

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

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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



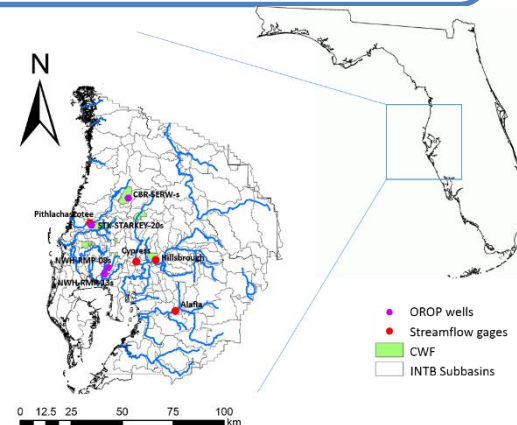
Retrospective period: 1982-2005

Future period 1: 2030-2060

Future period 2: 2070-2100

## Changes in streamflow and groundwater level

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



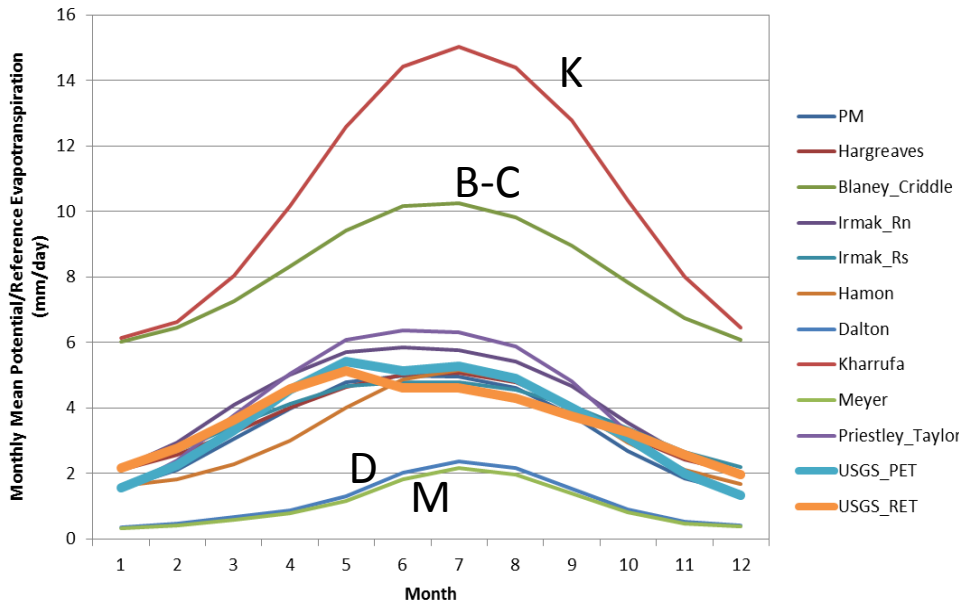
## Methods and Materials

3  $ET_0$  estimation methods

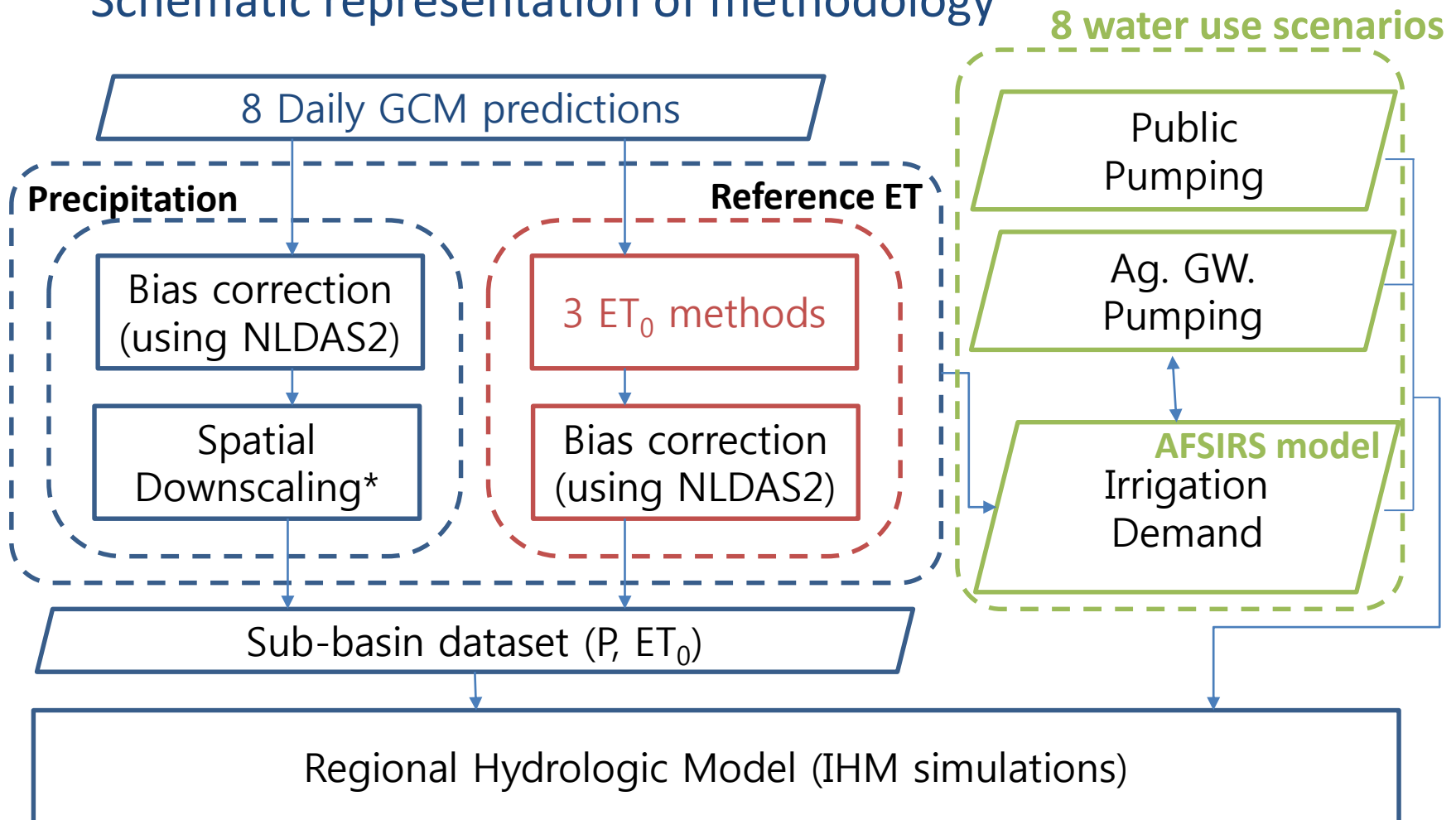
Temperature based:  
Hargreaves method

Radiation based:  
Priestley-Taylor method

Combination method:  
