SRNL™
SAVANNAH RIVER NATIONAL LABORATORY
Operated by Savannah River Nuclear Solutions, LLC

We Put Science To Work

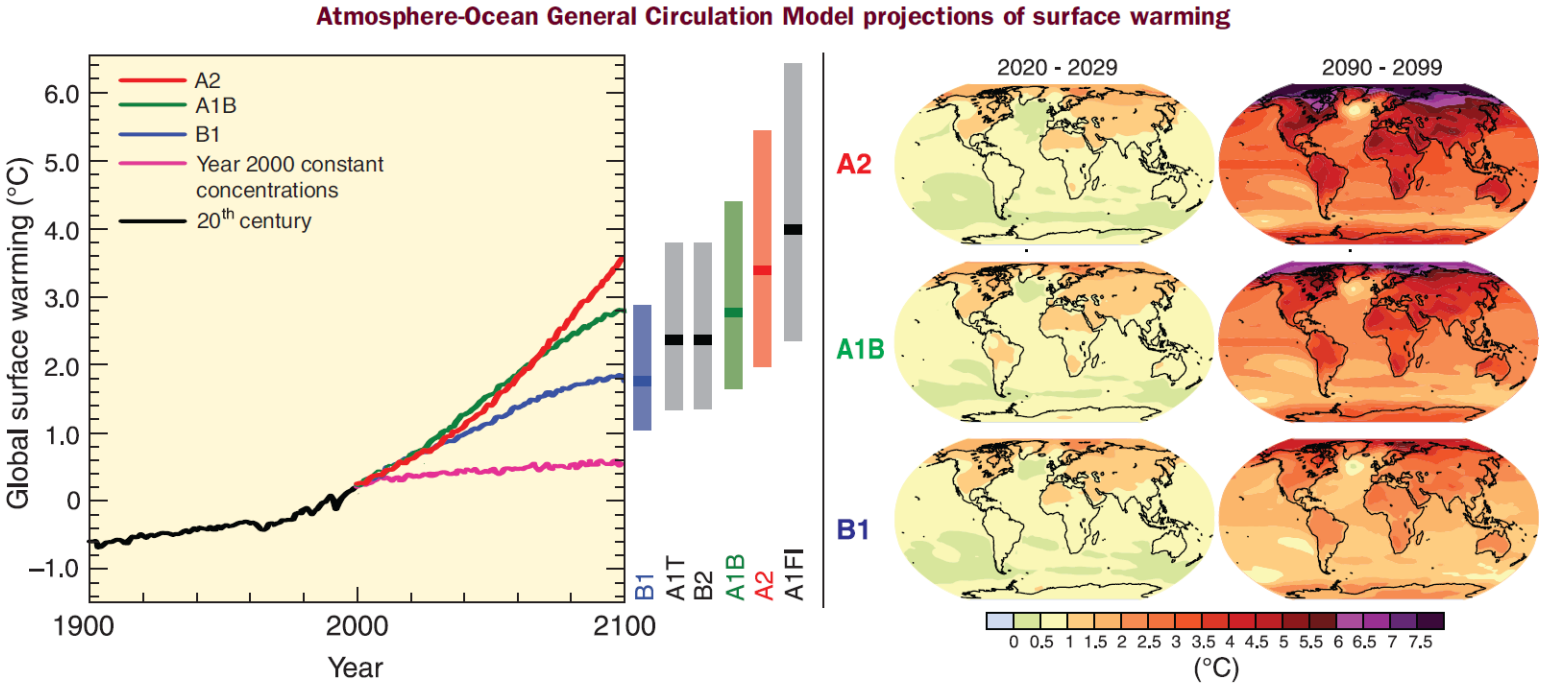
The Use of Statistical Downscaling to Project Regional Climate Changes

