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/#sectors-and-contacts) before starting permafrost simulations.

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.

* Simulations using the human influence & land-use scenario design of the Biomes sector are also accepted (see Section 6.1), but nosoc is preferred.

Table 39 ISIMIP2b scenario specification for the permafrost simulations. Simulations using the scenario specifications of the Biomes sector are also accepted (see Section 6.1), but the permafrost specifications are preferred.

	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**
IIa	RCP2.6 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	RCP6.0 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 40 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 is preferred over monthly.
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	**cvegbg-<pft>**	kg m-2	per pft and gridcell total	annual	Gridcell total cvegbg 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	**npp**	kg m-2 s-1	gridcell total	daily (monthly)	

Primary Production on Land					
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 gridcell that is covered by burnt vegetation
N_2O emissions into atmosphere	**n2o**	kg m-2 s-1	gridcell total	monthly	From land, not from industrial fossil fuel emissions and transport
CH4 emissions into atmosphere	**ch4**	kg m-2 s-1	gridcell total	monthly	From land, not from industrial fossil fuel emissions and transport

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