University of Florida Water Institute

UF Water Institute Mission

- To bring together talent from throughout the University to address complex water issues through innovative interdisciplinary research, education and outreach programs

Water Institute Thrust Areas

- **Water Resource Sustainability**
- **Water and Ecosystems**
- **Water and Climate**
- **Water and Society**

Water & Climate Thrust Area

- **Water Resources Challenges**
  - Increasing Demand
  - Floods & Droughts
  - Decreasing Storage & Recharge
  - Water Quality Degradation
  - Uncertain future Land use, Water use and Climate trends

Current Climate Variability Drivers

- Seasonal variations in precipitation and temperature, floods and droughts.
- El Nino Southern Oscillation (ENSO)
- Atlantic Multi-decadal Oscillation (AMO)
- Tropical storms

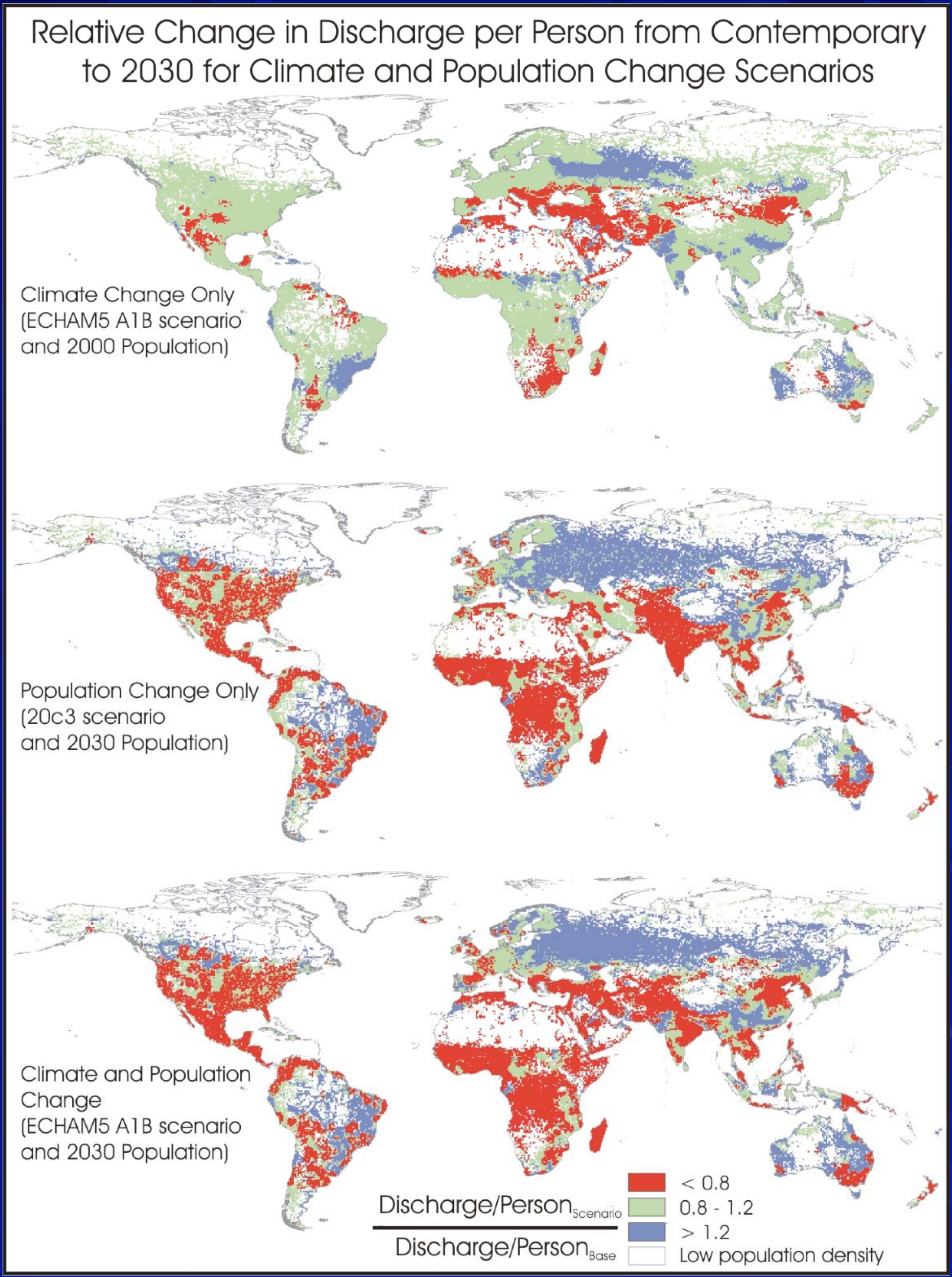
Anticipated Climate Change Drivers

- Higher surface air temperatures
- Sea-level rise
- Longer, more frequent droughts (?)
- Shorter, higher intensity rainy seasons (?)

Note.....

- Climate Change only part of our water resource worries
- Population growth and land use change are critical issues
- These added pressures will further increase water competition

Vorosmarty et al, Science , 2000



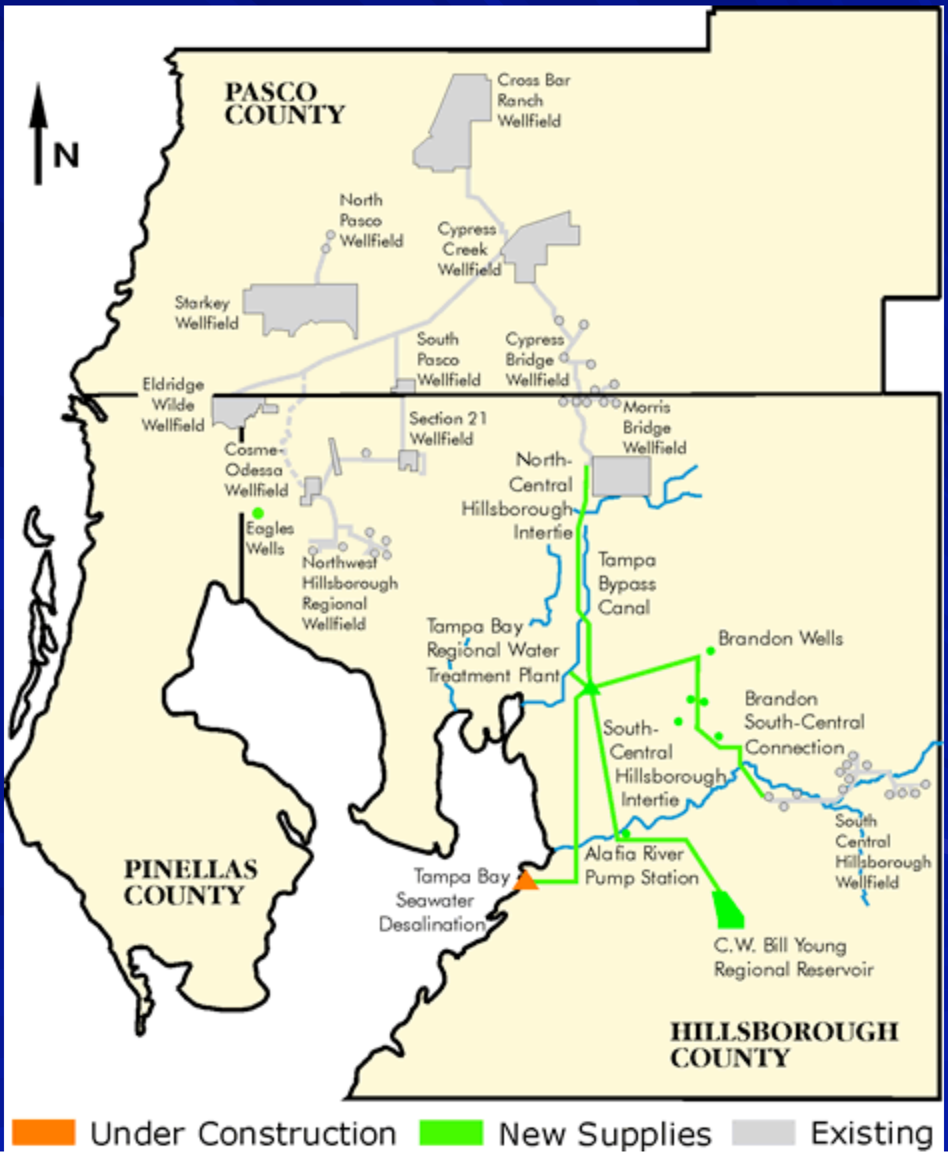
Public Water Supply Utilities Climate Impacts Working Group

What is needed? (among many other things!)

