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Supplement of

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

Katja Frieler et al.

Correspondence to: Katja Frieler (katja.frieler@pik-potsdam.de)

1 Individual contributions to sea level rise

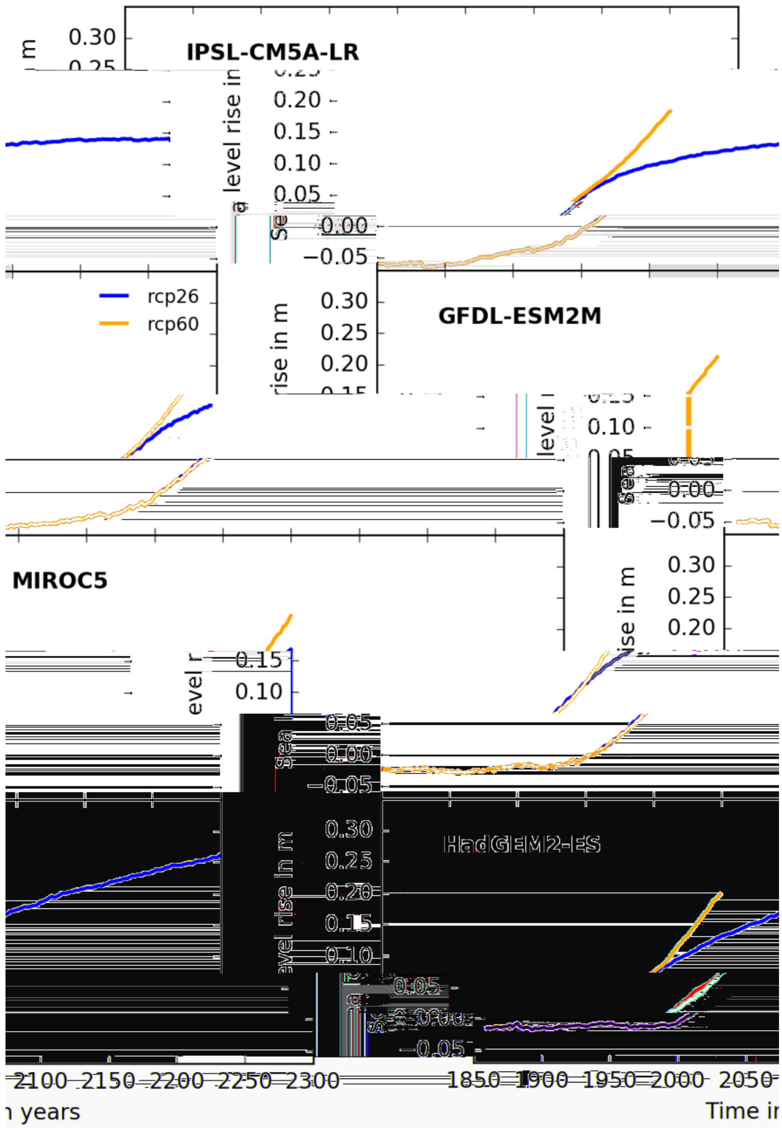

Figure S1 Time series of sea level rise due to thermal expansion as projected by GFDL-ESM2M (panel 1), HadGEM2-ES (panel 2), IPSL-CM5A-LR (panel 3) and MIROC5 (panel 4) for the historical simulations and RCP2.6 (blue) and RCP6.0 (yellow). All timeseries relative to year 2005.

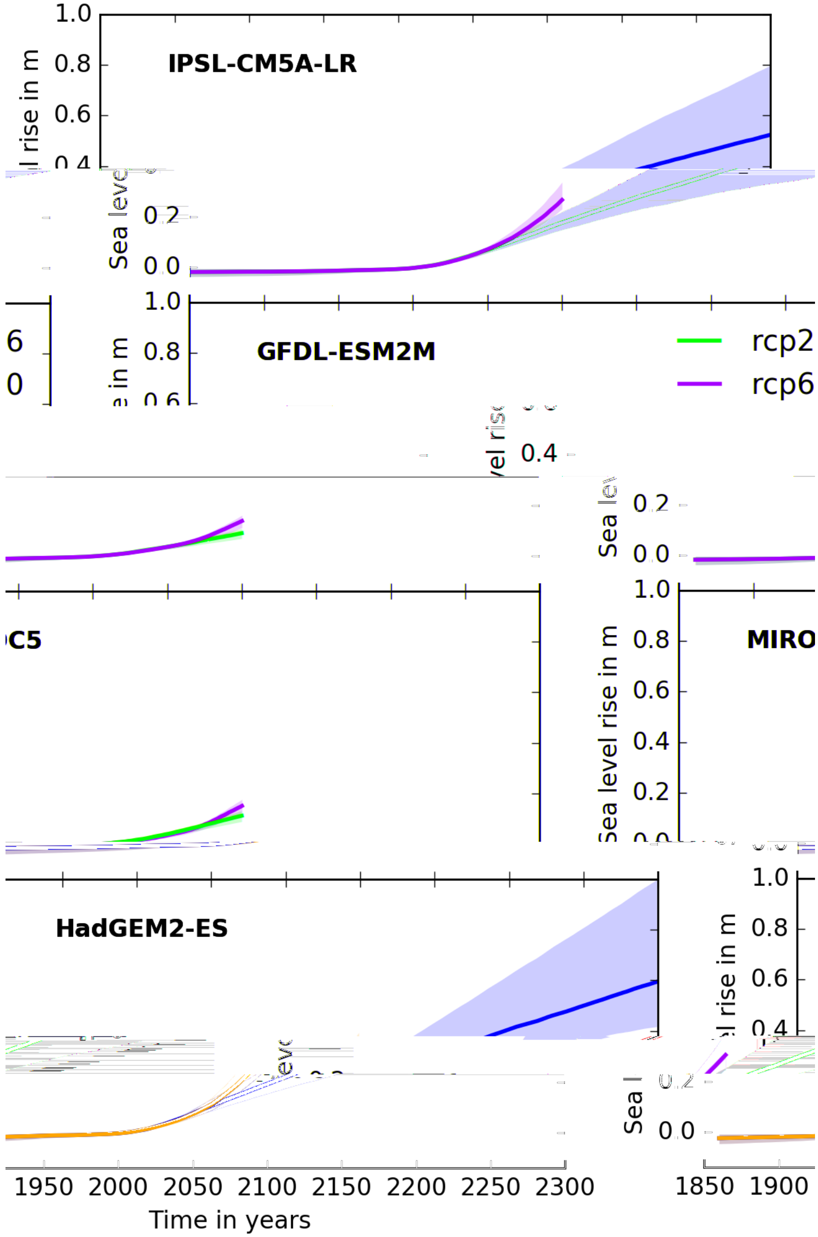

Figure S2 Time series of Greenland's combined contribution from solid ice discharge and surface mass balance changes to sea level rise based on global mean temperature change from GFDL-ESM2M (panel 1), HadGEM2-ES (panel 2), IPSL-CM5A-LR (panel 3) and MIROC5 (panel 4). Solid lines: Median projections, shaded areas:

uncertainty range between the 5th and 95th percentile of the distribution. Blue: RCP2.6, yellow: RCP6.0. All timeseries relative to year 2005.

