Quantifying the relative uncertainties of changes in climate and water demand for water supply planning

2017. 5. 9

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01 Introduction

Long Term Climate Projections Working Group Update:

What do CMIP5 projections say about Florida's future climate?

How much variation is there in projections using CMIP5 over GCMs, RCP scenarios, ET method, and water use scenario?

What are the major factors causing variations among future projections?

Evaluation of impact of climate change, anthropogenic change, and ET_0 estimation method on regional hydrology.

- What is the relative impact, and relative uncertainty, associated with climatic vs anthropogenic factors in predicting future hydrologic conditions in the Tampa Bay region?

- Will the reliability of the use of streamflow for water supply purposes change under future climatic and anthropogenic conditions?

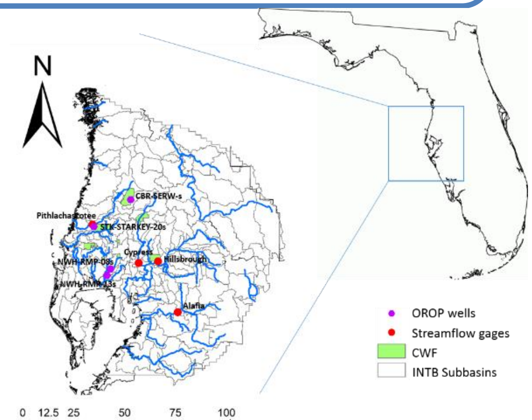
Methods and Materials

- 8 GCMs (CMIP5)
- 8 Water use scenarios
- 3 ET_0 estimation methods

Retrospective period: 1982-2005
Future period 1: 2030-2060
Future period 2: 2070-2100

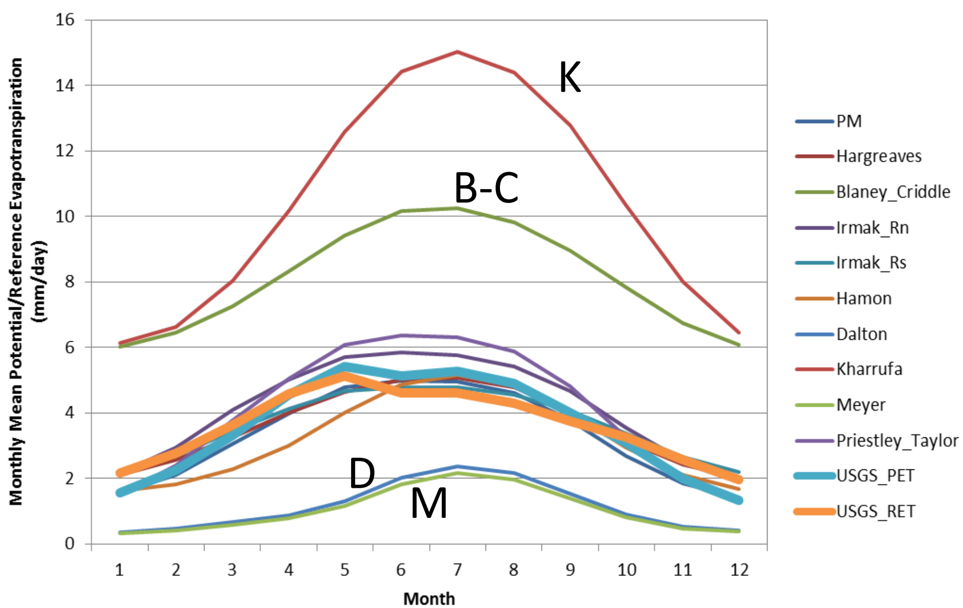
Changes in streamflow and groundwater level

- Reference data: NLDAS-2 (1/8th degree grid, 1982-2005)
- Hydrologic model: Integrated Hydrologic Model (IHM)
- Study region: Integrated Northern Tampa Bay (INTB)



