Supporting Online Material for:

Assessing the impacts of 1.5°C global warming – simulation protocol of the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP2b)

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1 Output data

The variable names only consist of lower-case letters. Please make sure that you do not use capital letters in the variable and file names. There may be minor adjustments of the lists below that turn out to be helpful in the course of the project. Therefore a most up-to-date version of the simulation protocol will be provided at the ISIMIP website (www.isimip.org). Please refer to this latest version when starting your simulations.

If storage issues keep you from reporting daily data, please contact the ISIMIP team to discuss potential solutions.

1.1 Water (Global & Regional)

Note that variable names are chosen to comply, where feasible, with the ALMA convention (www.lmd.jussieu.fr/~polcher/ALMA/convention_output_3.html) and the names used in WATCH/WaterMIP. .

All variables are to be reported as time-averages with the indicated resolution; do not report instantaneous values ('snapshots'). An exception is **maxdis**, which is the maximum daily-average discharge in a given month, to be reported on a monthly basis (see below).

Table 1: *Output variables to be reported by water sector models. Variables highlighted in orange are requested from both **global and regional** models; discharge at gauge level (highlighted in purple) is requested only from regional models; other variables are requested only from global models. Variables marked by * are also relevant for the permafrost sector and also listed there.*

Variable (long name)	Variable name	Resolution	Unit (NetCDF format)	Comments
Hydrological Variables				
*Runoff	qtot	daily** (0.5°x0.5°)	kg m^{-2} s^{-1}	Total (surface + subsurface) runoff (qtot = qs + qsb). **If daily resolution not possible, please provide monthly. Please also deliver for the permafrost sector.

Surface runoff	qs	monthly (0.5°x0.5°)	kg m^{-2} s^{-1}	
Subsurface runoff	qsb	monthly (0.5°x0.5°)	kg m^{-2} s^{-1}	
Discharge (gridded)	dis	daily** (0.5°x0.5°)	m^3 s^{-1}	**if daily resolution not possible, please provide monthly
Discharge (gauge level)	dis	daily** (for gauge locations see www.isimip.org)	m^3 s^{-1}	**if daily resolution not possible, please provide monthly
Monthly maximum of daily discharge	maxdis	monthly (0.5°x0.5°)	m^3 s^{-1}	Reporting this variable is not mandatory, but desirable particularly if daily discharge data is unfeasible
Monthly minimum of daily discharge	mindis	monthly (0.5°x0.5°)	m^3 s^{-1}	Reporting this variable is not mandatory, but desirable particularly if daily discharge data is unfeasible
Evapotranspiration	evap	monthly (0.5°x0.5°)	kg m^{-2} s^{-1}	Sum of transpiration, evaporation, interception losses, and sublimation.
Potential Evapotranspiration	potevap	monthly (0.5°x0.5°)	kg m^{-2} s^{-1}	As evap, but with all resistances set to zero, except the aerodynamic resistance.
*Soil moisture	soilmoist	monthly (0.5°x0.5°)	kg m^{-2}	Please provide soil moisture for all depth layers (i.e. 3D-field), and indicate depth in m. Please also deliver for the permafrost sector.

Soil moisture, root zone	rootmoist	monthly (0.5°x0.5°)	kg m^{-2}	Total simulated soil moisture available for evapotranspiration. If simulated by the model. Please indicate the depth of the root zone for each vegetation type in your model
Frozen soil moisture for each layer	soilmoistfroz	monthly (0.5°x0.5°)	kg m^{-2}	Water content of frozen soil This variable only for the purposes of the permafrost sector.
*Temperature of Soil	tsl	daily** (0.5°x0.5°)	K	Temperature of each soil layer. Reported as "missing" for grid cells occupied entirely by "sea". Also need depths in meters. Daily would be great, but otherwise monthly would work. This variable only for the purposes of the permafrost sector **if daily resolution not possible, please provide monthly
*Snow depth	snd	monthly (0.5°x0.5°)	m	Grid cell mean depth of snowpack. This variable only for the purposes of the permafrost sector.
*Snow water equivalent	swe	monthly (0.5°x0.5°)	kg m^{-2}	Total water mass of the snowpack (liquid or frozen), averaged over a grid cell. Please also deliver for the permafrost sector.

*Annual maximum daily thaw depth	thawdepth	yearly (0.5°x0.5°)	m	This should be calculated from daily thaw depths, which do not need to be submitted themselves.
Rainfall	rainf	monthly (0.5°x0.5°)	kg m^{-2} s^{-1}	These variables are required for test purposes only. If you need to reduce output data volumes, please provide these variables only once, with the first (test) data set you submit, e.g. for the first decade of each experiment. NOTE: rainf + snowf = total precipitation
Snowfall	snowf	monthly (0.5°x0.5°)	kg m^{-2} s^{-1}	
Water management variables (for models that consider water management/human impacts)				
NOTE: Models that cannot separate different water use sectors may report the respective totals and include in the filenames the first letter of each sector included. E.g. combined potential water withdrawal in the **i**rrigation and **l**ivestock sectors would be "pilww"; combined actual water consumption in the **i**rrigation, **d**omestic, **m**anufacturing, **e**lectricity, and **l**ivestock sectors would be "aidmeluse" (see www.isimip.org for the latest naming convention regarding file names).				
Irrigation water demand (=potential irrigation water Withdrawal)	pirrww	monthly (0.5°x0.5°)	kg m^{-2} s^{-1}	Irrigation water withdrawal, assuming unlimited water supply
Actual irrigation water withdrawal	airrww	monthly (0.5°x0.5°)	kg m^{-2} s^{-1}	Irrigation water withdrawal, taking water availability into account; please provide if computed
Potential irrigation water consumption	pirruse	monthly (0.5°x0.5°)	kg m^{-2} s^{-1}	Portion of withdrawal that is evapo-transpired, assuming unlimited water supply