Penman-Monteith method



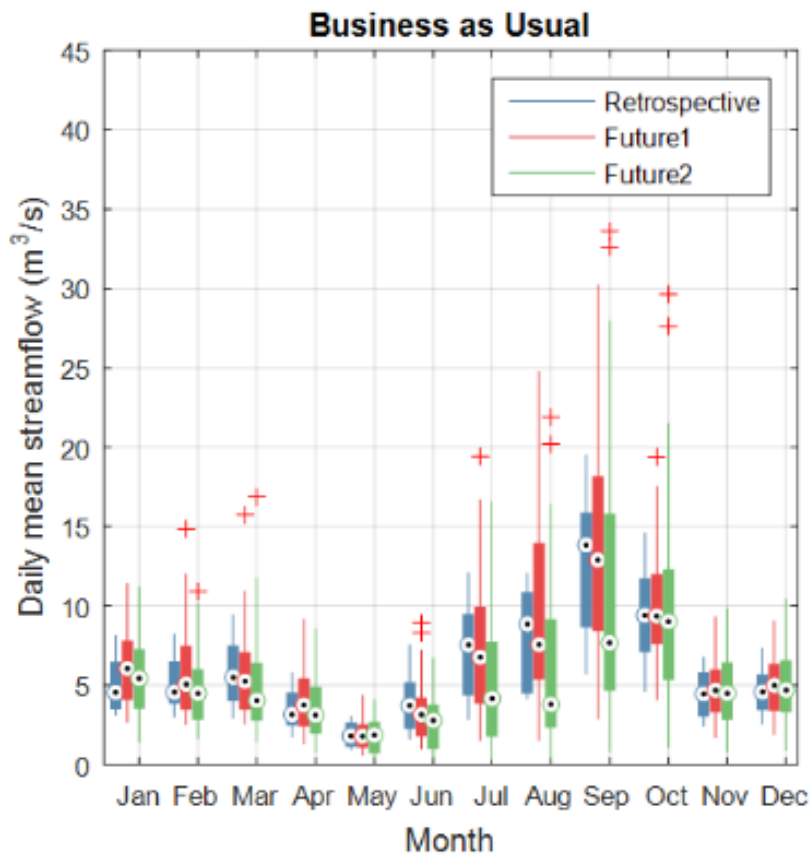
## Schematic representation of methodology



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

## 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

### 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

GCM is dominant



Very low





## Global sensitivity analysis results

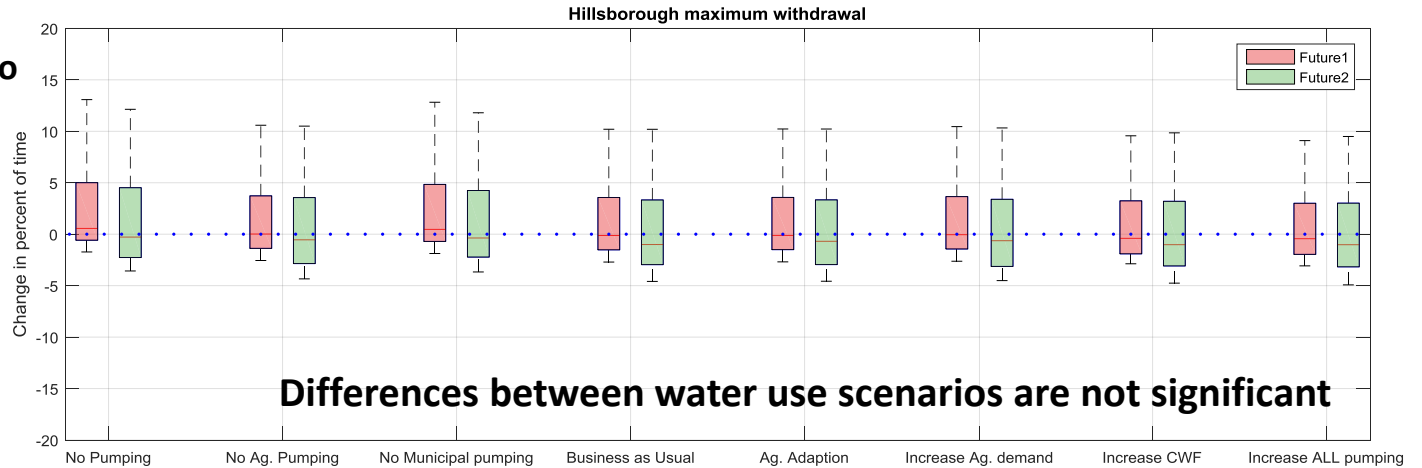
### The first order sensitivity index of change in groundwater level

GCM and water use scenario  
are dominant

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

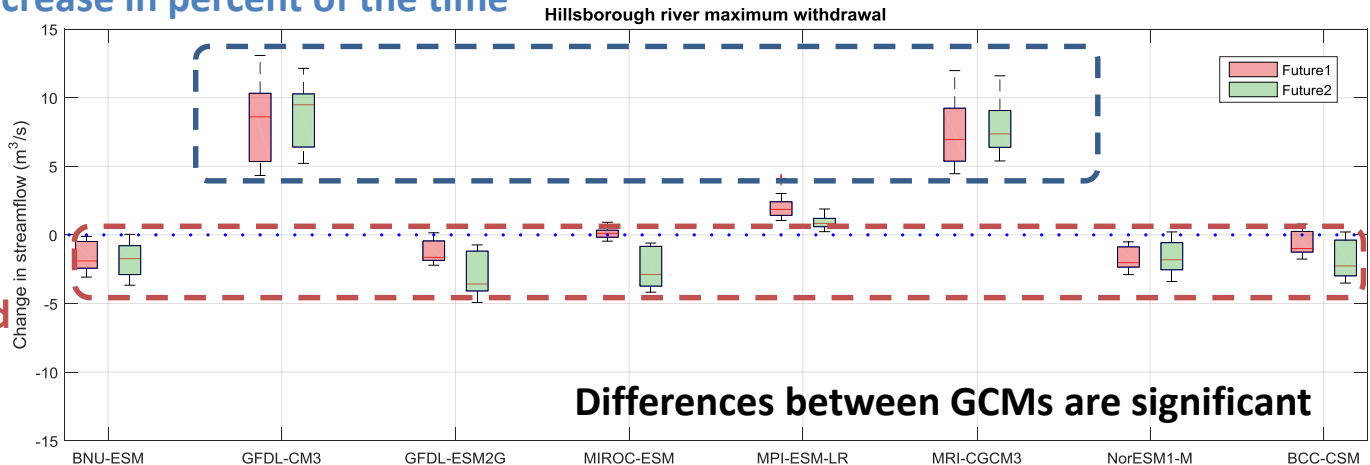
## Change in maximum water withdrawal (Hillsborough)

