Drought and its relationship to long-term climatological indicators in the Apalachicola-Chattahoochee-Flint River Basin

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February 27, 2008

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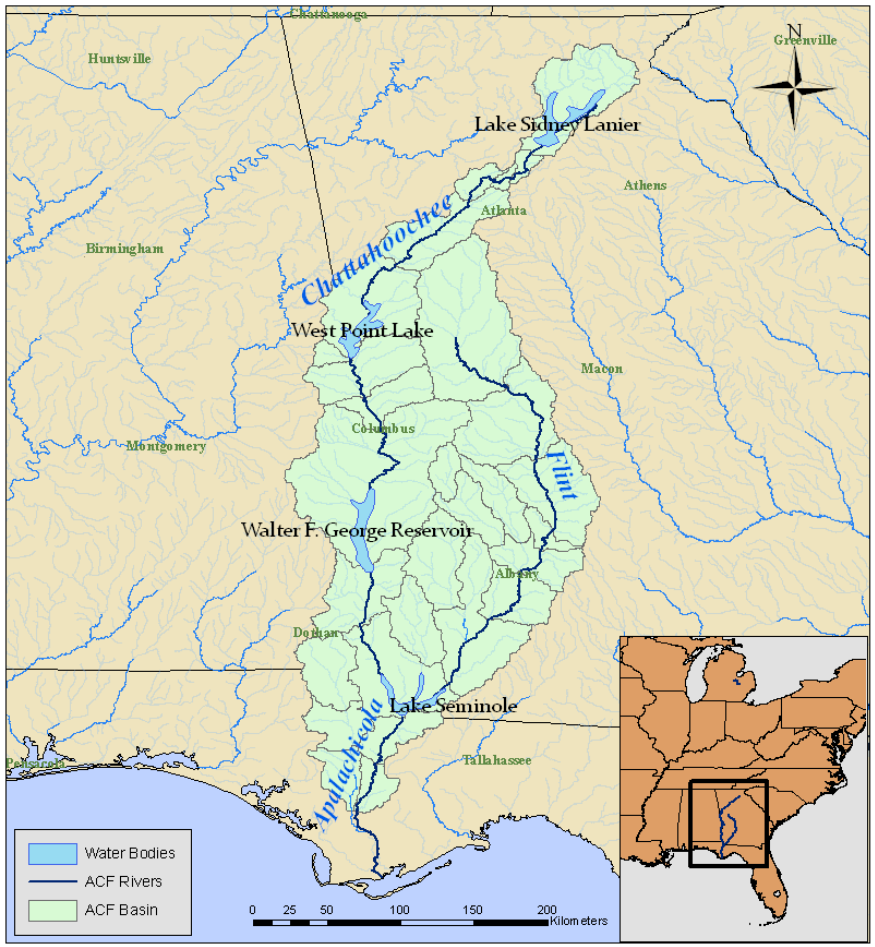
Apalachicola-Chattahoochee-Flint River Basin