David Werth

Savannah River National Laboratory

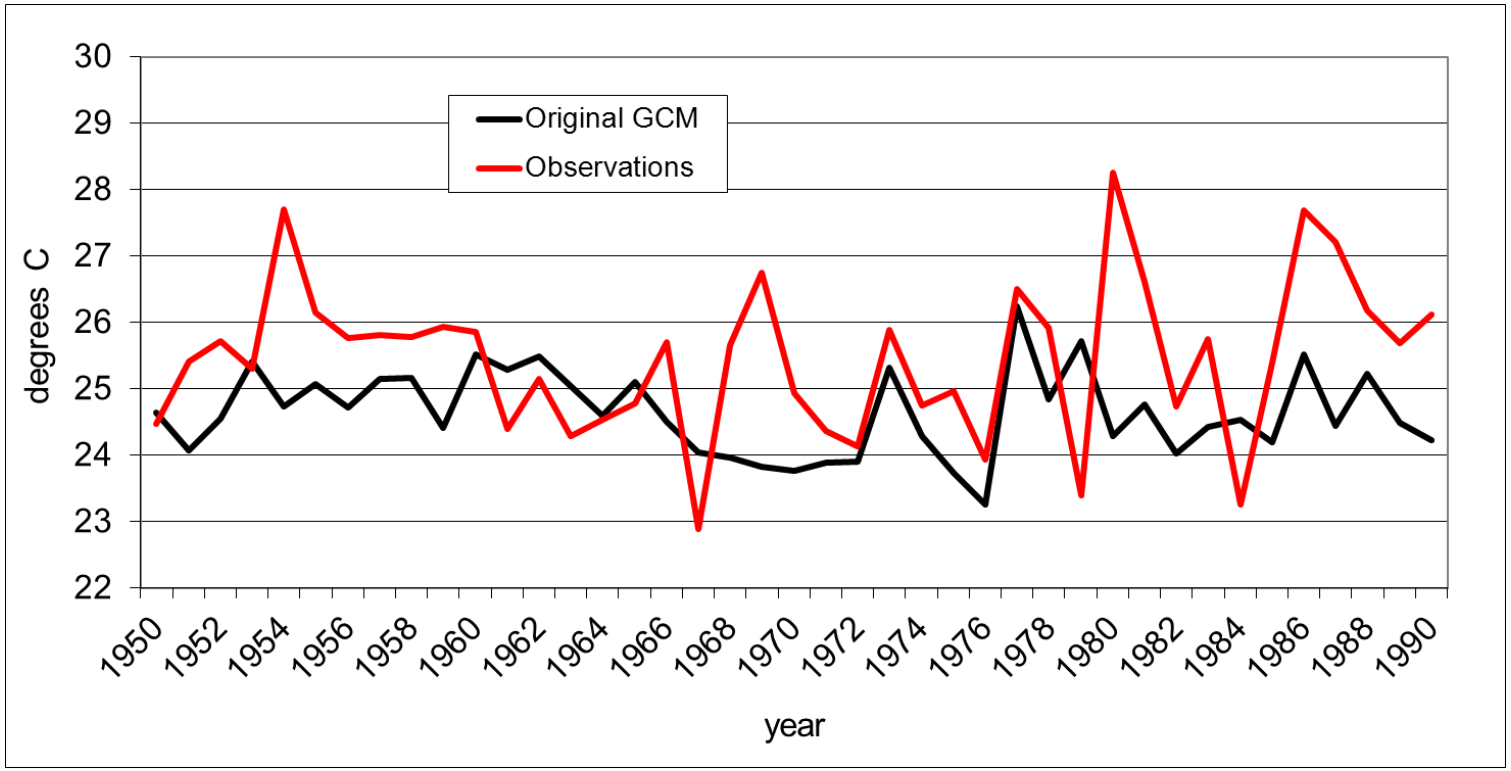
October 24th, 2012

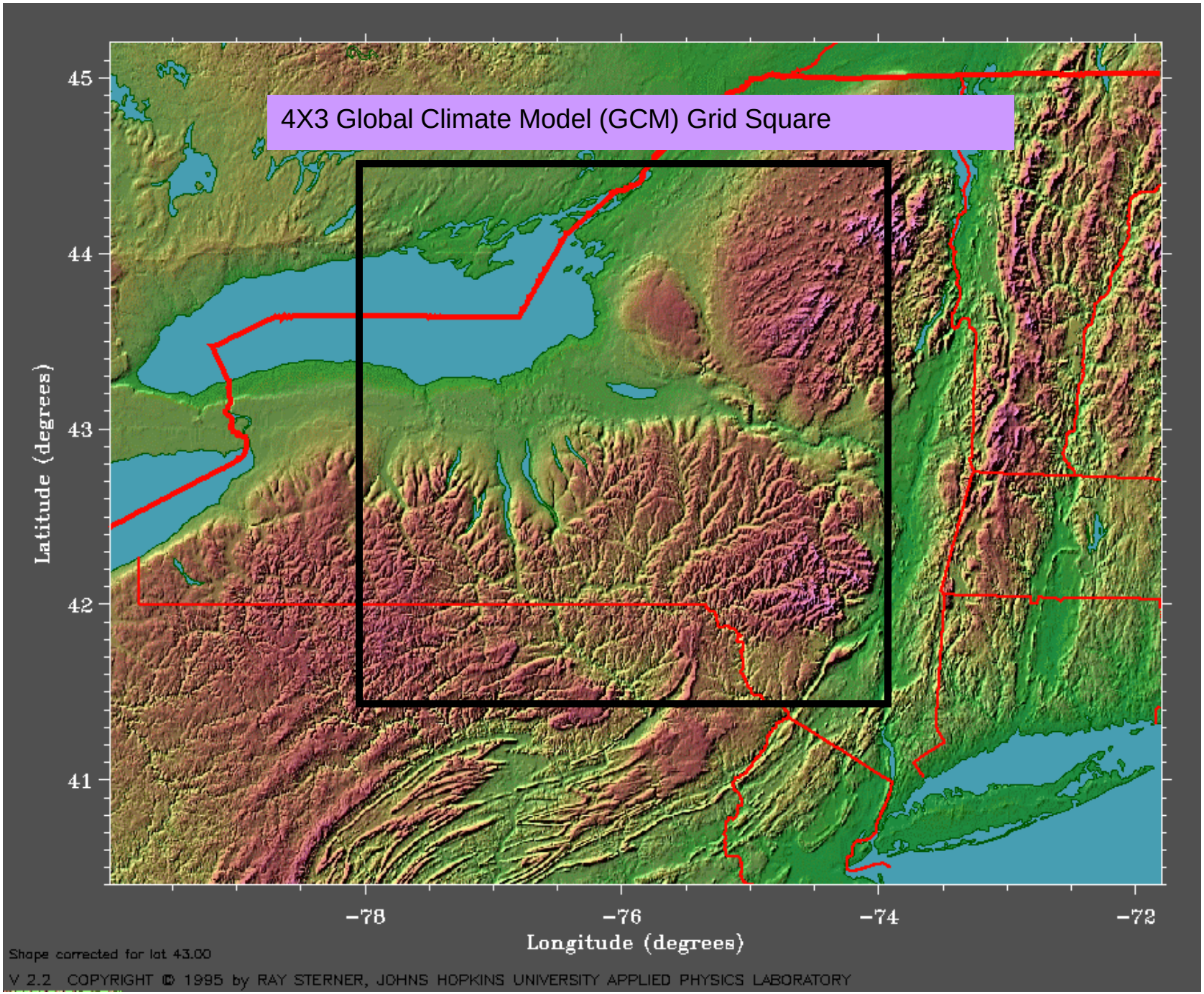
Future global climate is often predicted using global climate models (GCMs).



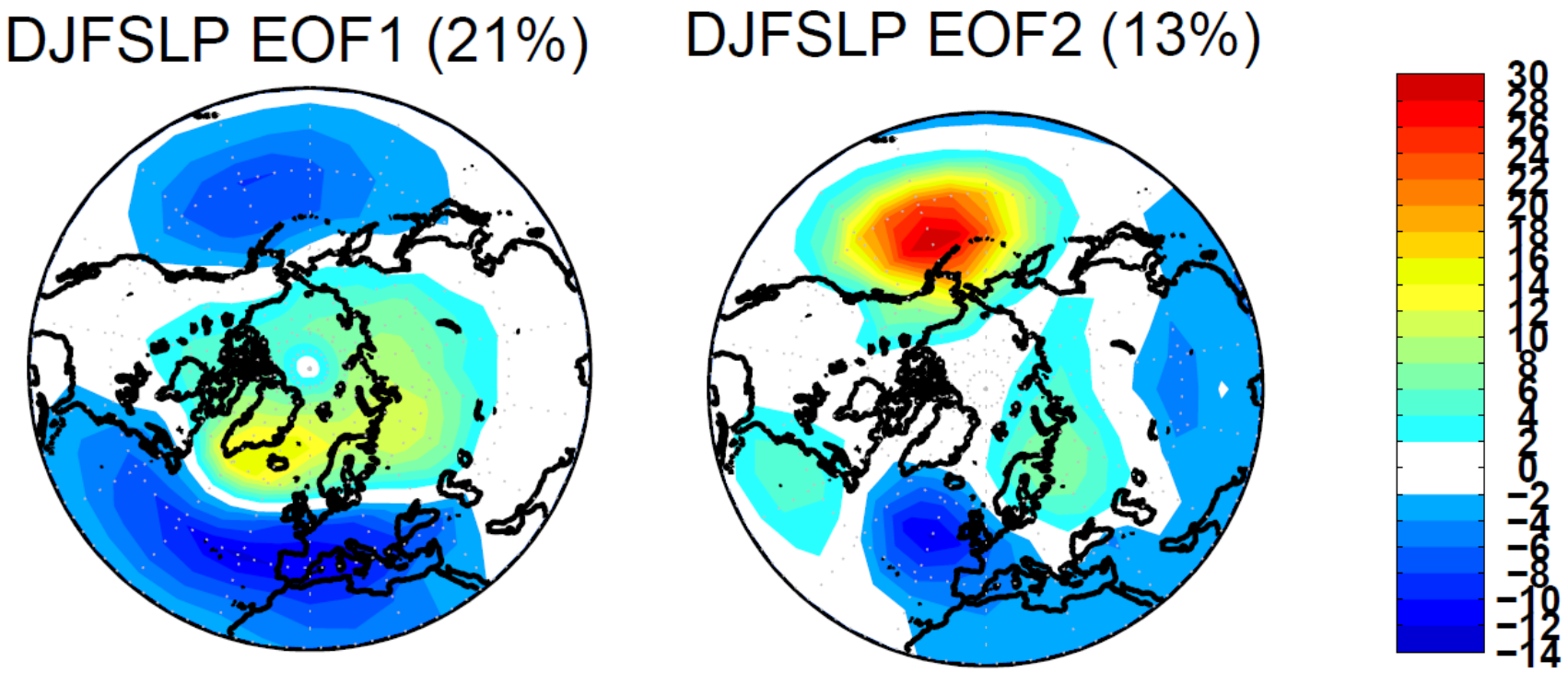
GCMs are largely unable to predict climate variables at the small-scale.

