How what we know about climate projections translates into hydrology projections and water resource decisions for Tampa Bay Water

2018. 4. 5

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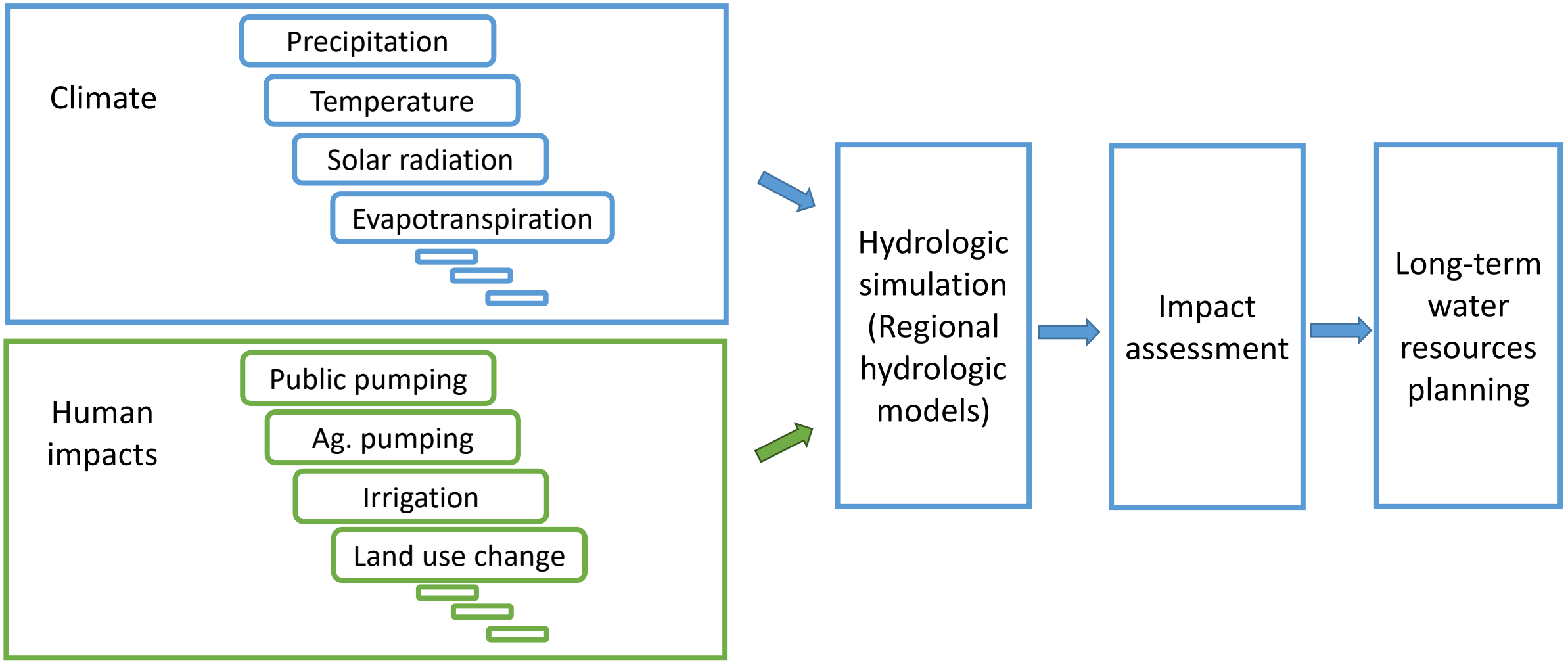
The FloridaWCA, UF Water Institute & Tampa Bay Water

Goal: To increase the regional relevance and usability of climate and sea level rise models for the specific needs of water suppliers and resources manages in Florida.

Tampa Bay Water Project Research objectives:
Evaluate impact of future climate scenarios on future water supply availability in the Tampa Bay region.

Long Term Water Resources Projection Analysis Framework:



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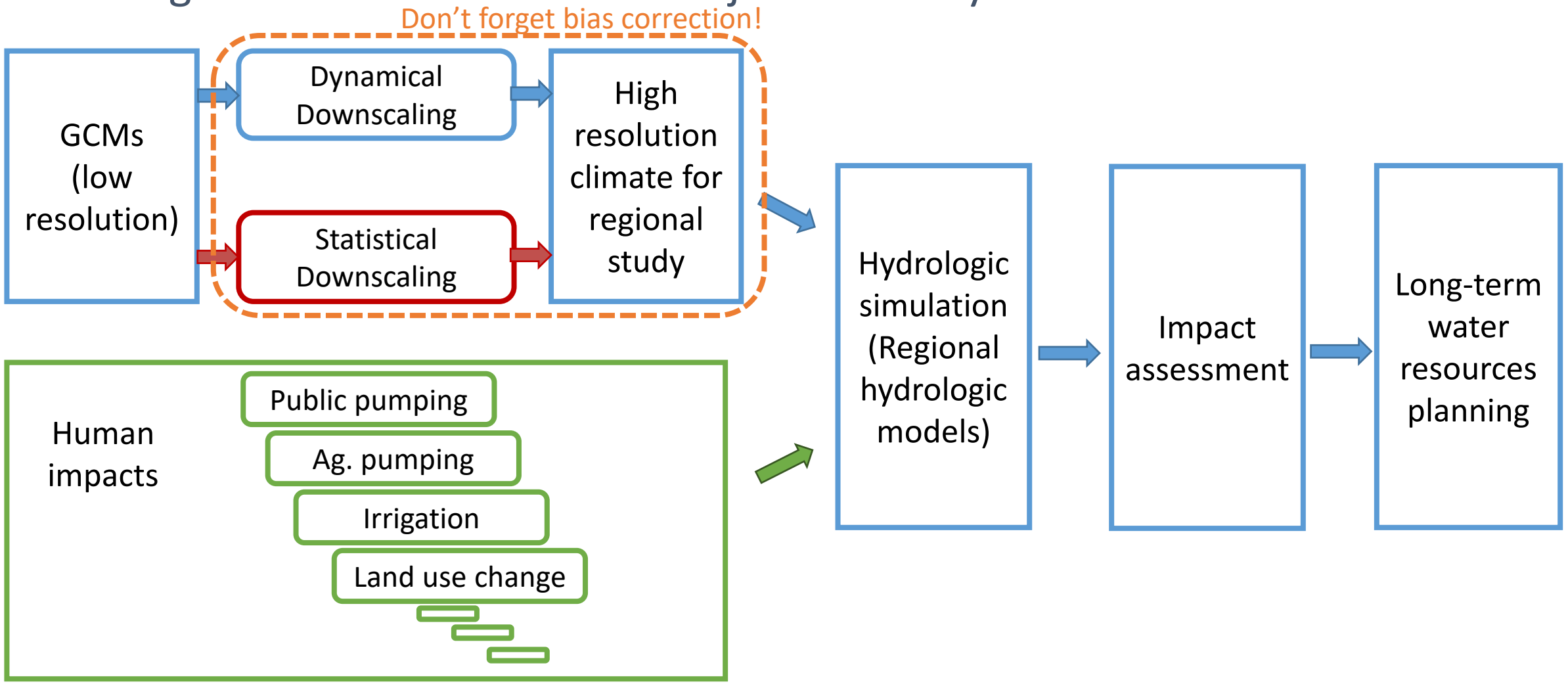
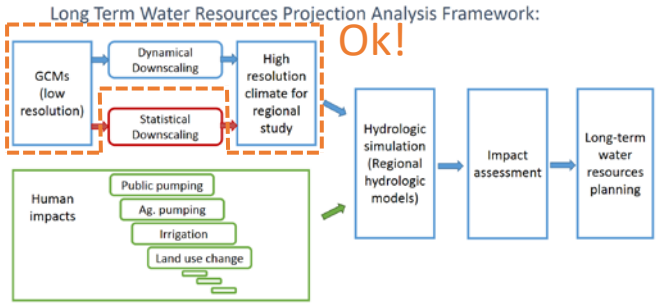
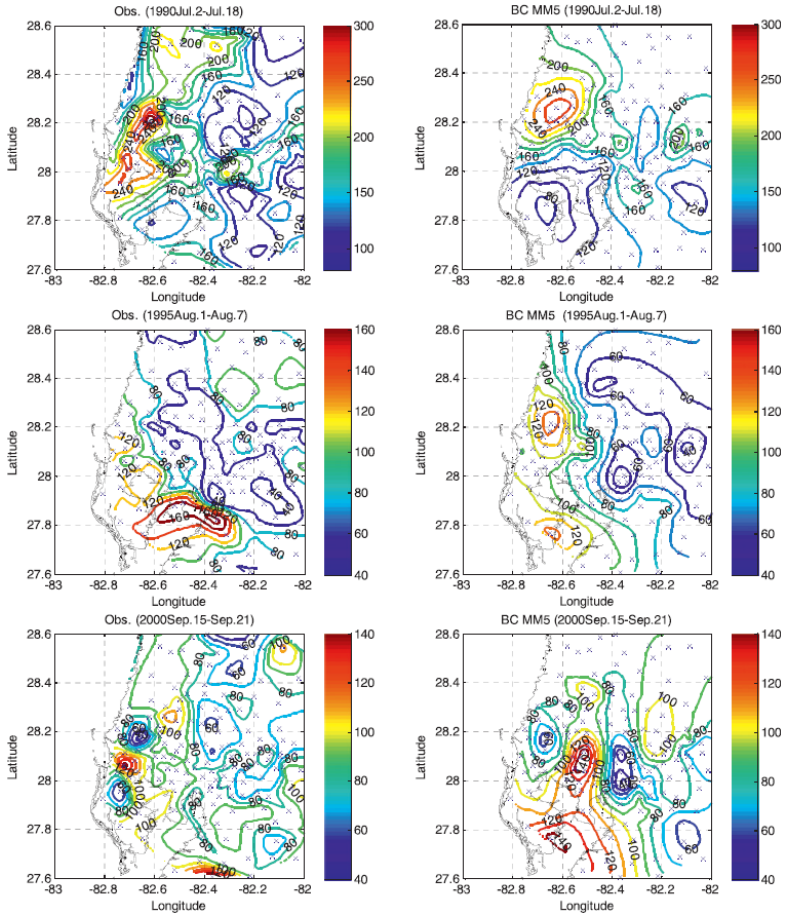


Dynamic downscaling of coarse climate data.





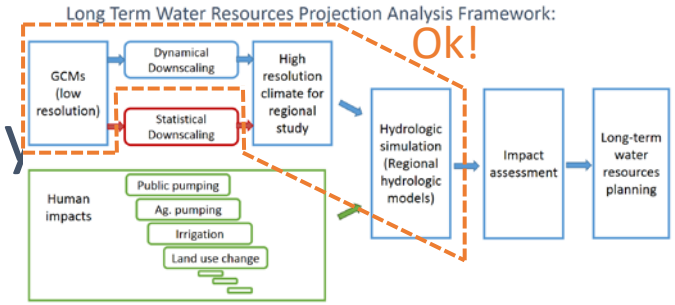
What we did?
- Used MM5 to dynamically downscale precipitation from NCEP-NCAR reanalysis data.

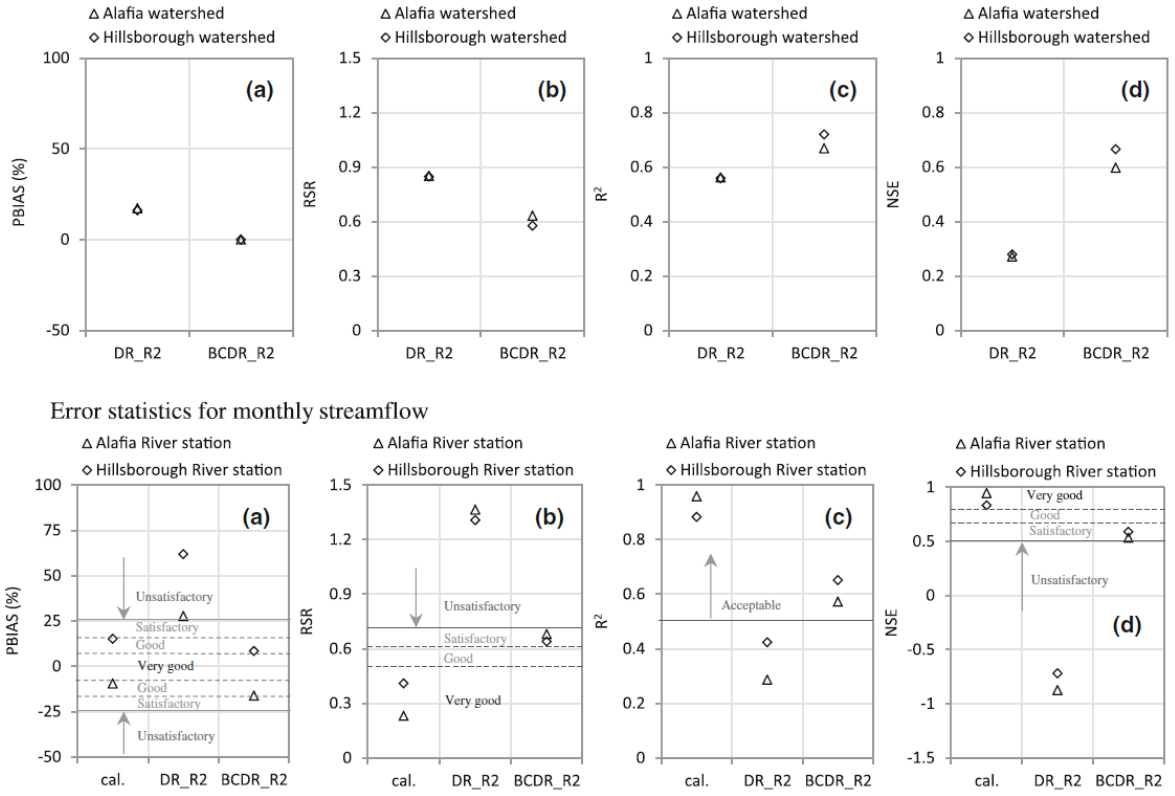
Why we did it?
- To test the accuracy of dynamically downscaled climate model to reproduce climate variables at scales needed for regional retrospective hydrologic studies.

