Do fewer clouds in winter cause more freeze injury to southern pine seedlings?

David B. South
Tom Starkey
Auburn University

AU Southern Forest Nursery Management Cooperative

Freeze injury to pines

Date	F
March 9, 1932	20
Nov 25, 1950	8
Nov 30, 1954	12
Dec 25, 1983	18
Jan 21, 1985	5
Dec 23, 1989	0
Nov 5, 1991	21
Jan 19-20, 1994	7
Jan 3-5, 1996	13
Jan 5, 1999	12
Dec 21, 2000	14
Jan 7, 2004	18
Dec 18, 2007	25
Jan 3, 2008	15
Jan 16-17, 2009	8
Feb 4, 2009	14

Freeze injury to pines

Date	F
March 9, 1932	20
Nov 25, 1950	8
Nov 30, 1954	12
Dec 25, 1983	18
Jan 21, 1985	5
Dec 23, 1989	0
Nov 5, 1991	21
Jan 19-20, 1994	7
Jan 3-5, 1996	13
Jan 5, 1999	12
Dec 21, 2000	14
Jan 7, 2004	18
Dec 18, 2007	25
Jan 3, 2008	15
Jan 16-17, 2009	8
Feb 4, 2009	14

4 in December
7 in January
13 since 1980

Freeze damage in 2004 affected pine seedling roots throughout the South.

Record warm temperatures were set for the first week of January.

In some places, it was 73°F.
on January 5th and then dropped to

21 F on January 7th.)

Date	Temperature (°F)		
	high	avg	low
January			
4	73	66	59
5	68	58	44
6	44	40	33
7	41	31	21
8	37	30	24
9	42	38	35
10	37	35	33

Freeze damage in 2008 also affected pine seedling roots in some regions of the South.

In some places, it was 77°F. on December 28th and then dropped to 22 F on January 3rd.)

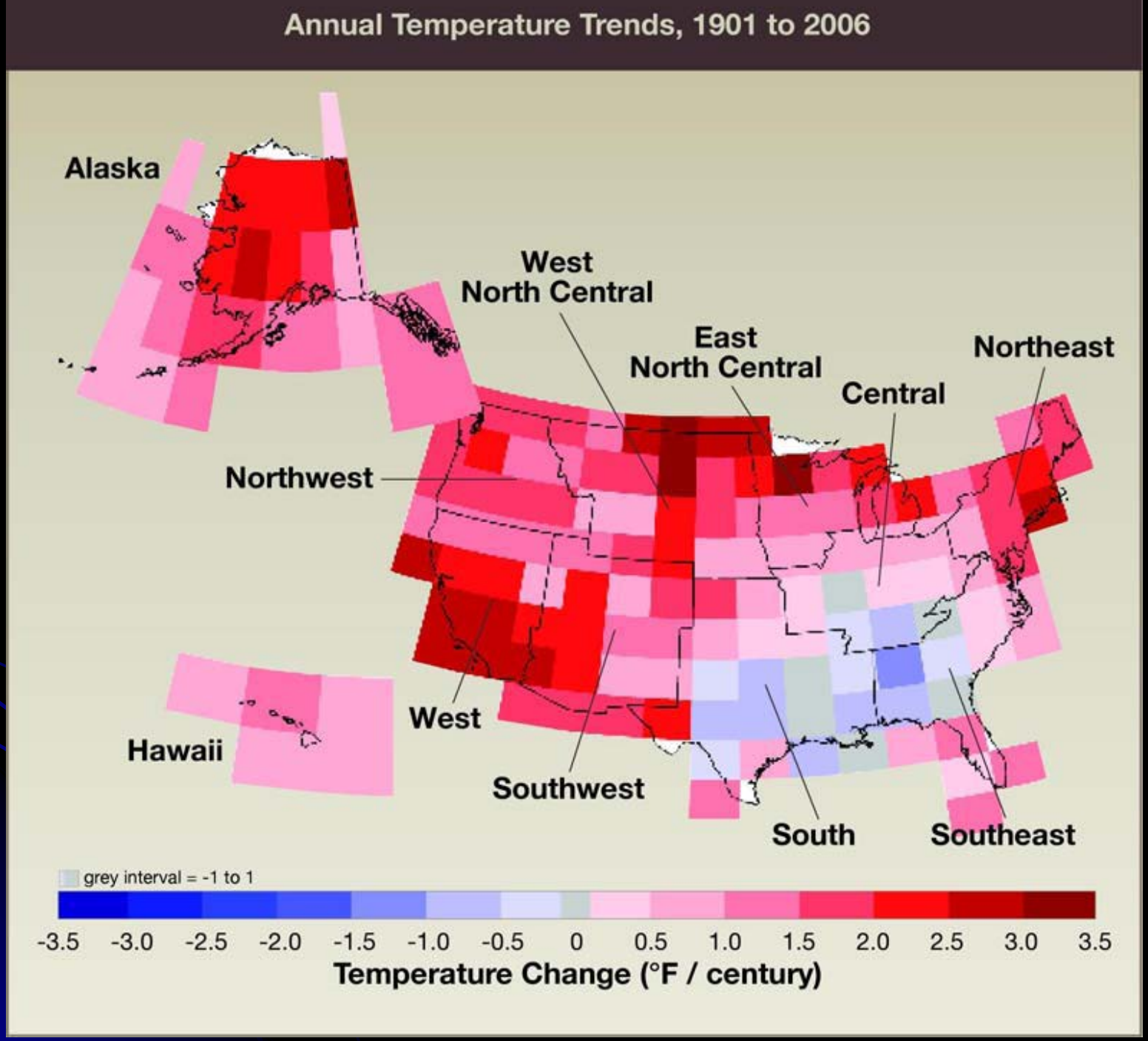
Dec 28, 2007	77.0	48.0
Dec 29, 2007	67.1	62.8
Dec 30, 2007	69.8	58.6
Dec 31, 2007	65.5	41.7
Jan 1, 2008	56.1	38.8
Jan 2, 2008	39.6	28.0
Jan 3, 2008	39.7	22.3
Jan 4, 2008	50.5	18.0

Question

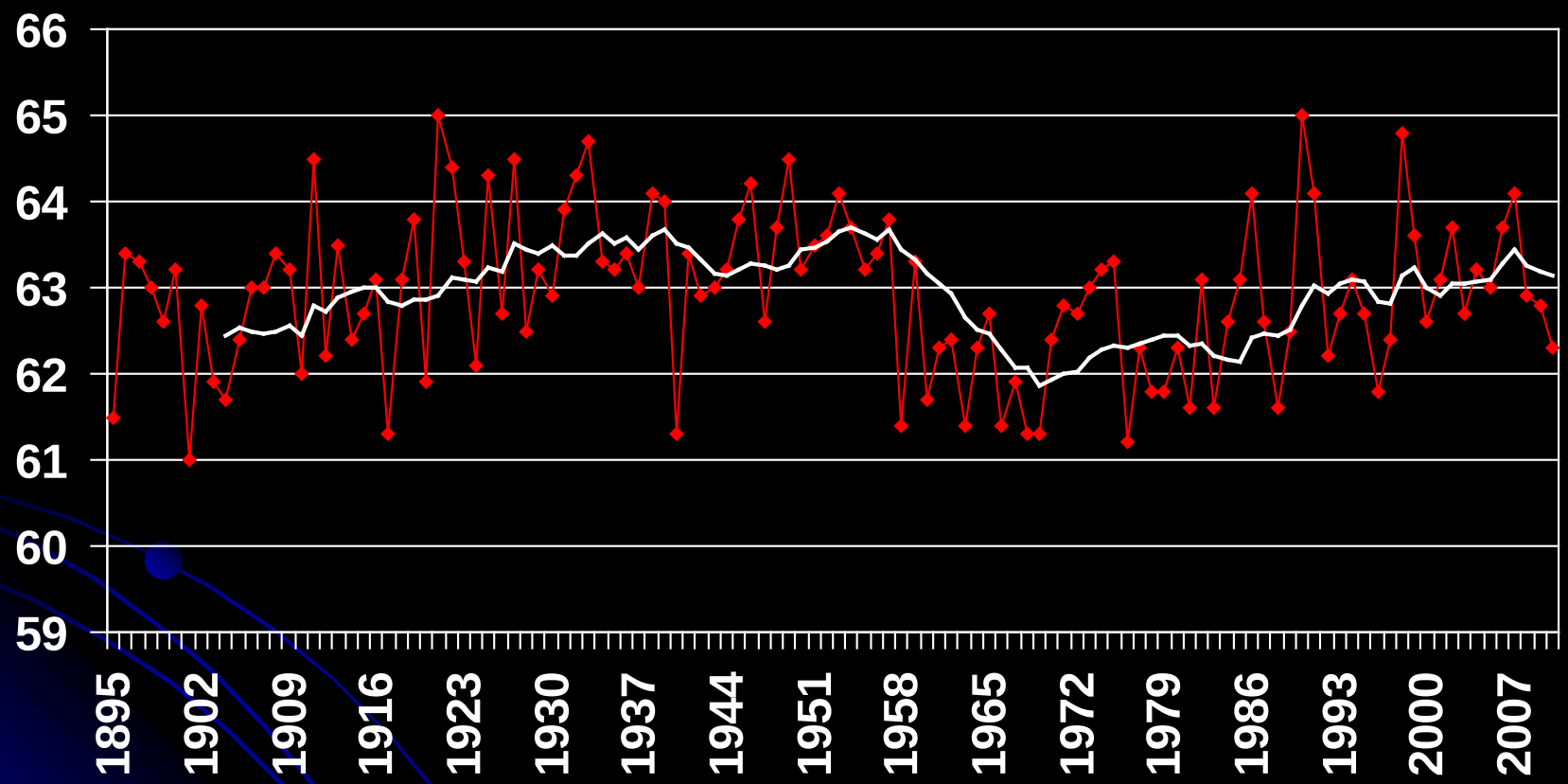
- Could changes in the climate or clouds explain why we are seeing more occurrences of frost injury?

- Dr. Melvin Cannel (1985) suggested that less chilling might result in more frost injury.

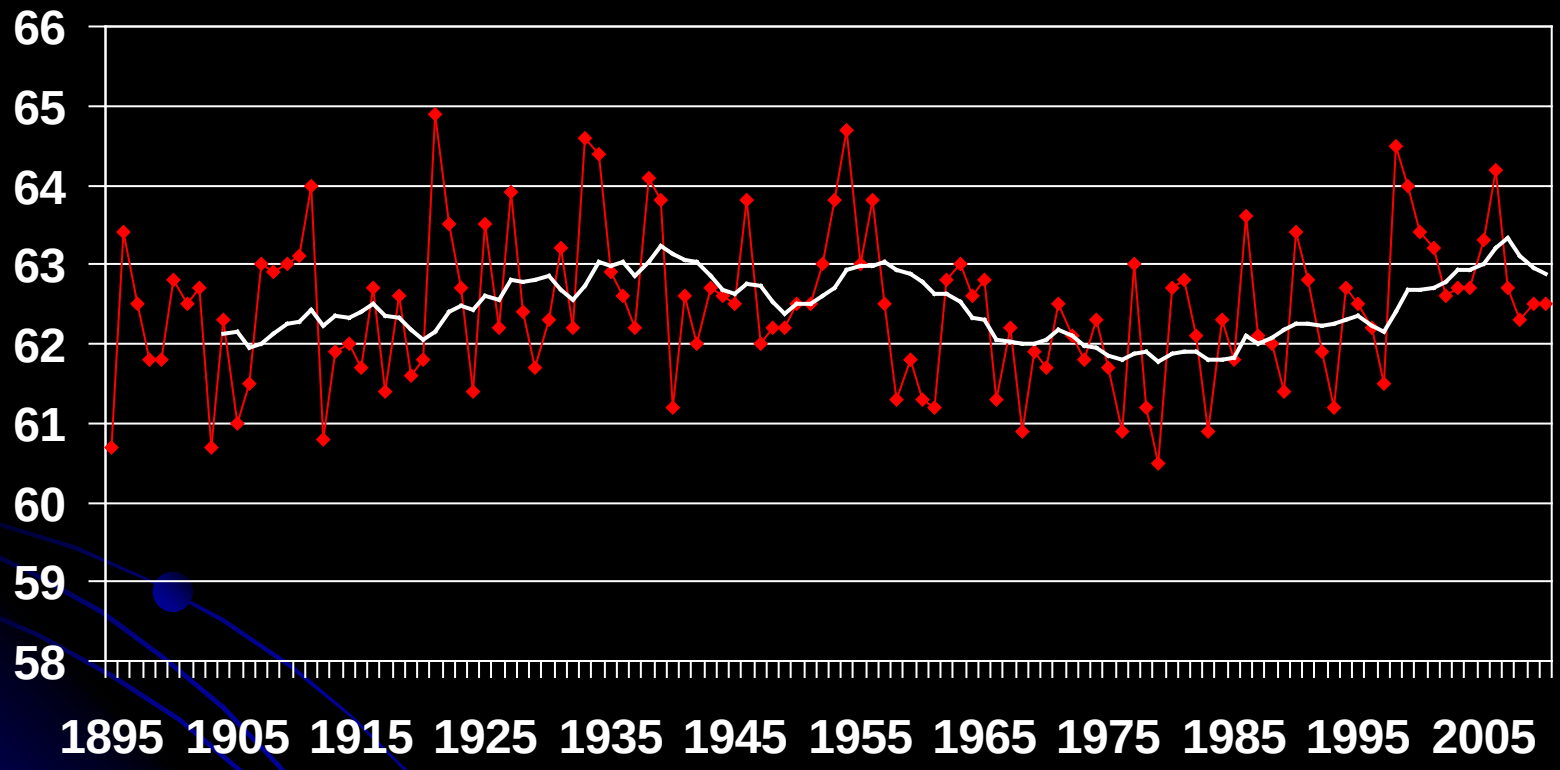
How has the climate of our area changed?