By water use scenario



## 2 GCMs projected increase in percent of the time

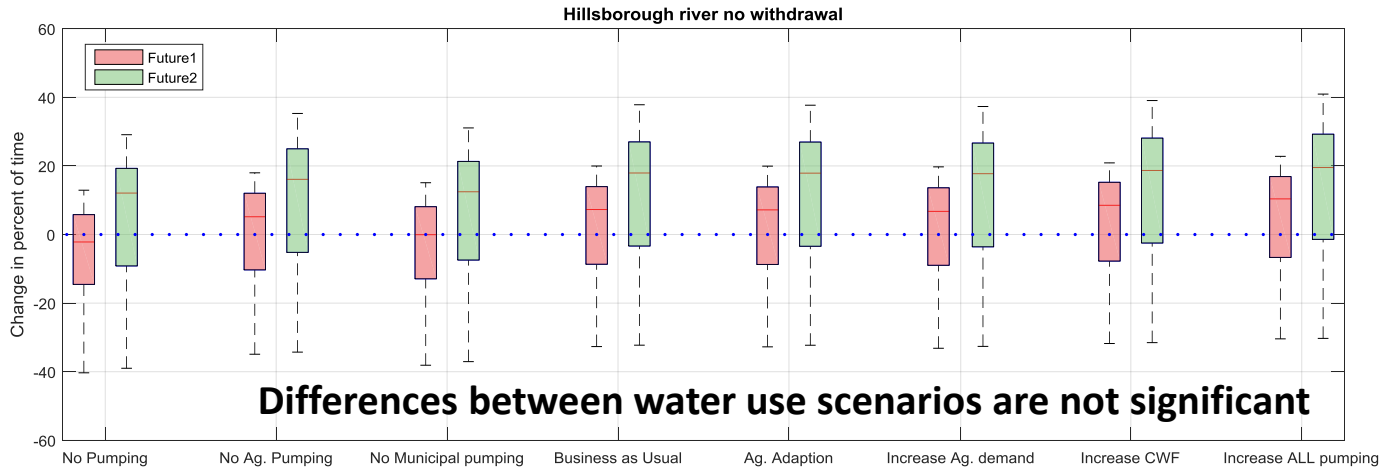
By GCM



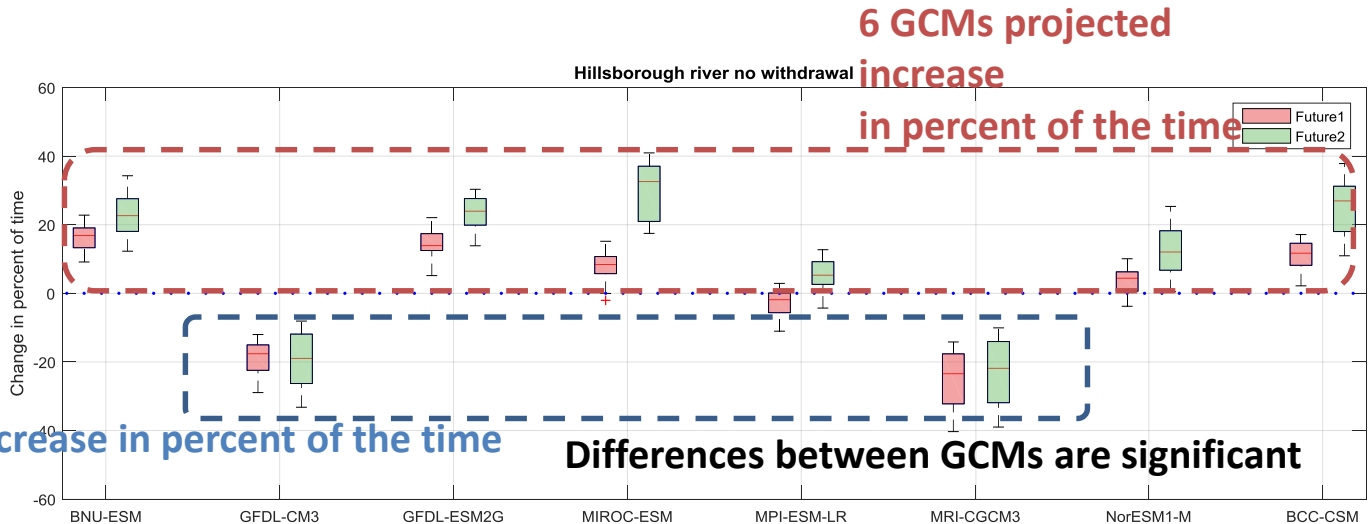
5 GCMs projected decrease in percent of the time

# Change in no water withdrawal (Hillsborough)

By water use scenario



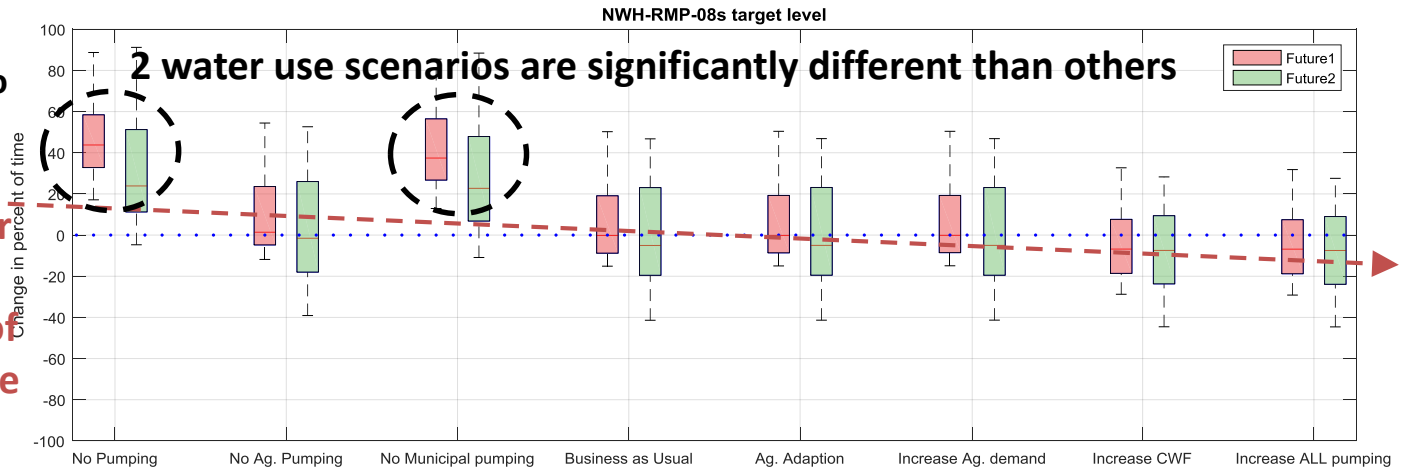
By GCM



2 GCMs projected decrease in percent of the time

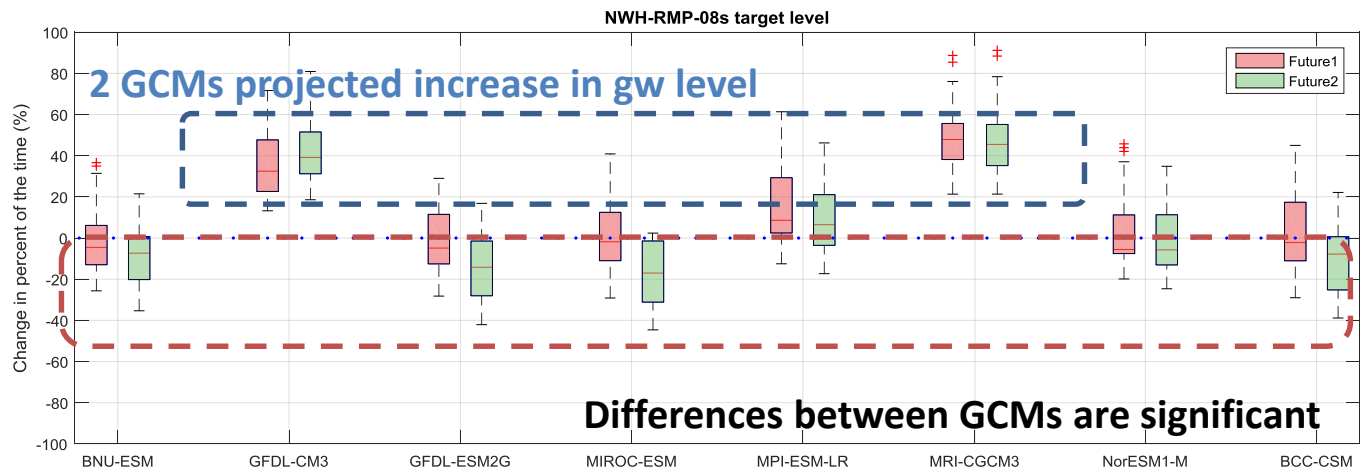
# Change in percent of the time that GW is above target level

