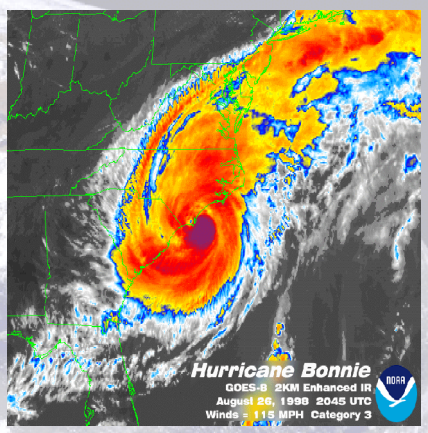
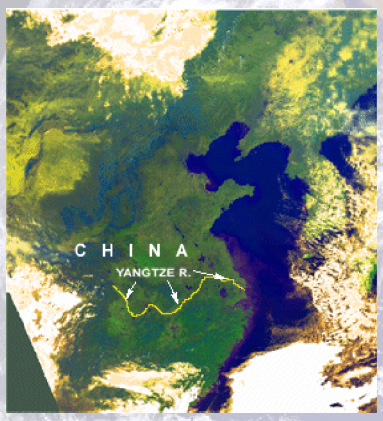
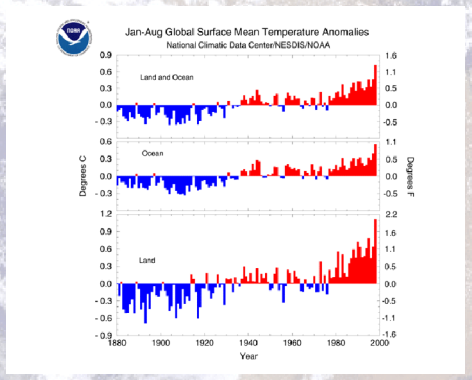
Technical Report 98-03 November 1998

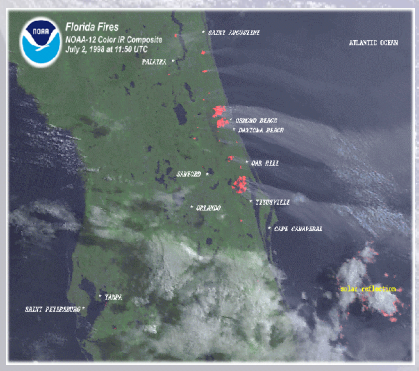
National Climatic Data Center

Climatic Extremes of the Summer of 1998









National Environmental Satellite, Data and Information Service

National Climatic Data Center Technical Report No. 98-03

Climatic Extremes of the Summer of 1998

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November 1998

U.S. Dept of Commerce
National Oceanic and Atmospheric Administration
National Environmental Satellite Data and Information Service
National Climatic Data Center
Asheville, NC 28801-5001

INTRODUCTION

Regions of the U.S. and other parts of the world experienced a variety of weather and climate extremes during the summer of 1998 (defined as June-August 1998). This report describes some of these events and conditions, including drought and fires in Florida, a heat wave and drought across parts of the south, flooding in China, flooding in parts of the U.S., Hurricane Bonnie striking North Carolina and Virginia, and an overall review of U.S. and global climatic conditions. Overall damages and costs for the events described in this report exceeded $30 billion (including over $10 billion in the U.S.), and the death toll exceeded 3000 (including over 200 fatalities in the U.S.).

FLORIDA DROUGHT AND FIRES

Fires began burning out of control in Florida on Memorial Day weekend. During May through July, nearly 500,000 acres were burned, with more than half being commercial timberland. Many of the fires were concentrated along the east side of the Florida peninsula in a line from Jacksonville southward to Titusville. The timber losses amounted to approximately $300 million, and at least 324 homes and businesses were damaged or destroyed. The costs of extinguishing an estimated 2000 fires were over $100 million. Over 120,000 residents were forced to evacuate for a day or more, including all of Flagler County. Fortunately, no fire-related deaths were reported. During July and August, the normal summer rains arrived with afternoon thunderstorms, ending the fire threat.

Over Florida, the unusually wet mild winter promoted abundant growth in the underbrush. The wet weather was immediately followed by a severe drought during April through June, which rapidly dried out the dense underbrush. The combination of a wet and mild winter followed by a dry and hot spring to early summer provided abundant fuel for the fires. Figure 1 is a NOAA-12 (polar-orbiting) multi-channel color composite of the fires on July 2.

Temperature and precipitation for June 1998, for many long-term stations in Florida, were at record or near-record levels. At many locations, the mean temperature for June 1998 was either the warmest June or warmest for any month since records began last century. In some cases, the new record means broke the old record means by a degree or more. For example, in Daytona Beach, Florida, the new record exceeded the old record by 2.2 degrees F. This is climatologically significant for Florida where monthly means are less variable than in most parts of the United States.

On a daily basis, many locations set an extraordinary number of daily maximum temperature records. Locations along the east coast of the state set a number of high minimum records, probably as a result of the insulating affect of the aerosols generated by the fires and the abnormally warm waters in the Gulf of Mexico and Atlantic Ocean. A persistent westerly air circulation at the surface and aloft precluded development of the normal southeast flow over the

state with consequent extreme dryness which began in mid-March 1998. Table 1 is a sampling of temperature data for June 1998. Included in parentheses are the former record means and year of occurrence prior to 1998.

Table 1 - ,June 1998 Temperature Statistics (degrees F)

	Mean Temperature	Departure From Normal	Number of Daily Max Records	Number of Days: >=95F	>=100F
Daytona Beach	84.5 (82.3-'77)	+5.1	12	25	9
Jacksonville	84.0 (83.3-'81)	+4.9	3	25	6
Melbourne	85.1 (81.9-'80)	+5.7	21	24	4
Orlando	85.0 (83.2-'81)	+3.9	9	25	3
Tallahassee	85.3 (83.8-'52)	+5.7	6	25	12
Tampa	85.6 (83.7-'85)	+4.3	6	8	0

The extremely hot weather was accompanied by near record drought across much of the state. The crop moisture index for each of Florida's climatic divisions 1 through 3 (the northern half of Florida) decreased dramatically during the agricultural growing season, which officially begins on March 1st. Ironically, top soil moisture conditions early in the year ranged from favorably moist to excessively wet across most of northern Florida, due to an exceptionally wet winter (related to El Nino). March crop moisture index values were as high as +7.8 for division 1 (panhandle of Florida), which signifies excessively wet conditions. Divisions 1 and 2 (all of northern Florida) were favorably moist through the end of April. During May, soil moisture decreased rapidly to excessively dry conditions by the end of the month through northern and central Florida. Conditions continued to worsen through June, reaching extreme dryness, with north-central Florida (division 3) experiencing an index value of -5.41. Figure 2 shows the rapid decrease in crop moisture for north-central Florida.

Table 2 - ,June 1998 Precipitation Statistics (inches)

	Total Rainfall	Departure From Normal	Percent of Normal
Daytona Beach	.83	-5.16	14%
Jacksonville	2.95	-2.74	52%
Melbourne	.16	-5.97	3%
Orlando	1.58	-5.74	22%
Pensacola	.91	-5.49	14%
Tallahassee	1.95	-4.98	28%
Tampa	2.65	-2.83	48%
West Palm Beach	1.68	-6.41	21%

SOUTHERN HEAT AND DROUGHT

Drought and extreme heat affected an expanding area of the south from Texas and Oklahoma eastward to the Carolinas, Georgia, and Florida. In agricultural losses (crops, cattle, etc), Texas estimates over $2.1 billion in losses, Oklahoma about $2.0 billion, Florida about $175 million, Georgia over $400 million, while other states are still counting the damages. Overall economic costs will probably be two to three times the agricultural losses. Also, at least 200 heat-related deaths occurred nationwide. Some of the more notable records and statistics for the summer of 1998 are shown below, with previous record years shown for comparison. Figures 3 and 4 show the crop moisture index nationally for July 11 and again on August 29, as a sample of the dry conditions experienced across the south.

