Supplementary Material- Crop productivity changes in 1.5°C and 2°C worlds under climate sensitivity uncertainty

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Table S1 |Changes in model setups from the detailed descriptions provided in (Müller et al 2017).

GGCM	Changes in GGCM setup	References
LPJmL	-	
LPJ-Guess	Includes nitrogen dynamics and limitations	(Olin *et al* 2015b, 2015a)
GEPIC	Use of static (annually re-initialized) soil profile rather than dynamic tracking of soil processes Soil data were pre-conditioned in a dynamic spin-up run Spin-up years changed from 30 to 8.	-
PEPIC	Spin-up years changed from 20 to 8.	(Liu *et al* 2016b, 2016a)
ORCHIDEE-crop	-	
Pegasus	-	
CLM-crop-ETH	Crop area abundance prescribed according to land cover maps from the Land Use Harmonisation Project Phase II (LUH2, Lawrence et al., 2016), rather than simulating 'all crops everywhere'. Winter wheat and spring wheat were simulated separately and aggregated into a single wheat field by (i) identifying the pixels with the highest winter, respectively spring wheat yield in the CAM4 All-Hist simulation (rainfed and irrigated crops separately), and (ii) subsequently applying this mask to all simulation output.	*(Lawrence et al 2011,2016)*

Table S2: Overview of GGCM data availability. Not all GGCMs have modelled all GCMs based on the bias corrected HAPPI model intercomparison climate input or all crops. The ensemble members from the HAPPI multi-ensemble simulations as well as the years per ensemble member (historical period or future warming) are given. The short time period leads to anomalies for annual harvest for some GGCMs, which leads to exclusion of the first or last year of each period. The resulting total number of model years per warming level is also given. The column CO_2 experiment indicates the models that provided data for all CO_2 levels investigated.

	GCM input				Crop				CO_2 Exp	Ensemble members	Years per run	Years per warming level and GCM
	MIROC5	NorESM1	CAM4	ECHAM6	Wheat	Maize	Soy	Rice				
CLM-crop-ETH	x	x	x		x	x	x		x	1-5	1-10	50
LPJmL	x	x	x	x	x	x	x	x	x	1-5	1-10	50
LPJ-Guess	x	x	x		x	x			x	1-5	2-10	45
GEPIC	no rice, wheat,	x	x	x	x	x	x	x	x	1-5	1-9	45
PEPIC		x	x		x	x		x	x	1-5	1-10	50
ORCHIDEE-crop	x	x			x	x		x		1-5	1-9	45
Pegasus	x	x		x	x	x	x		x	1-5	2-10	45

Table S3 |Global mean temperature differences between the recent past and the 1.5°C and 2°C future periods in the ensemble of HAPPI GCMs.

	Warming relative to the 2006-2015 period [°C]				**Ensemble Average**
	MIROC5	ECHAM6	NorESM1	CAM4	
Plus 1.5°C	0.68	0.64	0.71	0.66	**0.67**
Plus 2°C	1.14	1.11	1.12	1.13	**1.12**
Plus 2°C-1.5°C	0.46	0.47	0.41	0.47	**0.45**

