

# 10 Global crop simulations

## 10.1 Scenarios

5 Crop-model simulations should be provided as pure crop runs (i.e. assuming that each crop grows everywhere), so that future LU patterns can be applied in post-processing ensuring maximum flexibility. Simulations should be provided for the four major crops (wheat, maize, soy, and rice). For each crop there should be a full irrigation run (firr) and a no-irrigation run (noirr).

Those models that cannot simulate time varying management/human impacts/fertilizer input should keep these fixed at year 2005 levels throughout the simulations (“2005soc” scenario in Group 1 (dashed line in **Figure 1**) and “2005soc” scenario in Group 2). They only need to run the first preindustrial period of Experiment I (1661-1860). Group 3 runs only refer to models that are able to represent future changes in human management (varying crop varieties or fertilizer input).

10 To resolve potential double harvests within one year, crop yields should be reported per growing and not per calendar year. The unit of the time dimension of the NetCDF v4 output file is thus “growing seasons since YYYY-01-01 00:00:00”. Cumulative growing season variables as, e.g., actual evapotranspiration or precipitation are to be accumulated over the growing season. The first season in the file (with value time=1) is then the first complete growing season of the time period provided by the input data without any assumed spin-up data, which equates to the growing season with the first planting after this date. To ensure that data  
 15 can be matched to individual years in post-processing, it is essential to also provide the actual planting dates (as day of the year), actual planting years (year), anthesis dates (as day of the year), year of anthesis (year), maturity dates (day of the year), and year of maturity (year). This procedure is identical to the GGCM1 convention (Elliott et al. 2015: The Global Gridded Crop Model intercomparison: data and modeling protocols for Phase 1).

Climate & CO <sub>2</sub> scenarios	
<b>picontrol</b>	Pre-industrial climate and 286ppm CO <sub>2</sub> concentration. The climate data for the entire period (1661-2299) are unique – no (or little) recycling of data has taken place.
<b>historical</b>	Historical climate and CO <sub>2</sub> concentration.
<b>rcp26</b>	Future climate and CO <sub>2</sub> concentration from RCP2.6
<b>rcp60</b>	Future climate and CO <sub>2</sub> concentration from RCP6.0
<b>2005co2</b>	Fixed year 2005 levels of CO <sub>2</sub> at 378.81ppm.
Human influence & land-use scenarios	
<b>1860soc</b>	Pre-industrial levels of fertilizer input.
<b>histsoc</b>	Varying historical fertilizer input.
<b>2005soc</b>	Fixed year 2005 management
<b>rcp26soc</b>	Varying level of fertilizer input and varying varieties of the same crop associated with SSP2 and RCP2.6

<b>rcp60soc</b>	Varying level of fertilizer input and varying varieties of the same crop associated with SSP2 and RCP6.0
<b>2100rcp26soc</b>	Fertilizer input and varieties of the same crop fixed at year 2100.

**Table 25** ISIMIP2b scenarios for global crop simulations. \*Option 2 only if option 1 not possible.

Experiment		Input	Pre-industrial 1661-1860	Historical 1861-2005	Future 2006-2099	Extended future 2100-2299
<b>I</b>	no climate change, pre-industrial CO <sub>2</sub>	Climate & CO <sub>2</sub>	<b>picontrol</b>	<b>picontrol</b>	<b>picontrol</b>	<b>picontrol</b>
	varying management until 2005, then fixed at 2005 levels thereafter	Human & LU	Option 1*: <b>1860soc</b>	Option 1*: <b>histsoc</b>	<b>2005soc</b>	<b>2005soc</b>
			Option 2*: <b>2005soc</b>	Option 2*: <b>2005soc</b>		
<b>II</b>	RCP2.6 climate & CO <sub>2</sub>	Climate & CO <sub>2</sub>	Experiment I	<b>historical</b>	<b>rcp26</b>	<b>rcp26</b>
	varying management until 2005, then fixed at 2005 levels thereafter	Human & LU		Option 1*: <b>histsoc</b>	<b>2005soc</b>	<b>2005soc</b>
				Option 2*: <b>2005soc</b>		
<b>Ila</b>	RCP2.6 climate, CO <sub>2</sub> after 2005 fixed at 2005 levels	Climate	Experiment I	Experiment II	<b>rcp26, 2005co2</b>	<b>rcp26, 2005co2</b>
	varying management until 2005, then fixed at 2005 levels thereafter	Human & LU			<b>2005soc</b>	<b>2005soc</b>
<b>III</b>	RCP6.0 climate & CO <sub>2</sub>	Climate & CO <sub>2</sub>	Experiment I	Experiment II	<b>rcp60</b>	not simulated
	varying management until 2005, then fixed at 2005 levels thereafter	Human & LU			<b>2005soc</b>	
<b>IV</b>	no climate change, pre-industrial CO <sub>2</sub>	Climate & CO <sub>2</sub>	Experiment I	Experiment I	<b>picontrol</b>	<b>picontrol</b>

