ESM-SnowMIP simulation protocol

1. General remarks

This documents describes the ESM-SnowMIP numerical experiments proposed as complements to the simulations proposed in LS3MIP [1]. There are three types of simulations:

- Simulations using a global (distributed) land-surface model (LSM) coupled to an atmospheric general circulation model. These experiments are called "*coupled simulations*" in the following. The atmospheric model can further be coupled to an ocean general circulation model, and in all the simulations proposed here in addition to the LS3MIP setup, this is the case;
- Simulations using a global (distributed) land-surface model forced by prescribed meteorological forcing, according to the GSWP3 setup. These experiments are called "*offline simulations*" in the following;
- Plot-scale simulations at individual sites, using prescribed (observed) meteorological forcing and, where appropriate, site-specific parameters. These experiments are called "*site simulations*" in the following.

The coupled simulations planned in ESM-SnowMIP are complementary to those planned in LS3MIP. Therefore, the following section briefly describes the simulations proposed in LS3MIP[2]. For each ESM-SnowMIP simulation, the purpose and underlying hypotheses, methods and practical considerations, and the metrics and required observations are presented thereafter.

The ESM-SnowMIP offline simulations (global and site-scale) are primarily designed to provide insights into sources of coupled model biases and thus to deliver clues for future model developments and improvements, as opposed to the coupled simulations more focused on improving our understanding of the climate system and in particular its internal feedbacks. However, dedicated snow models not included in coupled models are very welcome to participate in ESM-SnowMIP even if their model is designed exclusively for site simulations.

The experiments are tiered. Tier 1 simulations should be carried out by all participating model groups, provided their model allows for the required setup.

A full list of the proposed ESM-SnowMIP simulations is given in Table 2 (page 3).

2. LS3MIP simulations

Following CMIP6 recommendations, the proposed LS3MIP simulations are tiered (Tiers 1 and 2). Two of the proposed LS3MIP simulations listed in Table 1 (taken from the LS3MIP CMIP6 endorsement application) are *offline simulations* (LMIP-H, LMIP-F). In these

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[1] LS3MIP is a coordinated coupled modeling exercise endorsed by CMIP6. See http://www.climate-cryosphere.org/activities/targeted/ls3mip.

[2] More detail on the planned LS3MIP simulations is available at http://www.climate-cryosphere.org/activities/targeted/ls3mip.

simulations, the LSMs are used in their standard version for historical (1850-2014) and future (2015-2100) meteorological conditions, using, for the future simulations, bias-corrected meteorological forcing (probably under the RCP8.5 scenario) from several climate models to be determined.

The remaining LS3MIP simulations are *coupled simulations*. Among these, those whose purpose is to diagnose land-atmosphere feedbacks are of particular relevance for the proposed ESM-SnowMIP simulations: this is the suite of simulations with names starting with "LFMIP-CA" and "LFMIP-RA" in Table 1. In these coupled simulations, the state of the land-surface, in particular soil wetness and snow cover, are prescribed using the 1980-2014 land-surface conditions in the historical CMIP6 simulations (simulation names with "CA") or using 30-year running means from the historical and scenario CMIP6 experiments (simulation names with "RA").

Table 1: Summary of LS3MIP experiments. Details of separate sensitivity studies and selections of time slices for future simulations have not yet been included. The simulations directly relevant for ESM-SnowMIP, in the sense that ESM-SnowMIP simulations build on them, are listed in bold.