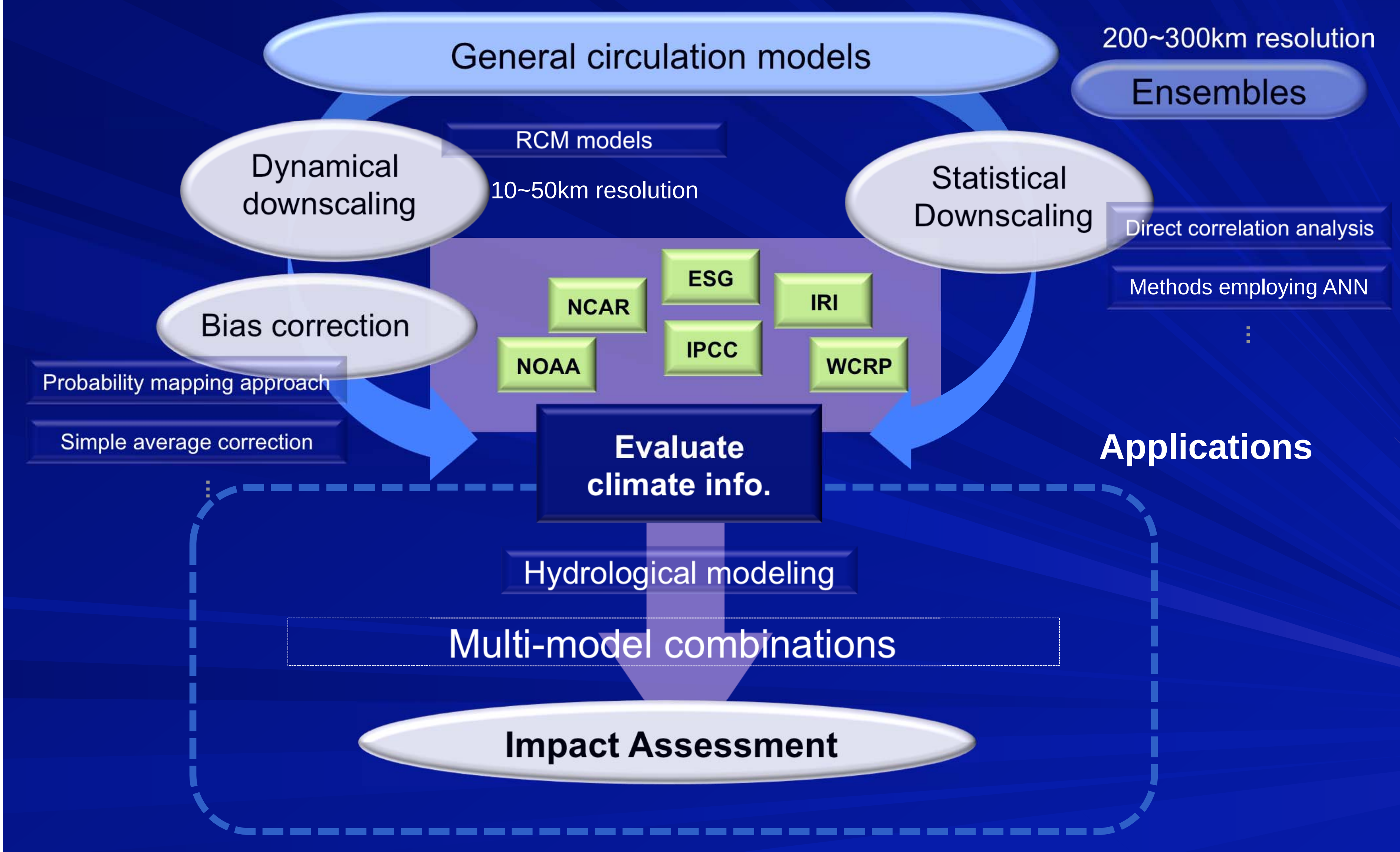
- Large-scale integrated climatic-hydrologic-landuse models that predict
  - hydrologic, ecologic, and socioeconomic impacts of short-term climate variability and water management decisions (1 to 18 months)
  - long-term hydrologic, ecologic and socioeconomic impacts of the effects land and water planning decisions and climate change (20-50 years).

Example: Tampa Bay Water

.... In this project we are coupling climate and hydrologic models to explore potential impacts of climate variability and climate change on water availability and water allocation decisions



BIG PICTURE


General circulation models
200~300km resolution
Ensembles
Dynamical downscaling
RCM models
10~50km resolution
Statistical Downscaling
Direct correlation analysis
Methods employing ANN
⋮
ESG
NCAR
IRI
Bias correction
IPCC
NOAA
WCRP
Probability mapping approach
Simple average correction
⋮
Evaluate climate info.
Applications
Hydrological modeling
Multi-model combinations
Impact Assessment

Available downscaled climate modeling results for the study area

- Bias corrected MM5 results (1986-2008)
  - Downscaled NCEP-NCAR reanalysis
  - 3 spatial resolutions (3km, 9km, and 27km)
- World Climate Research Program (WCRP) CMIP3 (1950-1999 & 2000-2099)
  - 16GCM+bias correction + statistical downscaling
  - Monthly, 12km resolution
  - NetCDF data format or ASCII text format
- North American Regional Climate Change Assessment Program (NARCCAP) (1971-2000 & 2041-2070)
  - 4GCM+6RCM combination results
  - Daily, 50km resolution
  - NetCDF data format

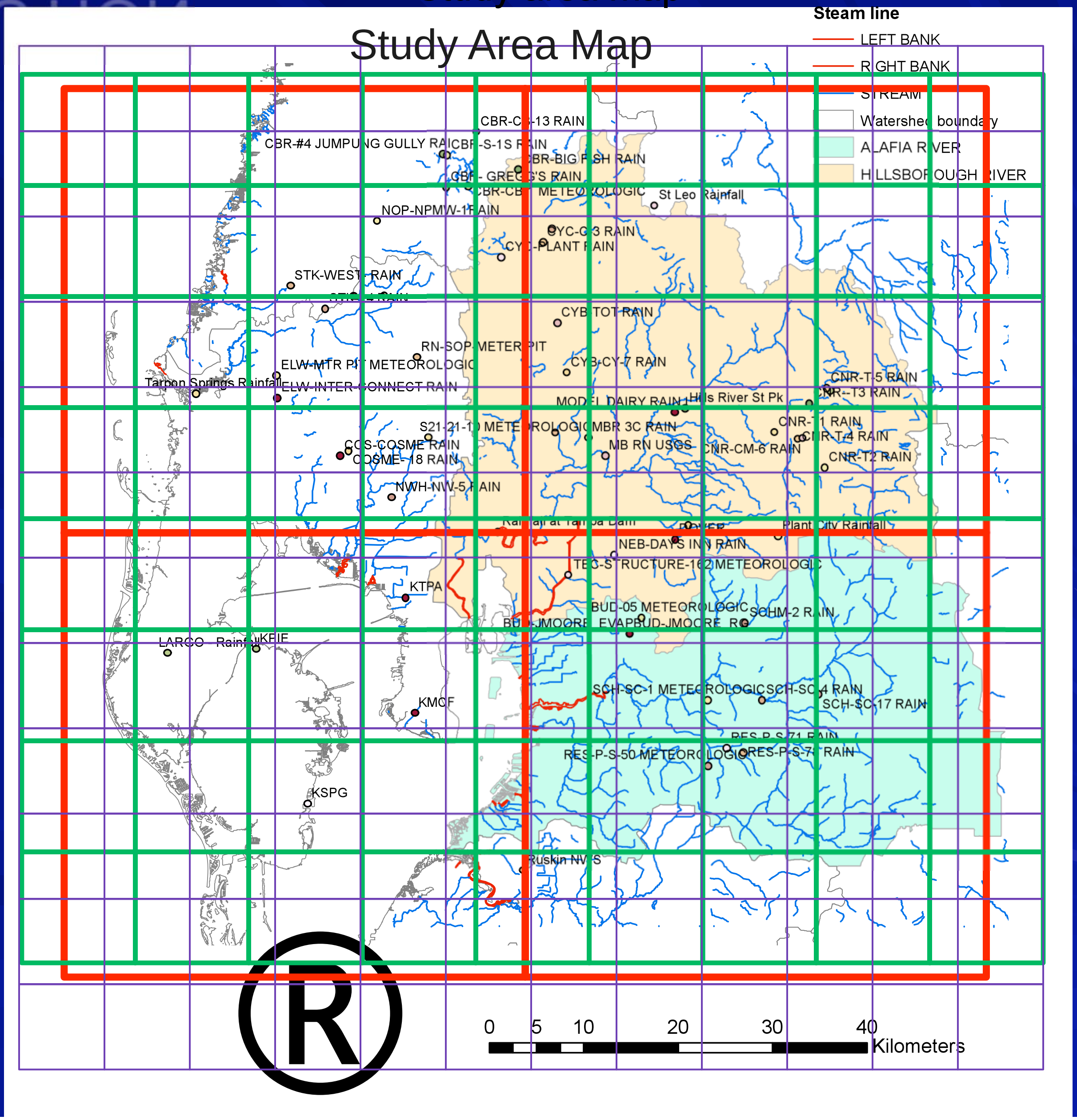
SPATIAL RESOLUTION

MM5 downscaled results (9km× 9km)

