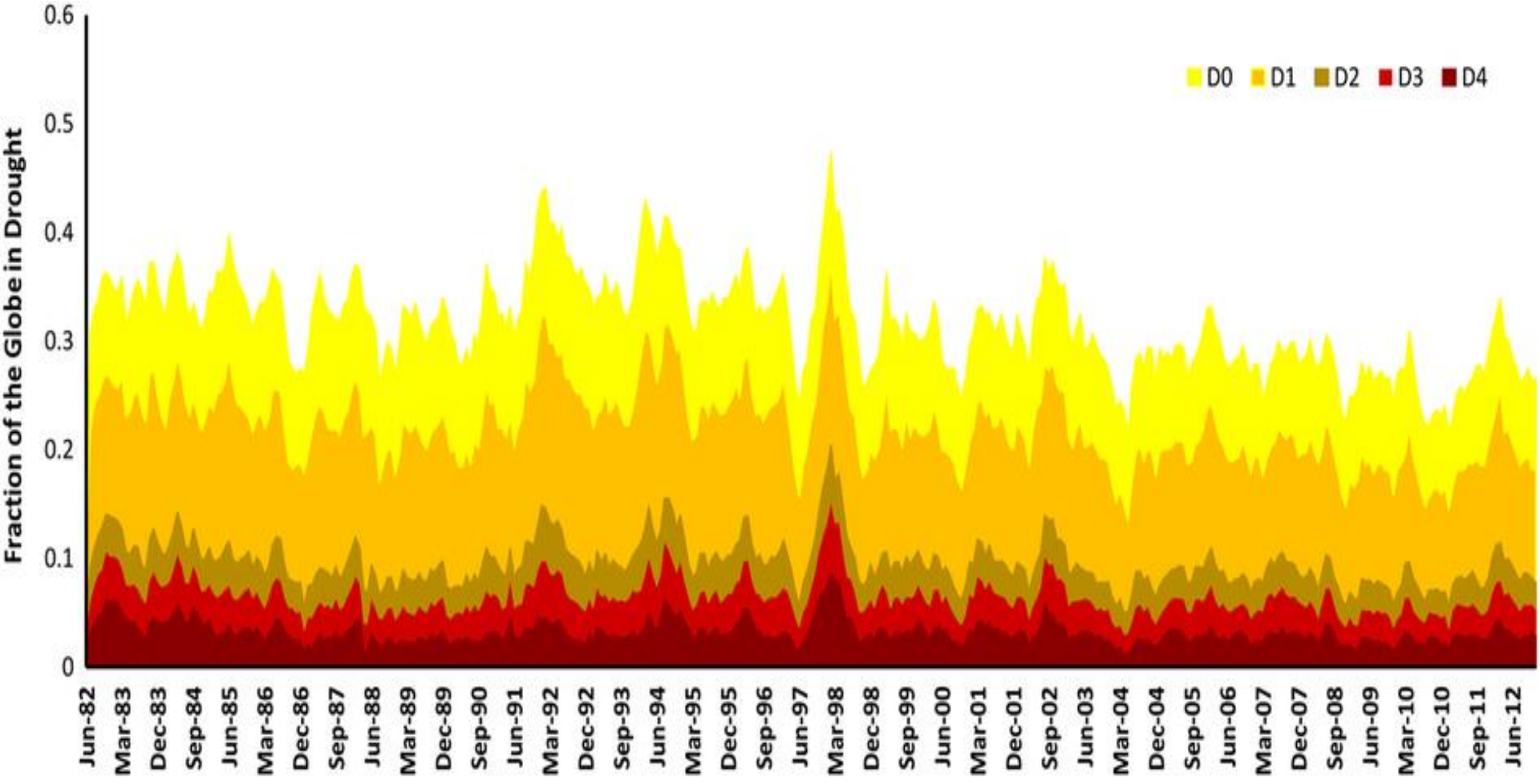
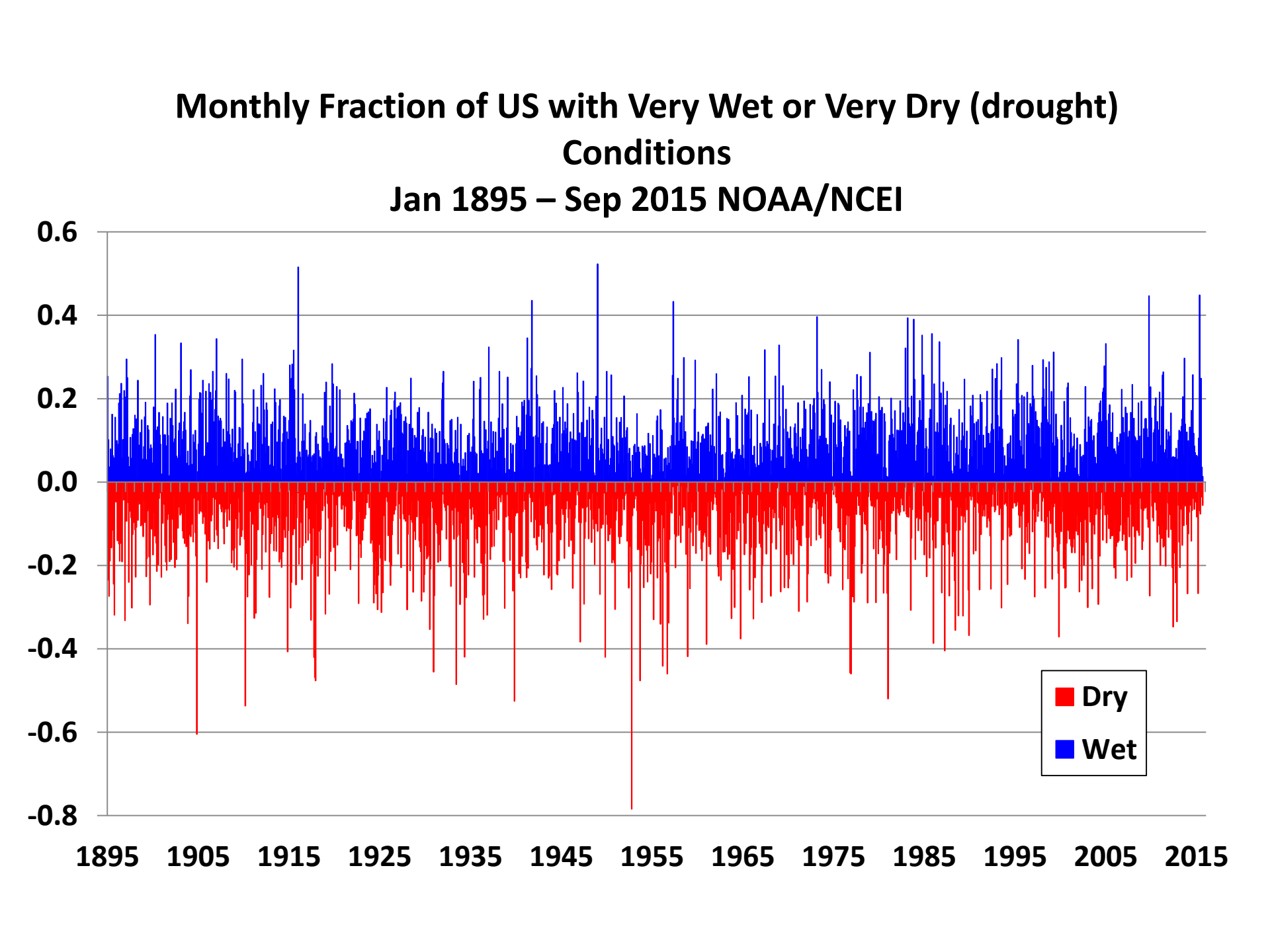
Climate Perspective Instrumental and Model

John R. Christy
Alabama State Climatologist
The University of Alabama in Huntsville
Richard McNider