Experiment name	Tier	Experiment description / design	Configu-ration	Start End	# Yrs per simu-lation	Ens. size	# Yrs total	Science question and/or gap addressed with this experiment	Possible synergies with other MIPs	Run schedule
LMIP-H	1	Land only simulations	LND	1850-2014	165	2	330	Land reanalysis	LUMIP, C4MIP, CMIP6 historical	2016-2017
LMIP-F	2			2015-2100	86	4	344	Climate trend analysis		
LFMIP-CAO1	1	Prescribed land conditions 1980-2014 climate	LND-ATM-OC	1980-2100	121	1	121	Diagnose land-climate feedback including ocean response	Scenario-MIP	After DECK (2017?)
LFMIP-CAO4	2					4	484			
LFMIP-CA5	2	Prescribed land conditions 1980-2014 climate; SSTs prescribed	LND-ATM			5	605	Diagnose land-climate feedback over land		
LFMIP-RAO1	1	Prescribed land conditions 30yr running mean	LND-ATM-OC			1	121	Diagnose land-climate feedback including ocean response		
LFMIP-RAO4	2					4	484			
LFMIP-RA5	2	Prescribed land conditions 30yr running mean; SSTs prescribed	LND-ATM			5	605	Diagnose land-climate feedback over land		
LFMIP-HP10	2	Initialized pseudo-observations land	LND-ATM-OC	1980-2014	35	10	350	Land-related seasonal predictability	CMIP6 historical	

A final ensemble of LS3MIP simulations, less directly relevant for ESM-SnowMIP, concerns land-related seasonal predictability studies (LFMIP-HP).

A full list of the proposed ESM-SnowMIP simulations is given below, followed by a detailed description of Tier1 simulations. The same outputs are requested for ESM-LS3MIP and SnowMIP simulations. Daily resolution is required in order to address the role of land surface-climate feedbacks on climate extremes on land. Full details on the requested variables will be provided once finalized for CMIP6.

Table 2: List of proposed ESM-SnowMIP simulations

Experiment name	Tier	Experiment description / design	Configu-ration	Start End	# Yrs per simu-lation	Ens. size	# Yrs total	Science question and/or gap addressed with this experiment	Possible synergies with other runs	Run schedule
SnowMIP-CAO1	1	Prescribed snow conditions 1980-2014 climate	LND-ATM-OC	1980-2100	121	1	121	Diagnose snow-climate feedback including ocean response	CMIP6 historical, Scenario-MIP, LFMIP-CAO	2017
SnowMIP-CAO4	2	Prescribed snow conditions 1980-2014 climate	LND-ATM-OC	1980-2100	121	4	484	Diagnose snow-climate feedback including ocean response	CMIP6 historical, Scenario-MIP, LFMIP-CAO	2018-
SnowMIP-FA-LSM	1	Land only simulation, prescribed constant snow albedo	LND	1980-2014	35	1	35	Evaluate effect of snow albedo variations	LMIP-H	2016-
SnowMIP-SWE-LSM	1	Land only simulation, prescribed SWE	LND	1980-2014	35	1	35	Evaluate link between snow mass and snow fraction	LMIP-H	2016-
SnowMIP-NI-LSM	2	Land only simulation, no soil insulation	LND	1850-2014	165	1	165	Diagnose snow soil insulation effect	SnowMIP-TS-LSM	2017-
SnowMIP-Ref-Site	1	Site reference simulations	LND 1D	Variable				Evaluate snow model on site scale	LMIP-H	2016-
SnowMIP-LargeScale Forcing-Site	2	Site simulations, large-scale atmospheric. forcing	LND 1D	Variable				Evaluate effect of large-scale forcing data	SnowMIP-Ref-Site	2017-
SnowMIP-LSF-down-scaled-site	2	Site simulations, downscaled forcing	LND 1D	Variable				Evaluate impact of downscaled gridded forcing in complex topography	SnowMIP-Ref-Site	2017-
SnowMIP-Shallow-Site	2	Site simulations, shallow soil	LND 1D	Variable				Quantify effect of deep soil	SnowMIP-Ref-Site	2017-
SnowMIP-NI-Site	2	Site simulations, no soil insulation	LND 1D	Variable				Diagnose snow soil insulation effect	SnowMIP-Ref-Site	2017-
SnowMIP-FA-Site	2	Site simulations, prescribed constant snow albedo	LND 1D	Variable				Evaluate effect of snow albedo variations	SnowMIP-Ref-Site	2016-

3. Tier 1 ESM-SnowMIP experiments

3.1. Tier 1 Coupled simulations: SnowMIP-CAO

ESM-SnowMIP proposes one coupled Tier 1 experiment, which serves the purpose of quantifying the role of snow in global climate. It is designed to separate the effects of snow from the combined effects of snow and soil humidity, the combined effect being addressed by the LS3MIP Tier 1 coupled experiment LFMIP-CAO (van den Hurk et al., in preparation; http://www.climate-cryosphere.org/activities/targeted/ls3mip). This LS3MIP experiment uses prescribed 1980-2014 land conditions in a transient climate change experiment.