Methods and Materials

3 ET_0 estimation methods

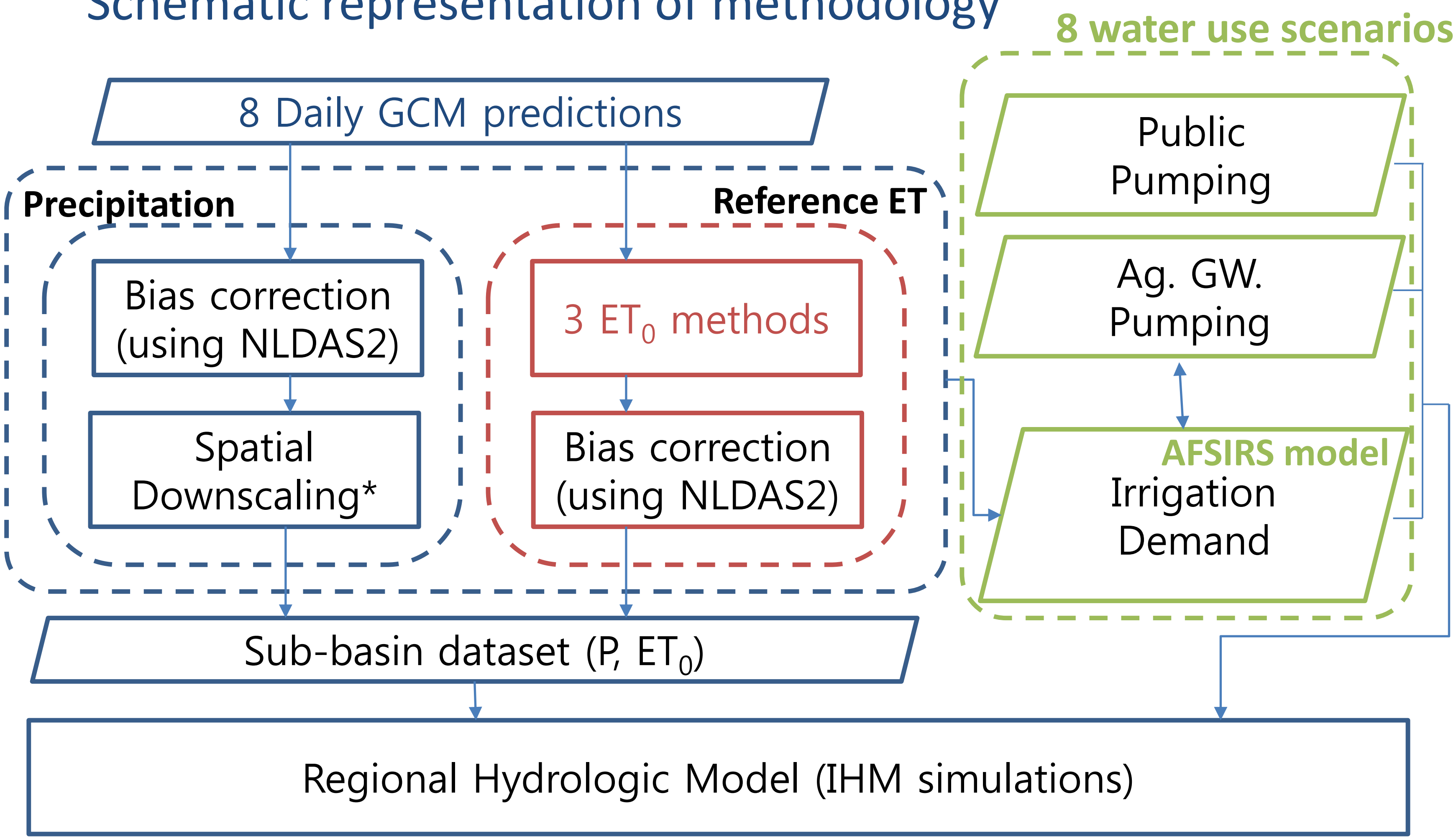


Temperature based: Hargreaves method

Radiation based: Priestley-Taylor method

Combination method: Penman-Monteith method

Schematic representation of methodology

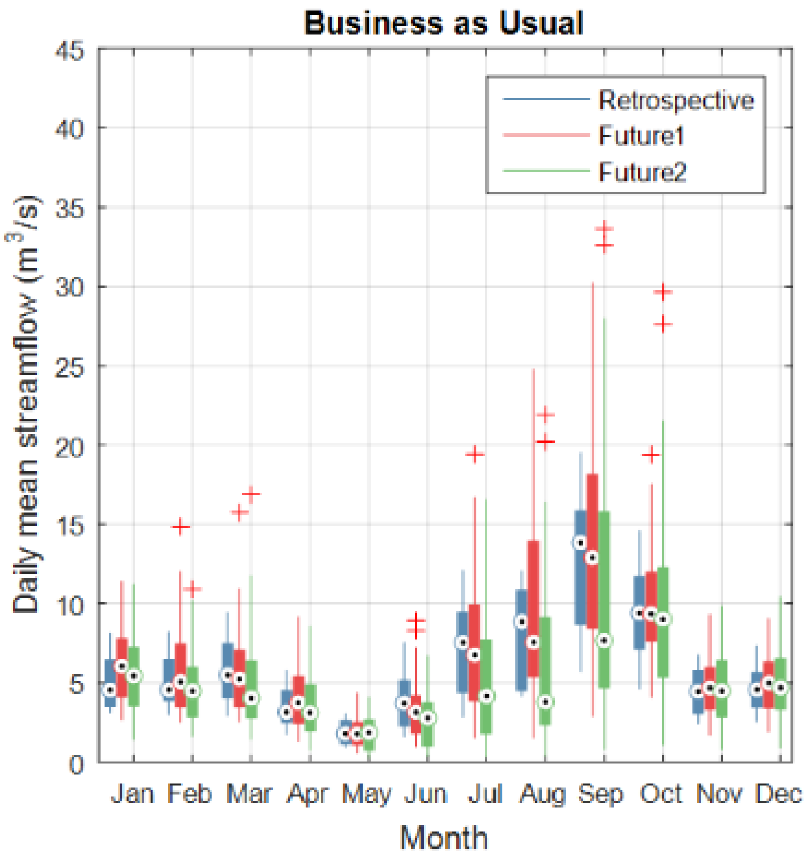


ANOVA, Variance-based GSA and Tukey's HSD test to evaluate the results.

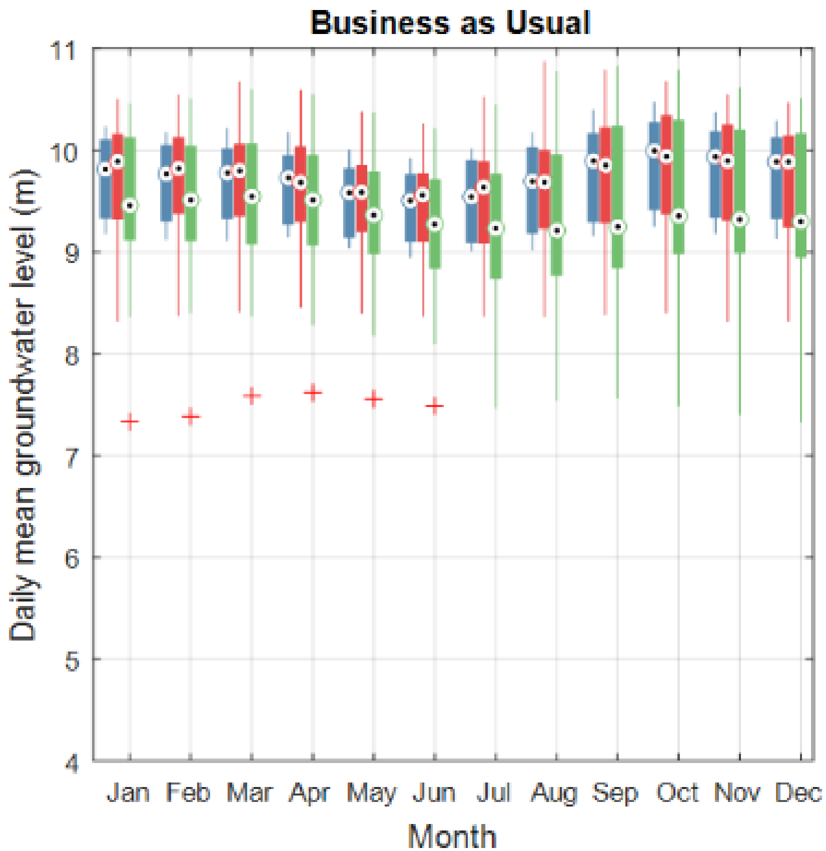
Ref: * Hwang & Graham (2013)

Mean daily streamflow and groundwater level

Future streamflow and groundwater level show more variation than retrospective Streamflow and groundwater level.



Mean daily streamflow by month for Hillsborough river



Mean daily groundwater level by month for NWH-RMP-08s

Global sensitivity analysis results

GCM is dominant

The first order sensitivity index of change in streamflow

River gage	Season	Period	GCM	MET	Scenario
Hillsborough	Wet season	Fut1	0.9436	0.0015	0.0155
		Fut2	0.9399	0.0409	0.0062
	Dry season	Fut1	0.9480	0.0117	0.0290
		Fut2	0.9605	0.0007	0.0178
Alafia	Wet season	Fut1	0.9279	0.0095	0.0312
		Fut2	0.9520	0.0211	0.0118
	Dry season	Fut1	0.8757	0.0123	0.0723
		Fut2	0.9265	0.0011	0.0680
Cypress	Wet season	Fut1	0.8673	0.0072	0.0434
		Fut2	0.8902	0.0495	0.0165
	Dry season	Fut1	0.8310	0.0357	0.0673
		Fut2	0.8898	0.0015	0.0393
Pithlachascotee	Wet season	Fut1	0.8481	0.0363	0.0322
		Fut2	0.9176	0.0087	0.0118
	Dry season	Fut1	0.8128	0.0563	0.0380
		Fut2	0.8656	0.0064	0.0310

Very low

Global sensitivity analysis results

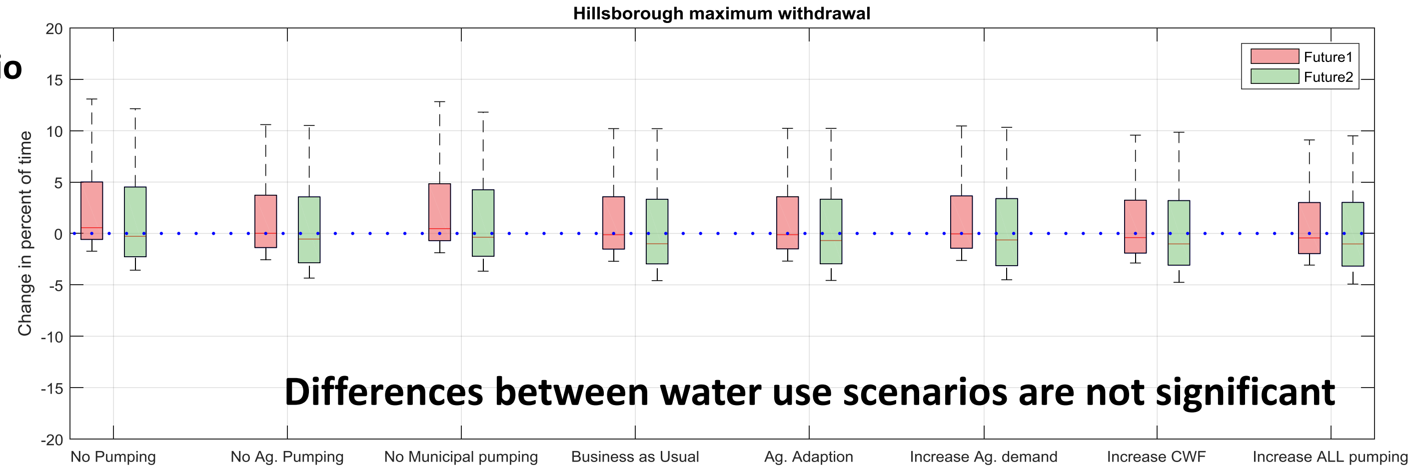
GCM and water use scenario are dominant

The first order sensitivity index of change in groundwater level

OROP well	Season	Period	GCM	MET	Scenario
NWH-RMP-08s	Wet season	Fut1	0.442	0.0045	0.5011
		Fut2	0.5764	0.0041	0.2776
	Dry season	Fut1	0.4748	0.0066	0.4352
		Fut2	0.5499	0.0019	0.2884
CBR-SERW-s	Wet season	Fut1	0.6561	0.0003	0.2144
		Fut2	0.7549	0.0024	0.1428
	Dry season	Fut1	0.6387	0.0005	0.2212
		Fut2	0.7467	0.0019	0.1456
NWH-RMP-13s	Wet season	Fut1	0.8293	0.0026	0.0297
		Fut2	0.8698	0.013	0.0033
	Dry season	Fut1	0.7541	0.0095	0.0614
		Fut2	0.8469	0.0036	0.0204
STK-STARKEY-20s	Wet season	Fut1	0.604	0.0004	0.3252
		Fut2	0.7181	0.0044	0.1984
	Dry season	Fut1	0.584	0.0021	0.329
		Fut2	0.7071	0.0013	0.2