Actual irrigation water consumption	airruse	monthly (0.5°x0.5°)	kg m^{-2} s^{-1}	Portion of withdrawal that is evapotranspired, taking water availability into account; if computed
Actual green water consumption on irrigated cropland	airrusegreen	monthly (0.5°x0.5°)	kg m^{-2} s^{-1}	Actual evapotranspiration from rain water over irrigated cropland; if computed
Potential green water consumption on irrigated cropland	pirrusegreen	monthly (0.5°x0.5°)	kg m^{-2} s^{-1}	potential evapotranspiration from rain water over irrigated cropland; if computed and different from airrusegreen
Actual green water consumption on rainfed cropland	arainfusegreen	monthly (0.5°x0.5°)	kg m^{-2} s^{-1}	actual evapotranspiration from rain water over rainfed cropland; if computed
Actual domestic water withdrawal	adomww	monthly (0.5°x0.5°)	kg m^{-2} s^{-1}	if computed
Actual domestic water consumption	adomuse	monthly (0.5°x0.5°)	kg m^{-2} s^{-1}	if computed
Actual manufacturing water withdrawal	amanww	monthly (0.5°x0.5°)	kg m^{-2} s^{-1}	if computed

Actual Manufacturing water consumption	amanuse	monthly (0.5°x0.5°)	kg m^{-2} s^{-1}	if computed
Actual electricity water withdrawal	aelecww	monthly (0.5°x0.5°)	kg m^{-2} s^{-1}	if computed
Actual electricity water consumption	aelecuse	monthly (0.5°x0.5°)	kg m^{-2} s^{-1}	if computed
Actual livestock water withdrawal	aliveww	monthly (0.5°x0.5°)	kg m^{-2} s^{-1}	if computed
Actual livestock water consumption	aliveuse	monthly (0.5°x0.5°)	kg m^{-2} s^{-1}	if computed
Static output				
Soil types	soil	static (0.5°x0.5°)		Soil types or texture classes as used by your model. Please include a description of each type or class, especially if these are different from the standard HSWD and GSWP3 soil types. Please also include a description of the parameters and values associated with these soil types (parameter values could be submitted as spatial fields where appropriate).
Leaf Area Index	lai	static (0.5°x0.5°) or monthly (0.5°x0.5°) where appropriate		If used by, or computed by the model

1.2 Biomes

Table 2 *Variables to be reported by biomes models. Variables marked by * are also relevant for the permafrost sector and also listed there.*

long name	units		output variable name	frequency	comment
Essential outputs					
Pools					
*Carbon Mass in Vegetation biomass	kg m^{-2}	per pft and gridcell total	**cveg_<pft>**	year	Per PFT information is desirable but if not possible please provide grid cell total
*Carbon Mass in Litter Pool	kg m^{-2}	per pft and gridcell total	**clitter_<pft>**	year	Per PFT information is desirable but if not possible please provide grid cell total
*Carbon Mass in Soil Pool	kg m^{-2}	per pft and gridcell total	**csoil_<pft>**	year	Per PFT information is desirable but if not possible please provide grid cell total
Fluxes					
*Carbon Mass Flux out of atmosphere due to Gross Primary Production on Land	kg m^{-2} s^{-1}	gridcell total	**gpp**	mon (day)	essential
*Carbon Mass Flux out of atmosphere due to Gross Primary Production on Land	kg m^{-2} s^{-1}	per pft	**gpp_<pft>**	year	desirable

*Carbon Mass Flux into atmosphere due to Autotrophic (Plant) Respiration on Land	kg m^{-2} s^{-1}	gridcell total	**ra**	mon (day)	
*Carbon Mass Flux out of atmosphere due to Net Primary Production on Land	kg m^{-2} s^{-1}	gridcell total	**npp**	mon (day)	essential
*Carbon Mass Flux out of atmosphere due to Net Primary Production on Land	kg m^{-2} s^{-1}	per pft	**npp_<pft>**	year	desirable
*Carbon Mass Flux into atmosphere due to Heterotrophic Respiration on Land	kg m^{-2} s^{-1}	gridcell total	**rh**	mon (day)	
*Carbon Mass Flux into atmosphere due to total Carbon emissions from Fire	kg m^{-2} s^{-1}	gridcell total	**fireint**	mon (day)	
*Carbon Mass Flux out of Atmosphere due to Net biome Production on Land (NBP) (please specify if NBP≠NPP+HR+Fires in your model)	kg m^{-2} s^{-1}	gridcell total	**ecoatmflux**	mon (day)	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					

*Leaf Area Index	1	per pft	**lai_<pft>**	year	
*Leaf Area Index	1	gridcell average	**lai_<pft>**	Mon (day)	
*Plant Functional Type Grid Fraction	%	per gridcell	**pft_<pft>**	year (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					
Total Evapo-Transpiration	kg m^{-2} s^{-1}	gridcell total	**evap**	mon (day)	
Evaporation from Canopy (interception)	kg m^{-2} s^{-1}	gridcell total	**intercep**	mon (day)	The canopy evaporation+sublimation (if present in model).
Water Evaporation from Soil	kg m^{-2} s^{-1}	per gridcell	**esoil**	mon (day)	Includes sublimation.
Transpiration	kg m^{-2} s^{-1}	per gridcell	**trans**	mon (day)	
*Runoff	kg m^{-2} s^{-1}	per gridcell	**qtot**	mon (day**)	total (surface + subsurface) runoff (qtot = qs + qsb). **for models also participating in the