What we found?
- Significant errors (daily P) are found even after bias-correction, maybe ok for multi-decadal water resource planning
- We should leave climate modeling to the climate modelers!

Hwang et al. (2011), Journal of Hydrometeorology

Dynamically downscaled climate data for regional hy





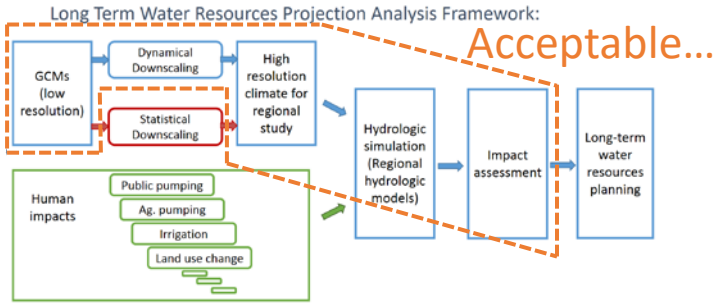
What we did?
- Used FSU's dynamically downscaled retrospective climate data to simulate streamflow.

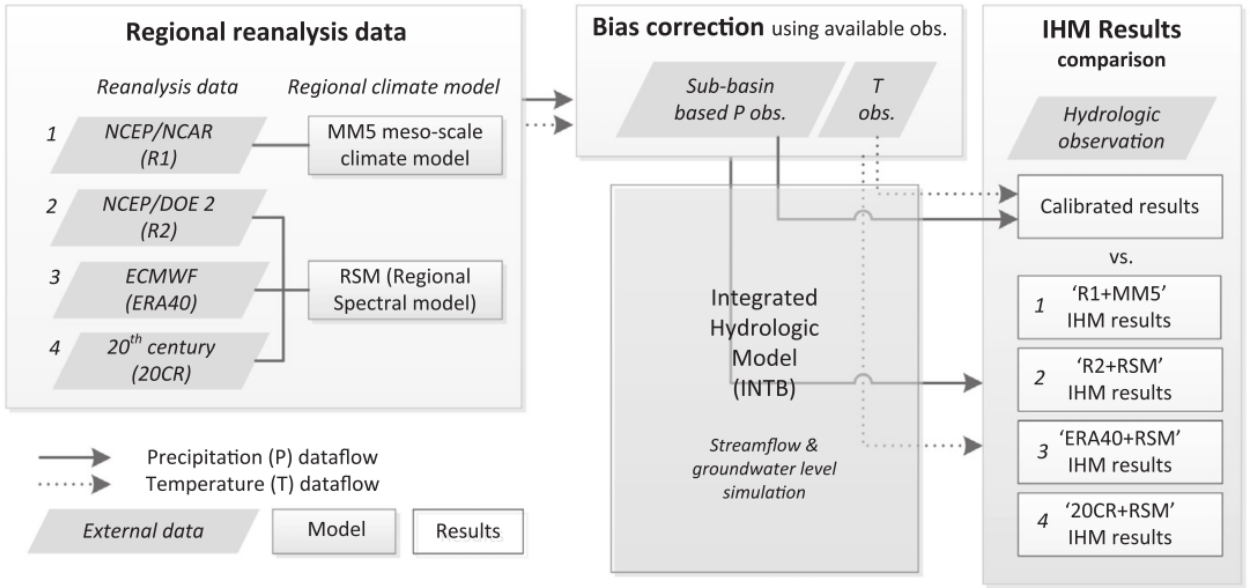
Why we did it?
- To test the ability of dynamically downscaled retrospective climate data to reproduce retrospective hydrology

What we found?
- Bias correction is required to obtain reliable hydrologic predictions.

Hwang et al. (2013), Reg. Env. Change

Comparison of dynamically downscaled reanalysis d





All four have timing issues and magnitude issues

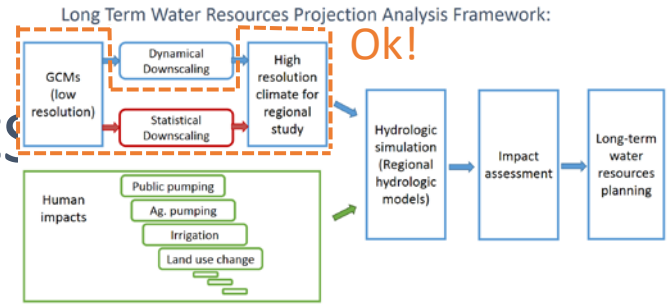
What we did?
- Compare four dynamically downscaled climate data to simulate streamflow and GW.

