

8 Permafrost

8.1 Scenarios

The simulation scenarios for models only participating as permafrost models are described below. Assuming that for the relevant regions “other human influences” only play a minor role, i.e. the regional simulations can be done as “naturalized” runs (**nosoc**). Results from permafrost modules embedded in global biomes models should be reported for the biomes model simulations specified in Section 6 and the extension beyond 2299 described below.

Since the pre-industrial simulations are an important part of the experiments, the spin-up has to finish before the pre-industrial simulations start. The spin-up should be using pre-industrial climate (**picontrol**) and year 1860 levels of “other human influences”. For this reason, the pre-industrial climate data should be replicated as often as required. The precise implementation of the spin up will be model specific, the description of which will be part of the reporting process.

IMPORTANT: Please contact the permafrost sector coordinators (see <https://www.isimip.org/about/#contact>) before starting permafrost simulations. The list of requested output variables may be added to.

Climate & CO ₂ scenarios	
picontrol	Pre-industrial climate and 286ppm CO ₂ concentration. The climate data for the entire period (1661-2299) are unique – no (or little) recycling of data has taken place.
historical	Historical climate and CO ₂ concentration.
rcp26	Future climate and CO ₂ concentration from RCP2.6.
rcp60	Future climate and CO ₂ concentration from RCP6.0.
rcp85	Future climate and CO ₂ concentration from RCP8.5.
2299rcp26	Repeating climate between 2270 and 2299 for additional 200 years up to 2500 (or equilibrium if possible), CO ₂ fixed at year 2299 levels.
2005co2	Fixed year 2005 CO ₂ concentration.
Human influence & land-use scenarios	
nosoc	No human influences.

Table 23 ISIMIP2b scenario specification for the permafrost simulations.

Experiment		Input	Pre-industrial 1661-1860	Historical 1861-2005	Future 2006-2099	Extended future 2100-2299	Beyond 2299
I	no climate change, pre-industrial CO ₂	Climate & CO ₂	picontrol	not simulated	not simulated	not simulated	not simulated
	no other human influences	Human & LU	nosoc				
II	RCP2.6 climate & CO ₂	Climate & CO ₂	Experiment I	historical	rcp26	rcp26	2299rcp26
	no other human influences	Human & LU		nosoc	nosoc	nosoc	nosoc
Ila	RCP6.0 climate, CO ₂ varying until 2005, then fixed at 2005 levels thereafter	Climate & CO ₂	Experiment I	Experiment II	rcp26, 2005co2	rcp26, 2005co2	2299rcp26, 2005co2
	no other human influences	Human & LU			nosoc	nosoc	nosoc
III	RCP2.6 climate & CO ₂	Climate & CO ₂	Experiment I	Experiment II	rcp60	not simulated	not simulated
	no other human influences	Human & LU			nosoc		
IV-VII	Not simulated						
VIII	RCP8.5 climate & CO ₂	Climate & CO ₂	Experiment I	Experiment II	rcp85	not simulated	not simulated
	no other human influences	Human & LU			nosoc		

8.2 Output data

Table 24 Variables to be reported by permafrost models.

Variable name (long name)	Variable name	Unit (NetCDF format)		Resolution	Comment
Essential outputs					
Temperature of Soil	tsl	K	per gridcell	daily (monthly)	Temperature of each soil layer. Reported as "missing" for grid cells occupied entirely by "sea". THIS IS THE MOST IMPORTANT VARIABLE. Also need depths in meters. Daily would be great, but otherwise monthly would work.
Pools (as Biomes output Table)					
Carbon Mass in Vegetation biomass	cveg-<pft>	kg m-2	per pft and gridcell total	annual	Gridcell total cveg is essential. Per PFT information is desirable.
Carbon Mass in aboveground vegetation biomass	cvegag-<pft>	kg m-2	per pft and gridcell total	annual	Gridcell total cvegag is essential. Per PFT information is desirable.
Carbon Mass in belowground vegetation biomass	cvebg-<pft>	kg m-2	per pft and gridcell total	annual	Gridcell total cvebg is essential. Per PFT information is desirable.
Carbon Mass in Litter Pool	clitter	kg m-2	per gridcell total	annual	Info for each individual pool.
Carbon Mass in Soil Pool	csoil	kg m-2	per gridcell total	annual	Info for each individual pool.
*Total Carbon Mass in Soil Pool	soilc	kg m-2	per gridcell total	annual	Integrated over the entire soil depth
Fluxes (as Biomes output Table)					
Carbon Mass Flux out of atmosphere due to Gross Primary Production on Land	gpp	kg m-2 s-1	gridcell total	daily (monthly)	