Purpose and underlying hypotheses

The LFMIP-CAO simulations consist of prescribing both snow mass and soil moisture in a coupled simulation. In order to isolate the effects of snow-atmosphere coupling, we suggest carrying out a simulation in which only the snow state is prescribed from the coupled model's CMIP6 climatology (not the observed climatology).

Methods and practical considerations

The LFMIP-CAO experiment setup is modified such that only the climatological snow variables (in particular snow water equivalent) are prescribed. Soil moisture and other land surface prognostic state variables are allowed to evolve freely. See section 3.2.2 for a discussion of techniques to prescribe snow water equivalent.

Because of internal variability in the climate system, a 5-member ensemble simulation would be ideal, but this is expensive. Similar to the LFMIP-CAO setup, we propose the first ensemble member as Tier1, and suggest 4 other ensemble members as Tier2.

The simulation period is the same as in LFMIP-CAO, i.e. 1980-2100. Correct prescription of prescribed snow can be verified easily by comparing the simulated SWE for an individual year with the simulated climatological (1980-2014) SWE of the free CMIP6 simulation. It should be very close.

Analysis, reference simulations, metrics and required observations

This simulation is linked to the CMIP6 historical simulation and to the LFMIP-CAO experiments of LS3MIP. The SnowMIP-CAO experiments will allow evaluation of the effect of snow feedbacks on interannual to decadal time scales as well as on the centennial climate change signal (since even by the end of the 21st century, the 1980-2014 average snow conditions will be used).

The simulation will be analyzed in parallel to the LFMIP-CAO simulations, following very closely the methodologies of Seneviratne et al. (2013). Required observations are snow cover seasonality, in particular snow melt dates, and general climate variables such as surface air temperature, circulation patterns etc.

Snow Shortwave Radiative Effect diagnosis

Another useful measure of the impact of snow on climate is the "snow shortwave radiative effect" (SSRE) (e.g., Flanner et al, 2011; Perket et al, 2014; Singh et al, 2015). For the purposes outline here, SSRE is the instantaneous change in surface absorbed solar energy flux caused by the presence of terrestrial snow. The diagnosis of SSRE provides a precise, overarching measure of the snow-induced perturbation to solar absorption in each model, integrating over the variable influences of vegetation masking, snow grain size, snow cover fraction, soot content, etc. SSRE is also a useful measure for climate feedback analysis, and has a direct analog in the widely-used "cloud radiative effect". To enable us to calculate and analyze inter-model differences of SSRE and their causes, participating modeling groups are requested to provide specific gridded output (see below) from their LMIP-H, LMIP-F, SnowMIP-FA-LSM and SnowMIP-SWE-LSM simulations. Ideally, these output fields should also be provided for one or more of the coupled atmosphere-ocean simulations, ideally from the historical reference run.

SSRE can be calculated in a land surface model through the following procedures:

1) Conducting an additional surface albedo calculation each model timestep with zero snow. This implies setting to zero the mass of snow on ground, mass of snow in vegetation canopy, and snow cover fraction, but only for the purpose of this diagnostic albedo calculation. It should have no effect on the prognostic snow simulation.
2) Calculating net and reflected surface solar energy fluxes, each model timestep, using the diagnostic albedo from (1) and using the same surface downwelling (incident) flux that would otherwise be used to calculate solar heating.
3) Archiving the diagnostic calculations from (1) and (2) at the same frequency as other model output (e.g., daily or monthly).

