Comparison of Statistical and Dynamic Downscaling methods for Hydrologic Applications in West Central Florida

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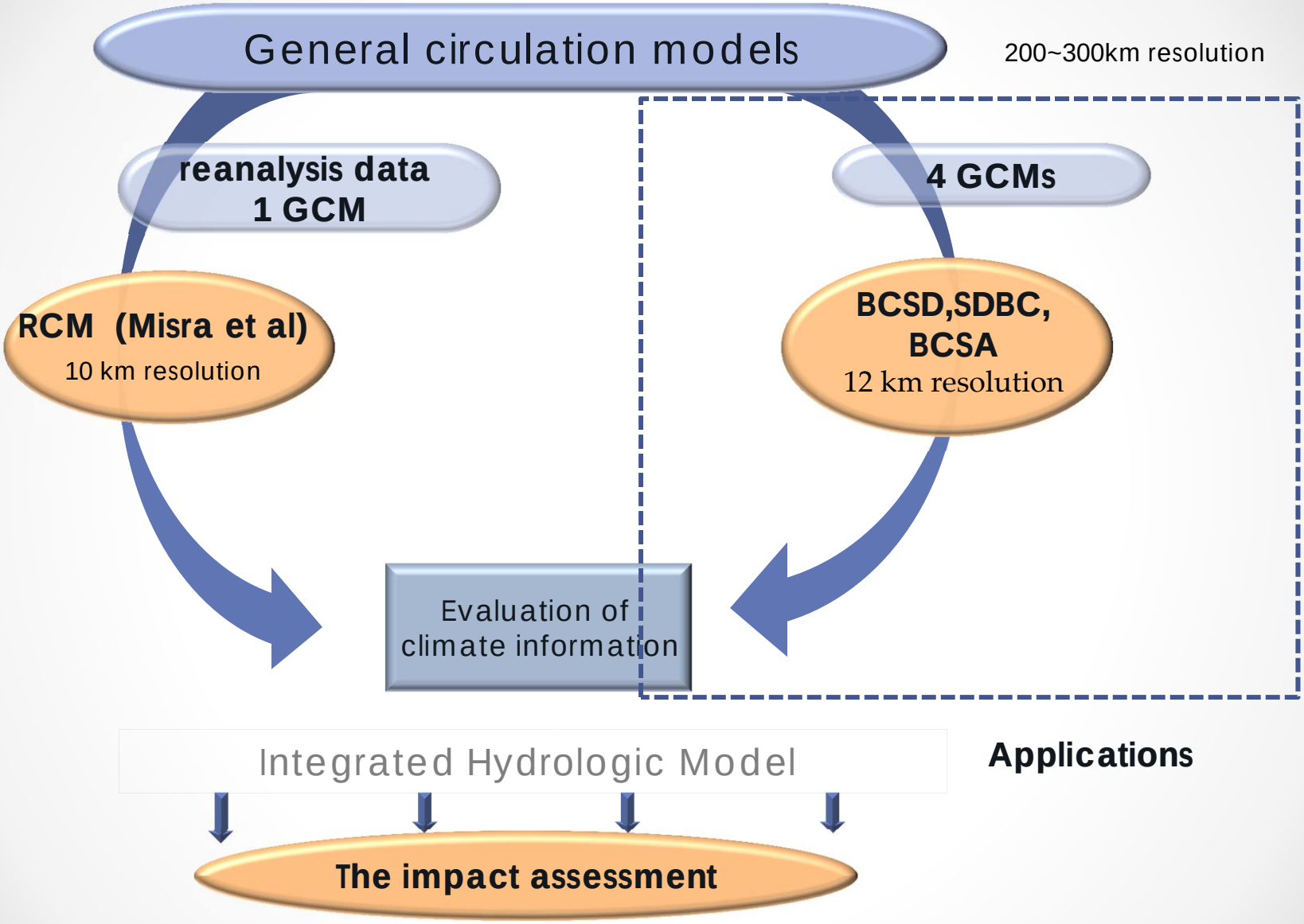
Tampa Bay Water

Goal of the research

- To compare the ability of three statistical downscaling methods and one dynamic downscaling to generate precipitation fields at hydrologically relevant space-time scales over the Tampa Bay region of west-central Florida.

In this research we…

- quantitatively evaluate the skills of existing methods in terms of both temporal and spatial precipitation patterns.
- develop a new stochastic downscaling technique which improves over the existing statistical downscaling methods in reproducing observed spatiotemporal variability of daily precipitation
- evaluate hydrologic implications of differences in downscaled climate scenarios over the study area using an existing integrated hydrologic model.

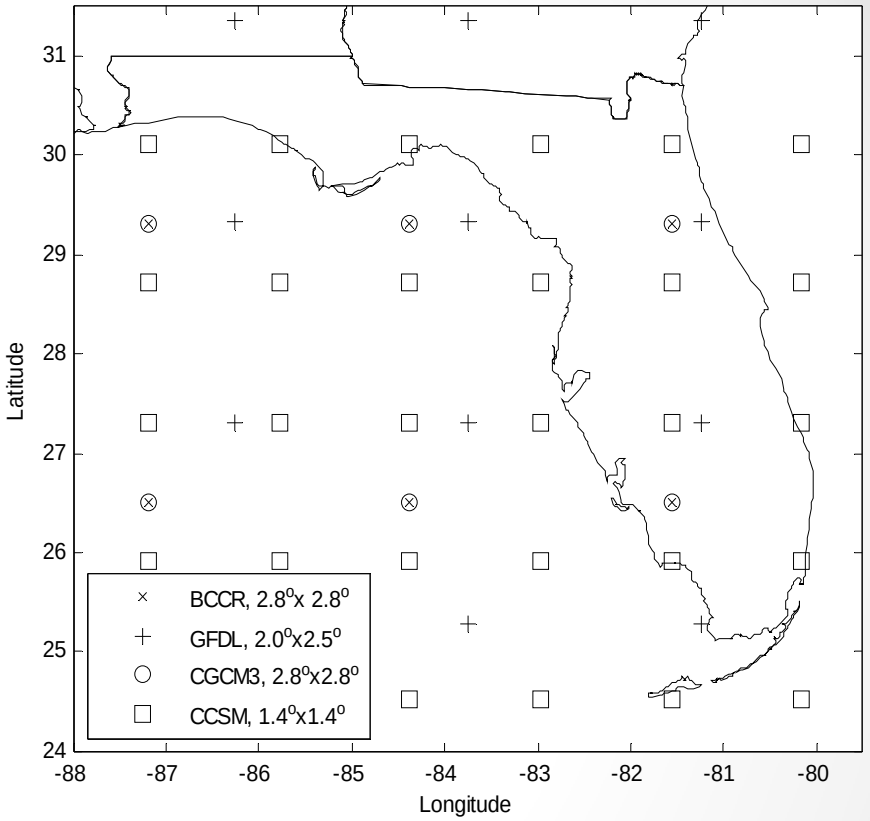

General circulation models
200~300km resolution
reanalysis data
1 GCM
4 GCMs
RCM (Misra et al)
10 km resolution
BCSD,SDBC,
BCSA
12 km resolution
Evaluation of
climate information
Integrated Hydrologic Model
Applications
The impact assessment