By water use scenario



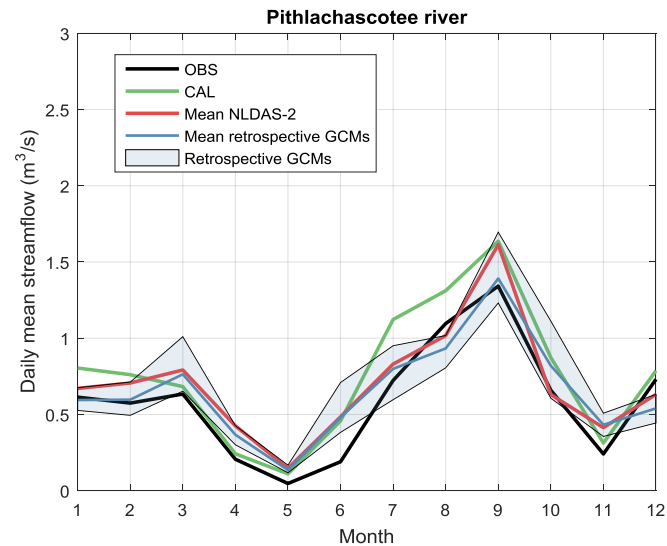
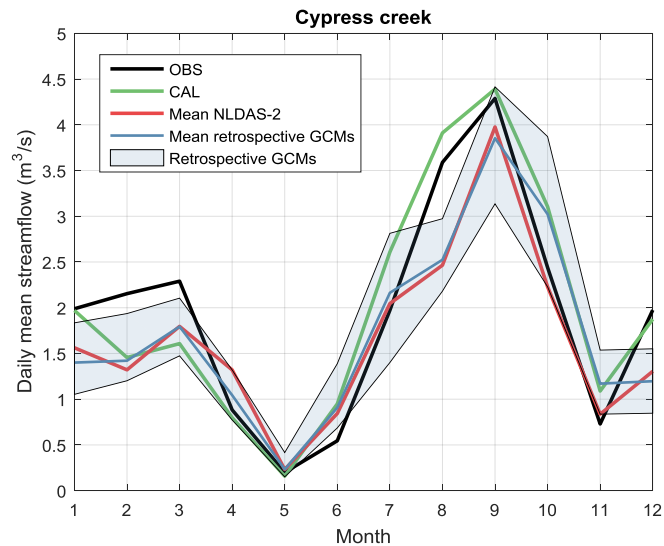
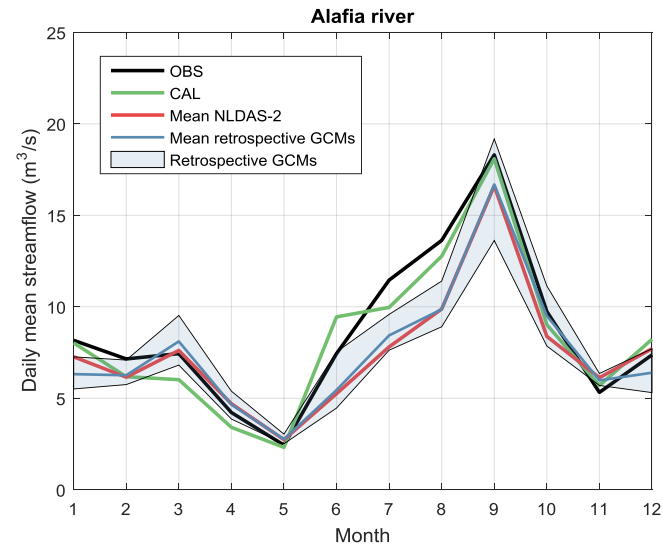
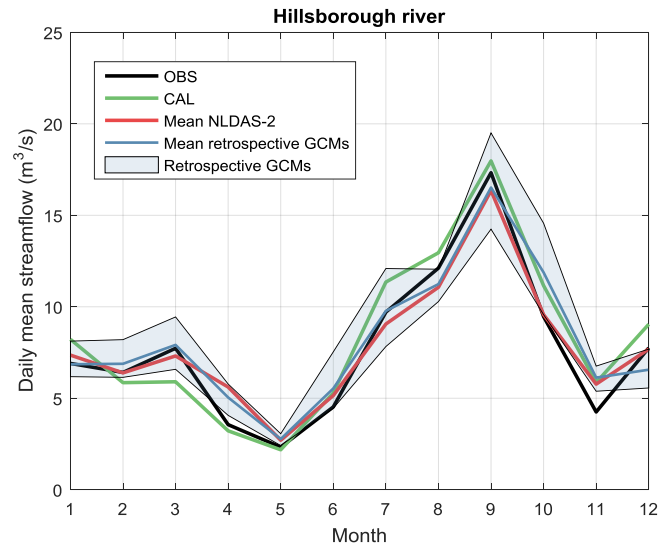
Increase groundwater pumping scenarios decrease in percent of time that GW is above the target level

By GCM



5 GCMs projected decrease in gw level

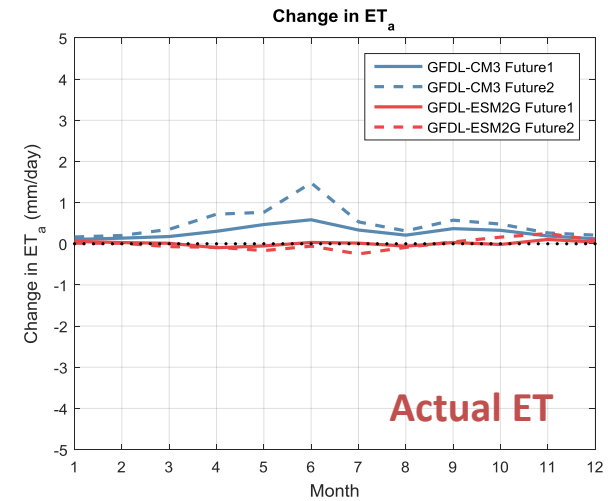
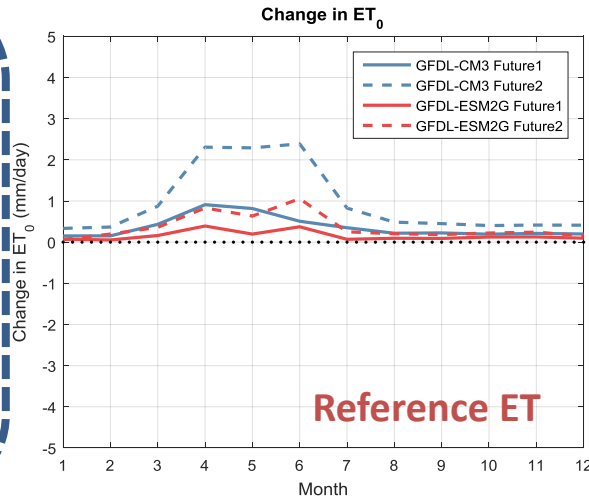
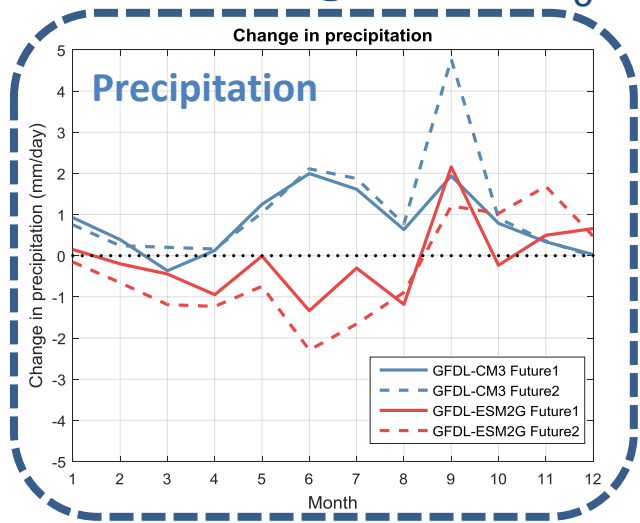
## Monthly streamflow