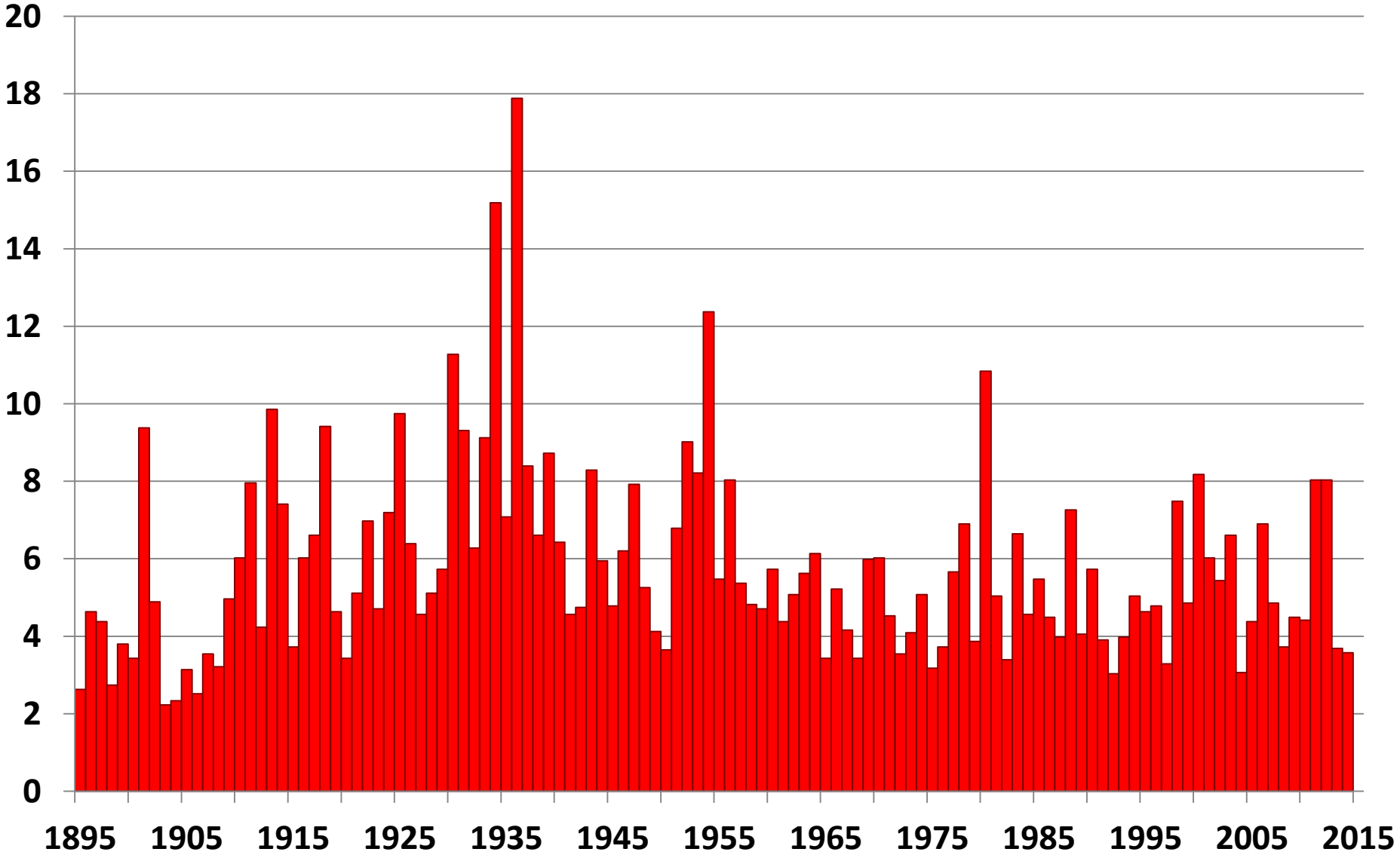
Global Drought Indices 1982-2012



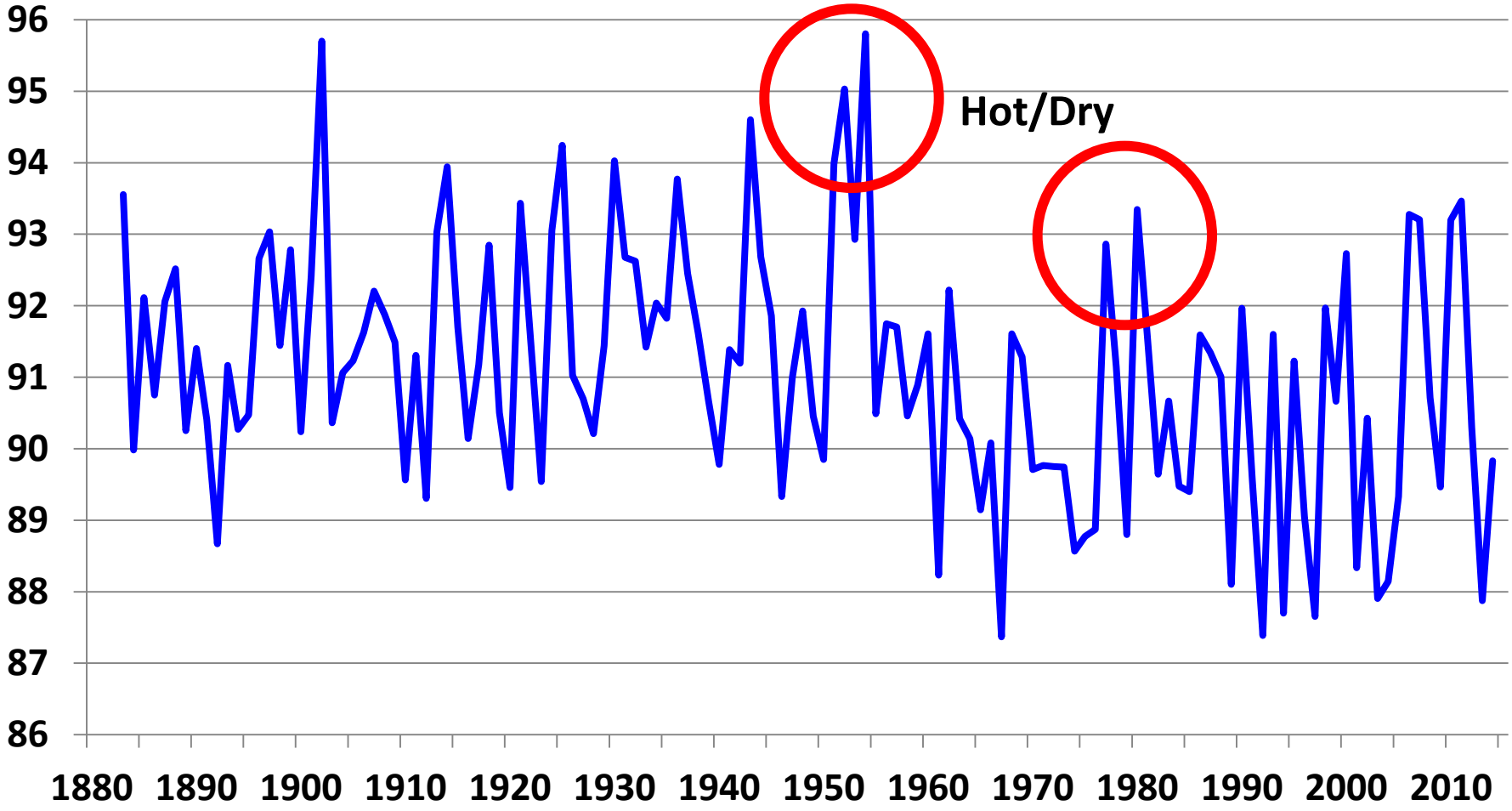
Hao et al. 2014


Monthly Fraction of US with Very Wet or Very Dry (drought) Conditions
Jan 1895 – Sep 2015 NOAA/NCEI
0.6
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
1895
1905
1915
1925
1935
1945
1955
1965
1975
1985
1995
2005
2015
Dry
Wet

Average Number of Daily High Temperatures at 982 USHCN Stations exceeding 100°F per year 1895-2014



Alabama Summer Daily Maximum Temperature
Average of 4, 100-mile-diameter regions centered on MOB, MGM, BHM and HSV, 1883-2014

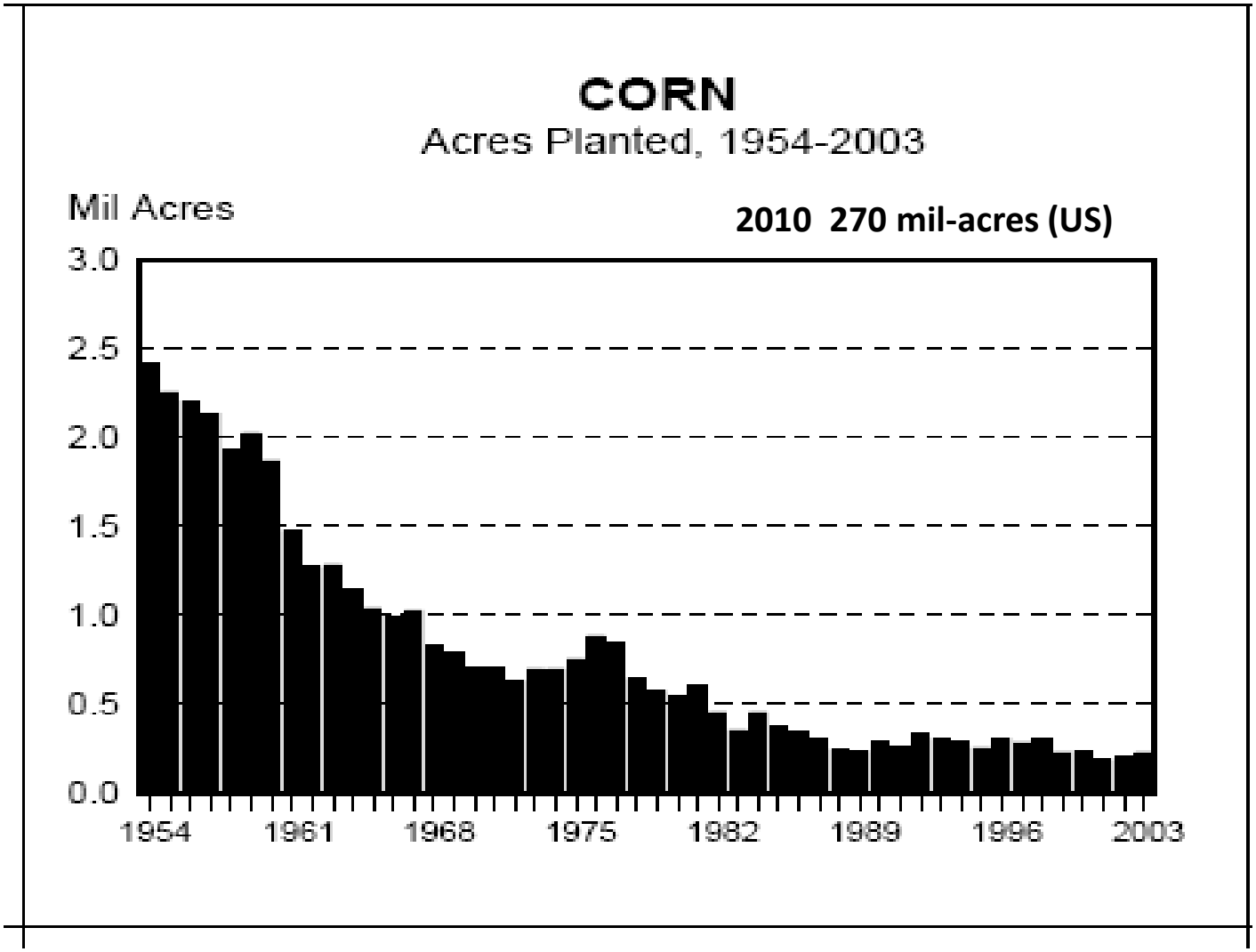


THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

J. Christy Alabama State Climatologist,
The University of Alabama in Huntsville

AOSC THE ALABAMA OFFICE OF THE STATE CLIMATOLOGIST UAHuntsville

Alabama Acres Planted
(Nearly all rain-fed)



San Joaquin Valley Climate

What's Going On?

January 1969: My personal observations

January 1969

T	F	1	–	10	42	42	39	41	24	30.28	SW	0	89	T		
	F	2	–	10	42	42	39	41	24	30.26	NW	2	86			
G	F	3	–	10	42	43	39	41	24	30.31	– N	0	76			
	F	4	–	10	42	42	37	40	25	30.22	– N	2	82			
	F	5	–	10	41	41	38	40	25	30.15	– SE	4	86	T		
T	F	6	–	10	41	41	37	39	26	30.15	– N	0	86	T		
T	F	7	–	10	41	41	37	39	26	30.03	– SE	0	86	T		
.04	F	8	(Thing)	10	40	41	38	40	25	30.02	– N	2	89	.04		
H	F	9		10	44	44	40	42	23	29.92	– SW	0	76			
	F	10		9	43	45	35	40	25	30.00	– SE	3	70			
	T	11		10	49	49	36	43	22	29.88	– S	0	77	T		
	T	12		10	56	56	40	48	17	29.81	– SE	6	66	T		
.94		13		10	53	54	49	52	13	29.79	– SE	2	66	1.38		
.10		14		9	50	53	43	48	17	29.95	+ NW	10	80	.66		
	I	15		8	50	53	38	46	19	30.12	– NW	8	61			
		16		10	48	48	37	43	22	30.09	– SW	4	71	T		
		17		9	51	53	31	42	23	30.10	– E	0	66			
.96		18		10	47	55	38	47	18	29.80	– SE	10	90	.87		
1.18		19		10	56	58	55	57	8	29.68	SE	12	87	1.27		
.70		20		10	61	64	54	59	6	29.71	– SE	2	75	.15		
T		21		8	60	62	56	57	8	29.73	+ SE	0	70	.82		
	T	22		9	50	52	39	46	19	30.09	NE	2	46	.07		
.10		23		10	46	47	32	40	25	30.07	– W	6	68	.01		
.58		24		10	56	58	43	51	14	29.79	– SE	10	89	.56		
1.14		25		9	61	63	55	60	5	29.67	SE	14	75	2.14		
.38		26		8	54	62	43	53	12	29.88	+ NE	2	51	.49		
K	T	27		4	52	53	41	47	18	29.92	– SW	0	54	T		
T		28		7	44	47	35	41	24	29.82	– NW	10	73	.19		
		29		3	48	48	31	40	25	30.25	SE	6	53			
SNOW		30		4	43	44	32	38	27	30.23	W	10	74	.07		
	F	31	–	5	39	39	31	35	30	30.36	– NE	2	76			
		Average		8.4	48.2	49.7	39.8	44.8	17.7			SE	4.1	70.5	.25	
1.94		Hi Extreme		10	61	64	57	60	30	30.36		SE	14	90	1.38	
		Lo Extreme		1	40	39	31	35	5	29.67		9	0	46	T	
		Normal			53	55.4	36.7	46.1	58.2					67	2.1	
		Total		265	1493	1545	1232		619				129		7.72	

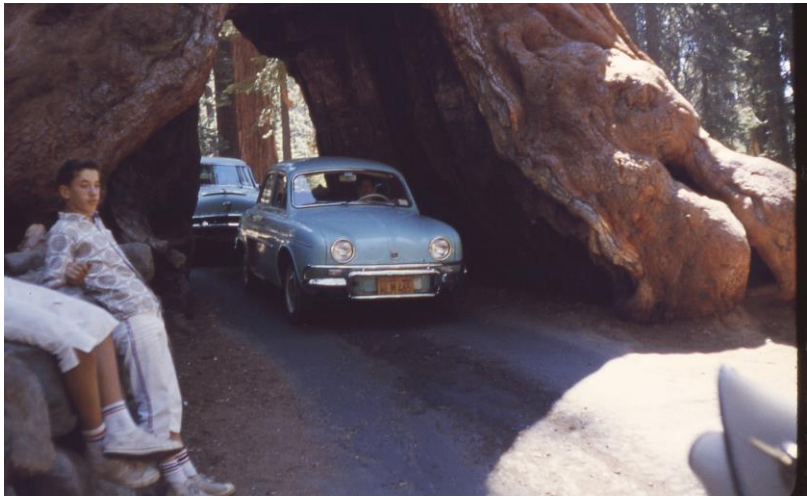
86	2.51					
1.09	1.03	2.13				
T	T	.53				
		5.7				
3.66	4.01					