Table 3 - Summer 1998 Temperature Extremes

Texas state records:

Warmest April - July for Texas:	Driest April - July for Texas:
1998: Average 77.65 degrees	1998: 4.46 inches
1925: Average 77.65 degrees	1956: 6.20 inches

Monthly mean temperatures in the south central states:

Del Rio	May: 1998	84.2 degrees (record for May)
	June: 1998	89.1 degrees (2nd warmest June)
	July: 1998	91.7 degrees (record for July and for any month)
	July: 1980	90.1 degrees (2nd warmest July and month)
Shreveport	July: 1998	88.5 degrees (record for July and any month)
	July: 1884	87.9 degrees (2nd warmest July and month on record)
Austin	July: 1998	88.0 degrees (record for July and any month)
	July: 1980	87.9 degrees (2nd warmest July and month on record)
San Antonio	July: 1998	88.1 degrees (record for July and any month)
	July: 1980	88.1 degrees (tie: warmest July and month on record)
Corpus Christi	July: 1953	87.1 degrees (warmest July on record)
	July: 1998	86.7 degrees (2nd warmest July on record)
Midland	July: 1964	86.9 degrees (warmest July on record)
	July: 1998	86.8 degrees (2nd warmest July on record)

San Angelo	July: 1912	87.6 degrees (warmest July on record)
	July: 1998	87.4 degrees (3rd warmest July on record)
Abilene	July: 1980	89.4 degrees (warmest July on record)
	July: 1998	87.6 degrees (3rd warmest July on record)
Brownsville	June: 1998	87.3 degrees (record for June)
	July: 1980	87.5 degrees (warmest July on record)
	July: 1998	87.1 degrees (3rd warmest July on record)
College Station	May: 1998	79.4 degrees (record for May)
	June: 1998	86.7 degrees (record for June)
	July 1998	101.0 degrees (warmest average July maximum)
Houston	May thru July: 1998	83.6 degrees (warmest May-July on record)
	May thru July: 1980	83.2 degrees (2nd warmest May-July)

Consecutive number of days with maximum temperatures 100 degrees F or higher:

	Year	Consecutive Days	Date Range
College Station	1998	30	July 6 - August 4
	1917	26	
Dallas-Fort Worth	1998	29	July 6 - August 3
	1980	42	June 23 - August 3
Oklahoma City	1998	16	July 18 - August 2
	1936	22	August 4- August 25
	1966	19	July 1- July 19
	1956	16	August 3 - August 18

Consecutive number of days with maximum temperatures 95 degrees F or higher:

Corpus Christi	1998	41	July 5 - August 14
	1977	36	

Consecutive number of days with maximum temperatures 90 degrees F or higher:

Amarillo	1998	41	June 16 - July 26
	1934	46	

Total number of days with maximum temperatures 100 degrees F or above:

	Year	Annual Total
San Antonio	1998	36
Del Rio	1998	69
Houston	1998	24
Dallas-Fort Worth	1998	56
College Station	1998	49

Warmest average minimum temperature (degrees F):

	Month-year	Mean Value	
Little Rock	July 1998	76.5 Degrees	Warmest average minimum for any month
	July 1980	75.9 Degrees	2nd warmest average minimum

Consecutive number of days with minimum temperature 80 degrees F or higher:

	Year	No. Consecutive Days	Date Range
Dallas Fort-	1998	14	July 19 - August 1
Worth	1952	11	

Total number of days minimum temperatures 80 degrees F or higher:

	Year	Total Number of Days
Dallas Fort-	1998	39
Worth	1952	22
	1980	22

Table 4 - Summer 1998 Precipitation Extremes

April - July 1998 precipitation totals in inches, record driest for each location:

Brownsville	0.30
McAllen	0.03
Harlingen	1.15
Raymondville	0.28
Houston	5.79
College Station	2.00
Crockett	1.40
Corpus Christi	0.64
Lubbock	1.98

1998 annual totals for January through August, in inches:

Midland	3.05
Brownsville	4.42

1998 monthly and multi-month extremes:

	Total	Month	
College Station	0.11 inches	May 1998	Driest May on record
	Trace	June 1998	Driest June on record
Brownsville	0.97 inches	March-July 1998	Driest March-July on record
	1.24 Inches	March-July 1996	2nd driest March-July on record
	0.30 inches	May-July 1998	Driest May-July on record
	0.65 Inches	May-July 1915	2nd driest May-July on record
	Trace	July 1998	Driest July on record (tie)
Midland	2.02 inches	January-July 1951	Driest January-July on record
	2.13 Inches	January-July 1998	2nd driest January-July on record
Lubbock	1.98 inches	April-July 1998	Driest April-July on record

FLOODING IN CHINA

China suffered massive flooding concentrated in three areas during the 1998 summer: Along the Yangtze River in south central China; across extreme southern China in the area around the Gulf of Tonkin; and across the north near the Russian border. The heaviest reported rainfall was at Qinzhou, with an incredible 68.28 inches of rain during the June-July period. According to official Chinese government reports, 3656 people were killed by the floods, the second worst to hit the country in more than 130 years. Many observers believe the death toll is higher, although it is unlikely the total will reach 1954's level of 30,000 dead. The floods left 14 million people homeless, affected 240 million people, and caused well over $20 billion ($U.S.) in estimated damages.

Figure 5 is a 1 km resolution visible image of part of the Yangtze River Basin taken by the NOAA-14 polar-orbiting satellite on August 14, 1998. The numbers annotated on the image are correlated to precipitation totals for the June-July 1998 period in descending order (see Table 5).

All stations are in southeast China (WMO blocks 53, 54, 57, 58, and 59). The satellite image does not include other areas where flooding was a major problem; specifically, around the Gulf of Tonkin in the south, and in the Manchuria area across the north.

Figure 6 is a graph of the daily precipitation recorded at Qinzhou, near the Gulf of Tonkin, for June-July 1998. The precipitation plot shows several extreme rainfall episodes during the two-month period. For example, the greatest June event occurred over a three-day period with a total of over 12.00 inches, and the greatest one-day amount was over 9.00 inches. In July, there was an eight-day stretch of rain between the 2nd and the 9th when 29.18 inches of rain was recorded. Two tropical systems, Nichole and 01W, affected the extreme southern part of China during the month of July and contributed to the extraordinary rainfall amounts.

Figure 7 is a plot of daily precipitation for the city with the most precipitation in the Yangtze River basin, Jingdezhen, which reported 51.25 inches of rain. This station had a one-day total over 9.00 inches in June 1998; in July 1998, there was a ten-day period between the 17th and the 26th when 16.07 inches of rain was recorded.

Table 5 - Southeast China ,June-,July 1998 Rainfall Amounts

Following are the top 30 rainfall amounts in southeast China for June-July 1998, in inches and hundredths. 'Precip' is the rainfall amount in inches. 'Days' indicates number of days with rainfall data for the two months. Lat/lon are in degrees and minutes; 'elev' is the elevation in meters. Stations with an * indicate they are not plotted in Figure 5 since they're outside the map area.