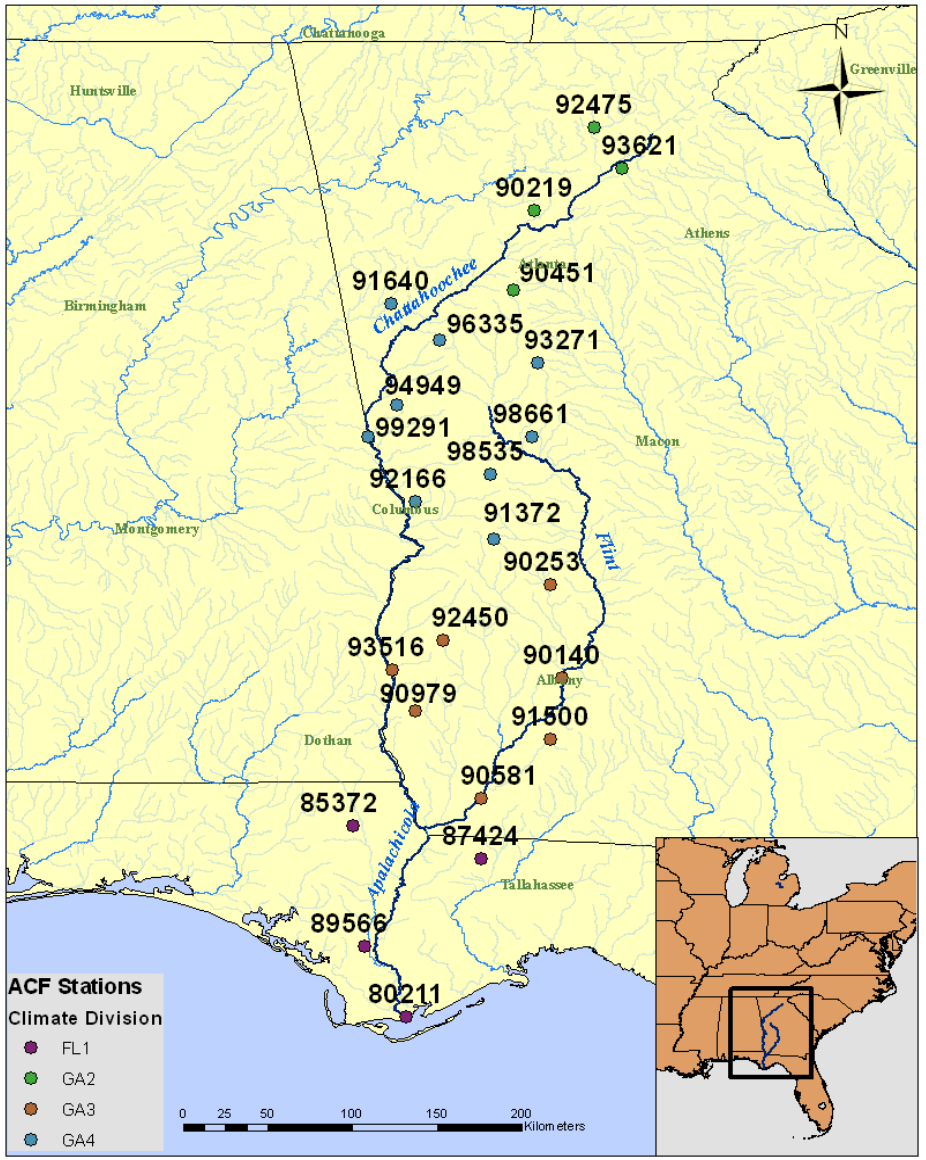
- ACF Basin northern GA, SW GA, drain Apalachicola in FL
- Area famous for "Water Wars" over two decades concerning water allocation between GA, FL, AL
- Look at variables involved with evapotranspiration and relationships to climate oscillations
  - Input data: surface meteorological variables and climate indicators
  - Methods: Canonical correlation analysis
  - Results



Apalachicola Chattahoochee Flint River Basin

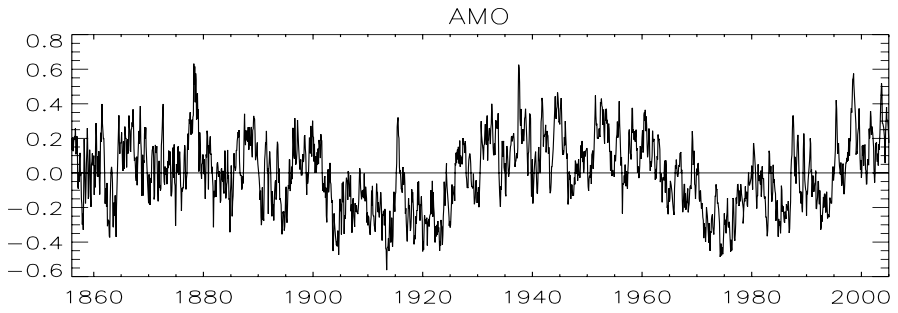
Surface Data

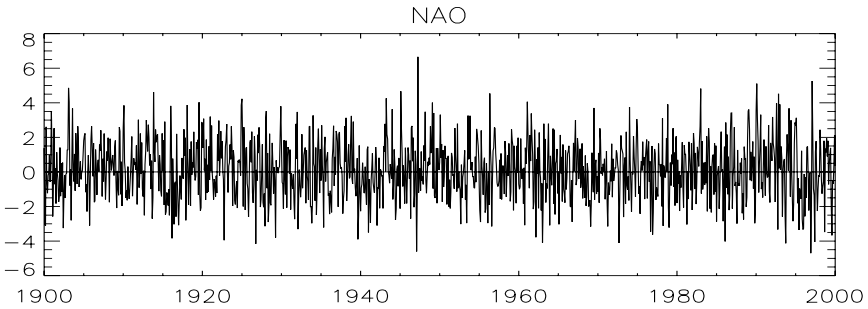
- Minimum and maximum temperature and precipitation
  - National Climatic Data Center (NCDC) 1901-2000
  - Parameter-elevation Regressions on Independent Slopes Model (PRISM) fill gaps
- Standardized Precipitation Index (SPI) (McKee et al. 1993) for 3, 6, 12, 24 month intervals
  - Normalized and based on standard deviations
  - SPI represents managed water systems better than Palmer indices (Steinmann 2003)