The following gridded fields should be provided from the model:

- Net surface shortwave irradiance calculated without snow (rss_nosno)
- Mean shortwave surface albedo calculated without snow (albs_nosno)

Net surface solar energy flux in the absence of snow can then be differenced from that calculated with snow (output by default) to provide the SSRE. Depending on the spectral resolution of solar energy in each model, it would also be useful to provide the visible and near-infrared partitions of these fields:

- Net surface visible (0.2-0.7µm) irradiance calculated without snow
- Net surface near-IR (0.7-5.0µm) irradiance calculated without snow
- Mean visible surface albedo calculated without snow
- Mean near-IR surface albedo calculated without snow

Although the no-snow albedo fields are not strictly needed for the calculation of SSRE, they will complement standard albedo output from the model to facilitate convenient evaluation and the derivation of hypothetical SSRE from different (e.g., clear-sky) surface downwelling irradiance fields.

3.2. Tier 1 global offline simulations

3.2.1. Fixed snow albedo (SnowMIP-FA-LSM)

Purpose and underlying hypotheses

Seasonal and subseasonal variations of snow albedo are substantial and strongly influence the energy balance of the snow pack. This is particularly true during the melting season when complex processes within the snow pack lead to strong and rapid variation of snow albedo. During that time of the year, a strong positive feedback is at play that strongly influences snowmelt timing. Snow melt timing is a critical climatic variable that is often incorrectly represented in climate models, but because of the strong feedbacks involved, it is difficult to untangle the effects of the simulation of snow albedo from other processes. We therefore propose an experiment in which snow albedo is fixed to 0.7 (which approximates the CMIP5 multi-model mean peak snow albedo for non-boreal snow) to enable evaluation of the effect of seasonal snow albedo variations and biases in

LSMs, although the model response will depend very much on how snow masking by vegetation is parameterized.

Methods and practical considerations

Simulated snow water equivalent (SWE), fractional snow cover, vegetation masking, etc. will still influence the grid-point average surface albedo. The simulation period is 1980-2014. If possible, the fixed snow albedo value should also be used over the ice sheets and sea ice. Correct prescription of snow albedo can be easily verified by checking grid-scale average surface albedo in areas with deep snow cover and low vegetation.

Analysis, reference simulations, metrics and required observations

This simulation is linked to the LMIP-H offline reference simulation. Comparison with the same period in the reference simulation allows evaluation of the effect of snow albedo in terms of timing of snow melt, winter season surface temperature, energy flux partitioning and potentially as a source of model biases. In addition, the effect of vegetation masking on surface albedo in snow-covered areas will be isolated, since the snow-vegetation parameterizations will vary between models, but snow albedo will remain fixed. A basic metric to evaluate the effect of prescribed snow albedo will be the duration of snow cover (in particular melt onset) in this experiment compared to the reference simulation and observation. Required observations therefore concern snow cover seasonality, in particular snow melt dates, and general climate variables such as surface air temperature etc.

3.2.2. Prescribed observed snow water equivalent (SnowMIP-SWE-LSM)

Purpose and underlying hypotheses

The relationship between grid-scale snow water equivalent (SWE), fractional snow cover and hence surface albedo is complicated and very diverse solutions are presently implemented in coupled climate models. To identify LSM biases linked to the parameterization of surface albedo as a function of snow cover fraction (which in turn is usually a function of SWE), a prescribed SWE experiment is proposed here. The aim is to evaluate the simulated grid-scale albedo in these simulations against satellite-based observations of surface albedo.