	varying management up to 2100 (RCP2.6), then fixed at 2100 levels thereafter	Human & LU			rcp26soc	2100rcp26soc
<b>V</b>	no climate change, pre-industrial CO <sub>2</sub>	Climate & CO <sub>2</sub>	Experiment I	Experiment I	picontrol	not simulated
	varying management (RCP6.0)	Human & LU			rcp60soc	
<b>VI</b>	RCP2.6 climate & CO <sub>2</sub>	Climate & CO <sub>2</sub>	Experiment I	Experiment II	rcp26	rcp26
	varying management up to 2100 (RCP2.6), then fixed at 2100 levels thereafter	Human & LU			rcp26soc	2100rcp26soc
<b>VII</b>	RCP6.0 climate & CO <sub>2</sub>	Climate & CO <sub>2</sub>	Experiment I	Experiment II	rcp60	
	varying management (RCP6.0)	Human & LU			rcp60soc	

## 10.2 Output data

**Table 26** Variables to be reported by crop models

Variable	Variable name	Resolution	Unit	Comments
Key model outputs				
Crop yields	yield-<crop>-<irrigation setting>	per growing season (0.5°x0.5°)	dry matter (t ha <sup>-1</sup> per growing season)	
Irrigation water withdrawal (assuming unlimited water supply)	pirrw-<crop>-<irrigation setting>	per growing season (0.5°x0.5°)	mm per growing season	<i>Irrigation water withdrawn in case of optimal irrigation (in addition to rainfall), assuming no losses in conveyance and application.</i>
Key diagnostic variables				

Actual evapotranspiration	aet-<crop>-<irrigation setting>	per growing season (0.5°x0.5°)	mm per growing season	portion of all water (including rain) that is evapo-transpired, the water amount should be accumulated over the entire growing period ( <b>not</b> the calendar year)
Nitrogen application rate	initr-<crop>-<irrigation setting>	per growing season (0.5°x0.5°)	kg ha <sup>-1</sup> per growing season	Total nitrogen application rate. If organic and inorganic amendments are applied, rate should be reported as inorganic nitrogen equivalent (ignoring residues).
Actual planting dates	plantday-<crop>-<irrigation setting>	per growing season (0.5°x0.5°)	Day of year	Julian dates
Actual planting year	plantyear-<crop>-<irrigation setting>	per growing season (0.5°x0.5°)	Year of planting	Attention: This is an additional output compared to the ISIMIP2a reporting. It allows for clear identification of planting that is also easy to follow for potential users from outside the project.
Anthesis dates	anthday-<crop>-<irrigation setting>	per growing season (0.5°x0.5°)	Day of year of anthesis	Attention: This has changed compared to the ISIMIP2a reporting where we asked for the “day from planting date”. Together with the year of anthesis added to the list of outputs (see below) it allows for clear identification of anthesis that is also easy to follow for potential users from outside the project.
Year of anthesis	anthyear-<crop>-<irrigation setting>	per growing season (0.5°x0.5°)	year of anthesis	Attention: This is an additional output compared to the ISIMIP2a reporting. It allows for clear identification of anthesis that is also easy to follow for potential users from outside the project.

Maturity dates	matyday- <crop>- <irrigation setting>	per growing season (0.5°x0.5°)	Day of year of maturity	Attention: This has changed compared to the ISIMIP2a reporting where we asked for the “day from planting date”. Together with the year of maturity added to the list of outputs (see below) it allows for clear identification of maturity that is also easy to follow for potential users from outside the project.
Year of maturity	matyyear- <crop>- <irrigation setting>	per growing season (0.5°x0.5°)	year of maturity	Attention: This is an additional output compared to the ISIMIP2a reporting. It allows for clear identification of maturity that is also easy to follow for potential users from outside the project.
Additional output variables (optional)				
Biomass yields	biom-<crop>- <irrigation setting>	per growing season (0.5°x0.5°)	Dry matter (t ha <sup>-1</sup> per growing season)	
Soil carbon emissions	sco2-<crop>- <irrigation setting>	per growing season (0.5°x0.5°)	kg C ha <sup>-1</sup>	Ideally should be modeled with realistic land-use history and initial carbon pools. Subject to extra study.
Nitrous oxide emissions	sn2o-<crop>- <irrigation setting>	per growing season (0.5°x0.5°)	kg N <sub>2</sub> O-N ha <sup>-1</sup>	Ideally should be modeled with realistic land-use history and initial carbon pools. Subject to extra study.