July Temperatures at Dalton, GA.




4X3 Global Climate Model (GCM) Grid Square
45
44
43
42
41
Latitude (degrees)
−78
−76
−74
−72
Longitude (degrees)
Shape corrected for lat 43.00
V 2.2 COPYRIGHT © 1995 by RAY STERNER, JOHNS HOPKINS UNIVERSITY APPLIED PHYSICS LABORATORY

The global atmosphere is dominated by the presence of preferentially-recurring patterns. A global climate model is better at simulating these patterns.



Sea Level Pressure

1. These patterns affect the small-scale weather.

1. These patterns affect the small-scale weather.

2. The GCM can correctly predict the *changes* in the frequencies of the different patterns.

1. These patterns affect the small-scale weather.

2. The GCM can correctly predict the *changes* in the frequencies of the different patterns.

3. The GCM can therefore predict changes in the statistical properties of the small-scale climate variables.

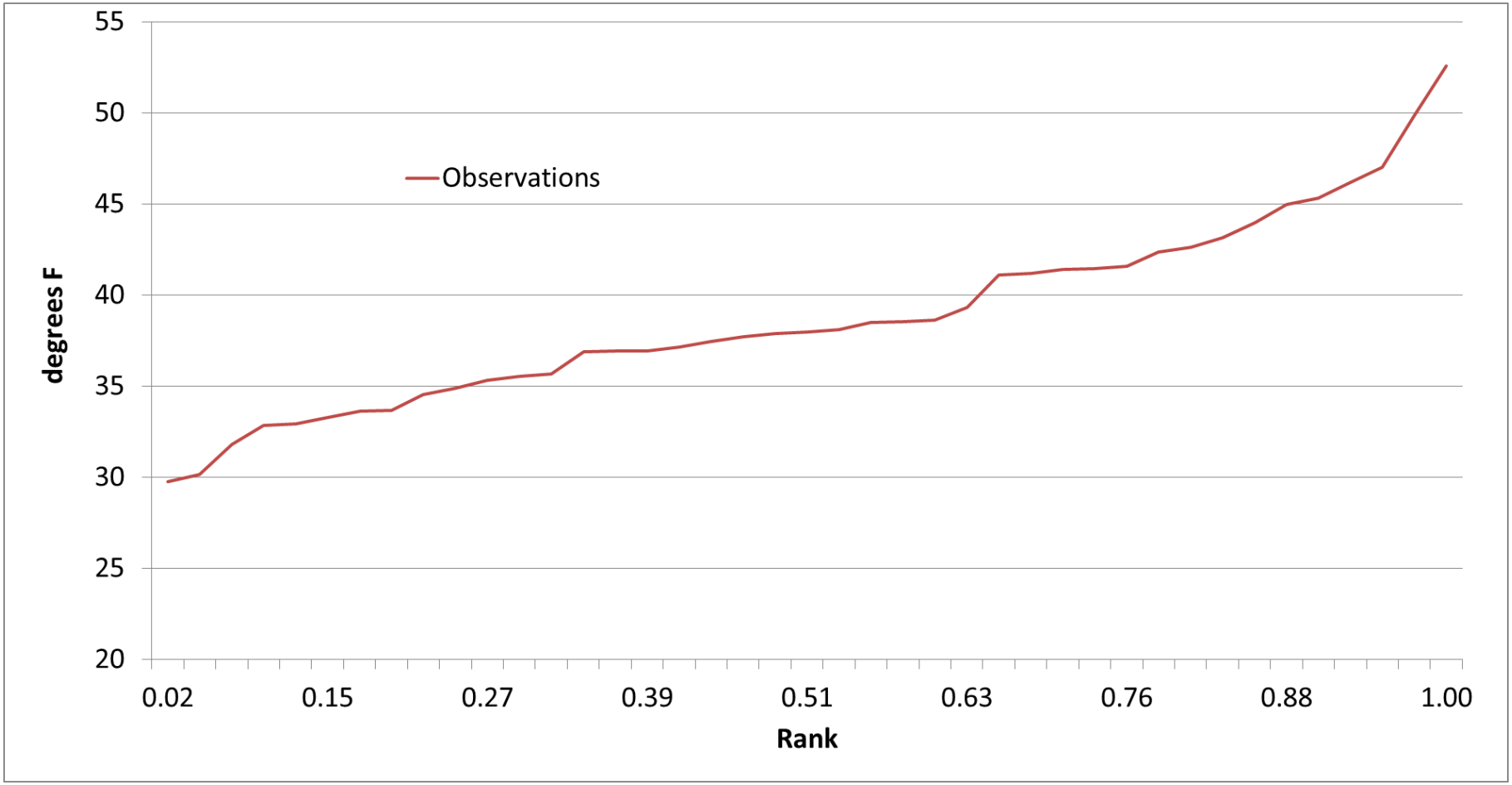
Quantile Regression

1. Start with the observed temperature and precipitation at the desired station (from 1950-1990).

Quantile Regression

1. Start with the observed temperature and precipitation at the desired station (from 1950-1990).
2. For each month, rank the values from lowest to highest to create a cumulative distribution function (CDF).