	STN ID	PRECIP	DAYS	NAME	LAT	LON	ELEV
1	596320	68.28	61	QINZHOU *	2157N	10837E	0006
2	587300	52.01	61	ZHENGHE	2722N	11851E	0456
3	585270	51.25	61	JINGDEZHEN	2918N	11712E	0060
4	584370	47.19	61	HUANG SHAN (MTNS)	3008N	11809E	1836
5	575980	46.45	61	XIUSHUI	2902N	11435E	0147
6	590580	43.29	61	MENGSHAN *	2412N	11031E	0145
7	585060	42.36	61	LU SHAN (MOUNTAIN)	2935N	11559E	1165
8	587310	41.89	61	PUCHENG	2755N	11832E	0275
9	579570	41.47	61	GUILIN *	2520N	11018E	0166
10	586060	39.91	61	NANCHANG	2836N	11555E	0050
11	586330	36.15	61	QU XIAN	2858N	11852E	0071
12	590870	36.10	61	FOGANG *	2352N	11332E	0068
13	587250	35.52	61	SHAOWU	2720N	11726E	0192
14	594560	34.16	61	XINYI *	2221N	11056E	0084
15	576550	34.07	61	YUANLING	2828N	11024E	0143
16	592090	33.91	61	NAPO	2318N	10557E	0794
17	587150	33.30	61	NANCHENG	2735N	11639E	0082

18	574940	32.52	61	WUHAN/NANHU	3037N	11408E	0023
19	576620	32.29	61	CHANGDE	2903N	11141E	0035
20	596730	32.26	61	SHANGCHUAN ISLAND*	2144N	11246E	0018
21	575540	31.64	61	SANGZHI *	2924N	11010E	0322
22	596630	31.58	61	YANGJIANG *	2152N	1158E	0022
23	592540	31.17	61	GUIPING *	2324N	11005E	0044
24	590460	31.03	61	LIUZHOU *	2421N	10924E	0097
25	574470	30.78	61	ENSHI *	3017N	10928E	0458
26	575840	29.68	61	YUEYANG	2923N	11305E	0052
27	576870	29.58	61	CHANGSHA	2814N	11252E	0068
28	544970	29.18	61	DANDONG	4003N	12420E	0014
29	594310	27.49	61	NANNING/WUXU *	2249N	10821E	0073
30	588130	27.08	61	GUANGCHANG	2651N	11620E	0142

U.S. FLOODING

In the U.S., NOAA's National Hydrologic Information Center reported 80 flood-related fatalities for January through August 1998. Fourteen of these occurred in June in the midwest and northeast as a result of heavy rains, with fatalities reported in Kentucky, Indiana, New Hampshire, Minnesota, Ohio, and West Virginia. Also, the following states were designated to receive federal disaster assistance during June and July: Indiana, Iowa, Maine, Massachusetts, Minnesota, New Hampshire, New York, North Dakota, Ohio, Pennsylvania, South Dakota, Vermont, and West Virginia. A number of counties in each state were severely affected by flooding. Examples of the heavy rains include Blue Hill, MA with 17.32 inches in June to set a record for the month, and Marion, IN with 6 inches of rain in 6 hours in early August.

Tropical Storm Charley struck southern Texas in late August with flooding rains, resulting in nine deaths in Texas and at least eleven deaths in Mexico. Del Rio recorded its wettest day ever on August 23, with 17.03 inches of rain from Charley's remnants.

Table 6 - Del Rio Precipitation Extremes

	Total	Period	
Del Rio	20.93 inches	Aug 1998	Wettest month on record
	15.79 inches	Sep 1964	2nd wettest month on record
	13.71 inches	Jun 1935	3rd wettest month on record
Del Rio	20.93 inches	Aug 1998	Wettest August on record
	6.10 inches	Aug 1971	2nd wettest August on record
Del Rio	17.03 inches	Aug 23, 1998	Wettest day on record any month
	8.79 inches	Jun 13, 1935	2nd wettest day on record

Table 7 - Rio Grande Flood Stages

Del Rio	16 feet on August 24 (recent record) 2nd highest recent flood: 14.08 feet (September 1974)
Eagle Pass	35 feet on August 25, 1998 (flood stage: 14 feet) Historical record: 53.51 feet in June 1954
Laredo International Bridge	35.02 feet on August 27, 1998 (flood stage: 8 feet)

HURRICANE BONNIE

Hurricane Bonnie edged into North Carolina's southern coastline near Wilmington on August 26, 1998. Bonnie was the first major hurricane (Category 3) of the 1998 season, and the winds and flooding rains damaged buildings and cut off power to nearly a half-million people. The storm which was nearly 400 miles wide, stalled near Wilmington for an hour after its eye crossed land at Cape Fear at 5 PM EDT on August 26.

Due to the slow movement of Bonnie, rainfall totals were rather high in parts of eastern North Carolina and extreme southeastern Virginia. Overall damages exceeded $1.0 billion. Insured losses were approximately $360 million, but these losses do not include flooding and agricultural damages. There were two fatalities directly attributed to the storm. Figure 8 is an enhanced infrared image of Bonnie on August 26. Figure 9 is the Raleigh-Durham NEXRAD-estimated storm total rainfall ending at 1250Z on Aug 27.

Peak wind gusts recorded during the hurricane included:

Frying Pan Shoals Light Tower (off NC coast) - 104 mph
Wilmington, NC - 74 mph
Myrtle Beach, SC - 77 mph

Table 8 - Hurricane Bonnie Rainfall Reports

Following are National Weather Service (NWS) precipitation reports (Raleigh, NC, Thursday, August 27, 1998) for stations reporting 1.00 inch or more rainfall. North Carolina stations contain 24 hour totals ending at 8:00 AM on the 27th. Stations with an * are 24 hour data ending at 9:00 AM on the 27th. Stations listed as NWS are three day totals from the 27th through the 29th.

STATION	RAINFALL
ARCOLA	1.66
CAPE HATTERAS NWS	2.12
CHERRY POINT *	5.68
CLAYTON	2.76
CLINTON	4.45
DURHAM	1.00
ENFIELD	1.41
ERWIN-DUNN	2.80
FAYETTEVILLE *	2.40
GOLDSBORO *	2.47
GOLDSBORO 2 N	3.74
JACKSONVILLE *	10.40
LOUISBURG	1.14
NEUSE	1.09
NORFOLK, VA NWS	2.49
ROANOKE RAPIDS	1.18
ROCKY MOUNT PC	2.74
ROCKY MOUNT-WILSON *	4.04
SCOTLAND NECK	1.89
SMITHFIELD	2.68
TARBORO	2.18
WILMINGTON NWS	9.45
WILSON	4.94
ZEBULON	1.81

U. S. AND GLOBAL CLIMATE CONDITIONS

1998 was marked by a summer of drought in the south, flooding in portions of the midwest and northeast and small portions of the south, and continued global warmth. Nationally, summer (June - August) 1998 was the 44th driest and the ninth warmest on record since detailed records began in 1895, according to preliminary data. The 1998 national averaged value for summer precipitation was 8.19 inches, just slightly below the 1961-1990 normal summer precipitation of 8.24 inches. The wettest summer on record occurred in 1928 with a national average precipitation of 10.24 inches. The driest summer on record occurred in 1930, with a national average precipitation of 5.98 inches.

Based upon preliminary data, summer 1998 was the fifth driest on record for Maryland, eighth driest for Delaware, Georgia, and South Carolina, ninth driest for Florida, and the tenth driest such three-month period on record for New Jersey. To the opposite extreme, summer 1998 was the second wettest on record for Wyoming, the third wettest for Vermont, and the seventh

wettest for Colorado, Iowa, and Missouri. Regionally, summer 1998 was the 11th wettest since 1895 for the West-North Central region and the ninth driest for the Southeast region.

The 1961-1990 normal summer temperature is 71.7 F. The 1998 national averaged summer temperature was 72.9 F. The warmest summer on record, with a national average temperature of 74.3 F, occurred in 1936. The coolest summer on record occurred in 1915 with a national average temperature of 69.5 F. Regionally, summer 1998 was the fourth warmest since 1895 for the South region and the sixth warmest for the Southeast region. Summer 1998 was the warmest on record for Florida and Louisiana, the third warmest for Texas, the fourth warmest for Washington, and the fifth warmest on record for Oklahoma. See Figure 10 for the state-by-state rankings of temperature and precipitation for the summer of 1998.