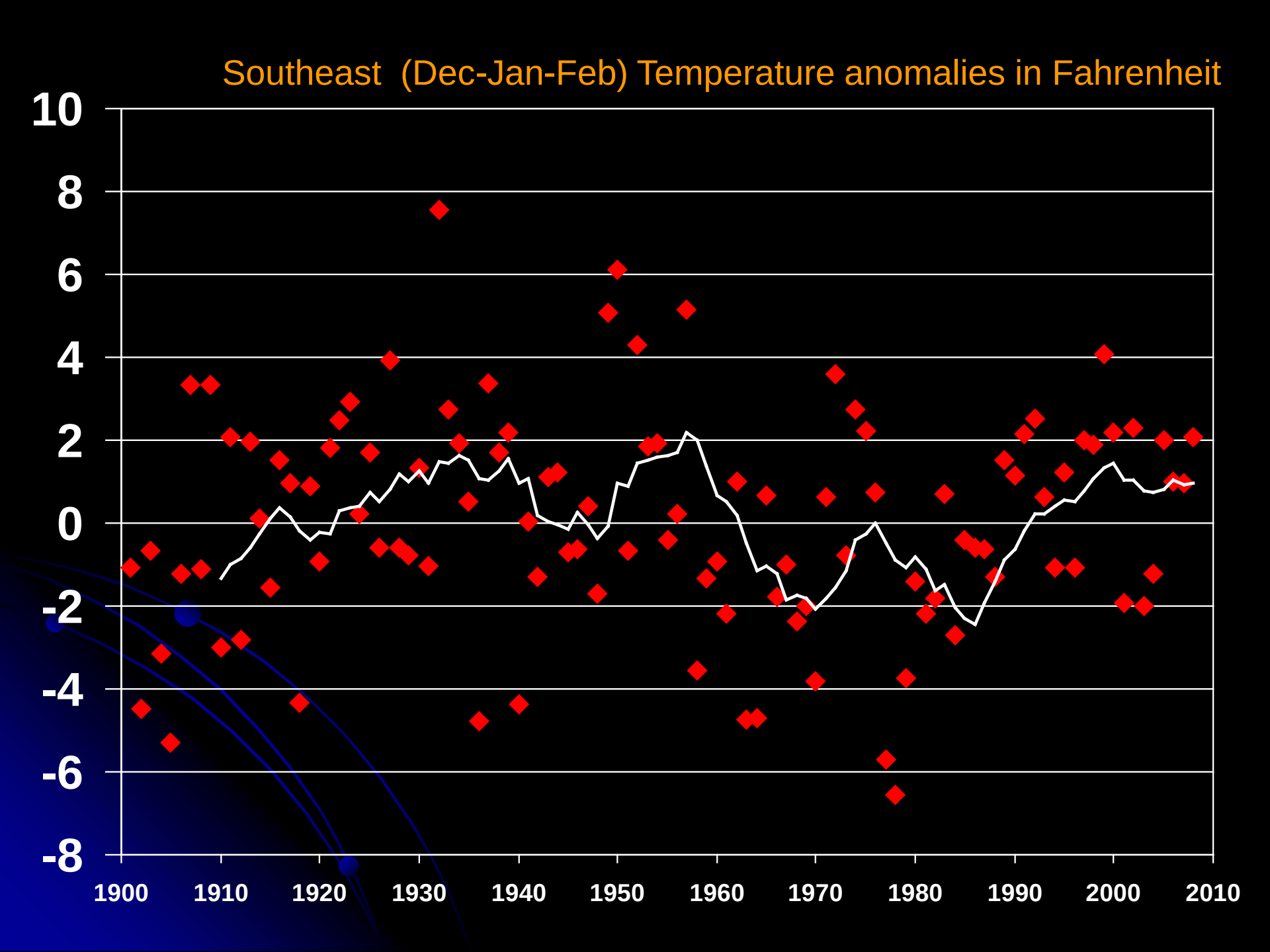

Annual Temperature Trends, 1901 to 2006
Alaska
West
North Central
East
North Central
Northeast
Central
Northwest
West
Hawaii
Southwest
South
Southeast
grey interval = -1 to 1
-3.5 -3.0 -2.5 -2.0 -1.5 -1.0 -0.5 0 0.5 1.0 1.5 2.0 2.5 3.0 3.5
Temperature Change (°F / century)

Annual temp (F) – AL, FL, GA, SC, NC, VA



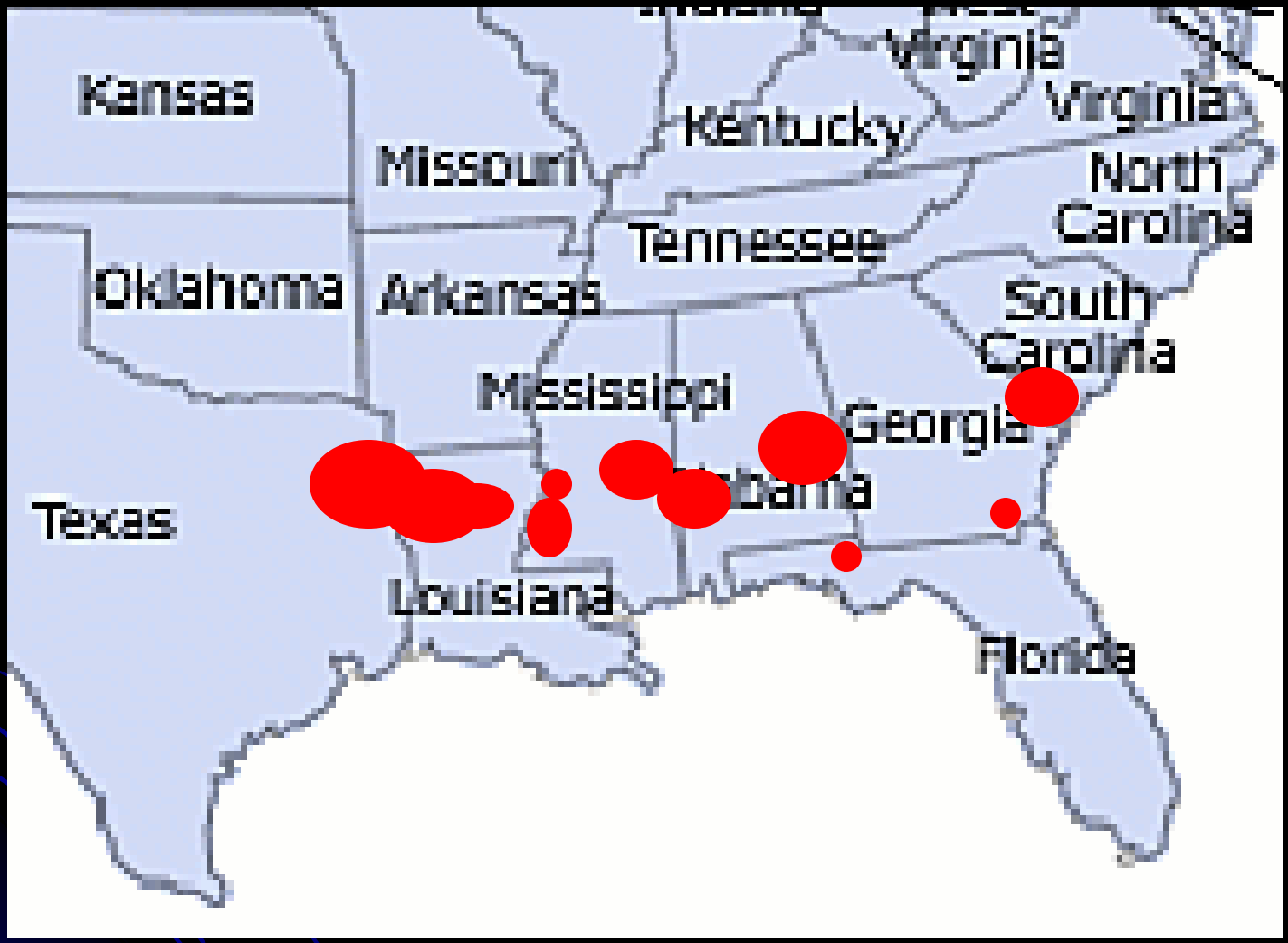
Annual temp (F) – TX, AR, LA, MS, OK, KS




Southeast (Dec-Jan-Feb) Temperature anomalies in Fahrenheit
10
8
6
4
2
0
-2
-4
-6
-8
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010

SE Anomalies by decade (F)

- Decade anomaly for winter in the Southeast
- 1901-10 - 1.33
- 1911-20 -0.22
- 1921-30 1.24
- 1931-40 0.98
- 1941-50 0.96
- 1951-60 0.66
- 1961-70 -2.09
- 1971-80 -0.83
- 1981-90 -0.63
- 1991-00 1.45
- 2001-08 0.40