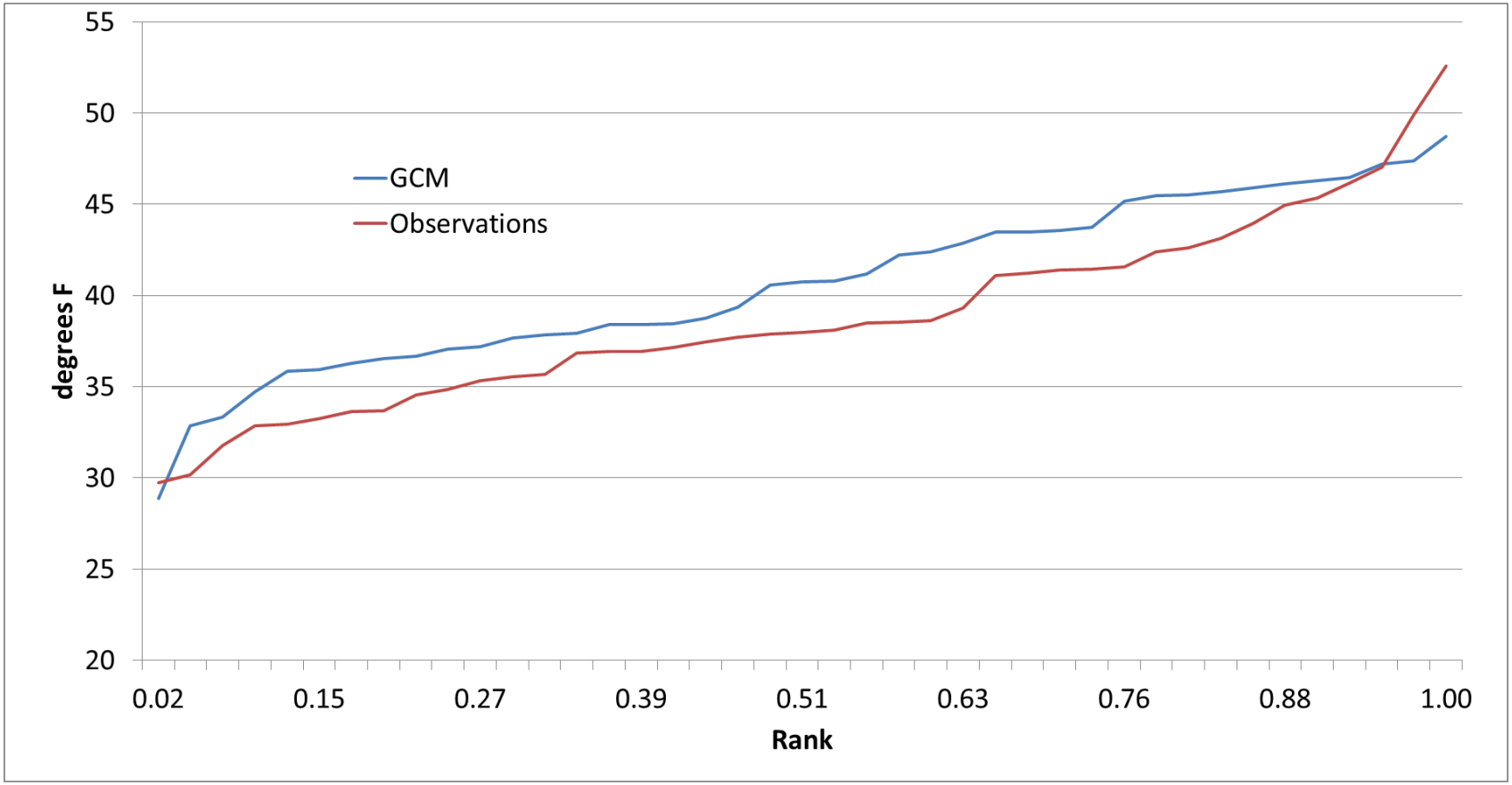
January Temperature, Dalton, GA, 1950-1990