Globally, preliminary surface data indicate that August 1998 and the year to date (January-August) remain at record warm levels with respect to 1880-1997 long-term means. Preliminary August land station temperatures were 2.1 degrees F above the mean, while sea surface temperature readings (including ship, buoy, and satellite measurements) were nearly 1 degree F above the mean, for a combined index value of 1.3 F above the average. For the year to date, land stations were 2 degrees F above the mean, sea surface temperatures were 1 degree F above the mean, and the global index stands at 1.3 degrees F on the warm side. See Figure 11 for the global temperature anomalies since 1880.

The lingering global surface warmth, likely related to the recent El Nino, has persisted, even as central equatorial Pacific sea surface temperatures cool down to La Nina levels (however, ocean temperatures off the NW South American coast remain quite warm). Near-surface global land and ocean temperatures for the month of August 1998 established an all-time record high. Temperatures averaged more than 1.3 degrees F above the 1880-1997 long-term mean. The high temperatures were particularly evident over the land as temperatures averaged over two degrees above the long-term mean, exceeding the old record by several tenths of a degree F. NOAA will continue to monitor global climate conditions and inform the public of ongoing trends.

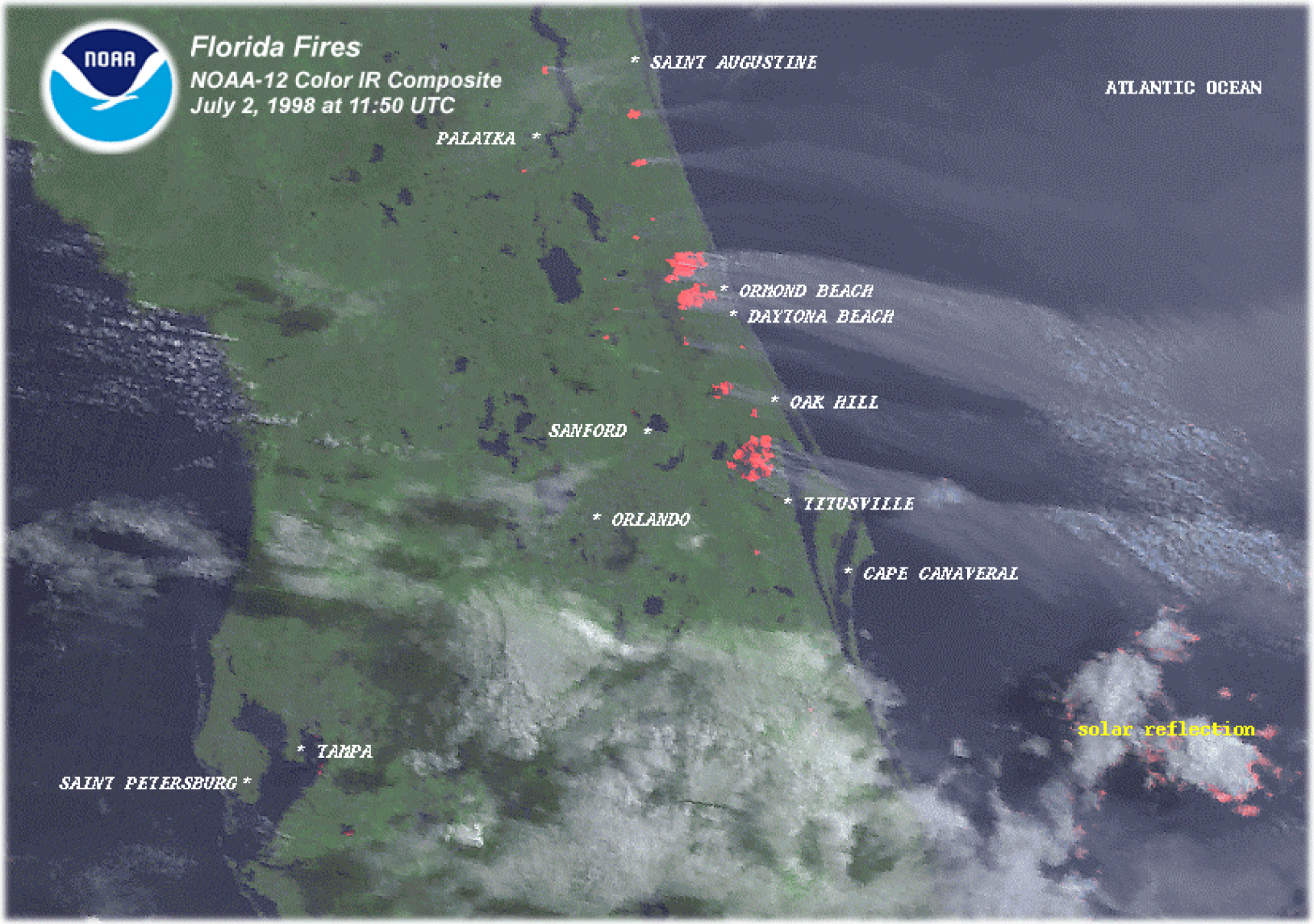
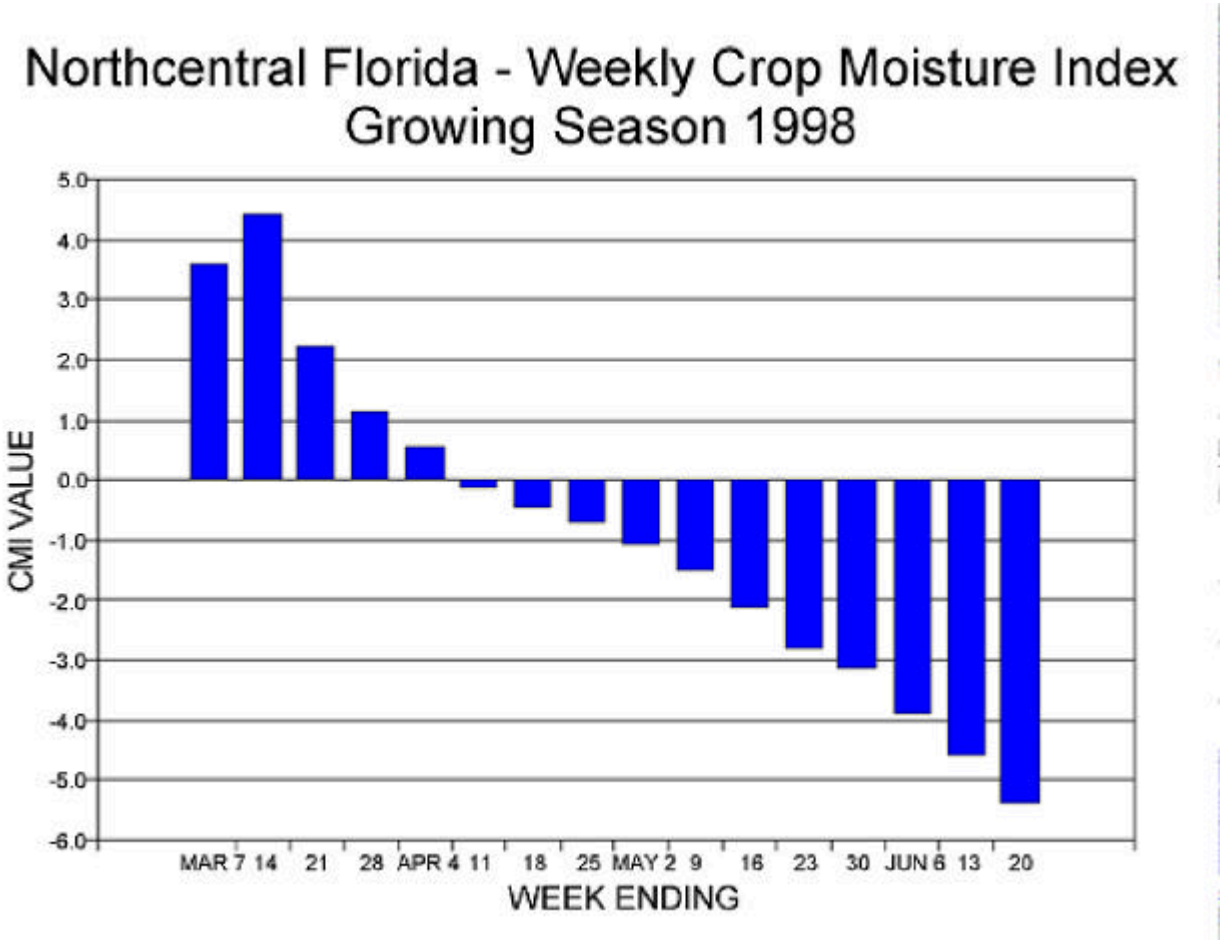