	Year	Month	
	14.09	7.72	Mesa
	1954	8.56	F.A.T

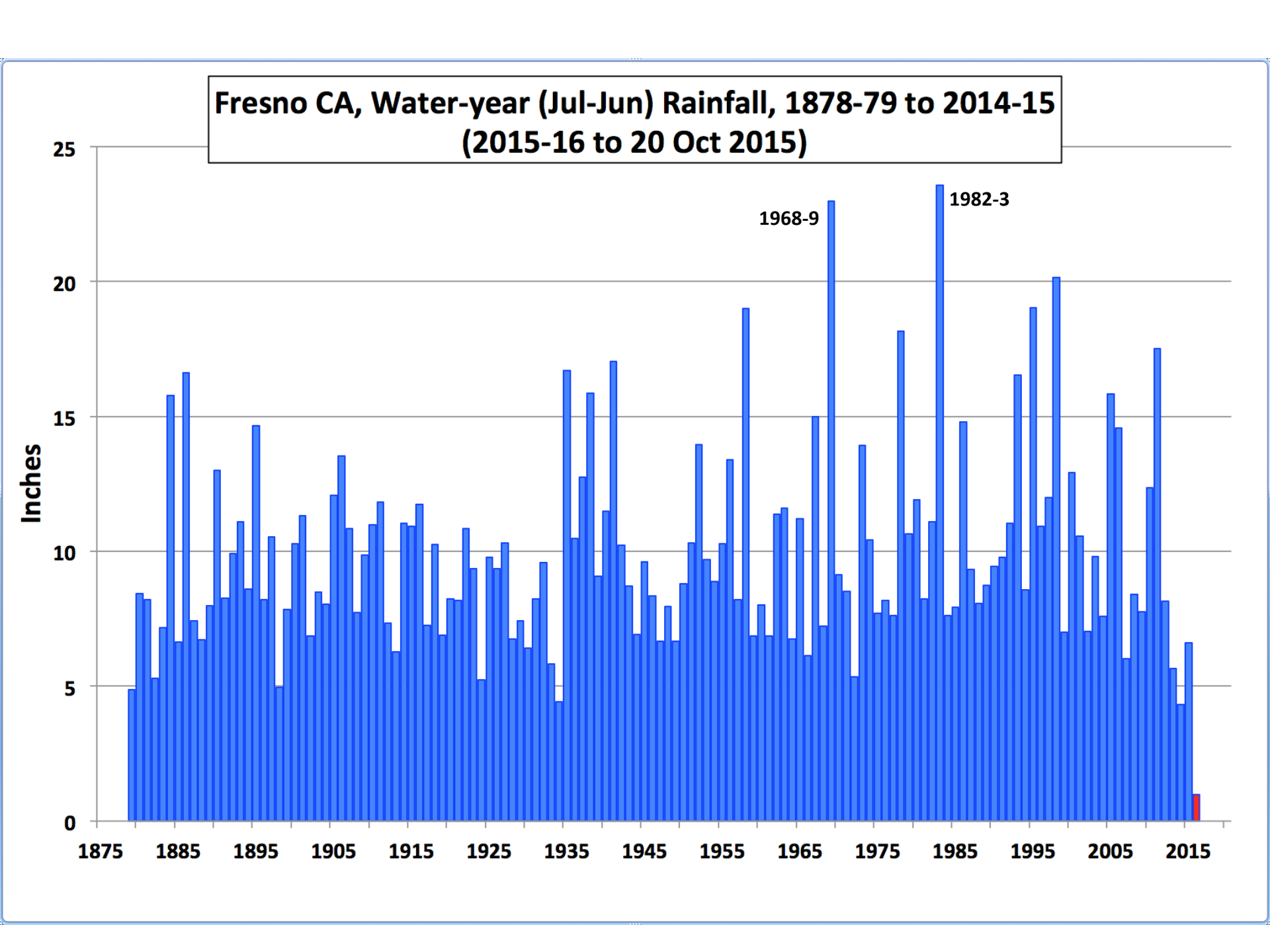
Total Jan to date - 36.99

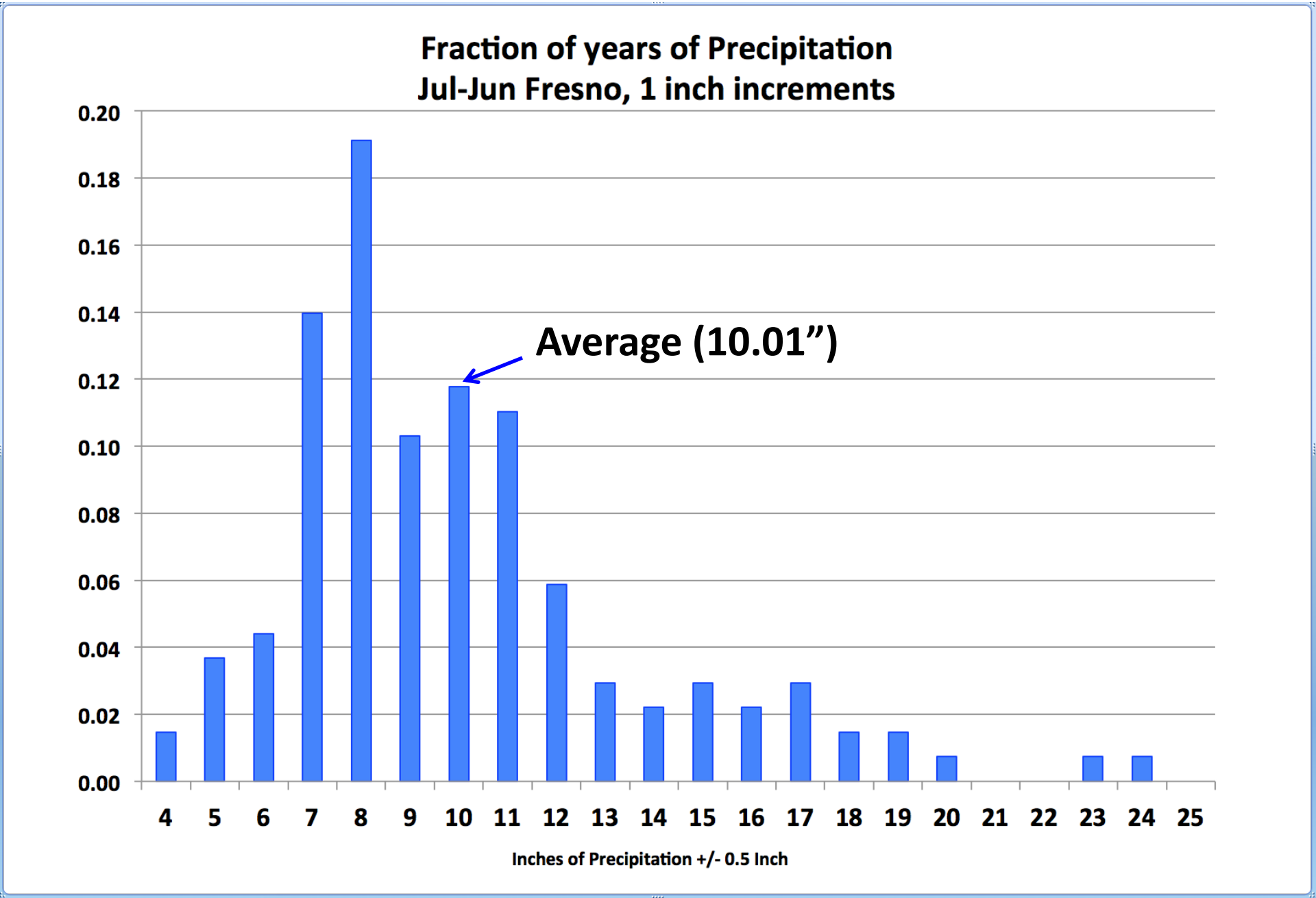
RAIN - 7.66 1229
SNOW - T

January 1969: Record Precipitation for any month at several San Joaquin Valley stations



Wawona Tunnel Tree - Yosemite

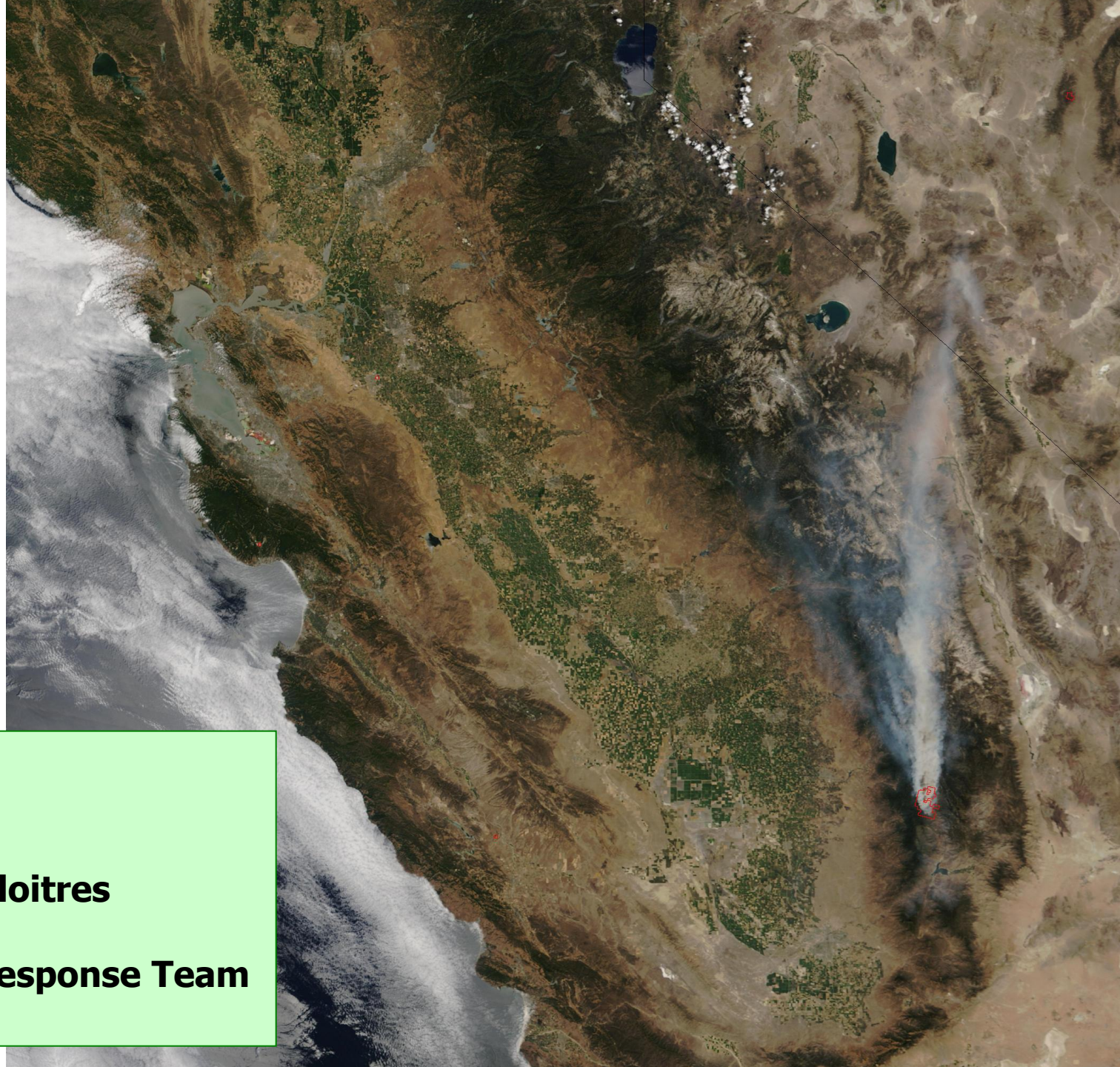

Fresno CA, Water-year (Jul-Jun) Rainfall, 1878-79 to 2014-15
(2015-16 to 20 Oct 2015)
Inches
25
20
15
10
5
0
1968-9
1982-3
1875
1885
1895
1905
1915
1925
1935
1945
1955
1965
1975
1985
1995
2005
2015


Fraction of years of Precipitation
Jul-Jun Fresno, 1 inch increments
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Average (10.01”)
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
Inches of Precipitation +/- 0.5 Inch