					water sector If daily resolution not possible, please provide monthly[1].
*Soil Moisture	kg m^{-2}	per gridcell	**soilmoist**	mon (day)	If possible, please provide soil moisture for all depth layers (i.e. 3D-field), and indicate depth in m. Otherwise, provide soil moisture of entire column.
Surface Runoff	kg m^{-2} s^{-1}	per gridcell	**qs**	mon (day)	The total surface runoff leaving the land portion of the grid cell.
*Frozen soil moisture for each layer	kg m^{-2}	per gridcell	**soilmoistfroz**	mon	Please provide soil moisture for all depth levels and indicate depth in m.
*Snow depth	m	per gridcell	**snd**	mon	Grid cell mean depth of snowpack.
*Snow water equivalent	kg m^{-2}	per gridcell	**swe**	mon	Total water mass of the snowpack (liquid or frozen), averaged over a grid cell.
*Annual maximum thaw depth	m	per gridcell	**thawdepth**	year	Calculated from daily thaw depths Please provide for purposes of permafrost sector.
Other outputs					

[1] If storage issues keep you from reporting daily data, please contact the ISIMIP team to discuss potential solutions.

*Temperature of Soil	K	per gridcell	**tsl**	day (mon)	Temperature of each soil layer. Reported as "missing" for grid cells occupied entirely by "sea". Also needs depths in meters. Daily would be great, but otherwise monthly would work.
Burnt Area Fraction	%	per gridcell	**burntarea**	mon (day)	fraction of entire grid cell that is covered by burnt vegetation
Albedo	-	per gridcell	**albedo**	mon	average of pfts, snow cover, bare ground and water surfaces, range between 0-1

Note: If you cannot provide the data at the temporal or spatial resolution specified, please provide it the highest possible resolution of your model. Please contact the coordination team (info@isimip.org) to for any further clarification, or to discuss the equivalent variable in your model.

1.3 Regional Forestry

Table 3 *Variables to be reported by forest models. Abbreviations are provided in Table* ***.***

Long name	units		output variable name	frequency	comment
Essential outputs					
Mean DBH	cm	per species and stand total	**dbh_<species/total>**	year	
Mean DBH of 100 highest trees	cm	stand total	**dbh_domhei**	year	
Stand Height	m	per species and stand total	**height_<species/total>**	year	For models including natural regeneration this variable may not make sense, please report dom_height
Dominant Height	m	stand total	**dom_height**	year	Mean height of the 100 highest trees
Stand Density	Trees ha^{-1}	per species and stand total	**density_<species/total>**	year	
Basal Area	m^{2} ha^{-1}	per species and stand total	**ba_<species/total>**	year	
Volume of Dead Trees	m^{3} ha^{-1}	per species and stand total	**mort_<species/total>**	year	
Harvest by dbh-class	m^{3} ha^{-1}	per species and stand total and dbh-class	**harv_<species/total>_<dbhclass>**	year	
Remaining stem number after disturbance and management by dbh class	Trees ha^{-1}	per species and stand total	**stemno_<species/total>_ <dbhclass>**	year	dbhclass_nameas specific in ***Table***
Stand Volume	m^{3} ha^{-1}	per species and stand total	**vol_<species/total>**	year	
Carbon Mass in Vegetation biomass (incl. Soil veg.?)	kg C m^{-2}	per species and stand total	**cveg_<species/total>**	year	
Carbon Mass in Litter Pool	kg C m^{-2}	per species and stand total	**clitter_<species/total>**	year	Info for each individual pool.
Carbon Mass in Soil Pool	kg C m^{-2}	per species and stand total	**csoil_<species/total>**	year	Info for each

					individual soil layer
Tree age by dbh class	yr	per species and stand total	**age_<species/total>_<dbhclass>**	year	dbhclass_name as specific in ***Table***
Gross Primary Production	kg m^{-2} s^{-1}	per species and stand total	**gpp_<species/total>**	day	As kg carbon*m^{-2}*s^{-1}
Net Primary Production	kg m^{-2} s^{-1}	per species and stand total	**npp_<species/total>**	day	As kg carbon*m^{-2}*s^{-1}
Autotrophic (Plant) Respiration	kg m^{-2} s^{-1}	per species and stand total	**ra_<species/total>**	day	As kg carbon*m^{-2}*s^{-1}
Heterotrophic Respiration	kg m^{-2} s^{-1}	stand total	**rh_< total>**	day	As kg carbon*m^{-2}*s^{-1}
Net Ecosystem Exchange	kg m^{-2} s^{-1}	per stand	**nee_<total>**	day	As kg carbon*m^{-2}*s^{-1}
Mean Annual Increment	m^3 ha^{-1}	per species and stand total	**mai_<species/total>**	year	
Fraction of absorbed photosynthetically active radiation	%	per species and stand total	**fapar_<species/total>**	day	
Leaf Area Index	m^2 m^{-2}	per species and stand total	**lai_<species/total>**	mon	
Species composition	% of basal area	per ha	**species_<species>**	year (or once if static)	The categories may differ from model to model, depending on their species and stand definitions.
Total Evapotranspiration	kg m^{-2} s^{-1}	stand total	**evap_< total>**	day	Sum of transpiration, evaporation, interception and sublimation. (=intercept + esoil + trans)
Evaporation from Canopy (interception)	kg m^{-2} s^{-1}	per species and stand total	**intercept_<species/total>**	day	the canopy evaporation+ sublimation (if present in model).