Data

GCMs used in this study

Modeling Group, Country	WCRP CMIP3* I.D.	Primary Reference
Bjerknes Centre for Climate Research, Norway	BCCR-BCM2.0	Furevik et al., 2003
US Dept. of Commerce/NOAA/Geophysical Fluid Dynamics Laboratory, USA	GFDL-CM2.0	Delworth et al., 2006
Canadian Centre for Climate Modeling & Analysis, Canada	CGCM3.1	Flato and Boer, 2001
National Center for Atmospheric Research, USA	CCSM	Collins et al., 2006

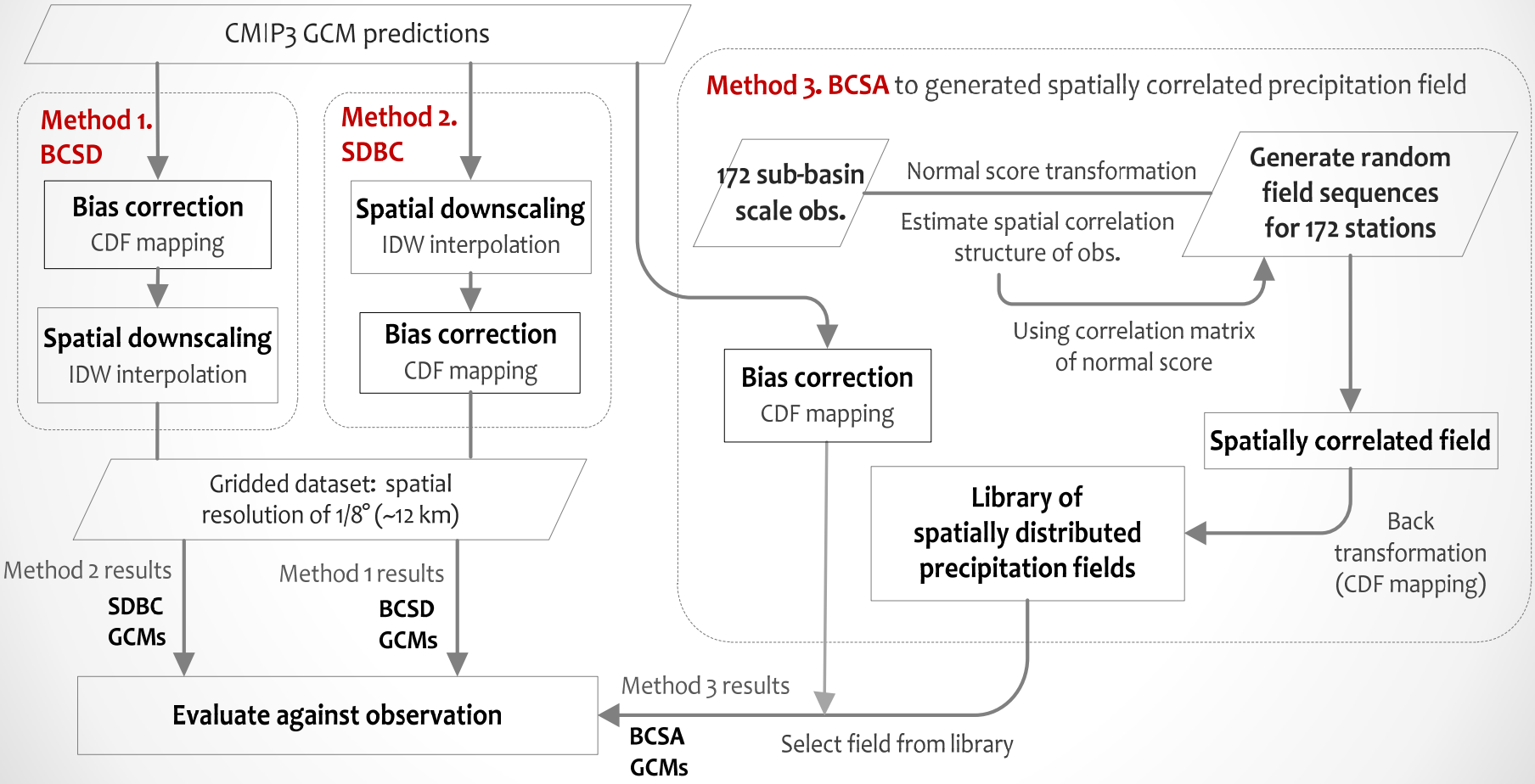
* WCRP CMIP3: World Climate Research Programme's Coupled Model Inter-comparison Project phase 3



Gridded observations

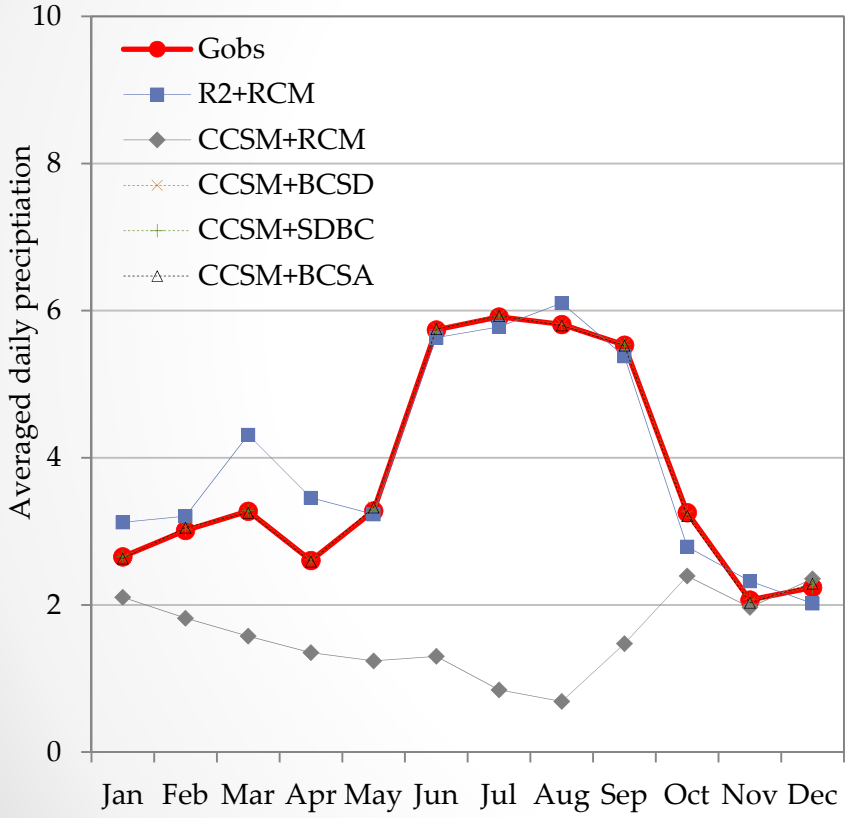
12x12km^2, 1/8 degree resolution: Maurer et al., 2002