Darwin Glacier, 1908

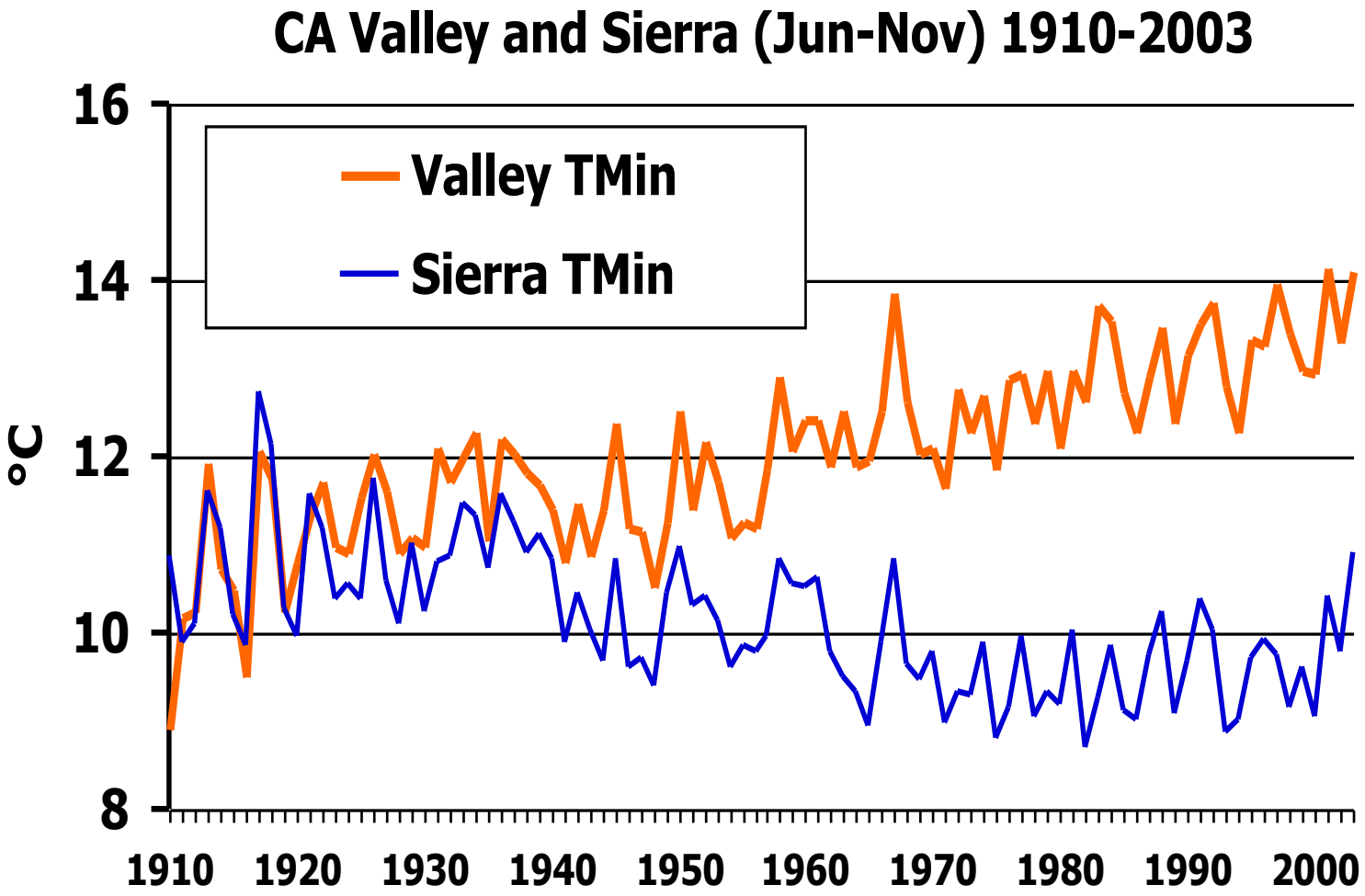
Darwin Glacier, 2003

Christy et al. 2006,
J. Climate

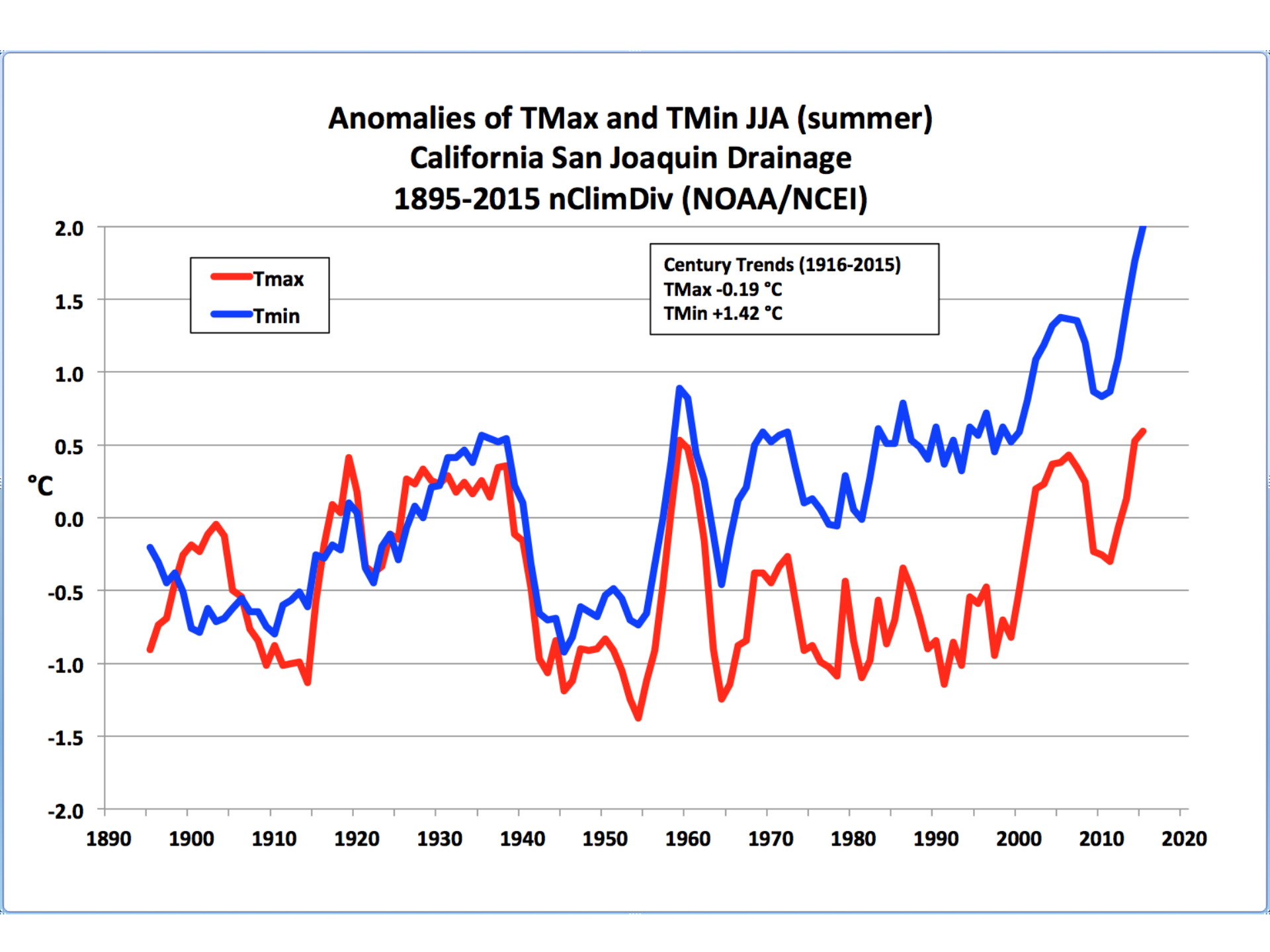


MODIS
21 Jul 2002

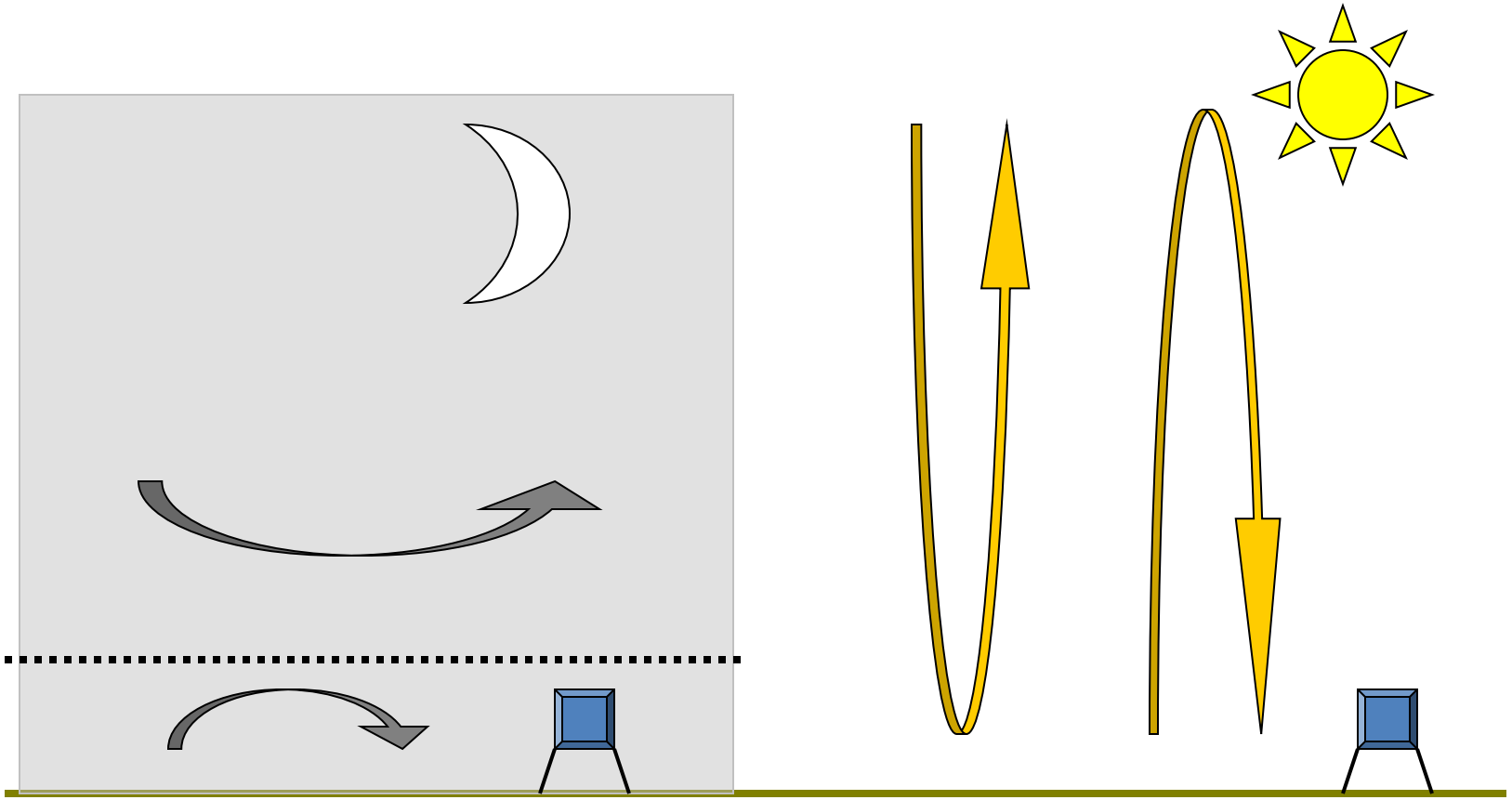
Jacques Descloitres
MODIS
Land Rapid Response Team
NASA GSFC



Christy et al. 2006


Anomalies of TMax and TMin JJA (summer)
California San Joaquin Drainage
1895-2015 nClimDiv (NOAA/NCEI)
Tmax
Tmin
Century Trends (1916-2015)
TMax -0.19 °C
TMin +1.42 °C
°C
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
1890
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020