Water Evaporation from Soil	kg m^{-2} s^{-1}	per stand	**esoil**	day	includes sublimation.
Transpiration	kg m^{-2} s^{-1}	per species and stand total	**trans_<species/total>**	day	
Soil Moisture	kg m^{-2}	per stand	**soilmoist**	day	If possible, please provide soil moisture for all depth layers (i.e. 3D-field), and indicate depth in m. Otherwise, provide soil moisture of entire column.
Optional outputs					
Removed stem numbers by size class by natural mortality	Trees ha^{-1}	per species and stand total	**mortstemno_<species/total>_ <dbhclass>**	year	dbhclass_name as specific in ***Table***
Removed stem numbers by size class by management	Trees ha^{-1}	per species and stand total	**harvstemno_<species/total>_ <dbhclass>**	year	dbhclass_name as specific in ***Table***
Volume of disturbance damage	m^3 ha^{-1}	per species and stand total	**dist_<dist_name>**	year	dist_name as specific in ***Table***
Nitrogen of annual Litter	g N m^{-2} a^{-1}	per species and stand total	**nlit_<species/total>**	year	
Nitrogen in Soil	g N m^{-2} a^{-1}	stand total	**nsoil_<total>**	year	
Net Primary Production allocated to leaf biomass	kg m^{-2} s^{-1}	per species and stand total	**npp_landleaf_<species>**	day	As kg carbon*m^{-2}*s^{-1}
Net Primary Production allocated to fine root biomass	kg m^{-2} s^{-1}	per species and stand total	**npp_landroot_<species>**	day	As kg carbon*m^{-2}*s^{-1}
Net Primary Production allocated to above ground wood biomass	kg m^{-2} s^{-1}	per species and stand total	**npp_abovegroundwood_ <species>**	day	As kg carbon*m^{-2}*s^{-1}
Net Primary Production allocated to below ground	kg m^{-2} s^{-1}	per species and stand total	**npp_belowgroundwood_ <species>**	day	As kg carbon*m^{-2}*s^{-1}

wood biomass					
Root autotrophic respiration	kg m^{-2} s^{-1}	per species and stand total	**rr_<species/total>**	day	As kg carbon*m^{-2}*s^{-1}
Carbon Mass in Leaves	kg m^{-2}	per species and stand total	**cleaf_<species>**	year	
Carbon Mass in Wood	kg m^{-2}	per species and stand total	**cwood_<species>**	year	including sapwood and hardwood
Carbon Mass in Roots	kg m^{-2}	per species and stand total	**croot_<species>**	year	including fine and coarse roots
Temperature of Soil	K	per stand	**tsl**	day	Temperature of each soil layer

Note: If you cannot provide the data at the temporal or spatial resolution specified, please provide it the highest possible resolution of your model. Please contact the coordination team (info@isimip.org) to for any further clarification, or to discuss the equivalent variable in your model.

Table 4 *Codes for species, disturbance names and dbh classes as used in protocol (species, dist_name, dbhclass).*

long name	Short name
Fagus sylvatica	fasy
Quercus robur	quro
Quercus petraea	qupe
Pinus sylvestris	pisy
Picea abies	piab
Pinus pinaster	pipi
Larix decidua	lade
Acer platanoides	acpl
Eucalyptus globulus	eugl
Betula pendula	bepe
Betula pubescens	bepu
Robinia pseudoacacia	rops
Fraxinus excelsior	frex
Populus nigra	poni
Sorbus aucuparia	soau
hard woods	hawo
fire	fi
wind	wi
insects	ins
drought	dr
grazing	graz
diseases	dis
DBH_class_0-5*	dbh_c0
DBH_class_5-10*	dbh_c5
DBH_class_10-15*	dbh_c10
DBH_class_15-20*	dbh_c15
DBH_class_20-25*	dbh_c20
DBH_class_25-30*	dbh_c25
DBH_class_30-35*	dbh_c30
DBH_class_35-40*	dbh_c35
DBH_class_40-45*	dbh_c40

DBH_class_45-50*	dbh_c45
DBH_class_50-55*	dbh_c50
DBH_class_55-60*	dbh_c55
DBH_class_60-65*	dbh_c60
DBH_class_65-70*	dbh_c65
DBH_class_70-75*	dbh_c70
DBH_class_75-80*	dbh_c75
DBH_class_80-85*	dbh_c80
DBH_class_85-90*	dbh_c85
DBH_class_90-95*	dbh_c90
DBH_class_95-100*	dbh_c95
DBH_class_100-105*	dbh_c100
DBH_class_105-110*	dbh_c105
DBH_class_110-115*	dbh_c110
DBH_class_115-120*	dbh_c115
DBH_class_120-125*	dbh_c120
DBH_class_125-130*	dbh_c125
DBH_class_130-135*	dbh_c130
DBH_class_135-140*	dbh_c135
DBH_class_>140*	dbh_c140

*the boundaries of the dbh classes should be interpreted as follows: dbh_class_0-5 = 0 to<5 cm; dbh_class_5-10 =5 to<10 cm, etc…. the dbh class dbh_c140 includes all trees of 140cm dbh and larger.

Table 5 *Business-as-usual management scenarios for the different tree species. Please apply the following generic management guidelines. For past simulations and depending on the model, modellers should use the observed stem numbers from the time series of stand and tree level data to mimick stand management. Future management should then be added according to the generic management guidelines outlined below. E.g., The last management for the Peitz site can be infered from the tree data is taking place in 2011, hence the next management would then happen in 2026.*

Species	Thinning regime	Intensity [% of basal area]	Interval [yr]	Stand age for final harvest
pisy	below	20	15	140
piab	below	30	15	120
fasy	above	30	15	140
quro/qupe	above	15	15	200
pipi	below	20	10	45