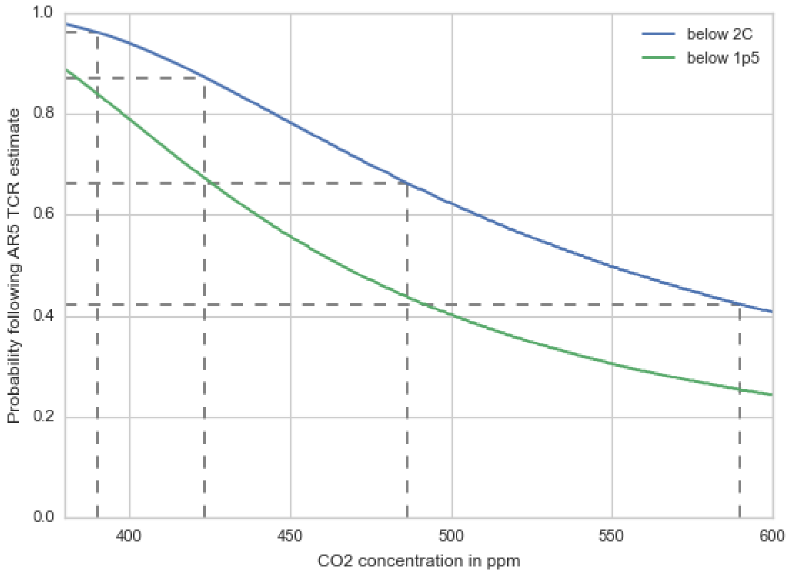

Figure S1: Probabilities of staying below certain warming levels in the transient climate response following IPCC AR5 estimates for the TCR distribution (see Methods).

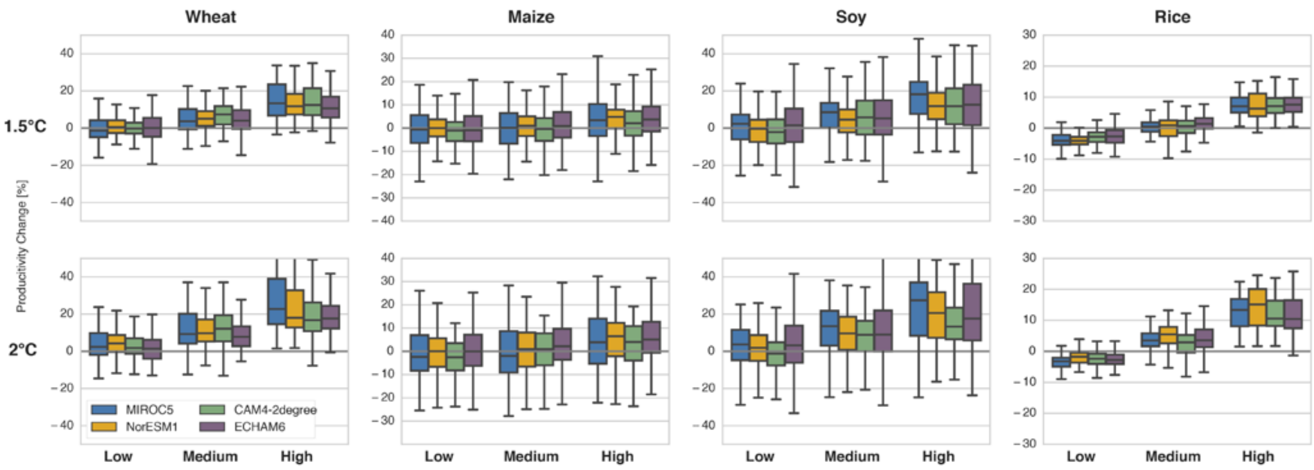

Figure S2: As Figure 1, but resolved for different GCMs. See table S1 for data availability of GCM-GGCM pairs.

Table S4: Changes in crop productivity between the 1.5°C and 2°C periods relative to 2006-2015 (in percent). Crop production is aggregated over SREX regions, the Tropics (between 30°S/°N) and global. Regions with less than 0.1% contribution to global crop production according to the MIRCA2000 dataset are masked out. Numbers in brackets give the 66% (likely) range over the GGCM-GCM ensemble.

