Use of Climate Information in Water Supply Planning

TAMPA BAY WATER
Supplying Water To The Region

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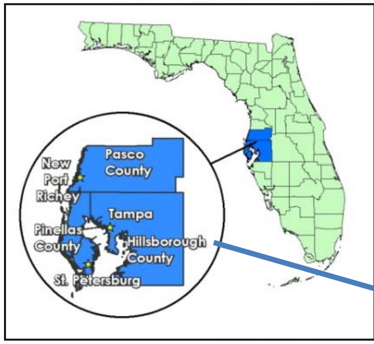
CESM-SDWG

February 19, 2013

Florida's Largest Regional Public Water Supplier

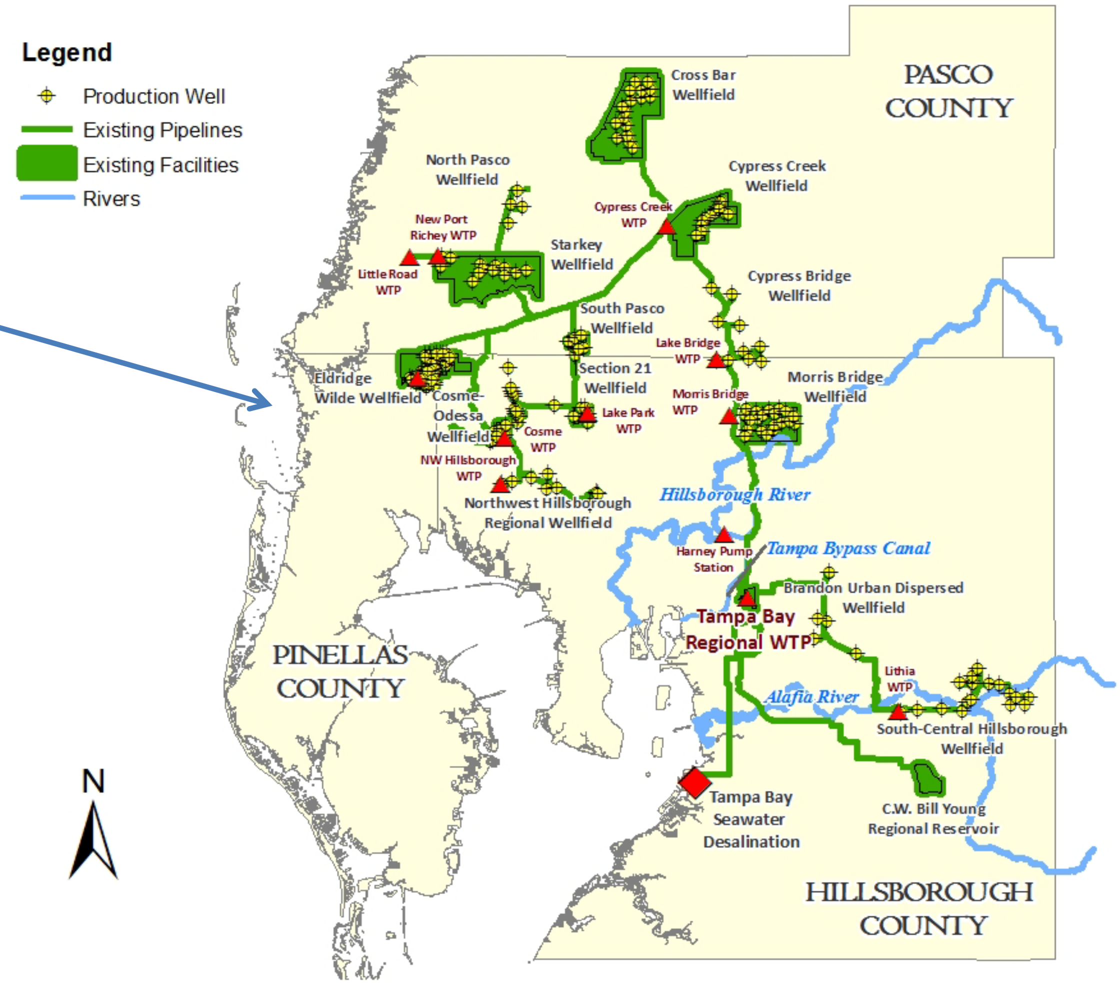


Wholesale drinking water to six governments

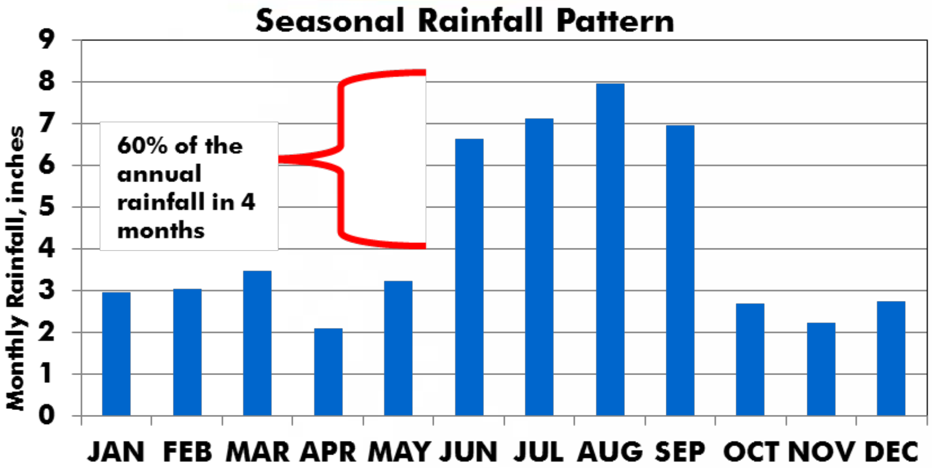
2.4 Million Residents

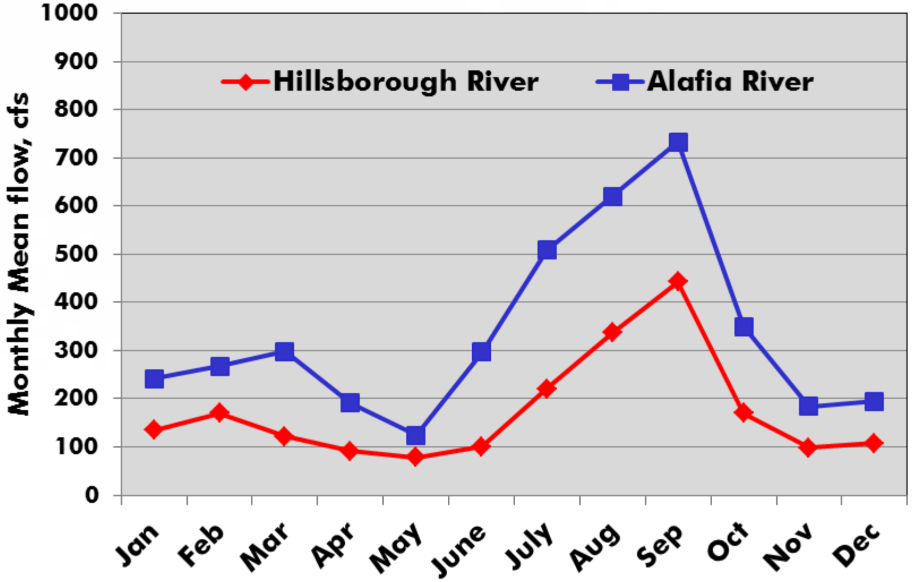
220-250 mgd annual average

Seasonal to multi-year variable climate

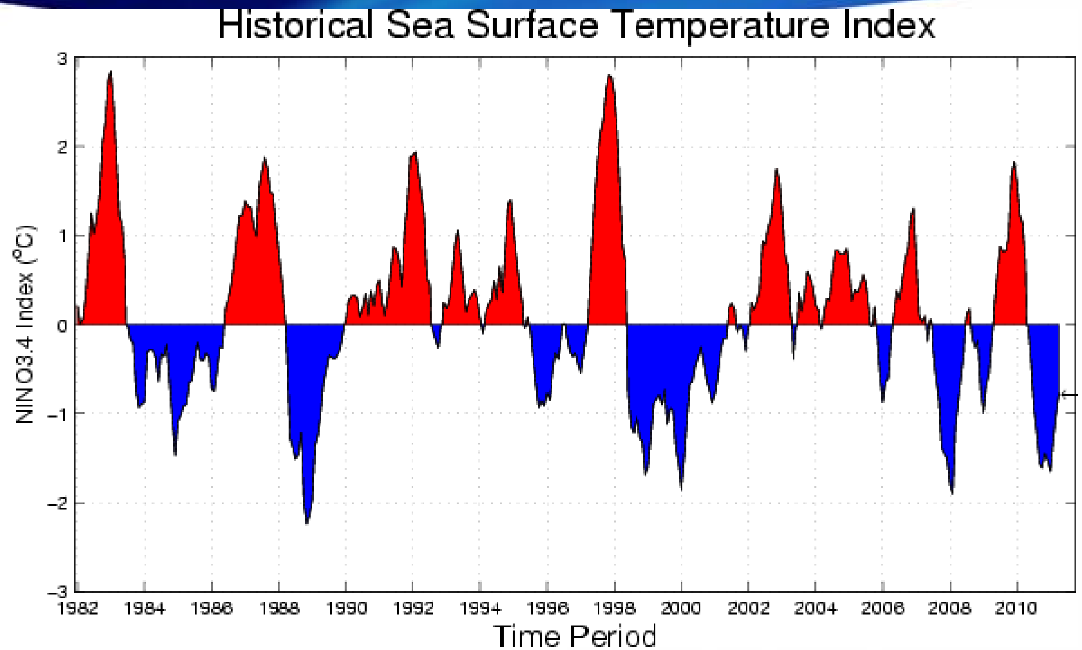


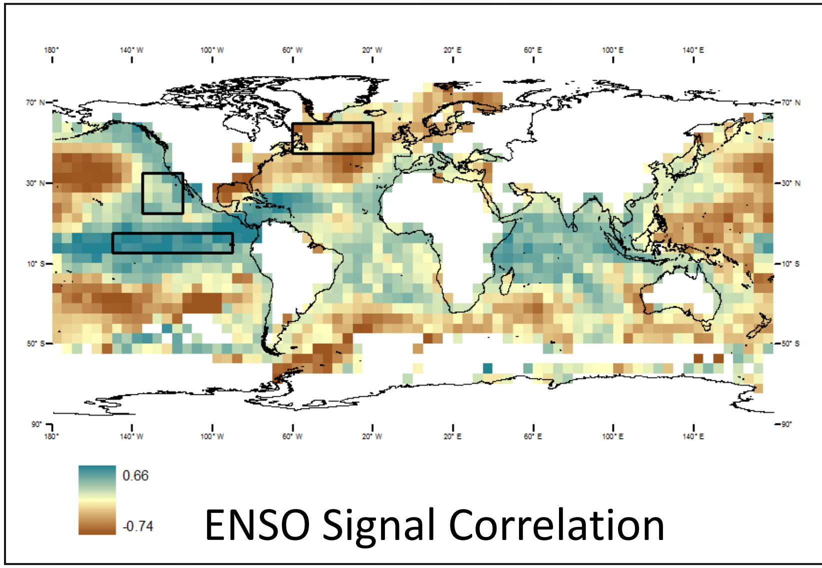
Why Climate Variability is Important





ENSO Affects Local Rainfall Patterns

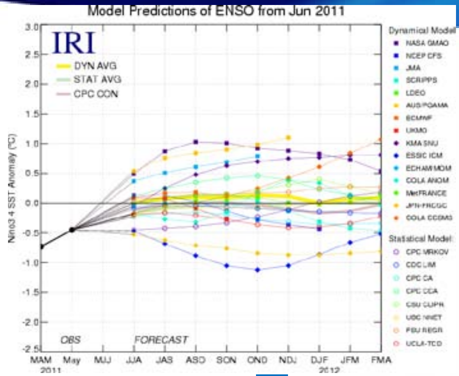


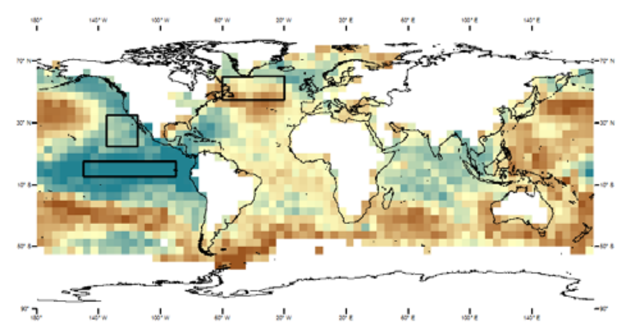


Plant City rainfall probabilities (%) conditional of La Niña

	Below Normal	Normal	Above Normal
DJF	65	35	0
JFM	85	12	3
FMA	71	21	8

Tampa Bay Water's Seasonal Outlook

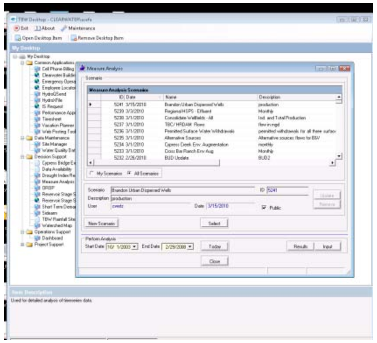




Climate Outlook

&

Real time observation

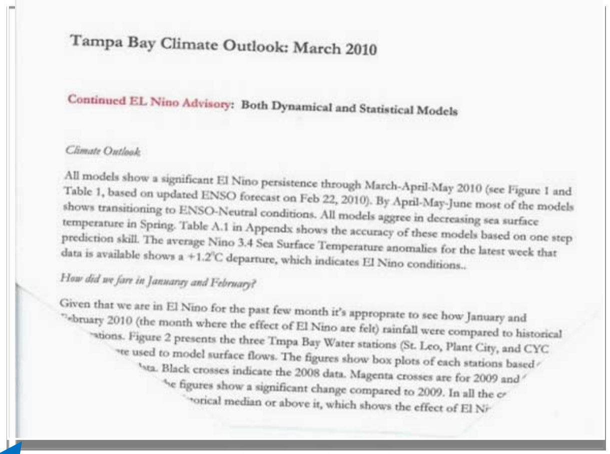


Contingency Table

	Below Normal	Normal	Above Normal
DJF	65	35	0
JFM	85	12	3

Conditional Markov Rainfall Model

Rainfall/Runoff Model



Tampa Bay Climate Outlook: March 2010

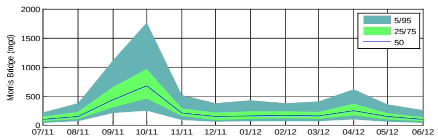
Continued EL Nino Advisory: Both Dynamical and Statistical Models

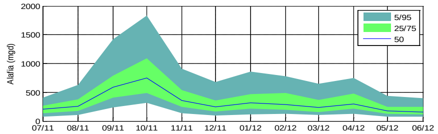
Climate Outlook

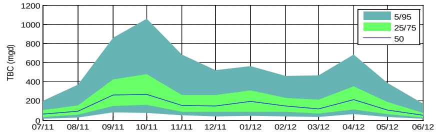
