Climate Sensitivity Runs Using the South Florida Water Management Model

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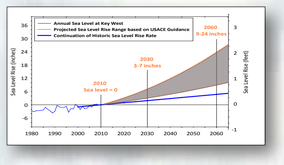
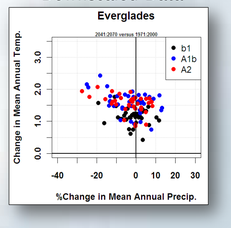
Introduction

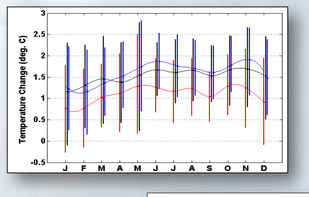
With current projections of climate change and sea level rise, the concept of “stationarity”, which traditional planning efforts have used in the past, is no longer appropriate. Current literature is abundant with projections of temperature and precipitation for the 21st century at a global scale but such information is not readily available or has not been evaluated adequately for regional scales such as the Everglades. The South Florida Water Management District (SFWMD) has conducted preliminary work and is currently evaluating the more recent work of CMIP5 to create a series of sensitivity model runs using the South Florida Water Management Model (SFWMM). The SFWMM simulates the period 1965-2005 with current water control operations and land use in place. The sensitivity runs change the climate and sea level and run the simulation for 1965-2005 while the climate data reflects a potential future climate (50-year horizon). In previous efforts no attempts were made to mitigate the effects of climatic shifts or sea level rise but current efforts aim to identify adaptation strategies.

Unified Sea Level Rise Projections of the Southeast Climate Compact

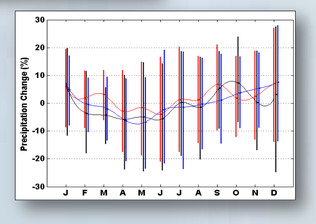


Analysis of Statistically Downscaled Data





Global Climate Model Data for the Southeast region

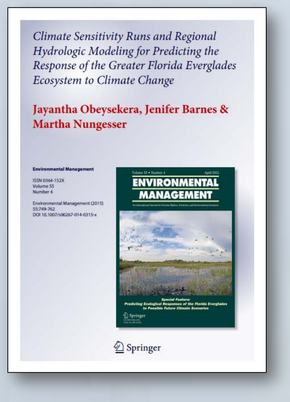


Summary of Median Climate Change for Circa 2050

Variable	Global Climate Model	Statistically Downscaled Data	Dynamically Downscaled Data
Average Temperature	1 to 1.5 ºC	1 to 2 ºC	1.8 to 2.1 ºC
Precipitation	-10% to +10%	-5% to +5%	-3 to 2 inches
Reference Crop Evapotranspiration			3 to 6 inches

List of Scenarios for CES Workshop in 2013

- 2010 Baseline (demands and landuse corresponding to 2010 simulated with the 1965-2005 rainfall & ET (**BASE**)
- 2010 Baseline with 10% decrease in rainfall (**decRF**)
- 2010 Baseline with 10% increase in rainfall (**incRF**)
- 2010 Baseline with 1.5° Celsius increase and 1.5 foot sea level rise with increased coastal canal levels (**incET**)
- 2010 Baseline with 10% decrease in rainfall, 1.5° Celsius increase and 1.5 foot sea level rise with increased coastal canal levels (**decRFincET**)
- 2010 Baseline with 10% decrease in rainfall, 1.5° Celsius increase and 1.5 foot sea level rise with no increased coastal canal levels (**decRFincETnoC**)
- 2010 Baseline with 10% increase in rainfall, 1.5° Celsius increase and 1.5 foot sea level rise with increased coastal canal levels (**incRFincET**)



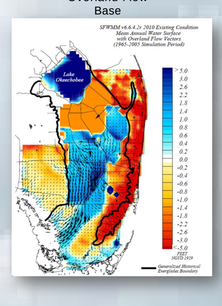
Summary of Previous Efforts

A series of SFWMM runs were made for the workshop entitled ‘Predicting Ecological Changes in the Florida Everglades under a Future Climate Scenario’ conducted by Florida Atlantic University’s Center for Environmental Studies (CES) in February 2013. These runs attempted to characterize wholesale changes to climate based on statistical analysis of global climate model output. The climate data was simplistically adjusted and did not account for seasonal shifts which may happen in the future. The runs were intended to provide quick information for use in a review by Everglades scientists. The results of these analyses have been published by Springer’s Environmental Management journal.

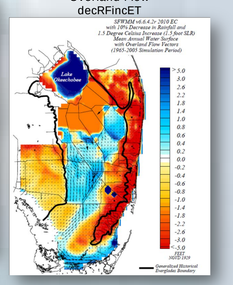
Recommendations from this workshop included the need for more ‘realistic’ climatic shifts which would require more intense pre-processing of model input data. Plans were then made to start a more in-depth analysis of global climate output to characterize possible futures more closely aligned with Global Climate Model output.