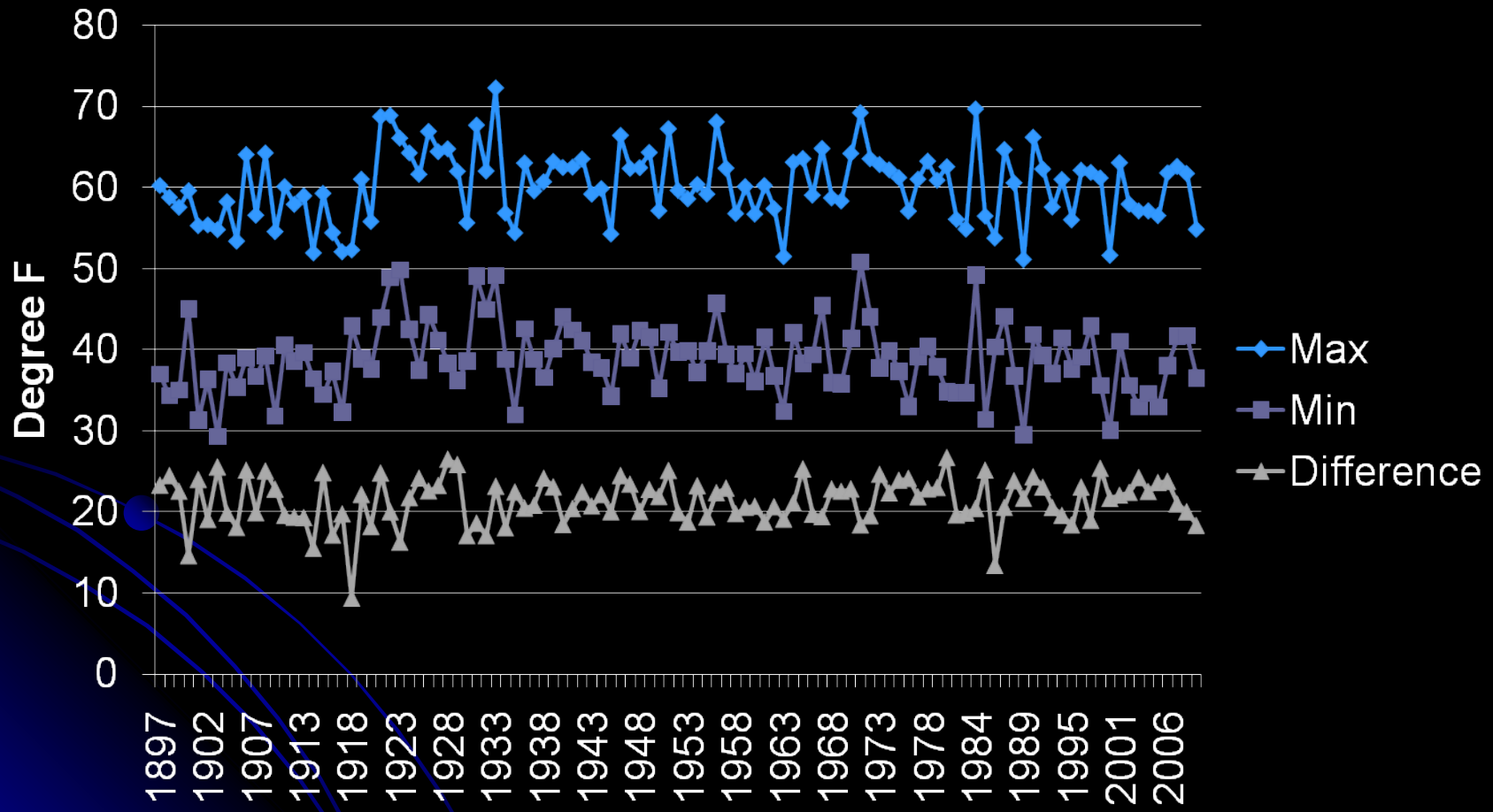


Injury in 2004 occurred from TX to SC

21 weather stations daily max and min temp

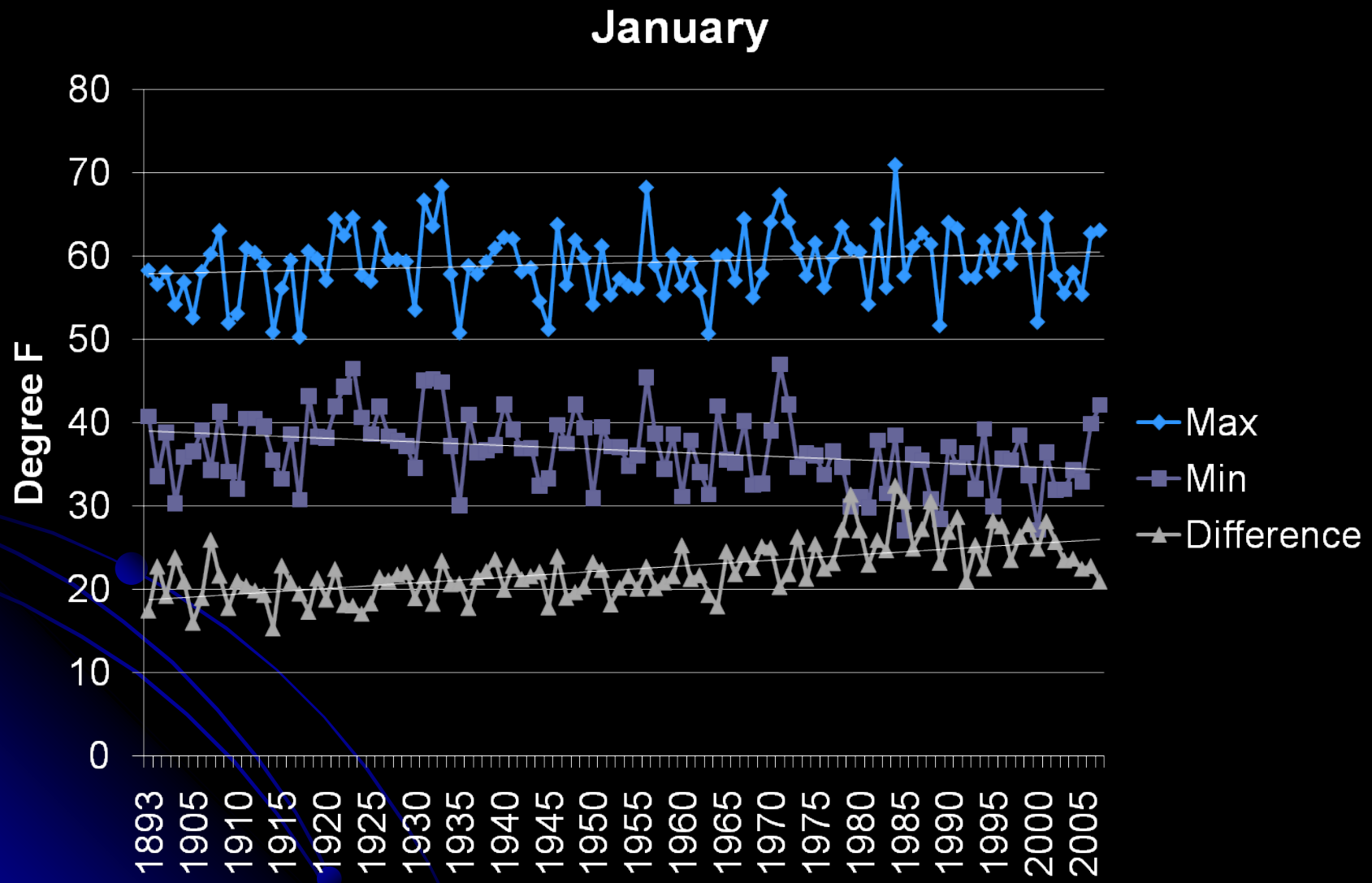
Anderson SC
Aiken SC
Newberry SC
Chester SC
Sumpter SC
Walterboro Sc
Miledgeville GA
Hawkinsville GA
Washington GA
Thomasville GA
Talladega AL
Troy AL
Selma AL
Anniston Al
Monticello MS
Brookhaven MS
Batesville MS
Kosciusko MS
Ruston LA
Miden LA
Camden AR

Selma, AL - DEC



No significant trends

Aiken, SC

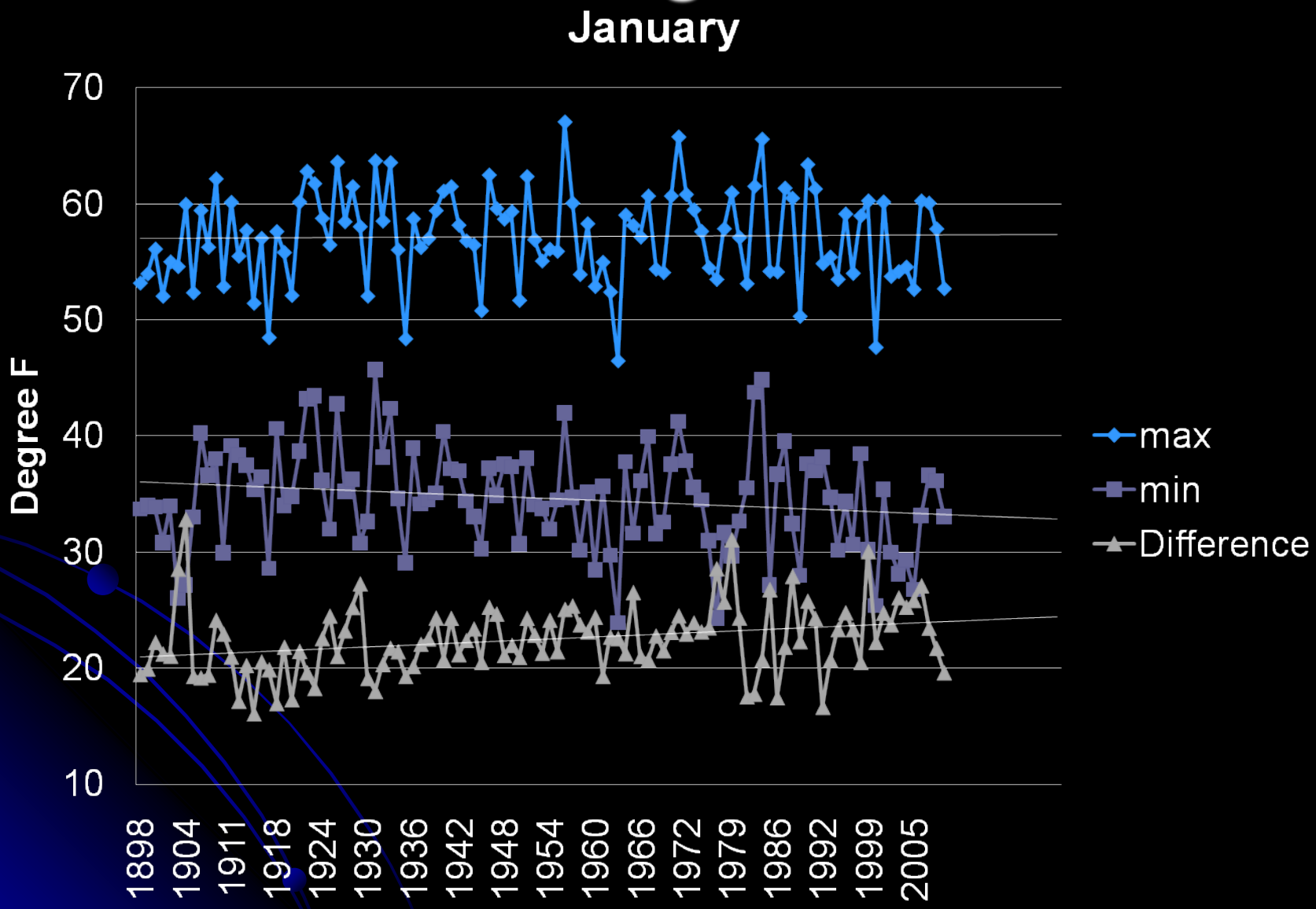


two significant trends

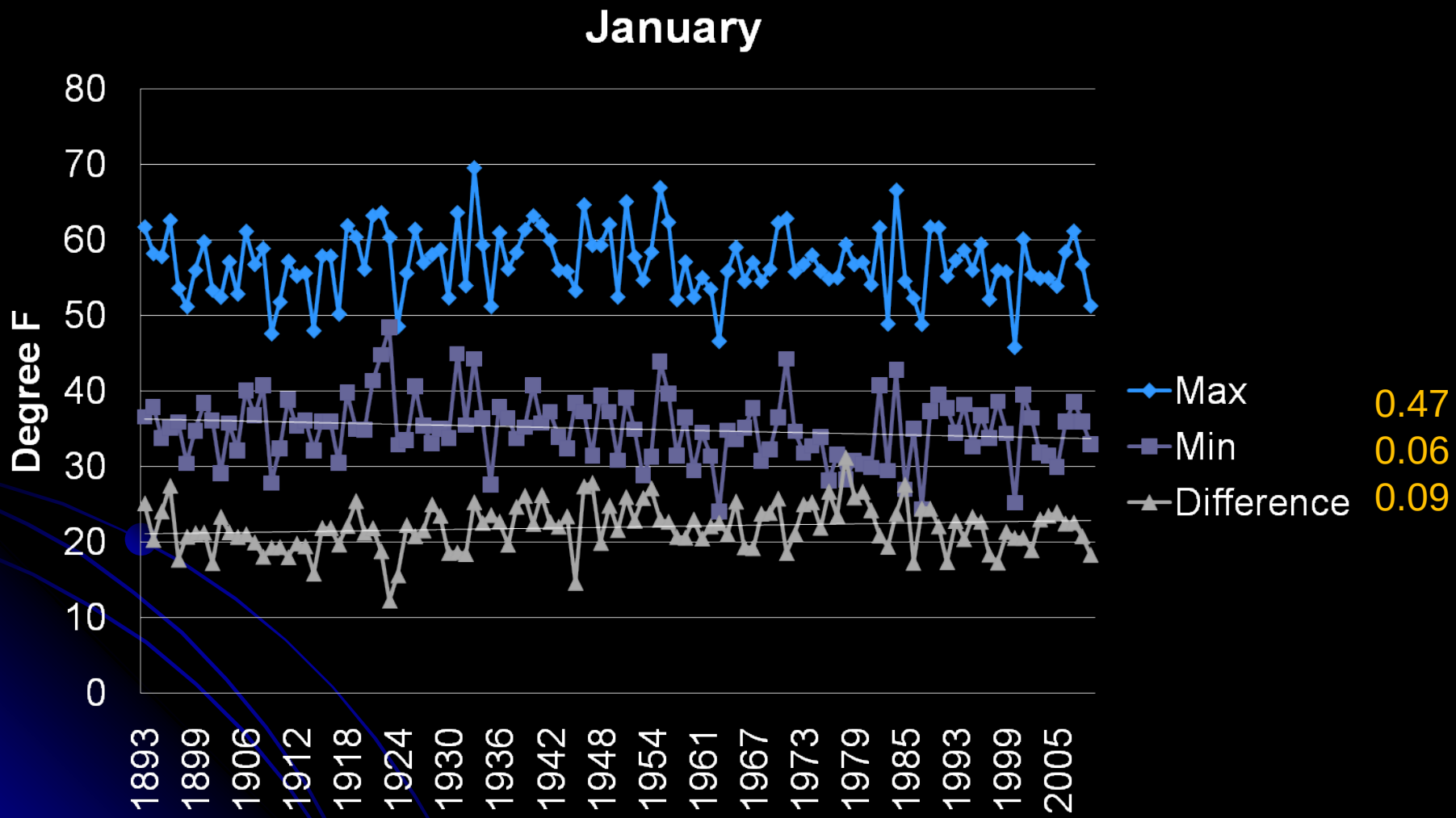
Aiken, SC

- At Aiken, the average minimum temperature in January is now about 4.3 °F cooler now than 100 years ago.
- The difference between daily min and max has increased by about 6.7 °F (Jan).
- No significant change in maximum temp.

Talladega, Al



Kosciusko, MS



two significant trends P>F <0.1

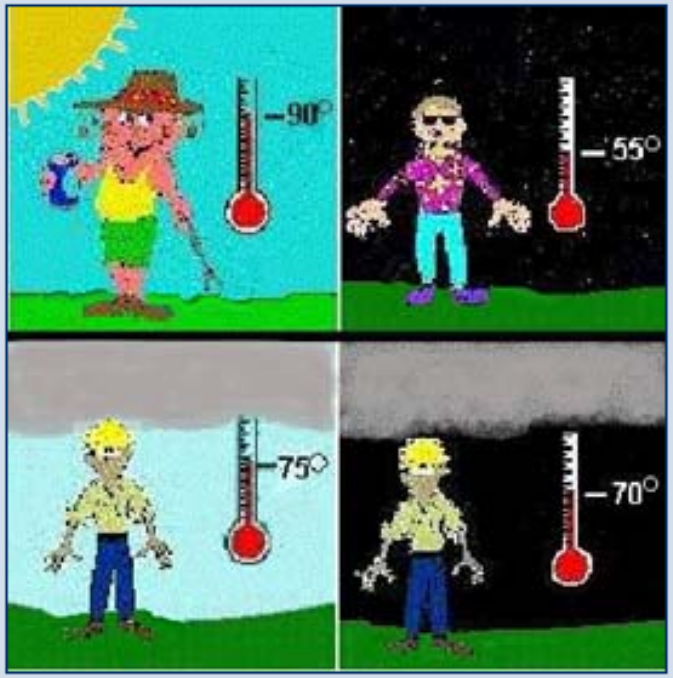
January - Change per century (degrees F)

	Minimum	Maximum	Difference
Anderson	-5.2		4.9
Aiken	-5.2		4.9
Newberry	-3.3		4.4
Chester	-4.8	-6.7	
Sumpter	-6.9	-4.9	2.1
Walterboro	-5.5	-7.1	
Miledgeville	-7.7	-2.9	4.8
Hawkinsville		-2.6	
Washington	-2.6		3.1
Thomasville	-2.0		2.4
Talladega	-5.9	-3.6	2.2
Troy	-6.3	-4.9	1.5
Selma	-2.8	-3.6	
Anniston			
Monticello	-7.0	-6.9	
Brookhaven	-3.8	-3.5	
Batesville	-3.6	-4.4	
Kosciusko	-5.0	-3.7	1.5
Ruston	-5.0	-5.2	
Miden	-3.4	-3.8	
Camden	-3.1	-2.8	

Slopes with P > 0.1 not shown

A change in cloud cover might explain the increase in the difference between day and night temperatures

Effect of Clouds on Temperature



You are probably aware that the presence of clouds affects the temperature. But you may not know exactly how they affect it.

