Decadal snow cover trends in response to precipitation and temperature forcing
Richard Essery, Cécile Ménard, Eleanor Burke
MIPs, MIPs, MIPs

CMIP6

21 endorsed MIPs

GeoMIP    ISMIP    LS3MIP    LUMIP    OMIP

Land Surface, Snow and Soil MIP

ESM-SnowMIP    GSWP3    GLACE-CMIP

ESM experiments with constrained snow
In-situ land surface model forcing from reference sites
Large-scale forcing from GSWP3
GSWP3 forcing downscaled to reference site elevations
GSWP3 large-scale forcing data

20\textsuperscript{th} century reanalysis

nudging

Global Spectral Model

Bias correction

assimilating surface pressure, SST, sea ice concentration
downscaling to T248 (~ 0.5°)

GPCC precipitation, CRU temperature, SRB radiation

3-hour 1850-2010 near-surface meteorology on 0.5° global land grid

1-hour 1980-2010 forcing at ESM-SnowMIP reference sites
Elevation bias in reference sites c.f. GSWP3

0.5°

- Weissfluhjoch
- Col de Porte

- Elevation (m)
- Temperature (°C)
- Precipitation (mm year⁻¹)
- Snowfall (mm year⁻¹)

- low-level sites vs. mountain sites
- sites higher than GSWP3 grid
- sites colder
- sites wetter
- sites much snowier
Bias-corrected temperature

Col de Porte

Reynolds Mountain East

Sodankyla

Weissfluhjoch

Temperature (°C)

Temperature (°C)

Temperature (°C)

Temperature (°C)
Bias-corrected snowfall
## ESM land surface schemes in ESM-SnowMIP

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+ snow physics and hydrology models
Snow cover duration mean and trend statistics

Mean annual SCD (days)

Annual SCD trend (days/year)

Col de Porte  Reynolds Mnt E  Sodankyla  Weissfluhjoch

Col de Porte  Reynolds Mnt E  Sodankyla  Weissfluhjoch
Conclusions

- observed 1980-2010 snow cover durations lie within the interquartile ranges of the ESM-SnowMIP ensemble for four long-term snow monitoring sites

- ensemble spread is large, but correlation between models is large due to common forcing
  - model spread will be larger in CMIP6 with atmospheric coupling and feedbacks than in GSWP3 without

- models predict that snow cover duration has decreased at all four sites but tend to exceed the observed trends (c.f. snow cover extend trend underestimated in CMIP5)

- JULES multi-layer snow model has longer snow cover duration and larger trends than the zero-layer snow model