Change in maximum water withdrawal (Hillsborough)

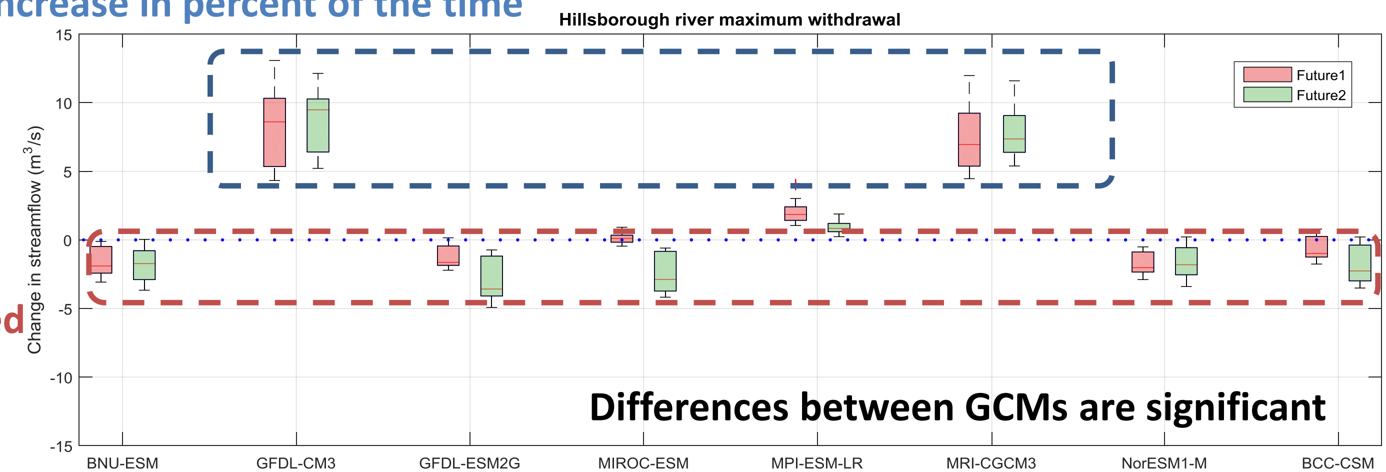
By water use scenario



2 GCMs projected increase in percent of the time

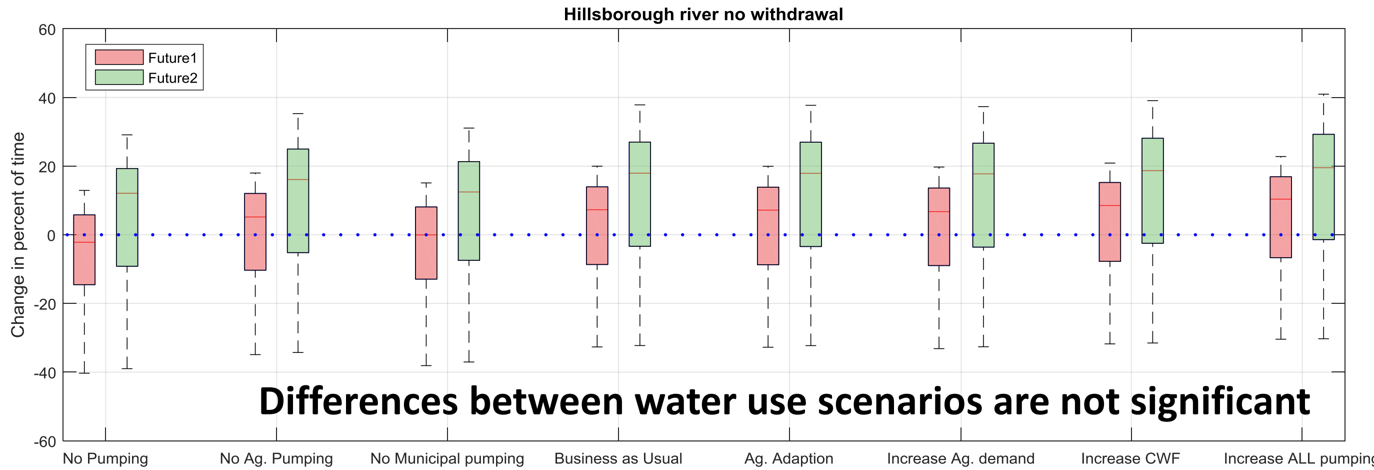
By GCM

5 GCMs projected decrease in percent of the time

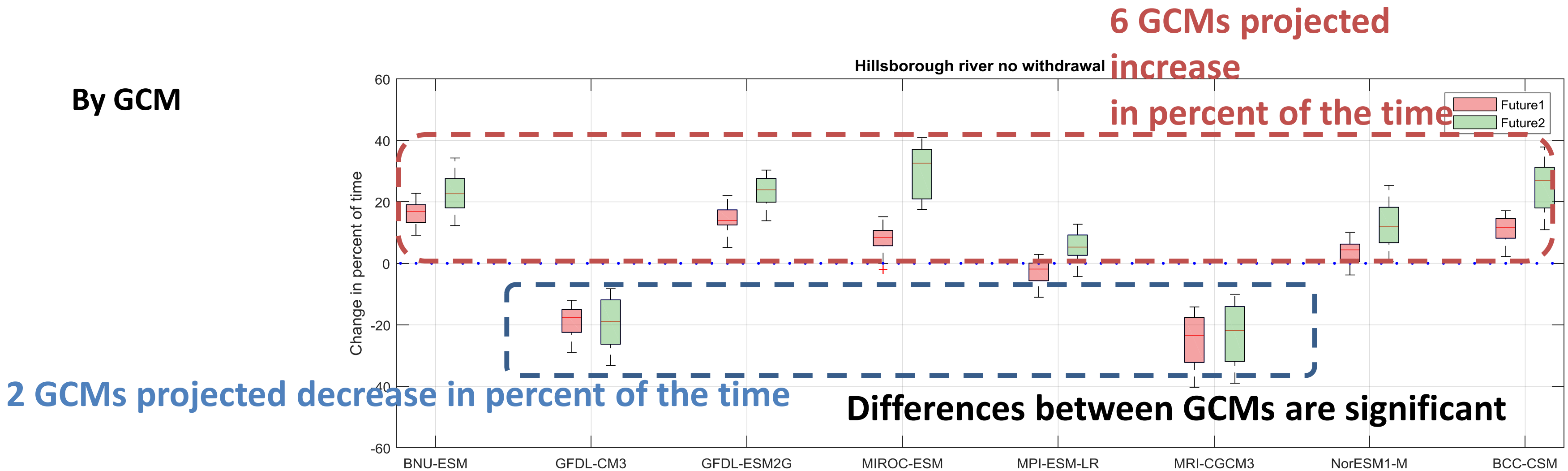


Change in no water withdrawal (Hillsborough)