1.4 Permafrost

Table 6 *Variables to be reported by permafrost models*

long name	units		output variable name	frequency	comment
Essential outputs					
Temperature of Soil	K	per gridcell	**tsl**	day (mon)	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	kg m^{-2}	per pft and gridcell total	**cveg_<pft>**	year	Gridcell total cveg is essential. Per PFT information is desirable.
Carbon Mass in Litter Pool	kg m^{-2}	per pft and gridcell total	**clitter_<pft>**	year	
Carbon Mass in Soil Pool	kg m^{-2}	per pft and gridcell total	**csoil_<pft>**	year	
Fluxes (as Biomes output Table)					
Carbon Mass Flux out of atmosphere due to Gross Primary Production on Land	kg m^{-2} s^{-1}	gridcell total	**gpp**	mon (day)	essential

Carbon Mass Flux out of atmosphere due to Gross Primary Production on Land	kg m^{-2} s^{-1}	per pft	**gpp_<pft>**	year	desirable
Carbon Mass Flux into atmosphere due to Autotrophic (Plant) Respiration on Land	kg m^{-2} s^{-1}	gridcell total	**ra**	mon (day)	
Carbon Mass Flux out of atmosphere due to Net Primary Production on Land	kg m^{-2} s^{-1}	gridcell total	**npp**	mon (day)	essential
Carbon Mass Flux out of atmosphere due to Net Primary Production on Land	kg m^{-2} s^{-1}	per pft	**npp_<pft>**	year	desirable
Carbon Mass Flux into atmosphere due to heterotrophic respiration on Land	kg m^{-2} s^{-1}	gridcell total	**rh**	mon (day)	
Carbon Mass Flux into atmosphere due to total Carbon emissions from fire	kg m^{-2} s^{-1}	gridcell total	**fireint**	mon (day)	

Carbon Mass Flux out of Atmosphere due to Net biome Production on Land (NBP) (please specify if NBP≠NPP+HR+Fires in your model)	kg m^{-2} s^{-1}	gridcell total	**ecoatmflux**	mon (day)	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	1	per pft	**lai_<pft>**	year	
Leaf Area Index	1	gridcell average	**lai_<pft>**	Mon (day)	
Plant Functional Type Grid Fraction	%	per gridcell	**pft_<pft>**	year (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 Biomes output Table]					
Runoff	kg m^{-2} s^{-1}	per gridcell	**qtot**	day** (mon)	total (surface + subsurface) runoff (qtot = qs + qsb). If daily resolution not possible, please provide monthly[2]. **For those models also participating in the water simulations
Soil moisture	kg m^{-2}	per grid cell	**soilmoist**	mon	please provide soil moisture for all depth layers (i.e. 3D-field), and indicate depth in m. Please also deliver for the permafrost sector.

[2] If storage issues keep you from reporting daily data, please contact the ISIMIP team to discuss potential solutions.

Frozen soil moisture for each layer	kg m^{-2}	per gridcell	**soilmoistfroz**	mon	Please provide soil moisture for all depth levels and indicate depth in m.
Snow depth	m	per gridcell	**snd**	mon	Grid cell mean depth of snowpack.
Snow water equivalent	kg m^{-2}	per gridcell	**swe**	mon	Total water mass of the snowpack (liquid or frozen), averaged over a grid cell.
Annual maximum thaw depth	m	per gridcell	**thawdepth**	year	calculated from daily thaw depths
Other outputs					
Burnt Area Fraction	%	per gridcell	**burntarea**	mon (day)	fraction of entire grid cell that is covered by burnt vegetation

1.5 Agriculture

Table 7 *Variables to be reported by crop models*

Variable	Variable name	Resolution	Unit	Comments
Key model outputs				
Crop yields	yield_<crop>	annual (0.5°x0.5°)	dry matter (t ha^{-1} yr^{-1})	
Irrigation water withdrawal (assuming unlimited water supply)	pirrww_<crop>	annual (0.5°x0.5°)	mm yr^{-1}	*Irrigation water withdrawn in case of optimal irrigation (in addition to rainfall), assuming no losses in conveyance and application.*
Key diagnostic variables				
Actual evapotranspiration	aet_<crop>	annual (0.5°x0.5°)	mm yr^{-1}	portion of all water (including rain) that is evapo-transpired, the water amount should be accumulated over the entire growing period (**not** the calendar year)
Nitrogen application rate	initr_<crop>	annual (0.5°x0.5°)	kg ha^{-1} yr^{-1}	Total nitrogen application rate. If organic and inorganic amendments are applied, rate should be reported as inorganic nitrogen equivalent (ignoring residues).
Actual planting dates	plant-day_<crop>	annual (0.5°x0.5°)	Day of year	Julian dates
Anthesis dates	anth-day_<crop>	annual (0.5°x0.5°)	Days from planting date	
Maturity dates	maty-day_<crop>	annual (0.5°x0.5°)	Days from planting date	

Additional output variables (optional)				
Biomass yields	biom_<crop>	annual (0.5°x0.5°)	Dry matter (t ha^{-1} yr^{-1})	
Soil carbon emissions	sco2_<crop>	annual (0.5°x0.5°)	kg C ha^{-1}	Ideally should be modeled with realistic land-use history and initial carbon pools. Subject to extra study.
Nitrous oxide emissions	sn2o_<crop>	annual (0.5°x0.5°)	kg N_2O-N ha^{-1}	Ideally should be modeled with realistic land-use history and initial carbon pools. Subject to extra study.