Methods and practical considerations

Simulated grid-scale surface albedo in the presence of snow can depend explicitly on subgrid-scale topography, parameterized patchiness, vegetation cover, snow albedo, and other factors. The vegetation cover dependence includes explicitly simulated masking of vegetation by snow or vice versa. In particular, the albedo effect of transient snow load on trees after snowfall with subsequent unloading due to wind and melting, which is sometimes represented in current-generation ESM snow modules, should not be offset by too simple a prescription of observed SWE. It should therefore be left up to the modeling groups to decide exactly how SWE is prescribed in their models. However, the model SWE should satisfy the condition that the weekly average SWE in the model is close (by less than 10% or so) to the observed value. This can, for example, be obtained by a Newtonian relaxation of SWE to the weekly average with a time constant of a few days. Other state variables of the snow module (e.g., snow internal temperature, water content, snow grain size, etc.) will have to be adapted accordingly; again, given the diversity of snow modules, it is impossible to define here exactly how this needs to be done in general. Note that these considerations also apply for the LFMIP simulations of LS3MIP in which soil wetness and SWE are to be prescribed. In cases of snow modules where an unequivocal relationship ties surface albedo to SWE, it might be sufficient to run only the albedo scheme with prescribed SWE as input.

A number of snow analyses are available to serve as prescribed SWE (ERA-int-land, MERRA, ERA-Crocus, ESA-GlobSnow, and GLDAS). Final determination of selecting one of these or using a blended product remains to be determined.

Analysis, reference simulations, metrics and required observations

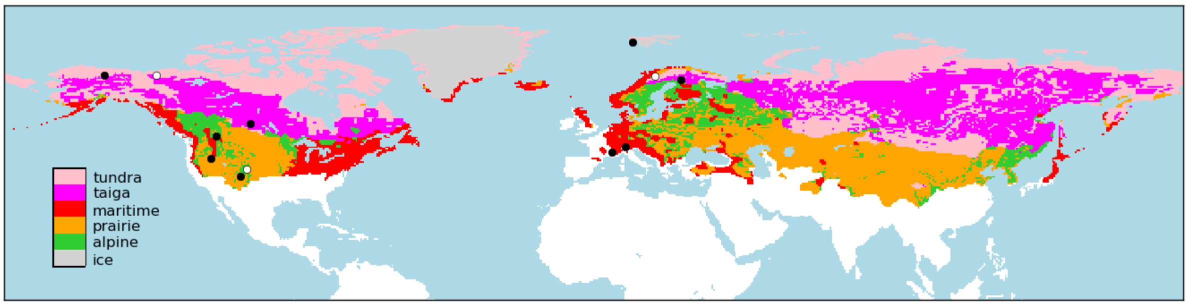
The simulated surface albedo will be compared to surface albedo as derived from satellite observations (MODIS, APP-x, GlobAlbedo). In particular, the change in the quality of the simulated surface albedo, compared to the "free" LFMIP simulation and the historical CMIP6 simulation will be evaluated in order to infer the part of surface albedo errors linked to erroneous snow mass balance.

3.3. Tier 1 Site simulations

3.3.1. Reference site simulation (SnowMIP-Ref-Site)

Purpose and underlying hypotheses

Site simulations are key to evaluating snow modules and identifying sources of model bias. Well-controlled boundary conditions (vegetation cover, meteorological forcing, etc.) are required to take full advantage of the potential of site simulations for this purpose. Our choice of reference sites draws on experience obtained from previous SNOWMIP phases, which concentrated on site simulations. Longer simulations than previously conducted in SnowMIP will be possible because of the recent publication of multi-year forcing and evaluation datasets from several well-instrumented and well-maintained sites listed in the Table 3 and shown in Figure 1.



Data provided by NCAR/EOL under sponsorship of the National Science Foundation. http://data.eol.ucar.edu/

Figure 1. Reference site locations on a map of seasonal snow classes.

Methods and practical considerations

Forcing data and site-specific ancillary information (vegetation cover, vegetation height, LAI, soil texture) will be provided for each of the reference sites. Ideally, models that have participated in LS3MIP will use the same configurations for SnowMIP-Ref-Site and SnowMIP-LargeScaleForcing-Site.

The models will start with saturated soil conditions. The ensuing spin-up consists of running twice through the period for which the site meteorological data are available. This yields at least 10 years of spin-up.