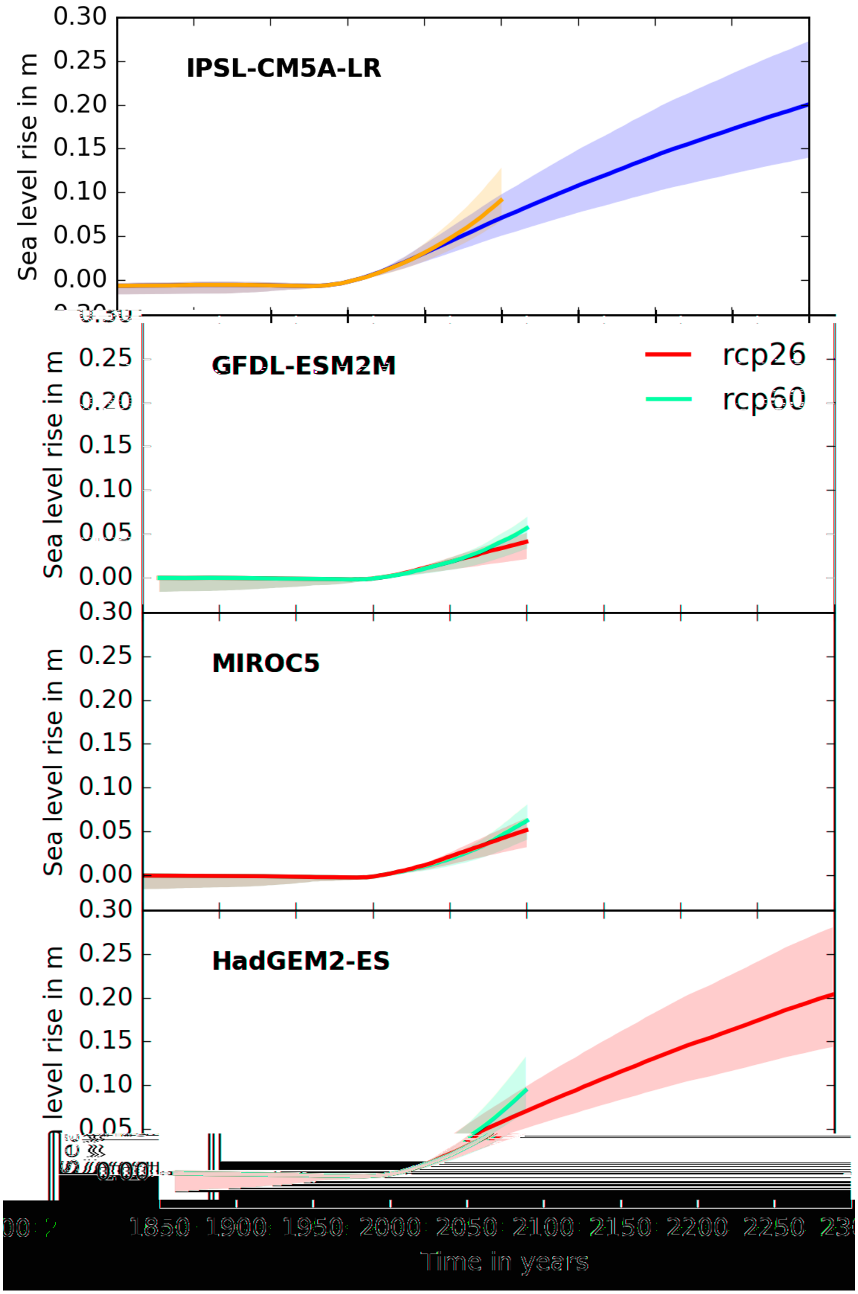

Figure S3 Time series of Antarctica's combined contribution from solid ice discharge and surface mass balance changes to sea level rise based on global mean temperature change from GFDL-ESM2M (panel 1), HadGEM2-ES (panel 2), IPSL-CM5A-LR (panel 3) and MIROC5 (panel 4). Solid lines: Median projections, shaded areas: uncertainty range between the 5th and 95th percentile of the distribution. Blue: RCP2.6, yellow: RCP6.0. All timeseries relative to year 2005.

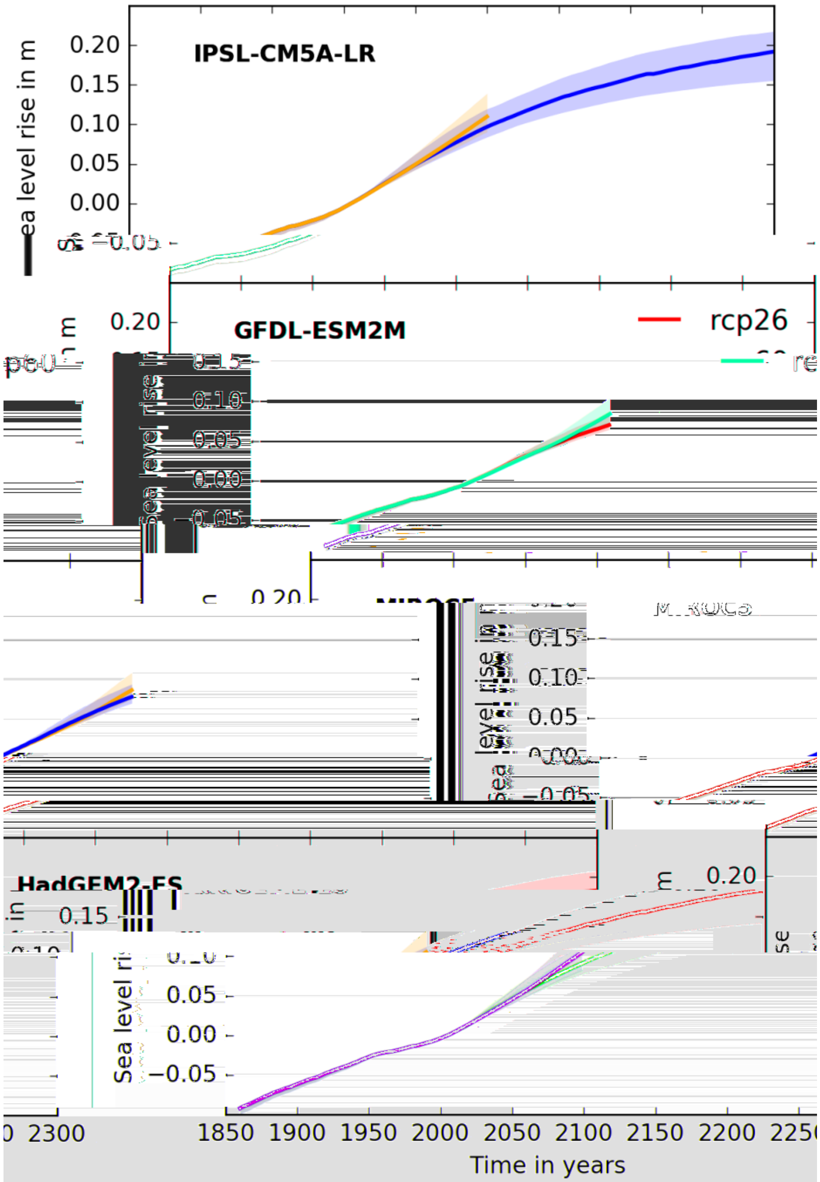

Figure S4 Time series of the contribution of mountain glaciers to sea level rise based on global mean temperature change from GFDL-ESM2M (panel 1), HadGEM2-ES (panel 2), IPSL-CM5A-LR (panel 3) and MIROC5 (panel 4). Solid lines: Median projections, shaded areas: uncertainty range between the 5th and 95th percentile of the distribution. Blue: RCP2.6, yellow: RCP6.0. We here show the combined non-anthropogenic and anthropogenic glacier response. All timeseries relative to year 2005.