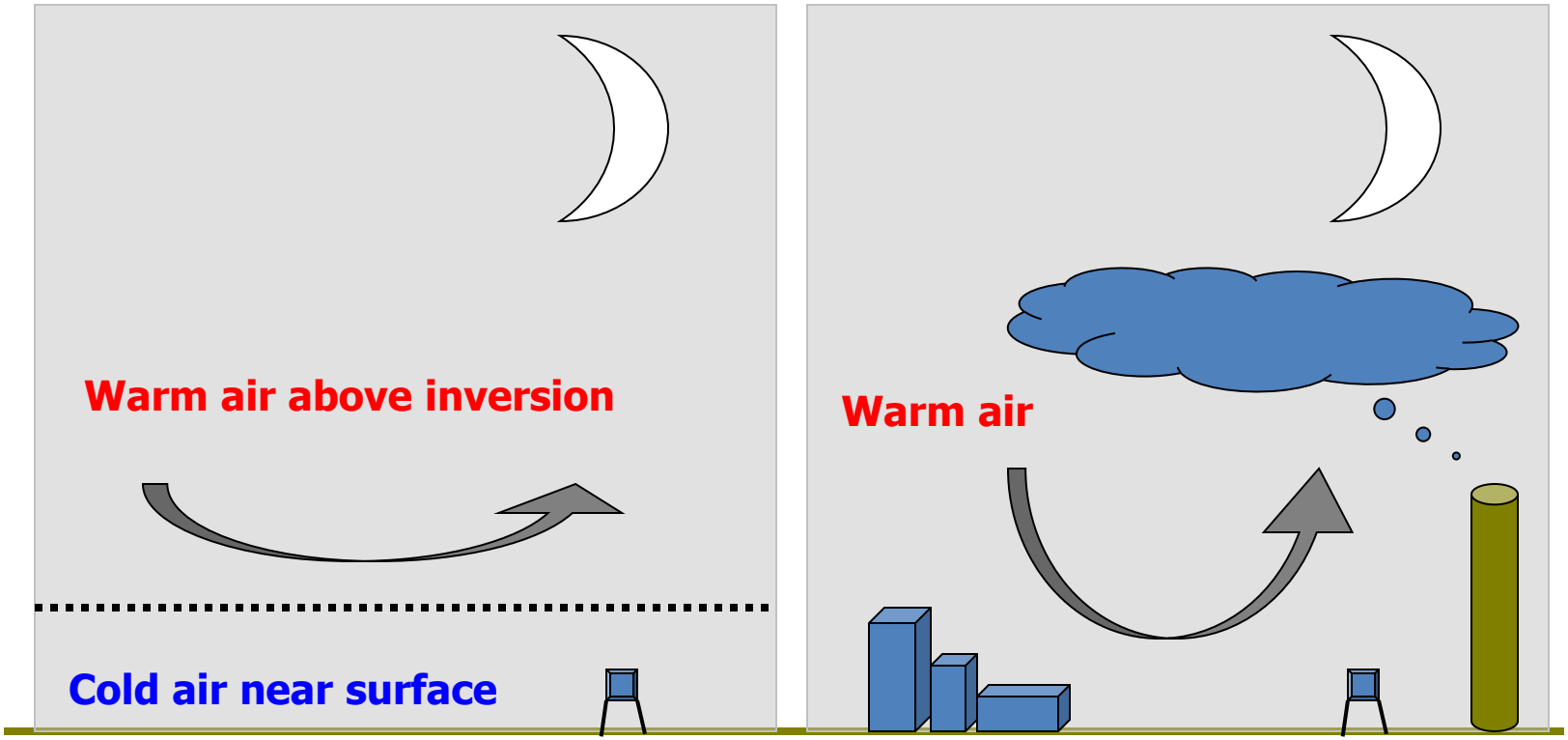
Day vs. Night Surface Temp



Nighttime - disconnected shallow layer/inversion. Temperature affected by land-use changes, buildings, farming, etc.

Daytime - deep layer mixing, connected with levels impacted by enhanced greenhouse effect

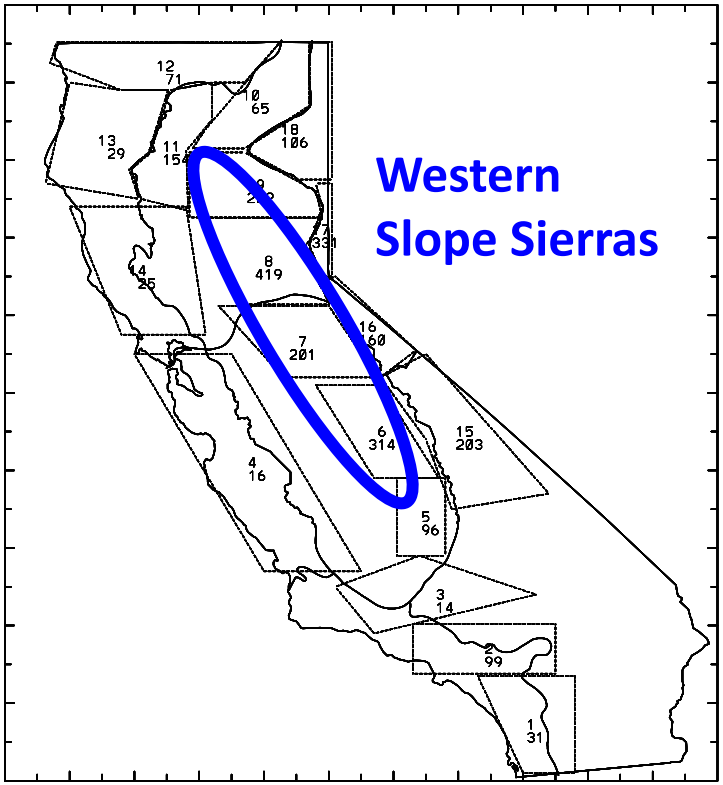
Night Surface Temp



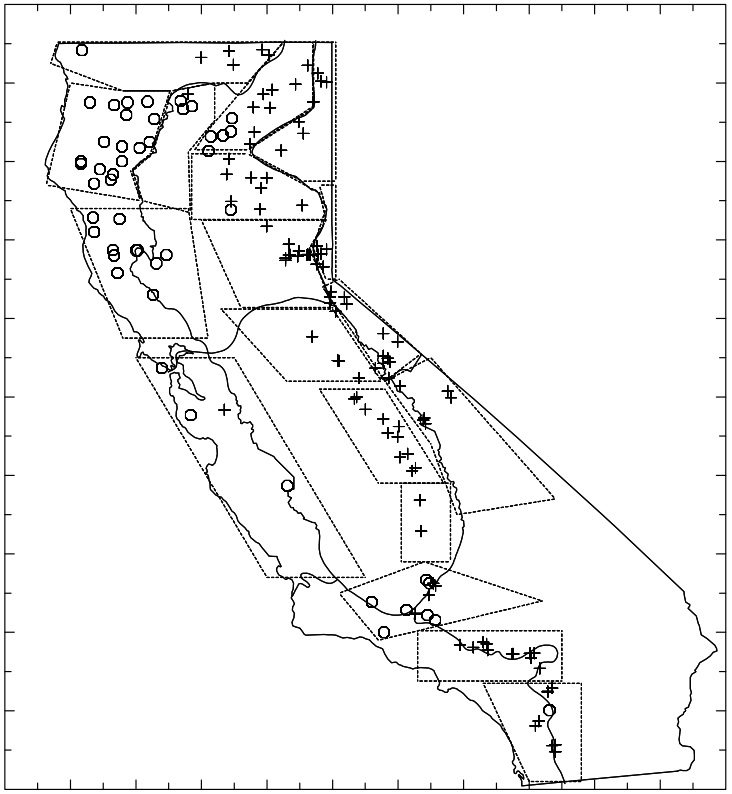
Nighttime - disconnected shallow layer/inversion. But this situation can be sensitive to small changes such as roughness or heat sources.

Buildings, heat releasing surfaces, aerosols, greenhouse gases, etc. can disrupt the delicate inversion, mixing warm air downward - affecting TMin.

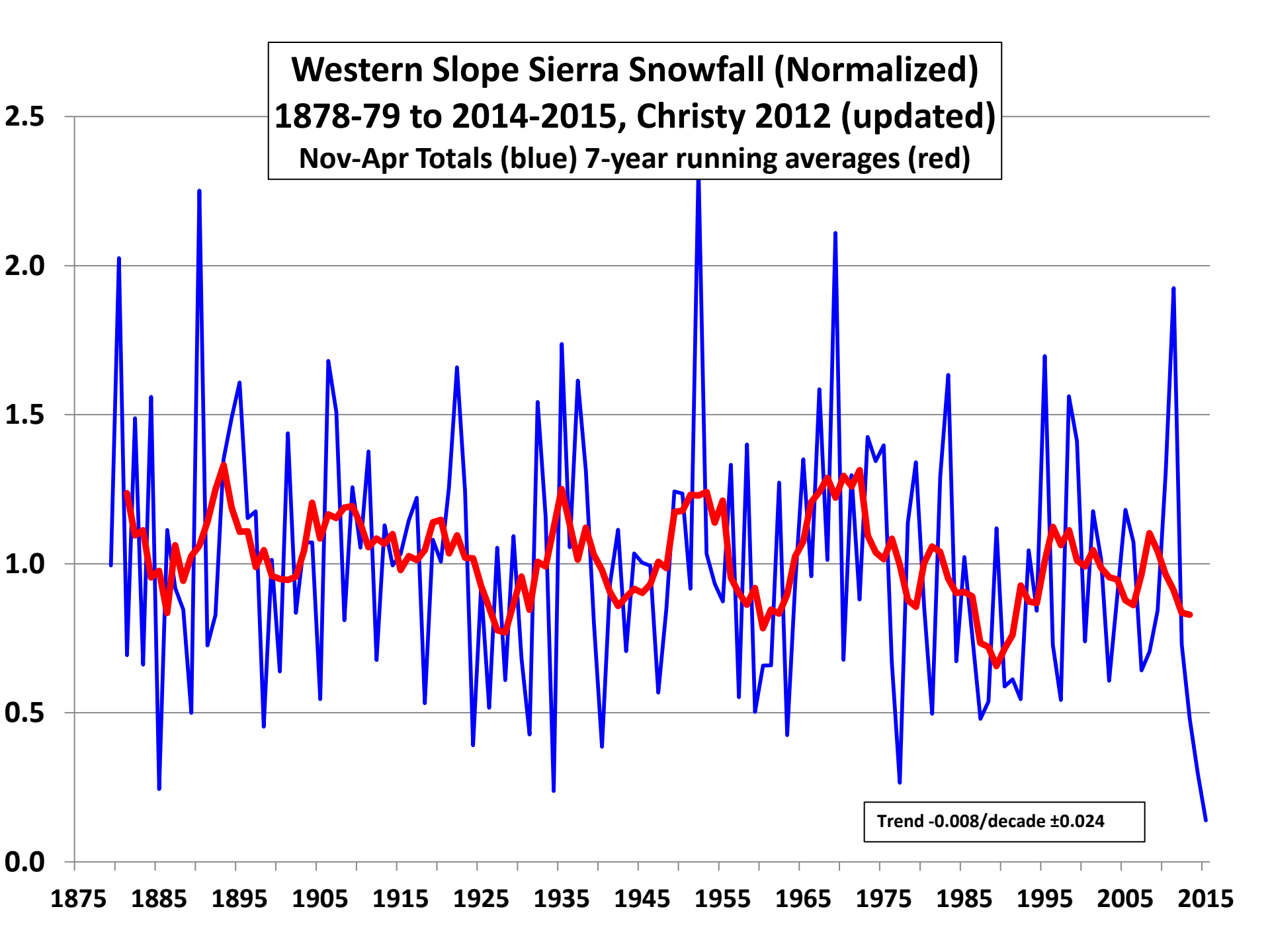
Snowfall California - Christy 2012 (1878-79 to 2014-15)