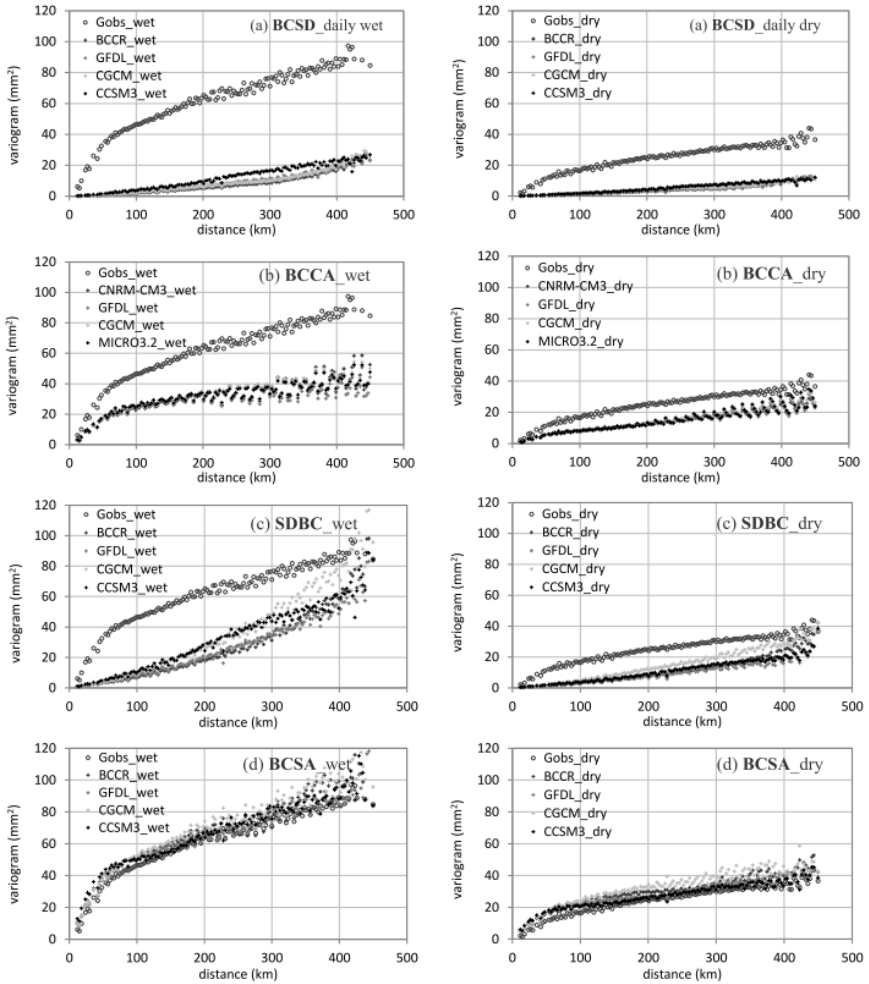
Why we did it?
- To investigate how differences in dynamically downscaled climate data propagate into hydrologic predictions

What we found?
- All products had errors that were propagated and enhanced by hydrologic models, results OK for multi-decadal planning

Hwang et al. (2014), Journal of Hydrology

Development of statistical downscaling method (BCS





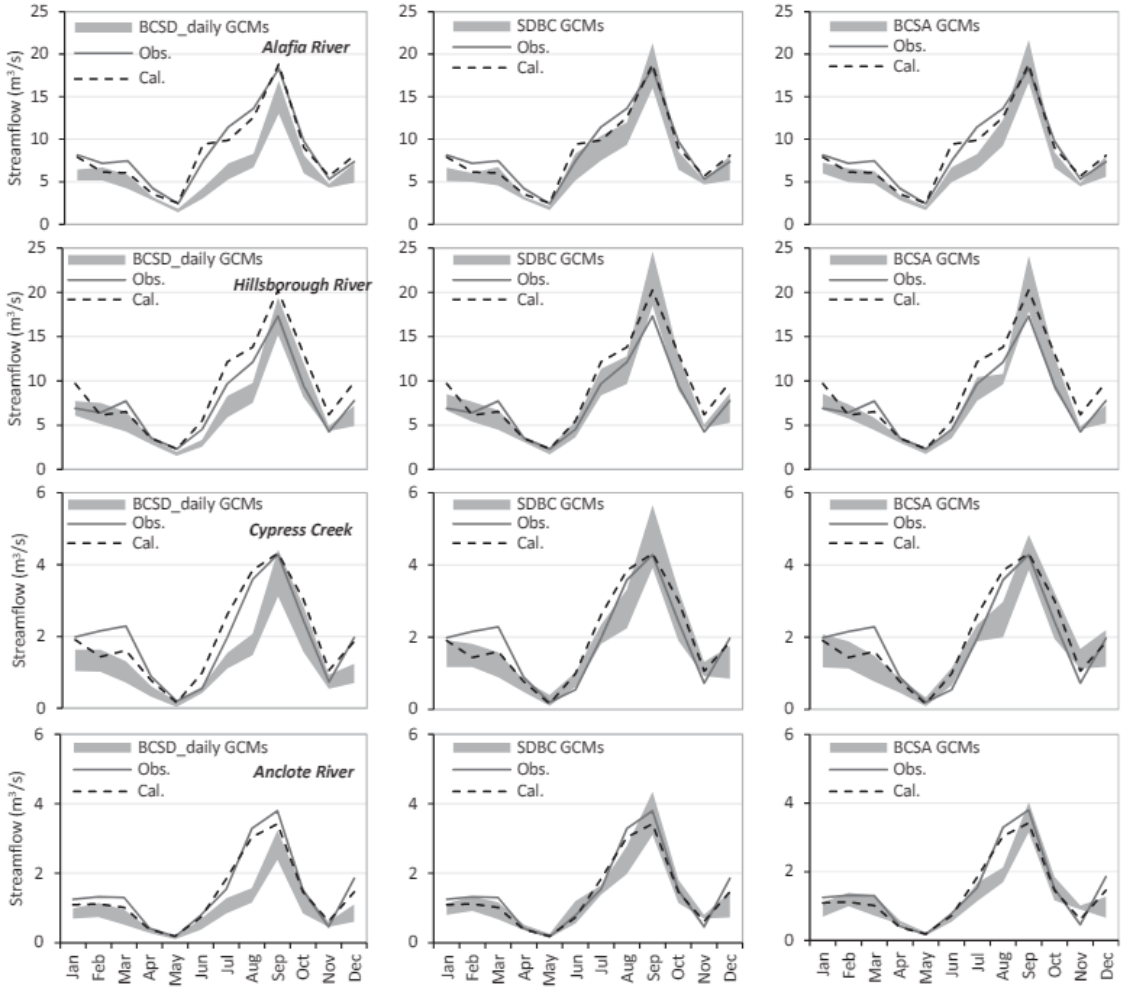
What we did?
- Developed a new statistical downscaling method.

Why we did it?
- Existing statistical downscaling methods did not reproduce rainfall characteristics in FL very well. Dynamic downscaling is computationally intensive

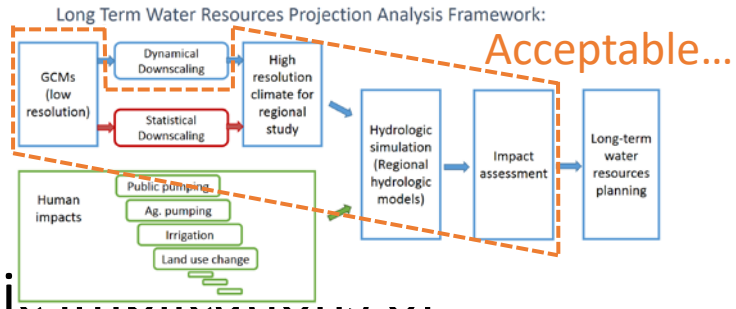
What we found?
- Choice of statistical downscaling method matters in FL. Small-scale spatial variability is important.