By water use scenario

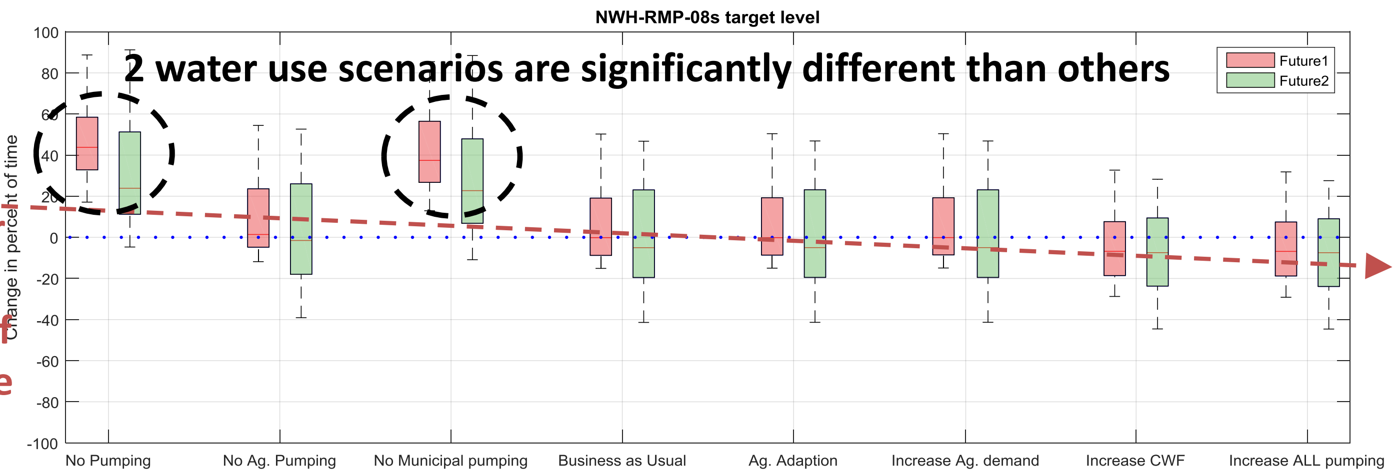


By GCM



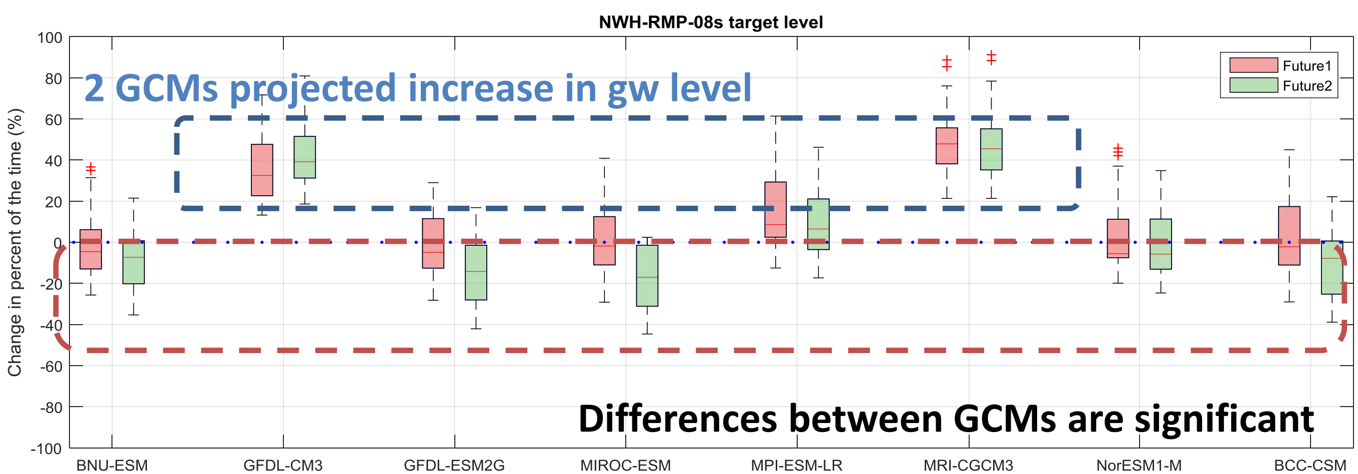
Change in percent of the time that GW is above target level

By water use scenario



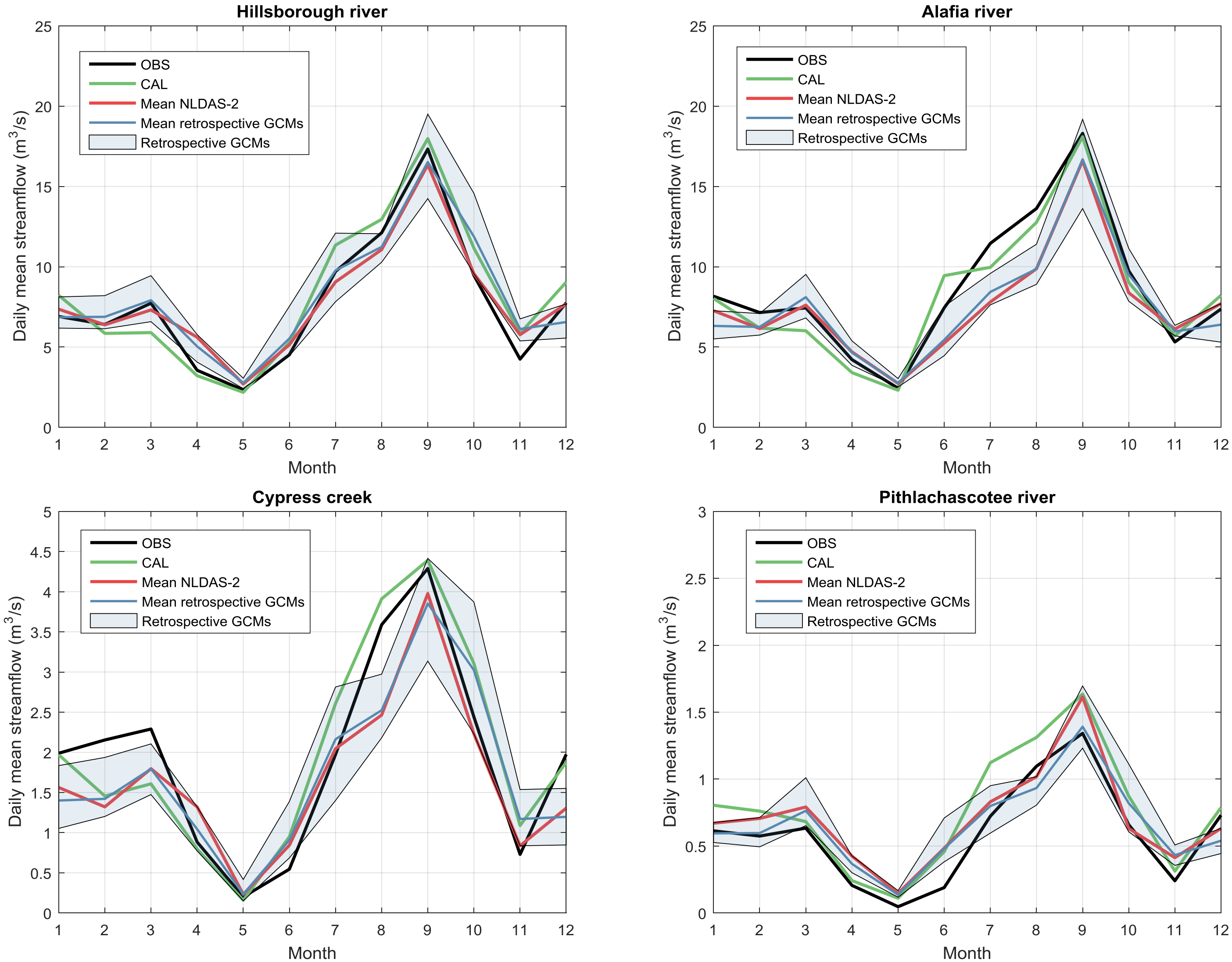
Increase groundwater pumping scenarios decrease in percent of time that GW is above the target level