Florida Fires
NOAA-12 Color IR Composite
July 2, 1998 at 11:50 UTC
* SAINT AUGUSTINE
ATLANTIC OCEAN
PALATKA *
* ORMOND BEACH
* DAYTONA BEACH
* OAK HILL
SANFORD *
* TITUSVILLE
* ORLANDO
* CAPE CANAVERAL
solar reflection
* TAMPA
SAINT PETERSBURG *

FIGURE 1


Northcentral Florida - Weekly Crop Moisture Index
Growing Season 1998
CMI VALUE
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4.0
3.0
2.0
1.0
0.0
-1.0
-2.0
-3.0
-4.0
-5.0
-6.0
MAR 7 14 21 28 APR 4 11 18 25 MAY 2 9 16 23 30 JUN 6 13 20
WEEK ENDING

FIGURE 2

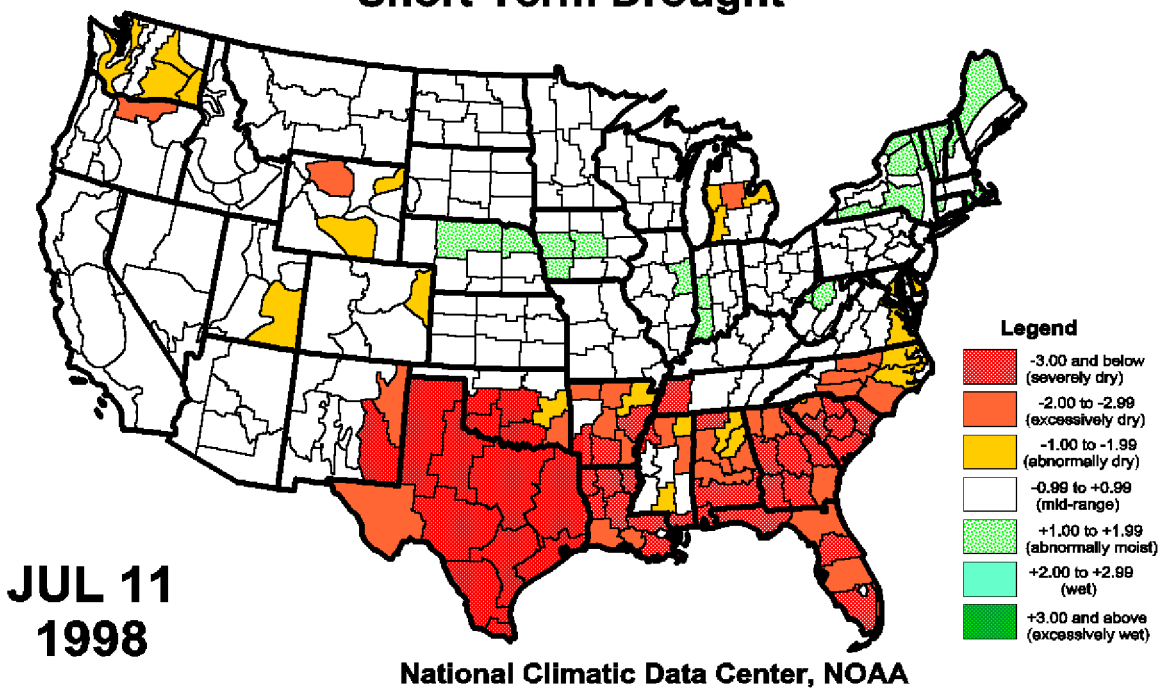


FIGURE 3

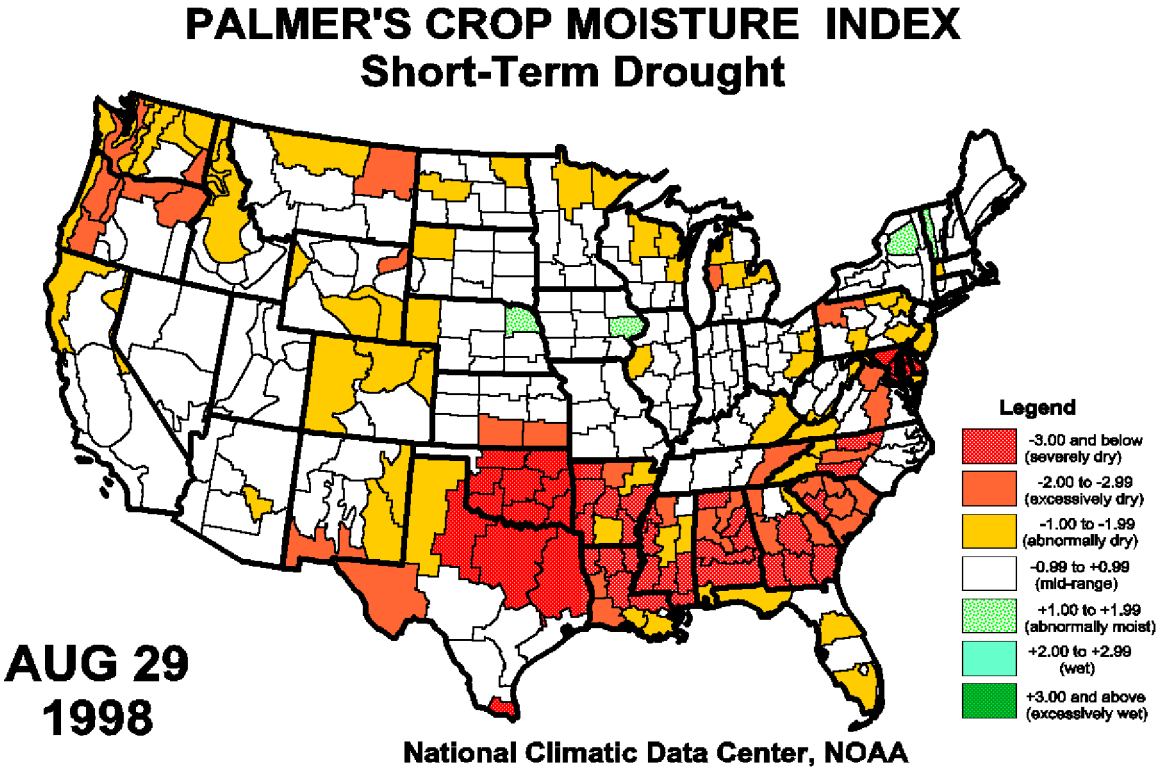
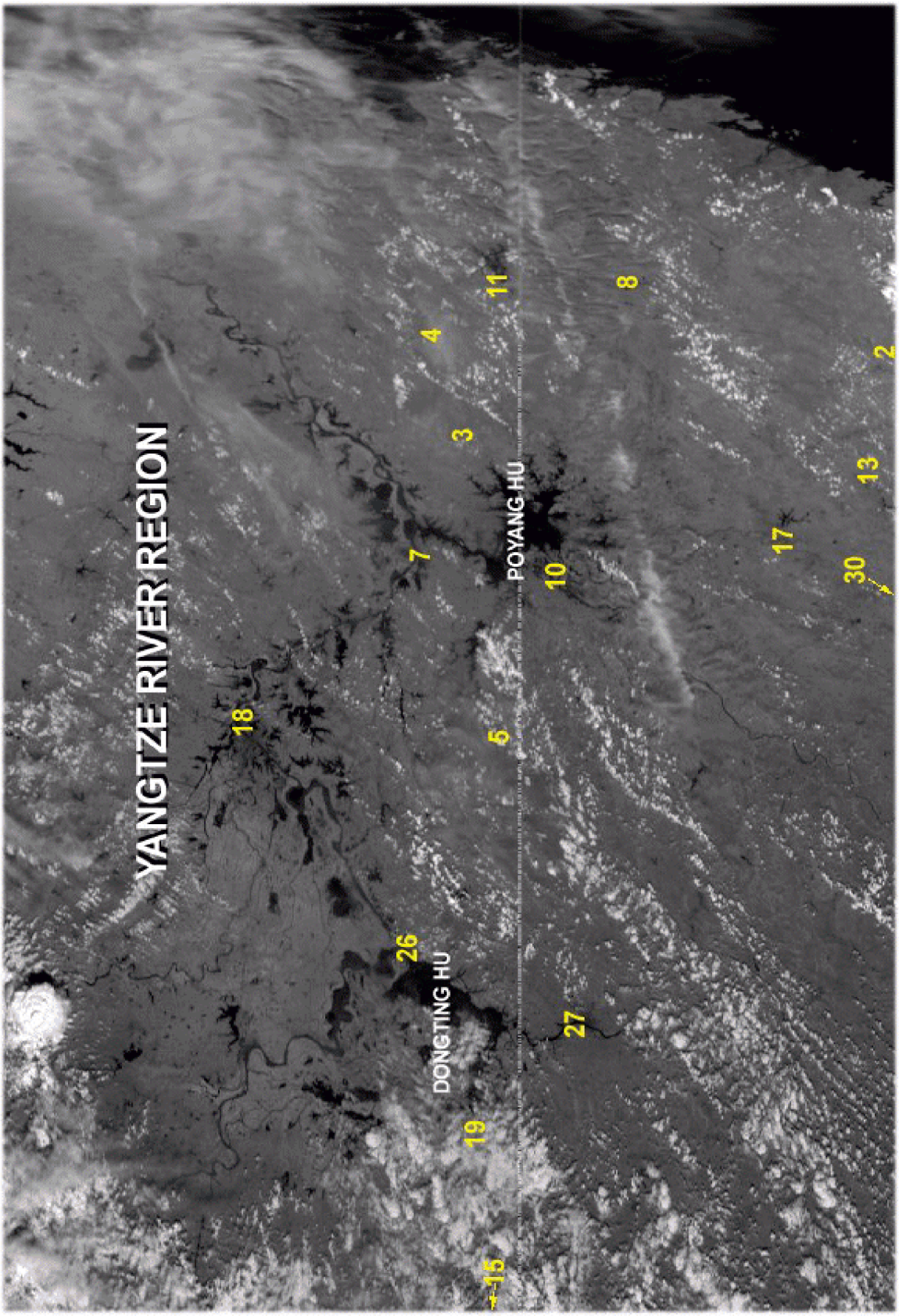


FIGURE 4


YANGTZE RIVER REGION
DONGTING HU
POYANG HU
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26
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11
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8
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2