Hwang and Graham (2013), Hydrology and Earth System Sciences

Comparison of downscaling methods



SDBC and BCSA ok!



What we did?

- Evaluated hydrologic implications of statistical downscaling methods.

Why we did it?

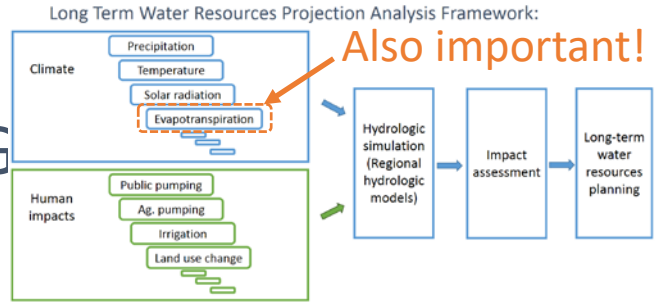
- To understand possible hydrologic implications of different statistical downscaling methods.

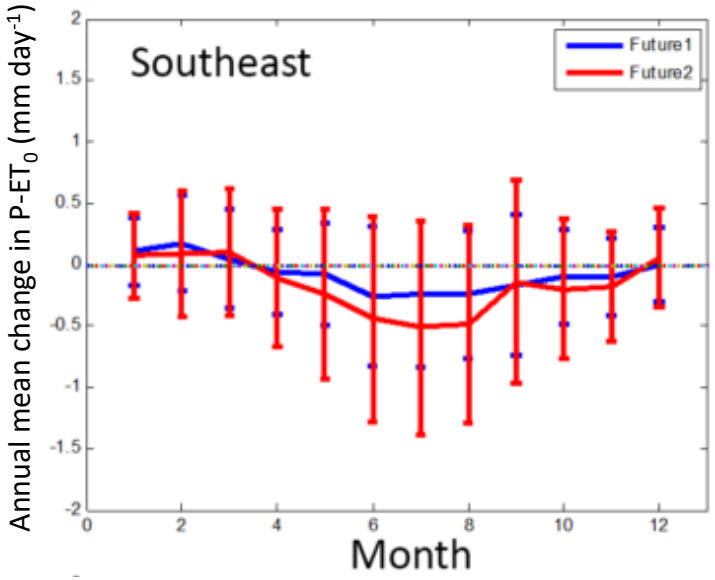
What we found?

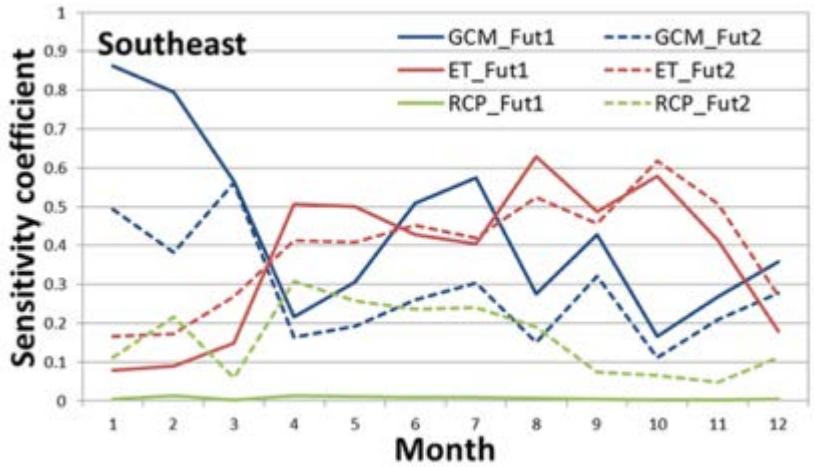
- Choice of how you translate global model output to finer spatial scales matters for water resources planning. SDBC and BCSA OK

Hwang and Graham (2013), Journal of the American Water Resources Association

Sensitivity of future water deficit projections using G







What we did?

- Evaluated the sensitivity of future water deficit projections to GCM, ET_0 method and RCP selection

Why we did it?

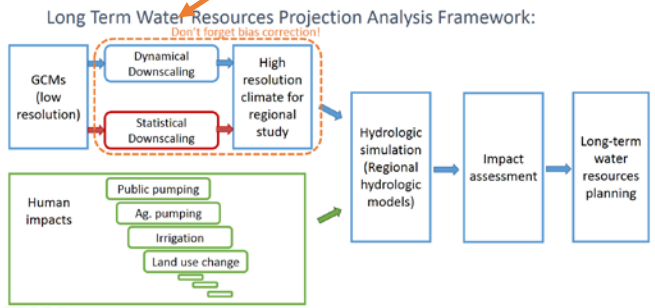
- To understand sources of uncertainty when using climate projections for future water resources planning.

What we found?

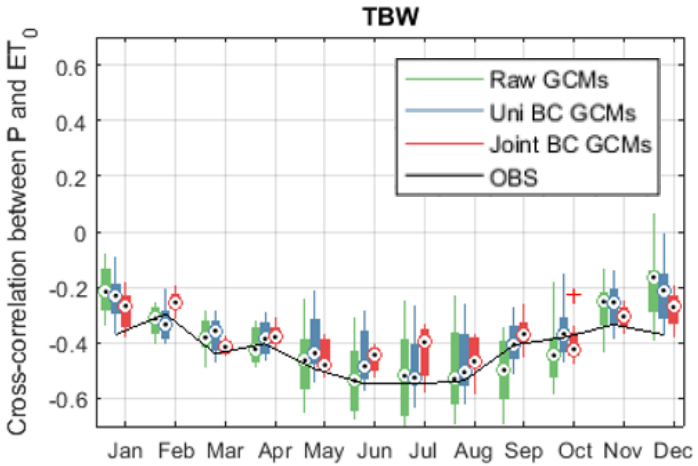
- For Southeast US, GCM uncertainties and ET_0 methods uncertainties are both important.

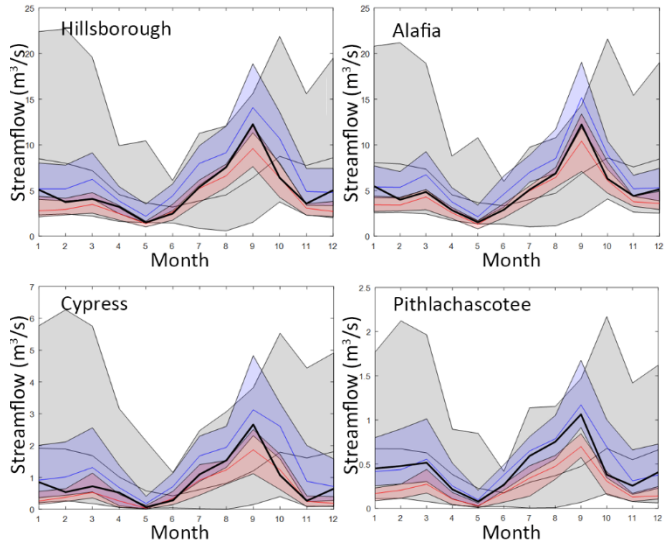
Chang et al. (2016), Hydrology and Earth System Sciences

Simple bias correction is good enough!