Climate Oscillations

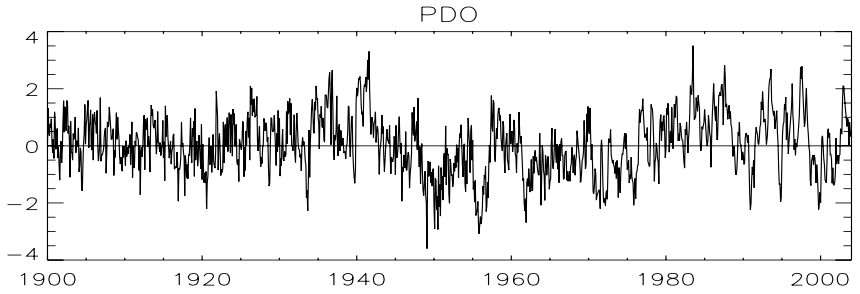
Atlantic Multidecadal Oscillation
60-85 year cycle, multidecadal

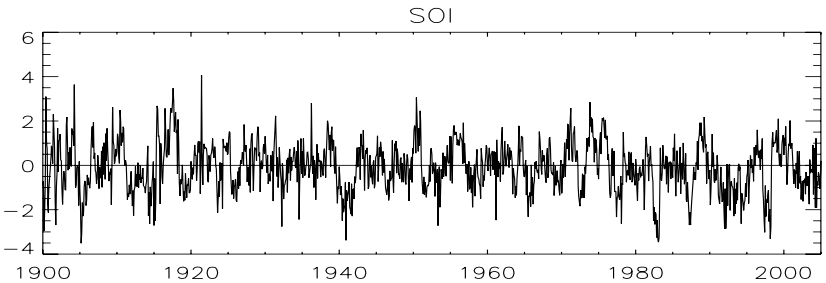




North Atlantic Oscillation
Intra-annual, interannual (2-7yrs)

Pacific Decadal Oscillation
20-30 years, multidecadal





Southern Oscillation Index
Intra-annual, interannual (3-4 years)

Canonical Correlation Analysis

- CCA developed by Hotelling 1935, similar to multiple linear regression (MLR), independent & dependent data sets
- Creates two variate arrays to maximize correlations by solving a coupled eigenproblem

Dep.: Surface Vars. → **Dep. variant**

Ind.: Climate Os. → **Ind. variant**

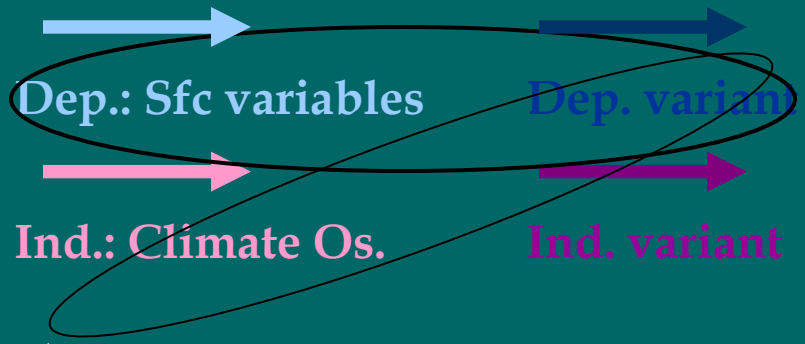
- Both tests independent: four seasons of four climate oscillations (16 variables)
- Test one dependent: maximum and minimum temperature with SPI 6
- Test two dependent: SPI of one interval of both northernmost and southernmost basins

- All results analyzed at the 95% significance level (p-value < 0.05)
- Data into seasons:

DJF season 1 = Winter
MAM season 2 = Spring
JJA season 3 = Summer
SON season 4 =Fall

Analysis

- Canonical loadings and cross loadings



- Direct and indirect
  - Ex. Indirect: - loading, + cross loading = AMO –, precip.
- Test 1 Results: Dependent data max & min temp, SPI 6
  - Temperature had the strongest loadings, particularly in winter
  - Relationships to SPI in wetter spring and summer only
  - Inverse relationships existed with temperature