Clouds tend to **moderate*** the air temperature

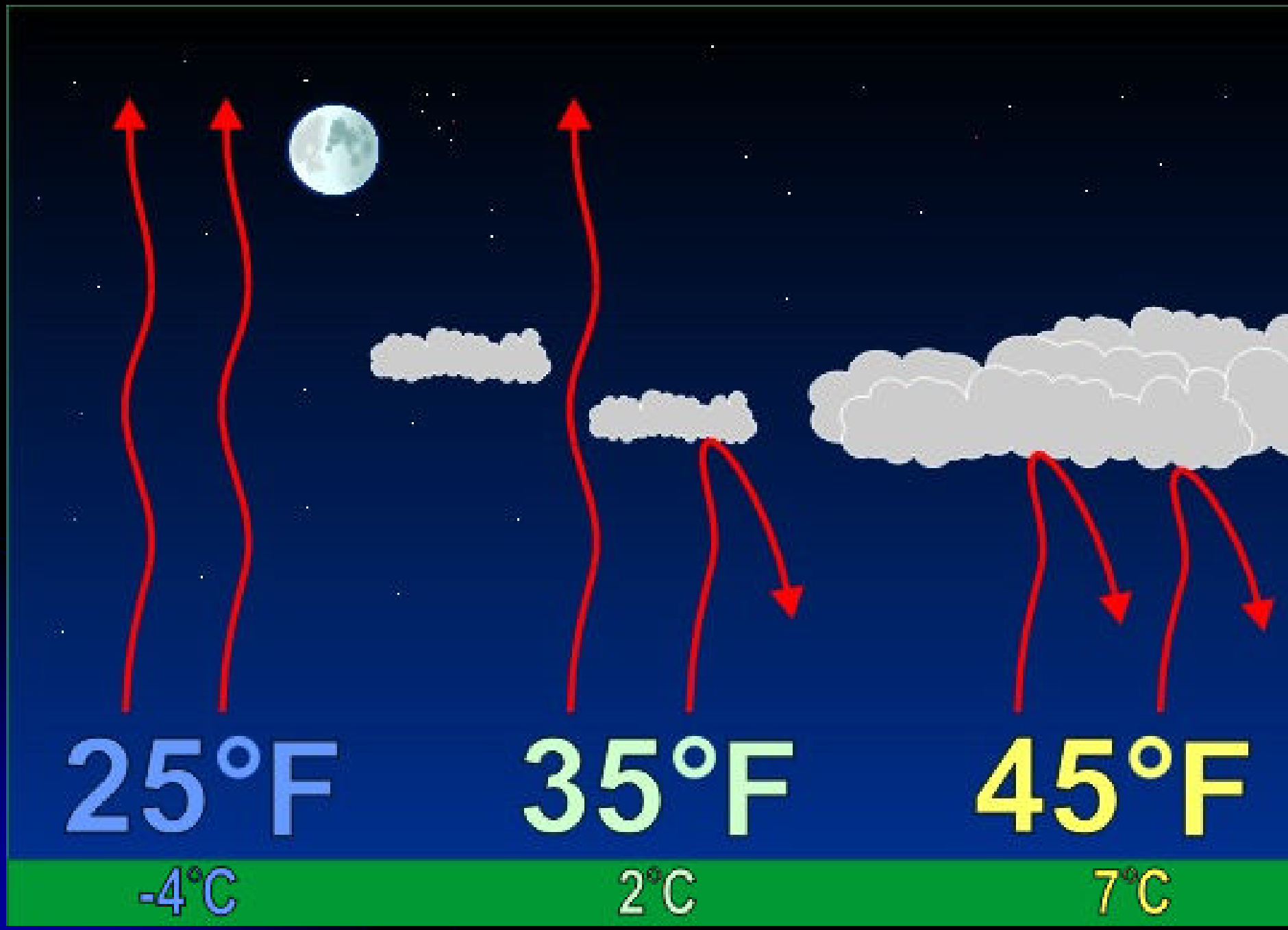
- Daytime clouds block sunlight, preventing the temperature from going up as much as it would have with no clouds.
- Nighttime clouds hold in heat like a blanket, preventing the temperature from going as low as it would have without clouds.

Clear skies mean cooler nights and warmer days.

Cloudy skies mean less difference between daytime highs and nighttime lows.

Cloud changes since 1952 have had a net cooling effect on the Earth

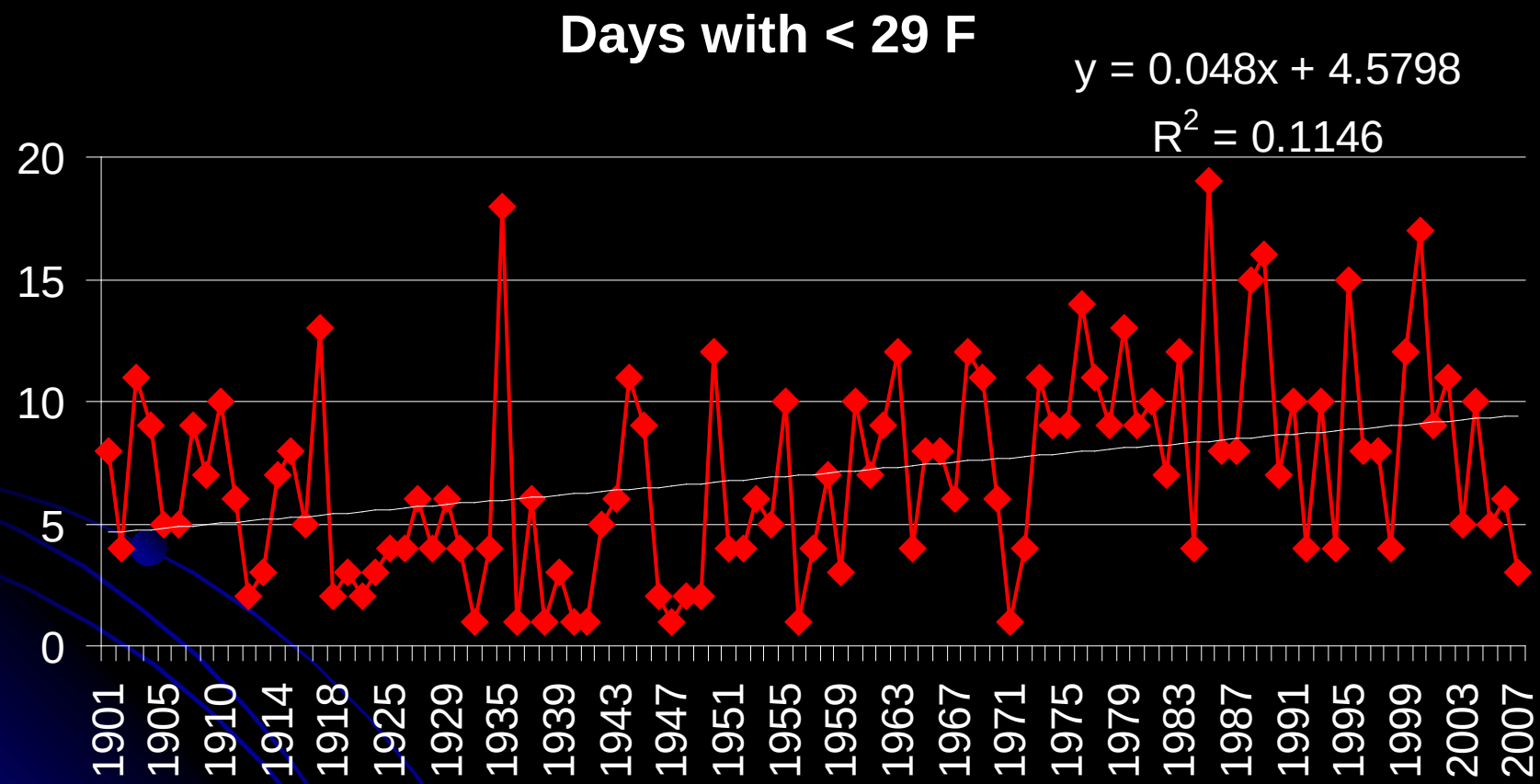
(Joel Norris – Scripps Institution of Oceanography)


25°F
35°F
45°F
-4°C
2°C
7°C

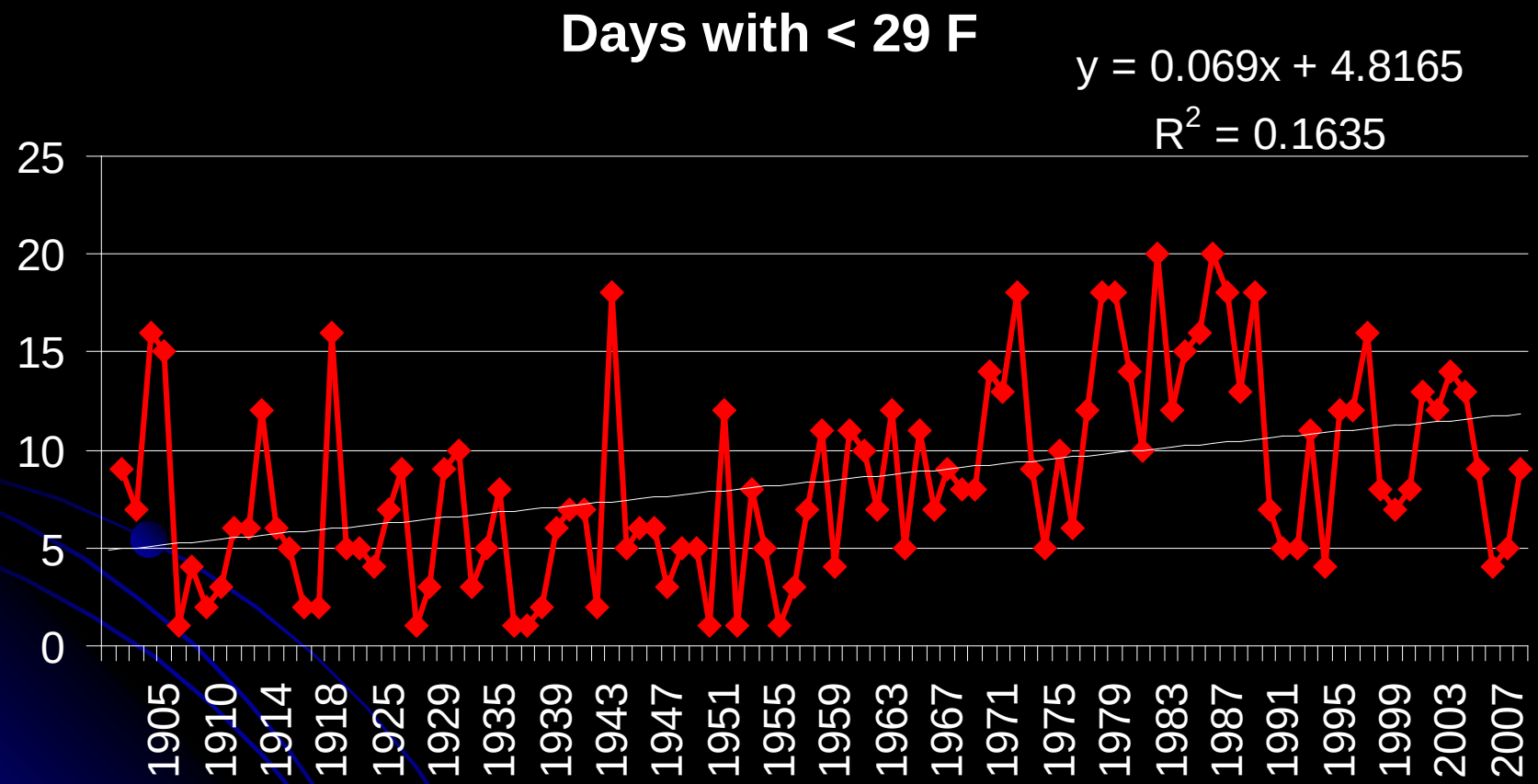
- Less clouds during the night means colder nighttime temp.
- Less clouds during the day means higher daytime temps.
- Wider differences in temp for Dec and Jan may mean less clouds in those months.