All models show a significant El Nino persistence through March-April-May 2010 (see Figure 1 and Table 1, based on updated ENSO forecast on Feb 22, 2010). By April-May-June most of the models shows transitioning to ENSO-Neutral conditions. All models aggree in decreasing sea surface temperature in Spring. Table A.1 in Appendx shows the accuracy of these models based on one step prediction skill. The average Nino 3.4 Sea Surface Temperature anomalies for the latest week that data is available shows a +1.2°C departure, which indicates El Nino conditions..

How did we fare in Januanry and February?

Given that we are in El Nino for the past few month it's appropriate to see how January and [illegible]ebruary 2010 (the month where the effect of El Nino are felt) rainfall were compared to historical [illegible]ations. Figure 2 presents the three Tmpa Bay Water stations (St. Leo, Plant City, and CYC [illegible]re used to model surface flows. The figures show box plots of each stations based [illegible]ta. Black crosses indicate the 2008 data. Magenta crosses are for 2009 and [illegible]he figures show a significant change compared to 2009. In all the c[illegible] [illegible]orical median or above it, which shows the effect of El N[illegible]



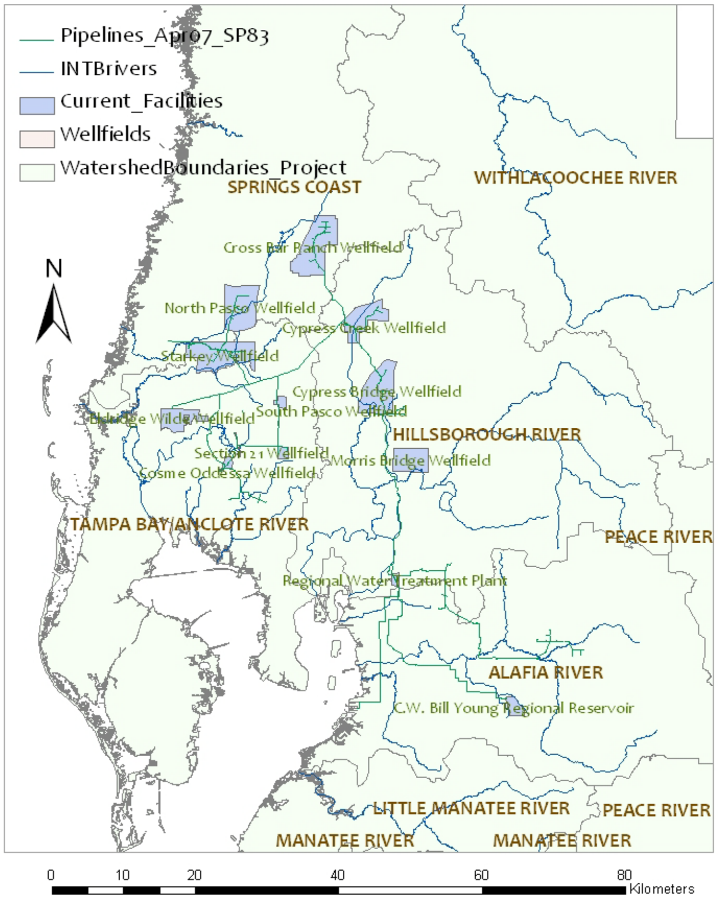




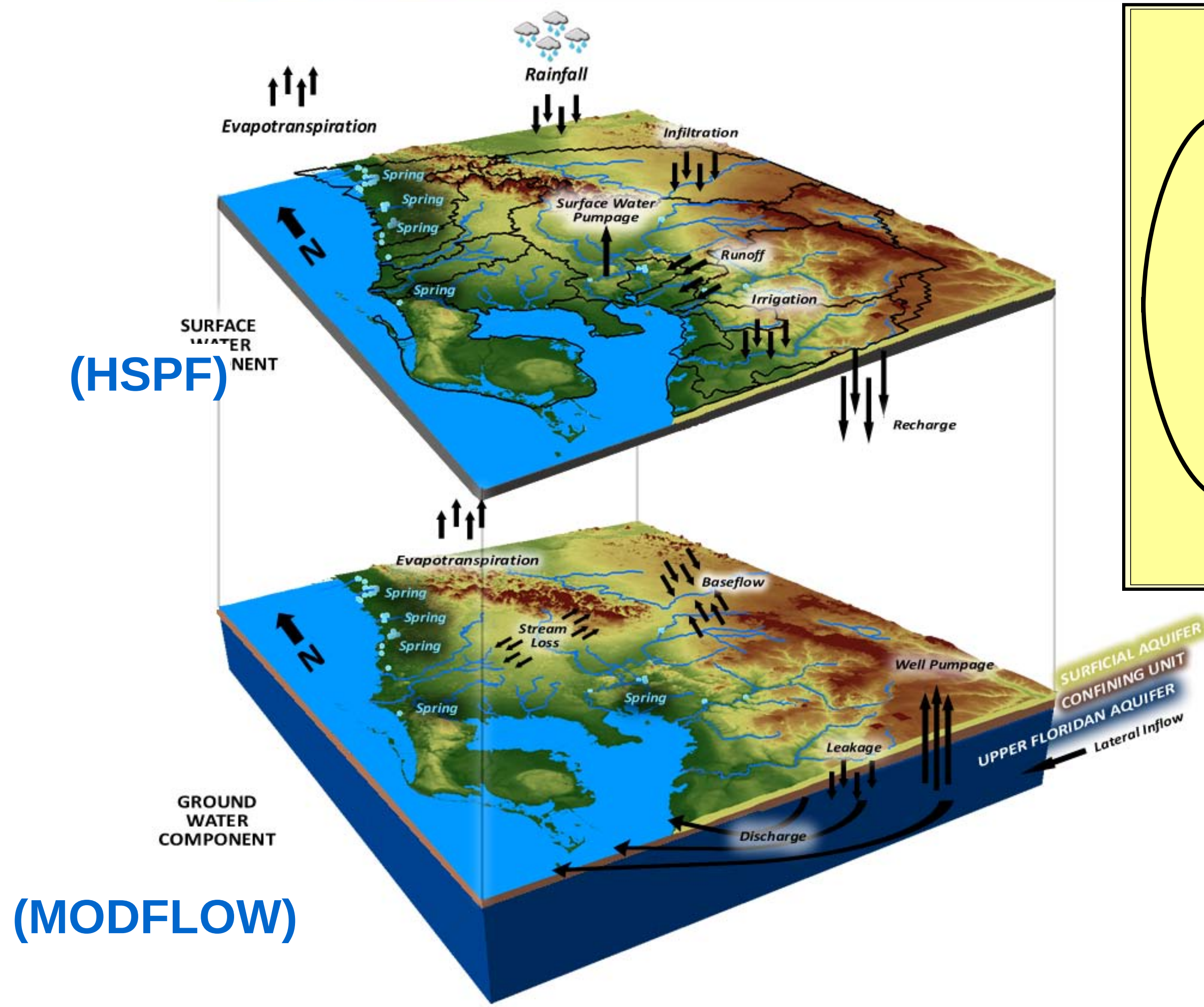
Tampa Bay Water's Climate Change Assessment Project

…. In this project we are using dynamically and statistically downscaled climate model output to drive hydrologic models and explore potential impacts of climate variability and climate change on water availability and water allocation decisions