WCRP CMIP3 data (12km × 12km)

NNARCCAP data (50km × 50km)

Study area map



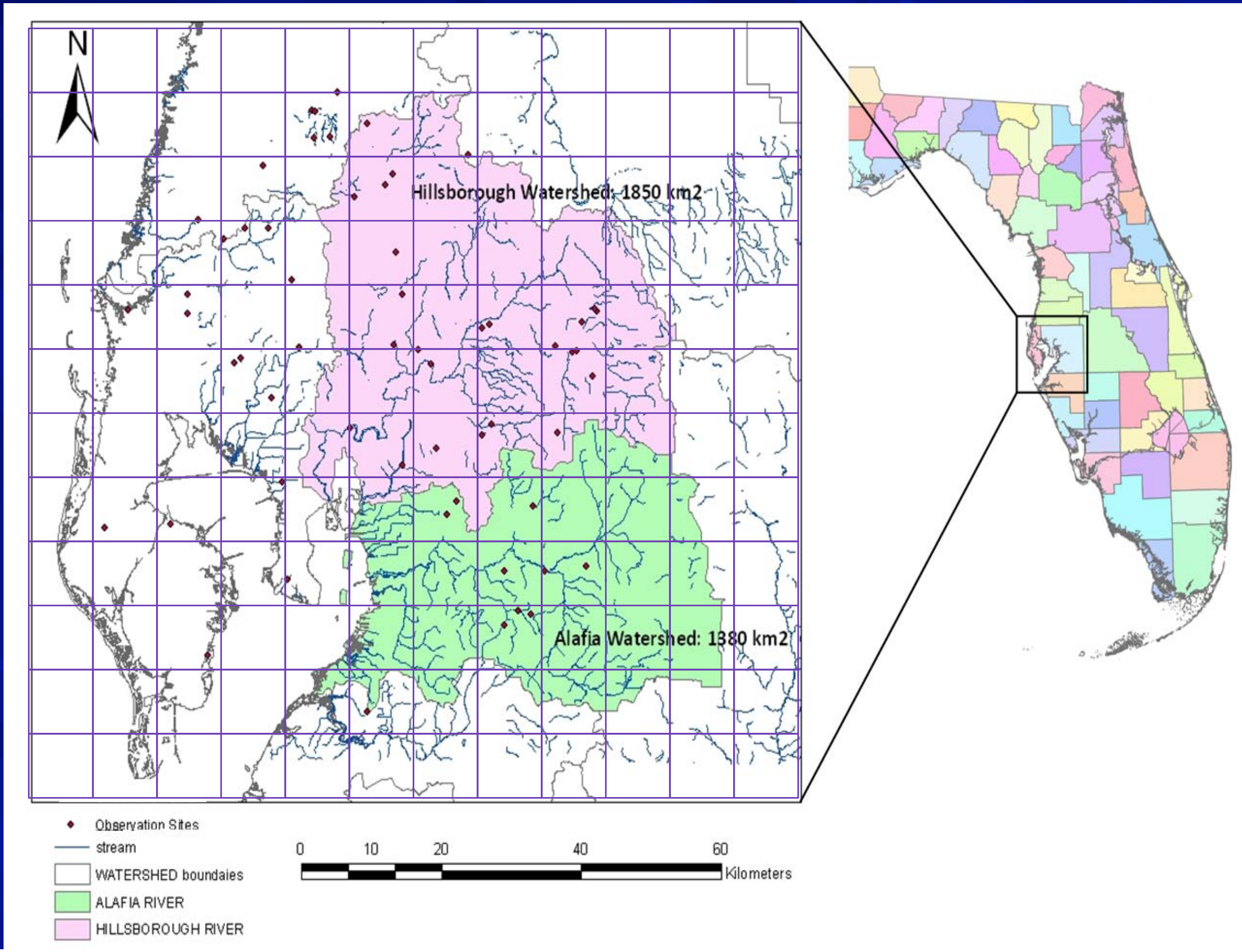
MM5 simulations

- MM5 run with nested grid (27km, 9km,3km)

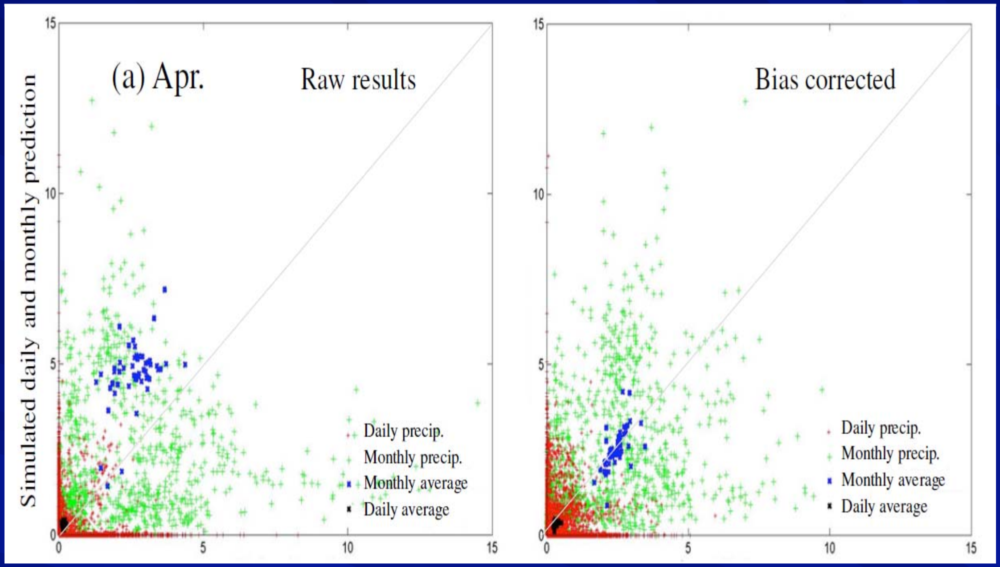
Physics Options in MM5	Used schemes in this study
Cumulus parameterizations	Grell scheme (useful for smaller grid size,10~30km)
Planetary boundary layer	Hong-Pan PBL (suitable for high resolution)
Radiation	CCM2 radiation scheme
Explicit Moisture	Simple ice scheme (adds ice phase process to basic moisture scheme)
Land surface	Five layer soil model (Temp. predicted in each layer)

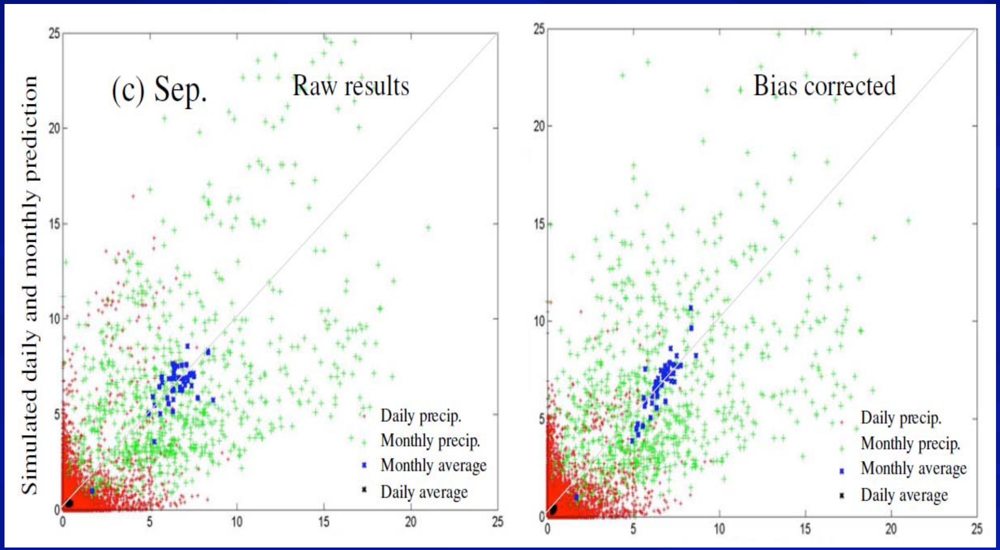
- Bias corrected on a daily basis using cdf mapping approach at 53 long term precipitation stations