FREEZE TRENDS
< 29 degrees F

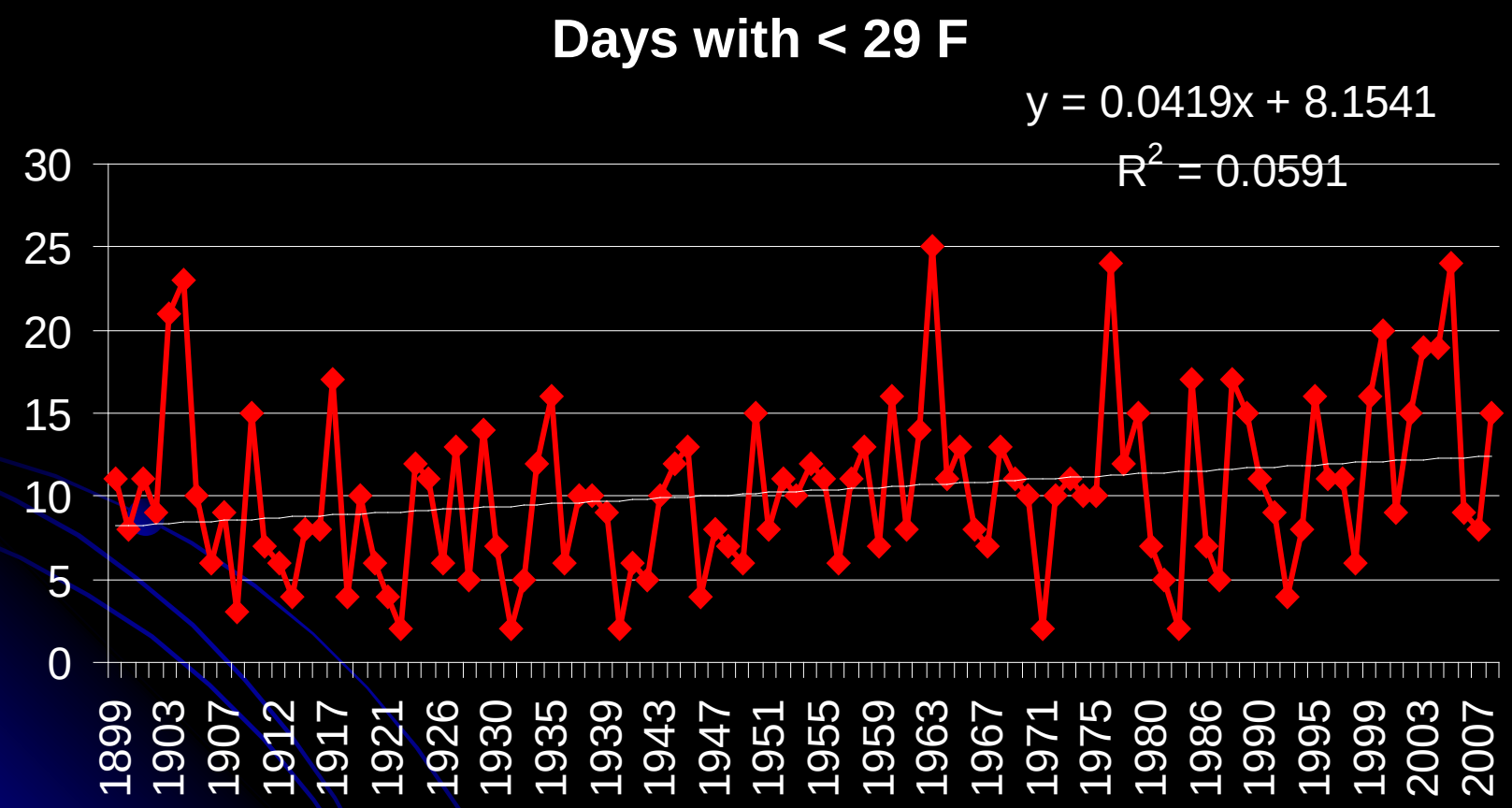
Aiken, SC - December



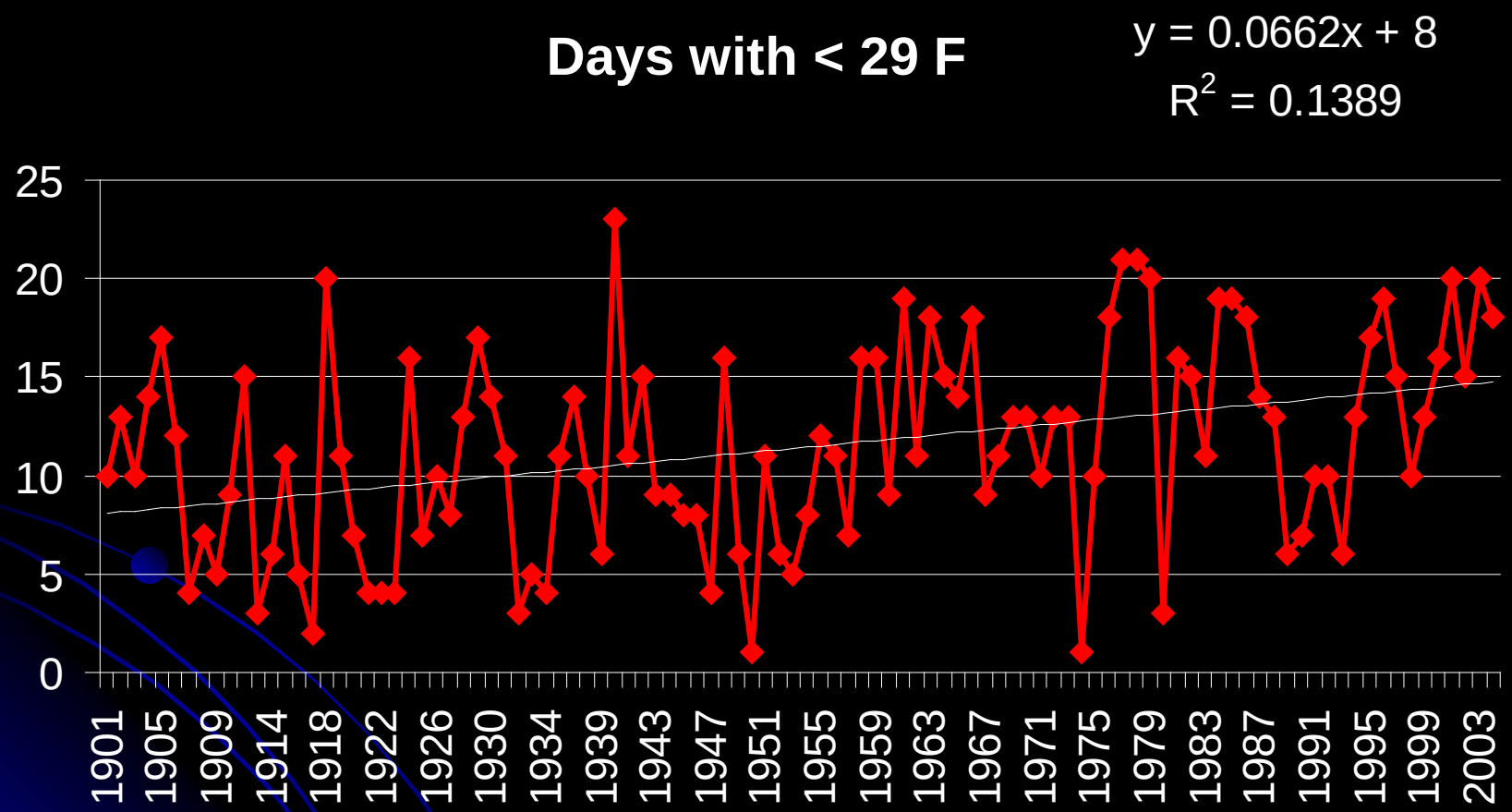
Aiken, SC - January



Taladega, AL - December



Taladega, AL - January



Extra days of freeze (<29 degrees F)

SC

GA

AL

MS

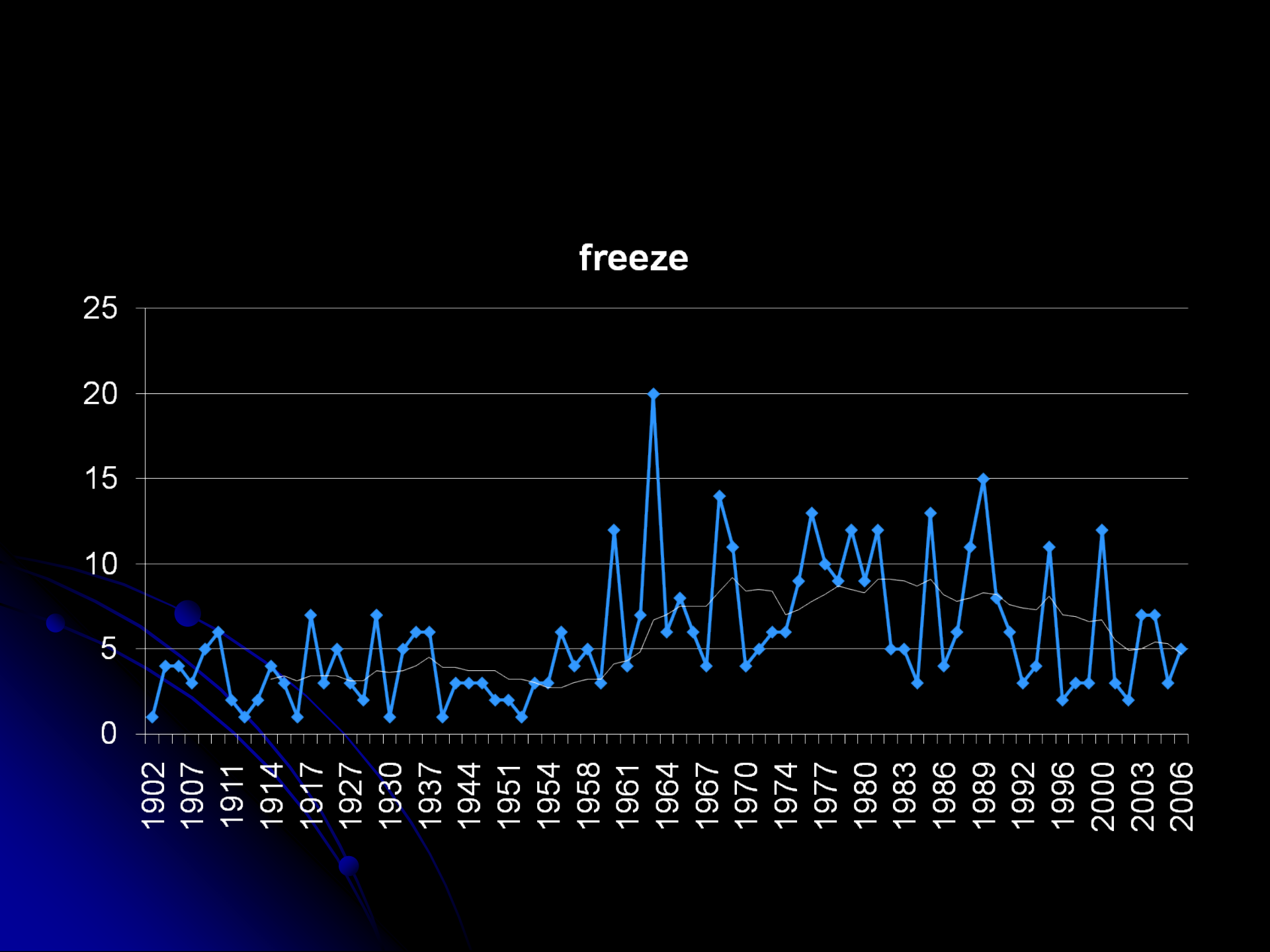
LA

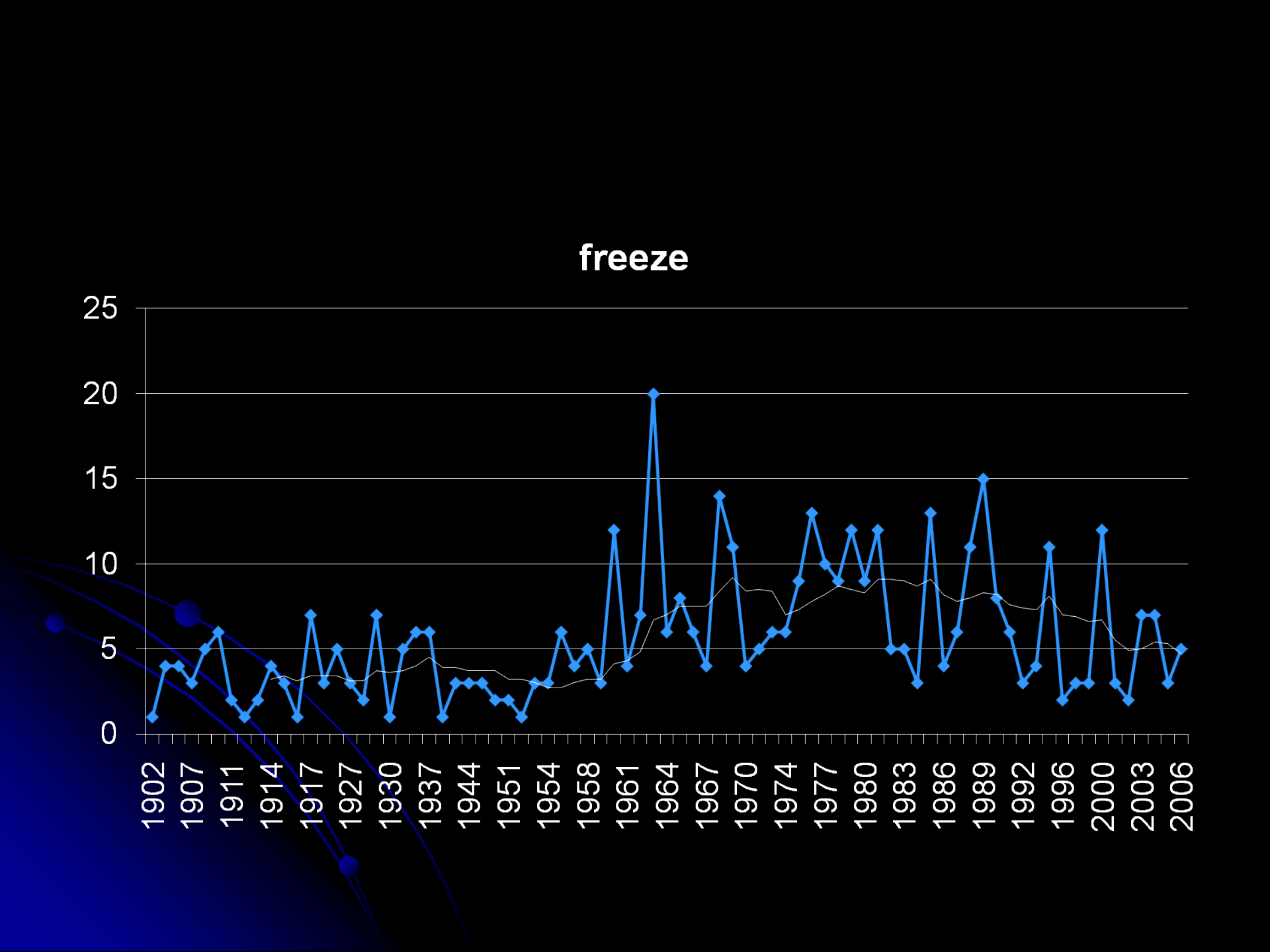
	December	January
Anderson	3.2	5.6
Aiken	4.6	6.0
Newberry	2.7	5.4
Chester	7.6	8.2
Sumpter		7.3
Walterboro		4.9
Miledgeville	4.9	7.5
Hawkinsville		
Washington	3.4	6.6
Thomasville		4.7
Talladega	3.6	6.2
Troy		
Selma	2.0	4.0
Anniston	-6.6	
Monticello	2.7	5.7
Brookhaven		3.5
Batesville	3.2	4.8
Kosciusko	3.9	6.1
Ruston	2.1	4.3
Miden	2.0	3.9
Camden AR		4.5