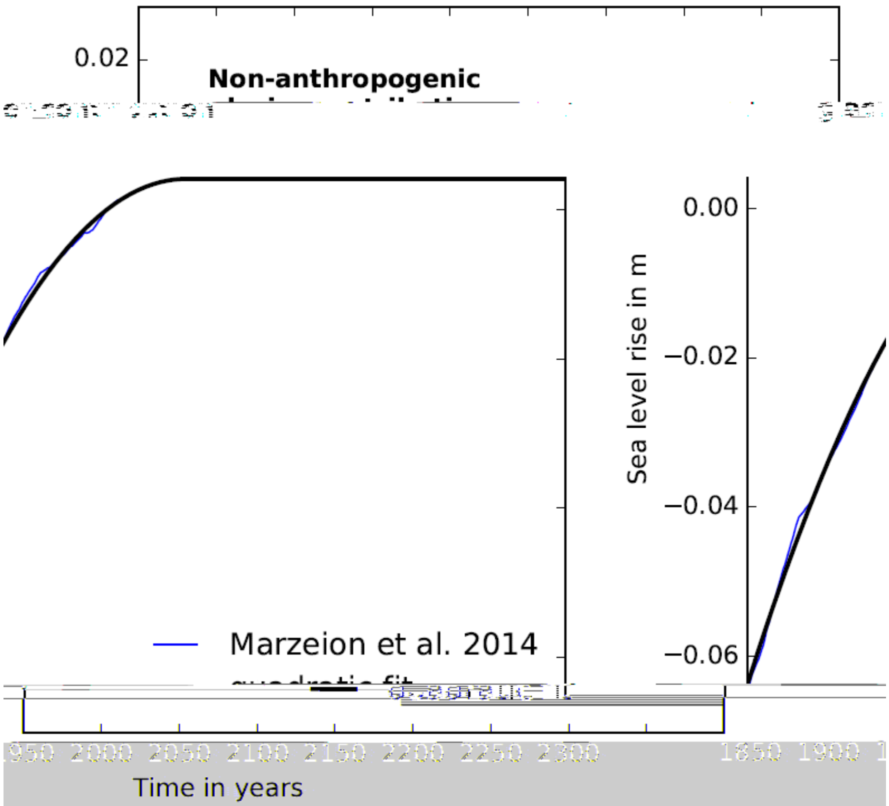

Figure S5 The sea level contribution from glaciers is partly due to an ongoing adjustment to climatic changes before the time of human intervention. We here parametrize this adjustment to past natural climate variation by fitting a quadratic curve (black line) to the modeled non-anthropogenic of Marzeion et al., 2014. In our parametrization the non-anthropogenic sea level rise from glaciers ceases in year 2056 and is assumed zero thereafter.

2 Comparison of MAgPIE crop land areas to the associated areas after harmonization

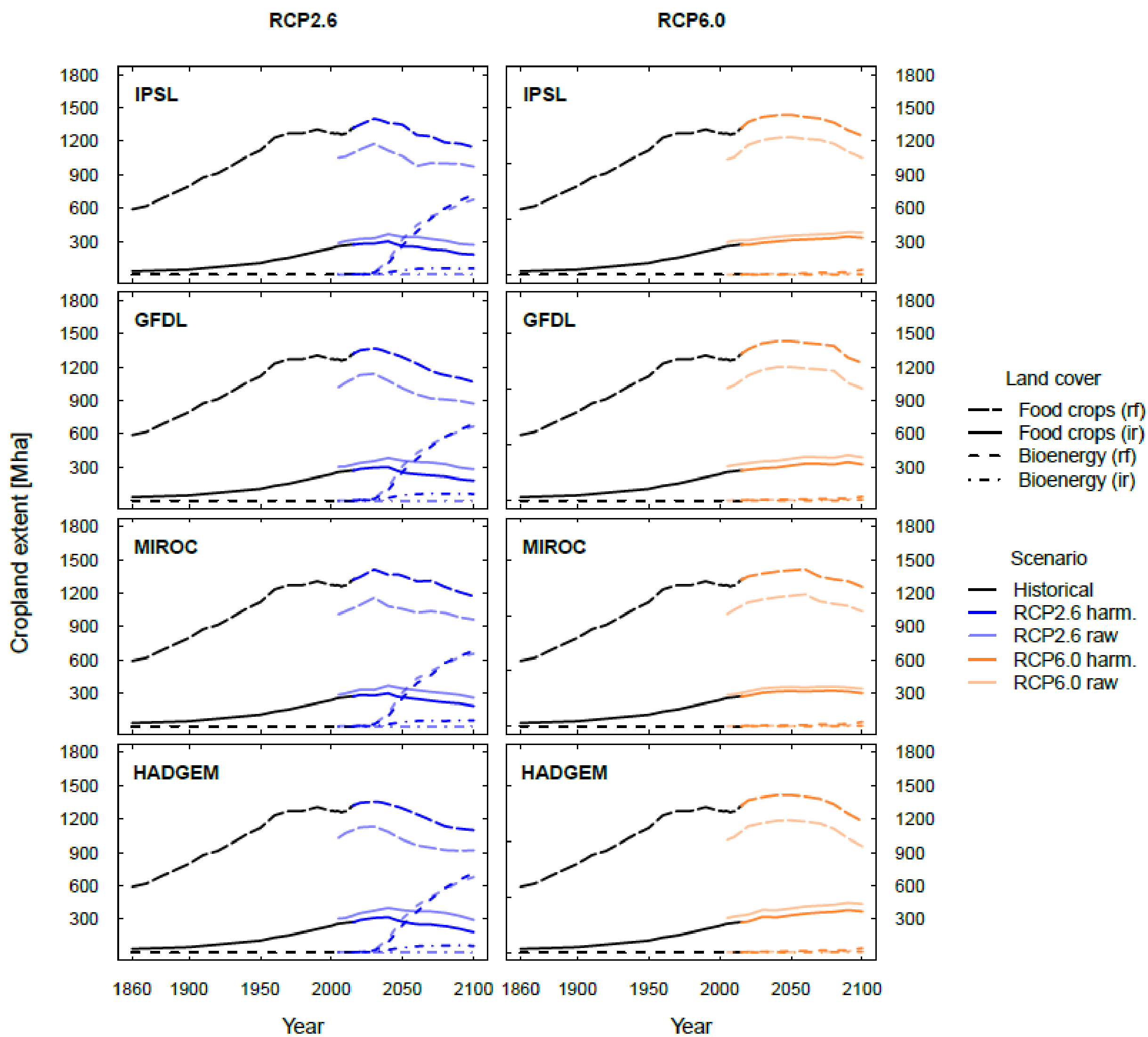

Figure S6: Comparison of areas of crop land from the original MAgPIE simulations and the harmonized version as derived for the four different climate projections. Left-hand column: Historical reconstruction (black lines) + crop land areas associated with RCP2.6 (blue lines); right-hand column: Historical reconstruction (black lines) + crop land areas associated with RCP6.0 (orange lines). Line types separate land cover classes: rainfed or irrigated food/feed crops and rainfed or irrigated bioenergy crops (see legend). Light hues indicate original MAgPIE simulations, dark hues indicate the total crop land extent after harmonization.