Study Area, MM5 grid, rainfall stations

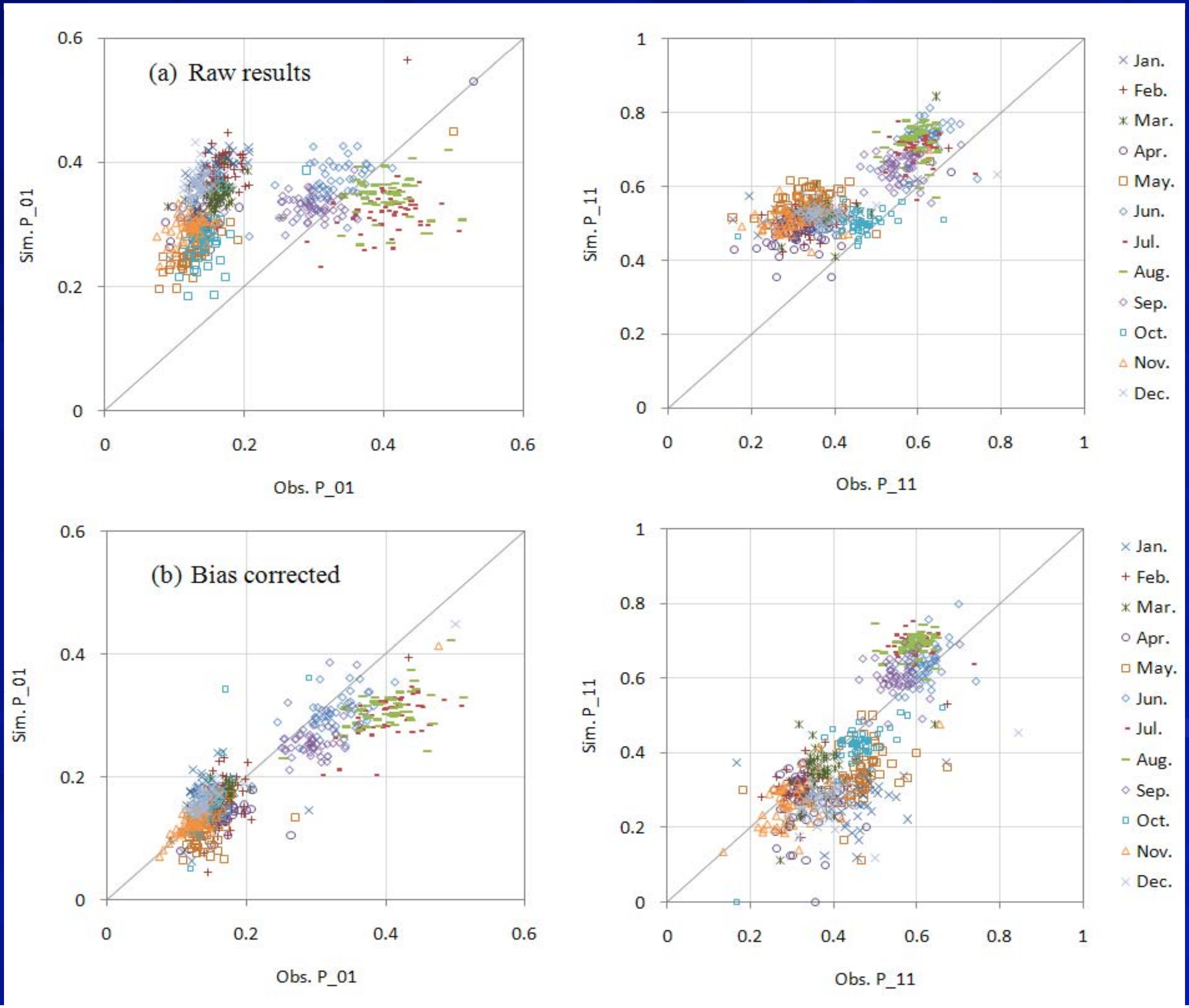


Predicted vs Observed Rainfall

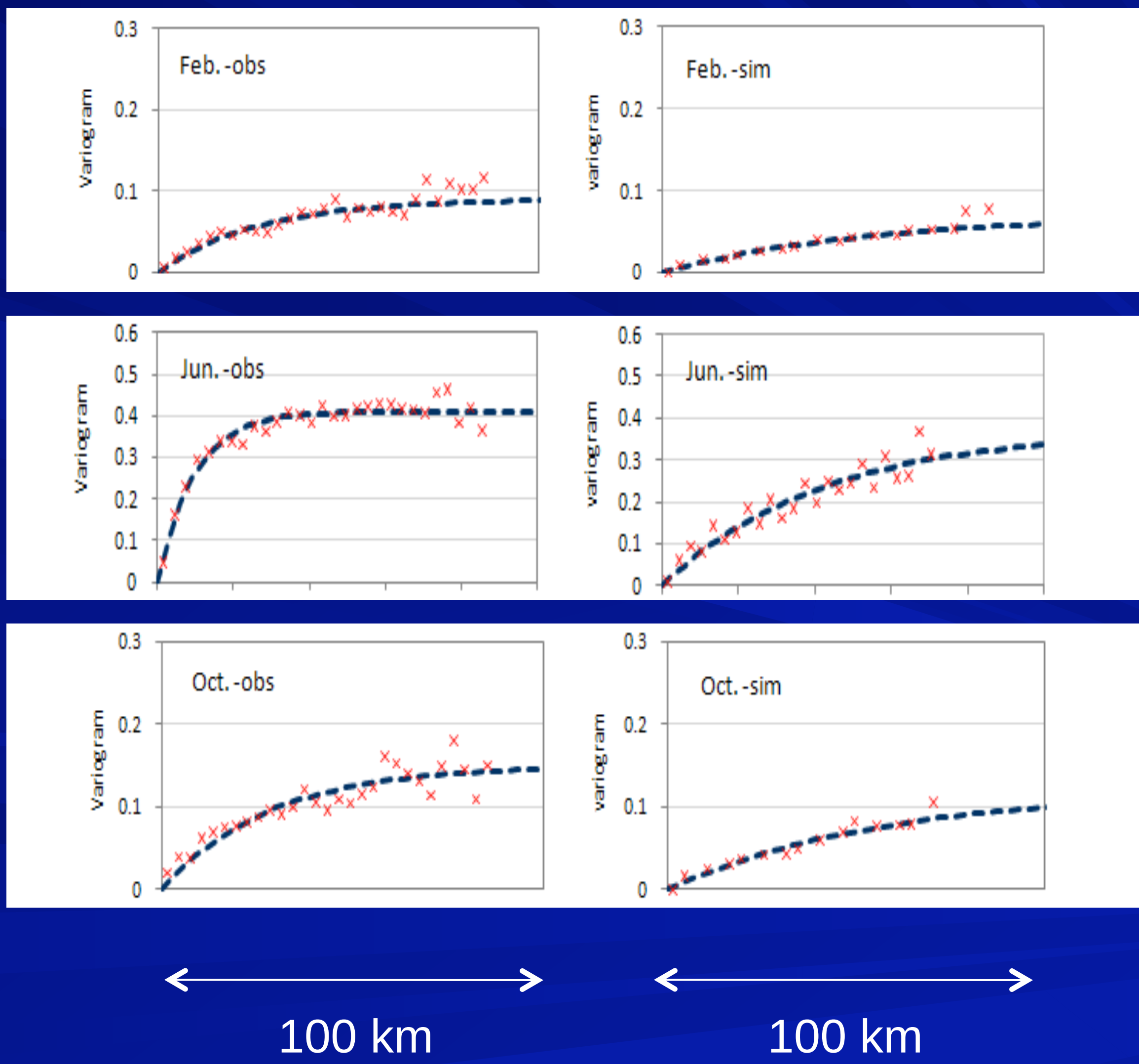




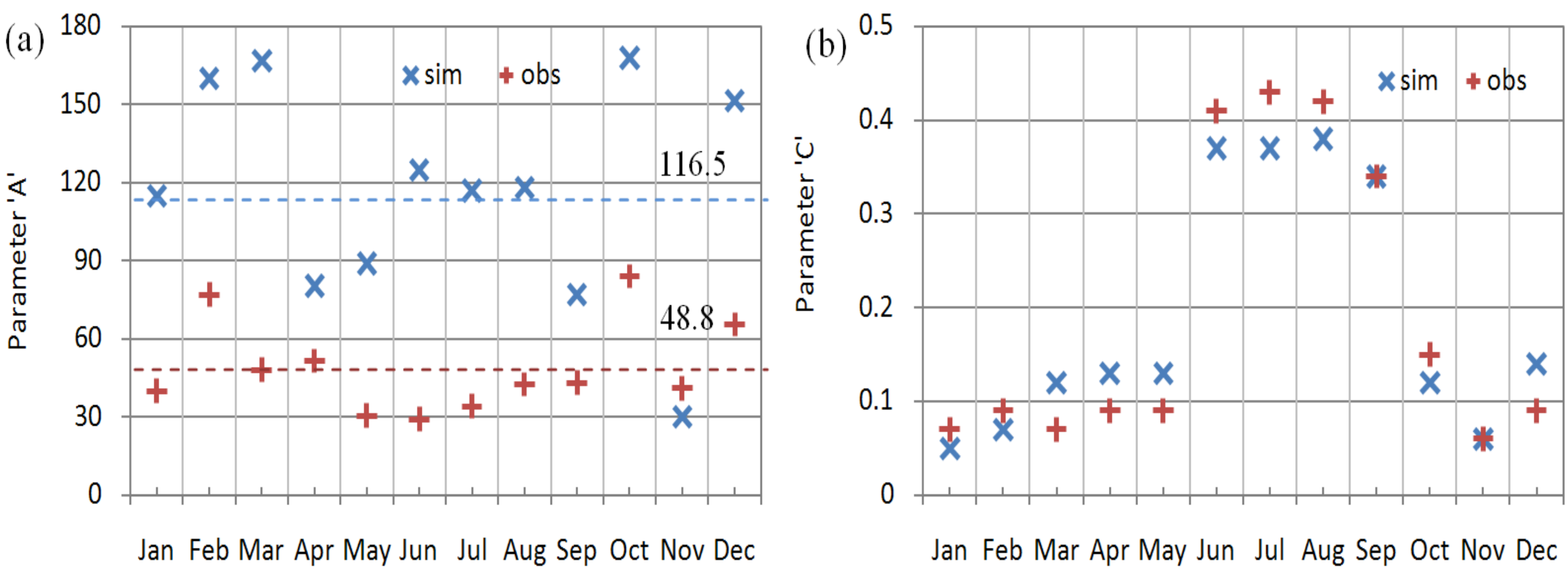
Daily Transition Probabilities



Variogram Comparison: Bias Corrected MM5 vs Observed



Spatial Variance and Correlation



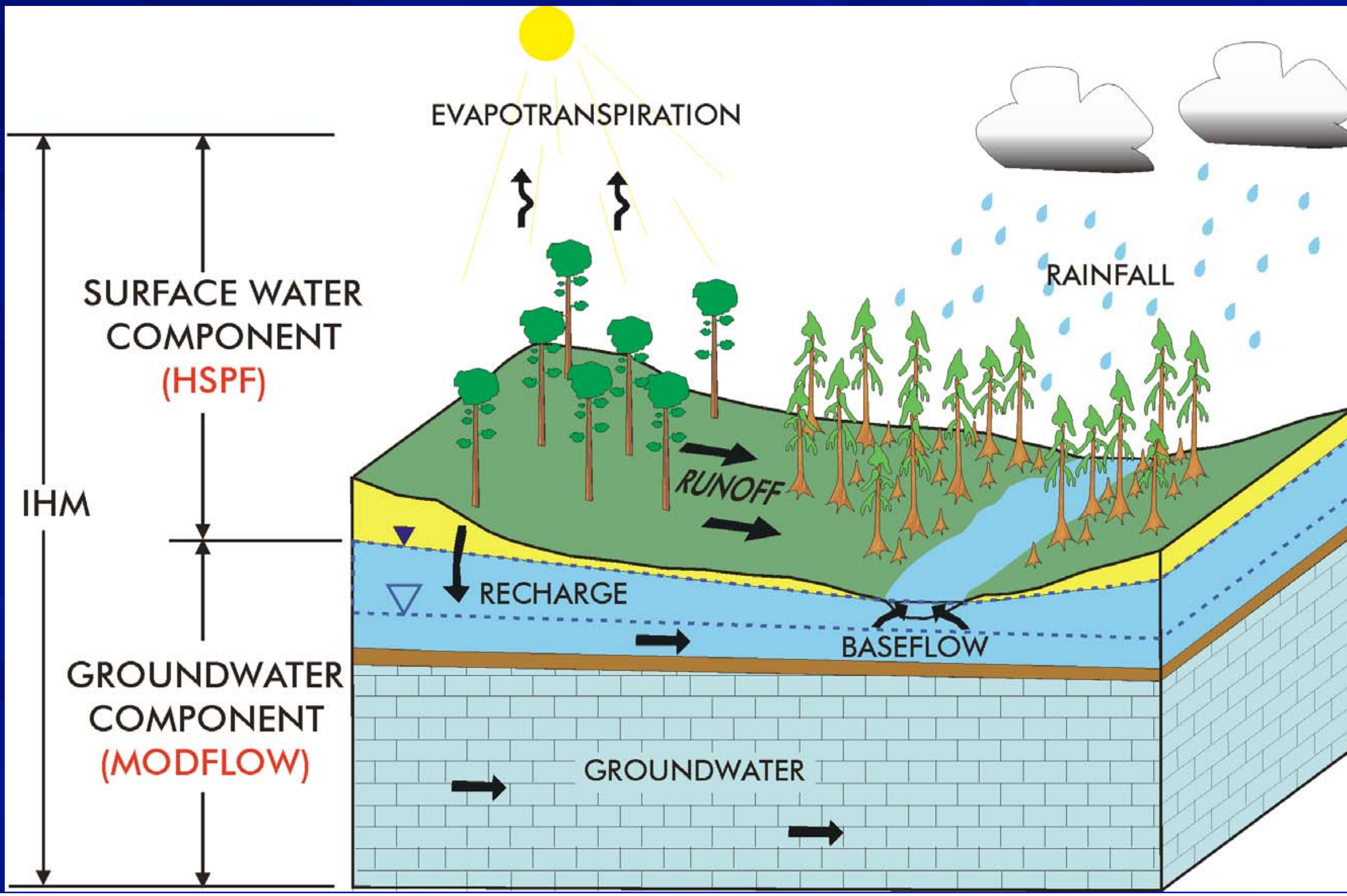
Spatial correlation over estimated for all seasons

Seasonality in spatial variance captured, underestimated in summer months

MM5 simulation results