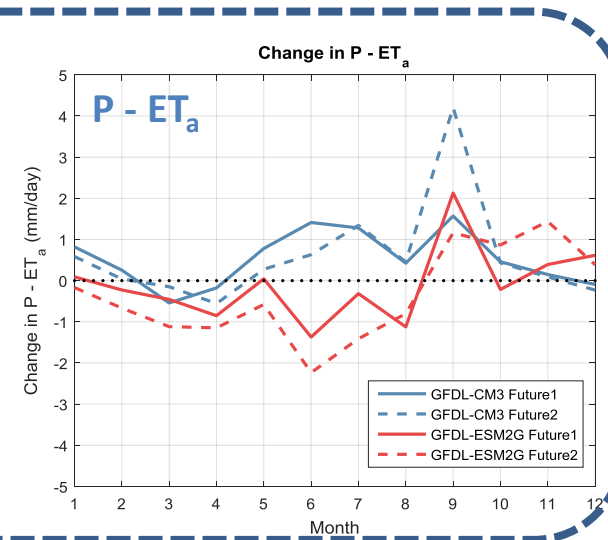
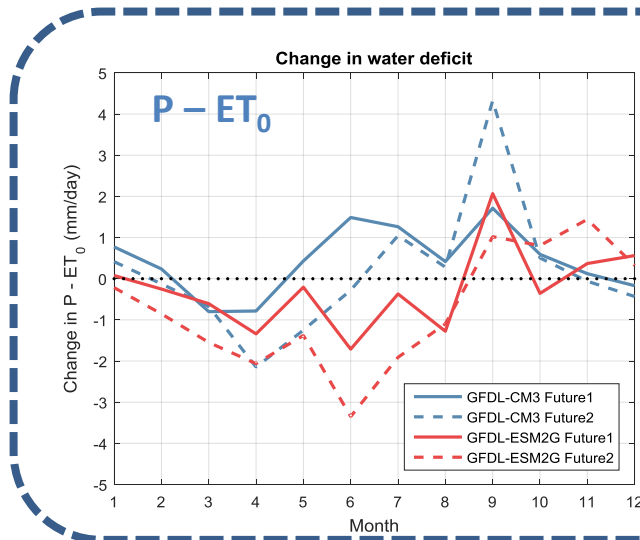
# 03

## Tampa Bay region

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

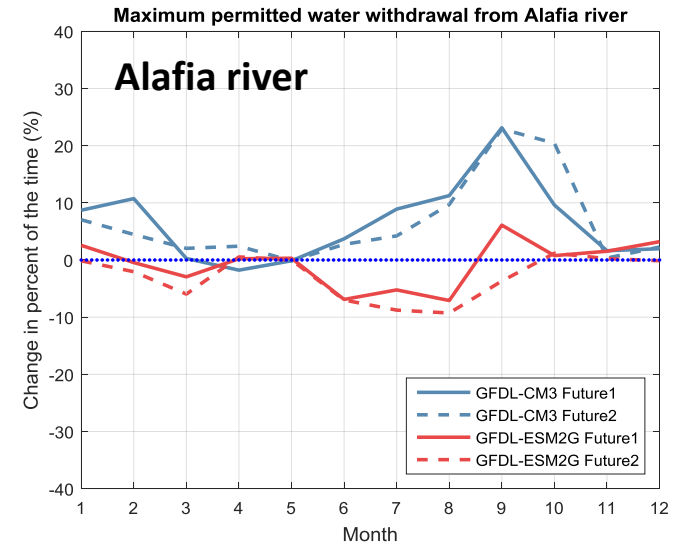
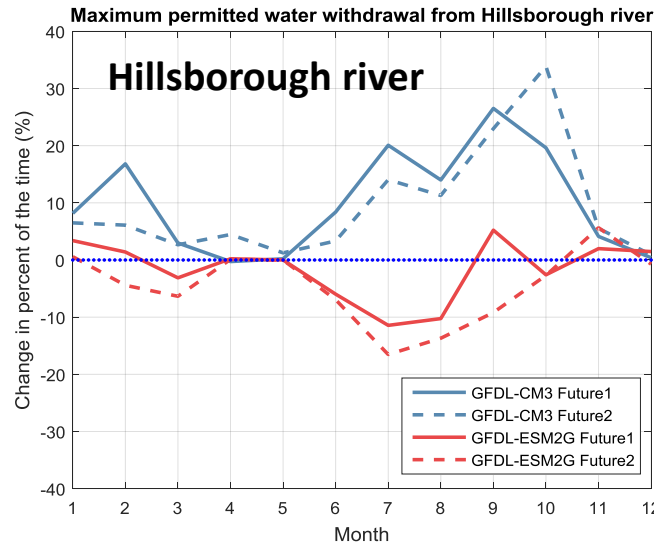


More similar

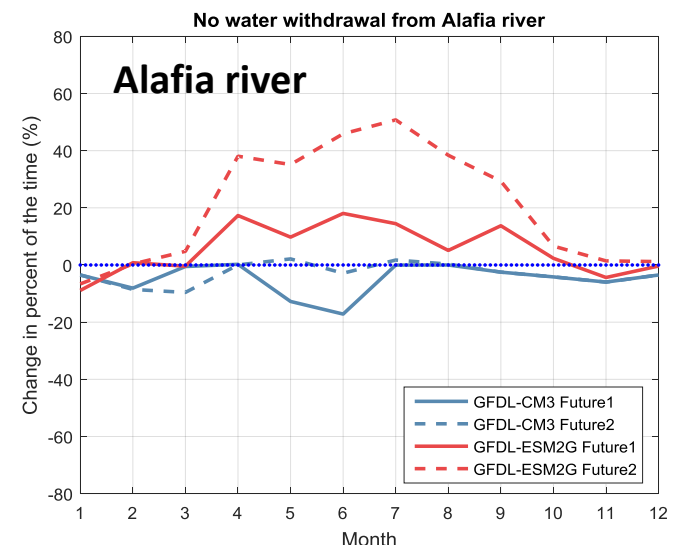
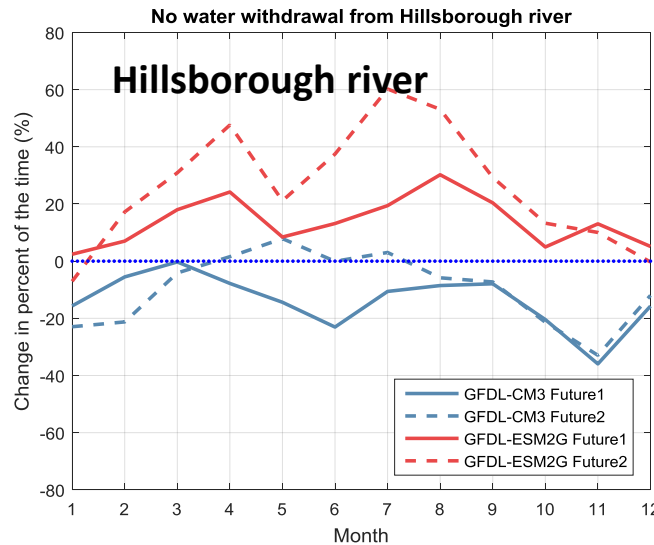