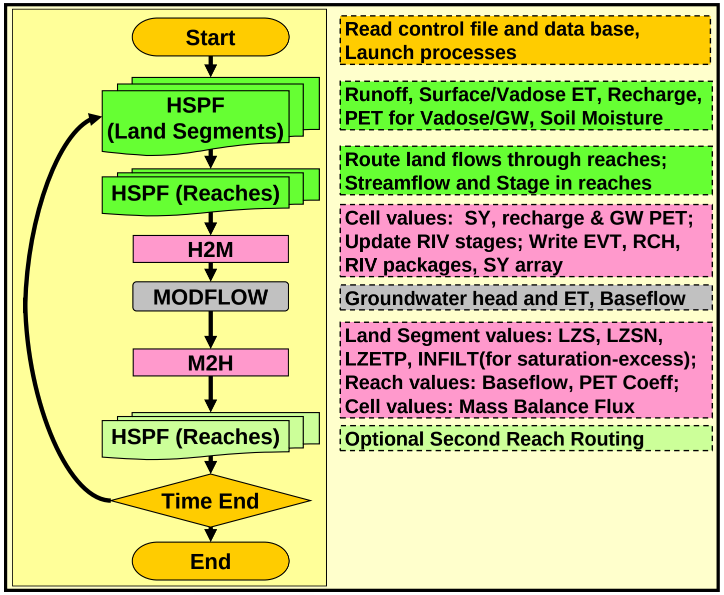
Study area map



Integrated Hydrologic Model (IHM) Hydrologic Processes



IHM Sequential Integration



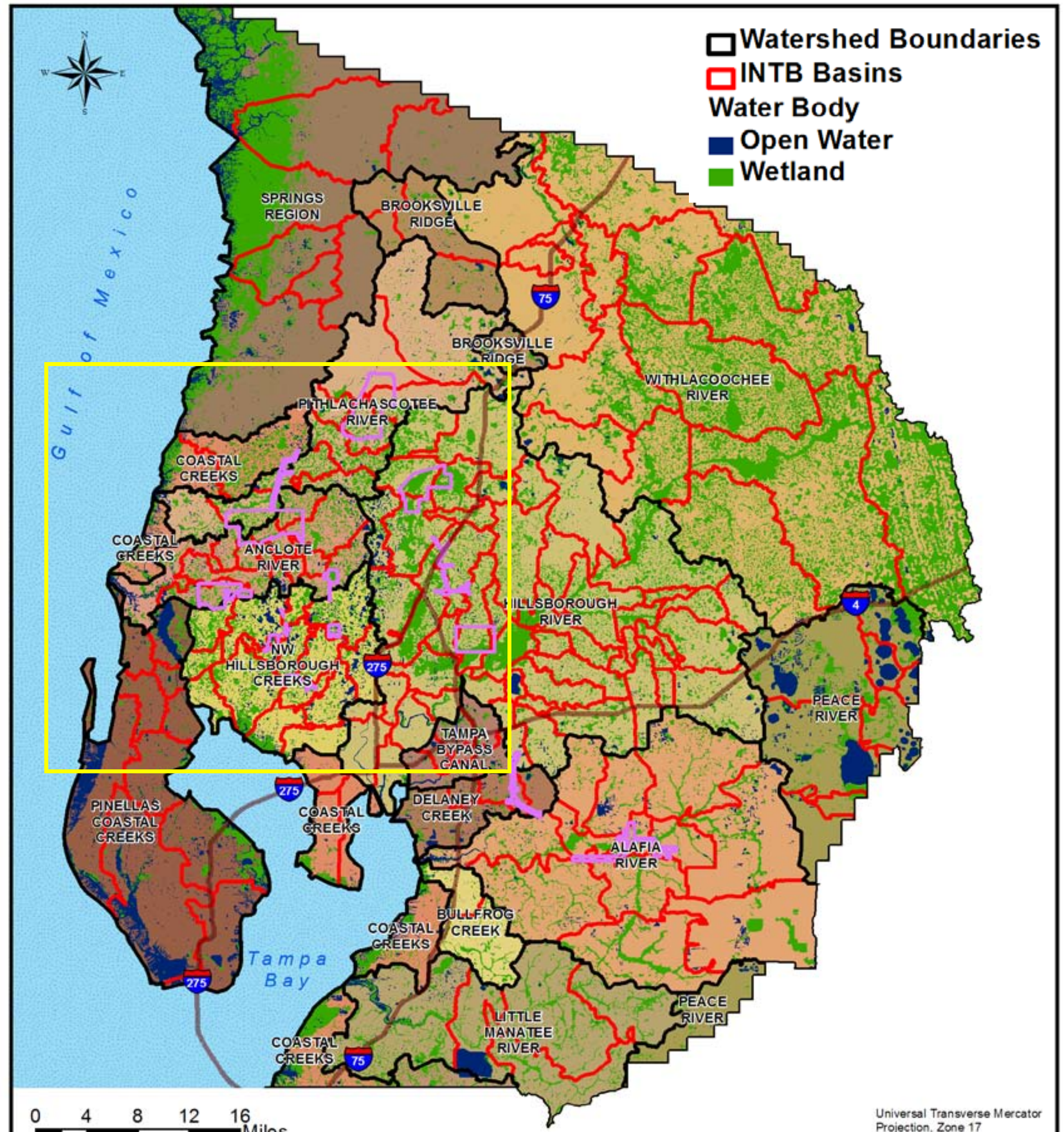
TAMPA BAY WATER

Integrated Northern Tampa Bay Model Surface-Water Component (HSPF)

- Convective Rainfall (4 months)
  - 60% volume / 75% events
  - 1.25-mile event spatial scale
- 65% of basins with 2 mile radius
- Rain input: 300 gauges, 15-min.
- ET – 5x seasonal variation

Average Annual Budget 1989-98

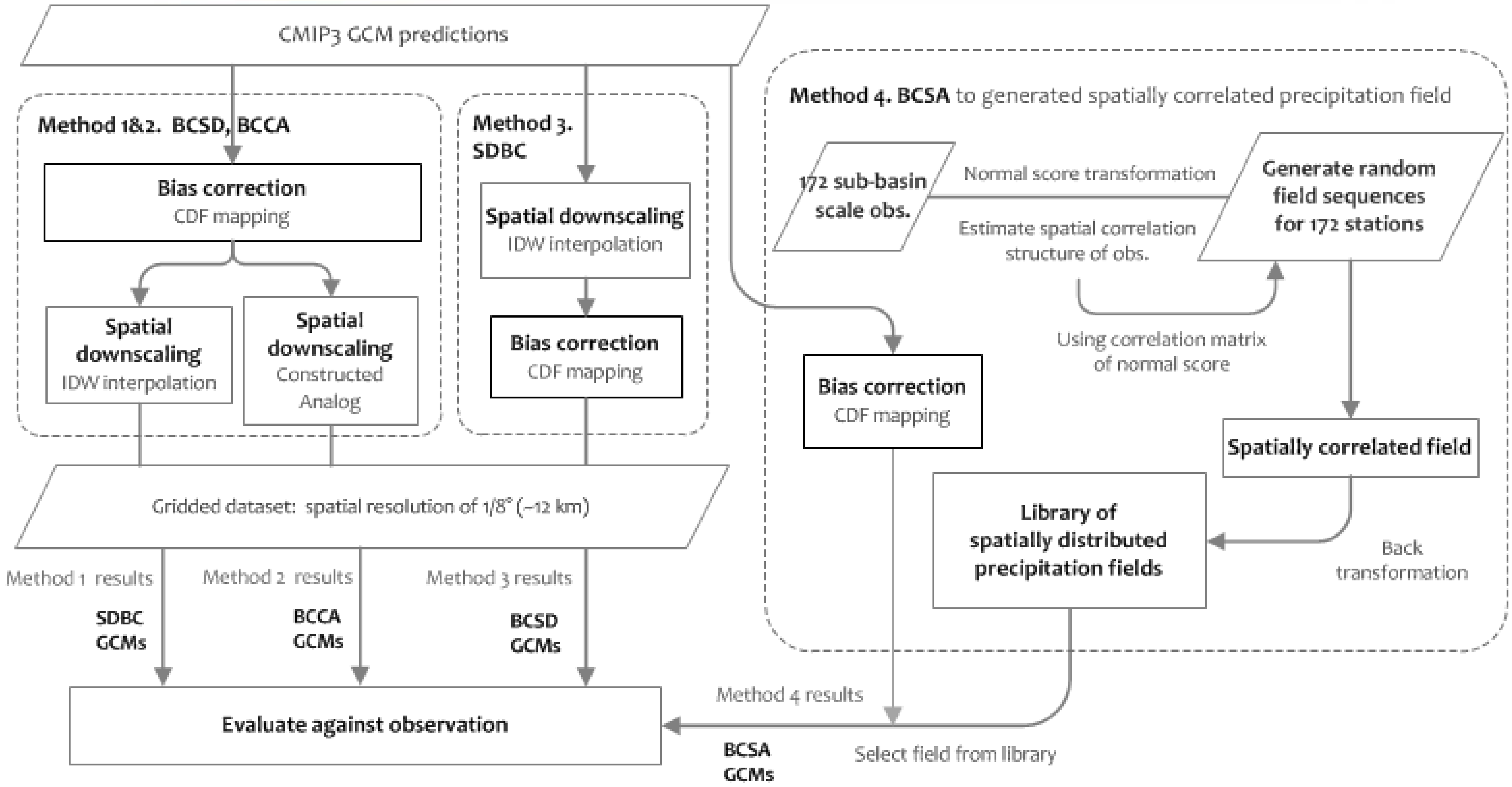
Budget Term	Percent	Flux (in/yr)
Evap. & Transp.	69	38.0
Stream & Spring Q	21	11.0
Well Pumping	5	3.0
GW Flow to Gulf	3	1.5
SW Pumping	1	0.5
Other GW Outflows	1	0.5
Total	100	54.5



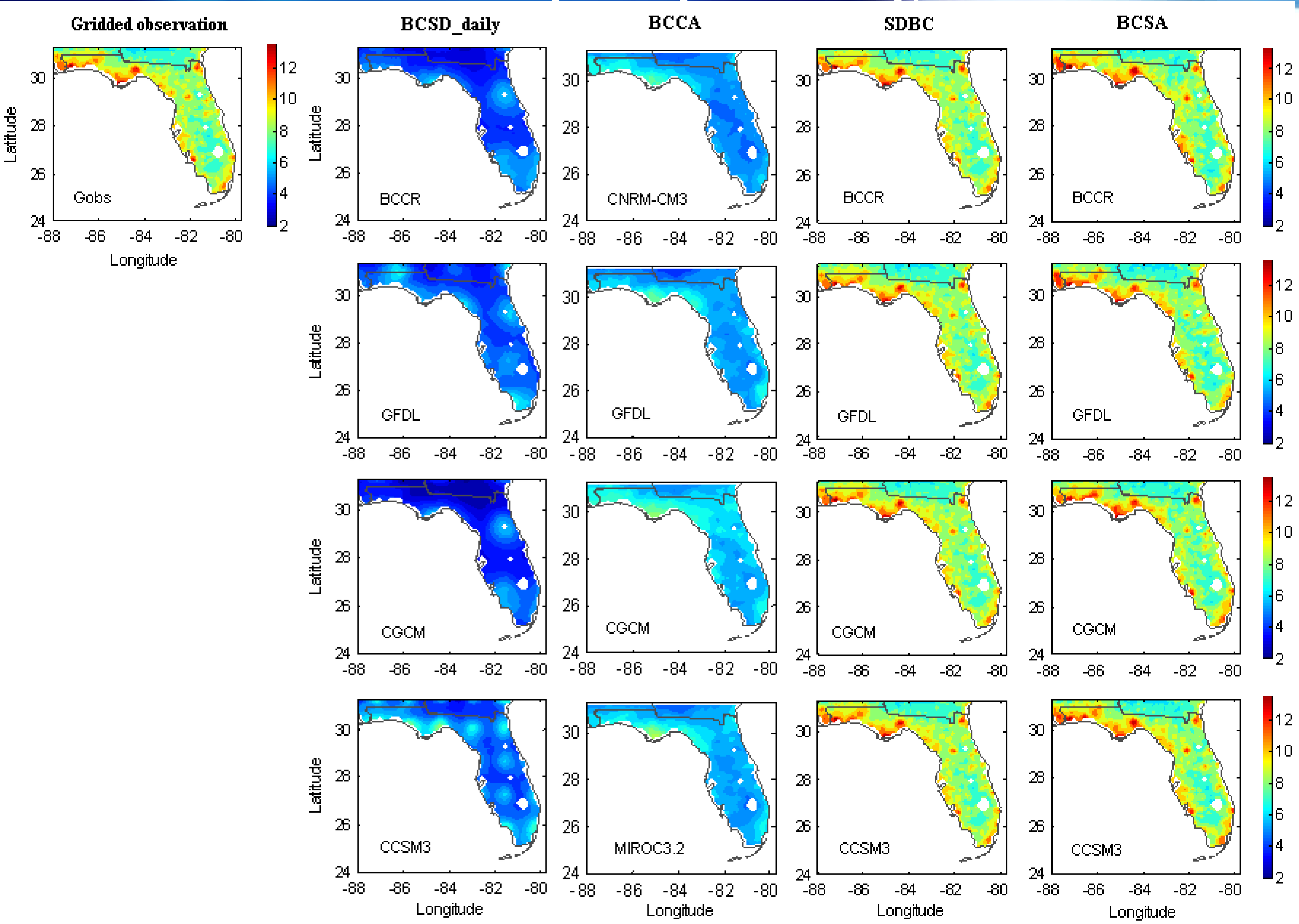
Current Research outline

1. Statistical downscaling
   - Comparative evaluation of 4 methods (BCSD_daily, BCCA, SDBC, BCSA)
     - Ready to submit Hydrology and Earth System Science
   - Hydrologic simulation
     - Submitting to ASABE transaction
2. Evaluation of downscaled reanalysis data
     - R1+MM5 (Hwang et al., 2011)
     - R2+RSM (Stefanova et al., 2011)
     - ERA40+RSM (Stefanova et al., 2011)
     - 20CR+RSM (DiNapoli and Misra, 2012)
   - Submitting to JAWRA
3. Uncertainty of Bias-correction in climate change impact assessment

