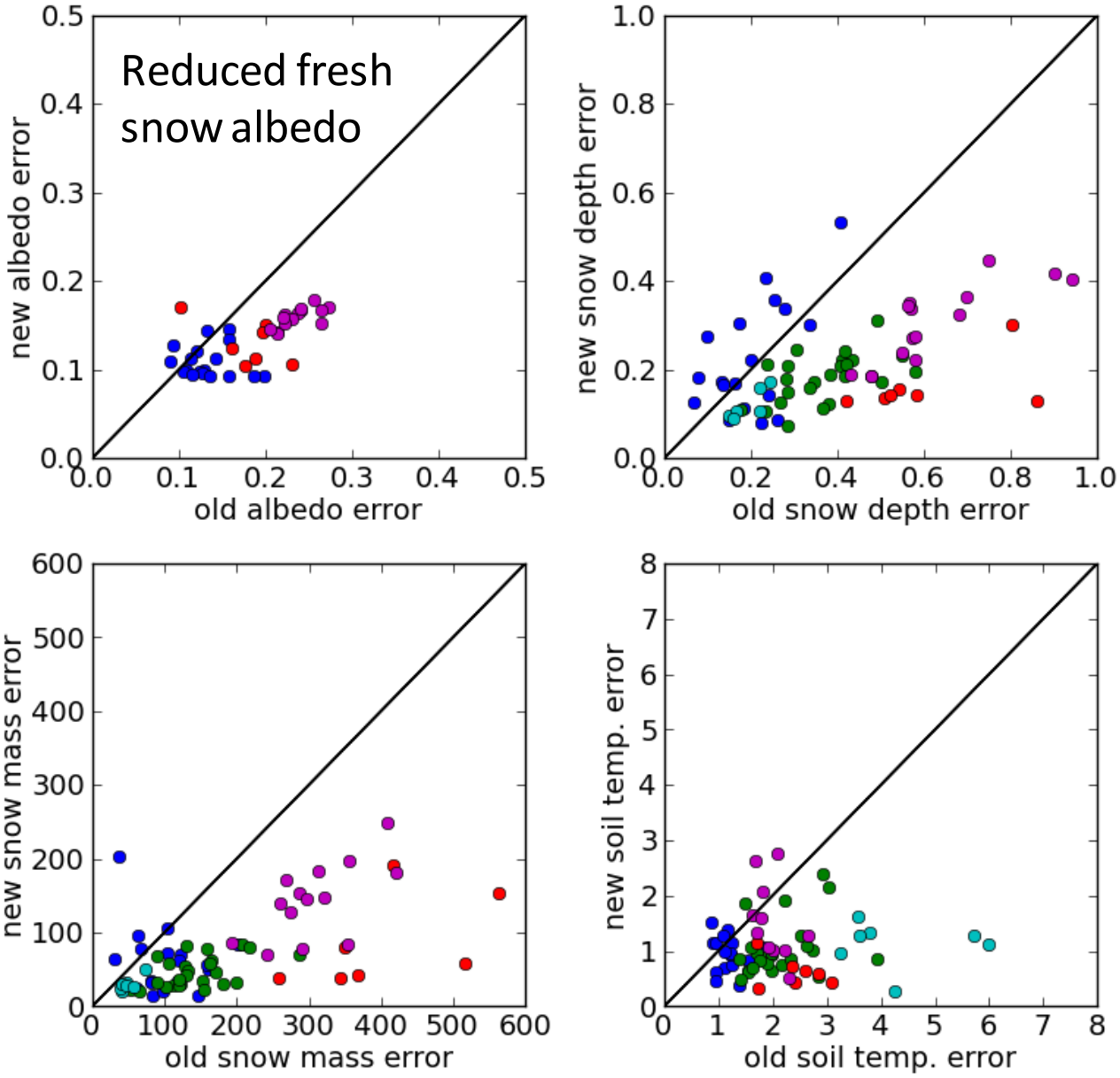
High-latitude, Low-altitude Site



Errors in 71 Winter Simulations Across 5 Sites



Errors in 71 Winter Simulations Across 5 Sites



Switching on the New Snow Model

default **new snow model**

JULES 3.4.1

`switches.nml`

`nsmax = 0` → `nsmax = 3`

JULES 4.0+

`jules_snow.nml`

`nsmax = 0` → `nsmax = 3`

`jules_radiation.nml`

`l_spec_albedo=.false.` → `l_spec_albedo=.true.`

`l_snow_albedo=.false.` → `l_snow_albedo=.true.`

Albedo parameters are in `jules_snow.nml`