Table 3: List of proposed ESM-SnowMIP reference sites

Site	Snow Class	Forcing and Evaluation	Global Offline Diagnostic	Time Period
Reynolds Creek, USA	Alpine	X	X	1984-2008
Col de Porte, France	Alpine	X	X	1993-2011
Senator Beck, USA	Alpine	X	X	2006-2012
Weissfluhjoch, Switzerland	Alpine	X	X	1996-2010
Sodankyla, Finland	Taiga	X	X	2007-2014
BERMS, Canada	Taiga	X	X	1997-2014
Imnavait Creek, USA	Tundra	X	X	2007-2013
Bayelva, Svalbard	Tundra	X	X	
Marmot Basin, Canada	Alpine	X	X	2007-2014
Fraser, USA	Alpine		X	
Trail Valley Creek, Canada	Tundra		X	
Abisko, Sweden	Taiga		X	

Analysis, reference simulations, metrics and required observations

SWE is measured at all of the reference sites and will be the primary evaluation variable for reference site simulations. In addition, all of the sites have measurements of one or all of snow depth, albedo, radiometric surface temperature, snow temperature and soil temperature; these will allow more detailed analyses of reasons for model errors in SWE simulations and snow cover duration.

The forcing datatsets for most sites are already described in the literature, with the data freely available. Notably, the reference sites cover all the primary snow-climate classes with the exception of prairie snow (Figure 1; Sturm et al., 1995) and much longer time series are available than were used in SnowMIP-2 (2 years focused on forested sites). Detailed instructions on carrying out the site scale simulations, including the benchmarking/evaluation strategy will be distributed to participants at a later date.

4. Tier 2 ESM-SnowMIP simulations

A set of further simulations is proposed here as Tier 2. These optional simulations are described in less detail and will be defined more precisely depending on the interest of the modeling groups participating the ESM-SnowMIP.

4.1. Tier 2 coupled simulations

4.1.1. Prescribed snow water equivalent from coupled model's CMIP6 climatology, 4 additional ensemble members (SnowMIP-CAO4)

These are four additional members of the SnowMIP-CAO ensemble. See section **Error! Reference source not found.** for the description. Although these additional ensemble members are declared Tier 2, it is highly recommended that these simulations be carried out if possible by as many groups as possible, because of excepted high internal variability.

4.2. Tier 2 offline simulations

4.2.1. No thermal insulation by snow (SnowMIP-NI-LSM)

Purpose and underlying hypotheses

The second major climatic effect of snow is linked to its thermal properties, in particular its low thermal conductivity. Although snow thermal conductivity is highly variable and often not very well represented in climate models, the basic thermal effect of snow cover – insulation of the underlying soil – is represented in climate models. To quantify this effect, we propose an experiment in which snow is attributed a very high ("infinite") thermal conductivity, while its other properties (albedo, latent heat of melting, etc.) are kept unchanged.

Methods and practical considerations

A very high thermal conductivity of 50 $Wm^{-1}K^{-1}$ (compared to a typical value of 0.2 $Wm^{-1}K^{-1}$ for snow) is thought to be sufficient to mimic the quasi-absence of the thermal insulation effect of snow. However, in some cases, the models' numerical schemes might become unstable for very high thermal conductivities; in that case, a lower thermal conductivity might be prescribed or another solution might be envisaged (such as resetting the temperature or the net heat flux at the soil-snow interface to that calculated at the snow surface).

A long simulation might be required to attain deep soil equilibrium. A long experiment (1850-2014) is proposed in the offline version to allow for a good evaluation of the effect of snow insulation on deep soil temperatures. This simulation is pertinent for models with a deep soil column.

Analysis, reference simulations, metrics and required observations

In these long offline simulations, attention will be in particular on deep soil temperatures and, tightly linked to this in areas of seasonal snow cover, simulated permafrost extent. Simulated permafrost extent and active layer thickness will be diagnosed from the thermal state of the lowermost soil layer in the simulations and compared to the corresponding output of the LFMIP-H reference simulation and observations (GTN-P). Required reference data are soil temperature measurements and observations and analyses of surface energy fluxes at all seasons in areas with seasonal snow cover.