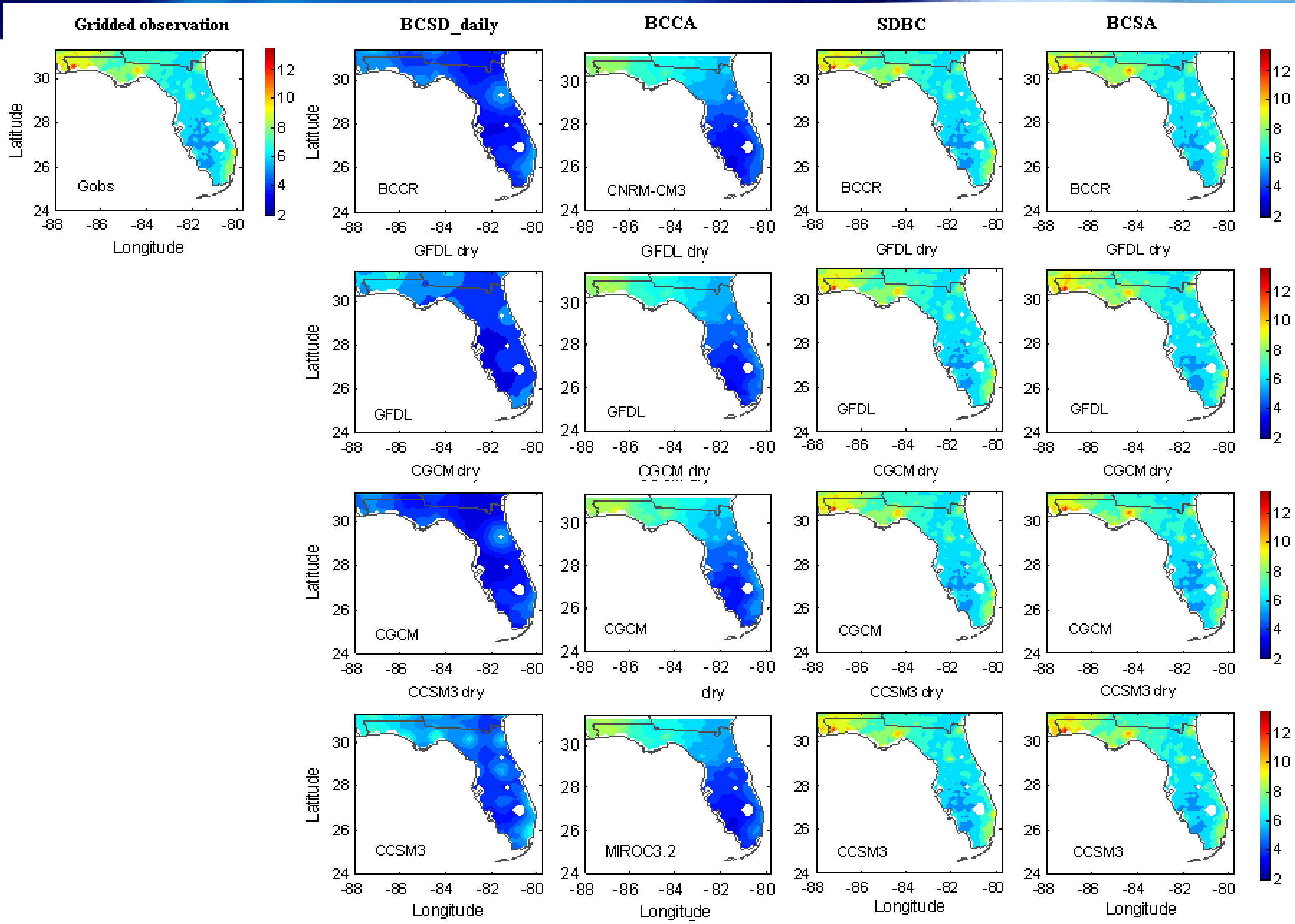
Methodology



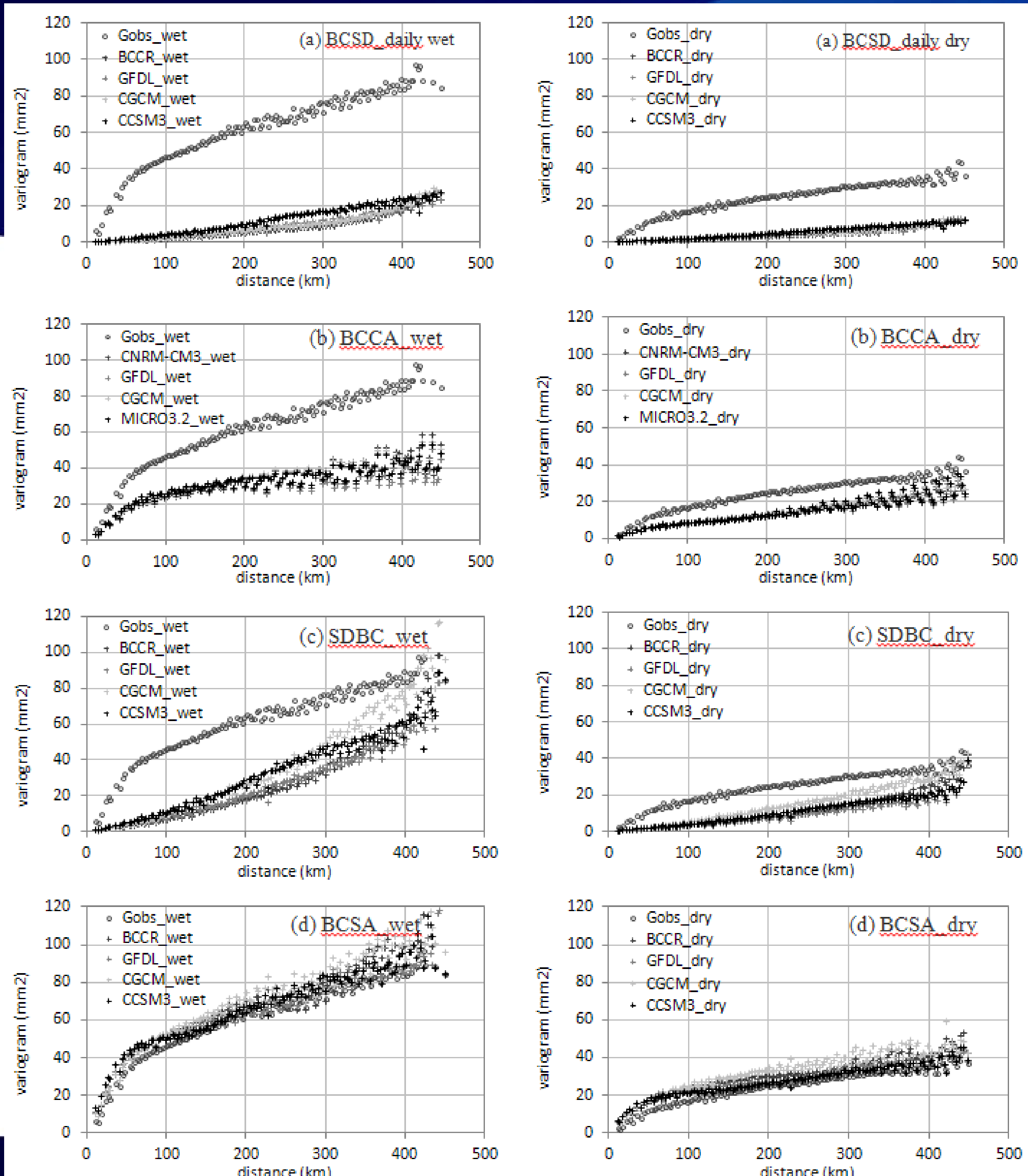
Spatial distribution of the temporal standard deviation for wet season (June through September), units in mm



The same but for dry season (October through May)



Spatial variability (Variograms)

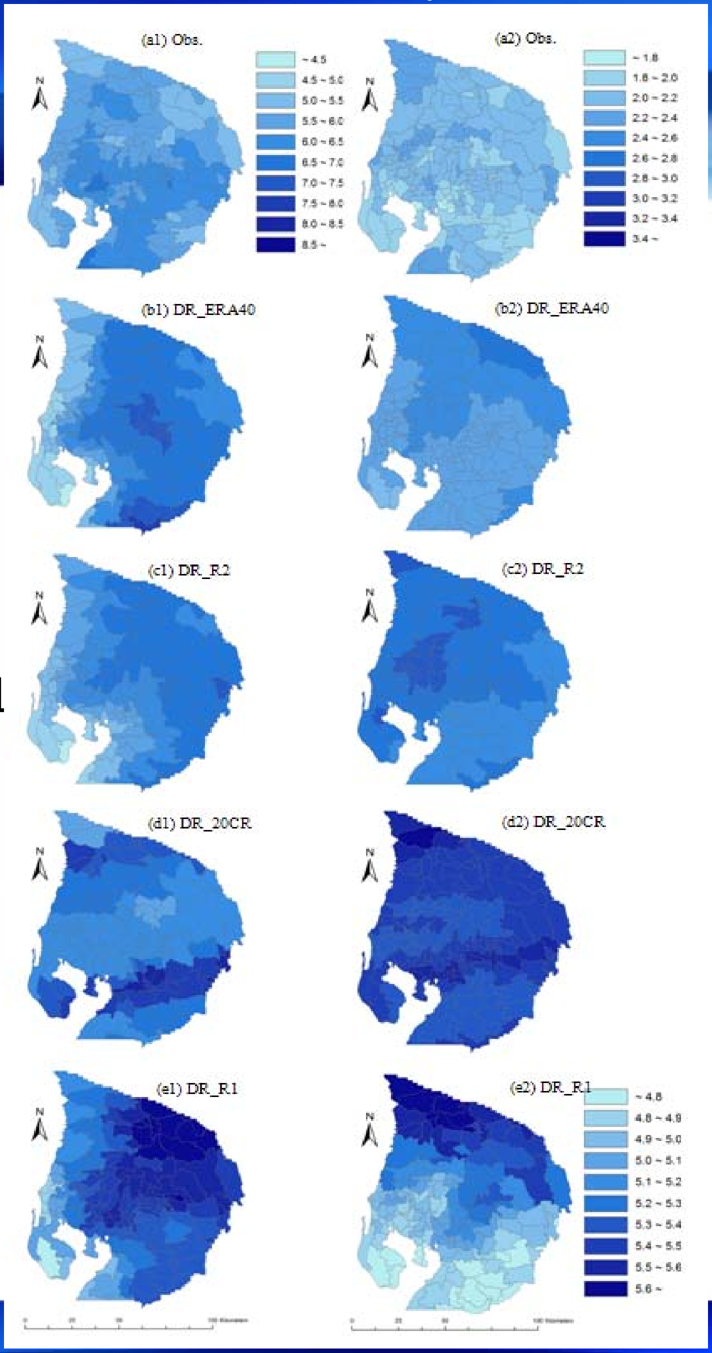


Dynamical Downscaling

- Assessment of the utility of dynamically-downscaled regional reanalysis data to predict streamflow in west central Florida
  - Reanalysis data – robust proxy of historic atmospheric observations
  - Verifying accurate prediction of historic climatic and hydrologic behavior using reanalysis data is an essential first step before using retrospective and future GCM projections to predict potential hydrologic impacts of future climate change

Spatial distribution of daily mean precipitation

Wet season Dry season



- Study period from 1989 to 2001

1. R1+MM5 (Hwang et al., 2011)
   1986-2008
2. R2+RSM (Stefanova et al., 2011)
   1979-2001
3. ERA40+RSM (Stefanova et al., 2011
   1979-2001
4. 20CR+RSM (DiNapoli and Misra, 2012)
   1903-2008