1.6 Energy

Table 8 *Variables to be reported by energy models*

Variable	Variable name	Unit	Comments
Energy Demand			
Total energy demand	ed_tot	EJ/time step	
Energy demand residential	ed_res	EJ/time step	
Energy demand industry	ed_ind	EJ/time step	
Energy demand transport	ed_trans	EJ/time step	
Energy Supply			
Solar power	p_sol	EJ/time step	
Wind power	p_wind	EJ/time step	
Gross hydropower	p_hydgross	EJ/time step	
Actual hydropower	p_hydact	EJ/time step	
Thermoelectric power total	p_therm	EJ/time step	Including nuclear, biomass, fossil-fueled power plants
Biomass production	prod_biom	EJ/time step	
Total energy extraction	extr_tot	EJ/time step	Sum of coal/shale/gas extraction

Economics			
Primary energy costs		US$2005/GJ	
Final energy costs		US$2005/GJ	Sum of average cost of electricity of all power plant technologies
Solar power costs		US$2005/GJ	
Wind power costs		US$2005/GJ	
Hydropower costs		US$2005/GJ	
Thermoelectric power costs		US$2005/GJ	Sum of average cost of electricity of coal/gas/nuclear/biomass-fueled plants
Adaptation costs		US$2005/GJ	
Electricity prices		US$2005/GJ	

1.7 Health

Table 9 *Variables to be reported by health models*

Long name	Units	Variable name	Spatial resolution	Comments
Number of deaths attributable to cold	number of people	an_cold	Per city/region/grid cell	Temperature below minimum mortality temperature (MMT)
Number of deaths attributable to heat	number of people	an_warm	Per city/region/grid cell	Temperature above MMT
Attributable fraction (cold)	%	af_cold	Per city/region/grid cell	Temperature below MMT
Attributable fraction (heat)	%	af_warm	Per city/region/grid cell	Temperature above MMT
Number of deaths attributable to cold extremes	number of people	an_extreme_cold	Per city/region/grid cell	< 2.5 percentile of daily temperature distribution
Number of deaths attributable to heat extremes	number of people	an_extreme_heat	Per city/region/grid cell	> 97.5 percentile of daily temperature distribution
Attributable fraction (heat extremes)	%	af_extreme_heat	Per city/region/grid cell	>97.5 percentile of daily temperature distribution
Attributable fraction (cold extremes)	%	af_extreme_cold	Per city/region/grid cell	< 2.5 percentile of daily temperature distribution

1.8 Infrastructure

Table 10 *Variables to be reported by coastal infrastructure models*

Variable	Variable name	Resolution	Unit	Comments
Expected number of people flooded annually	par	Time resolved grid	thousands/yr ($1000\ yr^{-1}$)	Par = People at risk.
Expected seaflood costs	seafloodcost		million dollars/yr (mio 2005US$ yr^{-1})	Expected annual damage caused by seafloods
Adaptation costs of building and upgrading dikes	seadikecost		million dollars/yr (mio 2005US$ yr^{-1})	Cost for building/upgrading dikes
Adaptation costs of maintaining dikes	seadikemain		million dollars/yr (mio 2005US$ yr^{-1})	Cost for maintenance of dikes build since the initial year (2000), but not cost for dikes “build” in the initialization of the model

1.9 Fisheries and Marine Ecosystems

Table 11 *Common output variables to be provided by global and regional marine fisheries models.*

Output variable	Variable name	Resolution	Unit (NetCDF format)	Comments
Essential outputs from global and regional models (provide as many as possible)				
TOTAL system biomass density	tsb	monthly	g C m^{-2}	all primary producers and consumers
TOTAL consumer biomass density	tcb	monthly	g C m^{-2}	all consumers (trophic level >1, vertebrates and invertebrates)
Biomass density of consumers >10cm	b10cm	monthly	g C m^{-2}	if L infinity is >10 cm, include in >10 cm class
Biomass density of consumers >30cm	b30cm	monthly	g C m^{-2}	if L infinity is >30 cm, include in >30 cm class
TOTAL Catch (all commercial functional groups / size classes) where fishing included in model	tc	monthly	g wet biomass / m^2, g m^{-2}	catch at sea (commercial landings plus discards, fish and invertebrates)
TOTAL Landings (all commercial functional groups / size classes) where fishing included in model	tla	monthly	g wet biomass / m^2, g m^{-2}	commercial landings (catch without discards, fish and invertebrates)

Optional output from global and regional models				
Biomass density of commercial species where fishing included in model	bcom	monthly	g C m^{-2}	Discarded species not included (Fish and invertebrates)
Biomass density (by functional group / size class) where fishing included in model	b-<class>-<group>	monthly	g C m^{-2}	Provide name of each size class (<class>) and functional group (<group>) used, and provide a definition of each class/group
Catch (by functional group / size class) where fishing included in model	c-<class>-<group>	monthly	g wet biomass / m^2,g m^{-2}	Provide name of each size class (<class>) and functional group (<group>) used, and provide a definition of each class/group

2 Individual contributions to sea level rise

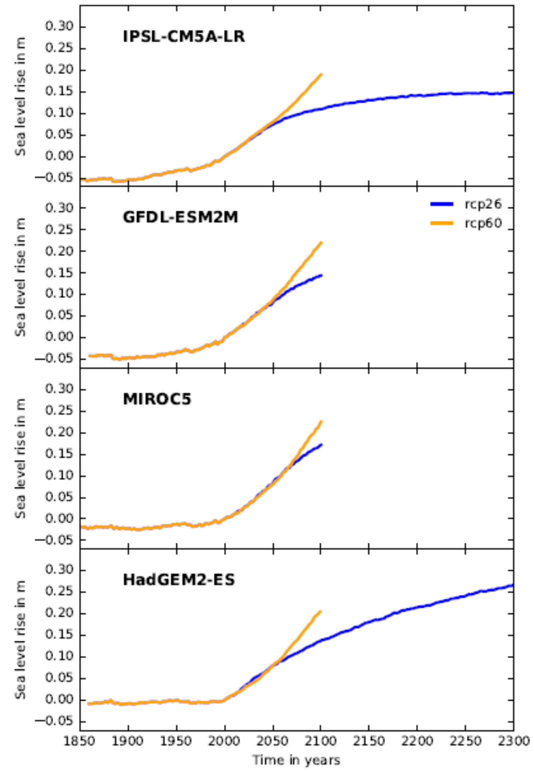

Figure S1 Time series of sea level rise due to thermal expansion as projected by GFDL-ESM2M (panel 1), HadGEM2-ES (panel 2), IPSL-CM5A-LR (panel 3) and MIROC5 (panel 4) for the historical simulations and RCP2.6 (blue) and RCP6.0 (yellow). All timeseries relative to year 2000.