Univariate bias correction vs Joint bias correction





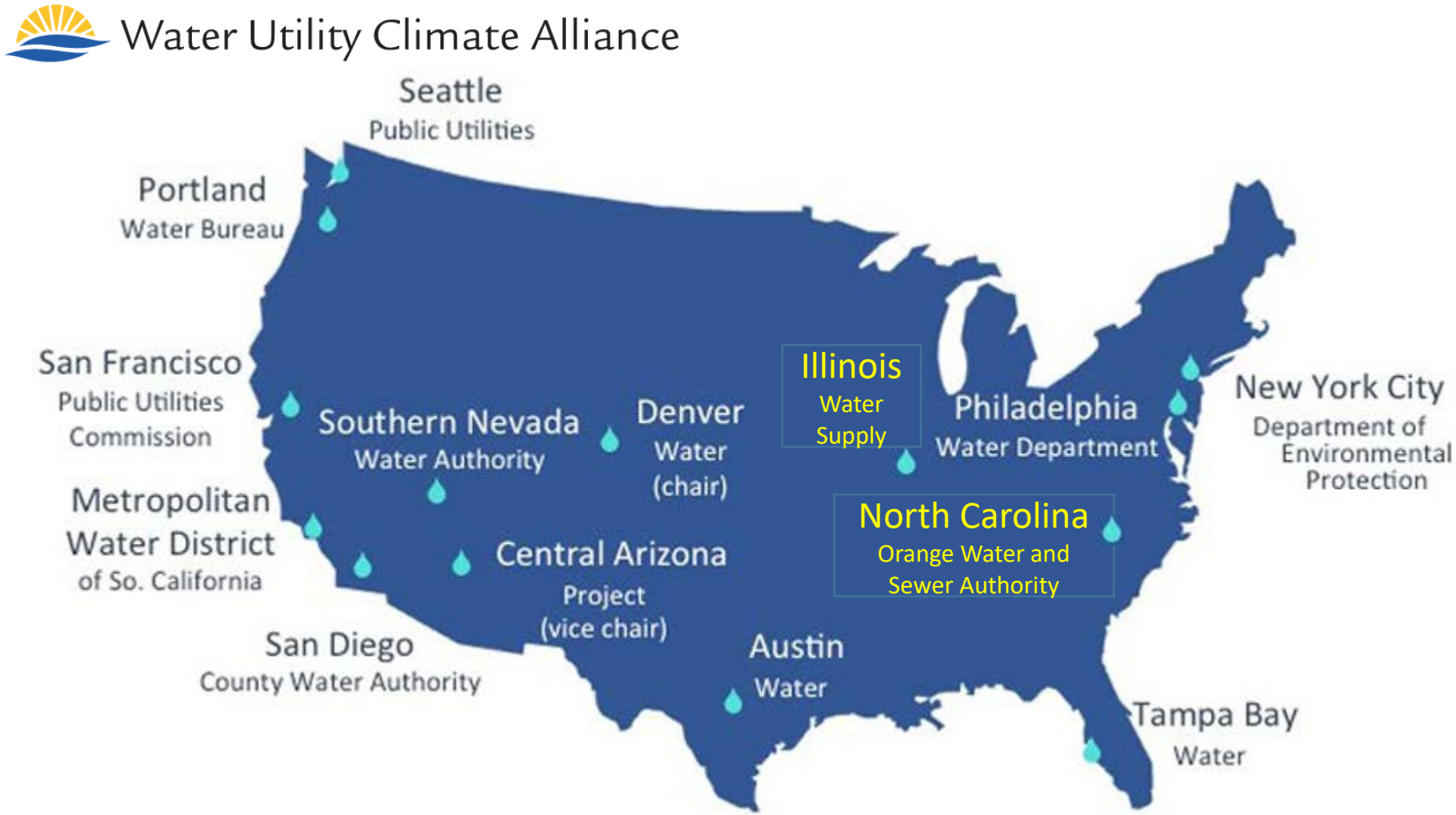
What we did?
- Compared the performance of two bias correction methods to reproduce correlation among hydrologically important climate variables (P and ET_0) and predict regional hydrologic response.

Why we did it?
- To determine most appropriate bias correction method for Tampa Bay Water region.

What we found?
- For TBW, simple sequential univariate bias correction was satisfactory for water resources planning.

Chang et al. (In progress)

Univariate bias correction vs Joint bias correction: What about rest of USA?