	Wheat		Maize		Soybean		Rice	
	423ppm	486ppm	423ppm	486ppm	423ppm	486ppm	423ppm	486ppm
Global	-2.1 [-2.7,-0.1]	-1.9 [-2.4,0.3]	-3.3 [-4.7,0.6]	-3.1 [-4.4,0.6]	-3.7 [-5.7,-0.8]	-2.9 [-5.6,-0.9]	-3.8 [-4.1,-3.1]	-3.5 [-4.1,-3.2]
Tropics	-5.3 [-8.6,-2.9]	-4.3 [-6.6,-2.6]	-2.0 [-2.7,0.2]	-1.8 [-2.6,0.9]	-3.3 [-4.7,-2.3]	-3.4 [-5.1,-1.0]	-3.1 [-4.5,-3.1]	-3.1 [-4.4,-3.0]
AMZ	-	-	-1.3 [-2.3,2.1]	-1.1 [-2.1,2.8]	-2.6 [-4.2,-1.7]	-2.6 [-4.4,-1.9]	-3.1 [-3.5,-1.6]	-3.1 [-3.4,-1.5]
CAM	-4.9 [-6.4,-2.9]	-4.3 [-6.2,-2.2]	-3.1 [-4.9,0.8]	-2.1 [-3.8,0.9]	-3.9 [-6.1,-2.3]	-2.8 [-5.0,-1.6]	-4.0 [-5.3,-2.9]	-4.0 [-5.0,-2.9]
CAS	-1.8 [-6.3,-0.5]	-1.6 [-4.4,-0.4]	-2.5 [-4.5,0.6]	-2.0 [-3.2,2.9]	-	-	-3.5 [-6.3,-2.4]	-3.7 [-6.0,-2.5]
CEU	-2.1 [-3.8,-1.1]	-1.8 [-3.7,-0.8]	-3.0 [-6.5,1.2]	-3.0 [-6.2,1.5]	-2.7 [-7.5,0.4]	-2.1 [-5.8,3.0]	-5.3 [-5.9,-4.6]	-5.5 [-6.0,-3.0]
CNA	-2.4 [-7.7,1.7]	-1.5 [-6.2,1.9]	-3.7 [-8.3,1.7]	-3.7 [-8.6,2.0]	-5.4 [-10.2,-1.1]	-5.9 [-10.0,3.1]	-4.0 [-5.8,-3.4]	-4.3 [-5.9,-2.4]
EAF	-3.5 [-5.0,-1.8]	-3.4 [-4.4,-0.1]	-1.2 [-3.4,0.3]	-1.2 [-3.0,1.6]	-1.4 [-8.3,2.1]	-1.1 [-7.2,19.1]	-1.9 [-4.0,-0.8]	-1.9 [-4.3,-0.7]
EAS	0.7 [-0.3,3.1]	1.7 [-0.2,3.6]	-2.2 [-4.4,1.4]	-2.0 [-4.4,0.9]	-2.9 [-4.3,1.9]	-1.7 [-4.2,2.0]	-3.1 [-4.3,-2.8]	-3.2 [-4.0,-2.8]
ENA	-1.8 [-3.4,-0.3]	-1.1 [-3.1,-0.0]	-3.1 [-6.1,1.4]	-3.1 [-4.7,1.7]	-4.1 [-7.0,-0.7]	-3.8 [-6.6,0.2]	-	-
MED	-2.4 [-3.6,-0.7]	-2.1 [-3.3,0.1]	-2.2 [-5.9,0.3]	-2.2 [-6.0,0.6]	-6.4 [-9.5,-1.7]	-5.1 [-9.6,2.4]	-5.5 [-7.2,-4.1]	-4.3 [-7.0,-3.5]
NAS	-0.4 [-2.4,1.8]	-0.3 [-2.5,3.2]	1.6 [-2.1,8.3]	2.1 [-2.1,7.3]	1.6 [-2.4,9.6]	4.1 [-1.6,11.2]	-	-
NAU	-4.2 [-9.8,0.9]	-1.6 [-7.0,2.3]	-	-	-	-	-	-
NEB	-	-	-1.8 [-4.2,0.1]	-1.5 [-3.0,1.2]	-3.6 [-6.1,-1.8]	-3.5 [-6.1,-1.7]	-2.8 [-3.4,-1.3]	-2.9 [-3.6,-1.3]
NEU	-2.6 [-4.4,0.1]	-2.5 [-5.8,0.3]	-2.2 [-6.8,3.2]	-2.0 [-6.2,3.2]	-	-	-	-
SAF	-3.6 [-9.0,-1.2]	-3.3 [-8.4,-0.9]	-1.0 [-4.8,1.4]	-0.8 [-4.5,1.7]	-2.2 [-7.9,-0.1]	-2.3 [-6.6,0.1]	-1.9 [-4.5,-1.0]	-1.9 [-4.8,-0.9]