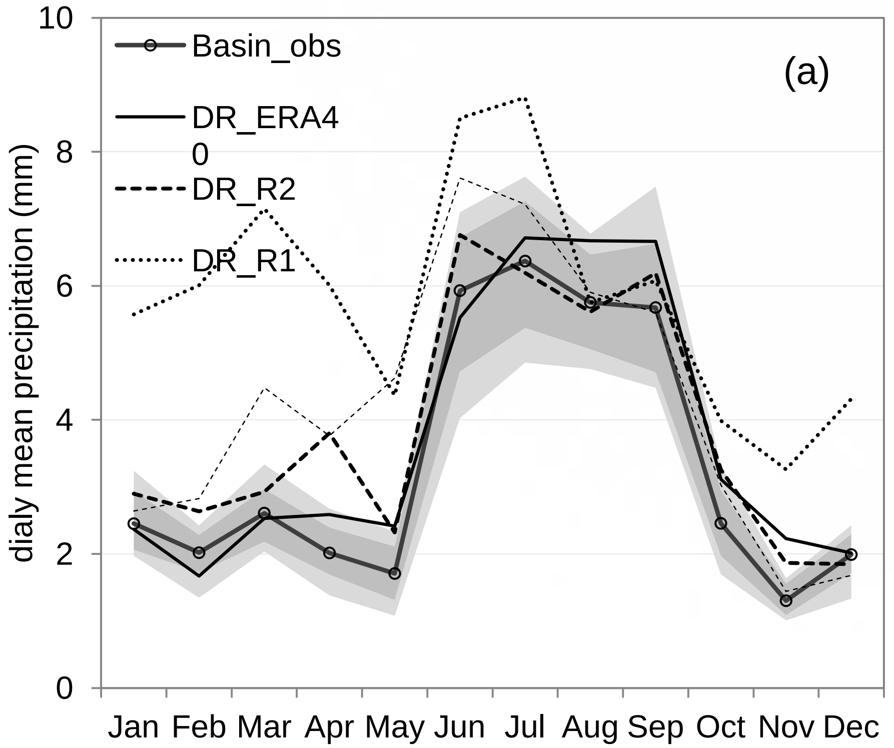
IHM calibration/verification period

1989-2006

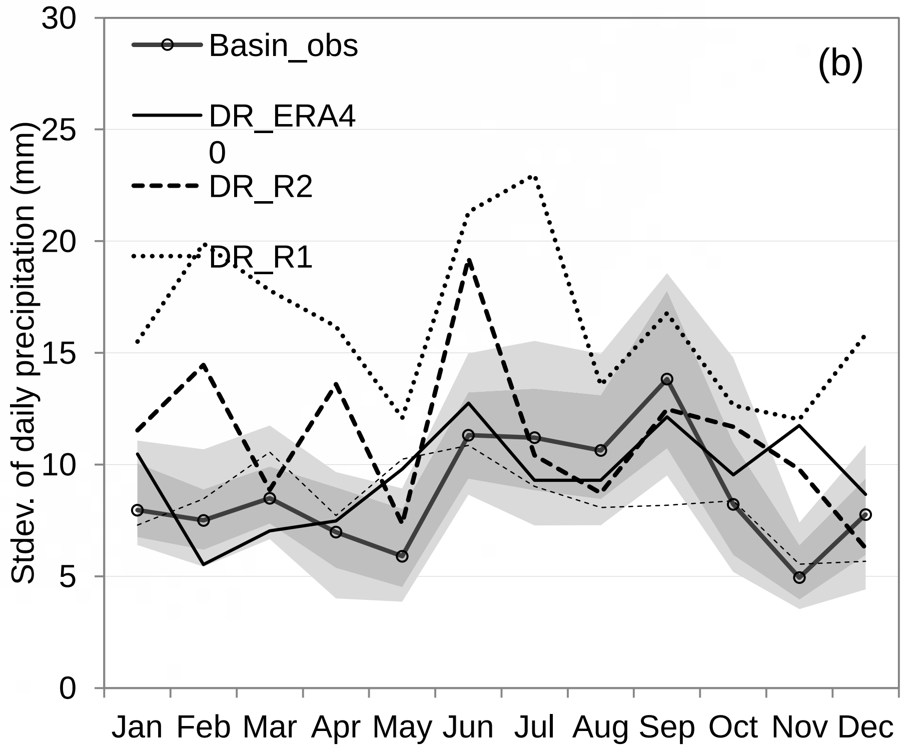
Comparison of the mean annual cycles of (a) monthly mean and (b) standard deviation of daily precipitation.

Raw results

monthly mean precipitation

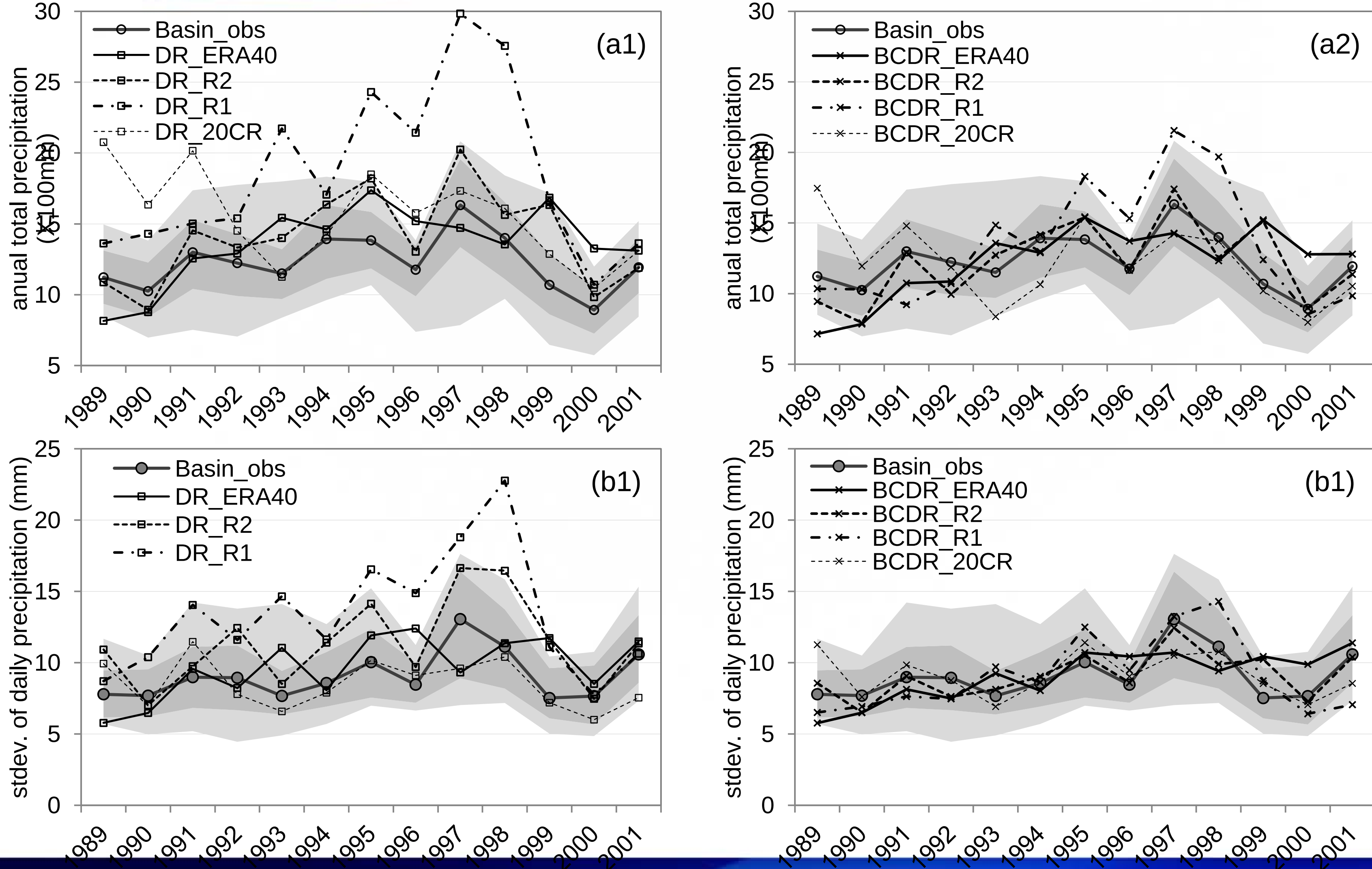


standard deviation of daily precipitation

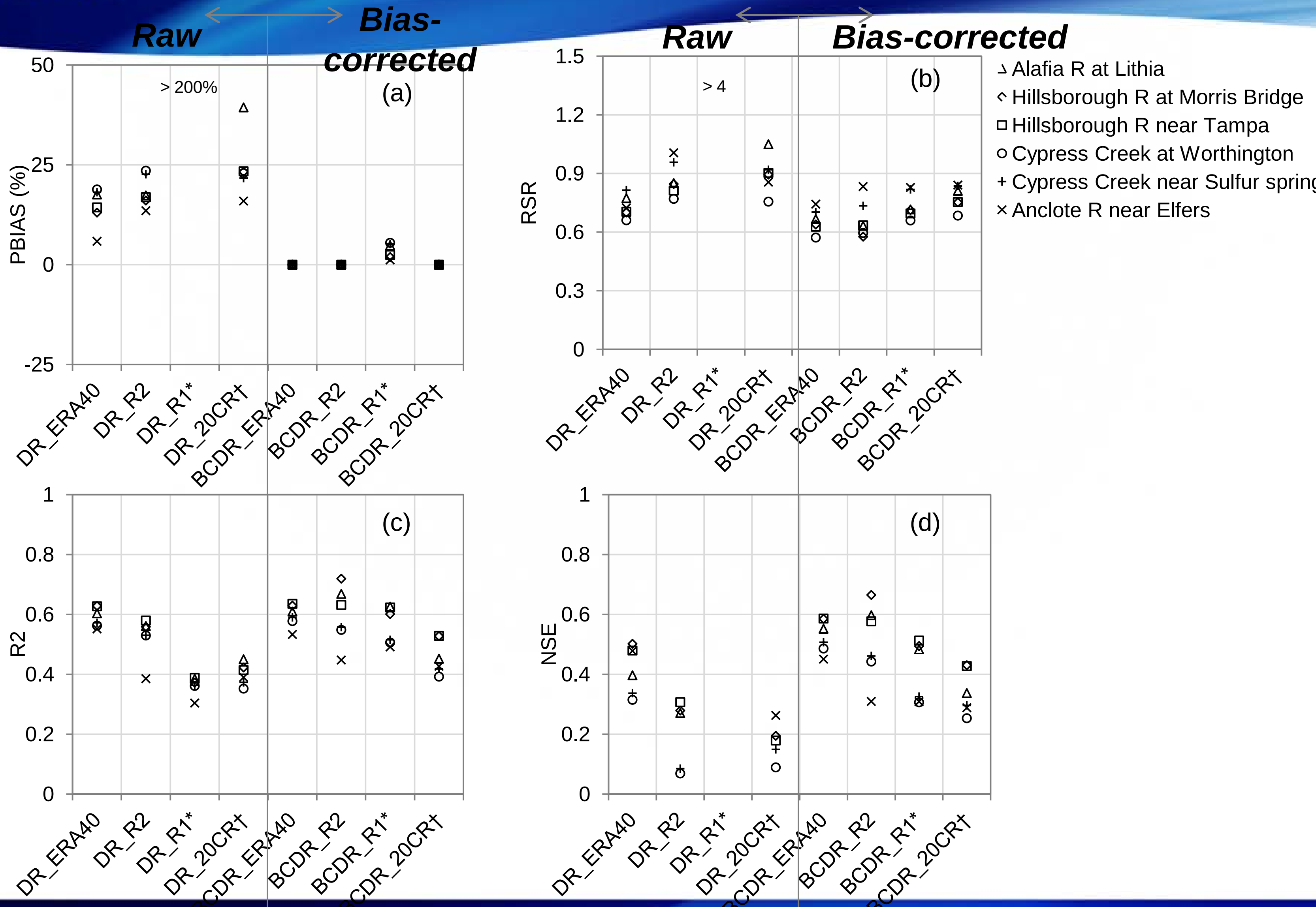


Comparison of time series of (a) annual total precipitation and (b) standard deviation of daily precipitation over the year