By GCM

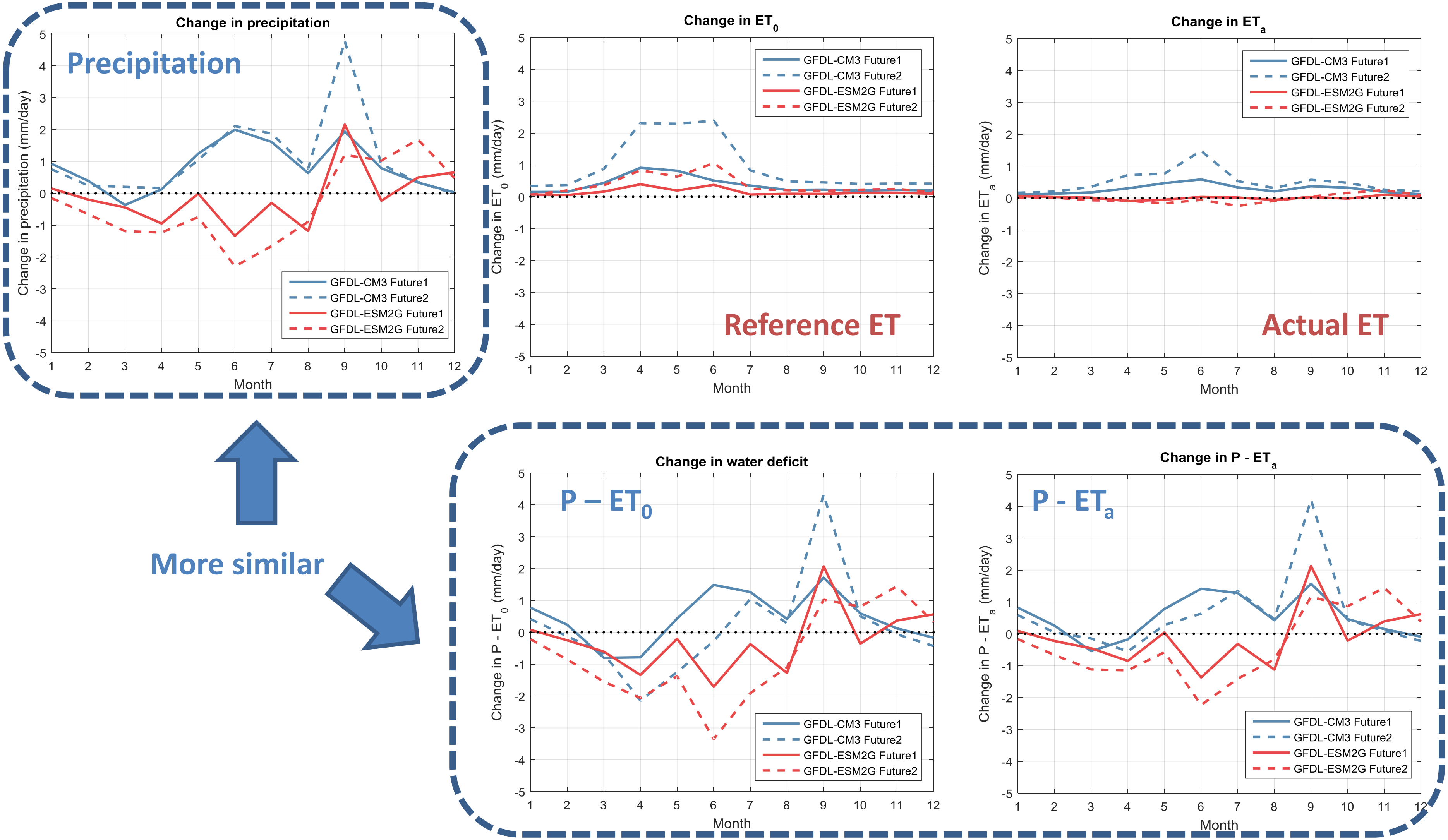


5 GCMs projected decrease in gw level

Monthly streamflow



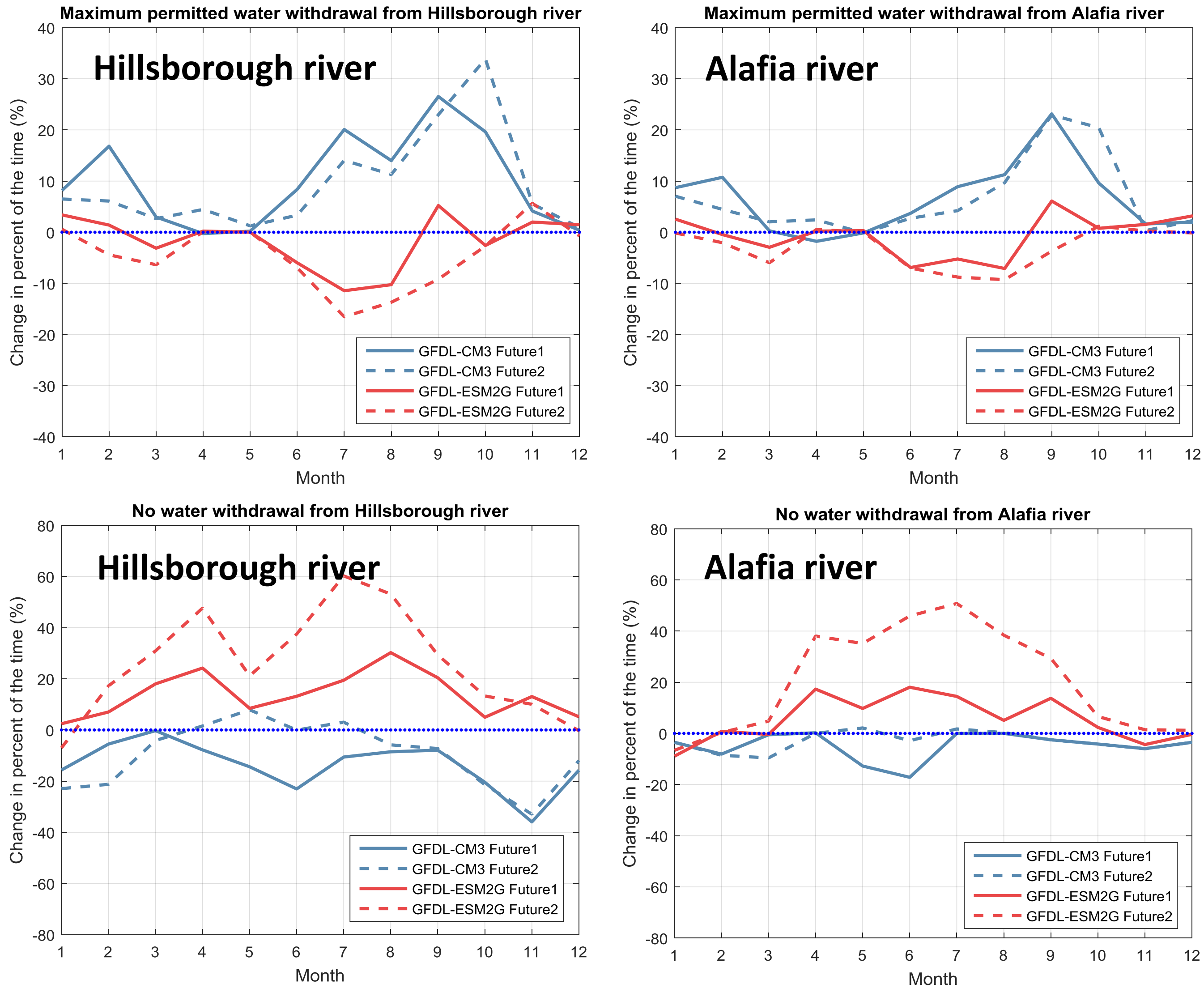
Change in P, ET_0, ET_a, P-ET_0 and P-ET_a (Two GCMs)