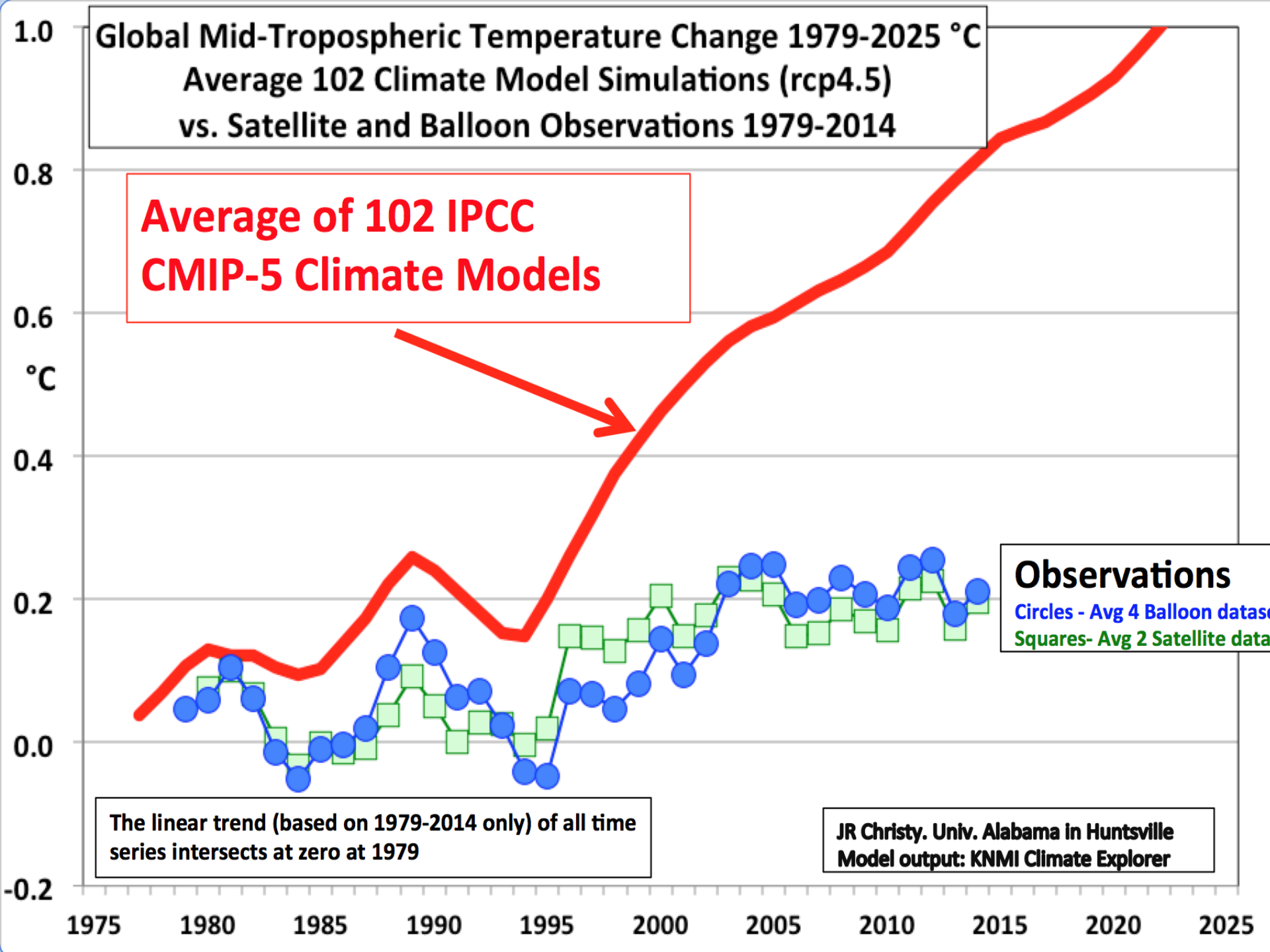
18 Snowfall Regions in California
Mean Nov-Apr Snowfall for Reference Station cm (Christy 2012)



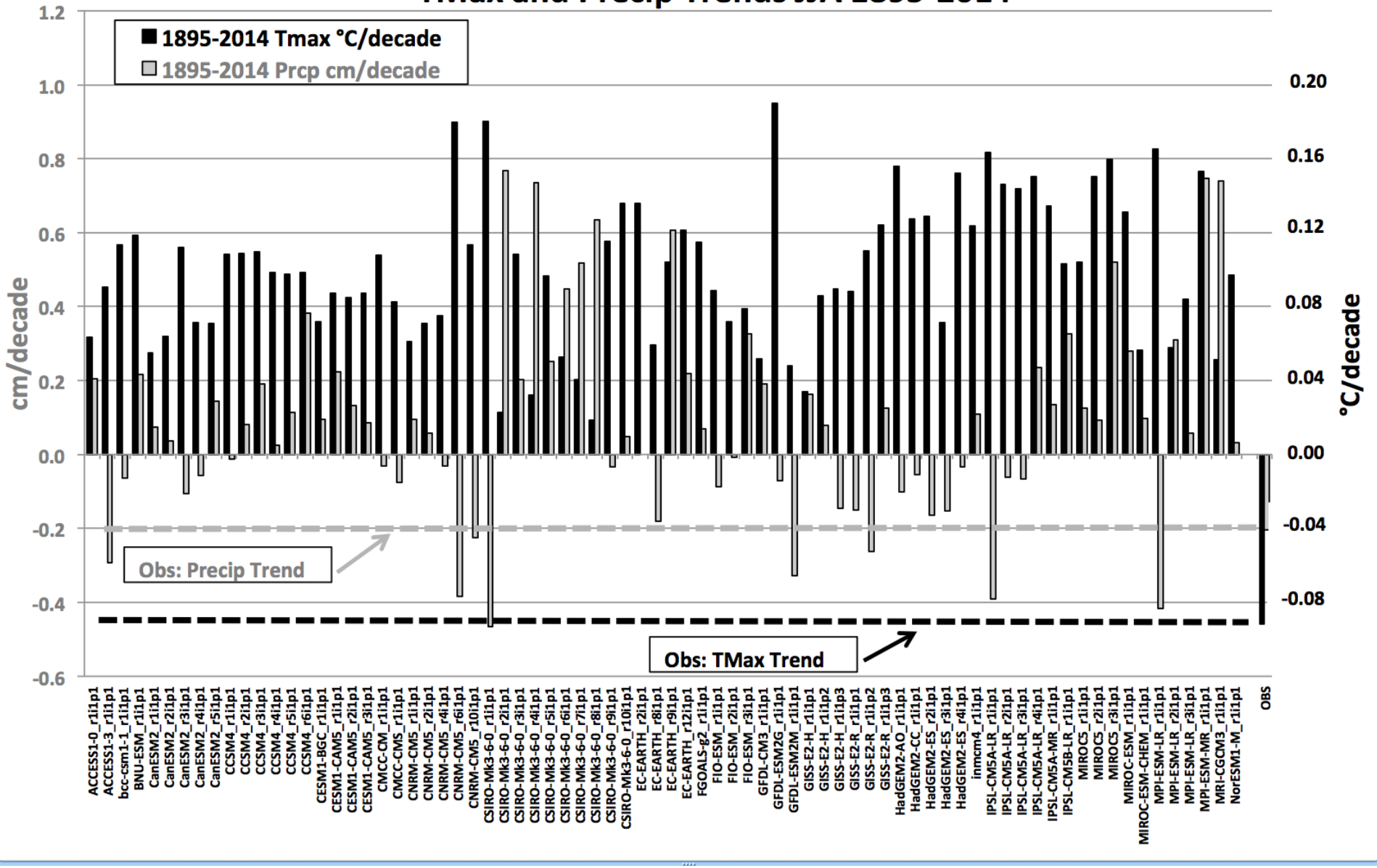
Location of stations with sufficient data and mean annual total for inclusion


Western Slope Sierra Snowfall (Normalized)
1878-79 to 2014-2015, Christy 2012 (updated)
Nov-Apr Totals (blue) 7-year running averages (red)
2.5
2.0
1.5
1.0
0.5
0.0
1875
1885
1895
1905
1915
1925
1935
1945
1955
1965
1975
1985
1995
2005
2015
Trend -0.008/decade ±0.024

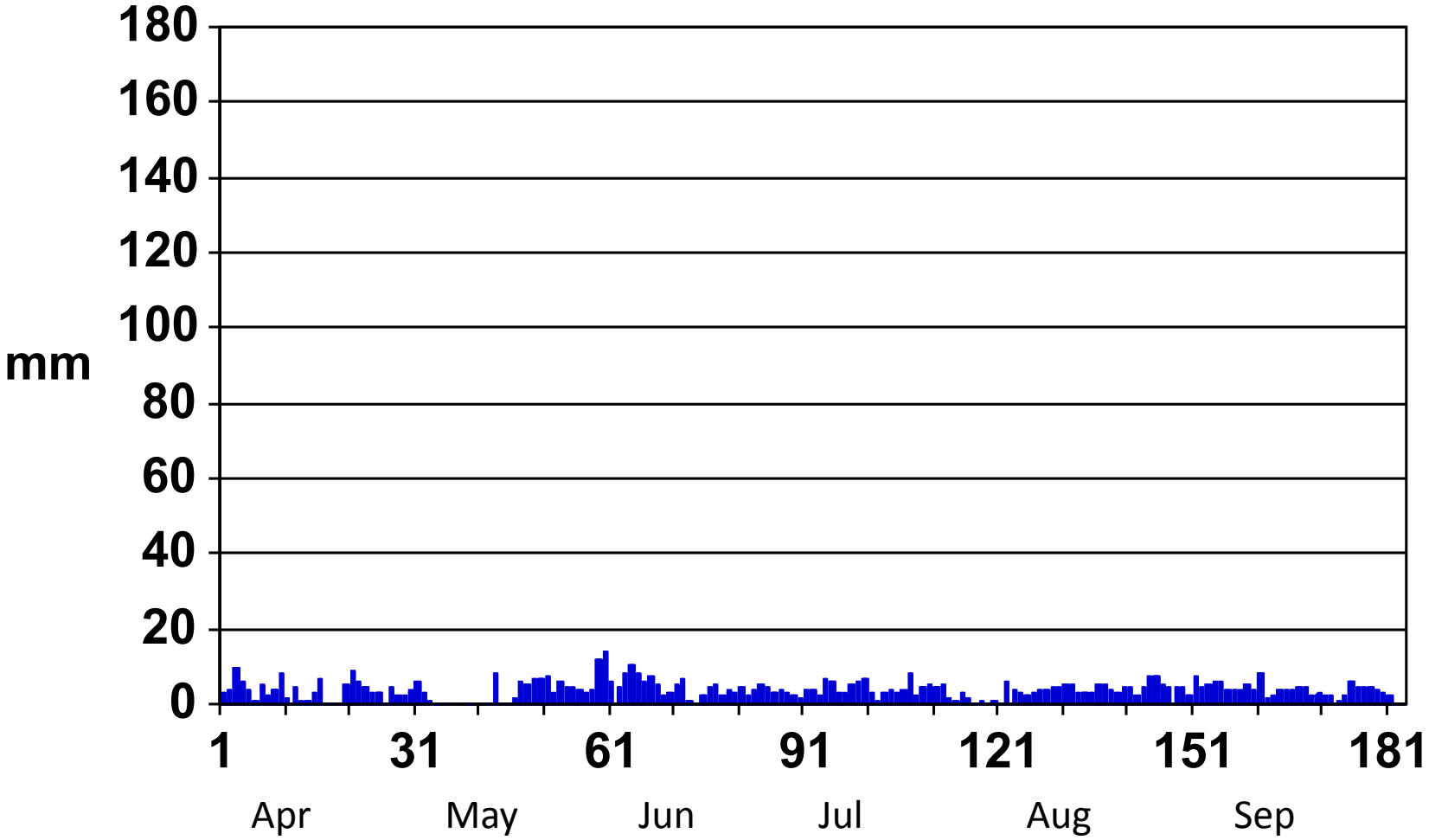
Implications about Models


Global Mid-Tropospheric Temperature Change 1979-2025 °C
Average 102 Climate Model Simulations (rcp4.5)
vs. Satellite and Balloon Observations 1979-2014
Average of 102 IPCC
CMIP-5 Climate Models
Observations
Circles - Avg 4 Balloon datase
Squares- Avg 2 Satellite data
The linear trend (based on 1979-2014 only) of all time series intersects at zero at 1979
JR Christy. Univ. Alabama in Huntsville
Model output: KNMI Climate Explorer
1.0
0.8
0.6
°C
0.4
0.2
0.0
-0.2
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025