## Percent of time that maximum or no water withdrawal

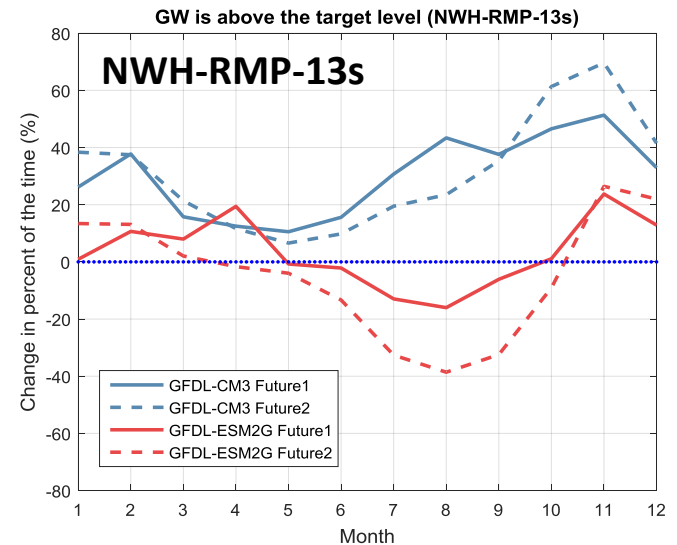
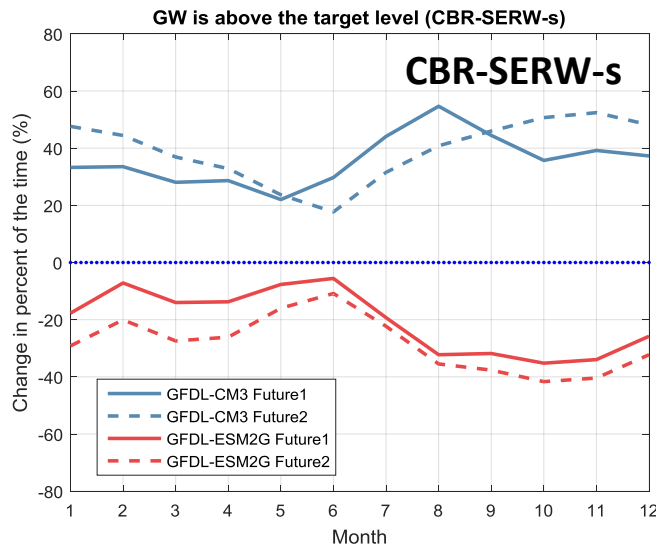
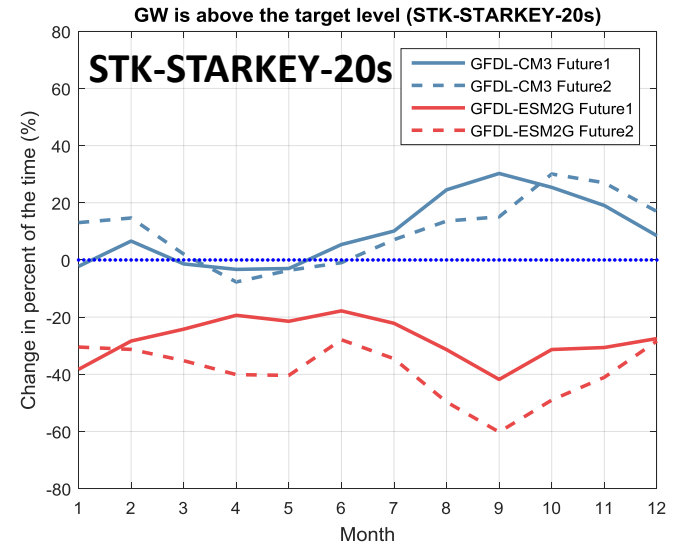
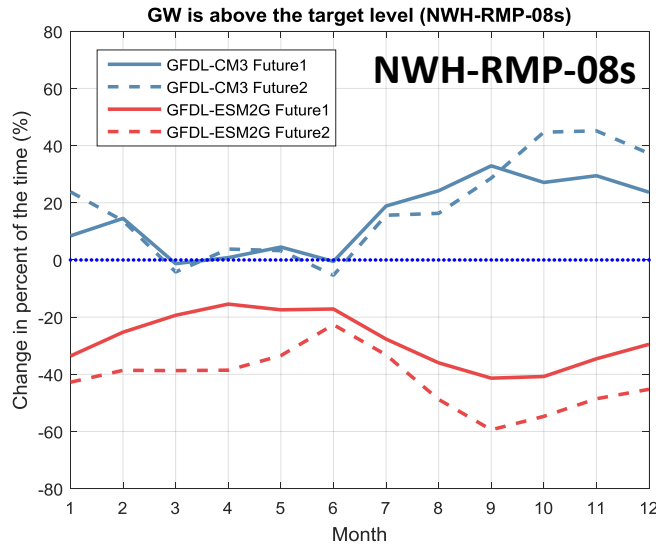
Percent of the time that maximum permitted water withdrawal



Percent of the time that no water can be withdrawn



## Percent of time that GW is above the target level

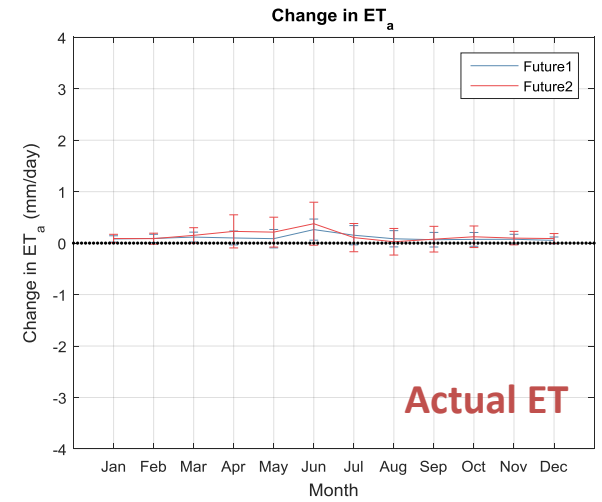
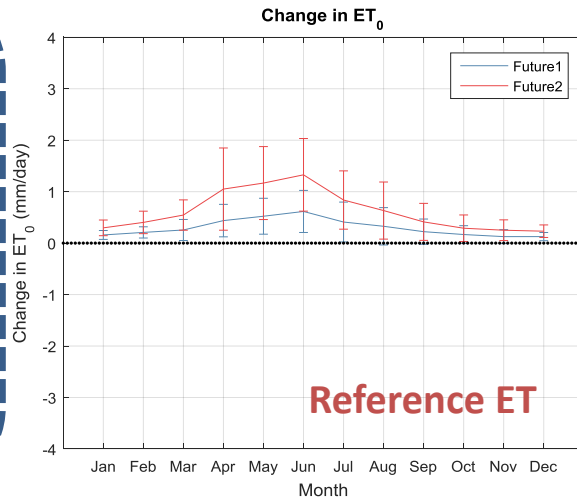
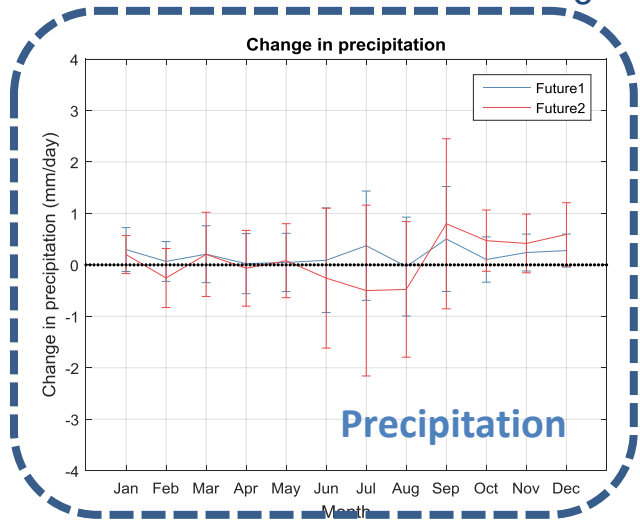