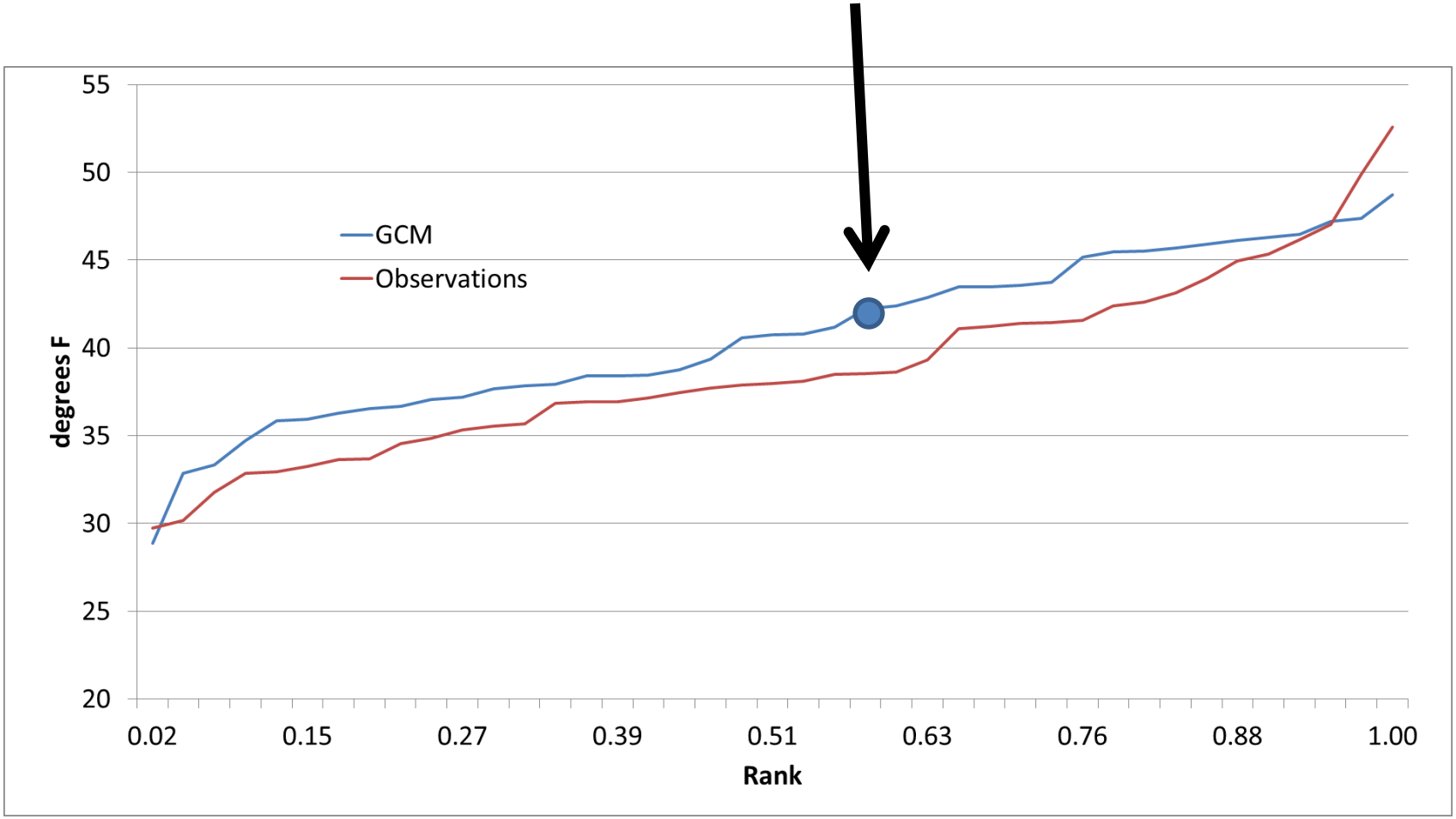
Quantile Regression

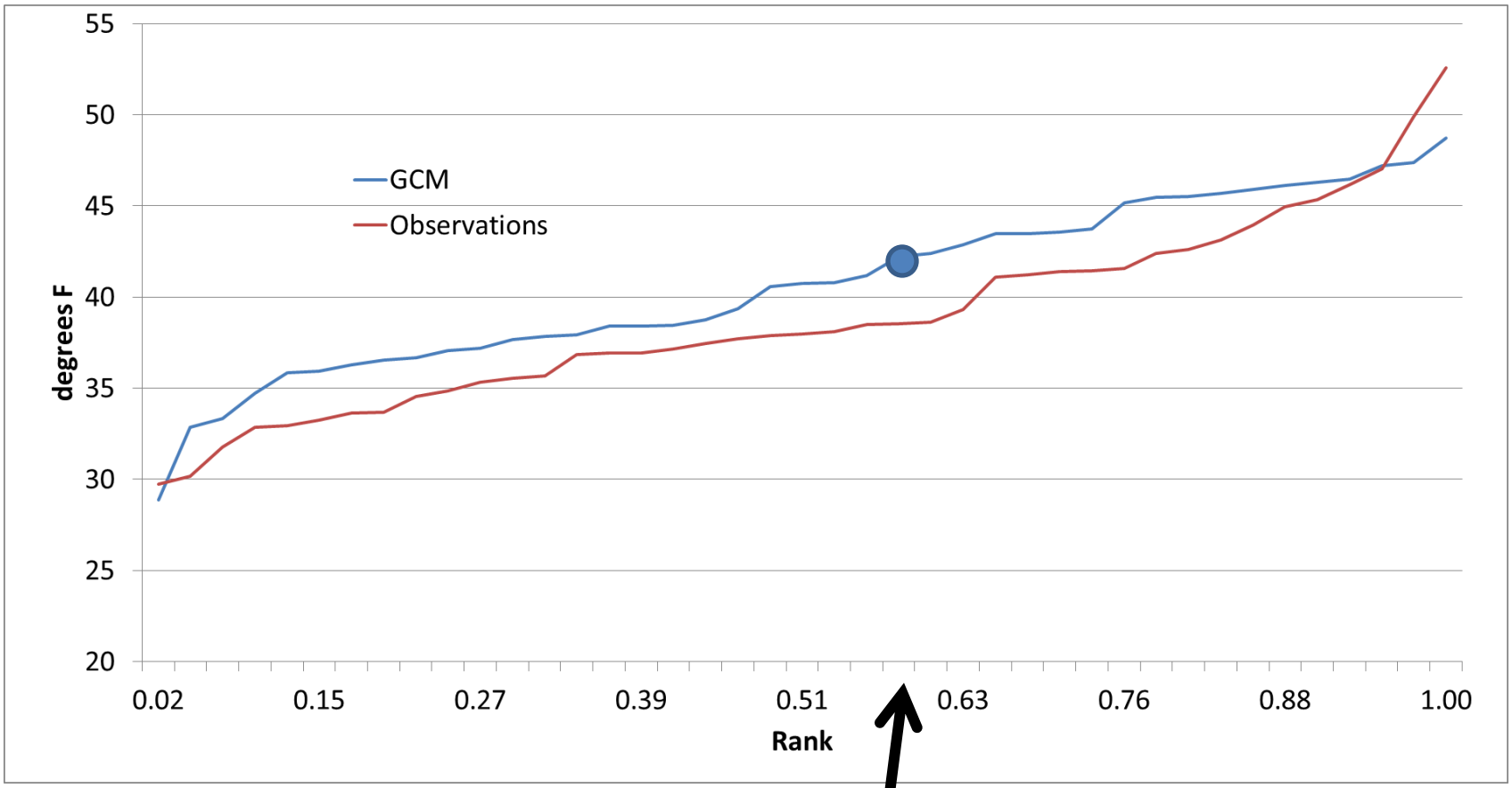
1. Start with the observed temperature and precipitation at the desired station (from 1950-1990).
2. For each month, rank the values from lowest to highest.
3. Do the same for the GCM data interpolated to the desired station, and compare the two.

January Temperature, Dalton, GA, 1950-1990

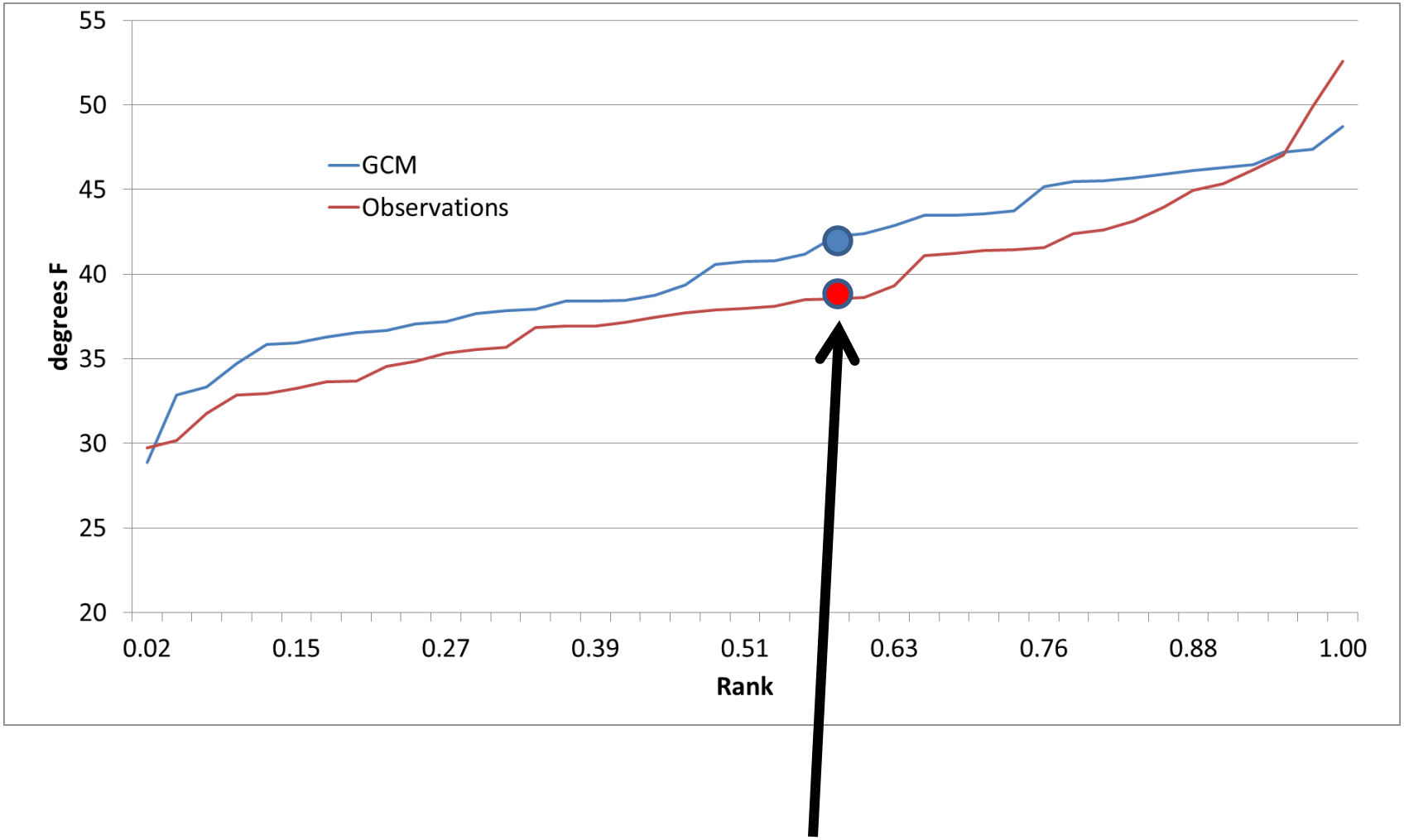


For a month in the future (e.g., January of 2045), start with the GCM value (e.g., 42F).