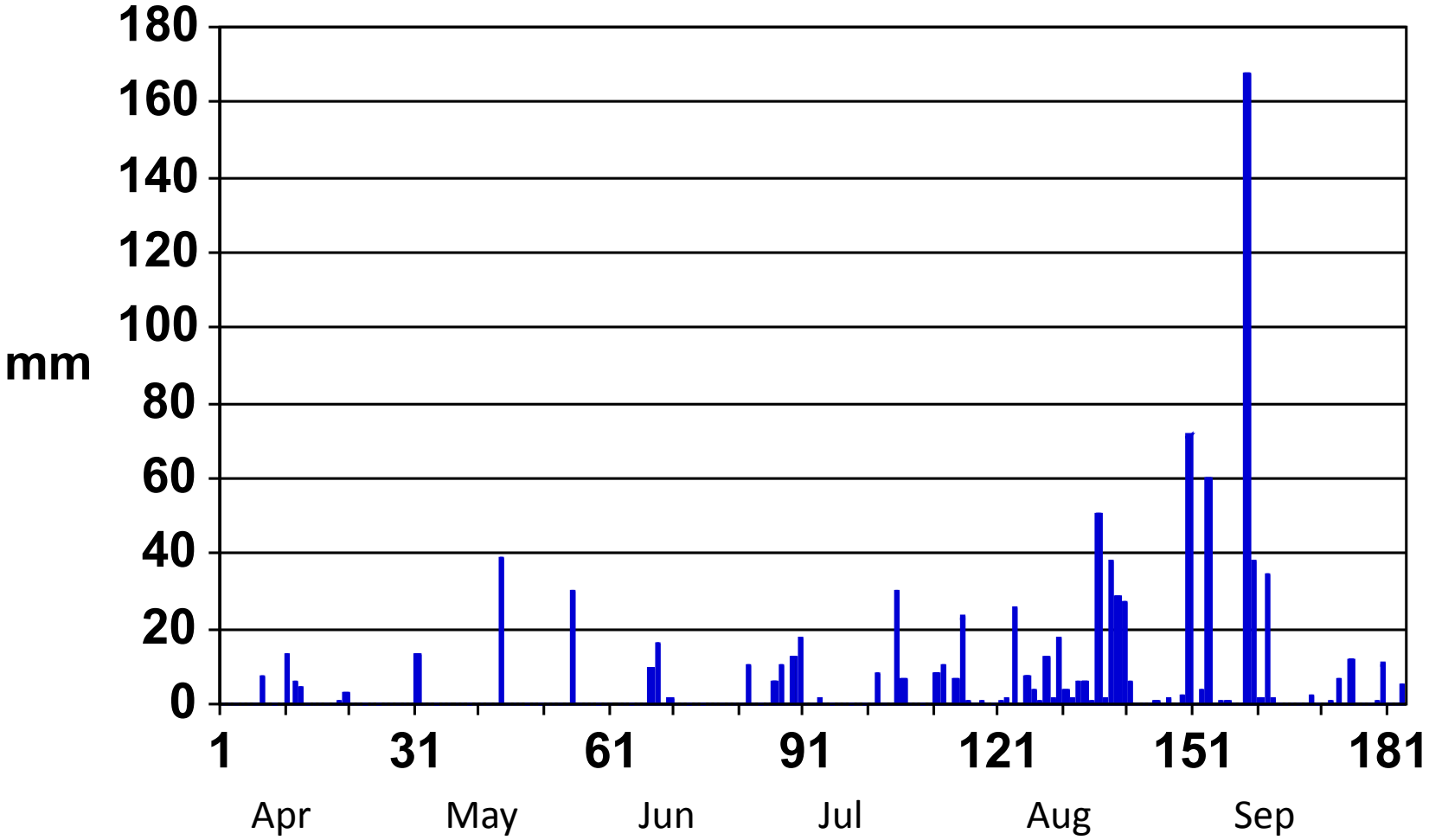
77 CMIP-5 rcp8.5 Model Runs for Alabama
TMax and Precip Trends JJA 1895-2014

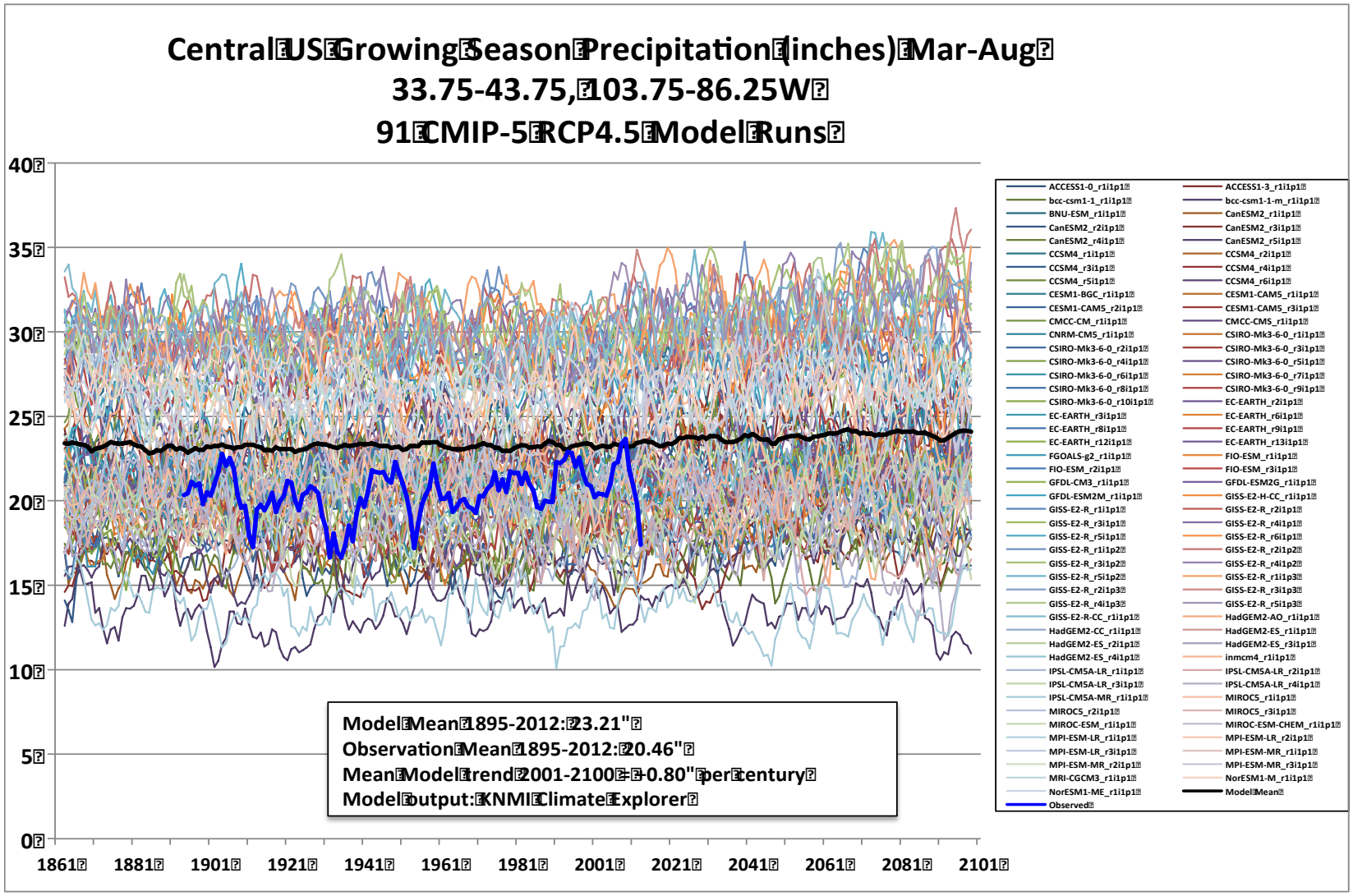


CNMR Climate Model Daily Precip:
29.6N 82.3W (Gainesville)
Apr-Sep “1988”