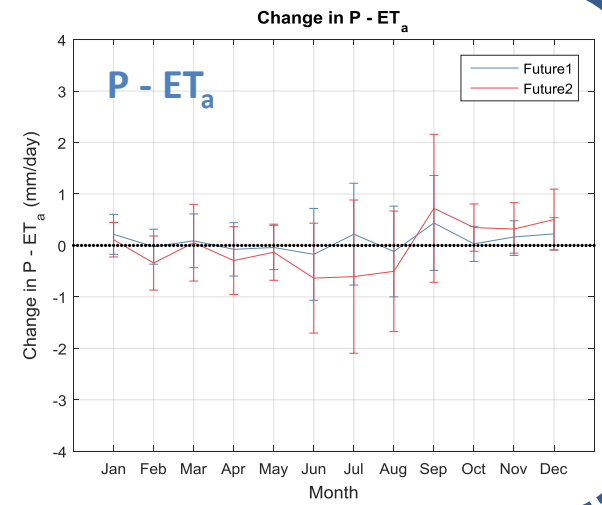
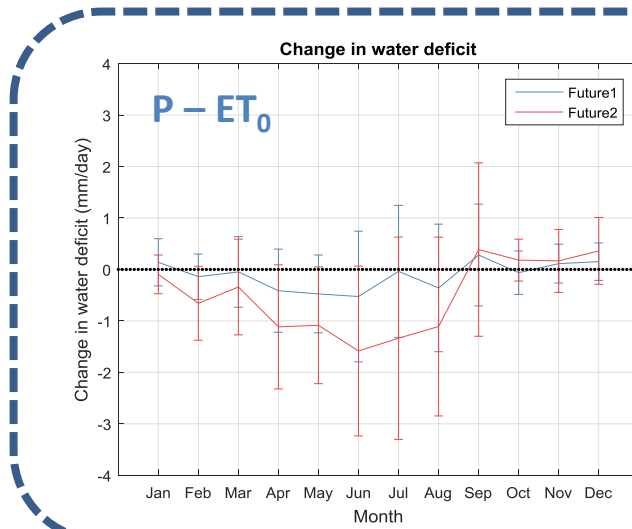
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## Tampa Bay region

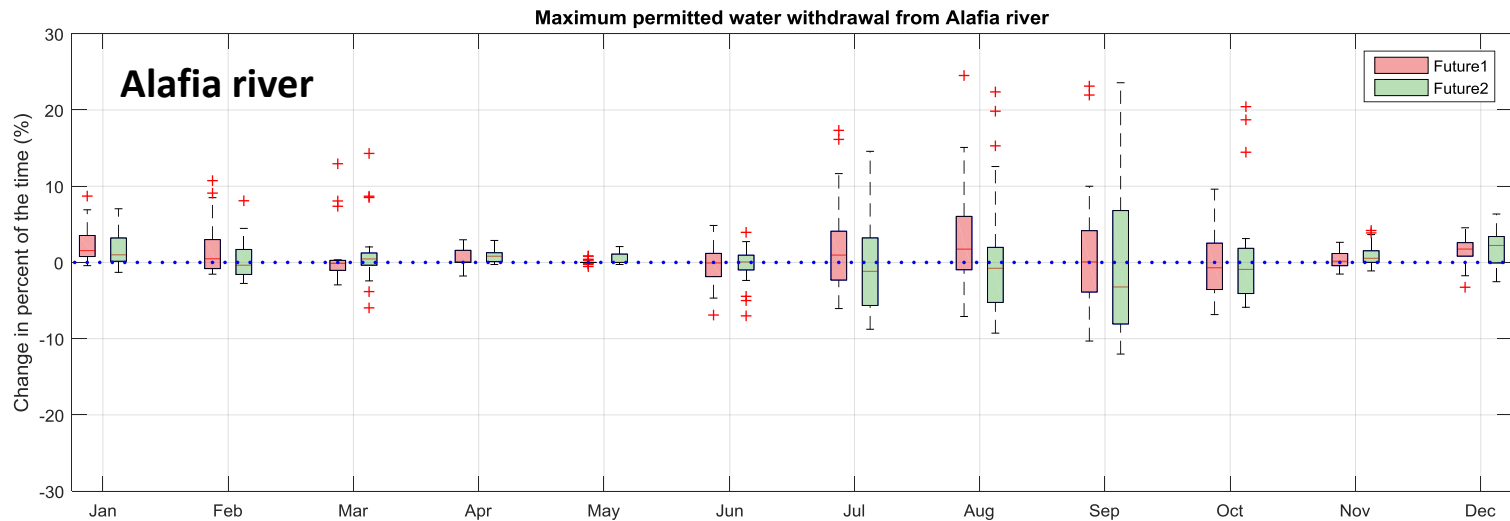
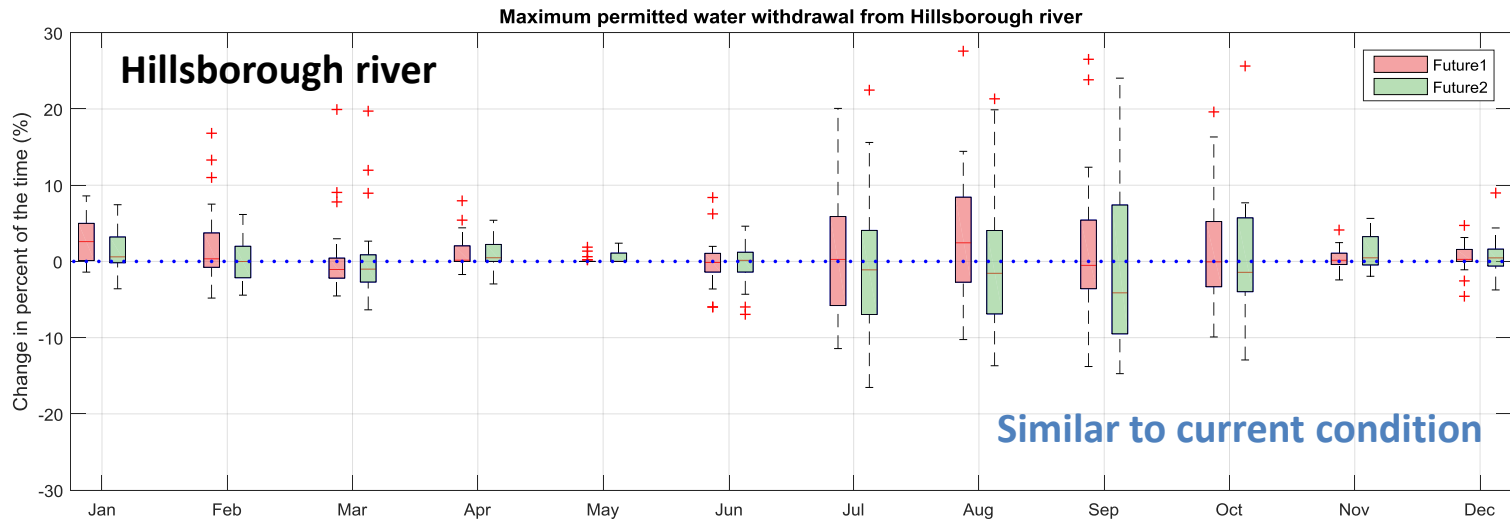
### Change in $P$ , $ET_0$ , $ET_a$ , $P-ET_0$ and $P-ET_a$ over all GCMs