Schematic representation of the methodology

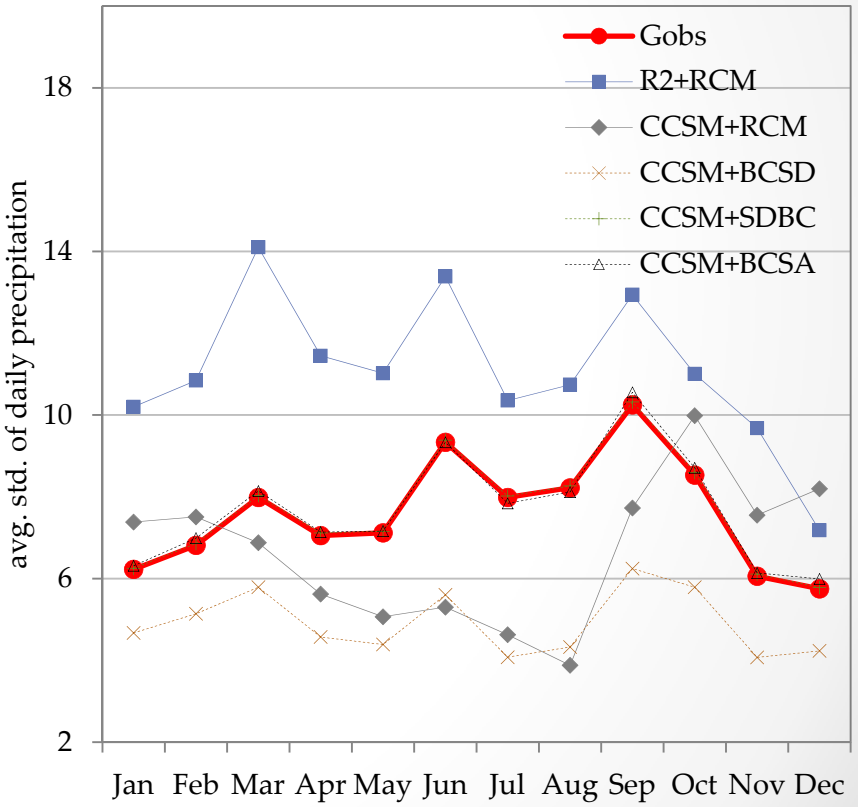


Temporal Statistics

Mean daily precipitation

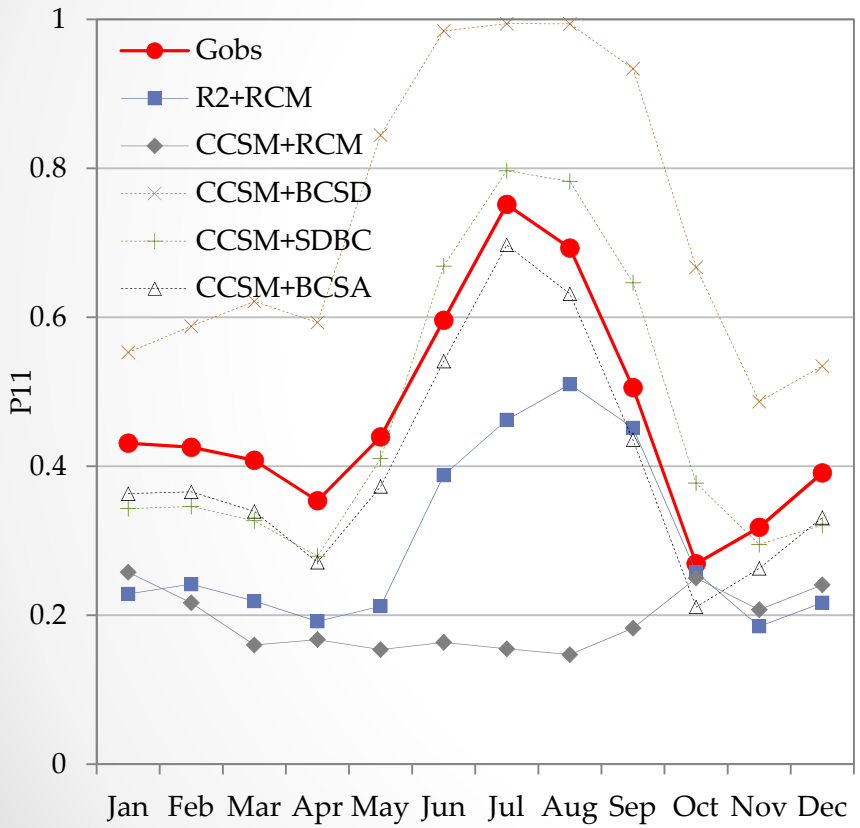


Std Dev daily precipitation

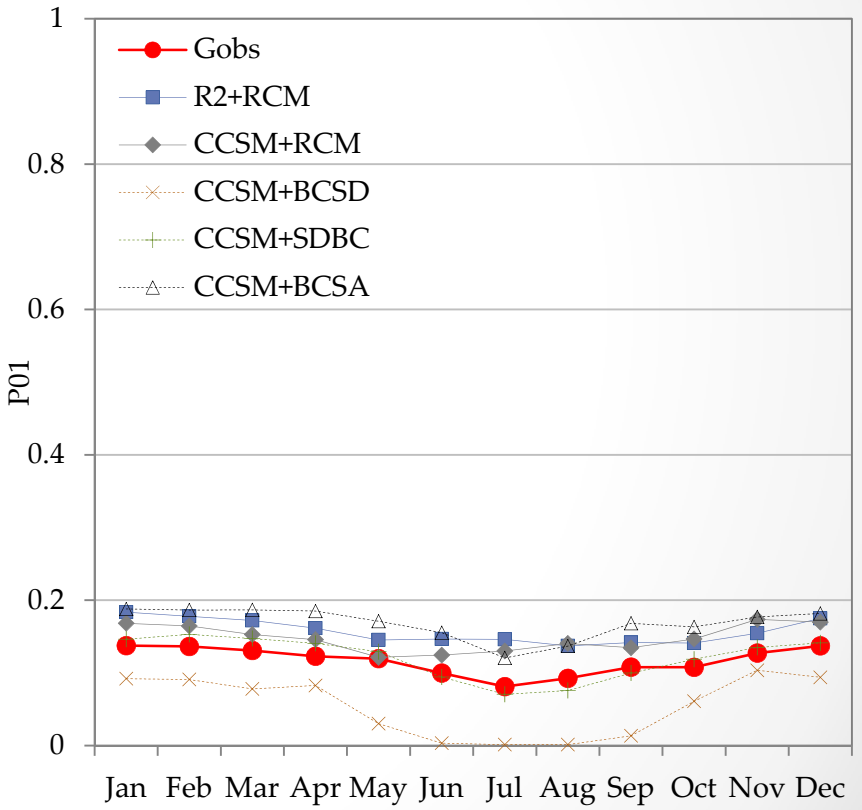