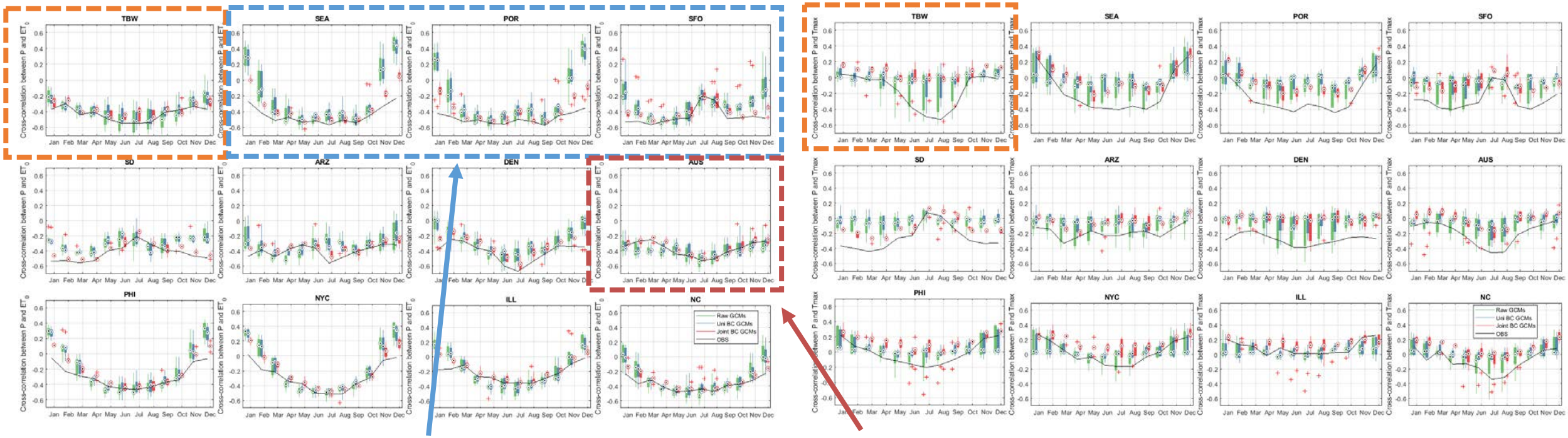


Univariate bias correction vs Joint bias correction

P vs ET_0 show better performance than P vs T

P vs ET_0

P vs Tmax

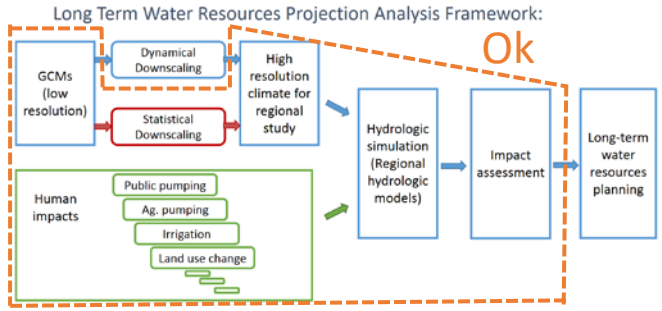


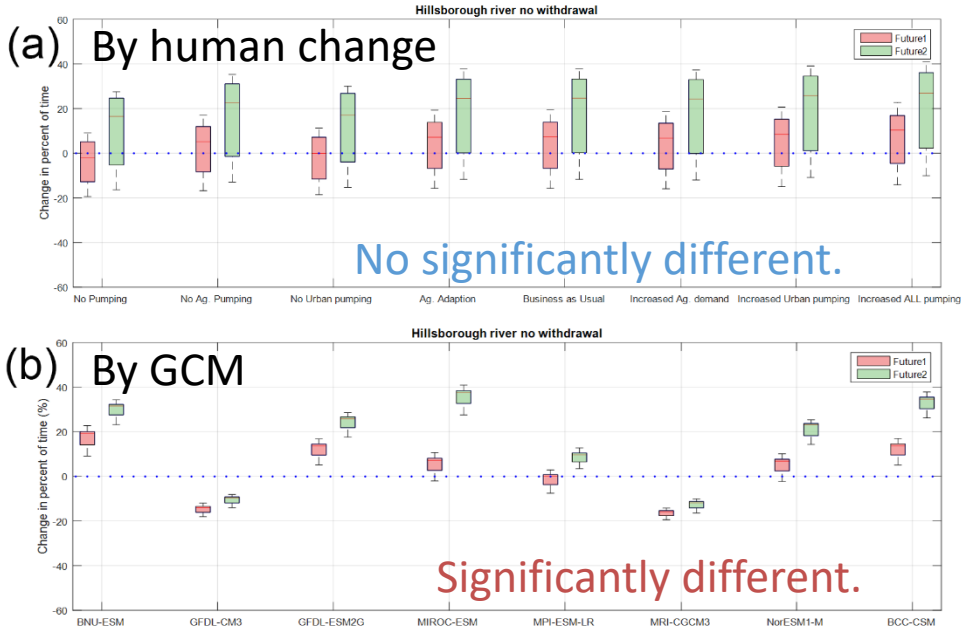
Joint bias correction is better.

Possible to use simple univariate bias correction.

Chang et al. (In progress)

Climate change vs anthropogenic change





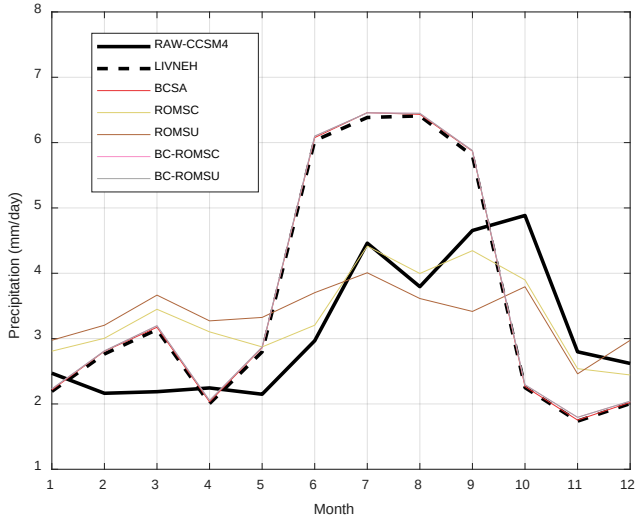
What we did?
- Evaluated future hydrologic projections resulting from alternative climate change and human water use scenarios.

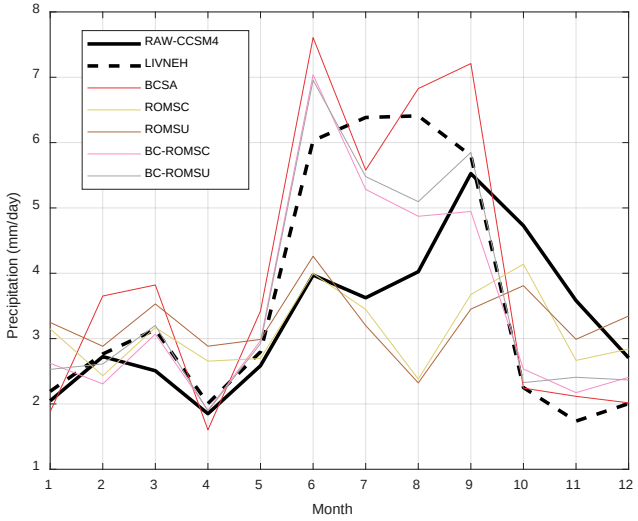
Why we did it?
- To understand the relative importance of changes in climate versus human water use for projecting future water supply

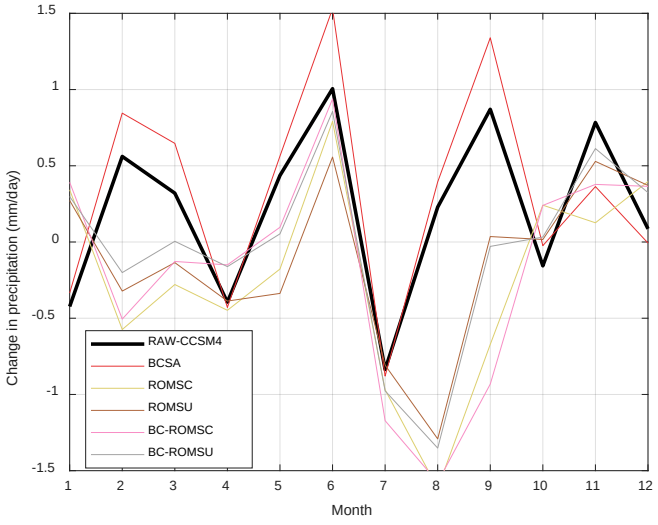
What we found?
- Differences among climate projections most significant for streamflow projections, but differences among human water use scenarios are also significant for GW projections.

