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Simulating the Impact of Climate Change and Adaptive Management on Maize Yield in Diamantino - MT, Brazil

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INTRODUCTION

Brazil appears as the third largest maize producer in the world, with production obtained in two seasons, the in-season called as summer season and the off-season known as 'safrinha', with both of them cultivated under rainfed conditions. Therefore, under climate change scenarios, with higher temperatures and possible reductions on water availability (AMBRIZZI et al., 2007; TORRES and MARENGO, 2013), it is expected that the current yield levels would be affected.

In this sense, crop simulation models have been shown as useful tools for yield simulations under different climate scenarios and also to evaluate different crop management strategies to mitigate climate change impacts on yields. Based on that, the objective of this study was to simulate the impact of climate change on maize yield in Diamantino, MT, Brazil, and to evaluate possible crop management strategies to mitigate these possible impacts, using the DSSAT/CSM-CERES-MAIZE model. .

MATERIAL AND METHODS

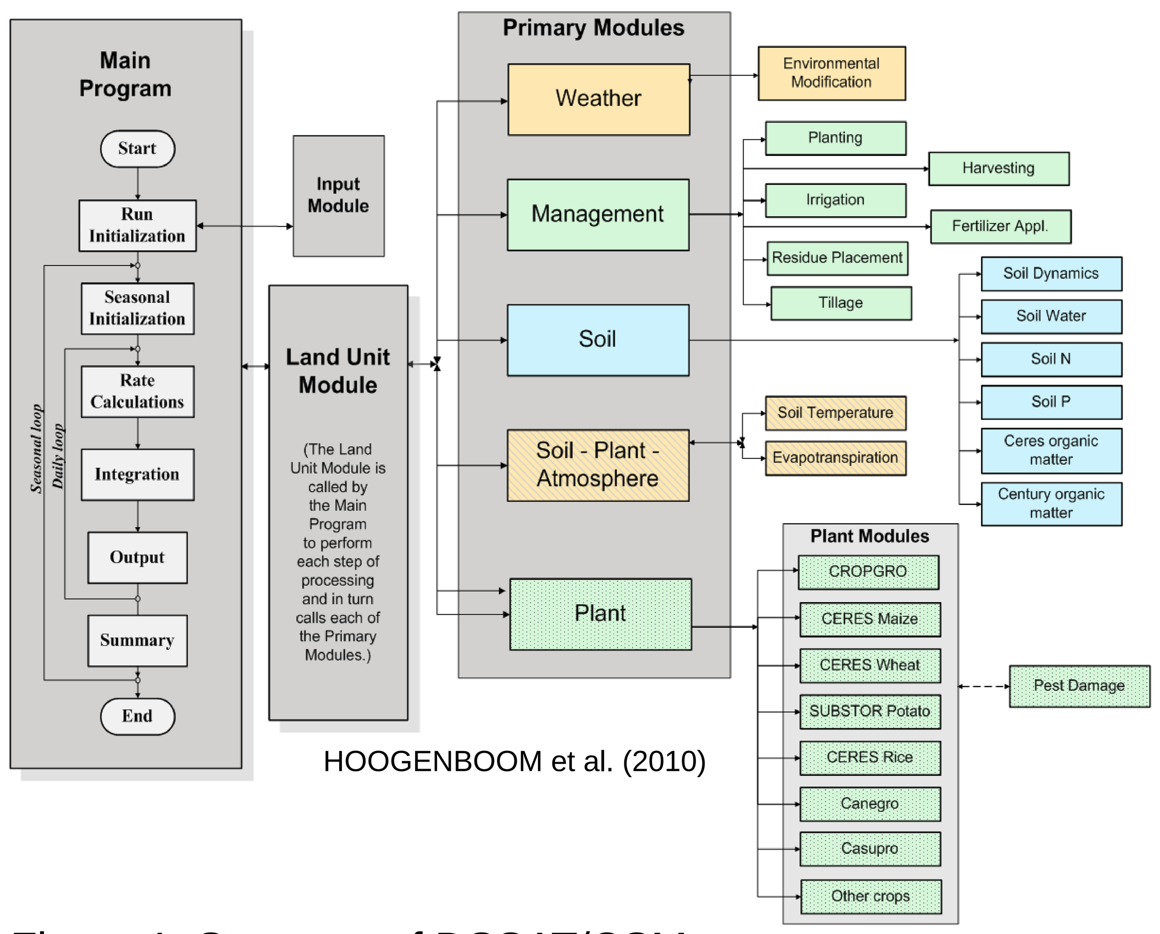

Figure 1: Structure of DSSAT/CSM

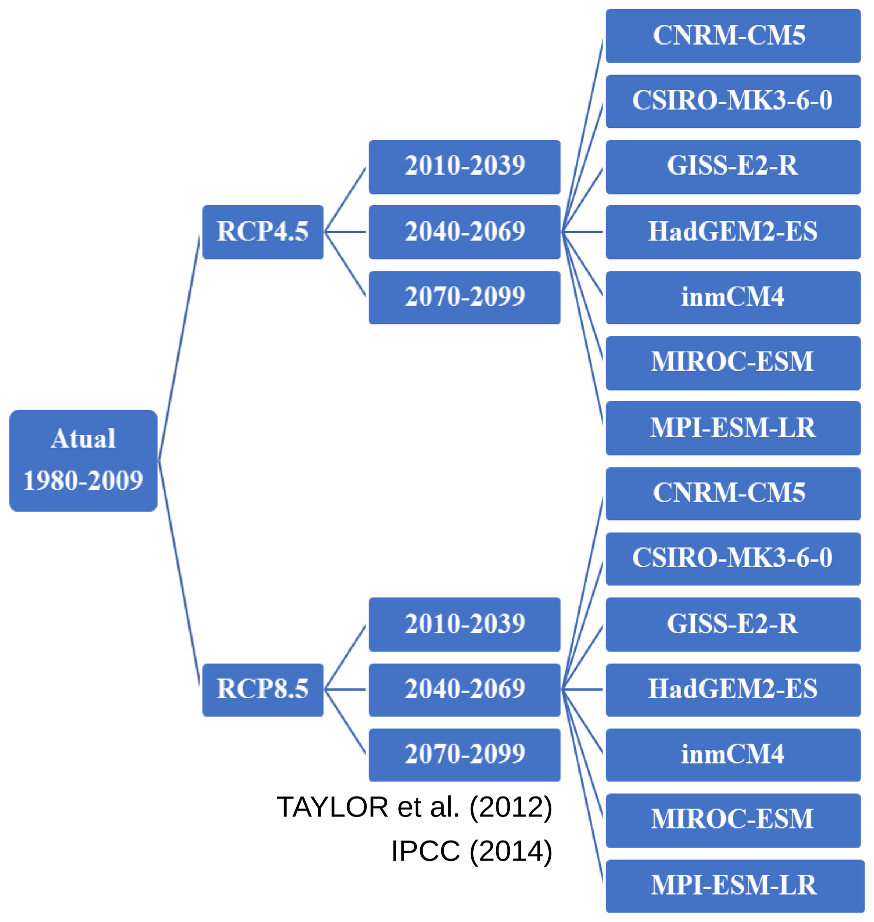

Figure 2: Future climate change scenarios