- Raw gridded MM5 results positively biased, producing too many wet days with low rainfall compared to point observations
- After bias correction MM5 successfully reproduced mean climatology (mean rainfall, daily transition probabilities)
- MM5 successfully reproduced seasonal patterns of spatial variability (higher spatial variance in wet season) but overestimated spatial correlation structure.

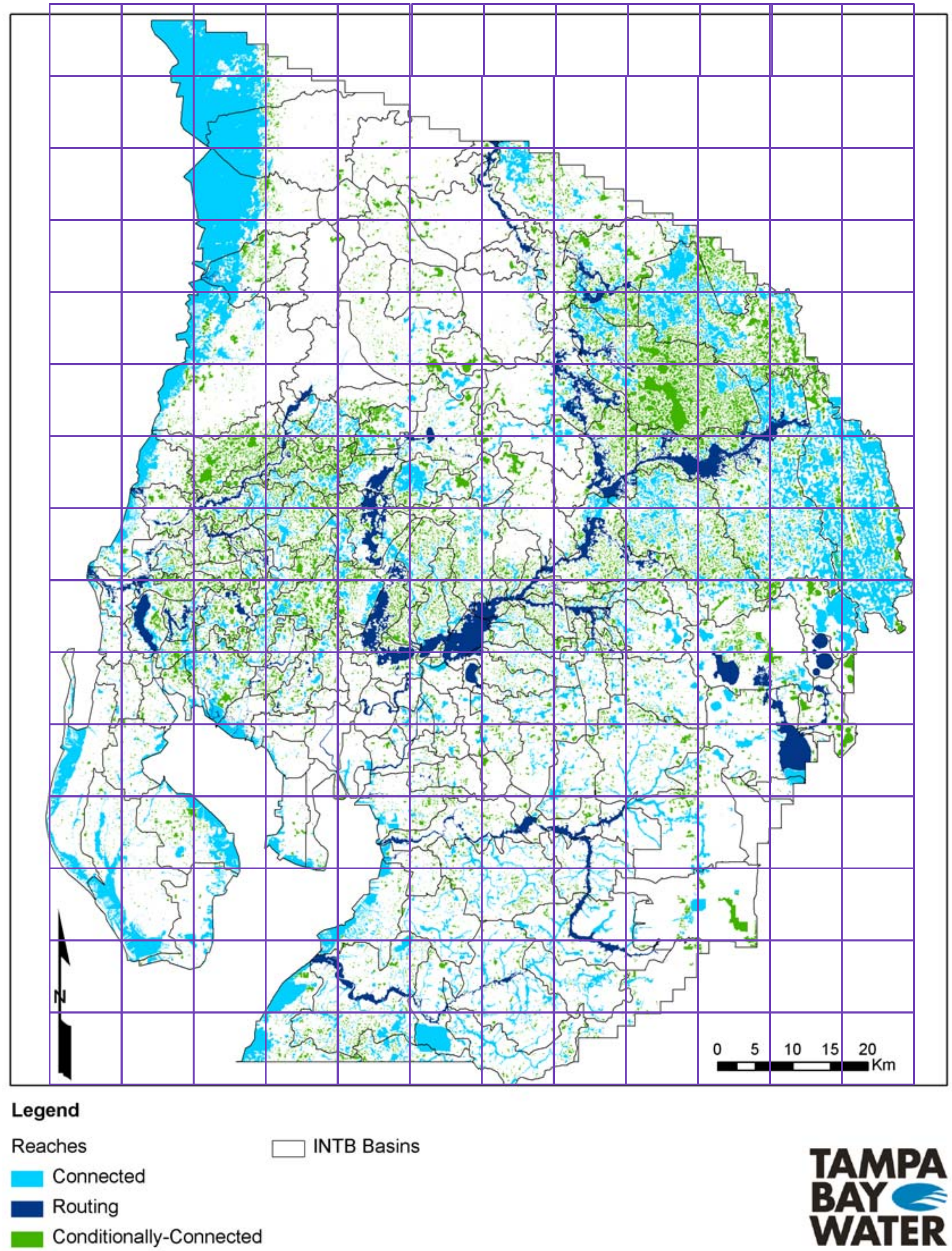
Integrated Hydrologic Model (IHM) Component Model Domains