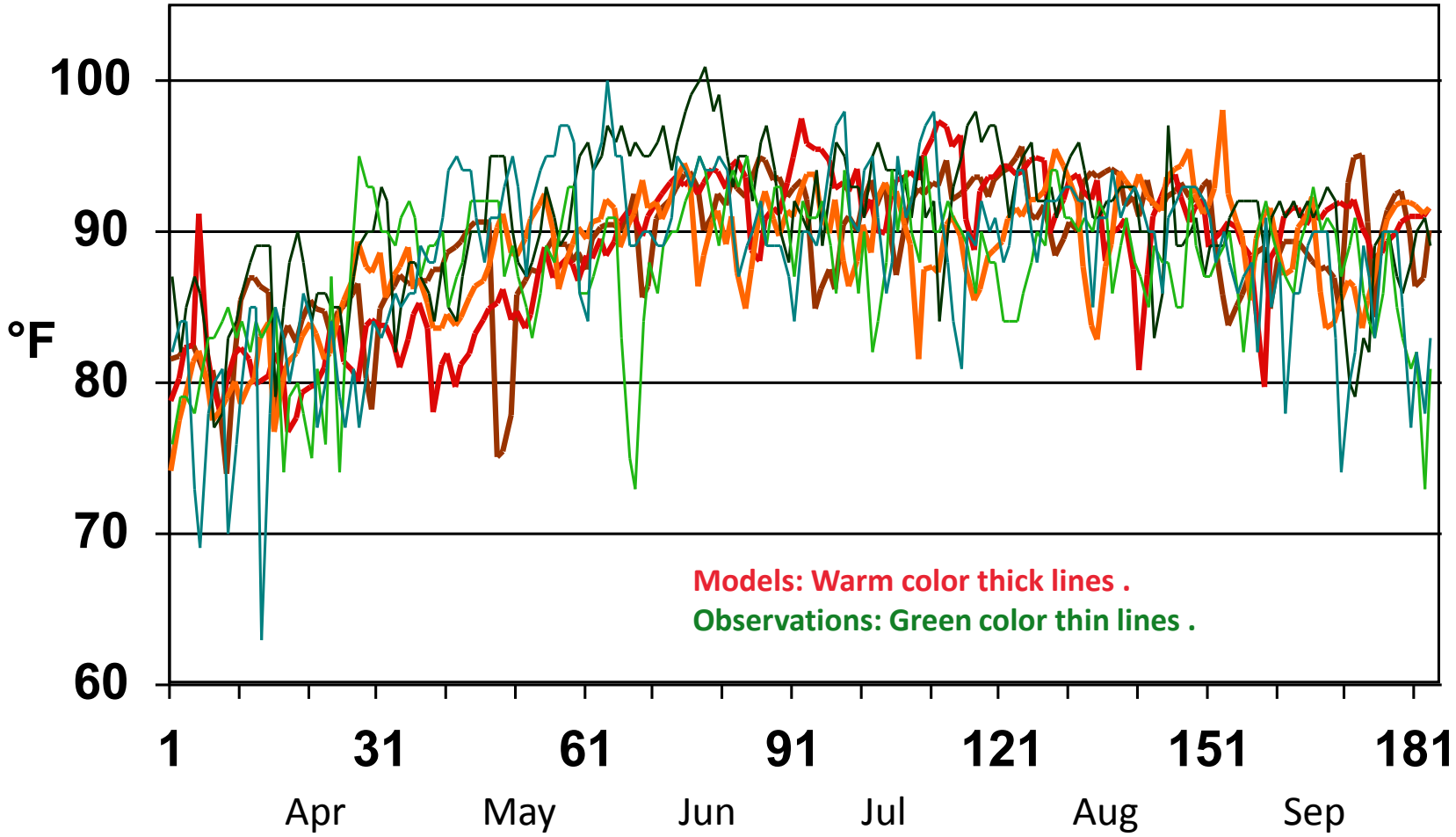


Observed Daily Precip:
29.6N 82.3W (Gainesville)
Apr-Sep 1988

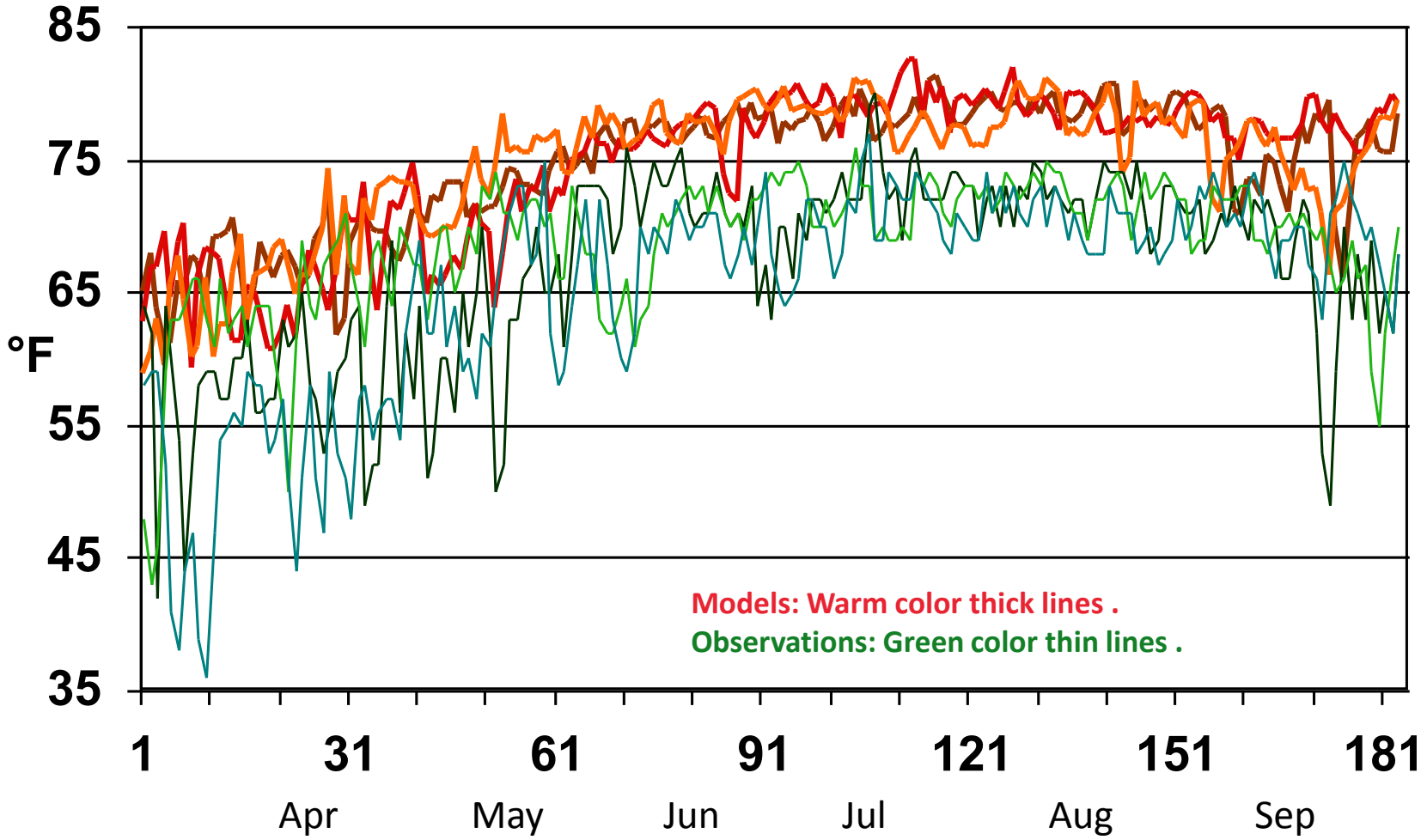



Central US Growing Season Precipitation (inches) Mar-Aug
33.75-43.75, 103.75-86.25W
91 CMIP-5 RCP4.5 Model Runs
40
35
30
25
20
15
10
5
0
1861
1881
1901
1921
1941
1961
1981
2001
2021
2041
2061
2081
2101
Model Mean 1895-2012: 23.21"
Observation Mean 1895-2012: 20.46"
Mean Model trend 2001-2100 = +0.80" per century
Model output: KNMI Climate Explorer
ACCESS1-0_r1i1p1
ACCESS1-3_r1i1p1
bcc-csm1-1_r1i1p1
bcc-csm1-1-m_r1i1p1
BNU-ESM_r1i1p1
CanESM2_r1i1p1
CanESM2_r2i1p1
CanESM2_r3i1p1
CanESM2_r4i1p1
CanESM2_r5i1p1
CCSM4_r1i1p1
CCSM4_r2i1p1
CCSM4_r3i1p1
CCSM4_r4i1p1
CCSM4_r5i1p1
CCSM4_r6i1p1
CESM1-BGC_r1i1p1
CESM1-CAM5_r1i1p1
CESM1-CAM5_r2i1p1
CESM1-CAM5_r3i1p1
CMCC-CM_r1i1p1
CMCC-CMS_r1i1p1
CNRM-CM5_r1i1p1
CSIRO-Mk3-6-0_r1i1p1
CSIRO-Mk3-6-0_r2i1p1
CSIRO-Mk3-6-0_r3i1p1
CSIRO-Mk3-6-0_r4i1p1
CSIRO-Mk3-6-0_r5i1p1
CSIRO-Mk3-6-0_r6i1p1
CSIRO-Mk3-6-0_r7i1p1
CSIRO-Mk3-6-0_r8i1p1
CSIRO-Mk3-6-0_r9i1p1
CSIRO-Mk3-6-0_r10i1p1
EC-EARTH_r2i1p1
EC-EARTH_r3i1p1
EC-EARTH_r6i1p1
EC-EARTH_r8i1p1
EC-EARTH_r9i1p1
EC-EARTH_r12i1p1
EC-EARTH_r13i1p1
FGOALS-g2_r1i1p1
FIO-ESM_r1i1p1
FIO-ESM_r2i1p1
FIO-ESM_r3i1p1
GFDL-CM3_r1i1p1
GFDL-ESM2G_r1i1p1
GFDL-ESM2M_r1i1p1
GISS-E2-H-CC_r1i1p1
GISS-E2-R_r1i1p1
GISS-E2-R_r2i1p1
GISS-E2-R_r3i1p1
GISS-E2-R_r4i1p1
GISS-E2-R_r5i1p1
GISS-E2-R_r6i1p1
GISS-E2-R_r1i1p2
GISS-E2-R_r2i1p2
GISS-E2-R_r3i1p2
GISS-E2-R_r4i1p2
GISS-E2-R_r5i1p2
GISS-E2-R_r1i1p3
GISS-E2-R_r2i1p3
GISS-E2-R_r3i1p3
GISS-E2-R_r4i1p3
GISS-E2-R_r5i1p3
GISS-E2-R-CC_r1i1p1
HadGEM2-AO_r1i1p1
HadGEM2-CC_r1i1p1
HadGEM2-ES_r1i1p1
HadGEM2-ES_r2i1p1
HadGEM2-ES_r3i1p1
HadGEM2-ES_r4i1p1
inmcm4_r1i1p1
IPSL-CM5A-LR_r1i1p1
IPSL-CM5A-LR_r2i1p1
IPSL-CM5A-LR_r3i1p1
IPSL-CM5A-LR_r4i1p1
IPSL-CM5A-MR_r1i1p1
MIROC5_r1i1p1
MIROC5_r2i1p1
MIROC5_r3i1p1
MIROC-ESM_r1i1p1
MIROC-ESM-CHEM_r1i1p1
MPI-ESM-LR_r1i1p1
MPI-ESM-LR_r2i1p1
MPI-ESM-LR_r3i1p1
MPI-ESM-MR_r1i1p1
MPI-ESM-MR_r2i1p1
MPI-ESM-MR_r3i1p1
MRI-CGCM3_r1i1p1
NorESM1-M_r1i1p1
NorESM1-ME_r1i1p1
Model Mean
Observed

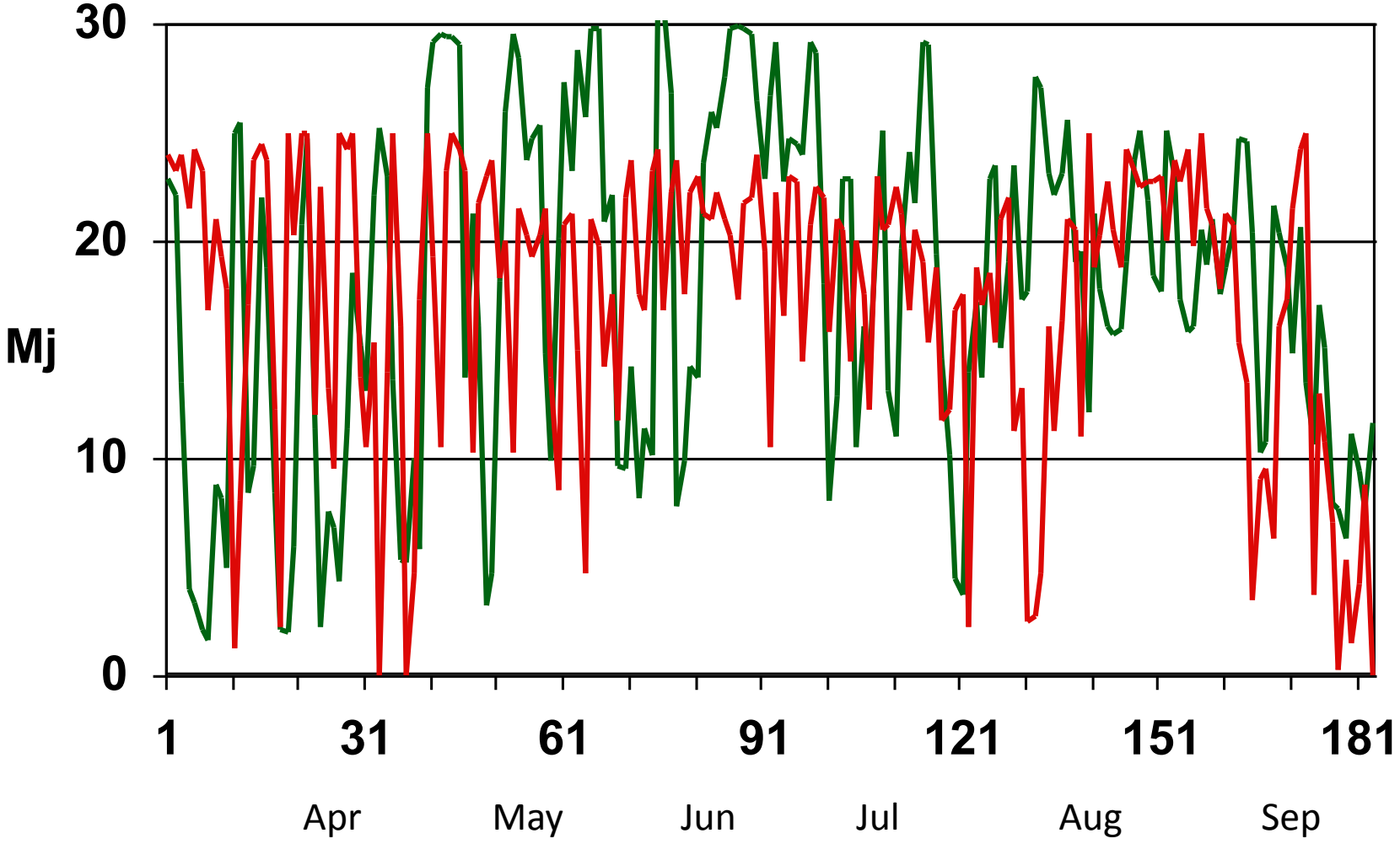
ECHAM5 Climate Model and Observed Daily TMax: Gainesville FL Apr-Sep 1981, 1991, 2000



ECHAM5 Climate Model and Observed Daily TMin:
Gainesville FL
Apr-Sep 1981, 1991, 2000



ECHAM5 Climate Model and Observed Daily Sfc Solar Flux: 32.5N 86.5W (Montgomery) Apr-Sep "1988"



Climate Variations, combined with human-management features, have longish-term impacts on agricultural systems

No real trends in Central California or Alabama climates (except as suggested by surface development)

Climate models yet to replicate (and thus predict) the types of variations important to agriculture

Longer term (paleo) variations give us even more concern for the West