Conclusions

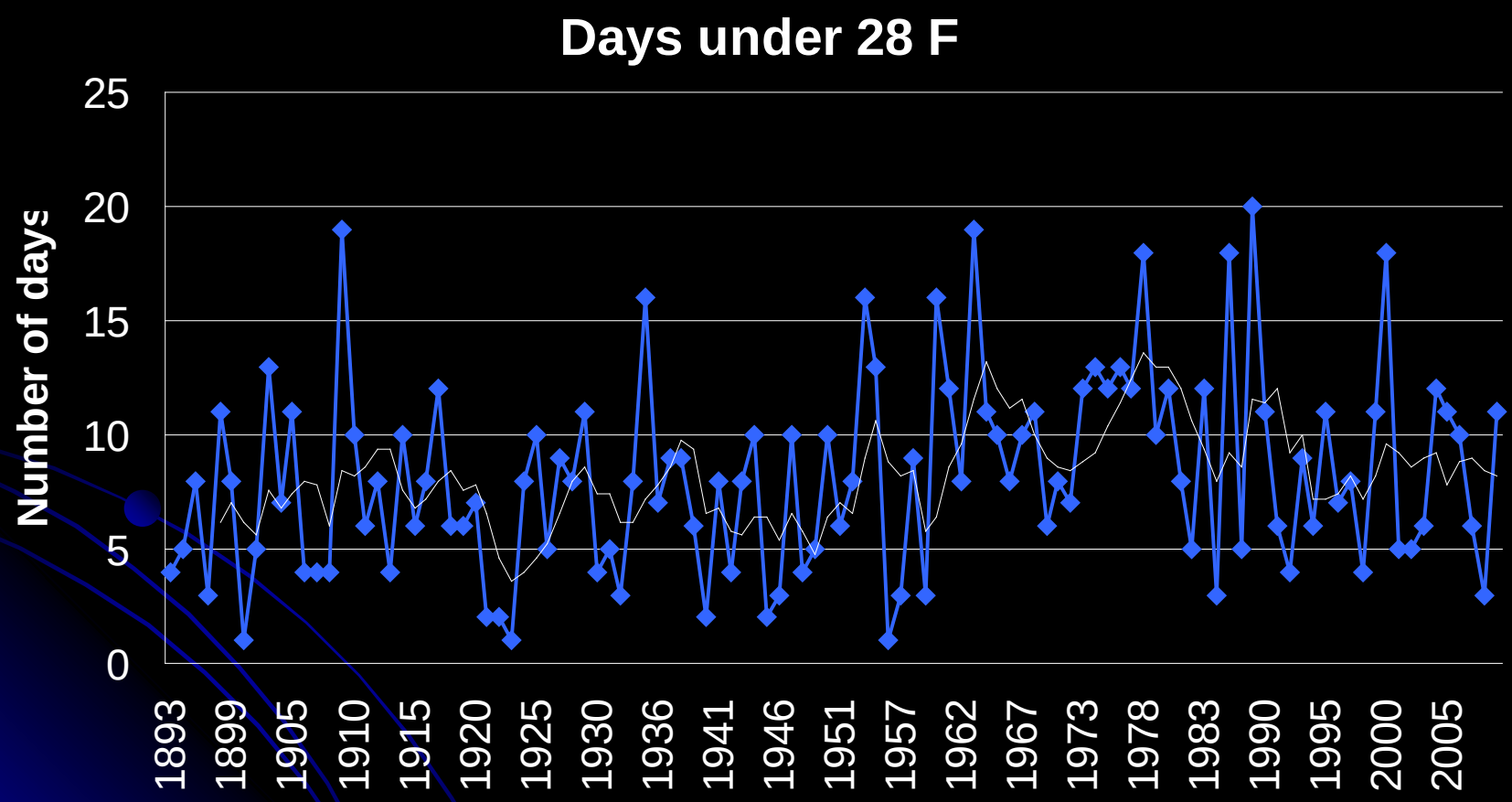
- At 19 out of 21 locations, the average minimum temperature in January is now 2 to 7° F cooler now than 100 years ago.
- At 15 out of 21 locations, the average maximum temperature in December is now 2 to 7° F cooler now than 100 years ago.
- At 18 out of 21 locations, the number of hard freezes (<29F) has increased (often doubled).
- Fewer clouds in Dec and Jan might account for the increase in frequency of hard freezes.

Questions?


freeze
25
20
15
10
5
0
1902
1907
1911
1914
1917
1927
1930
1937
1944
1951
1954
1958
1961
1964
1967
1970
1974
1977
1980
1983
1986
1989
1992
1996
2000
2003
2006


freeze
25
20
15
10
5
0
1902
1907
1911
1914
1917
1927
1930
1937
1944
1951
1954
1958
1961
1964
1967
1970
1974
1977
1980
1983
1986
1989
1992
1996
2000
2003
2006

Kosciusko, MS



December
Change per century (degrees F)

	Minimum	Maximum	Difference
Anderson	-2.1	2.5	4.6
Aiken	-4.3	2.5	6.7
Newberry		3.2	4.7
Chester			
Sumpter			
Walterboro			
Miledgeville	-5.3		5.8
Hawkinsville			
Washington			
Thomasville			
Talladega	-2.5		2.7
Troy	-3.7		1.9
Selma			
Anniston			-3.6
Monticello	-4	-2.7	
Brookhaven		-1.3	
Batesville	-2.3		1.3
Kosciusko	-2.3		1.4
Ruston			
Miden			
Camden			

Conclusion

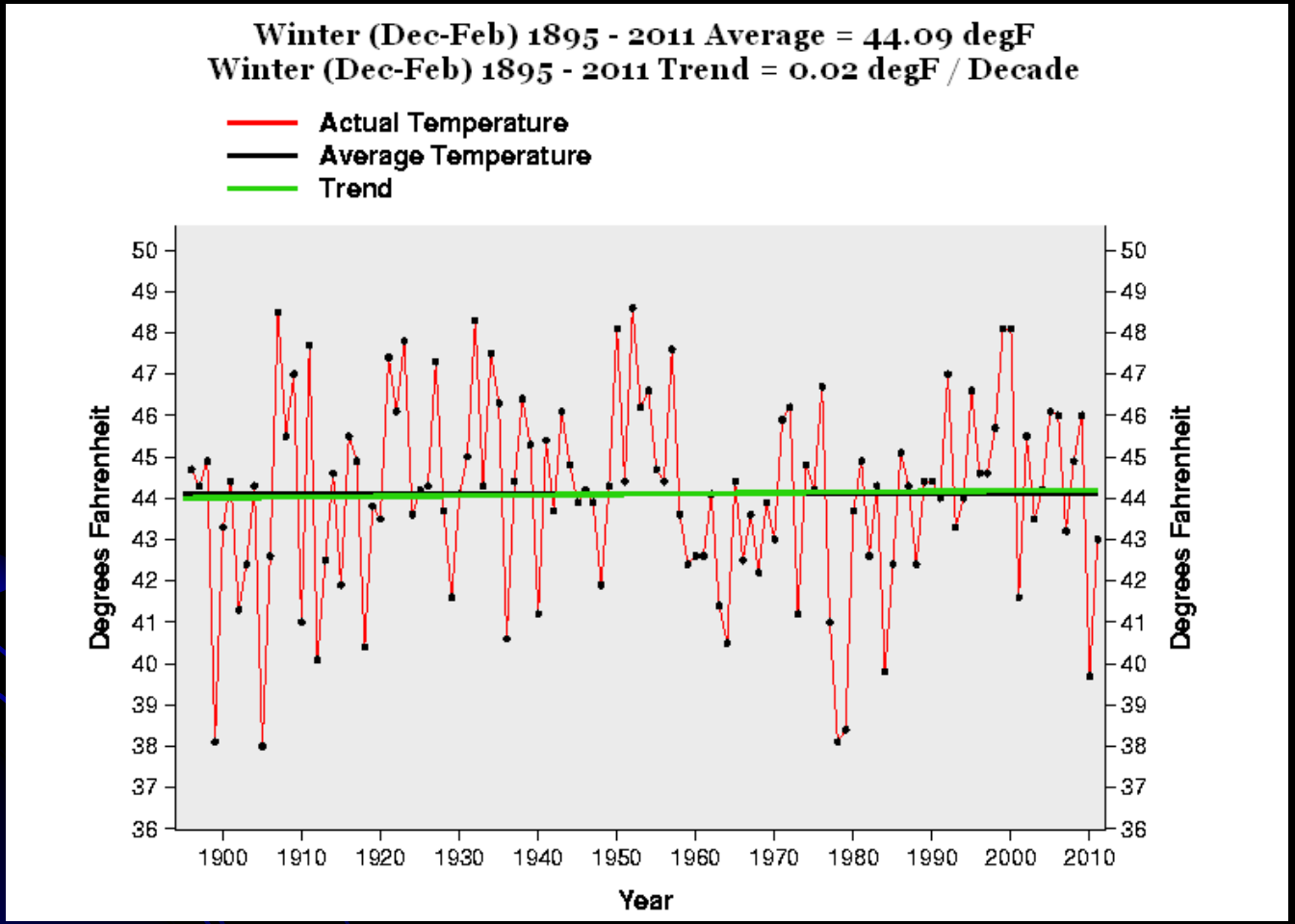
- At 8 out of 21 locations, the average minimum temperature in December is now 2 to 5 °F cooler now than 100 years ago.

- At 8 out of 21 locations, the average daily difference (max-min) in December temperature 1 to 6 °F greater now than 100 years ago.

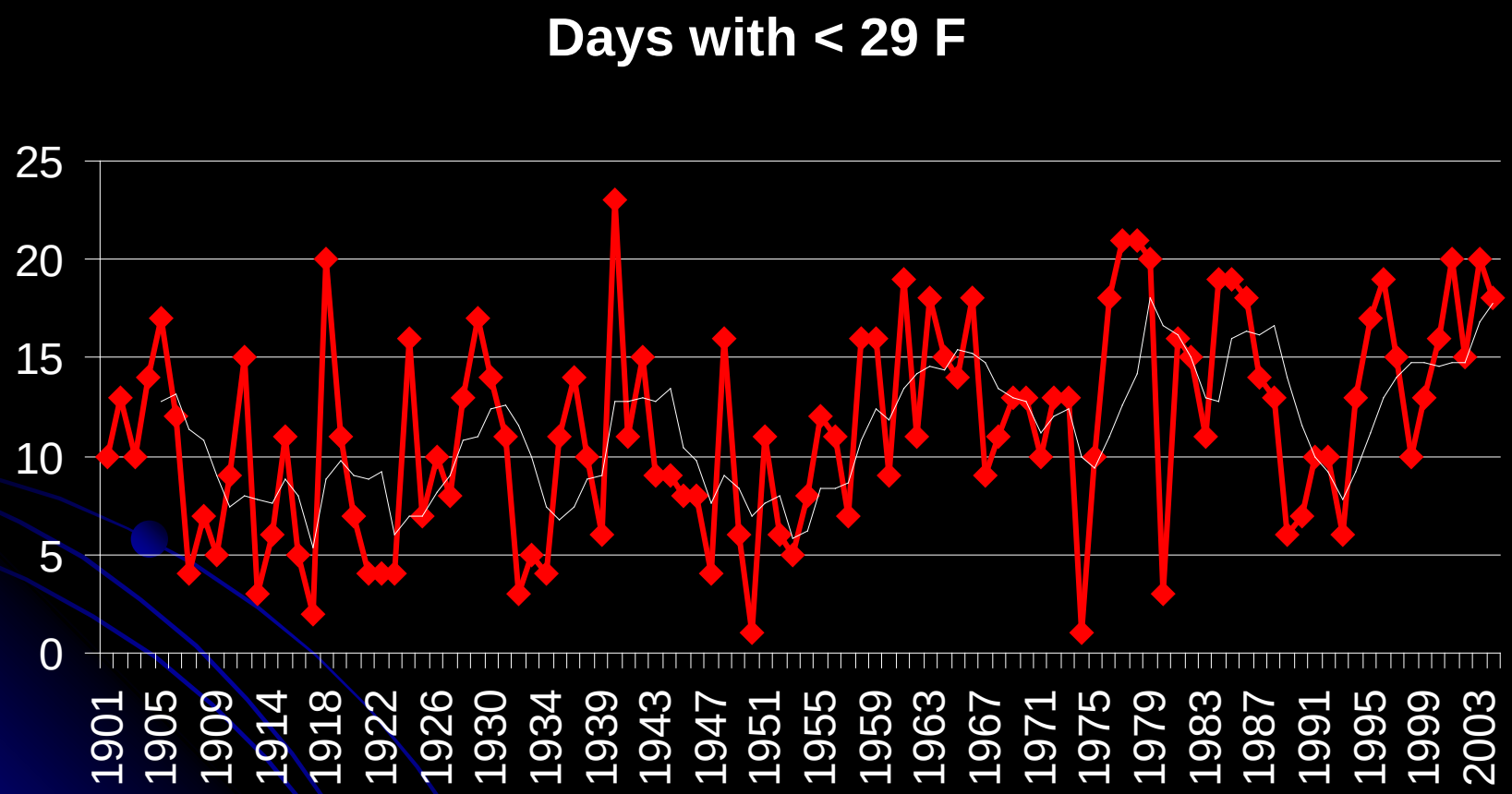
Summary

- Overall, there is no trend in average temperature for the southeastern states.
- For December and January, it seems the minimum daily temperature has decreased at several locations.