IHM Model Domain

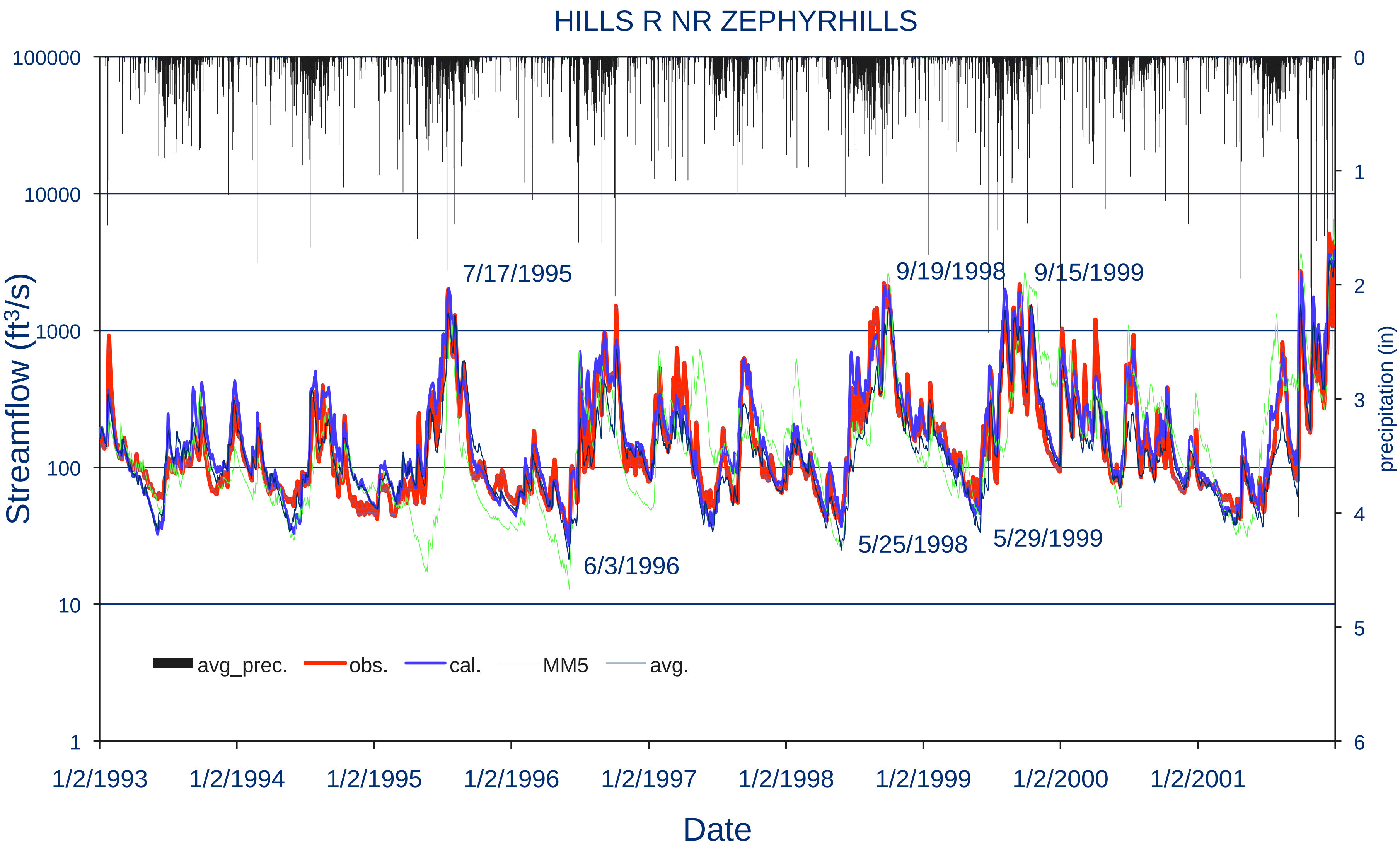
- **Land**
  - **172 Basins**
  - **Up to 5 general land segments per basin**
  - **815 land segments**
- **Water**
  - **409 Reaches**

Cond-conn	**172**
Connected	**163**
Routing	**74**



TAMPA BAY WATER

IHM Streamflow Predictions vs Observations: Hillsborough River near Zephyr Hills



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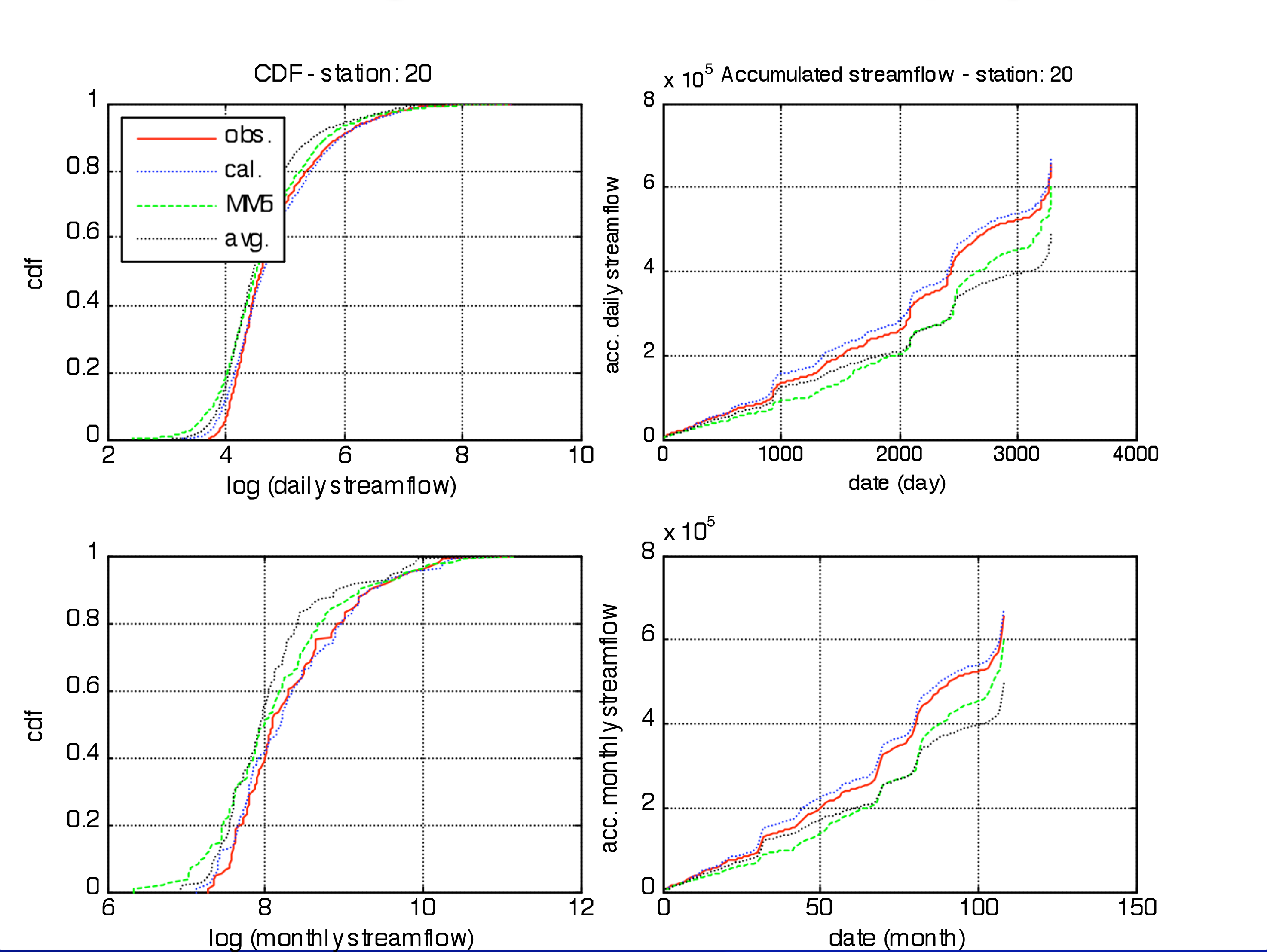