Carbon Mass Flux out of atmosphere due to Gross Primary Production on Land	gpp-<pft>	kg m-2 s-1	per pft	annual	
Carbon Mass Flux into atmosphere due to Autotrophic (Plant) Respiration on Land	ra	kg m-2 s-1	gridcell total	daily (monthly)	
Carbon Mass Flux out of atmosphere due to Net Primary Production on Land	npp	kg m-2 s-1	gridcell total	daily (monthly)	
Carbon Mass Flux out of atmosphere due to Net Primary Production on Land	npp-<pft>	kg m-2 s-1	per pft	annual	
Carbon Mass Flux into atmosphere due to Heterotrophic Respiration on Land	rh	kg m-2 s-1	gridcell total	daily (monthly)	
Carbon Mass Flux into atmosphere due to total Carbon emissions from Fire	fireint	kg m-2 s-1	gridcell total	daily (monthly)	
*Carbon loss due to peat burning	somcfire	kg m-2 s-1	gridcell total	monthly	
Carbon Mass Flux out of Atmosphere due to Net biome Production on Land (NBP)	ecoatmflux	kg m-2 s-1	gridcell total	daily (monthly)	This is the net mass flux of carbon between land and atmosphere calculated as photosynthesis MINUS the sum of plant and soil respiration, carbon fluxes from fire, harvest, grazing and land-use change. Positive flux is into the land.
Structure [as Biomes output Table]					
Leaf Area Index	lai-<pft>	1	per pft	annual	

Leaf Area Index	lai-<pft>	1	gridcell average	daily (monthly)	
Plant Functional Type Grid Fraction	pft-<pft>	%	per gridcell	annual (or once if static)	The categories may differ from model to model, depending on their PFT definitions. This may include natural PFTs, anthropogenic PFTs, bare soil, lakes, urban areas, etc.. Sum of all should equal the fraction of the grid-cell that is land.
Hydrological variables [as per Biomes output Table]					
Runoff	qtot	kg m ⁻² s ⁻¹	per gridcell	daily** (monthly)	total (surface + subsurface) runoff (qtot = qs + qsb). If daily resolution not possible, please provide monthly. If storage issues keep you from reporting daily data, please contact the ISI-MIP team to discuss potential solutions. **For those models also participating in the water simulations
Soil moisture	soilmoist	kg m ⁻²	per grid cell	monthly	Please provide soil moisture for all depth layers (i.e. 3D-field), and indicate depth in m.
Frozen soil moisture for each layer	soilmoistfroz	kg m ⁻²	per gridcell	monthly	Please provide frozen soil moisture for all depth levels and indicate depth in m.
Snow depth	snd	m	per gridcell	daily (monthly)	Grid cell mean depth of snowpack.
Snow water equivalent	swe	kg m ⁻²	per gridcell	daily (monthly)	Total water mass of the snowpack (liquid or frozen), averaged over a grid cell.
Annual maximum thaw depth	thawdepth	m	per gridcell	annual	calculated from daily thaw depths
Other outputs					
Burnt Area Fraction	burntarea	%	per gridcell	daily (monthly)	fraction of entire grid cell that is covered by burnt vegetation

N ₂ O emissions into atmosphere	n2o	kg m ⁻² s ⁻¹	gridcell total	monthly	From land, not from industrial fossil fuel emissions and transport
CH ₄ emissions into atmosphere	ch4	kg m ⁻² s ⁻¹	gridcell total	monthly	From land, not from industrial fossil fuel emissions and transport