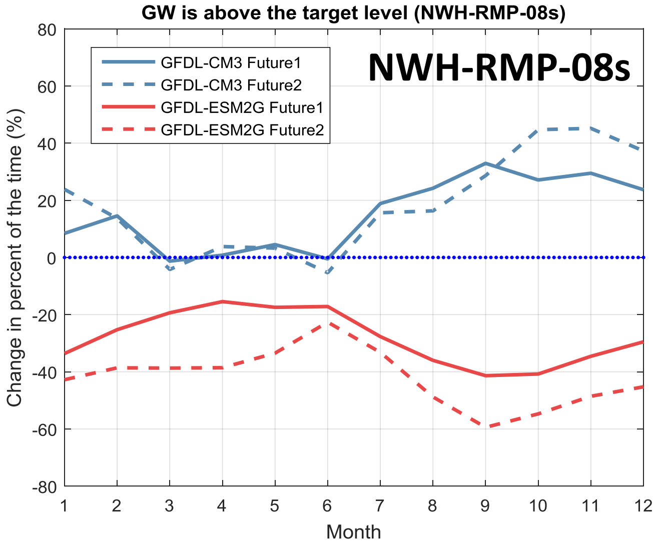
Percent of time that maximum or no water withdrawal

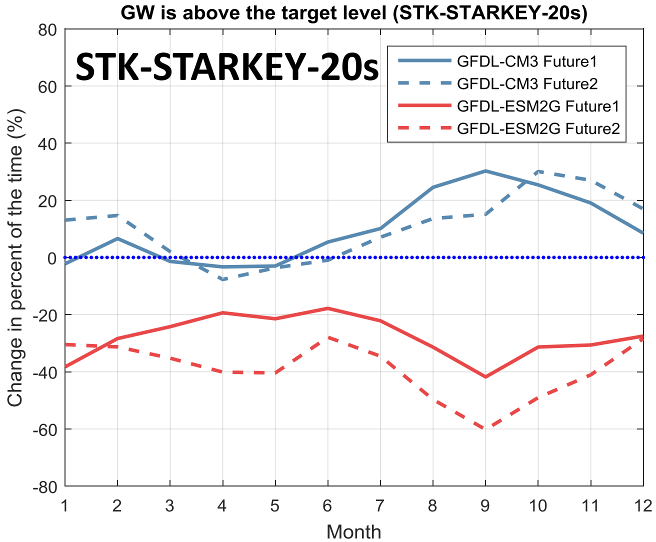
Percent of the time that maximum permitted water withdrawal

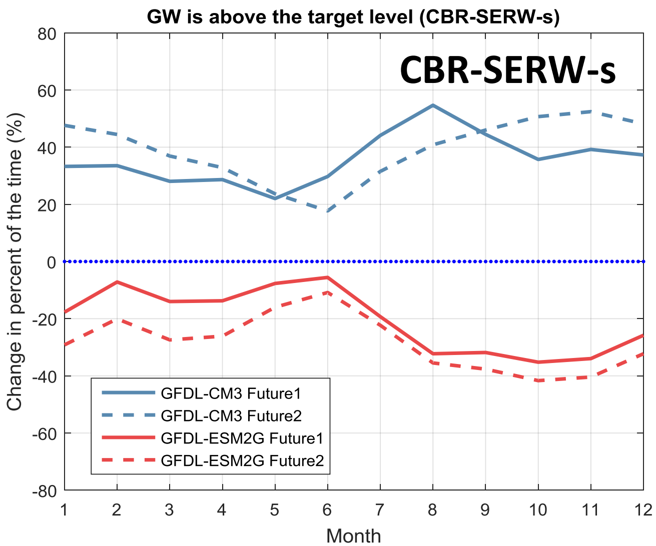
Percent of the time that no water can be withdrawn