Transition Probability

Wet to Wet

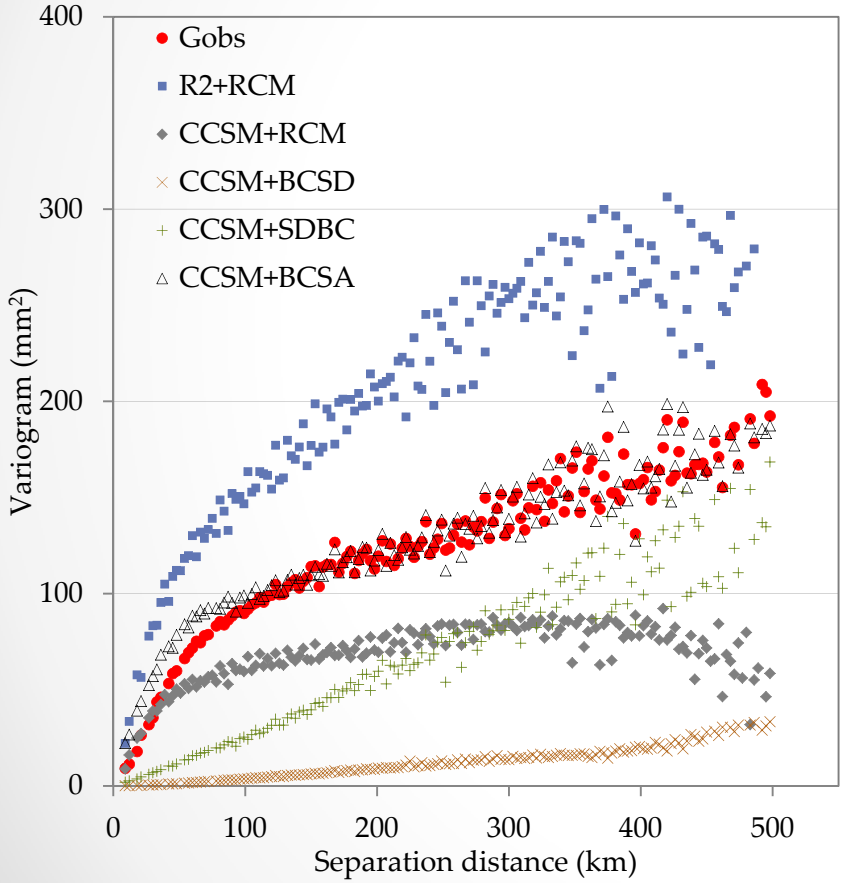


Dry to Wet

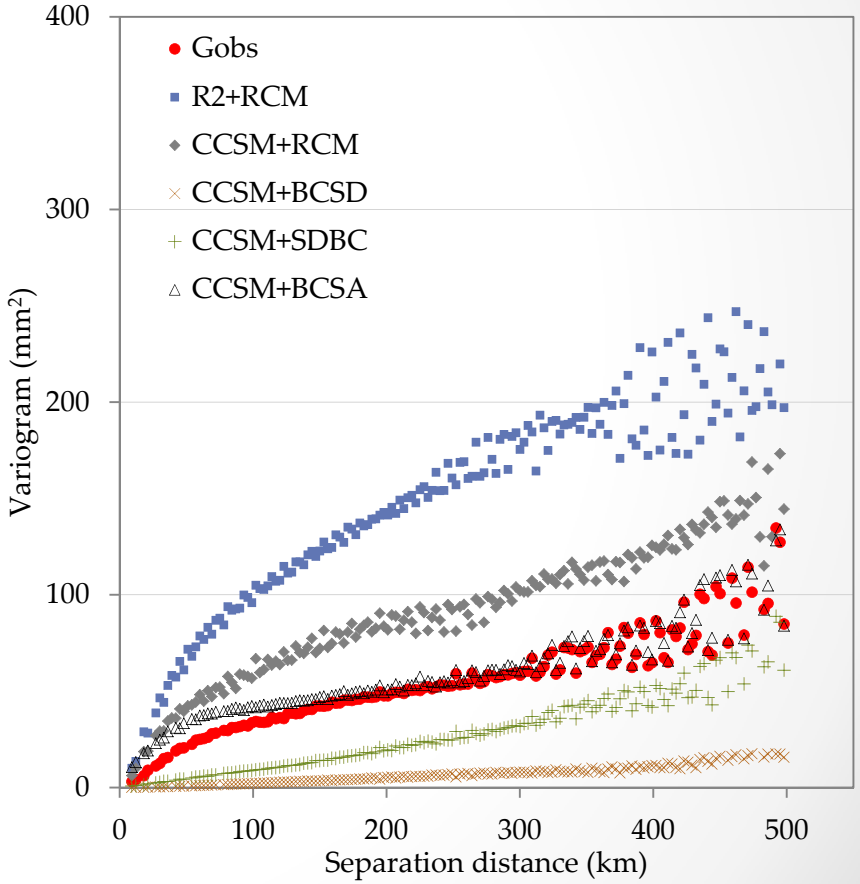


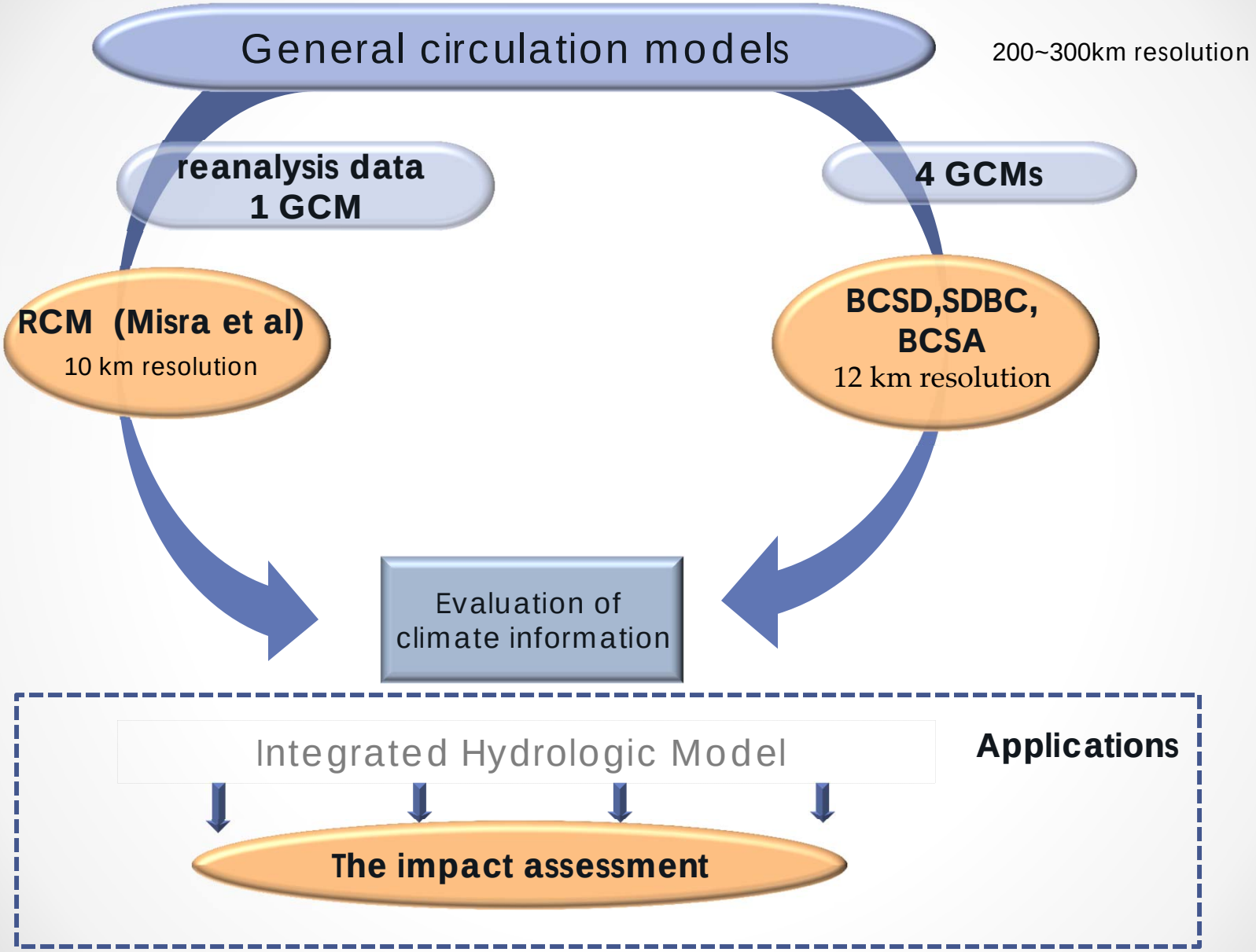
Variograms (spatial variability analysis)