4.3. Tier 2 site simulations

4.3.1. Site simulation using large-scale forcing (SnowMIP-LargeScaleForcing-Site)

Purpose and underlying hypotheses

In large-scale data-model comparisons such as the global offline simulations proposed here, many questions arise concerning the quality of the large-scale meteorological forcing. For example, concerning snow modeling, a frequent problem is the quality of large-scale solid precipitation fields: gauge undercatch, and possibly insufficient or erroneous correction thereof, and inaccurate production of precipitation by climate models or reanalyses are classical obstacles preventing progress. Although observed site meteorological forcing data are certainly not perfect (they can in particular also be affected by gauge undercatch), it is probable that locally observed meteorological forcing data will be of better quality than meteorological forcing extracted from large-scale datasets, which will necessarily be representative of a larger area, typically about 50 km. Site simulations using such a large-scale meteorological forcing will enable us to evaluate the effect of "imperfect" large-scale meteorological forcing.

Methods and practical considerations

The large-scale meteorological forcing for the grid points corresponding to the ESM-SnowMIP reference sites in LMIP-H will be extracted and provided to the modeling groups. For models that have participated in LS3MIP, these simulations will differ from simulations for the corresponding grid points in the global simulations due to the prescription of site-specific vegetation and soil parameters.

Analysis, reference simulations, metrics and required observations

Compare large-scale meteorological forcing to observed meteorological data. Establish links between biases in the large-scale meteorological forcing data and differences between the corresponding site simulation and the reference site simulation. Comparisons with simulations from LS3MIP and SnowMIP-Ref-Site will allow separation of errors in SWE simulations due to the lack of site-specific forcing data and boundary conditions from model errors.

4.3.2. Site simulations using downscaled large-scale forcing (SnowMIP-LSF-downscaled-site)

Most of the ESM-SnowMIP reference sites are in mountainous regions and the site elevations may differ greatly from the corresponding grid point elevations in the large-scale forcing, which would therefore be expected to be biased at the sites even if it were perfect on the grid scale.

Downscaling is commonly required when using regional climate predictions in hydrological impact studies. This experiment will be forced with a simple downscaling to remove temperature and precipitation biases from the large-scale forcing relative to in situ averages. This will be helpful for separating snow simulation errors due to errors in seasonal cycles of forcing variables from elevation errors.

4.3.3. Site simulations using a shallow soil (SnowMIP-Shallow-Site)

The importance of a sufficiently deep soil has been particularly clearly noted in studies focusing on permafrost. Simulated active layer dynamics crucially depends on the representation of deep soil thermal inertia, which requires the existence of sufficiently deep soil layers in the model. However, it could be of interest to also evaluate the effect of too shallow a soil – ESM land surface modules frequently only simulate soil thermal dynamics down to a few meters – on the quality of the simulated snow cover, in particular snow phenology. This might provide clues to the interpretation of biases of climate models that only have a very shallow soil. In practice, this test concerns models that do have a deep soil column. These models will be run with a soil depth of about 1 or 2 m, corresponding to the soil depth of presently used "shallow" models. The lower boundary condition type (presumably zero flux in most cases) should be the same as in the reference run SnowMIP-Ref-Site.

4.3.4. Site simulation without thermal insulation by snow (SnowMIP-NI-Site)

This is the plot scale version of the Tier 1 offline simulation SnowMIP-NI-LSM. It could be of particular interest for non-distributed specific snow models and be helpful for the interpretation of results of the corresponding global offline simulation.

4.3.5. Site simulation with prescribed snow albedo (SnowMIP-FA-Site)

Similar to SnowMIP-NI-site, this experiment could be of particular interest for non-distributed specific snow models and be helpful for the interpretation of results of the corresponding global offline simulation.

5. Additional simulations using alternative snow parameterizations

Tests of alternative snow parameterizations are highly welcome complements to the simulations described here. Using either different parameter settings or entirely revised LSM snow schemes, it will be particularly useful to re-run the reference site and global offline reference simulations (LMIP) to evaluate model performance.