3 Separation of bioenergy areas (first level of disaggregation)

The harmonization method provides land use data at 0.25° resolution where it does not designate bioenergy areas within the five crop classes (c3per, c4per, c3ann, c4ann, and c3nfx). Before separation bioenergy areas cell fraction below 0.001 are set to 0 and all data are aggregated to 0.5°, the common grid of input (and output) data considered within ISIMIP2b. In the original MAgPIE setting bioenergy grass and bioenergy trees are distinguished and considered as part of c4per and c3per, respectively. In addition, in the MAgPIE simulations areas of bioenergy production are considered purely rainfed. To separate bioenergy areas from the harmonized c4per and c3per areas we apply the following procedure:

Separation of bioenergy grass land from c4per

The disaggregation of c4per into food/feed crops (c4per_food/feed) and biofuel (c4per_bf) builds on the fractions of biofuel to total c4per crop land provided by MAgPIE. To this end the MAgPIE information about the fractions is linearly interpolated to provide data for each year while originally it comes at 10-year time steps. However, the harmonization allocates c4per to grid cells that do not contain any c4per in the original MAgPIE simulations. Nevertheless, to determine an associated bioenergy fraction, the available information about bioenergy fractions from MAgPIE (c4per_bf / c4per) has been further extrapolated. This is done by an averaging across the nearest neighbors, where the size of the averaging window is increased until at least 3 non-NA values are found. Finally, total c4per_bf and c4per_food/feed are split up into rainfed and irrigated areas according to the irrigation fractions of total c4per derived from the harmonization. Resulting crop types are c4per_irrigated_food/feed, c4per_rainfed_food/feed, c4per_irrigated_bf, c4per_rainfed_bf, which add up to c4per provided by the harmonization. The separation applied here generates irrigated bioenergy grass land that does not exist in the original MAgPIE patterns. However, this approach is chosen to preserve the total area of irrigated agricultural land.

Separation of areas bioenergy grass land from c3per

Harmonized c3per are split into rainfed and irrigated fractions according to the c3per irrigation fractions provided by the harmonization method. In the original MAgPIE simulations c3per areas are substantially smaller than the c3per area derived from the harmonization due to different associations of the sub-crop type ”others”. Therefore it is not reasonable to extrapolate sparse MAgPIE c3per information on bioenergy fractions to all grid cells containing c3per after the harmonization. As the original MAgPIE projections do not show any c3per bioenergy crops before 2050, we also assume there is no c3per bioenergy until 2050 in the harmonized data. Thereafter we allocate any expansion of c3per areas in the harmonized data after 2050 to be due to bioenergy trees. The irrigation fraction of c3per_food/feed and c3per_bf is equal to the irrigation fraction of total c3per provided by the harmonization.

4 Derivation of crop-specific land-use and irrigation patterns (second level of disaggregation)

The historical reconstruction and the harmonized MAgPIE future projections only provides information on land use at a aggregated level while many of the hydrological or biomes models that account for land use changes offer a 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 provide a further disaggregation of the historical and future agricultural land use categories into the following individual crops

1) maize, 2) groundnut, 3) rapeseed, 4) soybeans, 5) 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 fractions provided by the LUH2-ISIMIP2b dataset. The disaggregation from the LUH2 categories to the finer classes is based on the harvested areas of 175 crops provided by Monfreda et al. (2008) for the year 2000. The share

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

of a specific class $C_{i,j}$ (e.g. “maize”) in the broader class C_i (e.g. “C_4 annual”) is assumed to stay constant. For grid cells that contain crop land in the LUH2-ISIMIP2b data while they are not covered by crop land in Monfreda data set we apply a fraction $x_{i,j}$ that is representative of the country average crop mix the grid cell belongs to.

5 Regional climate change projections of ISIMIP2b GCMs compared to CMIP5 GCMs

Regional mean temperature and precipitation changes versus global mean temperature change as projected by a range of CMIP5 GCMs including those selected for ISIMIP2b are shown in Figures S6 and S7. To allow for a direct comparison it is based on the raw data of the ISIMIP2b GCMs before the bias-adjustment. In order to assess how well the ISIMIP2b set covers these ranges of regional climate change projections, an analysis of the Fractional Range Coverage (FRC) as proposed by (McSweeney and Jones, 2016) is presented in Figure S8. Here, the FRC is calculated for the slopes of the linear fit lines depicted in Figures S6 and S7. We generated 500 random four-member subsets of the GCMs included in Figures S6 and S7. For each of these subsets and for the ISIMIP2b subset we then calculated all regional temperature and precipitation change FRCs. Then we determined the subset that yields the greatest/least mean value of these FRCs. Following the McSweeney and Jones (2016) terminology, this subset is called the Best/Worst Global Set. For the sake of completeness, we also determined the Best/Worst Regional Sets, which are a collection of the subsets that yield the greatest/least intra-regional mean FRCs.