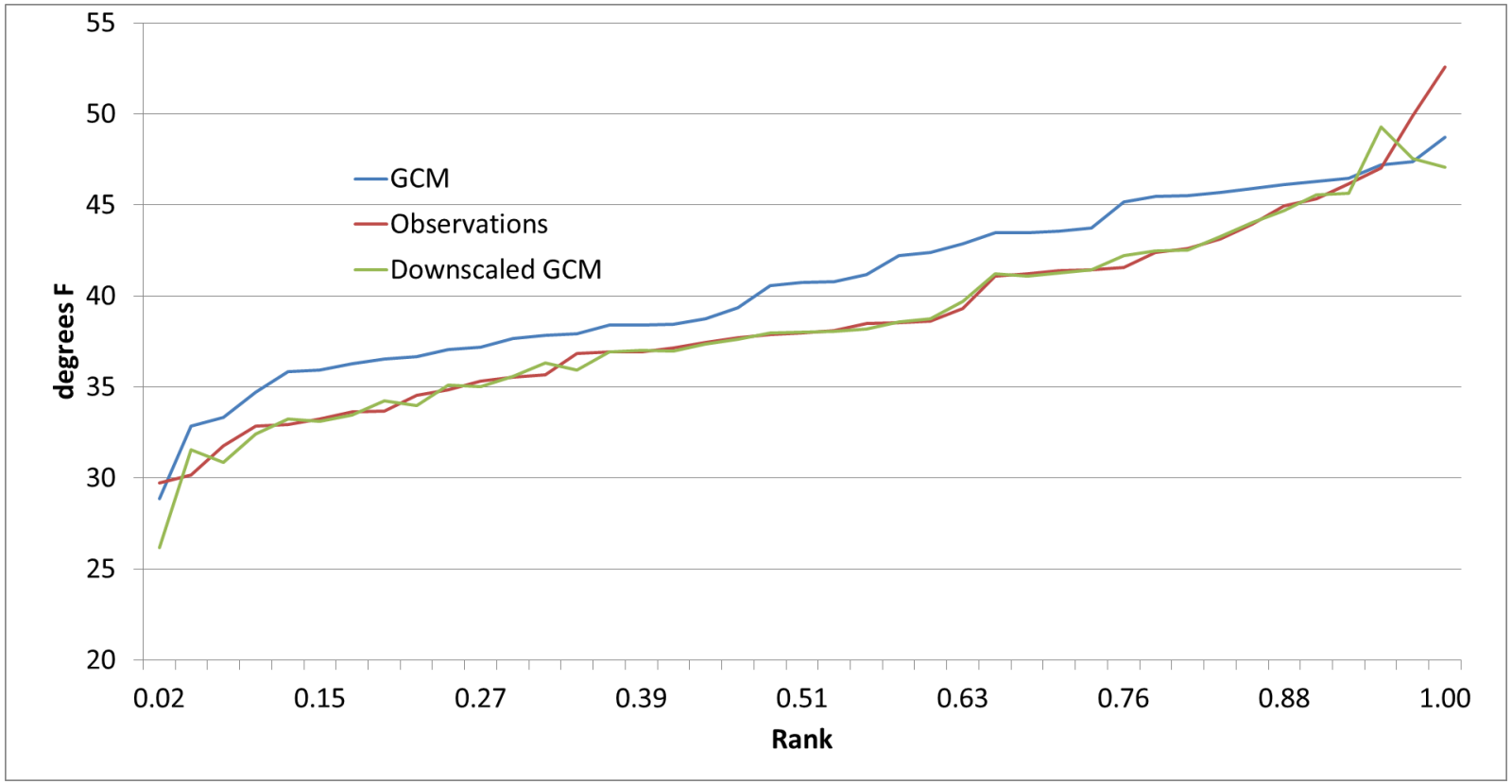


Find the percentile ranking of that value (.60).

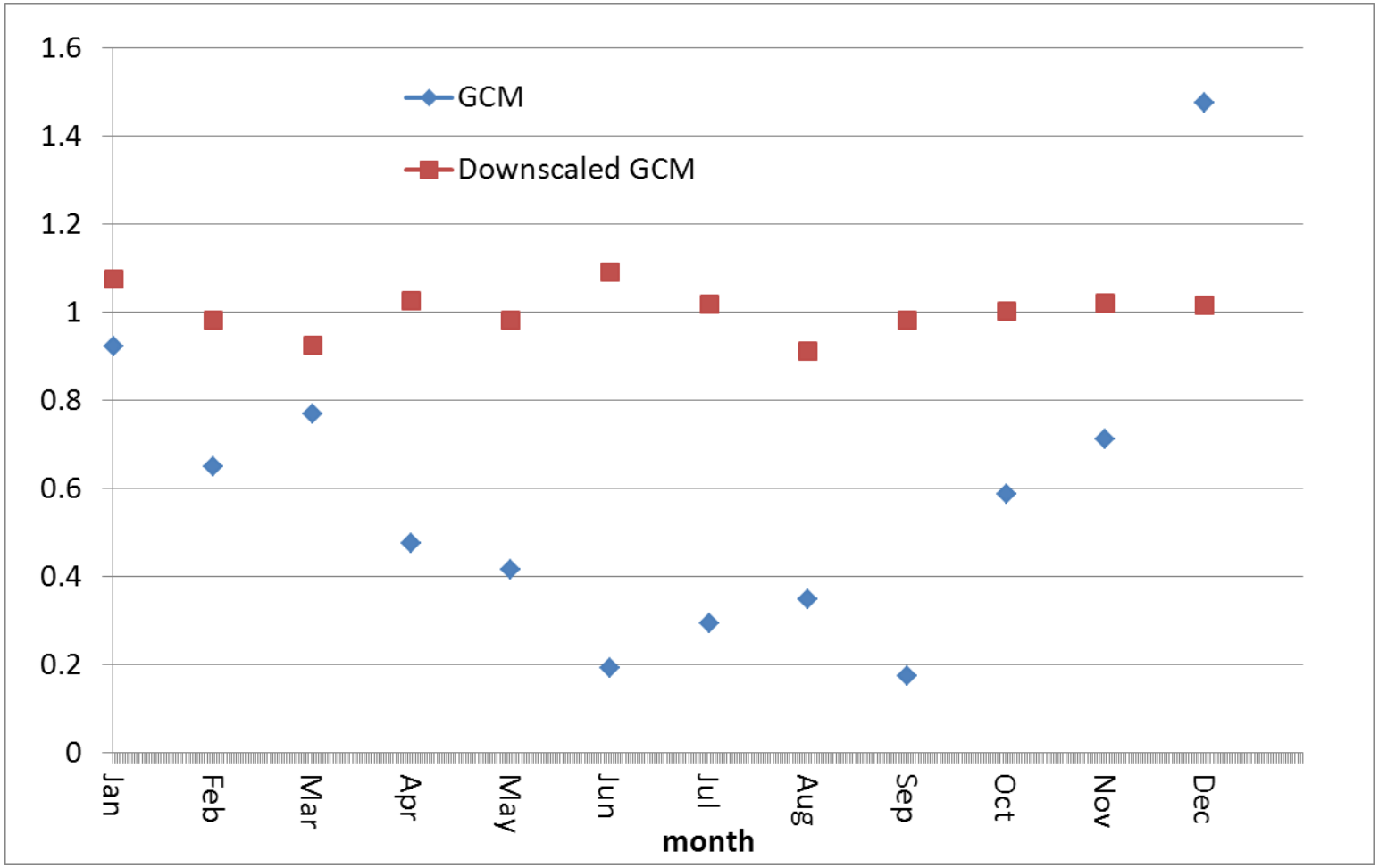


Find the observed value with that same ranking, and use that as the downscaled prediction.

Apply a cross validation, correcting each month, using the rankings determined from all other months.