Table 1: Genetic coefficients calibrated for a medium-cycle maize cultivar for Brazilian conditions

Season	P1	P2	P5	G2	G5	PHINT
In-season	290.6	0.5	907.1	749.9	9.40	46.79
Off-season	285.2	0.5	914.7	857.0	6.07	44.20

RESULTS AND DISCUSSIONS

Table 2: Management strategies under current and future climate scenarios

Season	Management	Current	RCP4.5			RCP8.5		
		1980-2009	2010-2039	2040-2069	2070-2099	2010-2039	2040-2069	2070-2099
In-season	Sowing date	Nov15	Nov1	Nov2	Nov2	Nov1	Nov2	Nov2
	Cycle	CM	CST	CST	CST	CST	CST	CST
	Irrigation	Rainfed	Rainfed	Rainfed	Rainfed	Rainfed	Rainfed	Rainfed
	Irrigation	Rainfed	A180	A180	A180	A180	A180	A150
	N fertilizer	N150	N250	N200	N250	N200	N250	N250
Off-season	Sowing date	Feb15	Jan2	Jan1	Jan1	Jan1	Jan1	Jan1
	Cycle	CM	CM	CM	CM	CM	CM	CM
	Irrigation	Rainfed	Rainfed	Rainfed	Rainfed	Rainfed	Rainfed	Rainfed
	Irrigation	Rainfed	A180	A180	A180	A180	A180	A120
	N fertilizer	N150	N250	N200	N250	N200	N250	N250

*CM - medium cycle; CST - super late cycle (20% longer); Rainfed - under rainfed conditions; A120 - 30 mm of water applied on 30, 45, 60 and 75 days after sowing date; A150 - 30 mm applied on 15, 30, 45, 60 and 75 days after sowing date; A180 - 30 mm applied on 15, 30, 45, 60, 75 and 90 days after sowing date. N150 - nitrogen amount of 150 kg ha^{-1}; N200 - nitrogen amount of 200 kg ha^{-1}; N250 - nitrogen amount of 250 kg ha^{-1} applied in proportion of 33% at sowing date and 67% 45 days after sowing date