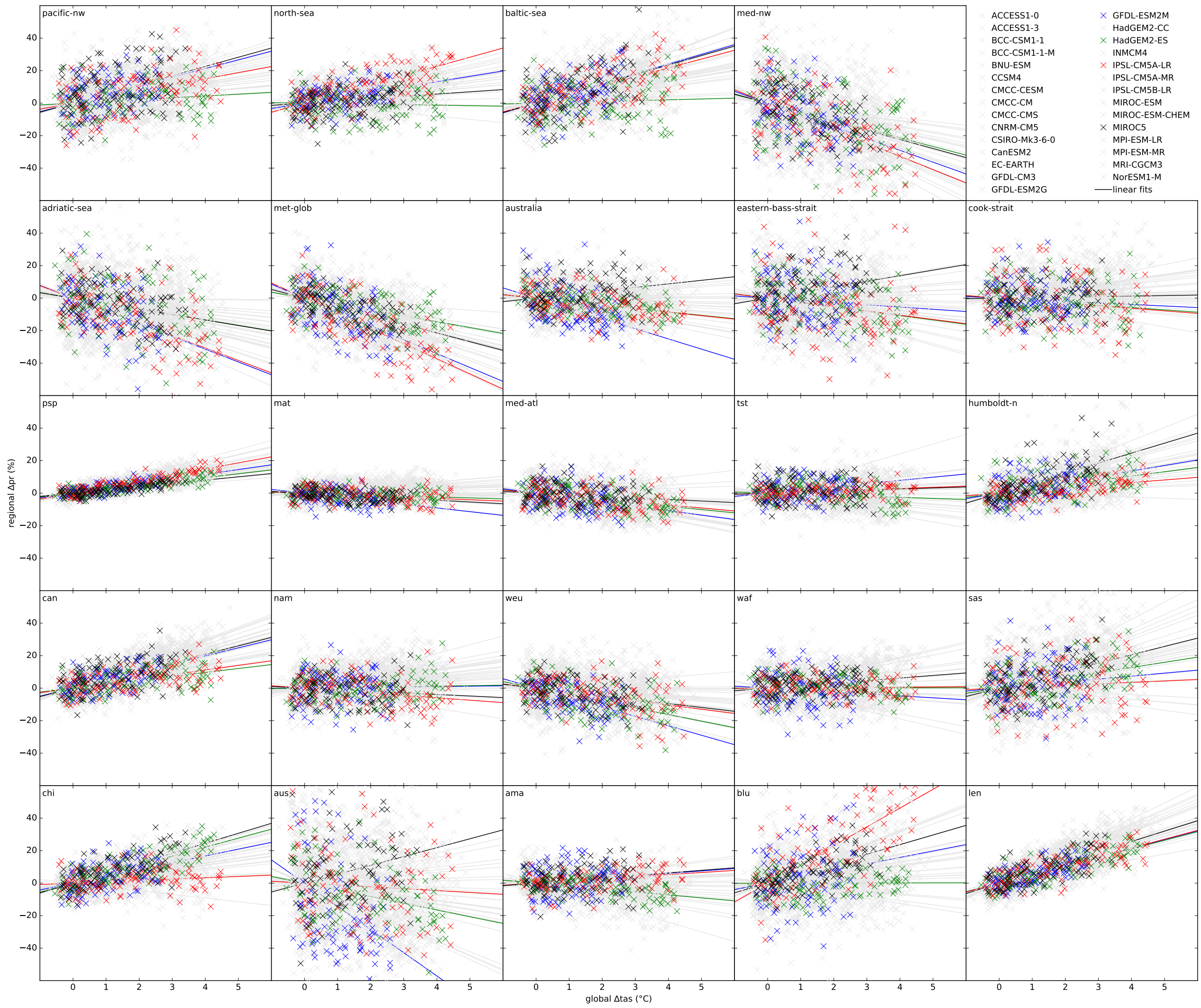

Figure S7 Regional versus global annual mean temperature change under RCP8.5 as simulated by the four ISIMIP2b GCMs (colored) and other CMIP5 GCMs (grey, see legend) for the 2006–2099 time period and all ISIMIP2b focus regions (see Figure 6 and Table 8). Temperature change is defined relative to the respective 2006–2028 mean value. Straight lines represent least-square zero-intercept linear fits to the annual data depicted as crosses.

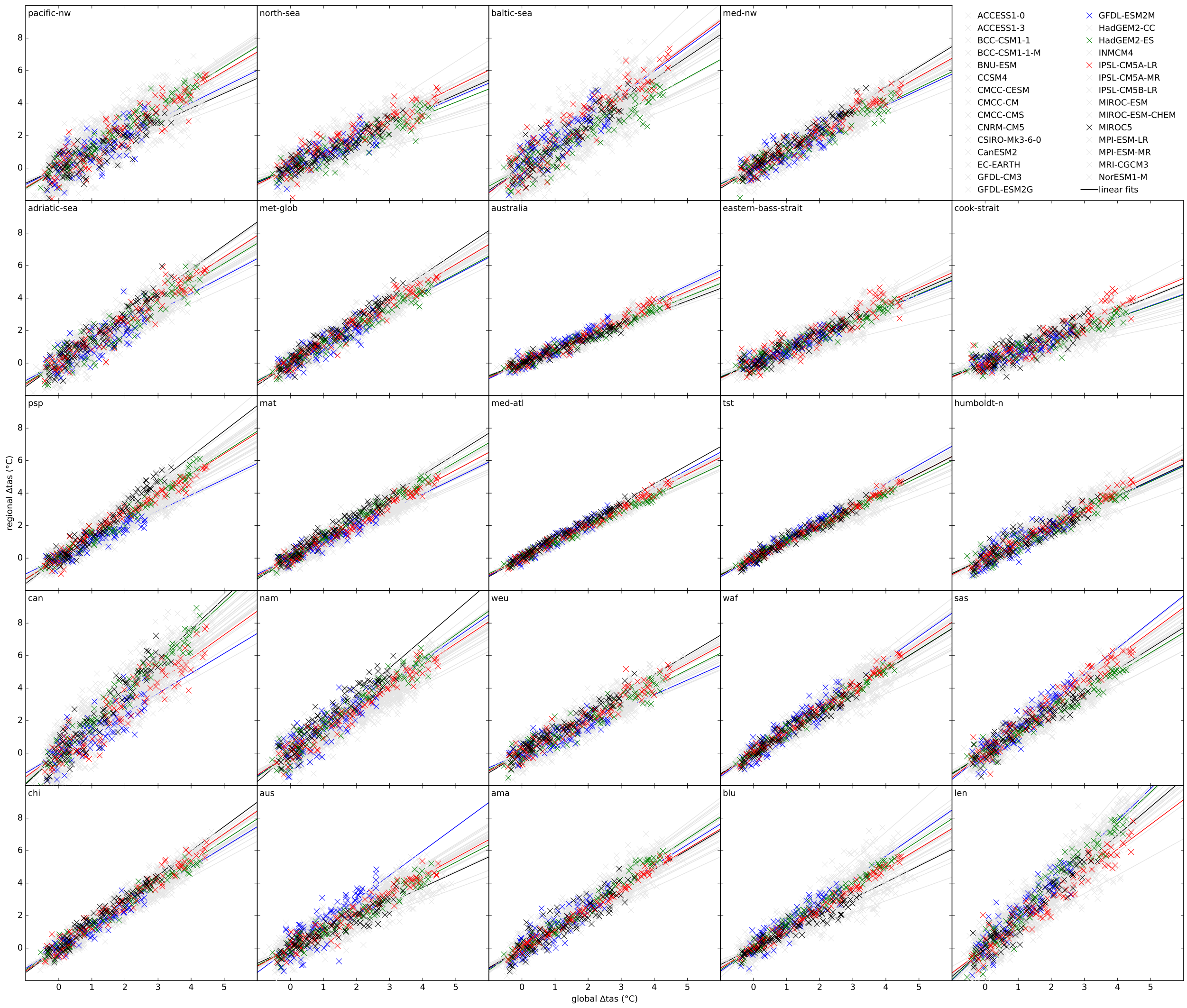

Figure S8 Regional annual mean precipitation change versus global annual mean temperature change under RCP8.5 as simulated by the four ISIMIP2b GCMs (colored) and other CMIP5 GCMs (grey, see legend) for the 2006–2099 time period and all ISIMIP2b focus regions (see Figure 6 and Table 8). All precipitation and temperature changes are defined relative to the corresponding 2006–2028 mean value. Straight lines represent least-square zero-intercept linear fits to the annual data depicted as crosses.

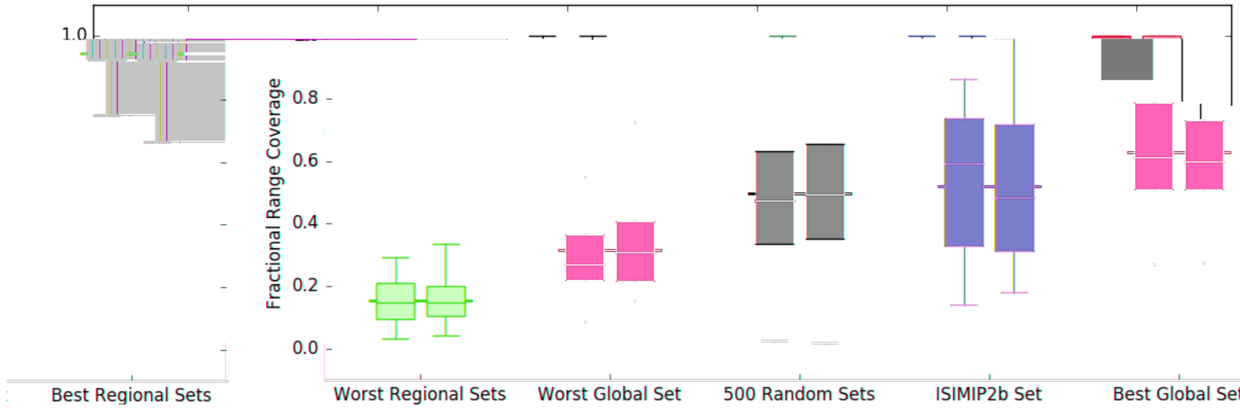

Figure S9 Distribution of the Fractional Range Coverage (FRC) of the regional temperature and precipitation change signals depicted as straight lines in Figures S6 and S7 for various (collections of) four-member subsets of the CMIP5 GCMs listed in Figures S6 and S7. Please see the text for a definition of the different subsets. For each subset or collection of subsets, left and right box-whisker plots represent distributions of regional temperature and precipitation change FRCs, respectively. The upper and lower whiskers are the maximum and minimum FRC, respectively. The thin horizontal lines represent the three quartiles. The thick line in the background represents the mean FRC of all regional temperature and precipitation change signals.