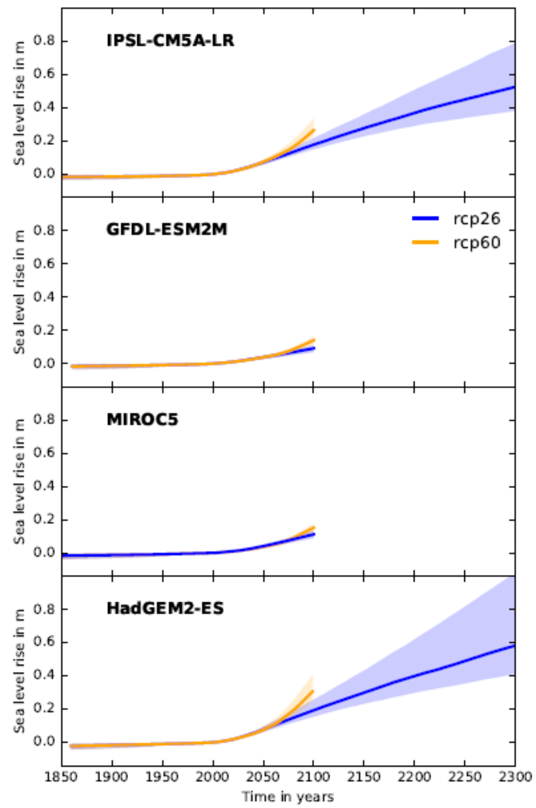

Figure S2 Time series Greenland's contribution to sea level rise based on global mean temperature change from GFDL-ESM2M (panel 1), HadGEM2-ES (panel 2), IPSL-CM5A-LR (panel 3) and MIROC5 (panel 4). Solid lines: Median projections, shaded areas: uncertainty range between the 5th and 95th percentile of the distribution. Blue: RCP2.6, yellow: RCP6.0. All timeseries relative to year 2000.

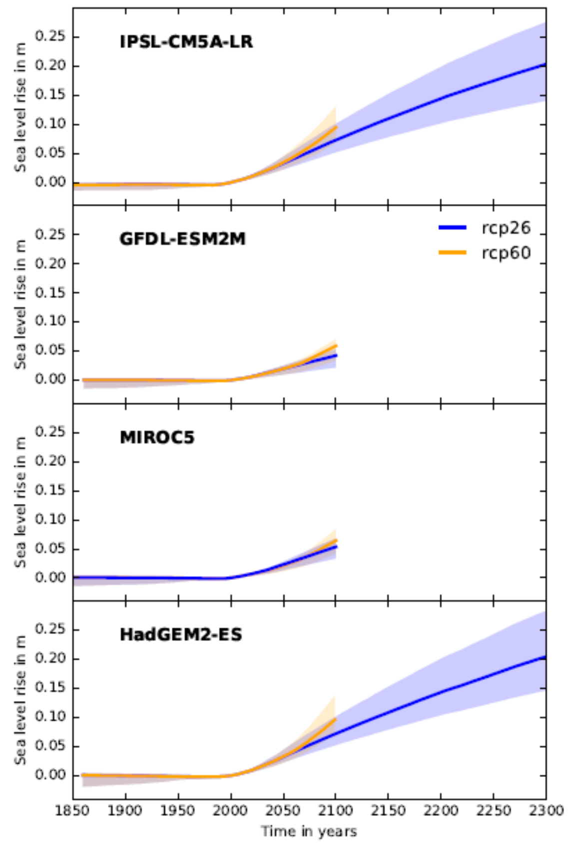

Figure S3 Time series Antarctica's contribution to sea level rise based on global mean temperature change from GFDL-ESM2M (panel 1), HadGEM2-ES (panel 2), IPSL-CM5A-LR (panel 3) and MIROC5 (panel 4). Solid lines: Median projections, shaded areas: uncertainty range between the 5th and 95th percentile of the distribution. Blue: RCP2.6, yellow: RCP6.0. All timeseries relative to year 2000.

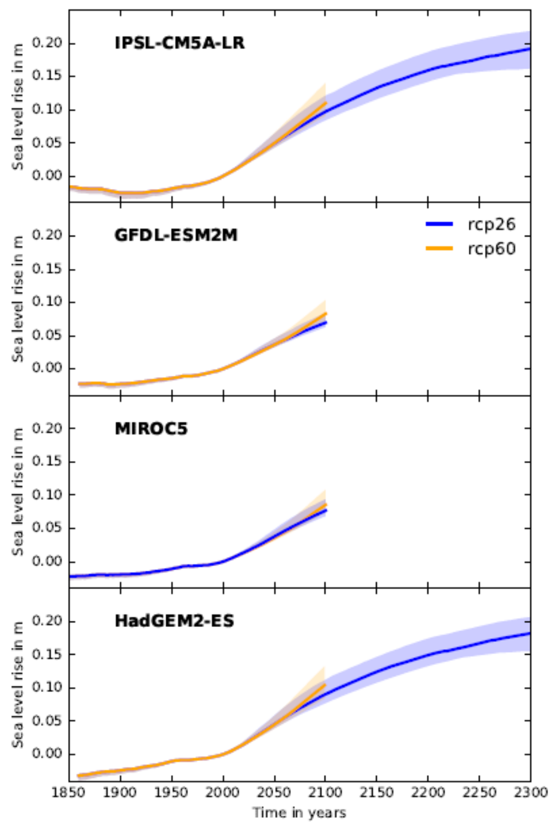

Figure S4 Time series of the contribution of mountain glaciers to sea level rise based on global mean temperature change from GFDL-ESM2M (panel 1), HadGEM2-ES (panel 2), IPSL-CM5A-LR (panel 3) and MIROC5 (panel 4). Solid lines: Median projections, shaded areas: uncertainty range between the 5th and 95th percentile of the distribution. Blue: RCP2.6, yellow: RCP6.0. All timeseries relative to year 2000.