FIGURE 5

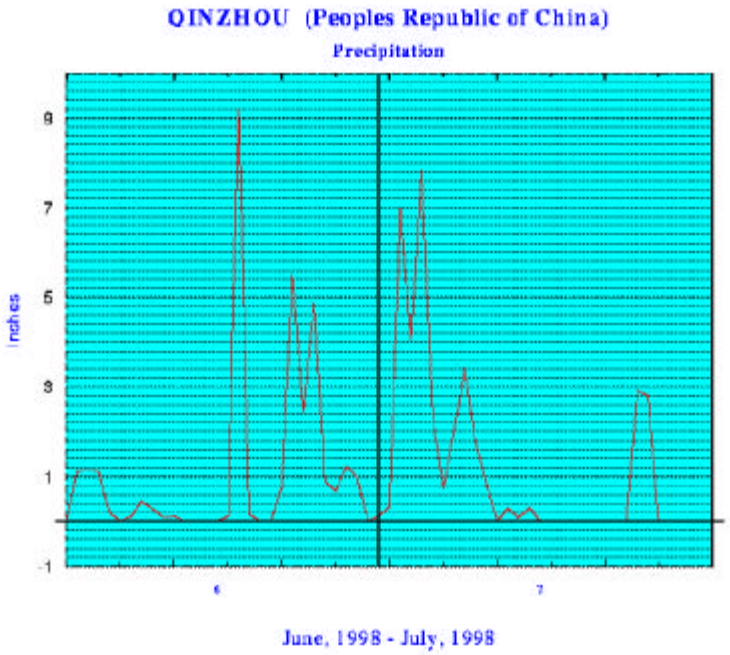


FIGURE 6

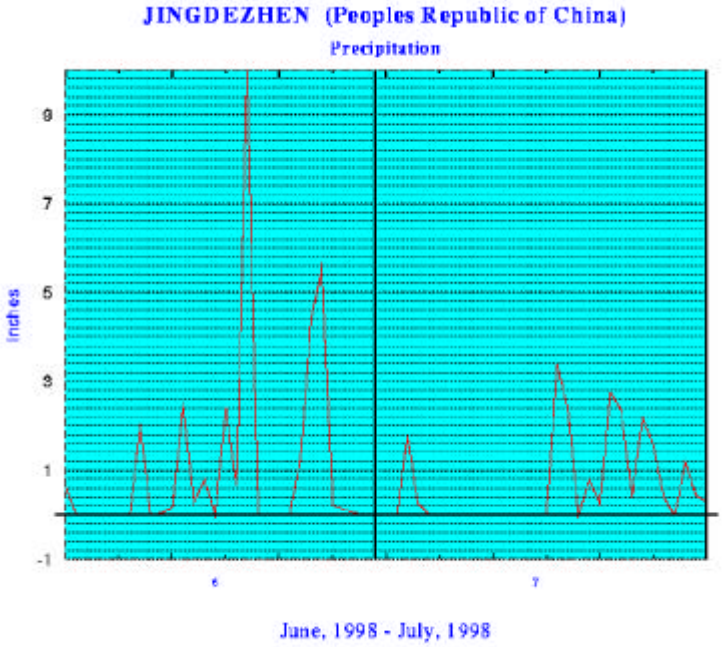


FIGURE 7

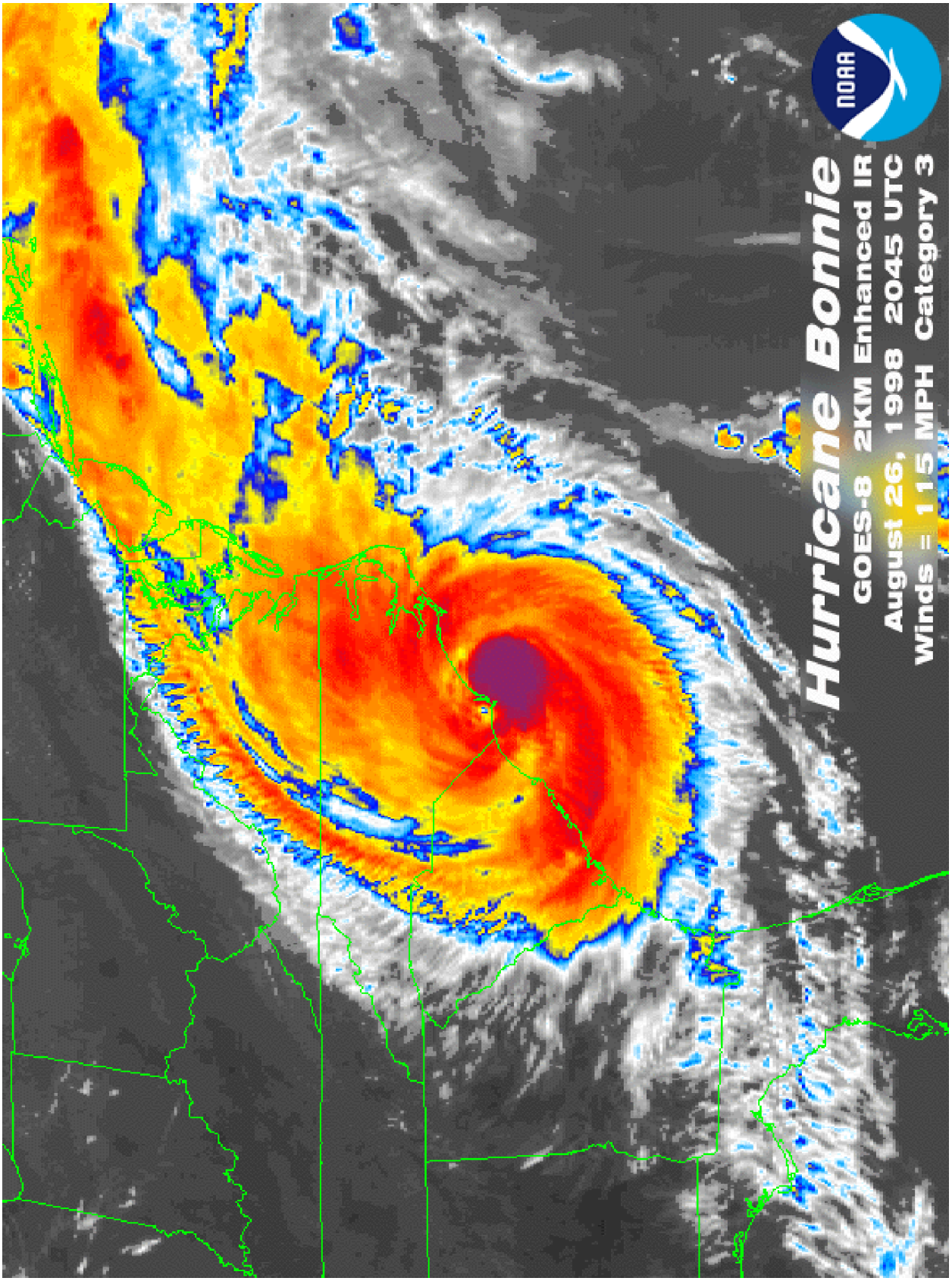

Hurricane Bonnie