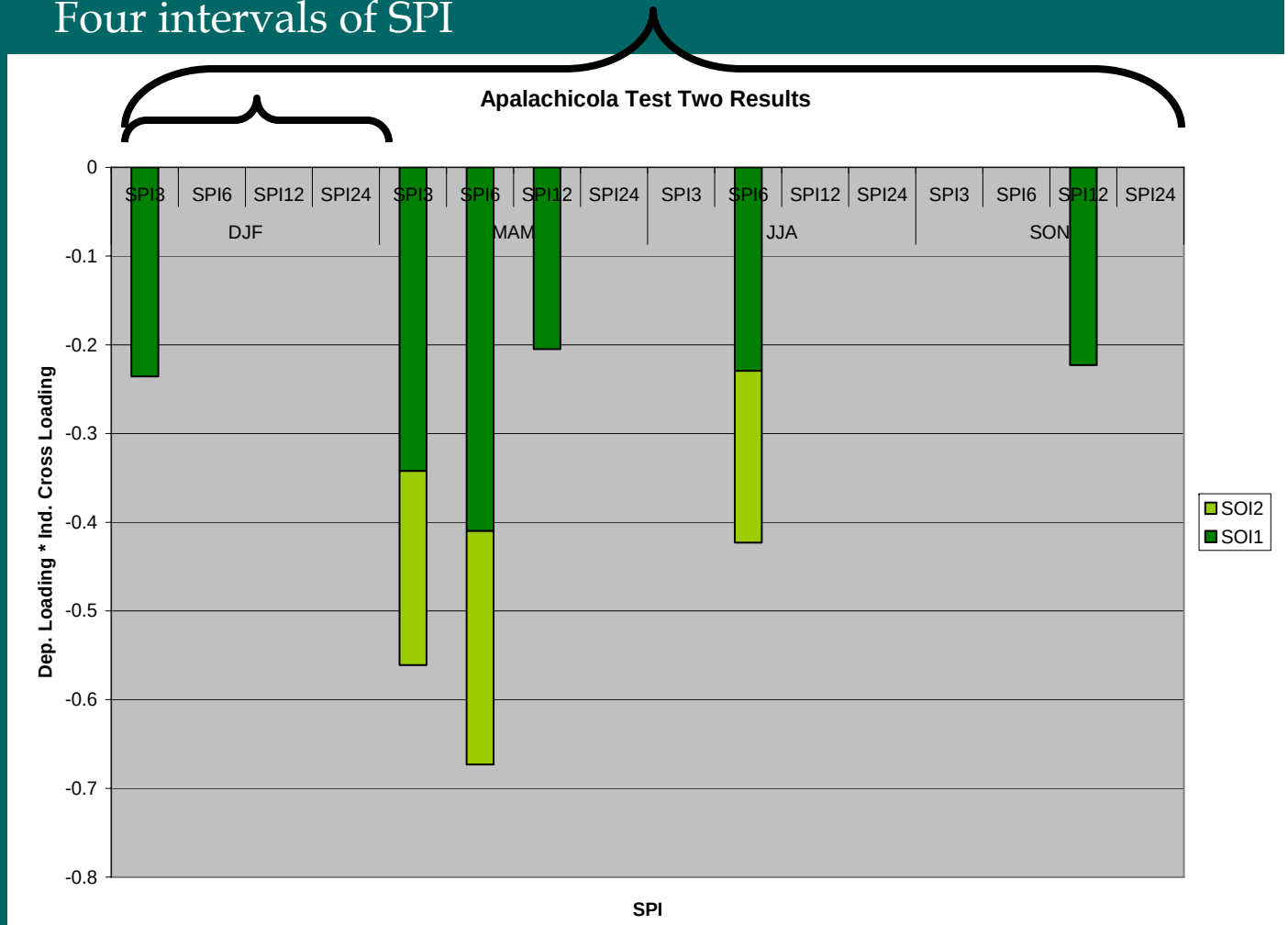
Test 2 (SPI): Apalachicola

- Dominated by SOI of winter and spring
- All indirect relationships
- Occur in the higher variance indices (SPI3, SPI6, SPI12)