Wet season (Jun.-Sep.)



Dry season (Oct.-May)

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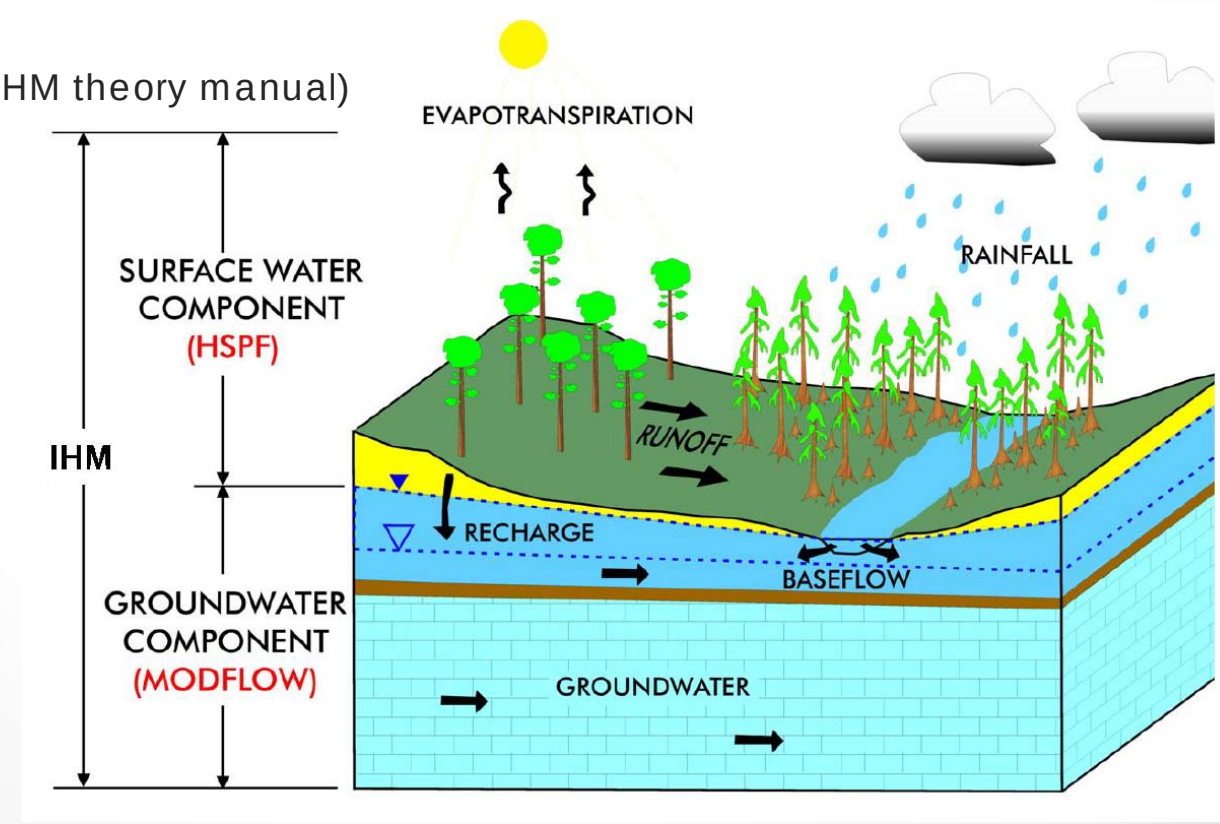
Method Integrated Hydrologic Model