6 Sector-specific implementation of scenario design

6.1 Biomes

Table S1: ISIMIP2b scenarios for the global biomes simulations.

	Experiment	Input	Pre-industrial 1661-1860	Historical 1861-2005	Future 2006-2100	Extended future 2101-2299
I	no climate change, pre-industrial CO_2	Climate & CO_2	picontrol	picontrol	picontrol	picontrol
	varying LU & human influences up to 2005, then fixed at 2005 levels thereafter	Human & LU	1860soc	histsoc	2005soc	2005soc
II	RCP2.6 climate & CO_2	Climate & CO_2	Experiment I	historical	rcp26	rcp26
	varying LU & human influences up to 2005, then fixed at 2005 levels thereafter	Human & LU		histsoc	2005soc	2005soc
IIa	RCP2.6 climate, CO_2 after 2005 fixed at 2005 levels	Climate & CO_2	Experiment I	Experiment II	rcp26, 2005co2	rcp26, 2005co2
	LU & human influences fixed at 2005 levels after 2005	Human & LU			2005soc	2005soc

III	RCP6.0 climate & CO_2	Climate & CO_2	Experiment I	Experiment II	**rcp60**	not simulated
	LU & human influences fixed at 2005 levels after 2005	Human & LU			**2005soc**	
IV	no climate change, pre-industrial CO_2	Climate & CO_2	Experiment I	Experiment I	**picontrol**	**picontrol**
	varying human influences & LU up to 2100 (RCP2.6), then fixed at 2100 levels thereafter	Human & LU			**rcp26soc**	**2100rcp26soc**
V	no climate change, pre-industrial CO_2	Climate & CO_2	Experiment I	Experiment I	**picontrol**	not simulated
	varying human influences & LU (RCP6.0)	Human & LU			**rcp60soc**	
VI	RCP2.6 climate & CO_2	Climate & CO_2	Experiment I	Experiment II	**rcp26**	**rcp26**
	varying human influences & LU up to 2100 (RCP2.6), then fixed at 2100 levels thereafter	Human & LU			**rcp26soc**	**2100rcp26soc**

VII	RCP6.0 climate & CO_2	Climate & CO_2	Experiment I	Experiment II	**rcp60**	not simulated
	varying human influences & LU (RCP6.0)	Human & LU			**rcp60soc**	

6.2 Regional Forest

Table S2: ISIMIP2b scenarios for the regional forestry simulations.

	Experiment	**Input**	**Pre-industrial** 1661-1860	**Historical** 1861-2005	**Future** 2006-2100	**Extended future** 2101-2299
I	no climate change, pre-industrial CO_2	Climate & CO_2	not simulated	**picontrol**	**picontrol**	**picontrol**
	varying LU & human influences up to 2005, fixed present-day management afterwards	Human & LU		**histsoc**	**2005soc**	**2005soc**
II	RCP2.6 climate & CO_2	Climate & CO_2	not simulated	**historical**	**rcp26**	**rcp26**
	varying LU & human influences up to 2005, fixed present-day management afterwards	Human & LU		**histsoc**	**2005soc**	**2005soc**

IIa	RCP2.6 climate, CO_2 fixed after 2005	Climate & CO_2	not simulated	Experiment II	**rcp26, 2005co2**	**rcp26, 2005co2**
	fixed present-day management after 2005	Human & LU			**2005soc**	**2005soc**
III	RCP6.0 climate & CO_2	Climate & CO_2	not simulated	Experiment II	**rcp60**	not simulated
	fixed present-day management after 2005	Human & LU			**2005soc**	
IV	no climate change, pre-industrial CO_2	Climate & CO_2	not simulated	Experiment I	**picontrol**	**picontrol**
	varying management (forest management for mitigation)	Human & LU			**rcp26soc**	**2100rcp26soc**
V	no climate change, pre-industrial CO_2	Climate & CO_2	not simulated	Experiment I	**picontrol**	
	varying management (forest management for adaptation)	Human & LU			**rcp60soc**	
VI	RCP2.6 climate & CO_2	Climate & CO_2	not simulated	Experiment II	**rcp26**	**rcp26**
	varying management (forest management for mitigation)	Human & LU			**rcp26soc**	**2100rcp26soc**

VII	RCP6.0 climate & CO_2	Climate & CO_2	not simulated	Experiment II	**rcp60**	
	varying management (forest management for adaptation)	Human & LU			**rcp60soc**	

The regional forest simulations as described above are carried out once using the ISIMIP2b climate of the grid cell in which the forest sites are located and once using locally bias-adjusted data based on locally observed meteorological data.

6.3 Permafrost

Table S3: ISIMIP2b scenario specification for the permafrost simulations.

	Experiment	**Input**	**Pre-industrial 1661-1860**	**Historical 1861-2005**	**Future 2006-2100**	**Extended future 2101-2299**	**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			**nosoc**	**nosoc**	**nosoc**	**nosoc**

	human influences	Human & LU					
IIa	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**		

6.4 Agriculture

Table S4: ISIMIP2b scenarios for global crop simulations. *Option 2 only if option 1 not possible.

	Experiment	Input	Pre-industrial 1661-1860	Historical 1861-2005	Future 2006-2100	Extended future 2101-2299
I	no climate change, pre-industrial CO_2	Climate & CO_2	**picontrol**	**picontrol**	**picontrol**	**picontrol**
	varying management until 2005, then fixed at 2005 levels thereafter	Human & LU	Option 1*: **1860soc**	Option 1*: **histsoc**	**2005soc**	**2005soc**
	management fixed at 2005 levels		Option 2*: **2005soc**	Option 2*: **2005soc**		
II	RCP2.6 climate & CO_2	Climate & CO_2	Experiment I	**historical**	**rcp26**	**rcp26**
	varying management until 2005, then fixed at 2005 levels thereafter	Human & LU		Option 1*: **histsoc**	**2005soc**	**2005soc**
	management fixed at 2005 levels			Option 2*: **2005soc**		
IIa	RCP2.6 climate, CO_2 after 2005 fixed at 2005 levels	Climate	Experiment I	Experiment II	**rcp26, 2005co2**	**rcp26, 2005co2**

	management fixed at 2005 levels	Human & LU			**2005soc**	**2005soc**
III	RCP6.0 climate & CO_2	Climate & CO_2	Experiment I	Experiment II	**rcp60**	not simulated
	varying management until 2005, then fixed at 2005 levels thereafter	Human & LU			**2005soc**	
IV	no climate change, pre-industrial CO_2	Climate & CO_2	Experiment I	Experiment I	**picontrol**	**picontrol**
	varying management up to 2100 (RCP2.6), then fixed at 2100 levels thereafter	Human & LU			**rcp26soc**	**2100rcp26soc**
V	no climate change, pre-industrial CO_2	Climate & CO_2	Experiment I	Experiment II	**picontrol**	not simulated
	varying management (RCP6.0)	Human & LU			**rcp60soc**	
VI	RCP2.6 climate & CO_2	Climate & CO_2	Experiment I	Experiment II	**rcp26**	**rcp26**
	varying management up to 2100 (RCP2.6), then fixed at 2100 levels	Human & LU			**rcp26soc**	**2100rcp26soc**

	thereafter					
VII	RCP6.0 climate & CO_2	Climate & CO_2	Experiment I	Experiment II	**rcp60**	
	varying management (RCP6.0)	Human & LU			**rcp26soc**	