GOES-8 2KM Enhanced IR
August 26, 1998 2045 UTC
Winds = 115 MPH Category 3
NOAA

FIGURE 8

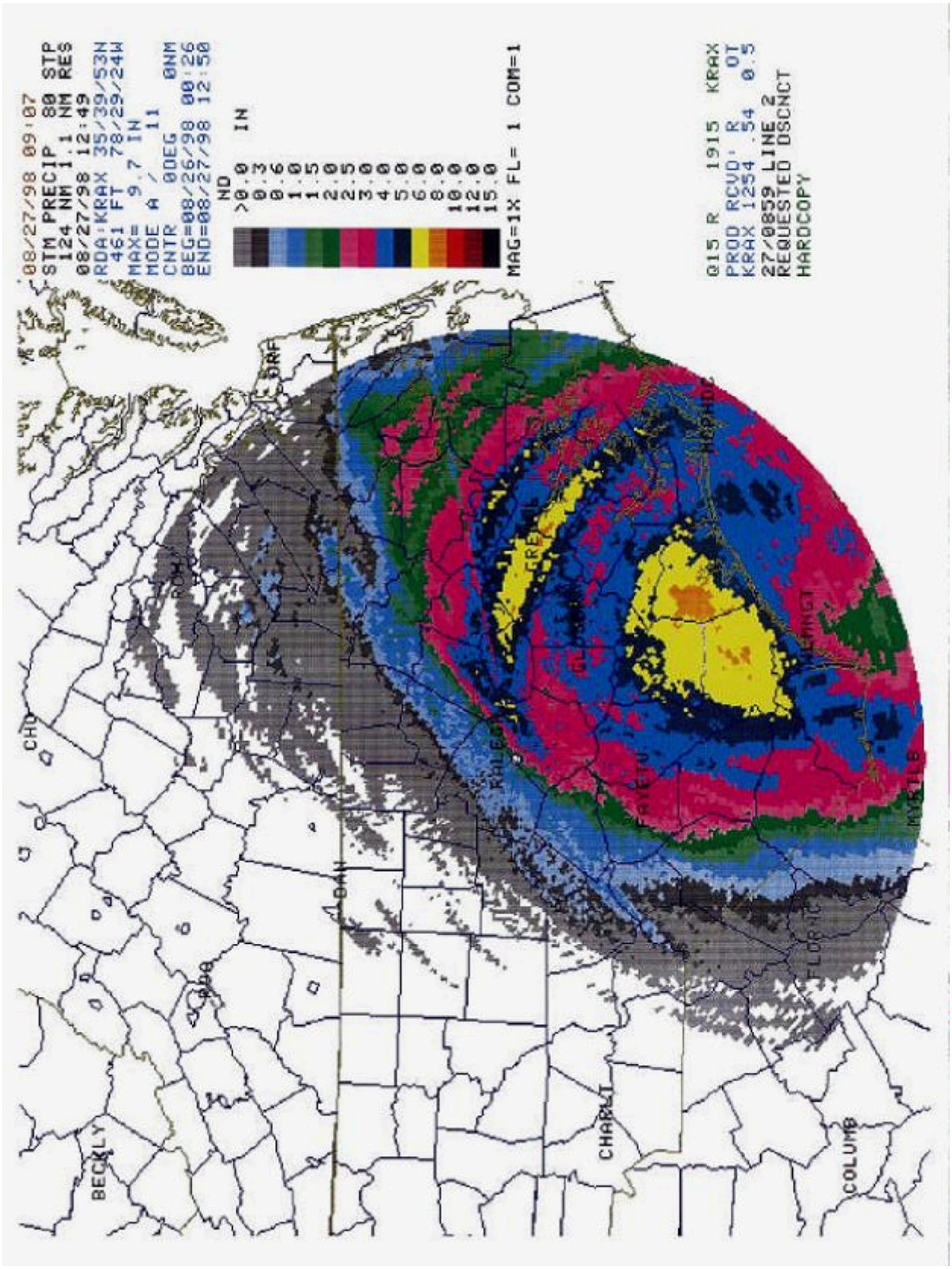
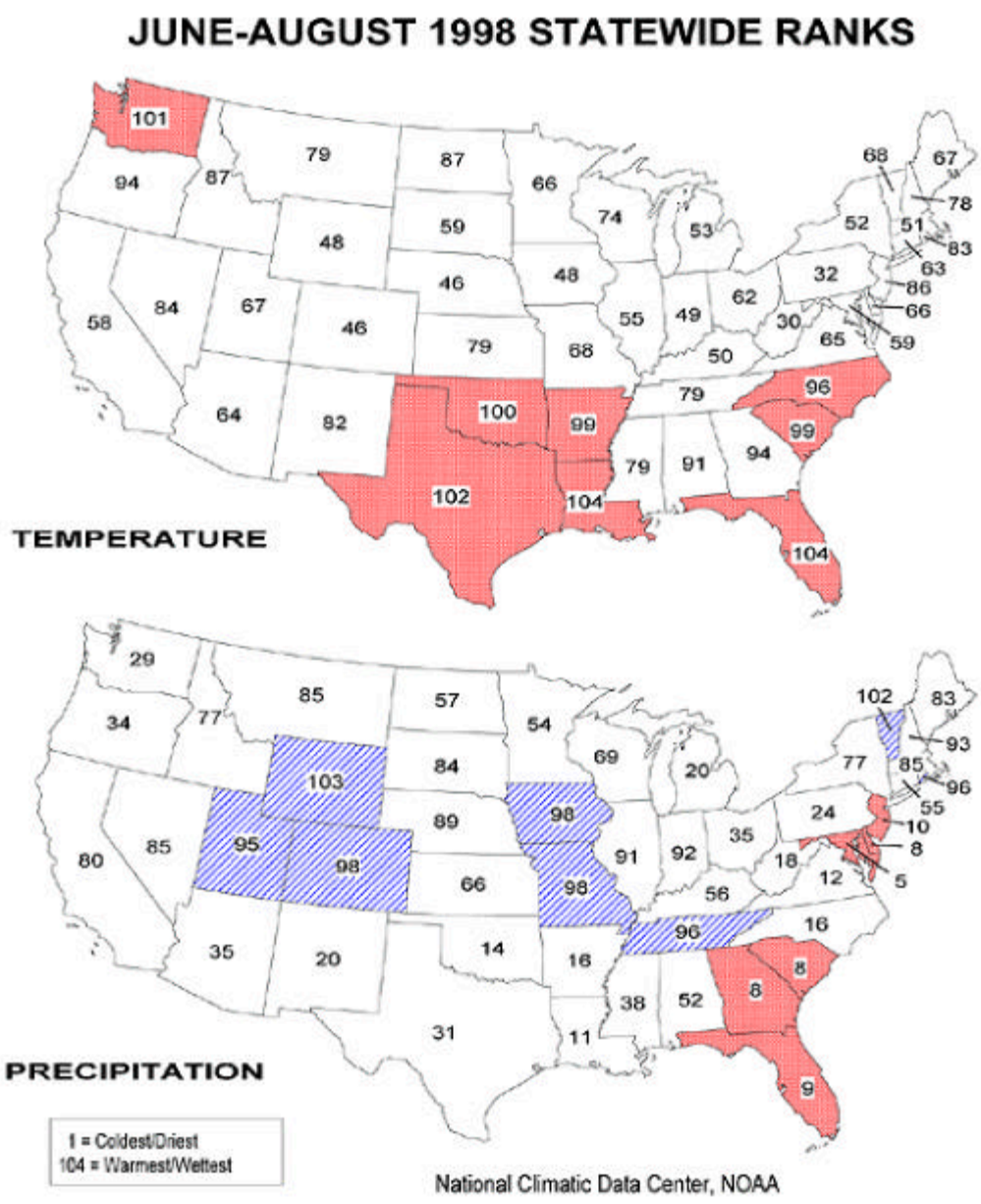