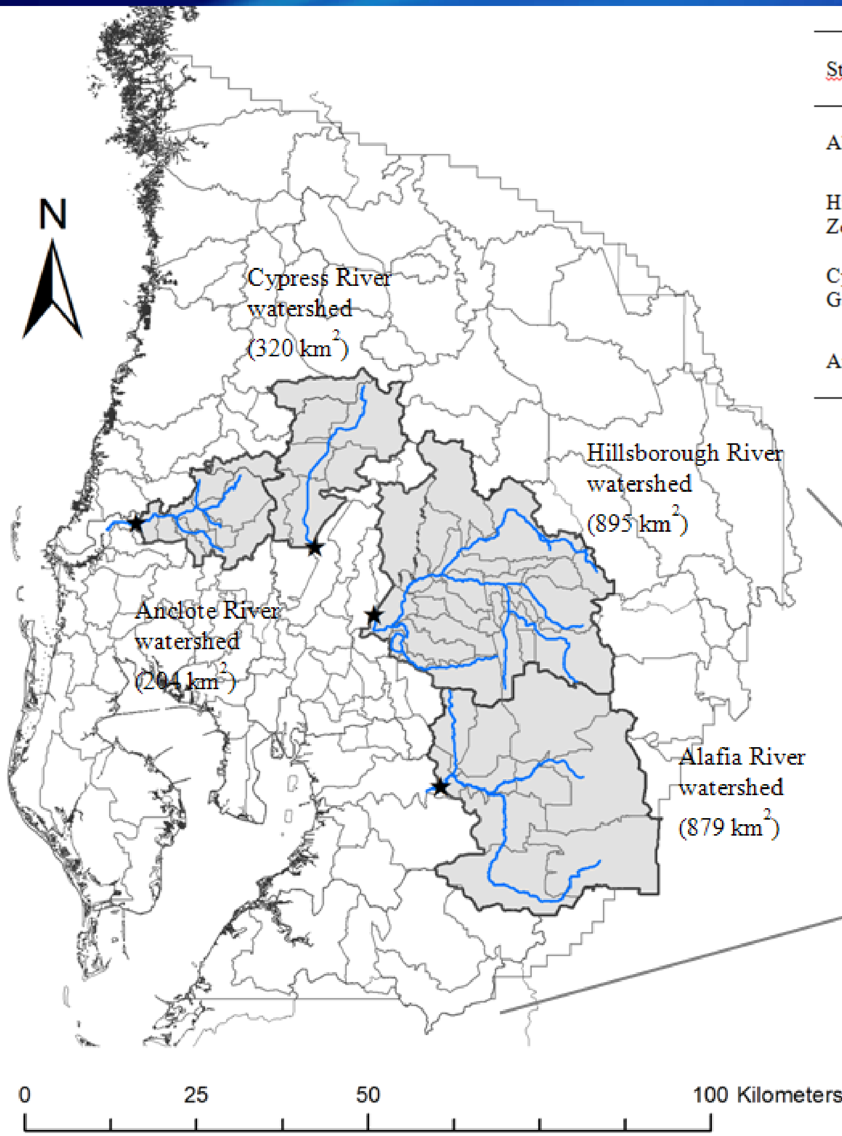
Raw results ***Bias-corrected results***



Comparison of error statistics of monthly areal precipitation predictions



Hydrologic implication



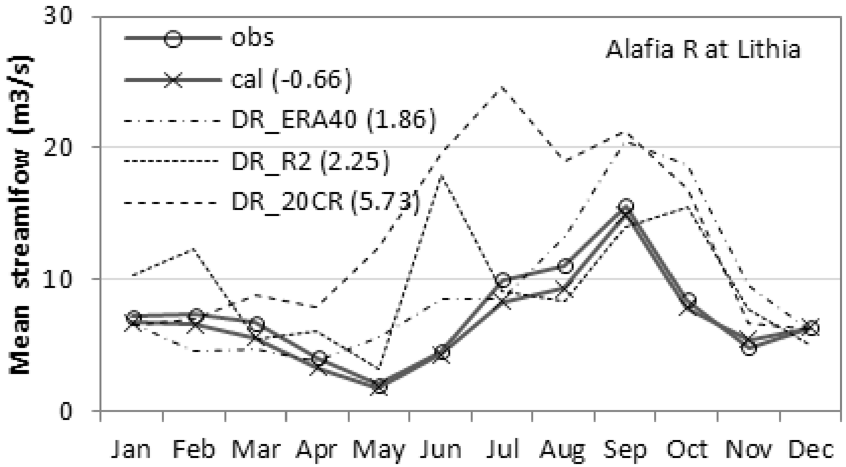
Streamflow stations	Watershed	Latitude	Longitude	Drainage area, (km^2)
Alafia River at Lithia	Alafia	27.8719	-82.2114	867.3
Hillsborough River near Zephyrhills	Hillsborough	28.1497	-82.2325	569.6
Cypress Creek at Worthington Gardens	Hillsborough	28.1856	-82.4008	302.9
Anclote River near Elfers	Anclote	28.2139	-82.6667	187.7

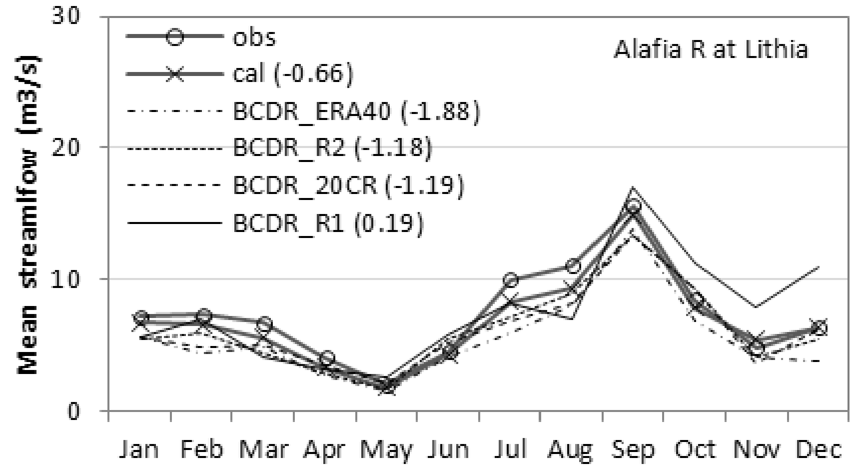
TAMPA BAY WATER

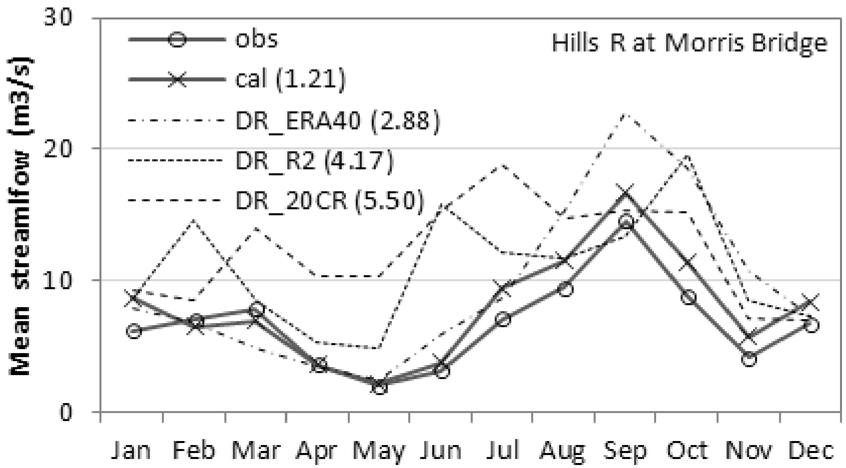
Comparison of observed vs. simulated mean monthly streamflow