No trend in winter avg. temperature (South)



Taladega, AL - January



Average max temperature

NORMALS 1971-2000	DEC	DEC
BIRMINGHAM AP, AL	35.2	56.0
HUNTSVILLE, AL	33.8	52.4
MOBILE, AL	41.6	62.9
MONTGOMERY, AL	37.6	60.3
FORT SMITH, AR	31.1	50.9
LITTLE ROCK, AR	33.9	52.5
NORTH LITTLE ROCK, AR	34.9	51.9
ATHENS, GA	35.3	54.2
ATLANTA, GA	36.2	54.6
AUGUSTA, GA	34.7	59.1
COLUMBUS, GA	39.0	59.2
MACON, GA	36.3	59.2
SAVANNAH, GA	40.1	62.6
BATON ROUGE, LA	42.1	62.8
LAKE CHARLES, LA	43.3	63.3
NEW ORLEANS, LA	45.6	64.5
SHREVEPORT, LA	38.3	58.5
JACKSON, MS	37.3	57.9
MERIDIAN, MS	37.2	60.5
TUPELO, MS	33.2	53.6
CHARLESTON AP, SC	39.3	61.6
CHARLESTON C.O., SC	45.5	60.0
COLUMBIA, SC	36.1	57.8
GREENVILLE-SPARTANBURG AP,	34.3	52.7

37 F 58 F = 21 difference

	Temperature Change in °F	
	1901-2008	1970-2008
Annual	0.3	1.6
Winter	0.2	2.7
Spring	0.4	1.2
Summer	0.4	1.6
Fall	0.2	1.1

AL, FL, GA, SC, NC, VA

AR, LA, MS TN, KY, part of TX

	Temperature Change in °F	
	1901-2008	1970-2008
Annual	0.0	0.3
Winter	0.0	0.4
Spring	0.0	0.2
Summer	0.0	0.3
Fall	0.0	0.5

AL, FL, GA, SC, NC, VA

	Temperature Change in °F	
	1901-2008	1970-2008
Annual	0.3	1.6
Winter	0.2	2.7
Spring	0.4	1.2
Summer	0.4	1.6
Fall	0.2	1.1

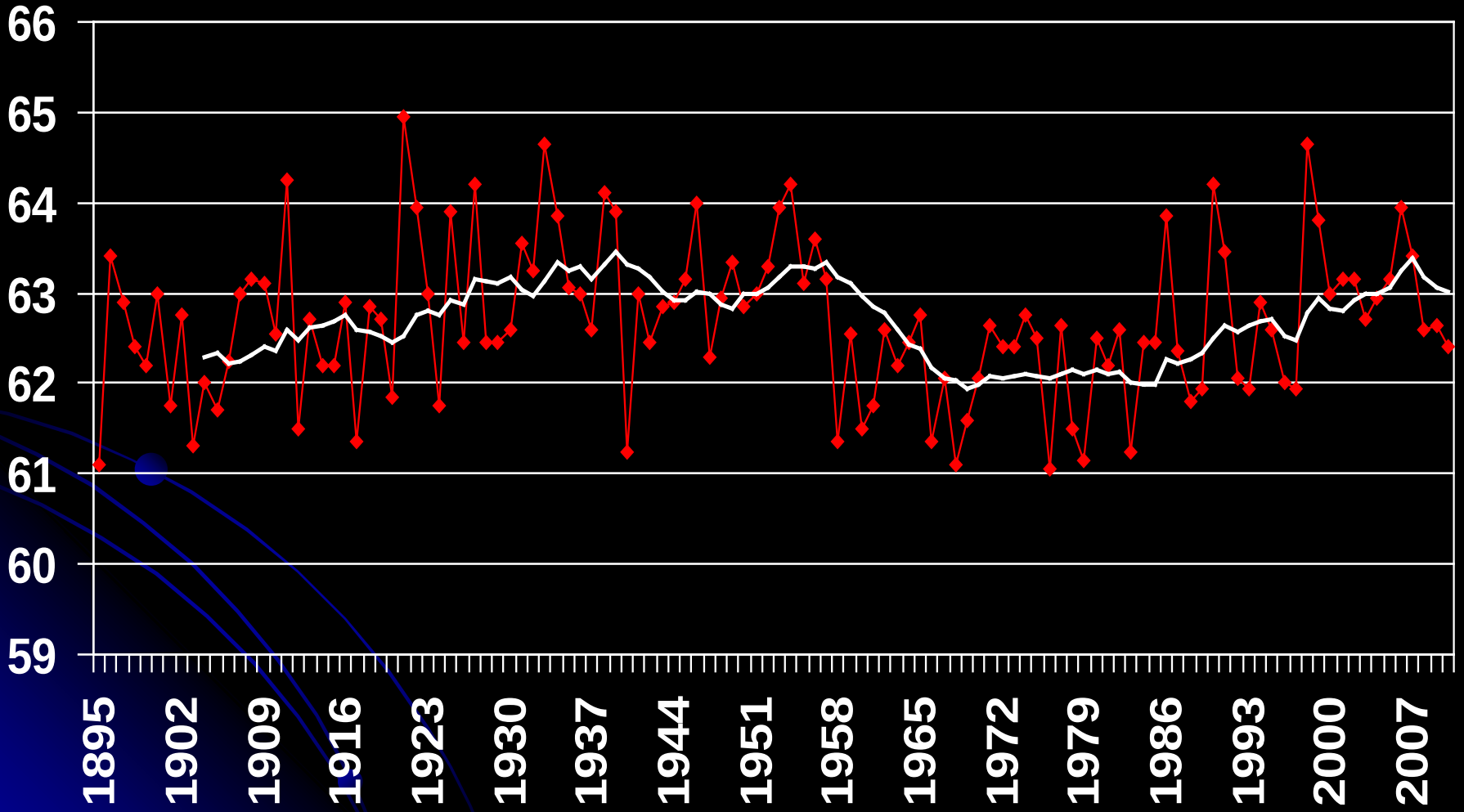
AL, FL, GA, SC, NC, VA

AR, LA, MS TN, KY, part of TX

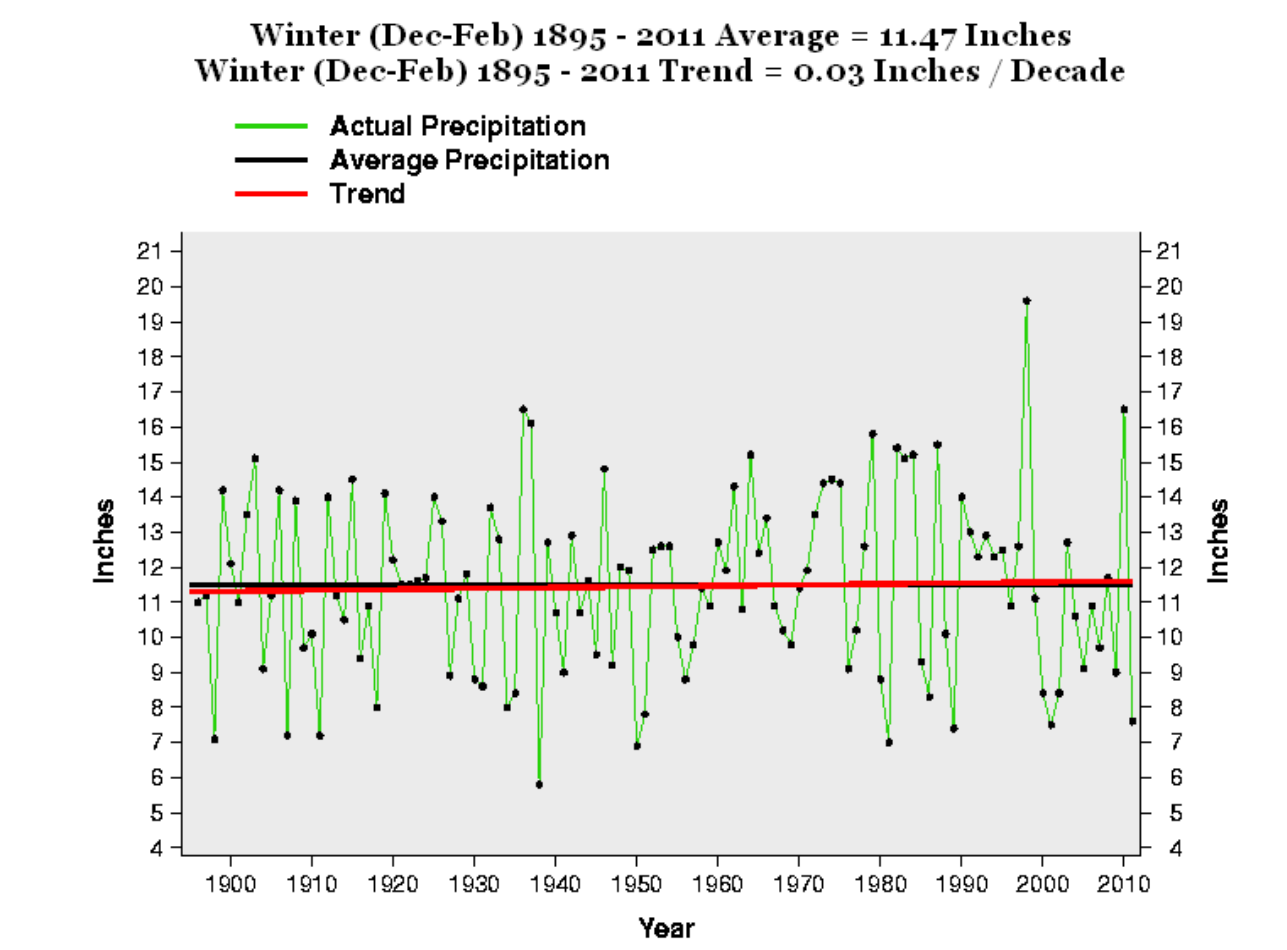
	Temperature Change in °F	
	1901-2008	1970-2008
Annual	0.0	0.4
Winter	0.0	0.4
Spring	0.06	0.2
Summer	0.0	0.3
Fall	-0.06	0.5