SAH	-3.1 [-5.6,1.1]	-1.3 [-5.1,1.9]	-4.4 [-6.4,-2.6]	-4.0 [-4.6,-1.6]	-	-	-5.3 [-8.5,-4.7]	-5.6 [-8.6,-4.1]
SAS	-3.3 [-8.2,-1.3]	-2.9 [-7.4,-0.9]	-2.3 [-3.2,0.9]	-1.6 [-3.1,2.4]	-2.8 [-4.2,-1.0]	-2.2 [-4.4,-0.6]	-4.2 [-5.0,-3.5]	-4.3 [-5.1,-3.5]
SAU	-0.4 [-2.9,2.3]	0.5 [-1.6,3.3]	-	-	-	-	-	-
SEA	-	-	-2.0 [-2.9,0.2]	-1.5 [-2.3,1.4]	-1.8 [-6.1,-0.2]	-1.8 [-2.6,1.8]	-2.9 [-4.3,-2.4]	-2.9 [-4.0,-2.4]
SSA	-3.2 [-6.9,-0.9]	-2.7 [-6.1,-0.2]	-1.1 [-3.7,0.6]	-0.7 [-2.7,1.4]	-2.9 [-9.3,-1.2]	-2.4 [-6.4,-1.2]	-2.1 [-4.0,-1.7]	-2.1 [-4.1,-1.6]
TIB	-2.3 [-4.8,2.7]	-2.0 [-4.4,2.8]	-1.6 [-3.8,-0.3]	-1.1 [-3.7,1.8]	-2.3 [-4.7,2.5]	-1.7 [-4.2,3.1]	-3.6 [-3.9,-2.7]	-3.8 [-4.1,-1.5]
WAF	-	-	-1.7 [-4.9,1.6]	-1.3 [-4.0,3.1]	-2.9 [-7.9,-0.3]	-1.6 [-3.9,0.0]	-1.6 [-3.9,-1.3]	-1.6 [-3.4,-1.3]
WAS	-0.1 [-3.3,1.2]	0.4 [-1.8,1.5]	-2.3 [-4.6,2.9]	-1.5 [-4.3,3.1]	-3.5 [-4.8,-0.4]	-1.2 [-4.5,2.7]	-5.8 [-6.9,-5.0]	-5.8 [-7.0,-4.5]
WNA	-4.3 [-10.8,-0.7]	-4.5 [-9.7,-0.2]	-2.6 [-4.6,0.7]	-2.2 [-4.5,-0.6]	-	-	-5.7 [-6.5,-5.4]	-6.0 [-6.7,-4.2]
WSA	-1.5 [-3.8,-0.7]	-1.1 [-2.9,2.3]	0.7 [-0.8,3.4]	0.8 [-0.0,4.3]	-	-	-1.3 [-2.3,0.1]	-1.2 [-2.5,0.2]

Table S5: Share of production areas (number of grid cells relative to global total based on MIRCA2000) for different the SREX regions and the Tropics (between 23.5°S/°N). Regions with less than 0.1% contribution to global crop production according to the MIRCA2000 dataset are masked out.

	Wheat	Maize	Soybean	Rice
Tropics	28%	44%	43%	58%
AMZ	-	7%	6%	11%
CAM	2%	3%	3%	4%
CAS	2%	1%	-	2%
CEU	5%	5%	4%	1%
CNA	5%	4%	6%	2%
EAF	4%	5%	5%	6%
EAS	9%	8%	10%	10%
ENA	2%	3%	2%	-
MED	4%	3%	4%	4%
NAS	9%	5%	5%	-
NAU	1%	-	1%	-
NEB	-	2%	2%	4%
NEU	1%	5%	-	-
SAF	5%	5%	5%	5%
SAH	1%	1%	-	1%
SAS	5%	4%	7%	7%
SAU	1%	-	-	-
SEA	-	4%	6%	7%
SSA	4%	4%	6%	5%
TIB	3%	1%	1%	1%
WAF	-	7%	5%	8%
WAS	4%	3%	4%	3%
WNA	5%	4%	-	1%
WSA	1%	1%	-	1%

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