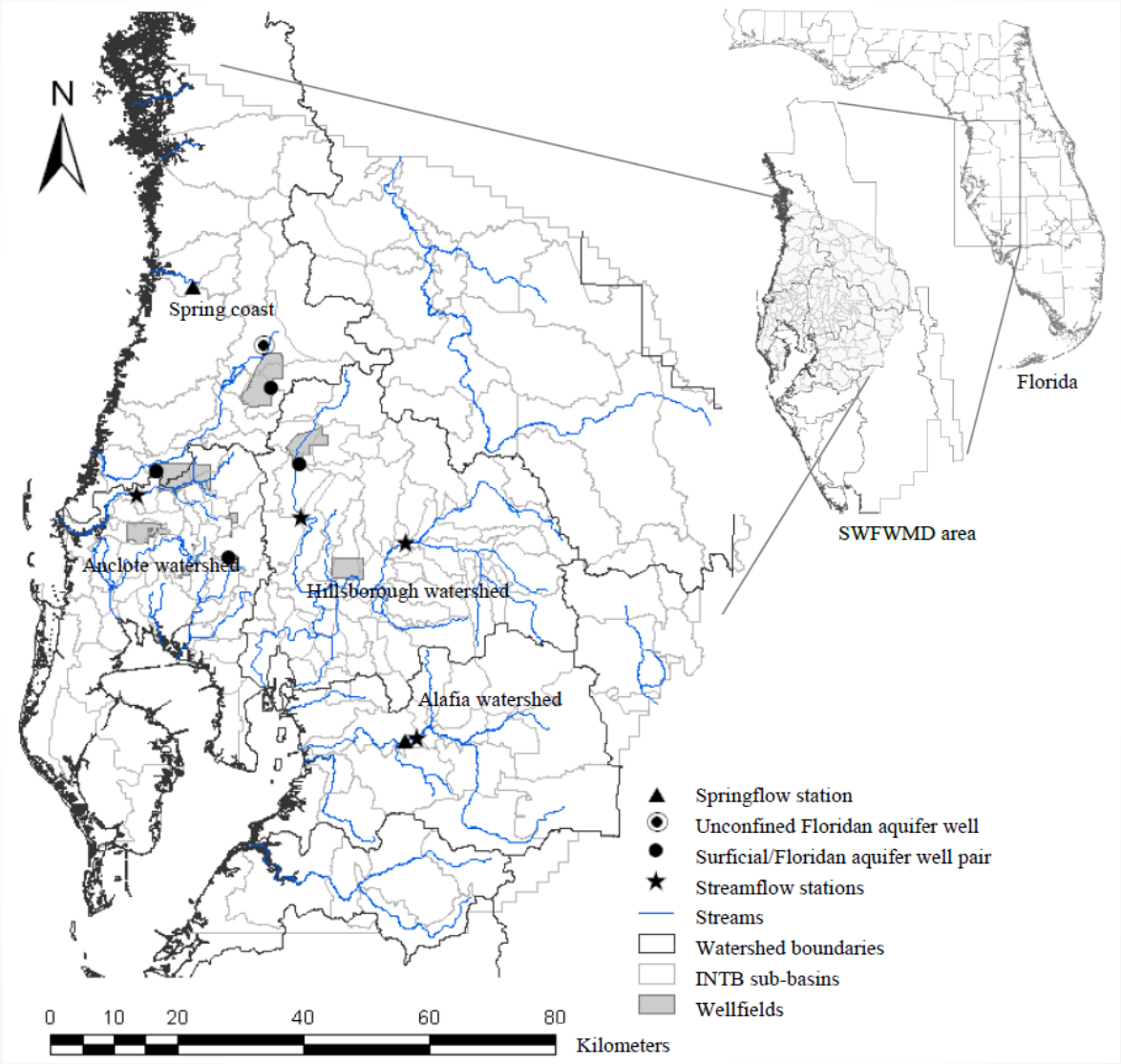
- TBW and SWFWMD commissioned the development and application of an integrated surface water/groundwater model for the Tampa Bay Region.
- The Integrated Hydrologic Model (IHM) was developed which integrates the EPA Hydrologic Simulation Program-Fortran for surface-water modeling with the US Geological Survey MODFLOW96 for groundwater modeling.

Ross et al., 2004 (IHM theory manual)