08/27/98 09:07
STM PRECIP 80 STP
124 NM 1.1 NM RES
08/27/98 12:49
RDA:KRAX 35/39/53N
461 FT 78/29/24W
MAX= 9.7 IN
MODE A / 11
CNTR 0DEG 0NM
BEG=08/26/98 00:26
END=08/27/98 12:50
ND
>0.0 IN
0.3
0.6
1.0
1.5
2.5
3.0
4.0
5.0
6.0
8.0
10.0
12.0
15.0
MAG=1X FL= 1 COM=1
Q15 R 1915 KRAX
PROD RCVD: R OT
KRAX 1254 .54 0.5
27/0859 LINE 2
REQUESTED DSCNCT
HARDCOPY
CHO
RDU
FLO
CHARLT
COLUMB
MYRTLE

FIGURE 9



Temperature and Precipitation Ranks for the contiguous United States. Each state is ranked based on its data from 1895-1998. States having a rank of top ten coldest or driest (rank 1-10) or top ten warmest or wettest (rank 95-104) are shaded.

FIGURE 10

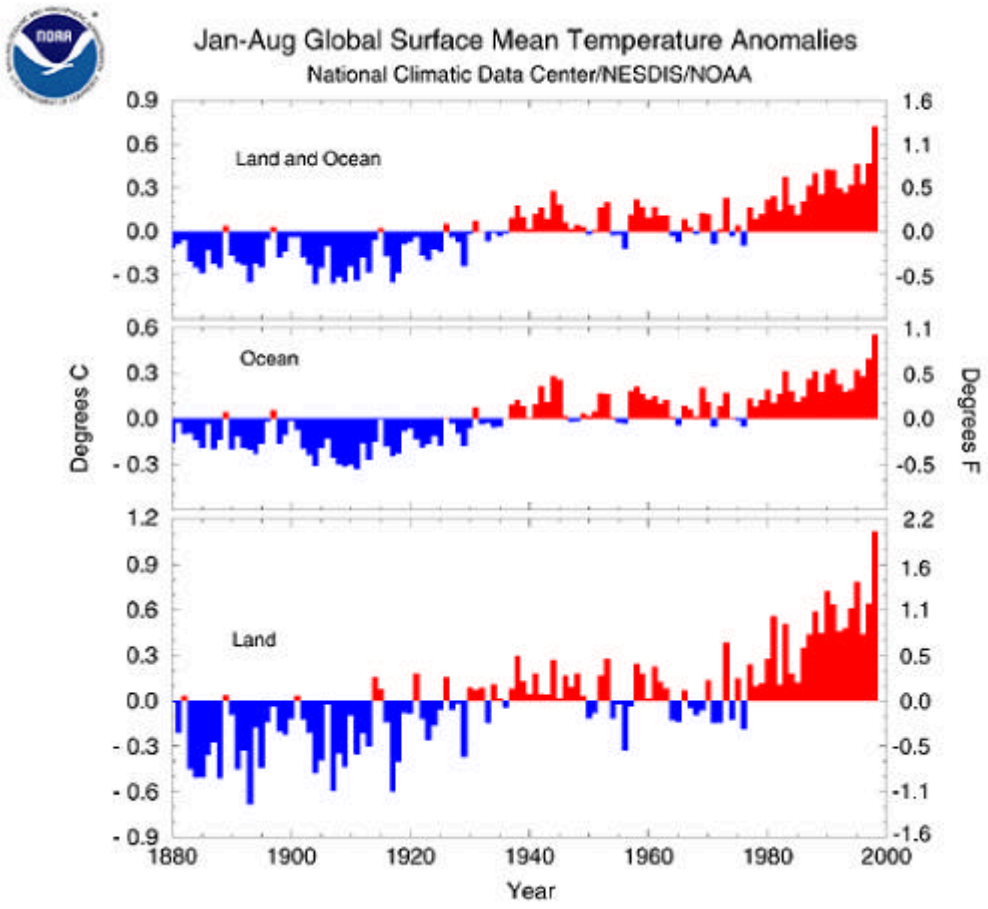

Jan-Aug Global Surface Mean Temperature Anomalies
National Climatic Data Center/NESDIS/NOAA
Land and Ocean
Ocean
Land
Degrees C
Degrees F
Year
0.9
0.6
0.3
0.0
- 0.3
- 0.6
- 0.9
1.6
1.1
0.5
0.0
-0.5
-1.1
-1.6
1.2
2.2
1880
1900
1920
1940
1960
1980
2000

FIGURE 11