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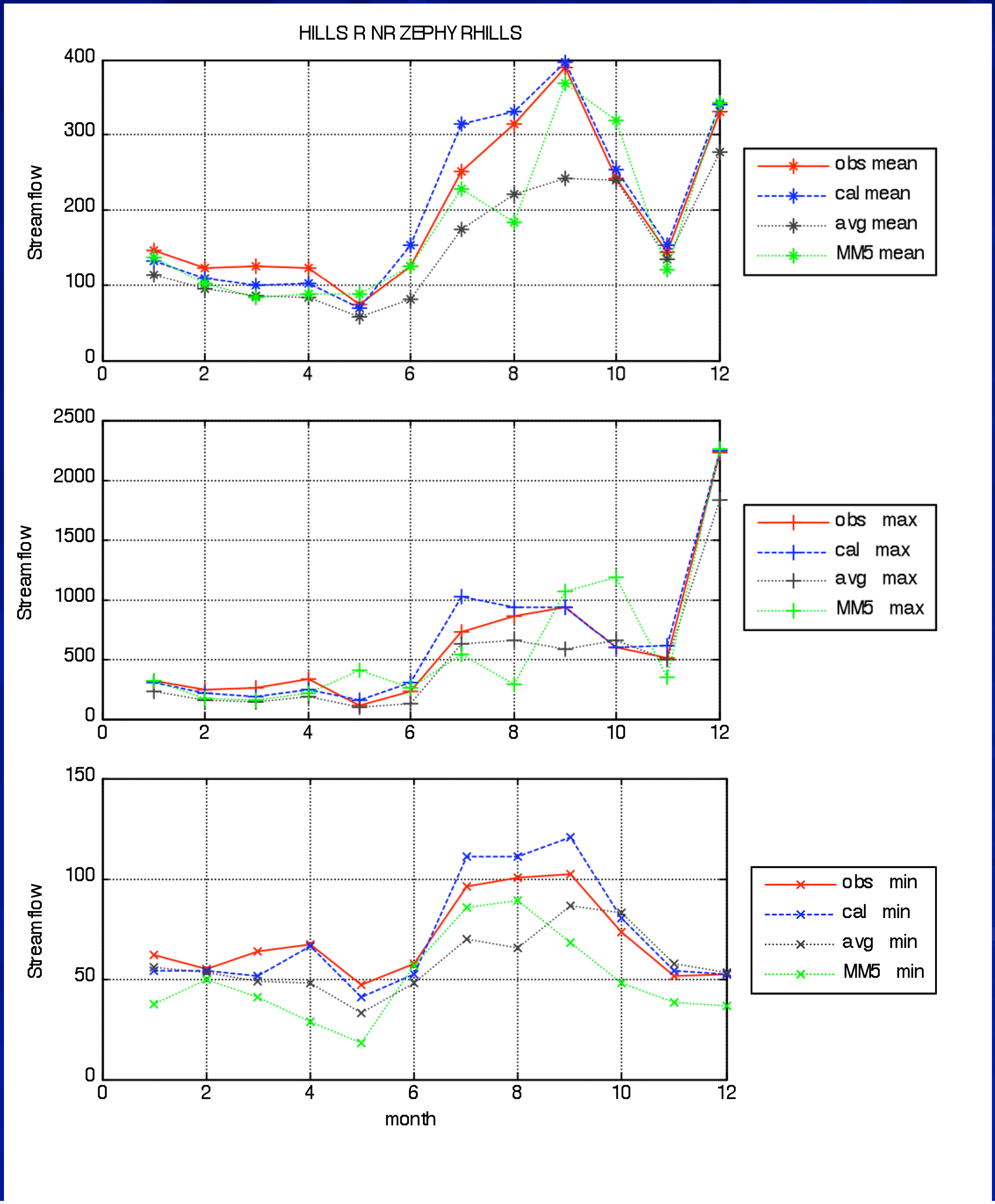


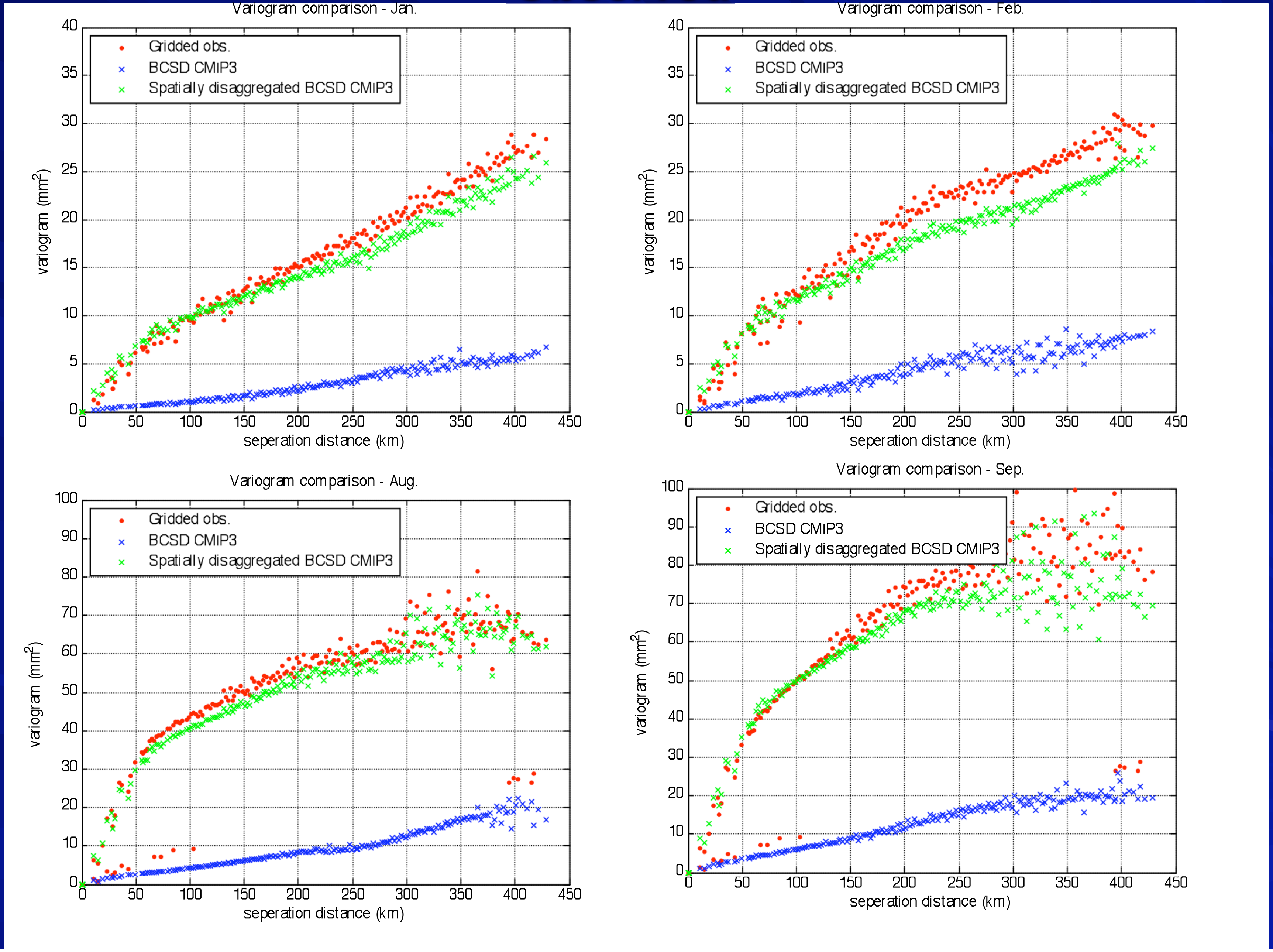
IHM simulation results (preliminary, hot off the press)