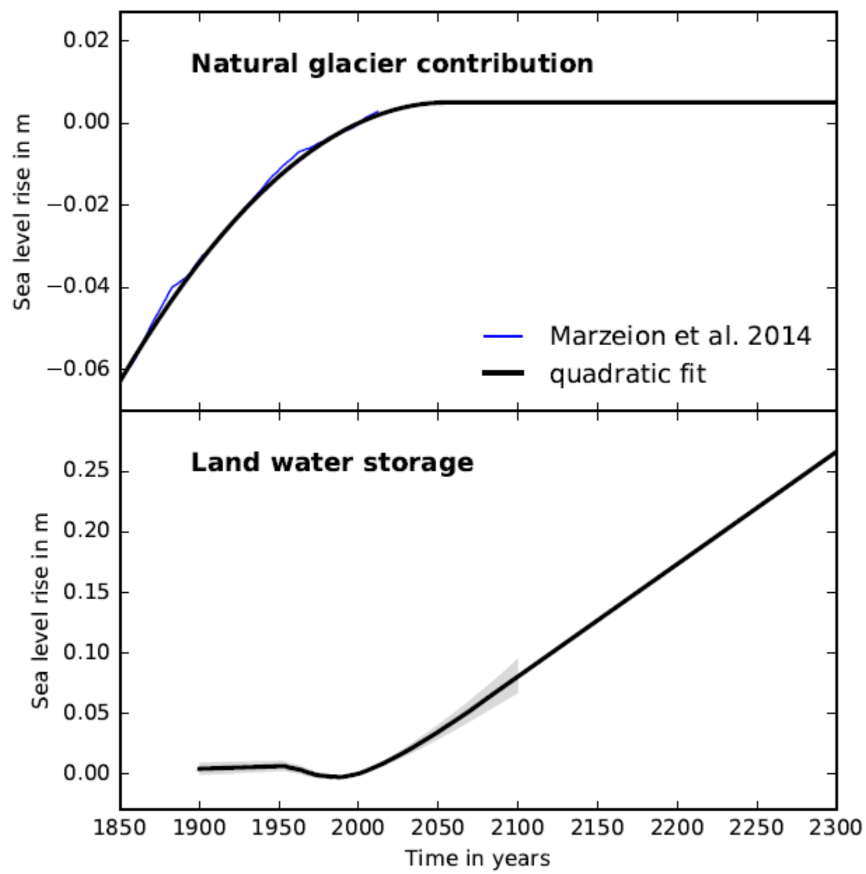

Figure S5 Sea level contributions that do not depend on current climate change: glaciers (upper panel: blue line as in Marzeion et al., 2014, black line: quadratic fit) and land water storage (Wada et al., 2012, lower panel). The land water storage timeseries is extended beyond 2100 with the 2050-2100 linear trend.

3 Derivation of crop-specific land-use and irrigation patterns

The HYDE3.2 land use patterns for the historical period as well as the MAgPIE patterns for the future only provide information on land use at a highly aggregated level while many of the hydrological or biomes models that account for land use changes offer a more specific representation of different crops and therefore also require a more detailed representation of land use patterns as input for their simulations. While LUH2 offers a disaggregation of the historical HYDE3.2 patterns into 5 crop classes (C_3 annual, C_3 nitrogen-fixing, C_3 perennial, C_4 annual, C_4 perennial) many models even need further disaggregation. To allow for an efficient use of the land use information for the historical and future period we i) extend the LUH2 disaggregation into the future based on the MAgPIE projections and ii) provide a further disaggregation of the historical and future agricultural land use categories into the following individual crops

1) maize, 2) oil crops (groundnut), 3) oil crops (rapeseed), 4) oil crops (soybeans), 5) oil crops (sunflower), 6) rice, 7) sugarcane

and crop classes

1) pulses, 2) temperate cereals (incl. wheat), 3) temperate roots, 4) tropical cereals, 5) tropical roots, 6) others annual, 7) others perennial, and 8) others N-fixing.

For all classes we also separate between rainfed and irrigated areas based on the irrigation fraction of total crop land described within HYDE3.2 or projected by MAgPIE.

The disaggregation is done in two steps: 1) From total crop land to the LUH2 categories where the information for the historical period is directly taken from the LUH2 data base (http://luh.umd.edu/data.shtml) and 2) from the LUH2 categories to the finer classes based on the harvested areas of 175 crops provided by Monfreda et al. (2008) for the year 2000. In both cases the share $x_{i,j}$ of a specific class $C_{i,j}$ (e.g. “annual C_3 crops” in step 1 or “maize” in step 2) in the broader class C_i (“total crop land” in step 1 or e.g. “C_4 annual”) at each grid cell

$$x_{i,j} = \frac{C_{i,j}}{C_i}$$

is assumed to stay constant over the historical period when disaggregating the HYDE3.2 or LUH2 data or over the future period when disaggregating the MAgPIE projections. For grid cells that contain crop land in the LUH2 or MAgPIE data while they are not covered by crop land in the LUH2 or Monfreda data set we apply a fraction $x_{i,j}$ that is representative of the country average crop mix the grid cell belongs to.

References

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