6.5 Energy

Table S5: ISIMIP2b scenarios for the simulations within the energy sector. *Option 2 only if option 1 not possible.

	Experiment	Input	Pre-industrial 1661-1860	Historical 1861-2005	Future 2006-2100	Extended future 2101-2299
I	no climate change, pre-industrial CO_2	Climate & CO_2	**picontrol**	**picontrol**	**picontrol**	**picontrol**
	varying society up to 2005, then fixed at 2005 levels thereafter	Human & LU	Option 1: **1860soc**	Option 1: **histsoc**	**2005soc**	**2005soc**
	fixed 2005 socio-economic conditions		Option 2*: **2005soc**	Option 2*: **2005soc**		
Ib	no climate change, pre-industrial	Climate &	**picontrol**	**picontrol**	**picontrol**	**picontrol**

	CO_2	CO_2				
	varying society up to 2015, then fixed at 2015 levels thereafter	Human & LU	Option 1: **1860soc**	Option 1: **histsoc**	**2015soc**	**2015soc**
	fixed 2015 socio-economic conditions		Option 2*: **2015soc**	Option 2*: **2015soc**		
II	RCP2.6 climate & CO_2	Climate& CO_2	Experiment I	**historical**	**rcp26**	**rcp26**
	varying society up to 2005, then fixed at 2005 levels thereafter	LU etc.		Option 1: **histsoc**	**2005soc**	**2005soc**
	fixed 2005 socio-economic conditions			Option 2*: **2005soc**		
IIb	RCP2.6 climate & CO_2	Climate & CO_2	Experiment Ia	**historical**	**rcp26**	**rcp26**
	varying society up to 2015, then fixed at 2015 levels thereafter	Human & LU		Option 1: **histsoc**	**2015soc**	**2015soc**
	fixed 2015 socio-economic conditions			Option 2*: **2015soc**		

III	RCP6.0 climate & CO_2	Climate & CO_2	Experiment I	Experiment II	**rcp60**	not simulated
	varying society up to 2005, then fixed at 2005 levels thereafter	LU etc.			**2005soc**	
IIIb	RCP6.0 climate & CO_2	Climate & CO_2	Experiment Ia	Experiment IIa	**Rcp60**	not simulated
	varying society up to 2015, then fixed at 2015 levels thereafter	Human & LU			**2015soc**	
IV	no climate change, pre-industrial CO_2	Climate& CO_2	Experiment I	Experiment I	**picontrol**	**picontrol**
	varying society up to 2100 (SSP2+RCP2.6), then fixed at 2100 levels thereafter	LU etc.			**rcp26soc**	**2100rcp26soc**
V	no climate change, pre-industrial CO_2	Climate	Experiment I	Experiment II	**picontrol**	not simulated
	varying society up to 2100 (SSP2+RCP6.0), then fixed at 2100 levels thereafter	LU etc.			**rcp60soc**	
VI	RCP6.0 climate & CO_2	Climate	Experiment I	Experiment II	**rcp26**	**rcp26**

	varying society up to 2100 (SSP2+RCP2.6), then fixed at 2100 levels thereafter	LU etc.			**rcp26soc**	**2100rcp26soc**
VII	RCP6.0 climate & CO_2	Climate	Experiment I	Experiment II	**rcp60**	
	varying society up (SSP2+RCP6.0)	LU etc.			**rcp26soc**	

6.6 Temperature-Related Mortality

Table S6: ISIMIP2b scenarios for temperature-related mortality simulations. Option 2* only if option 1 not possible.

	Experiment	**Input**	**Pre-industrial** **1661-1860**	**Historical** **1861-2005**	**Future** **2006-2100**	**Extended future** **2101-2299**
I	no climate change	Climate	**picontrol**	**picontrol**	**picontrol**	**picontrol**
	varying society up to 2005, then fixed at 2005 levels thereafter, no adaptation	Human	Option 1: **1860soc**	Option 1: **histsoc**	**2005soc**	**2005soc**
	society fixed at 2005 levels, no adaptation		Option 2*: **2005soc**	Option 2*: **2005soc**		

II	RCP2.6 climate	Climate	Experiment I	**historical**	**rcp26**	**rcp26**
	varying society up to 2005, then fixed at 2005 levels thereafter, no adaptation	Human		Option 1*: **histsoc**	**2005soc**	**2005soc**
	society fixed at 2005 levels, no adaptation			Option 2*: **2005soc**		
III	RCP6.0 climate	Climate	Experiment I	Experiment II	**rcp60**	not simulated
	society fixed at 2005 levels, no adaptation	Human			**2005soc**	
IV	no climate change	Climate	Experiment I	Experiment II	**picontrol**	**picontrol**
	varying society (SSP2) up to 2100, then fixed at 2100 levels thereafter, no adaptation	Human			**ssp2soc**	**2100ssp2soc**
V	Not simulated					
VI	RCP2.6 climate	Climate	Experiment I	Experiment II	**rcp26**	**rcp26**

	varying society (SSP2) up to 2100, then fixed at 2100 levels thereafter, no adaptation	Human			**ssp2soc**	**2100ssp2soc**
VIa	RCP2.6 climate	Climate	Experiment I	Experiment II	**rcp26**	not simulated
	varying society (SSP2) with adaptation	Human			**ssp2soc_adapt**	
VII	RCP6.0 climate	Climate	Experiment I	Experiment II	**rcp60**	not simulated
	varying society (SSP2), no adaptation	Human			**ssp2soc**	
VIIa	RCP6.0 climate	Climate	Experiment I	Experiment II	**rcp60**	not simulated
	varying society (SSP2), with adaptation	Human			**ssp2soc_adapt**	

6.7 Coastal infrastructure

Table S7: ISIMIP2b scenario specification for the simulations of impacts on coastal infrastructure.