SFWMM Output for CES Scenarios

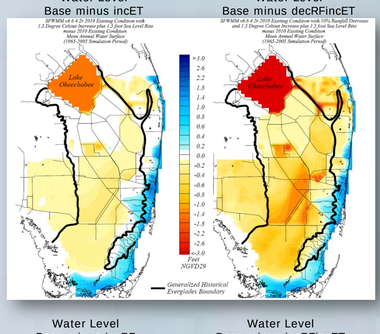
Overland Flow Base



Overland Flow decRFincET

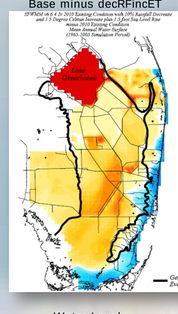


Water Level Base minus incET

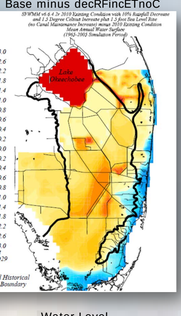


Water Level Base minus decRFincET

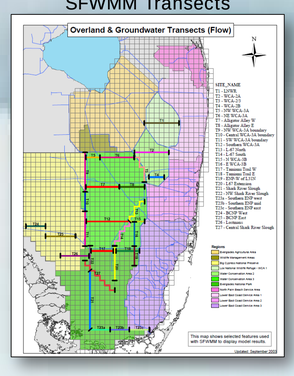
Water Level Base minus decRFincET



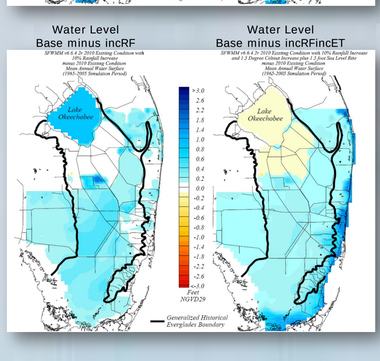
Water Level Base minus decRFincETnoC



SFWMM Transects

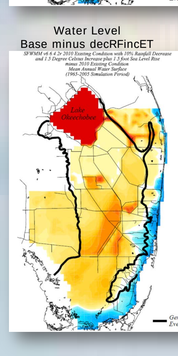


Water Level Base minus incRF

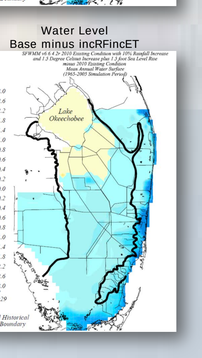


Water Level Base minus incRFincET

Water Level Base minus decRFincET



Water Level Base minus incRFincET



Changes in Mean Annual Overland Flow for SFWMM Transects

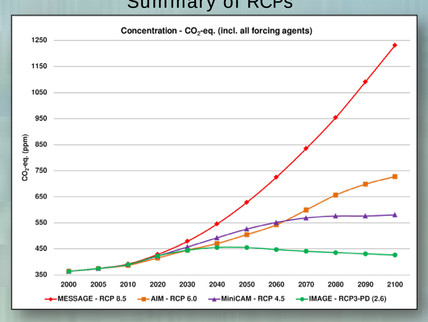
1,000 acre-feet/year	1	2	4	5	6	7	8	10	12	15	16	17	18	19	20	21	22	23	23a	23b	23c	27
Base (total)	74	299	92	245	68	477	507	77	824	168	-153	692	131	-117	7	675	133	154	19	67	68	730
decRF (delta)	-13	-111	-24	-66	-26	-171	-142	-27	-327	-91	+42	-381	-9	+28	+23	-347	-84	-68	-8	-31	-29	-384
incRF (delta)	+11	+119	+9	+62	+29	+173	+71	+4	+244	+25	-29	+502	-9	-22	-36	+419	+128	+79	+11	+37	+31	+476
incET (delta)	-7	-58	-11	-41	-15	-103	-78	-10	-182	-45	+20	-230	-10	+17	+13	-188	-52	-33	-22	-11	0	-234
decRFincET (delta)	-23	-167	-45	-107	-39	-269	-285	-39	-550	-139	+85	-513	-82	+50	+17	-468	-109	-99	-27	-41	-31	-486
decRFincETnoC (delta)	-23	-166	-45	-107	-39	-266	-273	-39	-535	-136	+85	-506	-30	+47	+20	-461	-107	-103	-27	-41	-35	-523
incRFincET (delta)	+3	+58	+4	+28	+13	+80	+29	+8	+111	+20	-13	+216	-9	-9	-9	+205	+53	+39	-17	+25	+30	+200

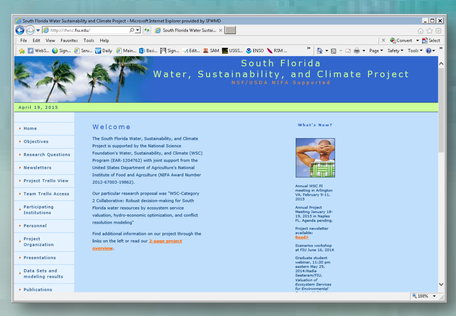
Summary of Current and Future Efforts

Currently, there are two major efforts which will benefit from updated SFWMM sensitivity runs: 1) The South Florida Water, Sustainability, and Climate Project which is supported by the National Science Foundation's Water, Sustainability, and Climate (WSC) Program (EAR-1204762) with joint support from the United States Department of Agriculture's National Institute of Food and Agriculture (NIFA Award Number 2012-67003-19862). 2) Flood and drought risk management under climate change: methods for strategy evaluation and cost optimization (NOAA-OAR-CPO-2014-2003692) with Deltares and funded by the National Oceanographic and Atmospheric Administration (NOAA).

The SFWMD is analyzing the World Climate Research Programme’s (WCRP’s) Coupled Model Intercomparison Project phase 5 (CMIP5) output which used the Bias Correction/ Constructed Analogs (BCCA) technique. The three RCPs (Representative Concentration Pathways) being used here are RCP2.6, RCP4.5 and RCP8.5. Efforts are underway to streamline SFWMM pre-processing tools to handle multiple scenarios and to distill the 119 scenarios into more manageable scenarios by characterizing the climatic behavior.

Summary of RCPs





Flood and drought risk management under climate change: methods for strategy evaluation and cost optimization

Deltares
Enabling Delta Life

Comparison of RCP2.6, RCP4.5 and RCP8.5 to SFWMM Rainfall for 1965-2005