Y-axis: dependent loading * independent cross loading

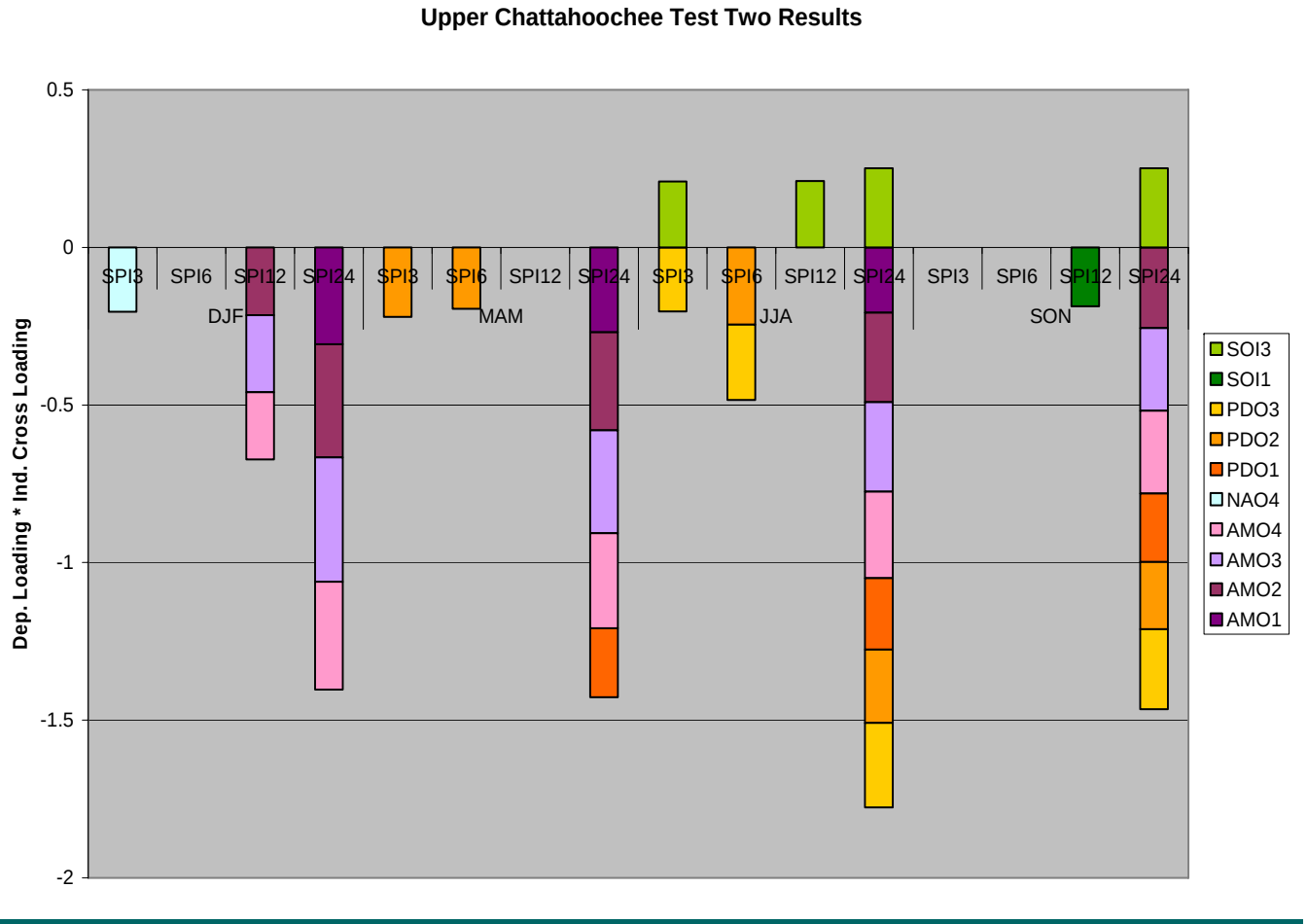
Four seasons Winter -> Fall

Four intervals of SPI



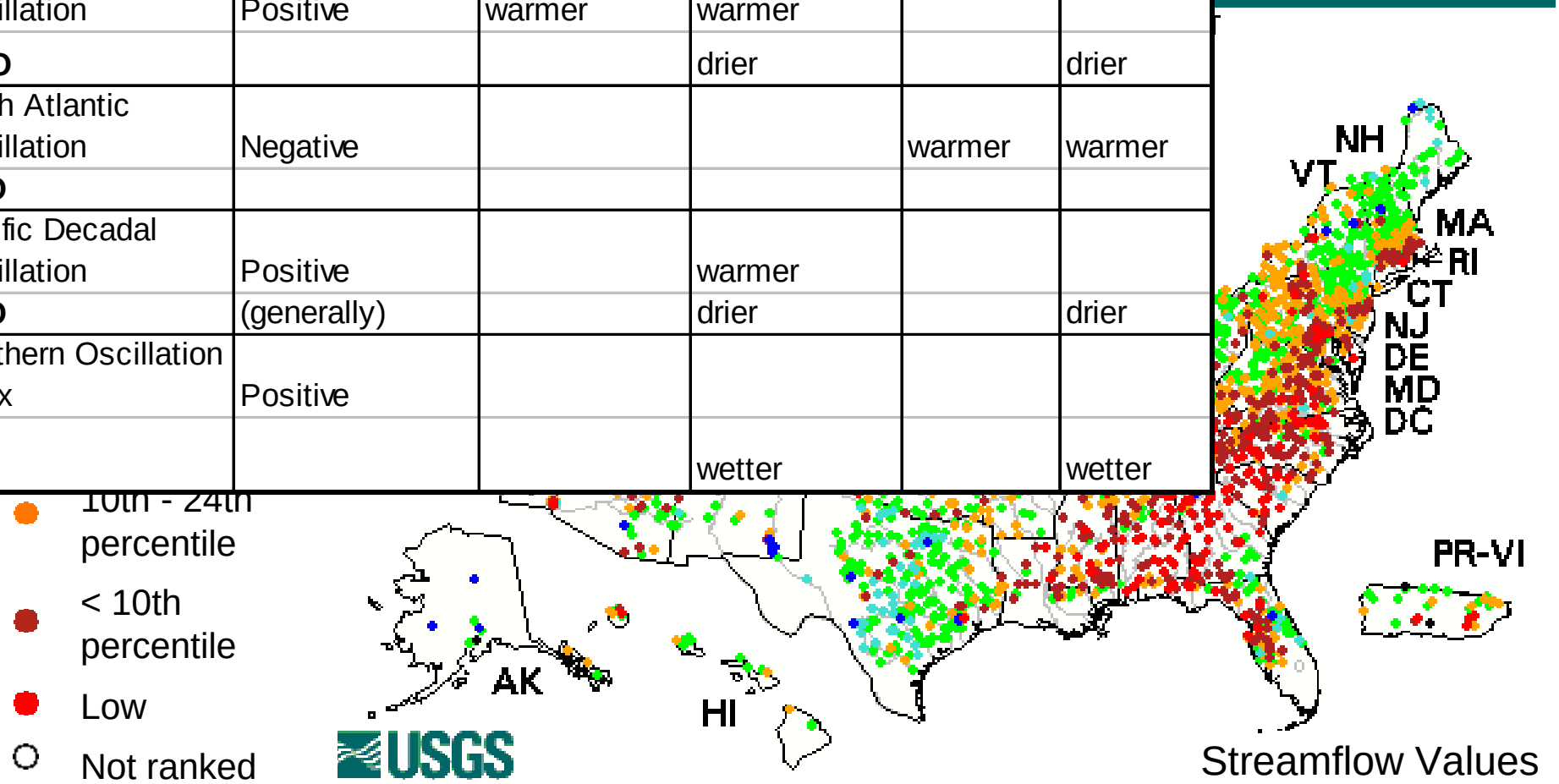
Test 2 (SPI): Upper Chattahoochee

- More climate oscillations
- AMO and PDO of several seasons in lowest variance SPI24
- SOI season 3 direct summer relationship
- All concurrent relationships consistent with previous research



Summer & Fall 2007

Name	Summer Phase (2007)	Summer Associations		Fall Associations	
		Southern	Northern	Southern	Northern
Atlantic Multidecadal Oscillation	Positive	warmer	warmer		
AMO			drier		drier
North Atlantic Oscillation	Negative			warmer	warmer
NAO					
Pacific Decadal Oscillation	Positive		warmer		
PDO	(generally)		drier		drier
Southern Oscillation Index	Positive				
SOI			wetter		wetter



General Conclusions

- Drought and low streamflow are not simple to statistically describe
- Canonical correlation analysis more comprehensive and complex description
- Cannot attribute climate patterns in ACF to one climate index
- Weather and climate patterns in ACF not heterogeneous spatially or temporally
  - Test 1: PDO & NAO relationships inverse winter & spring -> summer & fall
  - Test 2: Southern SOI northern AMO & PDO
- Best to use multiple scales and multiple indices for understanding patterns in the ACF
  - Higher variance SPI southern basin, lower variance SPI northern

Lake Lanier, courtesy of David Tulis AJC

Drying up Lake Lanier October 2007

http://www.hfxnews.ca/photos/TheDailyNews/stories/Lake1.jpg

http://cache.boston.com/resize/bonzai-fba/Globe_Photo/2007/11/16/1195270901_3015/539w.jpg