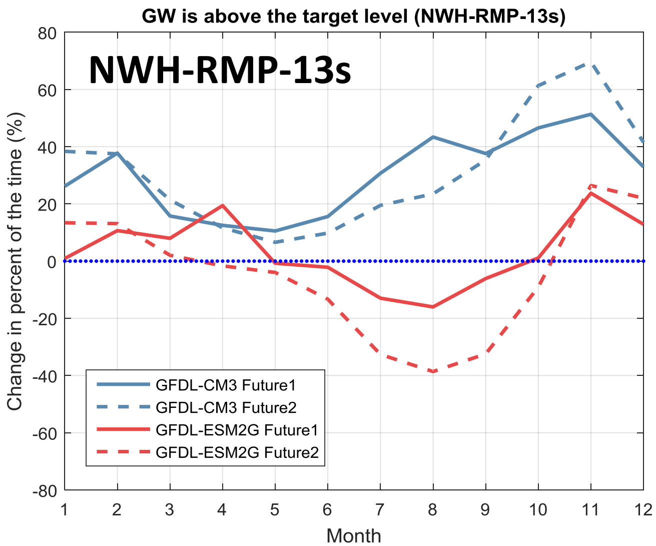


Percent of time that GW is above the target level

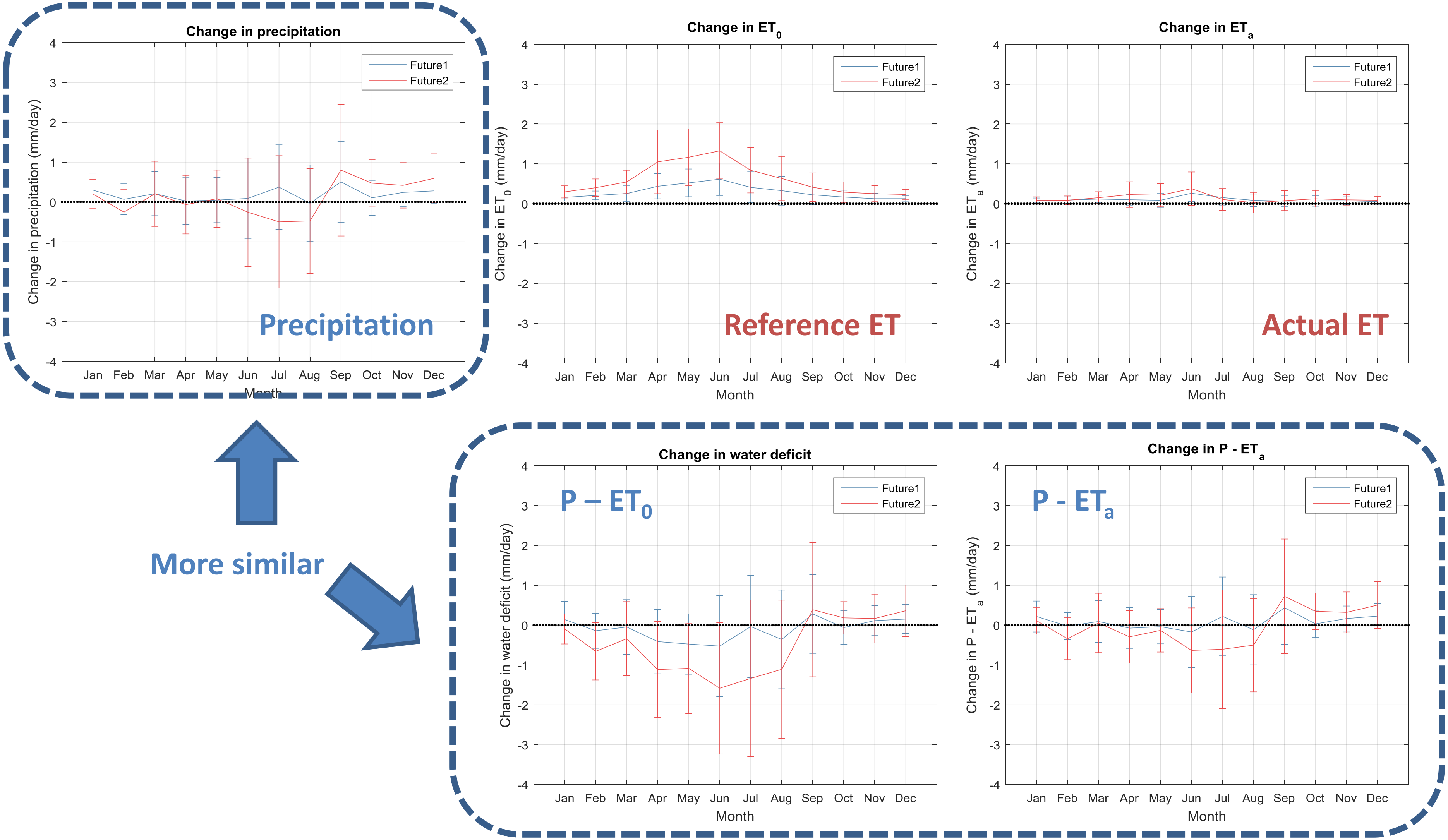




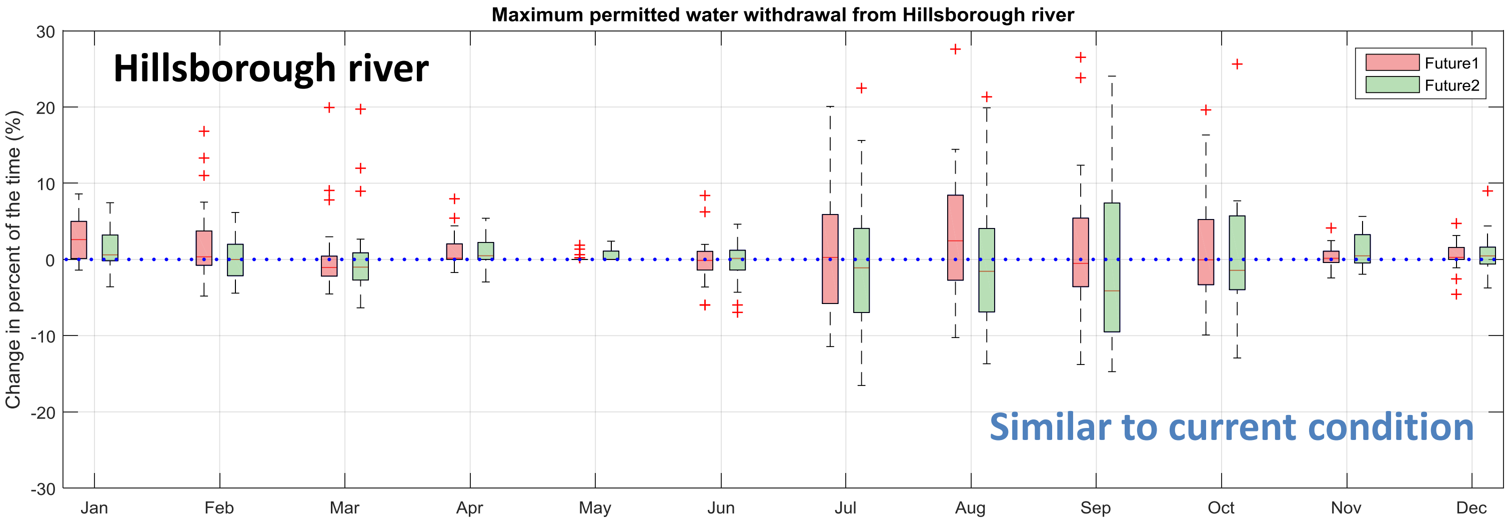


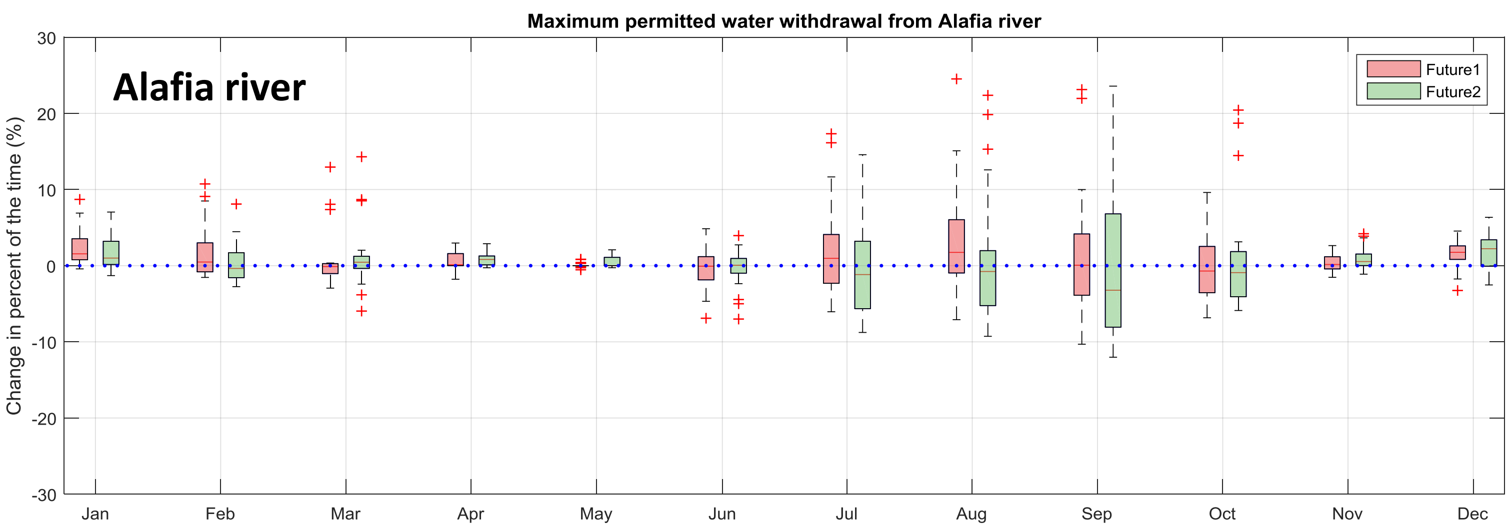


Change in P, ET_0, ET_a, P-ET_0 and P-ET_a over all GCMs

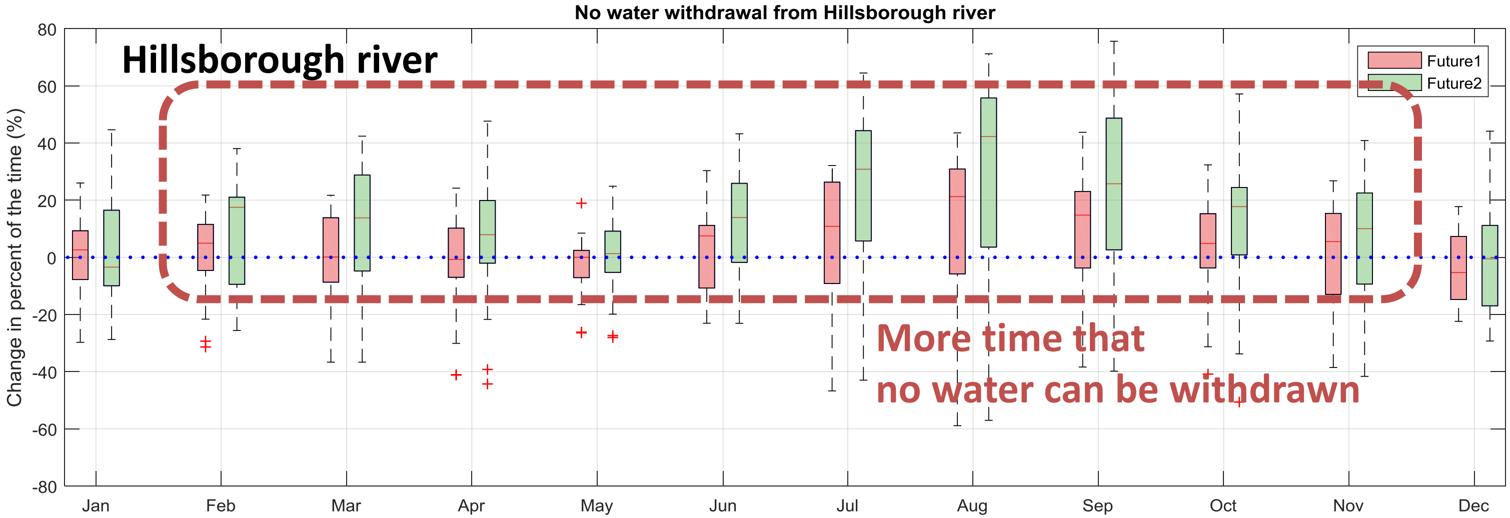


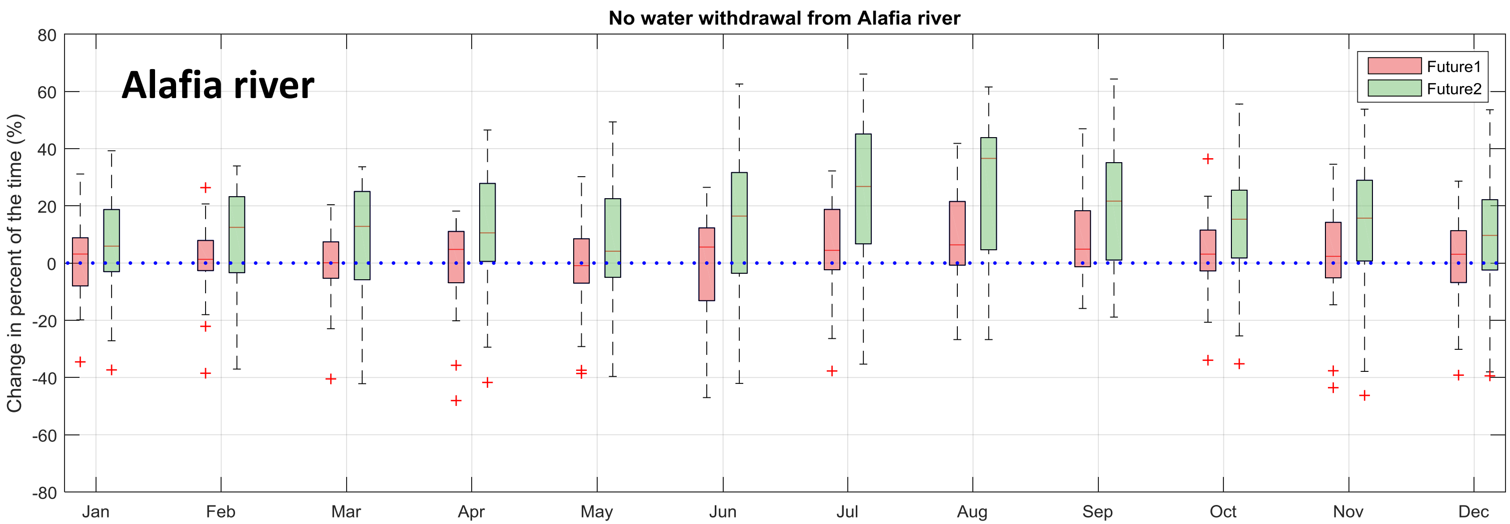
Percent of time that maximum permitted water withdrawal



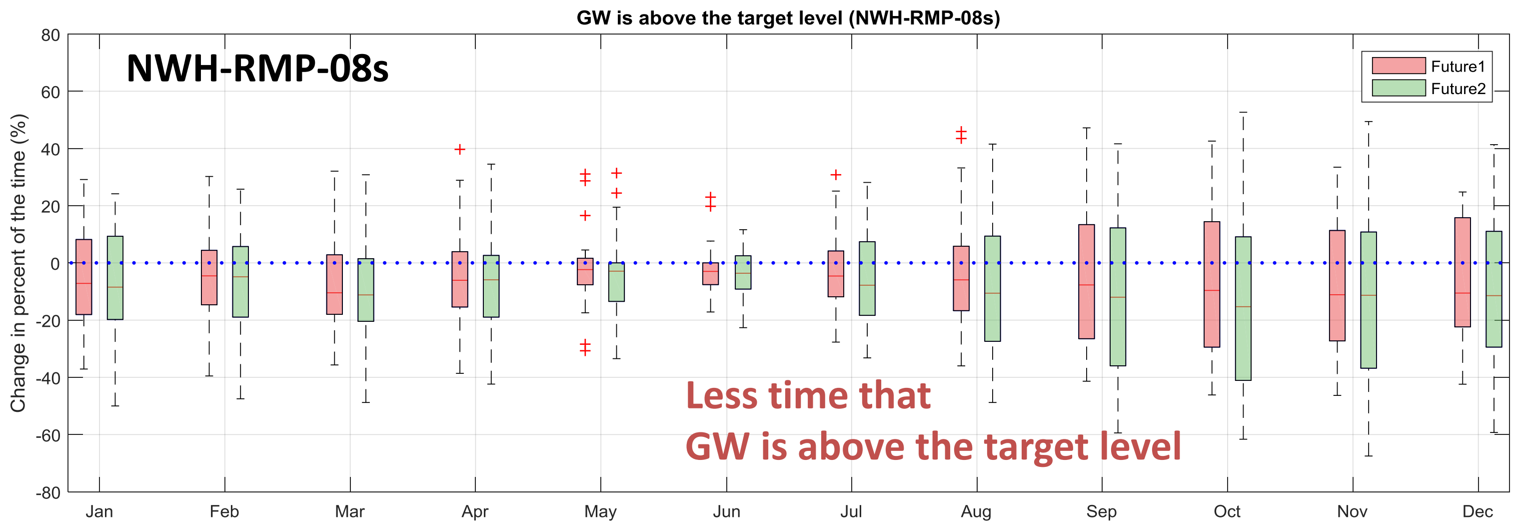


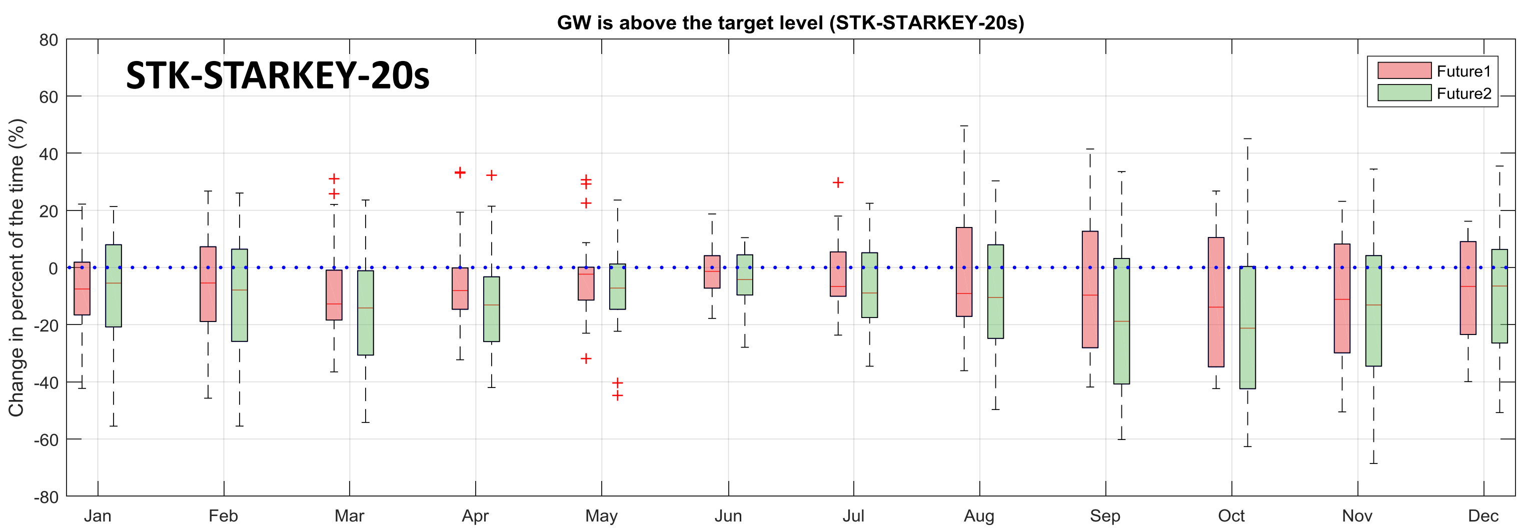
Percent of time that no water can be withdrawn





Percent of time that GW is above the target level





Take home messages

- The uncertainties attributed to GCM were the dominant factor influencing different future streamflow projections.

- The uncertainties attributed to GCM and water use scenario both contributed to significant differences in future groundwater level projections.

- Climate models projected significantly different changes in streamflow and groundwater level. 5 to 6 GCMs among 8 GCMs projected decreases in streamflow and groundwater level.

- Results indicate a good probability of decreased future water availability in the Tampa Bay region.

Thank you