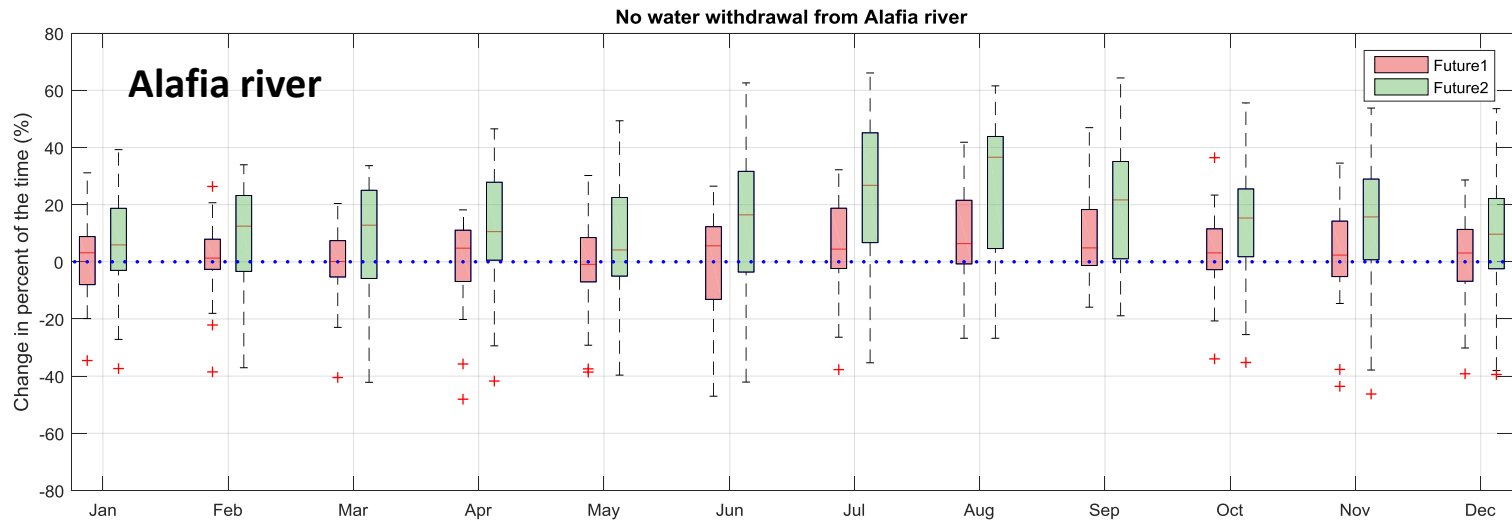
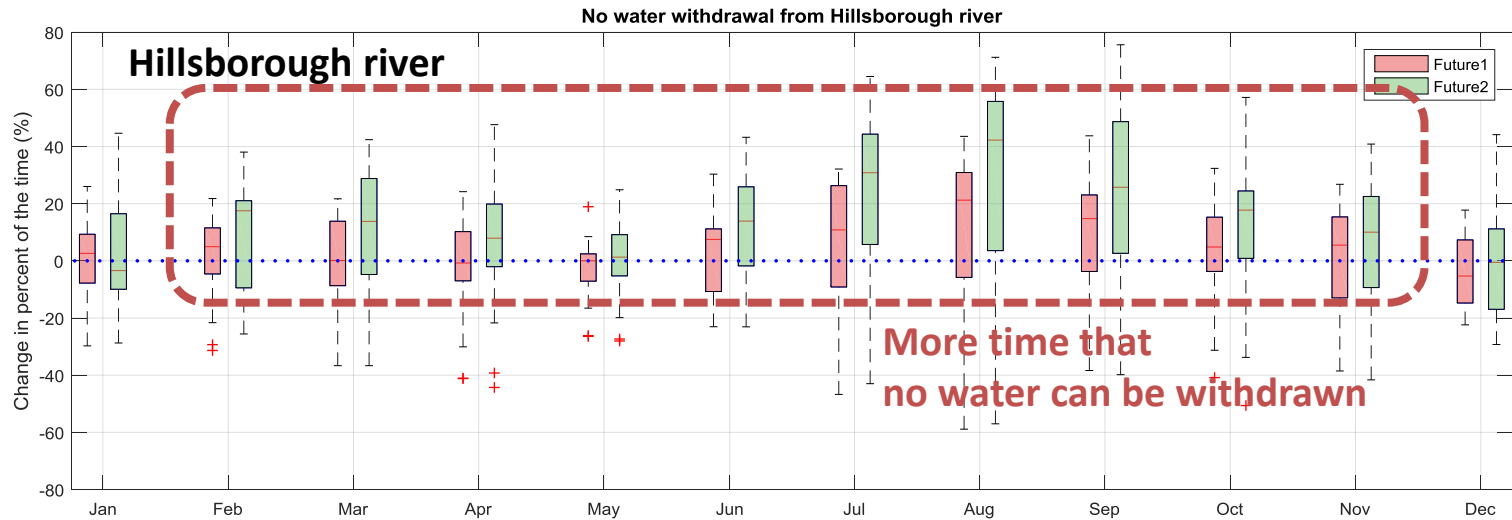
More similar



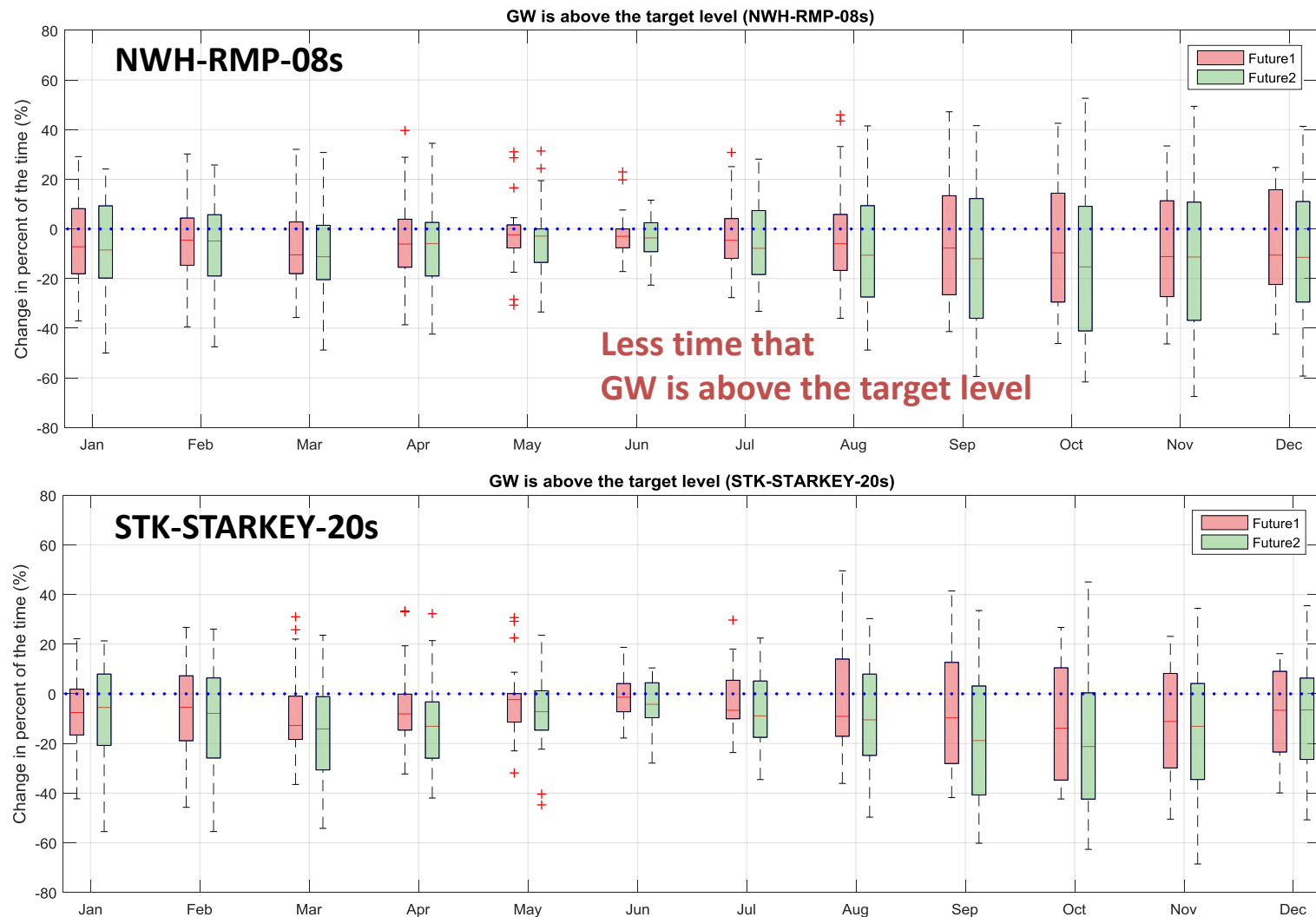
# Percent of time that maximum permitted water withdrawal



# 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**