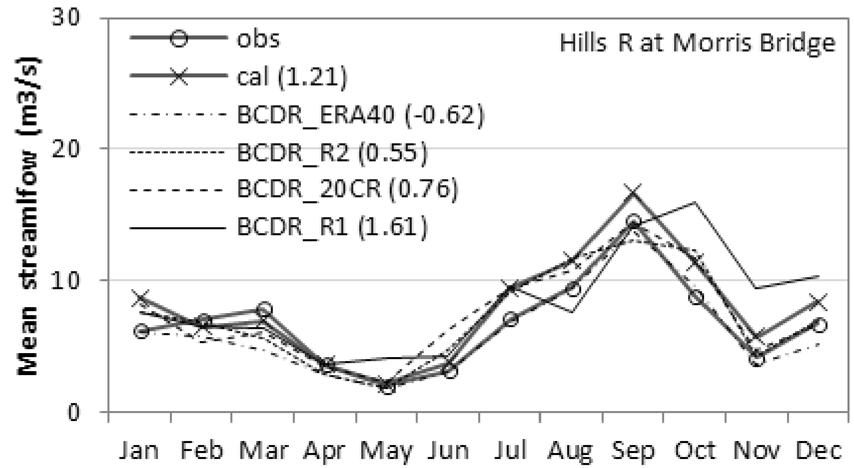
Raw results

Bias-corrected results





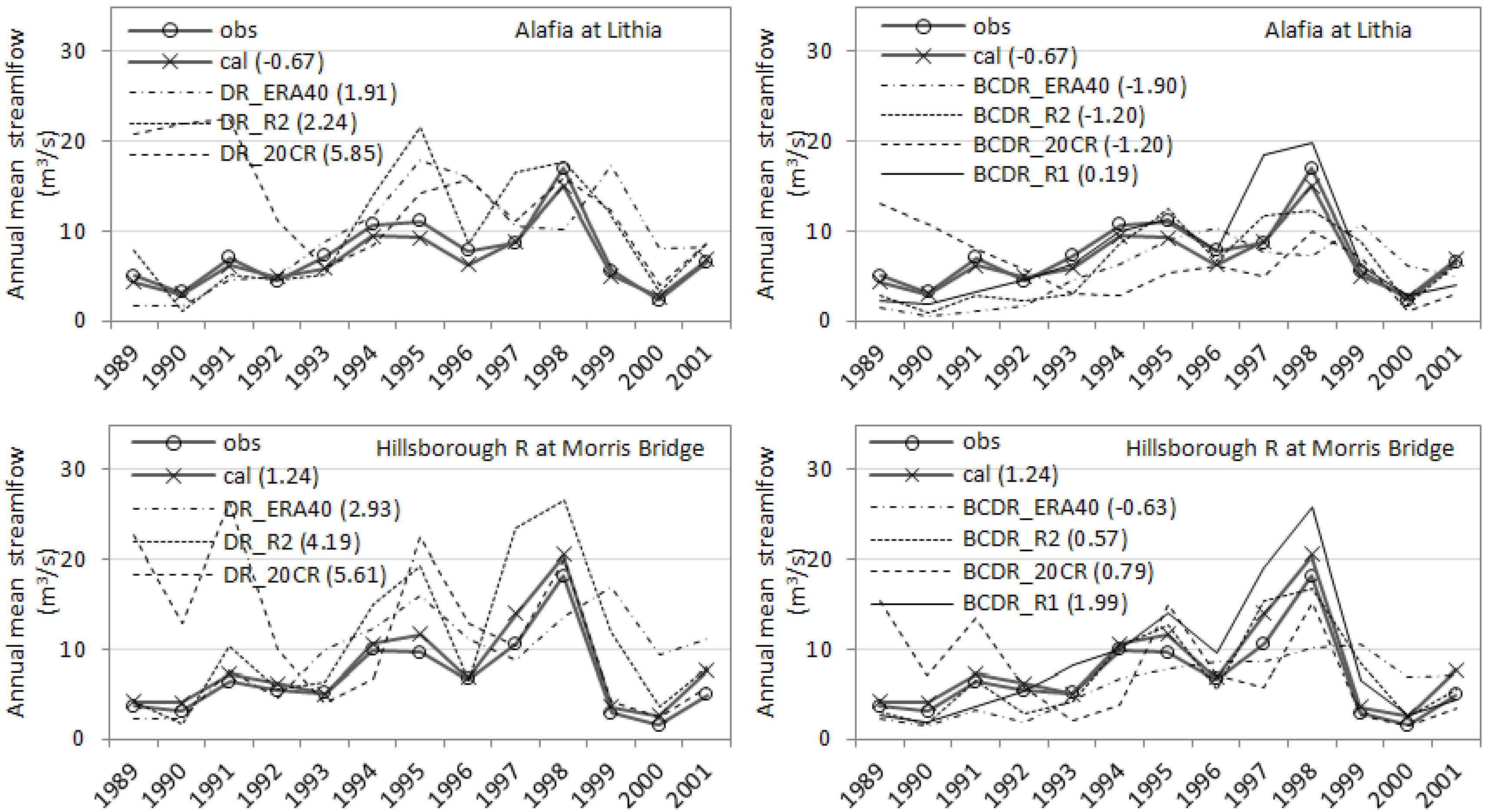




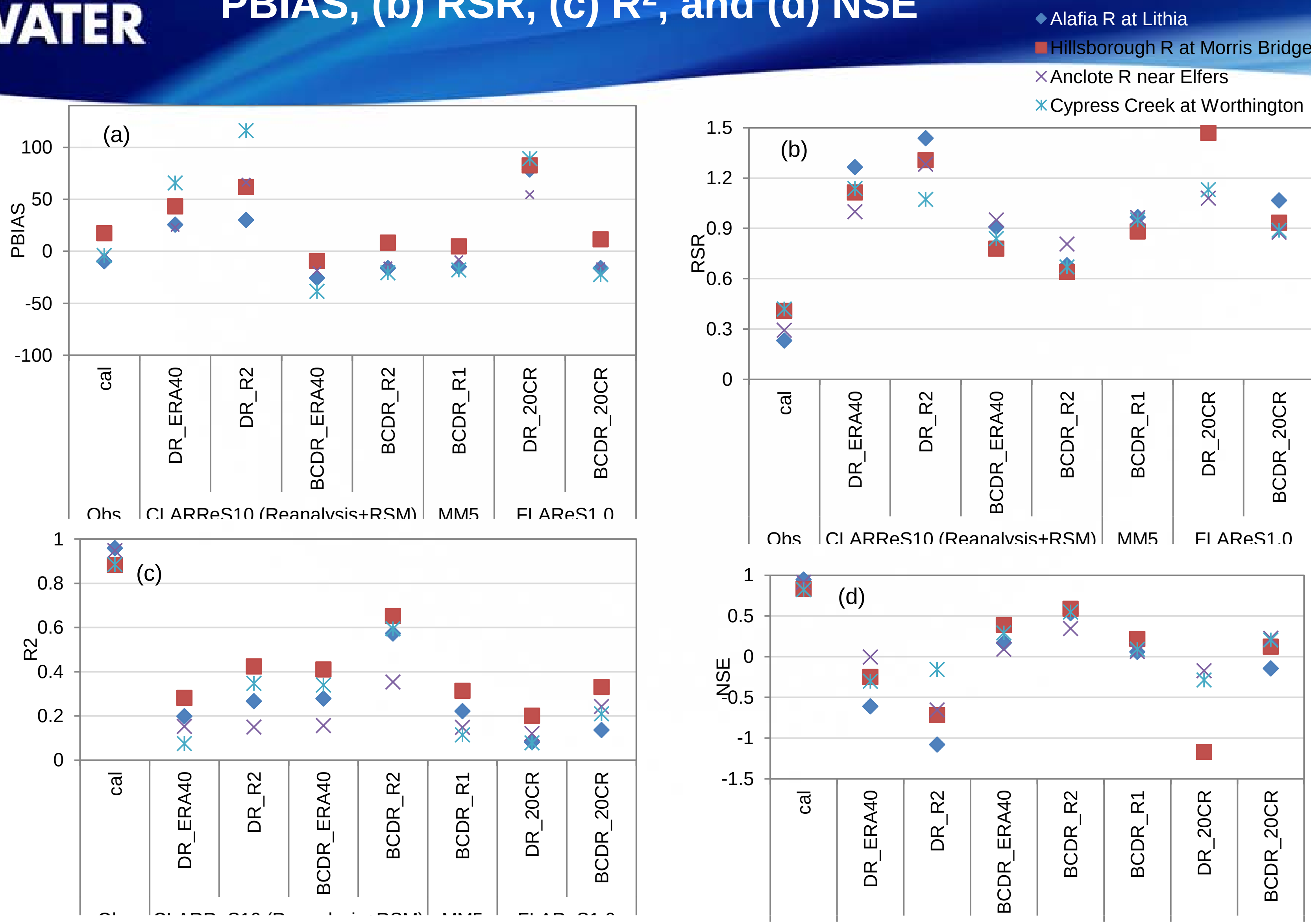
Comparison of observed vs. simulated annual time series

Raw results

Bias-corrected results



Comparison of error statistics of monthly streamflow simulations for each target station; (a) PBIAS, (b) RSR, (c) R^2, and (d) NSE



- Uncertainty of Bias-correction in climate change impact assessment

CLAREnCE10 data

http://coaps.fsu.edu/CLARReS10/index.shtml

- 3 GCMs + Regional Spectral Model (RSM)
  - CCSM, HadCM3, and GFDL (not available yet)
- Spatial resolution (10kmx10km)

  over southeastern US
- Variables
  - hourly Prec., humidity, wind speed, roughness, etc.
  - daily Tmax/min data
  - Daily bias-corrected Prec. data are available
- Retrospective simulation period
  - 1968-2000
- Future simulation (AR4 A2 scenario)
  - 2038-2070

Bias-correction (BC) Methodology

- 4 Future Bias Correction methods
  1. Correct using historic **bias *amount*** corresponding the '***magnitude***' of future prediction (**CDFm**, Wood et al)
  2. Correct using historic **bias *amount*** corresponding the '***Percentile***' of future prediction (**EDCDFm**, Li et al., 2010)
  3. Correct using historic **bias *percentage*** corresponding the '***magnitude***' of future prediction (**CDFm_%bias**)
  4. Correct using historic **bias *percentage*** corresponding the '***Percentile***' of future prediction (**EDCDFm_%bias**)

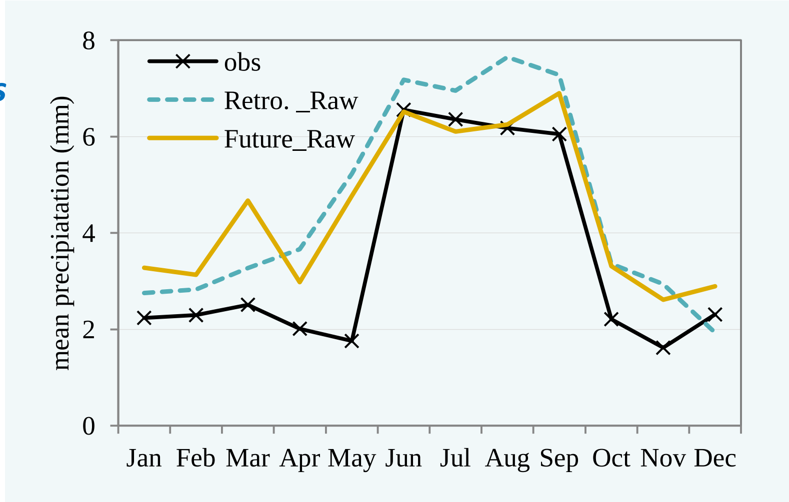
- 3 methods for CDF development
  1. Monthly CDF (≈30data)
  2. CDF for moving window (± 30 days, 61data)
  3. CDF for moving window (± 15 days, 31data)

Total 12 combination of methodologies!