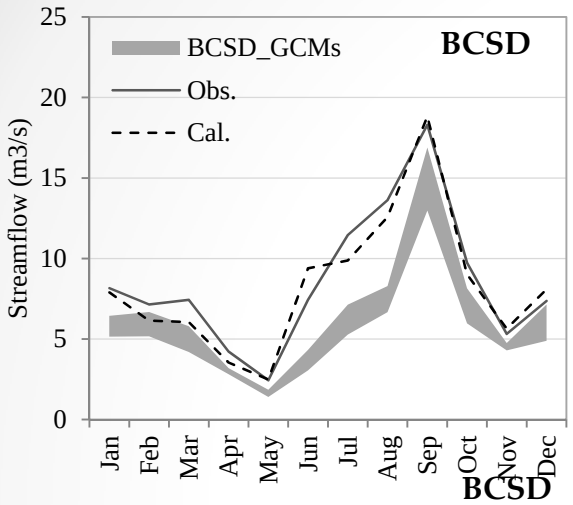
Method

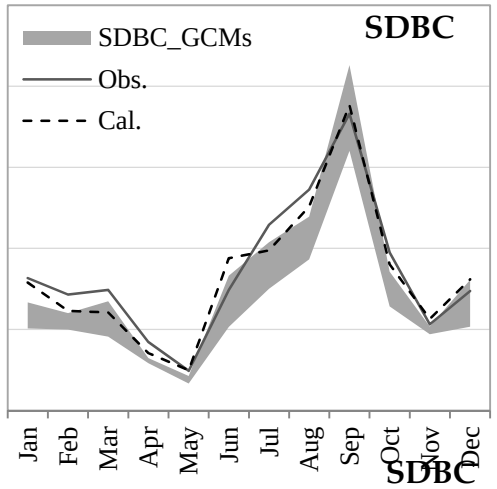
Study domain

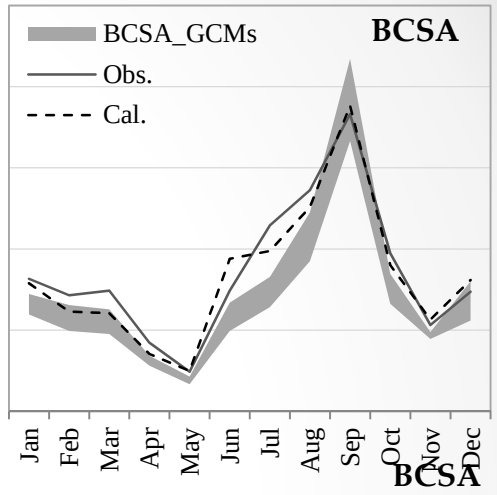


Monthly average streamflow

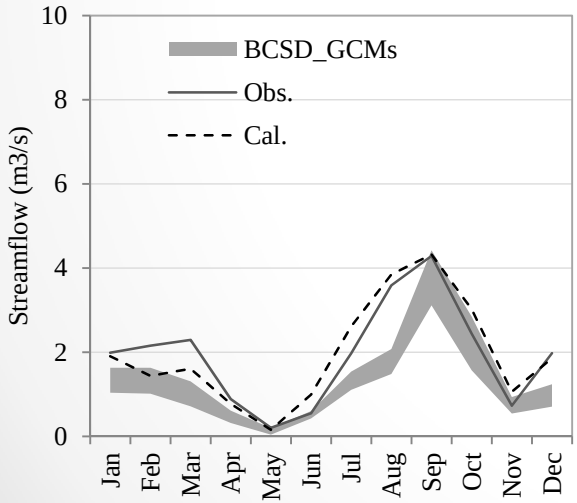
Alafia River

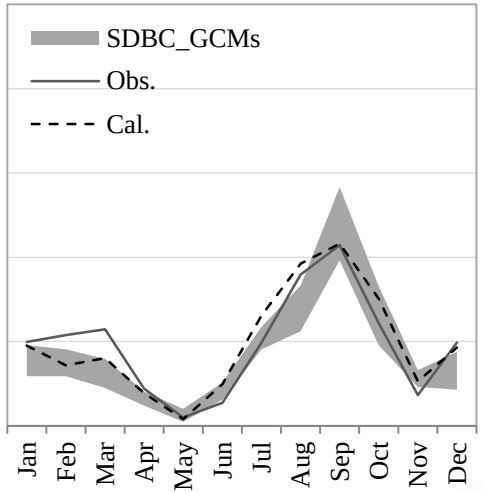


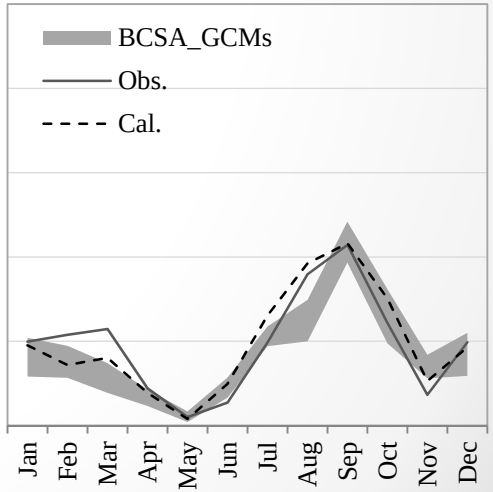




Cypress Creek

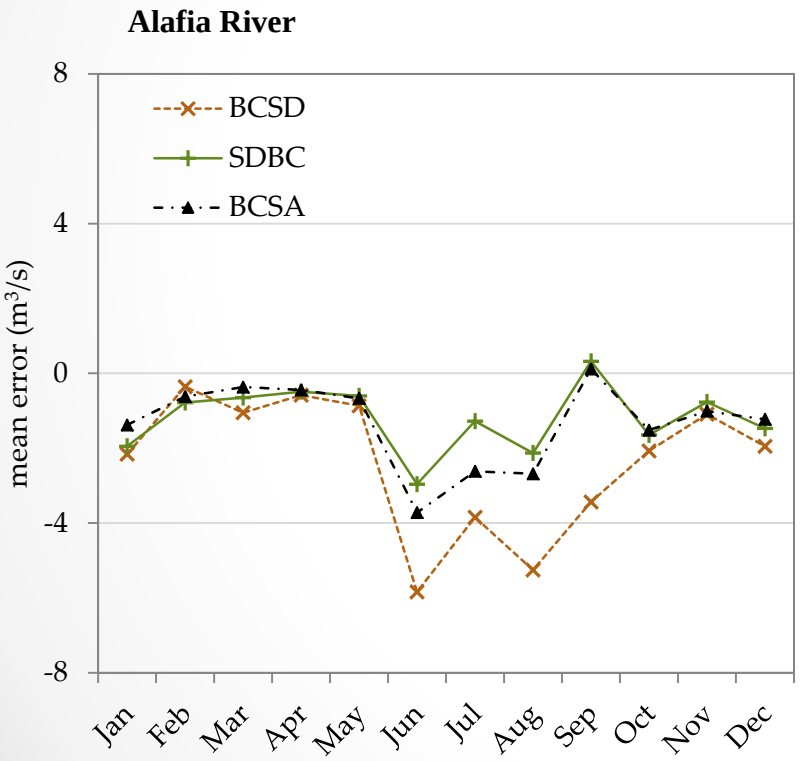


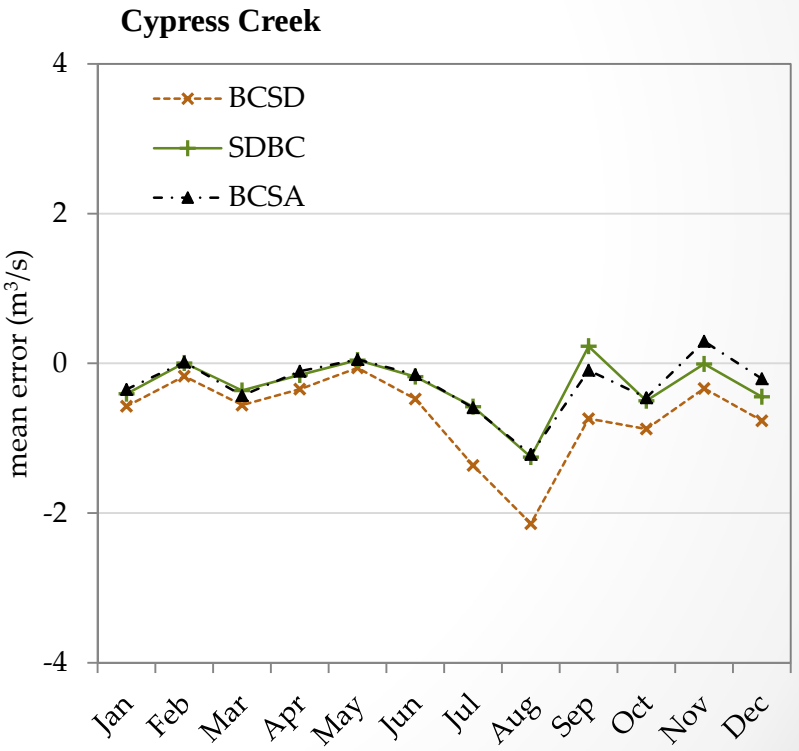




Mean of errors for monthly average streamflow

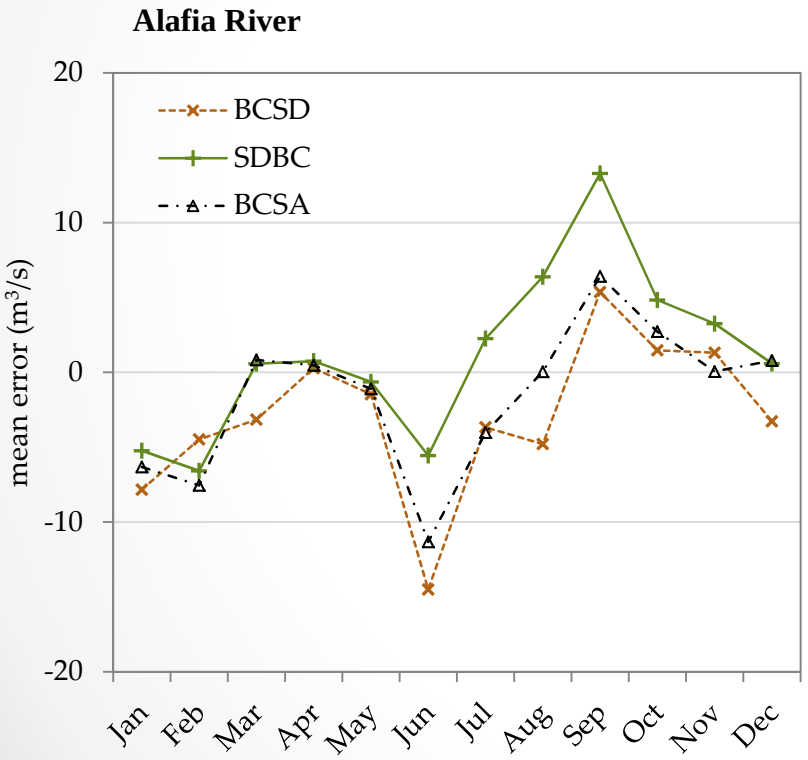
Mean of errors (simulated-calibrated) for monthly average streamflow over four GCM results for each target station