AR, LA, MS TN, KY, TX, OK, KS

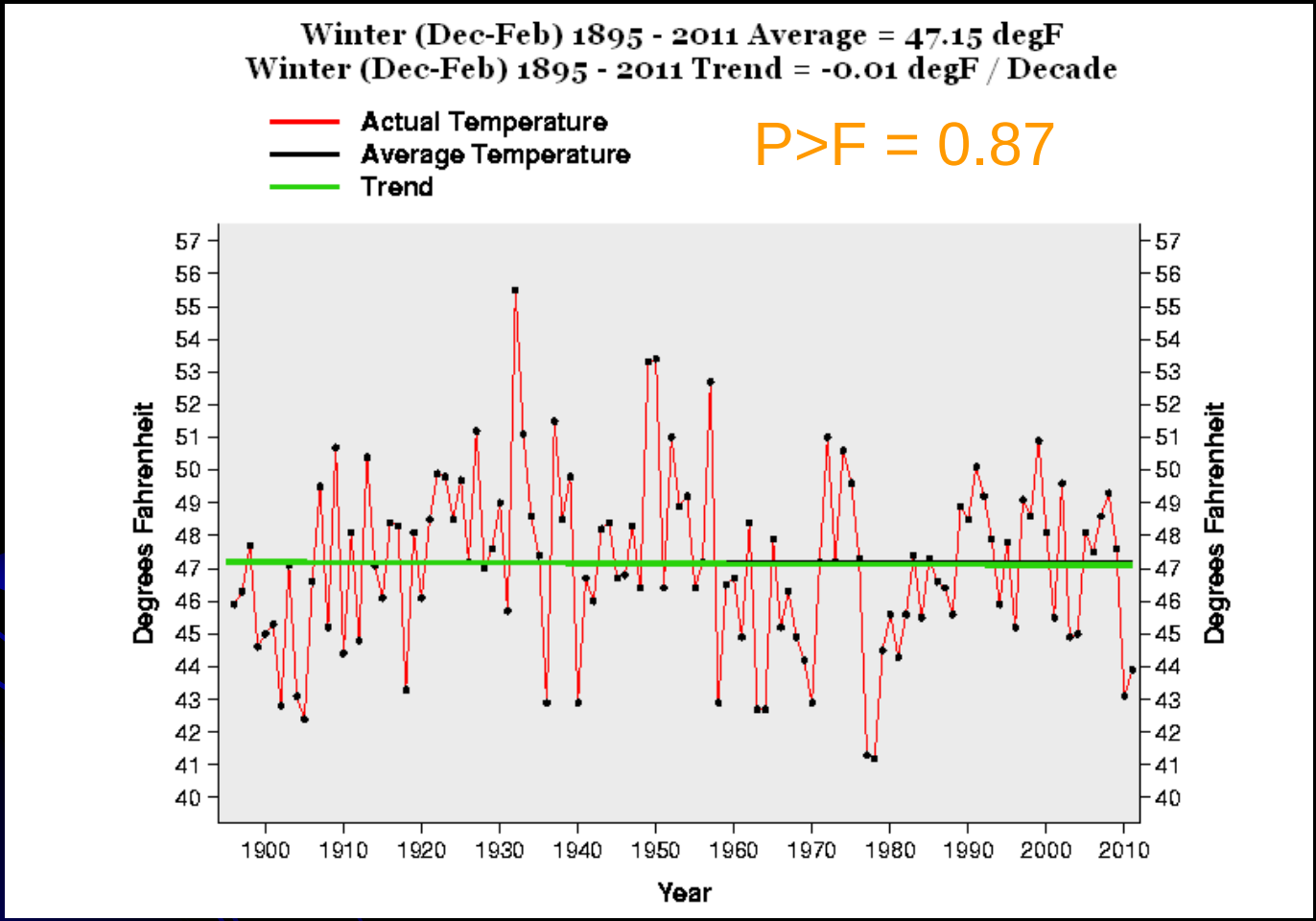
Annual temp – Both



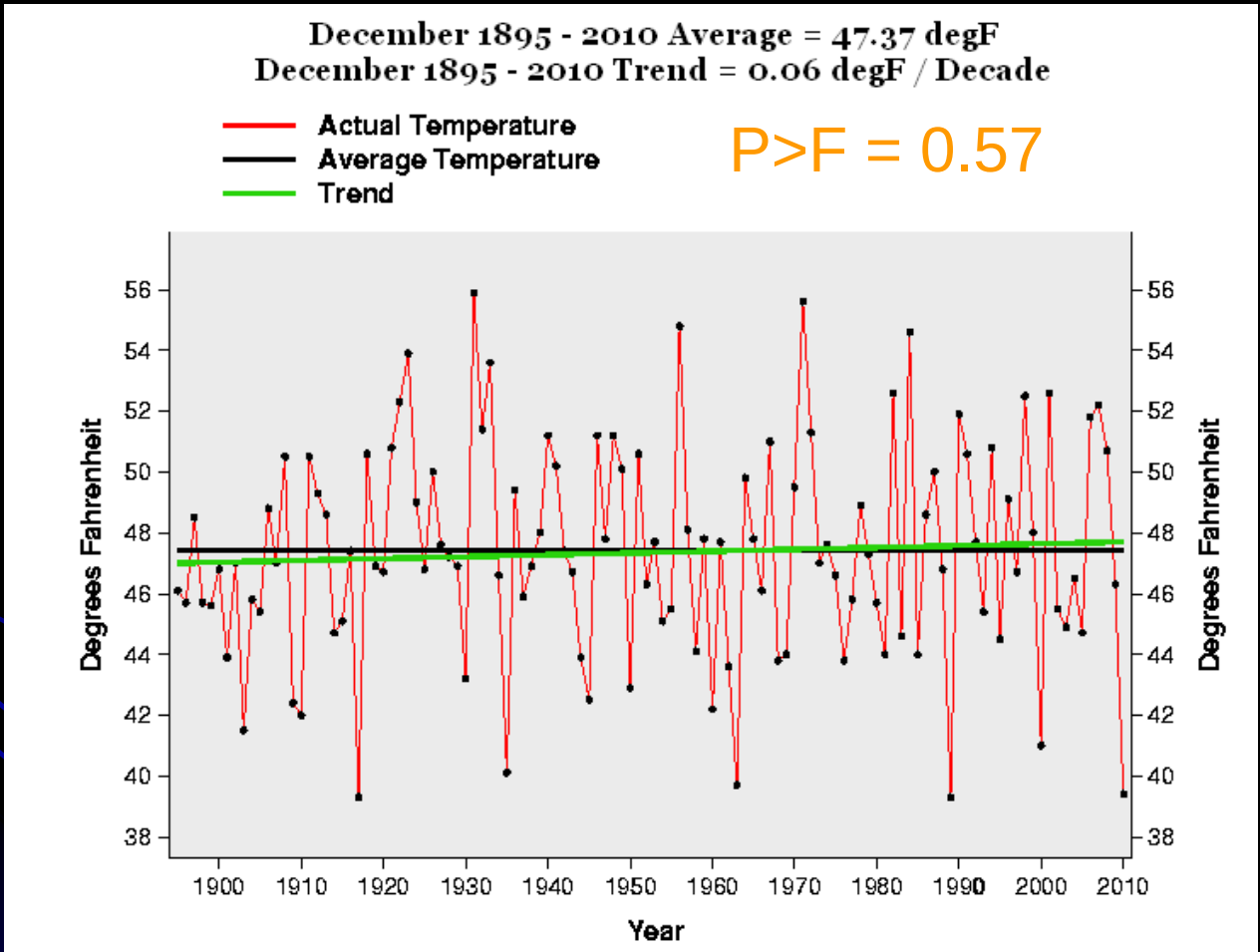
No trend in winter rainfall (SE)



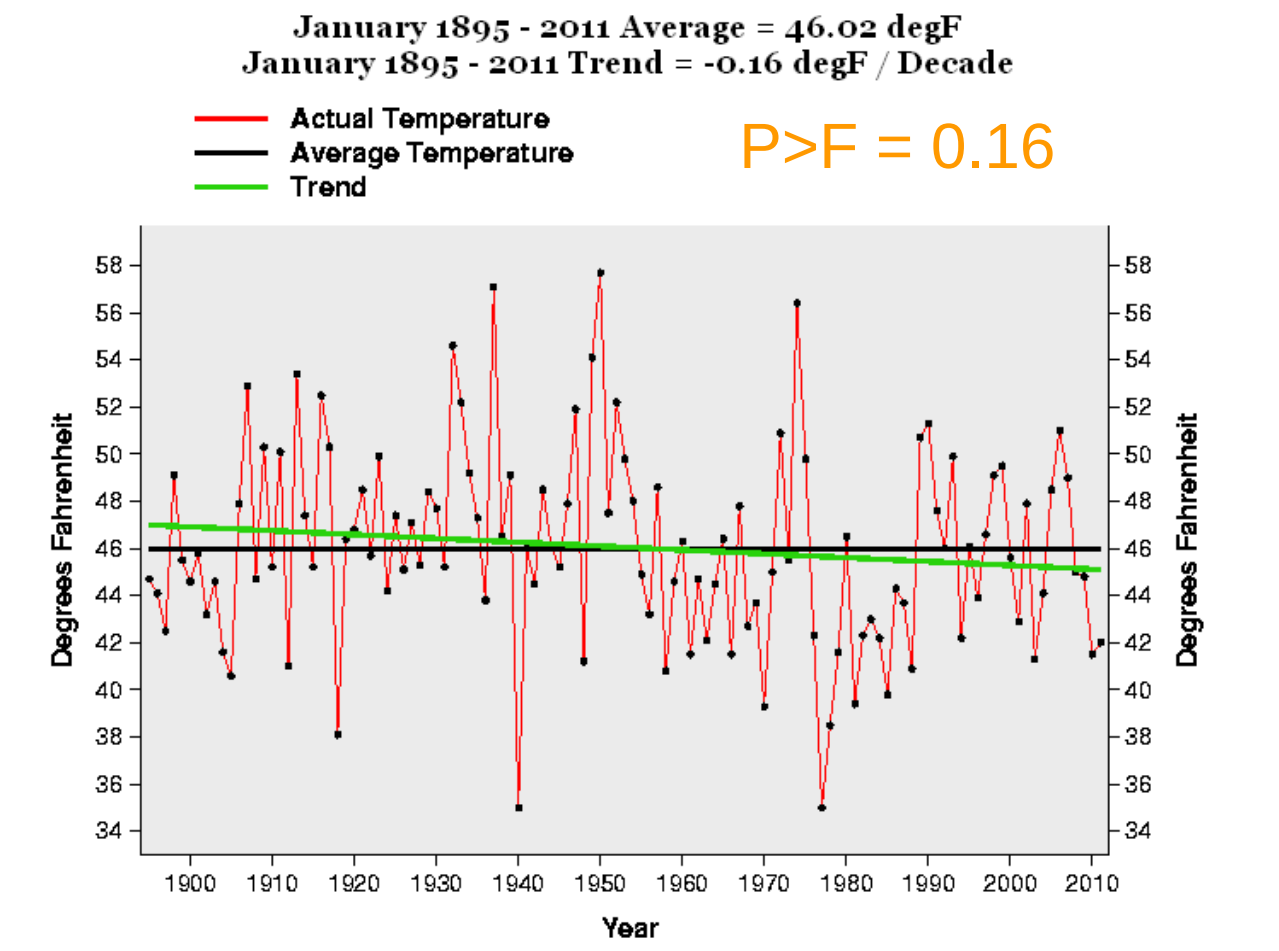
No trend in winter avg. temperature (SE)



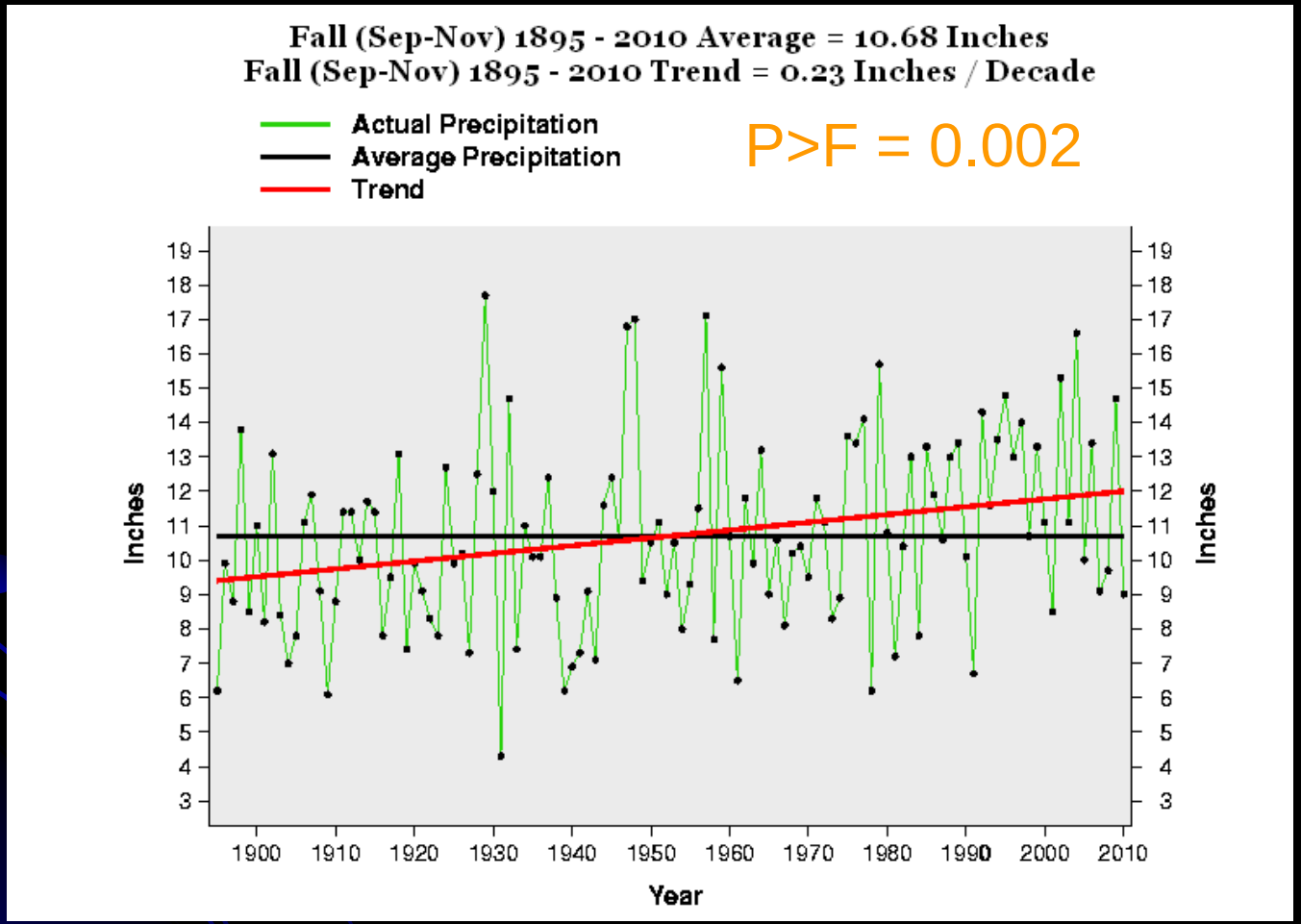
No trend in December avg. temperature (SE)



No trend in January avg. temperature (SE)



Fall is 2.3 inches wetter now than back in 1910 (SE)



Change in Freezing Days per Year

1976 to 2007