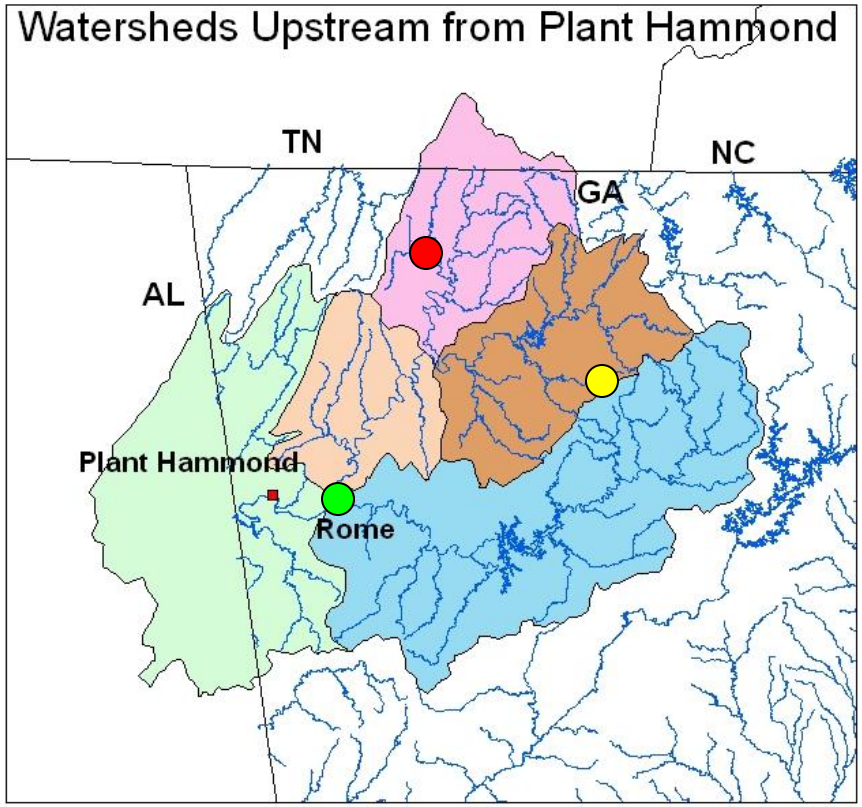
Ratio of GCM-to-Observed standard deviation of January temperature, 1950-1990, for Dalton, GA



Application

1. Downscale temperature and precipitation for three sites within the Coosa River watershed in north Georgia.

2. Use this data in as input to a model of basin hydrology to estimate flows in the 2040s.


Watersheds Upstream from Plant Hammond
TN
NC
GA
AL
Plant Hammond
Rome
Legend
Watershed
Upper Coosa. Alabama, Georgia.
Oostanaula. Georgia.
Etowah. Georgia.
Coosawattee. Georgia.
Conasauga. Georgia, Tennessee.
N
W
E
S
0
18,500
37,000
74,000 Meters
Dalton, GA
Jasper, GA
Rome, GA

Watershed Model

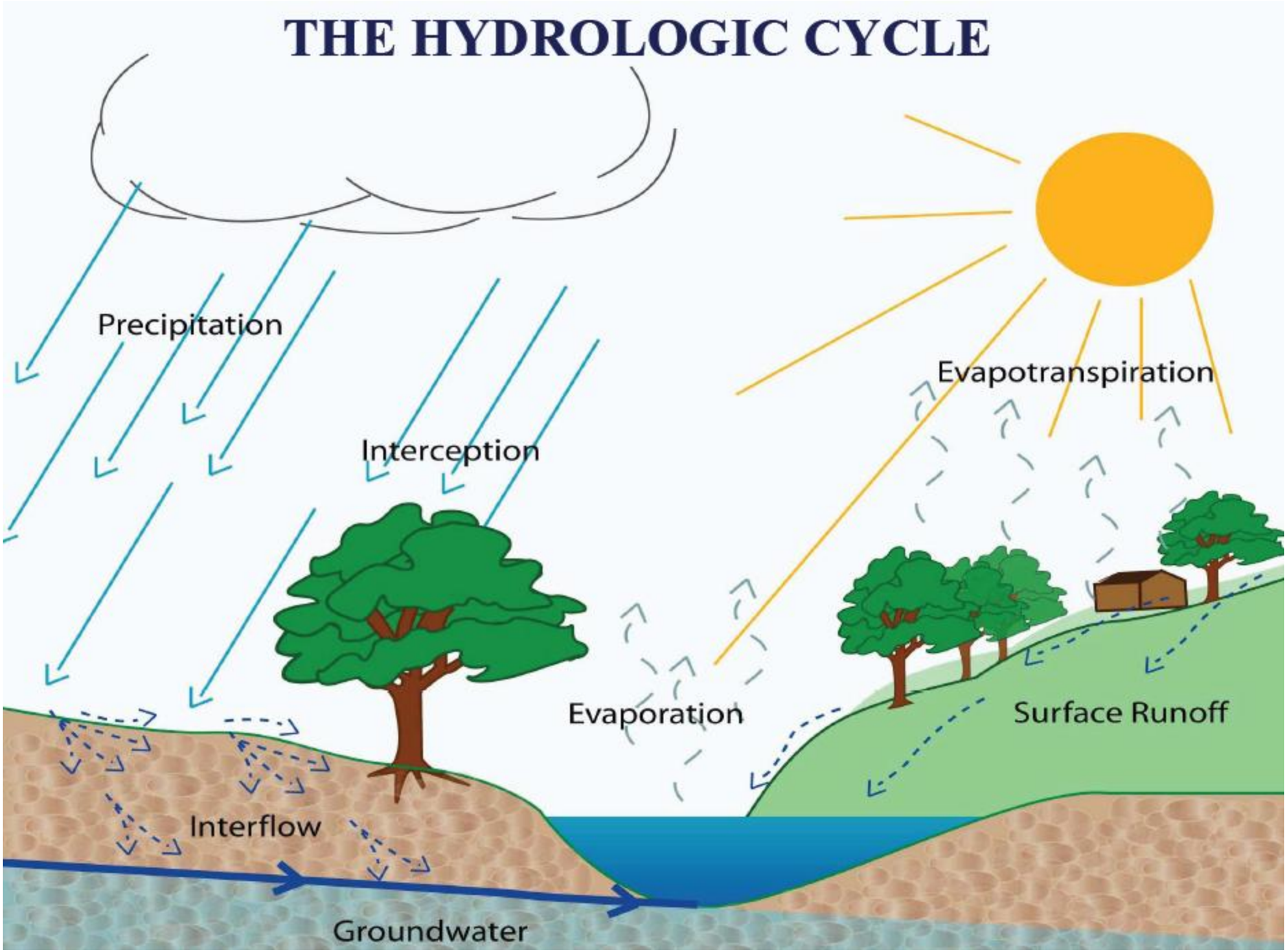
BASINS (Better **A**ssessment **S**cience **I**ntegrating **P**oint and **N**onpoint **S**ources)

1. US EPA Software

2. Integrated GIS – Data Analysis – Modeling Systems

- *Data (access to national data sets)*
- *Tools (access to analysis software)*
- *Models (software modules such as HSPF)*