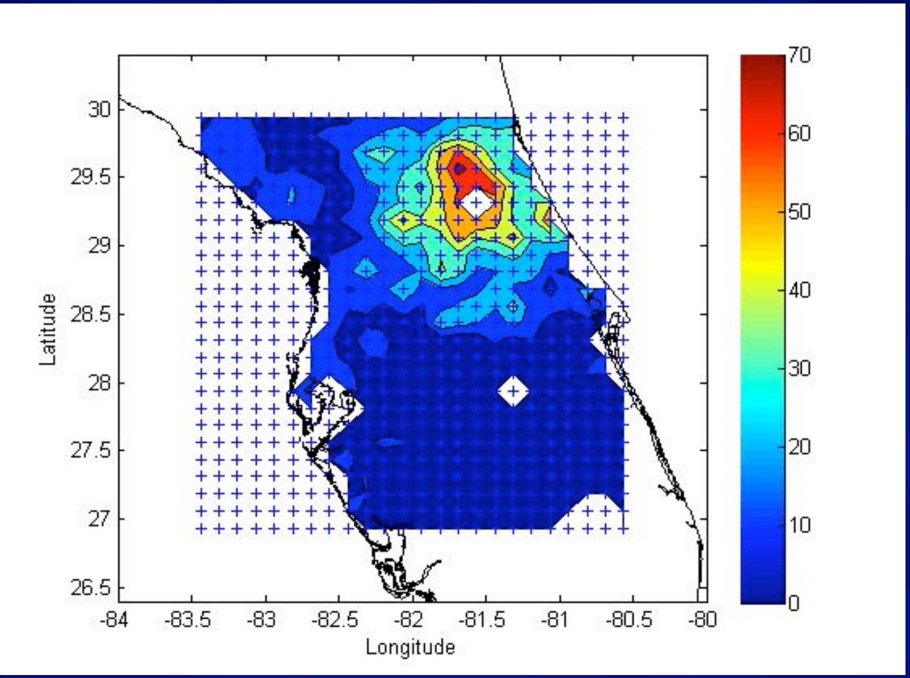
- MM5 precipitation successfully reproduced monthly streamflow patterns
- MM5 and spatial averaged observed precipitation predicts erroneously high probability of low flows
- MM5 and spatially averaged observed precipitation predicts erroneously low accumulated streamflow
- Small-scale spatial correlation structure of rainfall is important to preserve

Spatial Disaggregation

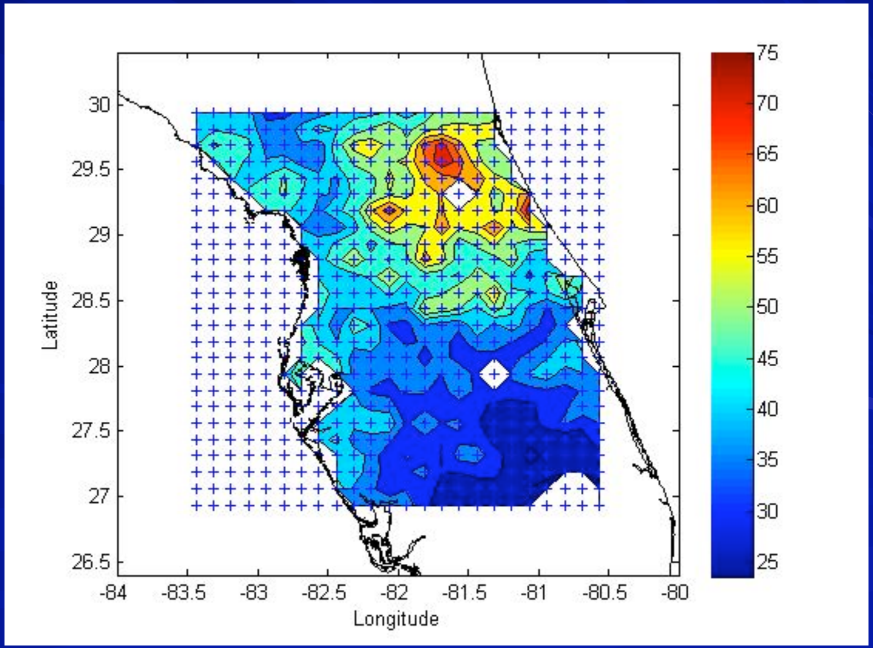
- New spatial disaggregation technique developed to improve small-scale spatial correlation structure of rainfall
  - Take normal score transform of observed daily precipitation data at each station
  - Estimate spatial covariance of transformed data
  - Generate random spatial distribution with spatial mean equal to MM5/CMIP3 large scale prediction but observed small-scale spatial structure

Variogram Comparison: Spatially Disaggregated CMIP3 vs Observed





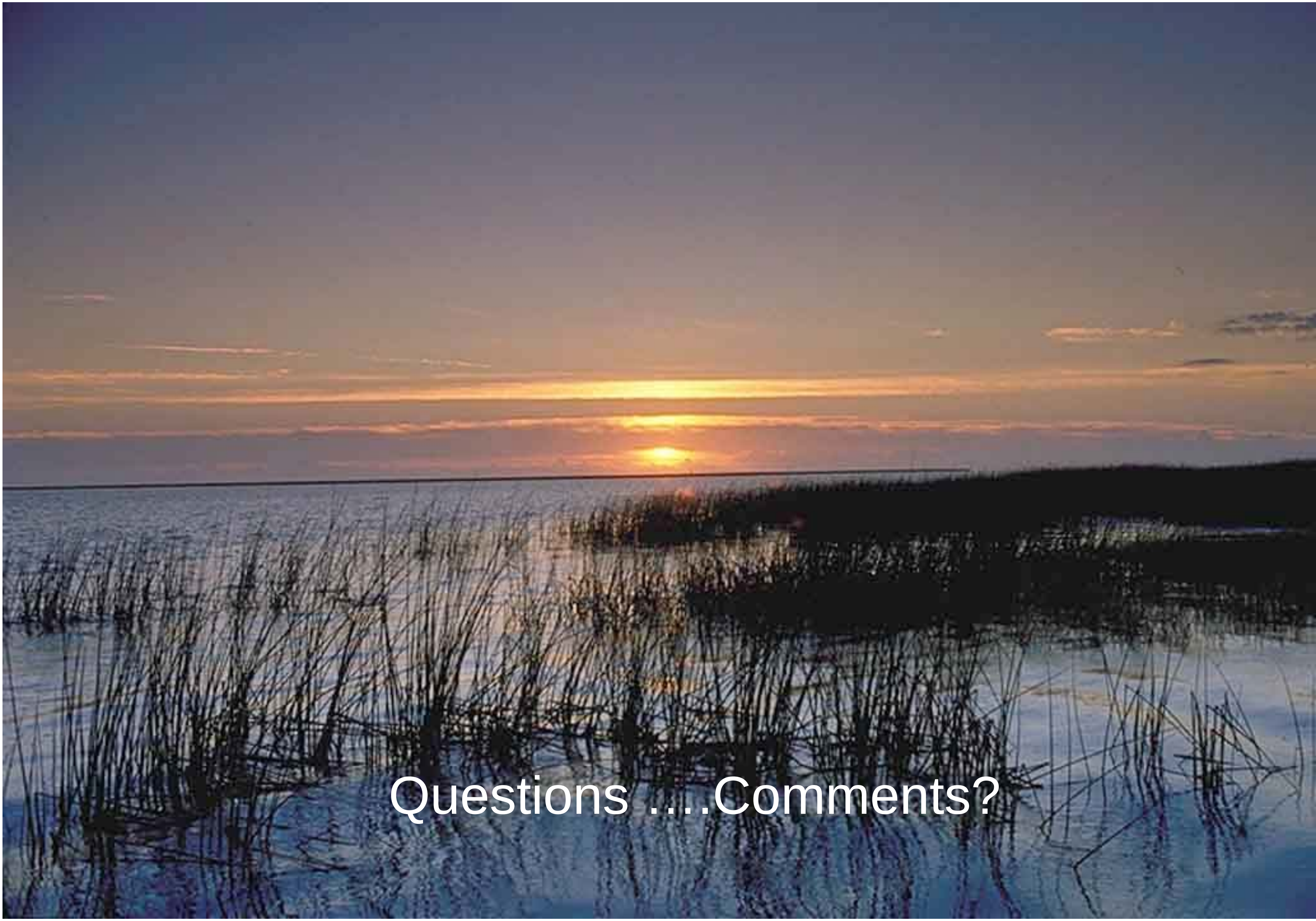
Spatial distribution of original CMIP3 rainfall field



Spatial distribution of CMIP3 rainfall field after new spatial disaggregation downscaling technique

Future Work

- Continue to evaluate hydrologic importance of accurately representing the spatiotemporal characteristics of precipitation fields using the Tampa Bay Water Integrated Hydrologic Model (TBW IHM)
- Evaluate the ability of bias-corrected, downscaled, spatially-disaggregated GCM retrospective simulations to reproduce observed hydrologic behavior using the TBW IHM
- Evaluated changes in hydrologic behavior that result from driving the TBW IHM with bias-corrected, downscaled, spatially disaggregated GCM future predictions at various timescales


Questions ….Comments?