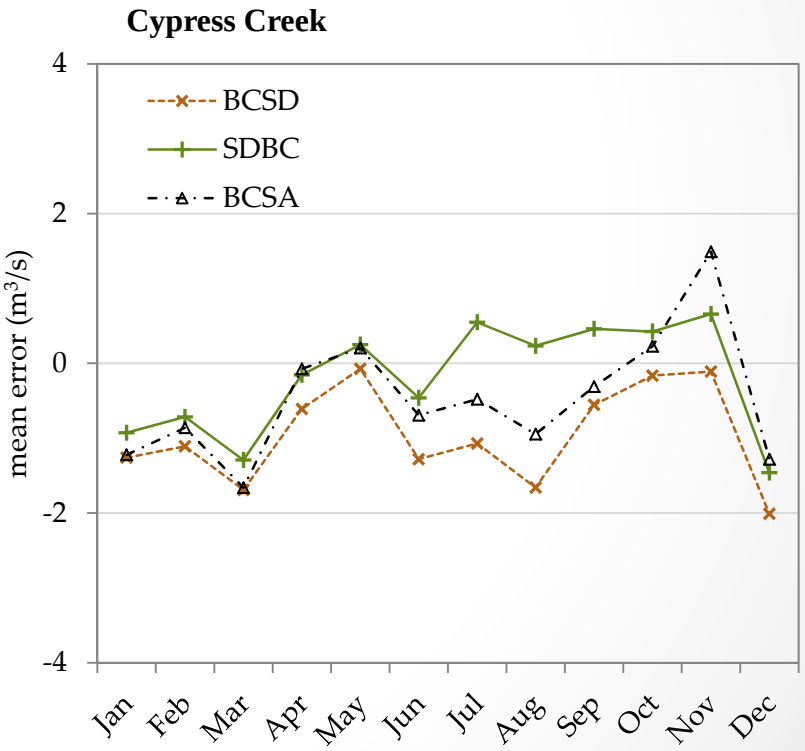




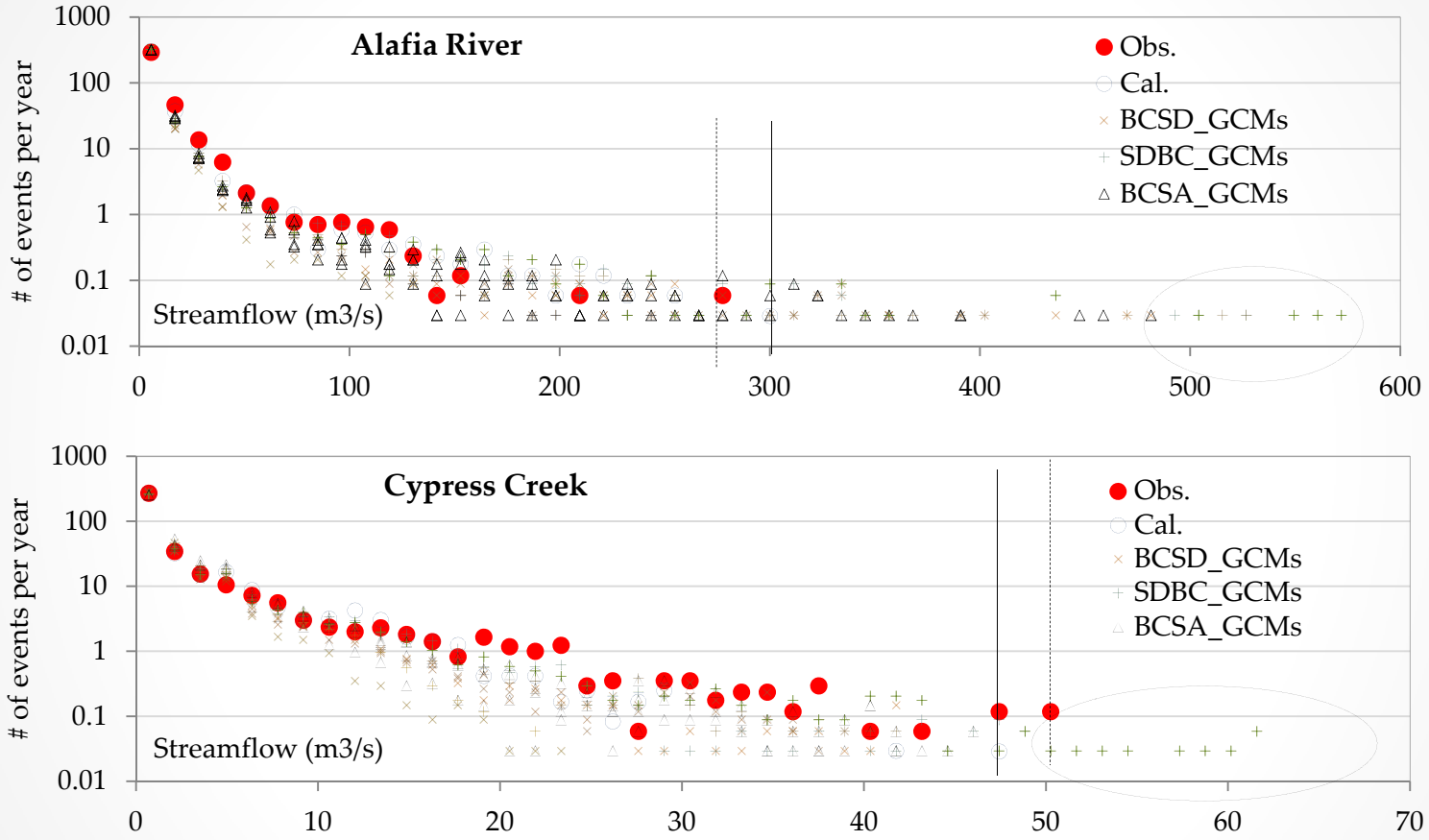
Mean errors for daily streamflow standard deviation

Mean of errors (simulated-calibrated) for daily streamflow standard deviation over four GCM results for each target station





Frequency of daily streamflow events



- The frequency of daily streamflow was not reproduced by SDBC as closely as for the BCSA results.
- Comparing the , it is evident that the under/overestimations of extreme events is canceled out when evaluating only the monthly mean streamflow.

Conclusions

- Commonly used **BCSD** method underestimates spatial and temporal variability of rainfall, and over estimates number of low precipitation days. These errors propagate into hydrologic predictions producing **higher ET and lower streamflow predictions in summer months**
- **SDBC** method improves estimates of day-to-day temporal variability at fine grid-scale, but underestimates spatial variability of rainfall and thus overestimates temporal variability of spatially averaged rainfall. As a result SDBC successfully reproduces mean monthly streamflow, but **significantly overestimates magnitude of peak streamflow events.**
- **BCSA** method reproduces spatial and temporal variability of rainfall accurately and successfully reproduces mean monthly streamflow. However BCSA slightly **overestimates magnitude of peak streamflow events for the larger river.**

Conclusions

- Dynamically downscaled results show promise, especially when driven by reanalysis data. Hydrologic implications of higher than observed spatial variability and temporal variability of local rainfall will be investigated.
- Dynamically downscaled retrospective GCM predictions are way off! Does it make sense to both dynamically downscale AND bias-correct these results?

Future work

- Evaluate the utility of using various downscaling methods with **seasonal GCM predictions and long-term projections of climate** change scenarios in the Tampa Bay region.
- Assess the potential to use downscaled seasonal predictions to **reduce risk for water management operations** in the Tampa Bay region.
- Assess potential **future climate change impacts on the hydrologic system** in west-central Florida.