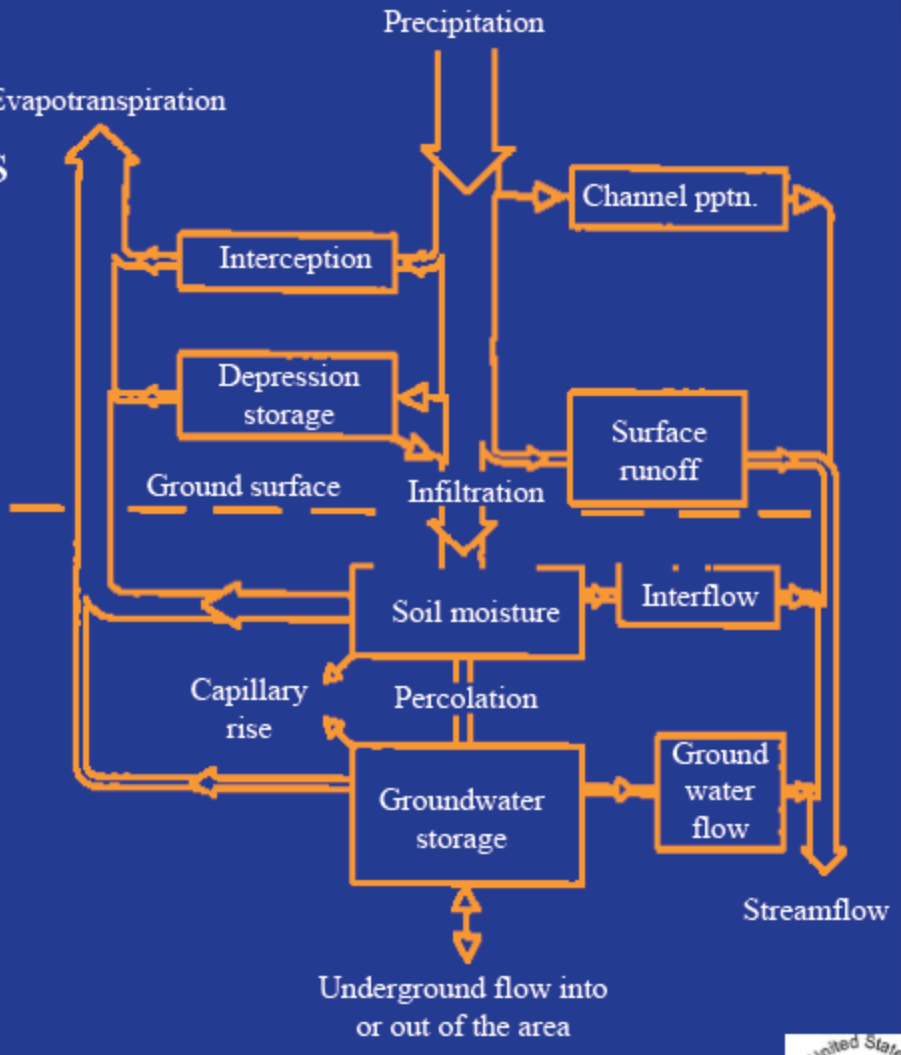
THE HYDROLOGIC CYCLE



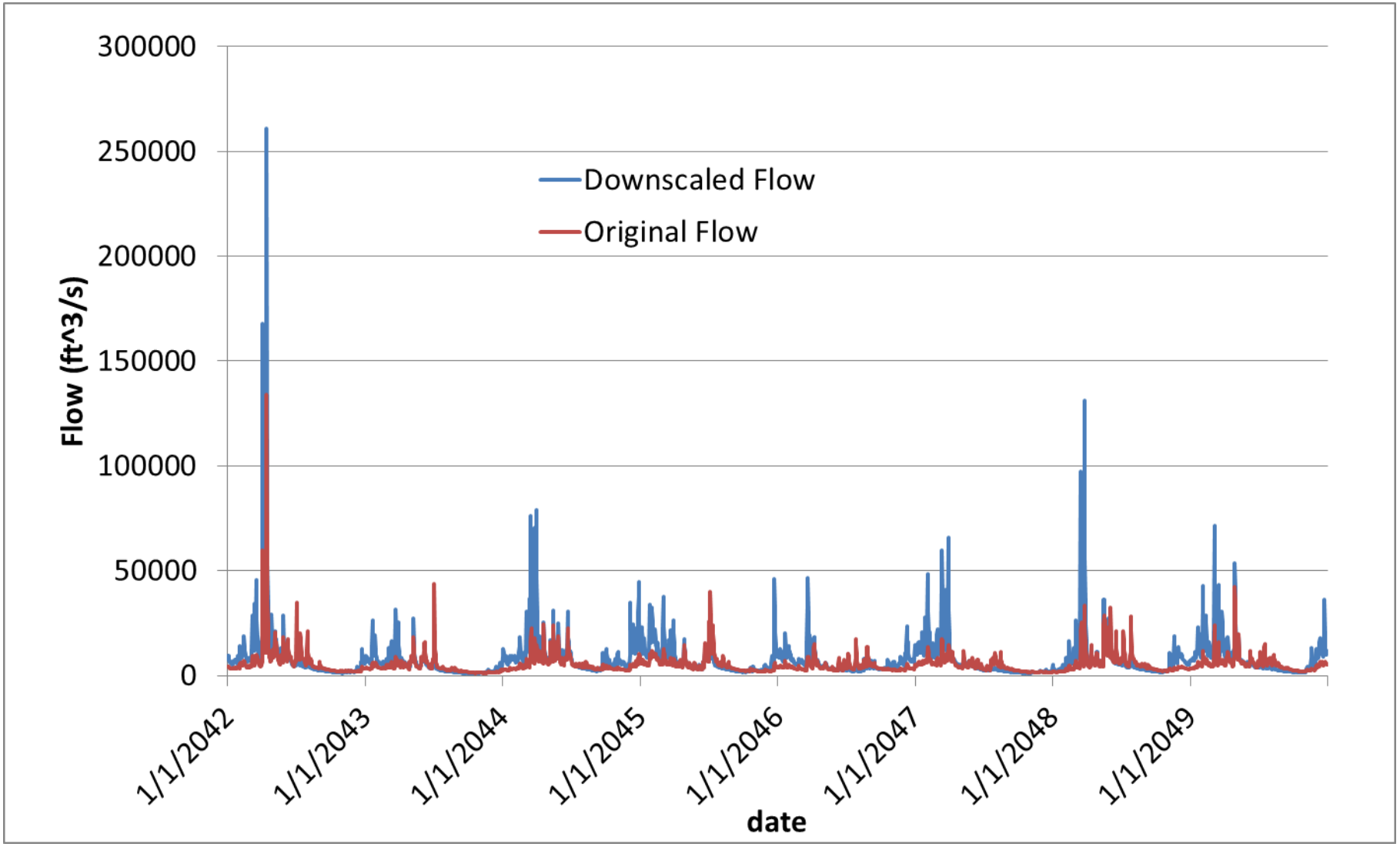
HYDROLOGY - HYDROLOGIC COMPONENTS

Hydrologic Components

- Rainfall or Snow
- Interception
- Depression storage
- Evapotranspiration
- Infiltration
- Surface storage
- Runoff
- Interflow
- Groundwater flow



GCM Simulated flow at Hammond gauge.



Conclusions

- Statistical downscaling is a useful tool for using global climate model data for local-scale applications.
- These predictions can be substantially different from the original GCM data.
- This data can be used as input to models of river flow to estimate the future of this resource.