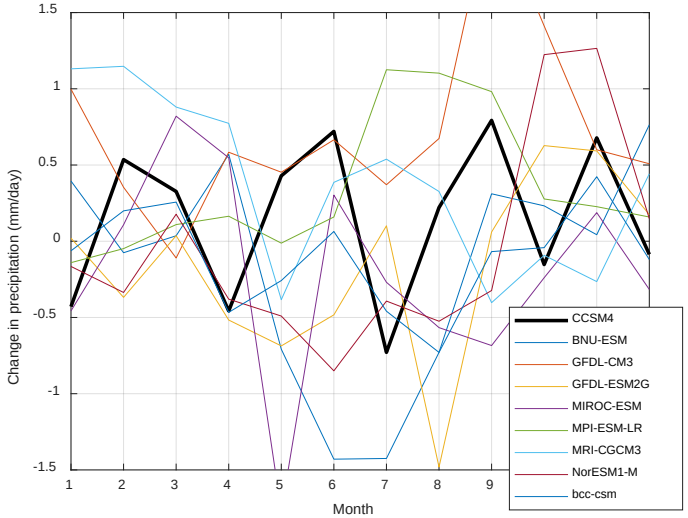
Chang et al. (Under review), Hydrology and Earth System Sciences

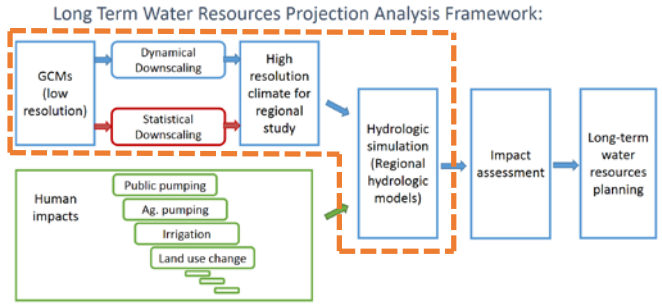
Dynamical vs Statistical Downscaling methods.











What we did?

- Compare FSU's new dynamically downscaled climate data to statistical downscaled climate to see if it improves regional hydrologic predictions.

Why we did it?

- To take advantage of recent advances in dynamic downscaling methods (coupled ocean-atmospheric regional climate models)

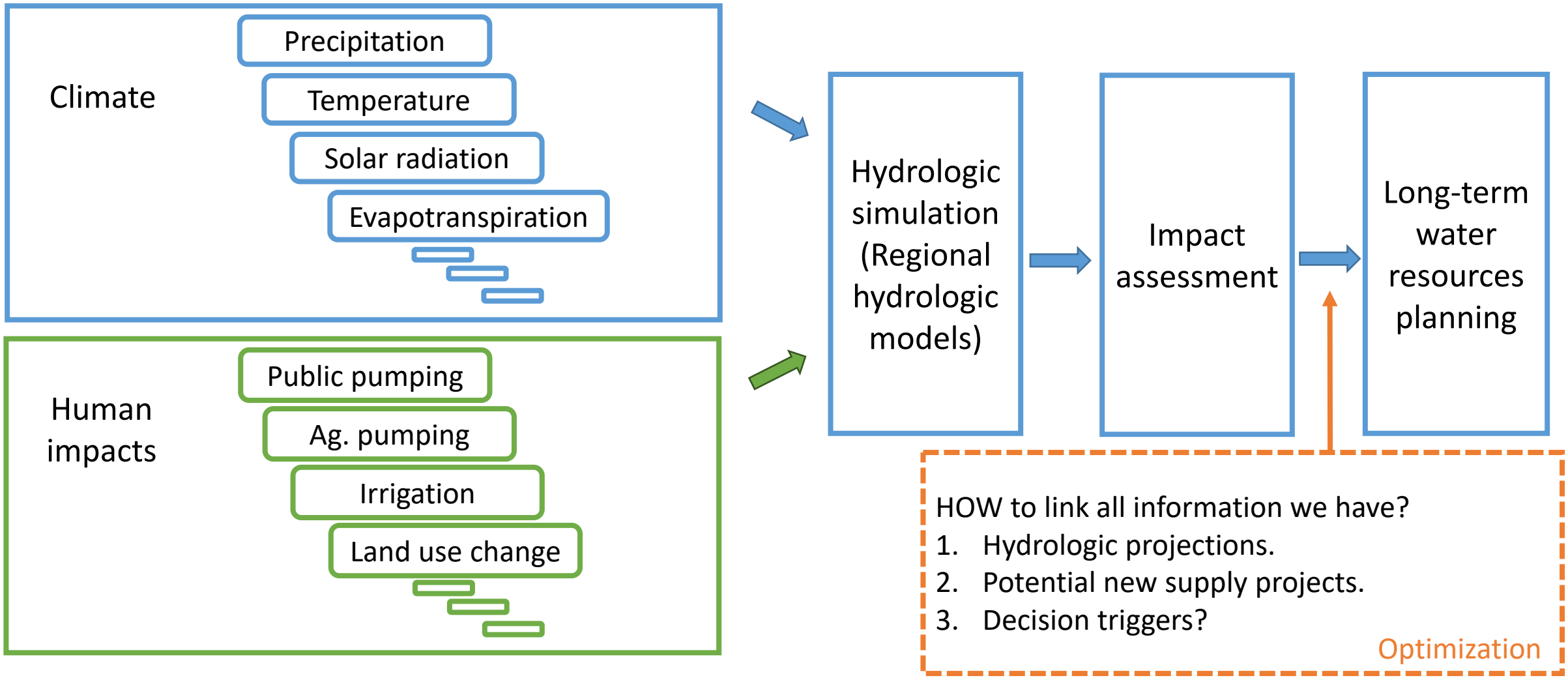
What we found?

- Bias correction is still required and …

What have we learned (big picture)?

- GCMs predict a consistent increase in temperature for Florida (1-3^{o}C for 2040-2070)
- Future GCM precipitation projections vary widely for Florida and these differences propagates into significantly different hydrologic projections
- Downscaling and bias-correction approach matters. Bias correction is always important
- Need to use multiple GCMs in any future water resource planning efforts and look for robustness of plans across wide range of projections.

Future plan: Water resources planning for Tampa Bay Water



Thank you

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