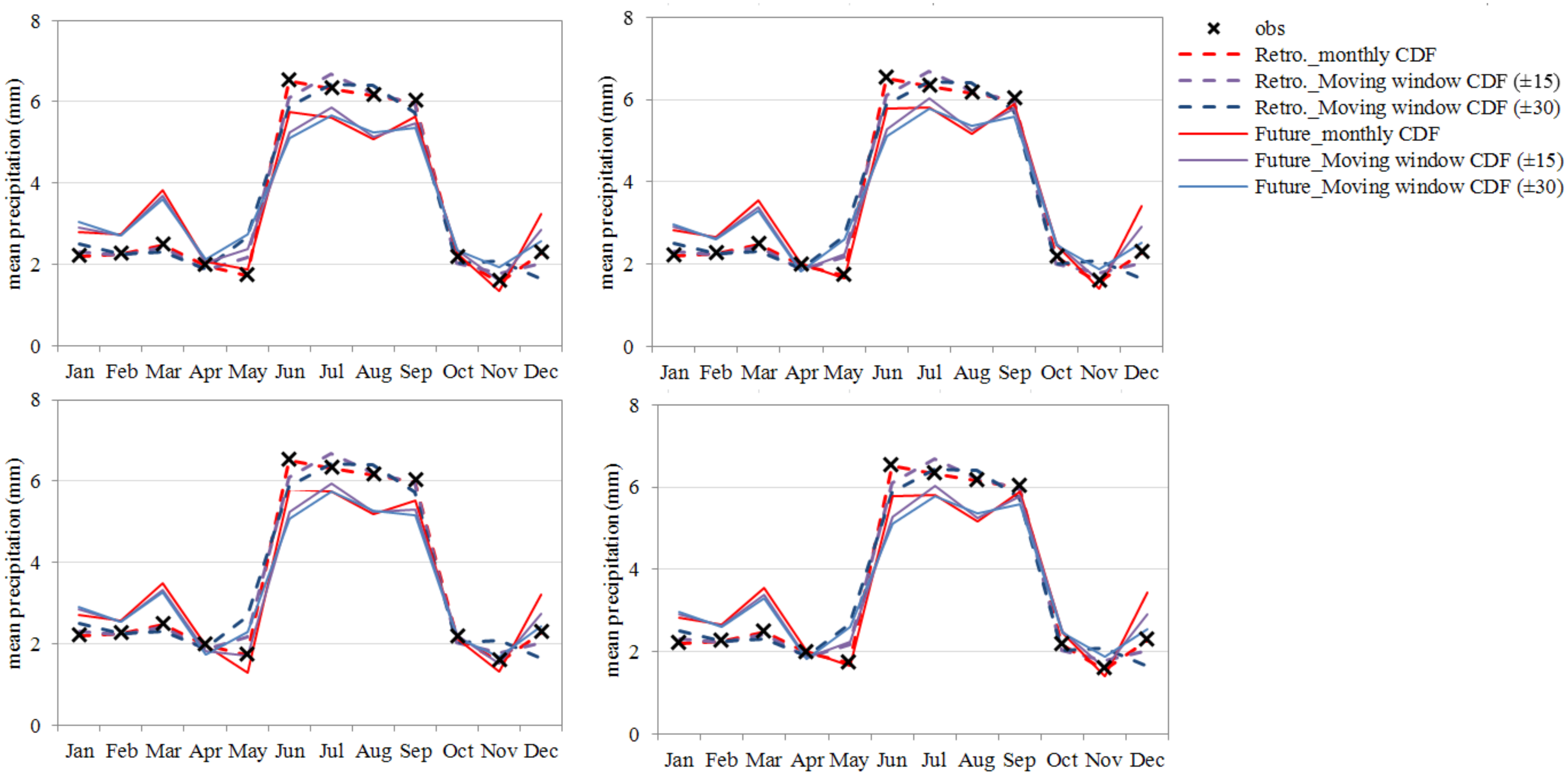
1. Mean daily precipitation

HadCM3+RSM

Raw results



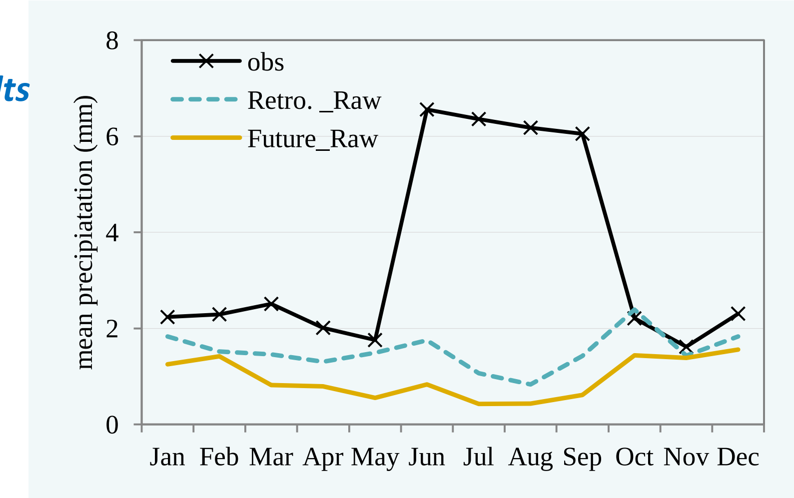
Bias-corrected results



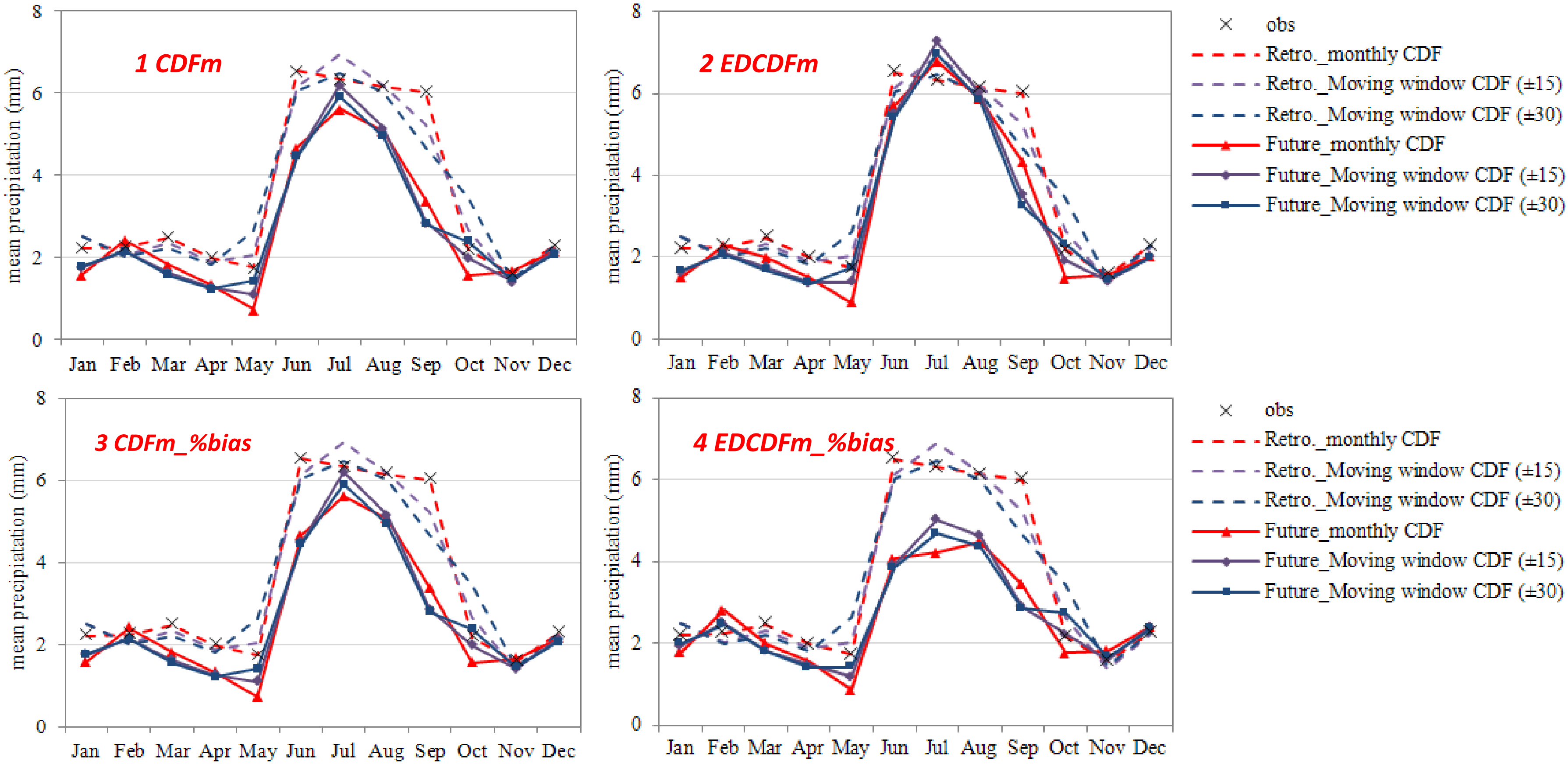
1. Mean daily precipitation

CCSM+RSM

Raw results



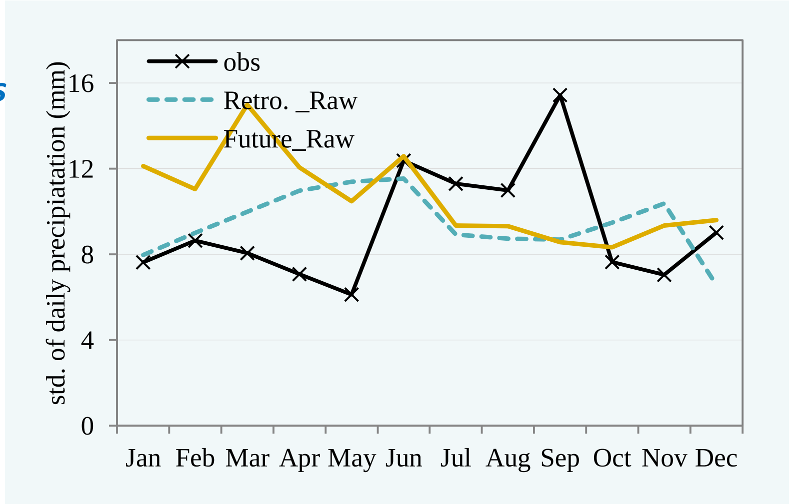
Bias-corrected results



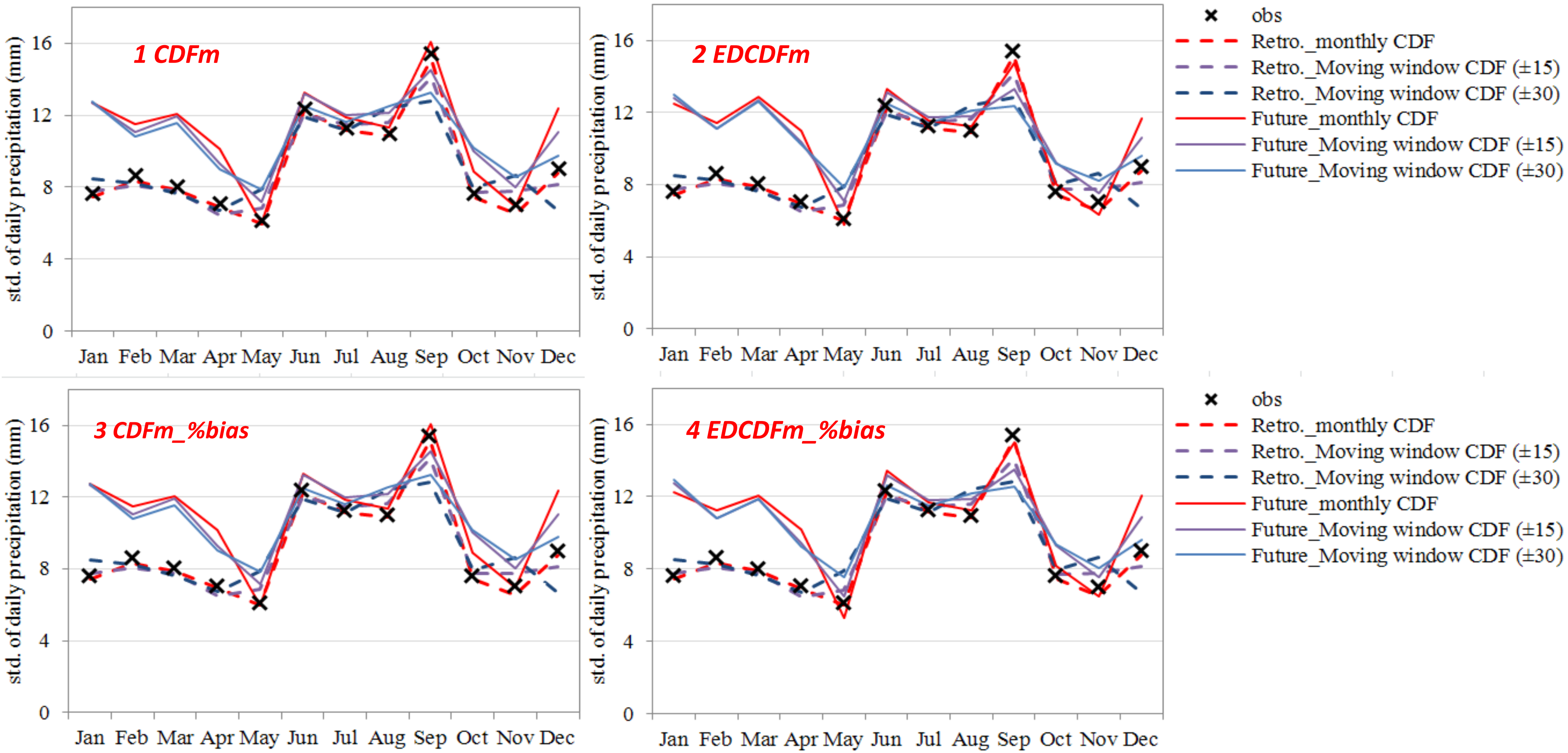
2. Std. of daily precipitation

HadCM3+RSM

Raw results



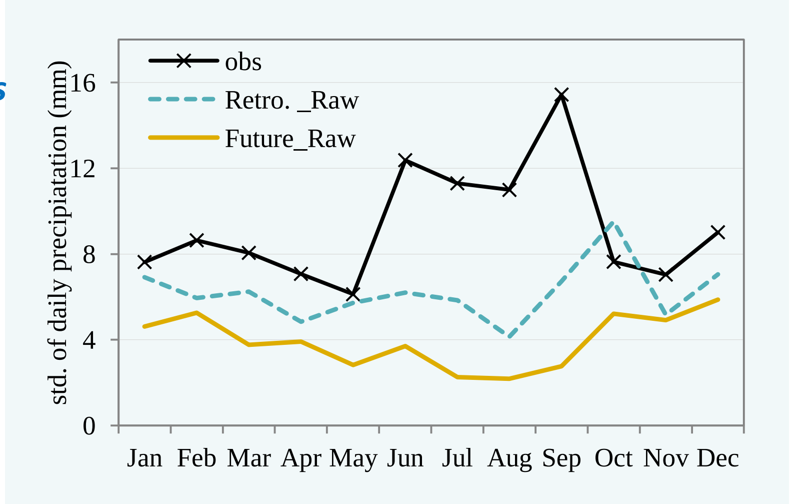
Bias-corrected results



2. Std. of daily precipitation

CCSM+RSM

Raw results



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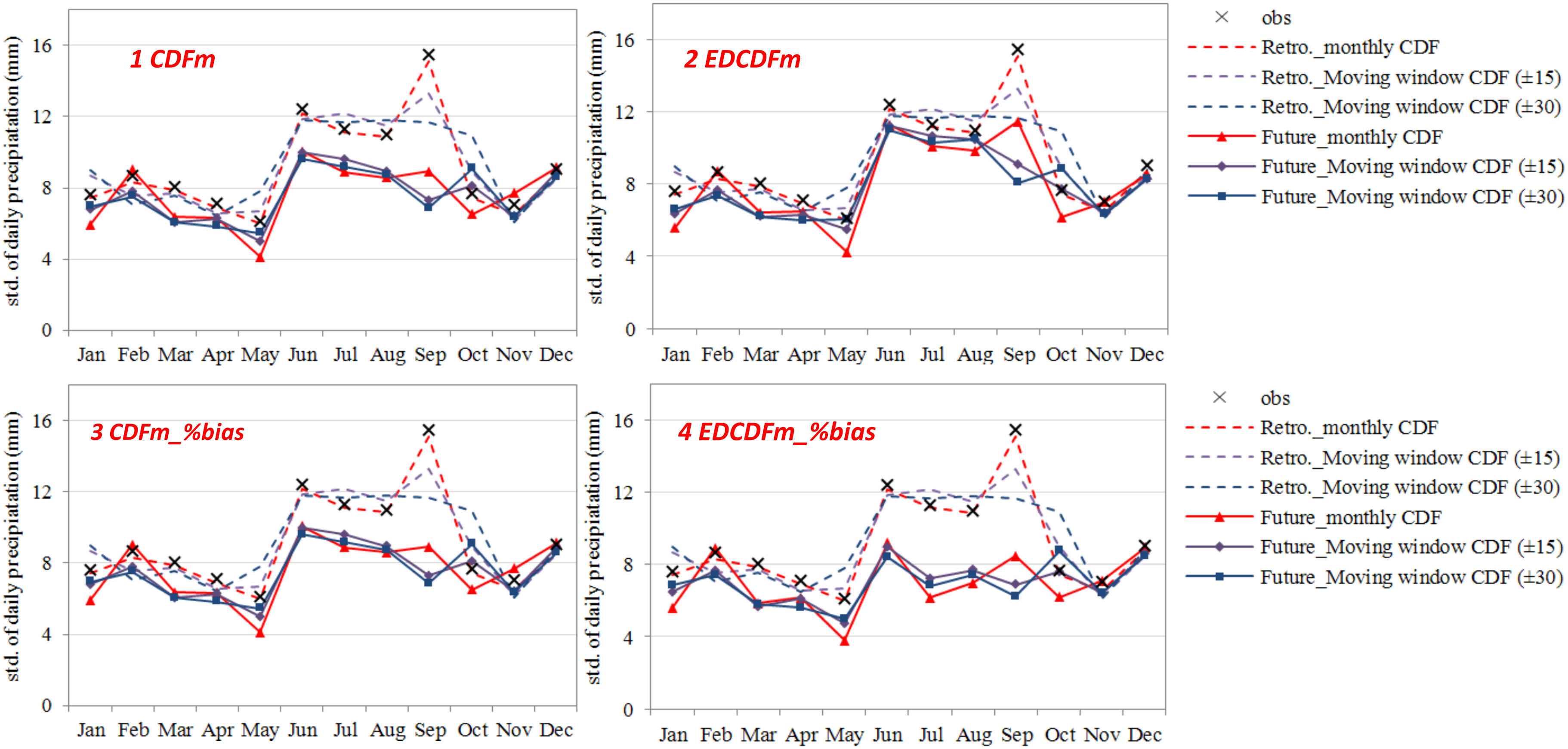

- QUESTIONS??