	Experiment	Input	Pre-industrial 1661-1860	Historical 1861-2005	Future 2006-2100	Extended future 2101-2299
I	no climate change, pre-industrial CO_2	Climate & CO_2	**picontrol**	**picontrol**	**picontrol**	**picontrol**
	varying society & protection up to 2005, then fixed at 2005 levels thereafter	Human & LU	Option 1: **1860soc**	Option 1: **histsoc**	**2005soc**	**2005soc**
	society & protection fixed at 2005 levels		Option 2*: **2005soc**	Option 2*: **2005soc**		
II	RCP2.6 climate & CO_2	Climate & CO_2	Experiment I	**historical**	**rcp26**	**rcp26**
	varying society & protection up to 2005, then fixed at 2005 levels thereafter	Human & LU		Option 1*: **histsoc**	**2005soc**	**2005soc**
	society & protection			Option 2*:		

	fixed at 2005 levels			**2005soc**		
III	RCP6.0 climate & CO_2	Climate & CO_2	Experiment I	Experiment II	**rcp60**	not simulated
	society & protection fixed at 2005 levels after 2005	Human & LU			**2005soc**	
IV	no climate change, pre-industrial CO_2	Climate & CO_2	Experiment I	Experiment I	**picontrol**	**picontrol**
	varying society & protection up to 2100 (SSP2), then fixed at 2100 levels thereafter	Human & LU			**ssp2soc**	**2100ssp2soc**
VI	RCP2.6 climate & CO_2	Climate & CO_2	Experiment I	Experiment II	**rcp26**	**rcp26**
	varying society & protection up to 2100 (SSP2), then fixed at 2100 levels thereafter	Human & LU			**ssp2soc**	**2100ssp2soc**
VII	RCP6.0 climate &	Climate &	Experiment I	Experiment II	**rcp60**	not simulated

	CO_2	CO_2				
	varying society & protection (SSP2)	Human & LU			**ssp2soc**	

6.8 **Marine Ecosystems and Fisheries**

Table S8: ISIMIP2b scenarios for simulations of the impacts on marine ecosystems and fisheries.

	Experiment	Input	Pre-industrial 1661-1860	Historical 1861-2005	Future 2006-2100	Extended future 2101-2299
I	no climate change, pre-industrial CO_2	Climate & CO_2	**picontrol**	**picontrol**	**picontrol**	**picontrol**
	varying fishing up to 2005, then fixed at 2005 levels thereafter	Human & LU	**nosoc**	**histsoc**	**2005soc**	**2005soc**
II	RCP2.6 climate & CO_2	Climate & CO_2	Experiment I	**historical**	**rcp26**	**rcp26**
	varying fishing up to 2005, then fixed at 2005 levels thereafter	Human & LU		**histsoc**	**2005soc**	**2005soc**
III	RCP6.0 climate & CO_2	Climate & CO_2	Experiment I	Experiment II	**rcp60**	not simulated

	varying fishing up to 2005, then fixed at 2005 levels thereafter	Human & LU			**2005soc**	

6.9 Terrestrial Biodiversity

Table S9: ISIMIP2b scenarios for simulations of the impacts on terrestrial biodiversity

	Experiment	Input	Pre-industrial 1660-1860	Historical 1861-2005[1]	Future 2006-2099[2]	Extended future 2101-2299[2]
I	pre-industrial climate	Climate & CO_2	**picontrol**	**picontrol**	**picontrol**	**picontrol**
	no other human influences	Human & LU	**nosoc**	**nosoc**	**nosoc**	**nosoc**
II	RCP2.6 climate	Climate & CO_2	Experiment I	**historical**	**rcp26**	**rcp26**
	no other human influences	Human & LU		**nosoc**	**nosoc**	**nosoc**
III	RCP6.0 climate	Climate & CO_2	Experiment I	Experiment II	**rcp60**	not simulated
	no other human influences	Human & LU			**nosoc**	

6.10 Lakes

Table S10: ISIMIP2b scenarios for simulations of the impacts on lakes

	Experiment	Input	pre-industrial 1661-1860	historical 1861-2005	future 2006-2100	extended future 2101-2299
I	no climate change, pre-industrial CO_2	Climate & CO_2	**picontrol**	**picontrol**	**picontrol**	**picontrol**
	varying LU and other human influences (e.g. point source inputs of nutrients and operational changes of reservoirs) up to 2005, then fixed at 2005 levels thereafter	Human & LU	Option 1: **1860soc**	Option 1: **histsoc**	**2005soc**	**2005soc**
	LU & human influences fixed at 2005 levels		Option 2*: **2005soc**	Option 2*: **2005soc**		
II	RCP2.6 climate & CO_2	Climate & CO_2	Experiment I	**historical**	**rcp26**	**rcp26**
	varying LU and other human influences (e.g. point source inputs of nutrients and operational changes of reservoirs) up to 2005, then fixed at 2005 levels thereafter	Human & LU		Option 1: **histsoc**	**2005soc**	**2005soc**
	LU & human influences fixed at 2005			Option 2*:		

	levels			2005soc		
IIa	RCP2.6 climate, CO_2 after 2005 fixed at 2005 levels	Climate & CO_2	Experiment I	Experiment II	**rcp26, 2005co2**	**rcp26, 2005co2**
	LU & human influences fixed at 2005 levels after 2005	Human & LU			**2005soc**	**2005soc**
III	RCP6.0 climate & CO_2	Climate & CO_2	Experiment I	Experiment II	**rcp60**	not simulated
	LU & human influences fixed at 2005 levels after 2005	Human & LU			**2005soc**	
IV	no climate change, pre-industrial CO_2	Climate & CO_2	Experiment I	Experiment I	**picontrol**	**picontrol**
	varying LU and other human influences (e.g. point source inputs of nutrients and operational changes of reservoirs) according to RCP2.6 + SSP2 up to 2100, then fixed at 2100 levels thereafter	Human & LU			**rcp26soc**	**2100rcp26soc**
V	no climate change, pre-industrial CO_2	Climate & CO_2	Experiment I	Experiment I	**picontrol**	not simulated
	varying LU and other human influences (e.g. point source inputs of nutrients and operational changes of reservoirs)	Human & LU			**rcp60soc**	

	according to RCP6.0 + SSP2 up to 2100, then fixed at 2100 levels thereafter					
VI	RCP2.6 climate & CO_2	Climate & CO_2	Experiment I	Experiment II	**rcp26**	**rcp26**
	varying LU and other human influences (e.g. point source inputs of nutrients and operational changes of reservoirs) according to RCP2.6 + SSP2 up to 2100, then fixed at 2100 levels thereafter	Human & LU			**rcp26soc**	**2100rcp26soc**
VII	RCP6.0 climate & CO_2	Climate & CO_2	Experiment I	Experiment II	**rcp60**	not simulated
	varying LU and other human influences (e.g. point source inputs of nutrients and operational changes of reservoirs) according to RCP6.0 + SSP2 up to 2100, then fixed at 2100 levels thereafter	Human & LU			**rcp60soc**	

The lake simulations as described above are carried out once using the ISIMIP2b climate of the grid cell in which the lakes are located and once using locally bias-adjusted data based on locally observed meteorological data.

References

Marzeion, B., Cogley, J. G., Richter, K. and Parkes, D.: Attribution of global glacier mass loss to anthropogenic and natural causes, Science (80-.)., 345(6199), 919–921, doi:10.1126/science.1254702, 2014.

McSweeney, C. F. and Jones, R. G.: How representative is the spread of climate projections from the 5 CMIP5 GCMs used in ISI-MIP, Clim. Serv., 1, 24–29, doi:10.1016/j.cliser.2016, 2016.

Monfreda, C., Ramankutty, N. and Foley, J. A.: Farming the planet: 2. Geographic distribution of crop areas, yields, physiological types, and net primary production in the year 2000, Glob. Biogeochem. Cycles, 22(GB1022), doi:10.1029/2007GB002947., 2008.