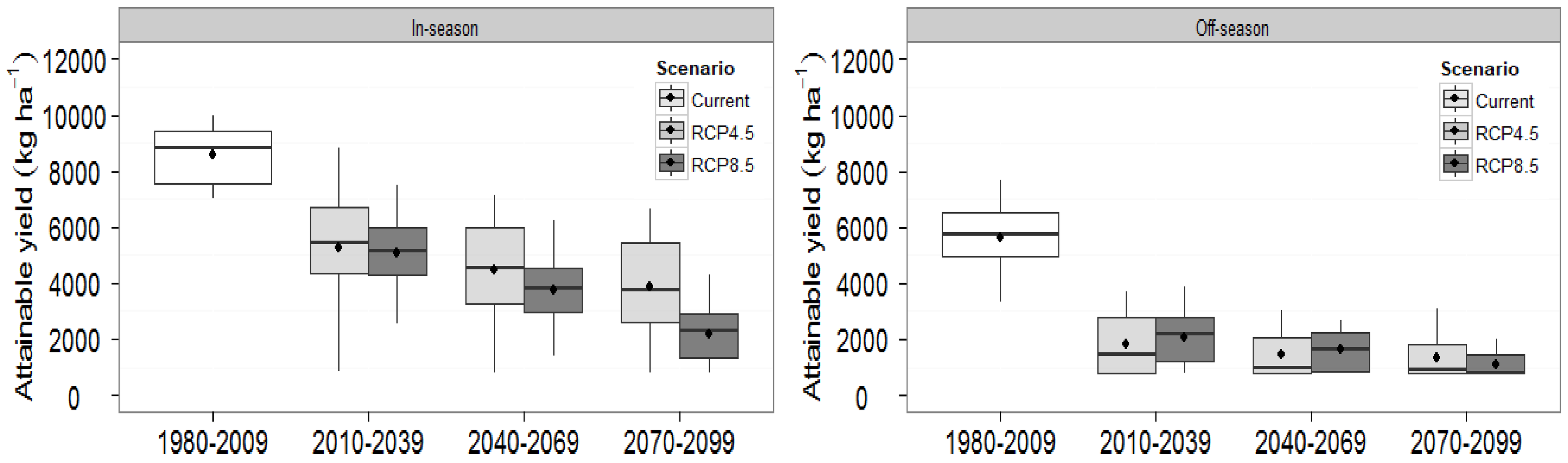

Figure 3: Attainable yield for in-season and off-season maize under current climate and future climate projections (ensemble of 7 GCM)

Table 3: Variation in cycle duration and relative water consumption for in-season and off-season growing maize under current climate and future climate projections (ensemble of 7 GCM)

Variable	Season	Current	RCP4.5			RCP8.5		
		1980-2009	2010-2039	2040-2069	2070-2099	2010-2039	2040-2069	2070-2099
Cycle duration	In-season	110	-7	-10	-20	-8	-13	-25
	Off-season	114	-11	-14	-14	-11	-16	-23
Relative water consumption	In-season	0.97	0.83	0.81	0.80	0.82	0.81	0.78
	Off-season	0.98	0.93	0.91	0.71	0.93	0.90	0.69

Table 4: Attainable yield variation for in-season and off-season growing maize under future climate changes and also the variation considering the combination of management strategies as sowing date, crop cycle duration, nitrogen fertilization in rainfed and irrigated conditions

Season	Attainable yield (kg ha^{-1})	Management	RCP4.5			RCP8.5		
	1980-2009		2010-2039	2040-2069	2070-2099	2010-2039	2040-2069	2070-2099
In-season	8185	Without	-32	-42	-50	-35	-51	-71
		Rainfed	27	2	-11	21	-12	-48
		Irrigated	49	19	5	43	2	-42
Off-season	6989	Without	-74	-78	-50	-74	-80	-70
		Rainfed	85	56	39	82	26	-16
		Irrigated	124	82	60	114	44	-11

CONCLUSIONS

Simulation under future climate changes showed losses in relation to the current yield levels for in-season and off-season maize, due to the reduction in the length of the crop cycle and increase of the relative water consumption, with average losses varying from 32% to 71% for in-season maize, and from 50 to 80% for the off-season.

The combination of different management strategies, even under rainfed condition, showed a reduction of yield losses or even some gain when irrigation was considered.

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