El NiZo of 1997-98: The Climatic Effects of El NiZo and Their Relation to Vector-Borne Disease Occurrence

Summary

This report provides a description of El Niño, details temperature and precipitation anomalies in the US during past El Niño events, and summarizes weather predictions for the US during the first half of 1998. It presents the potential for climatic conditions to affect insect populations that transmit diseases of animals and briefly reviews difficulties in linking large-scale climate events with disease occurrence. Widespread significant impacts on vector-borne diseases of concern to Veterinary Services are not expected to result from the current El Niño**.**

What is El NiZo?

El Niño is a climatic phenomenon with the following characteristics: an anomalous warming of surface water in the eastern half of the equatorial Pacific (off the coast of Ecuador and Peru); changes in pressure at sea level across the Pacific Ocean; a slackening of westward-flowing equatorial trade winds; recurrence but not at regular intervals; generally lasts between 12-18 months (Glantz, 1996).

Several direct results arise from these events. During non-El Niño years, the westward-flowing equatorial winds cause heavy rainfall in the western end of the Pacific ocean surrounding Indonesia. Because these winds weaken during El Niño years, the rainfall moves eastward. Another direct consequence results from the warm ocean waters. Since the warm waters cannot sustain as much plankton for fish to feed on, fish move northward or southward to cooler waters. Still another direct result of El Niño is a shift in the jet stream that moves from west to east across the Pacific, affecting weather, primarily in the winter, over parts of North America (NOAA, 1994).

Many other climate conditions have been attributed to El Niño. However it is not clear-cut to what degree they are consequences of El Niño and to what degree they are results of local weather patterns, especially in temperate climates like the US. Experts in the field caution about drawing direct associations, as illustrated by these quotes: “El Niño is only one of a number of factors that influence temperate climates. El Niño years, therefore, are not always marked by ‘typical’ El Niño conditions the way they are in parts of the tropics” (NOAA, 1994). “It is not yet clear exactly which of the worldwide climate anomalies are associated with El Niño events and which result from ‘normal’ atmospheric processes” (Glantz, 1996).

El Niño events range in size and severity, from very weak to very strong. The events are defined and measured by several indicators: (1) the increase in sea surface temperatures in either the central or eastern equatorial Pacific; (2) sea-level pressure and rainfall in the Pacific; (3) the geographic location and area covered by the warm pool of sea water; and (4) duration (NOAA, 1994; Glantz, 1996).

Five El Niño’s have occurred since 1970; in 1972-73, 1976-77, 1982-83, 1986-87, and 1991-93. El Niño’s generally span two years with peak effects appearing off Peru and Ecuador in late fall and early winter, around Christmas time (hence the name El Niño, Spanish for 'the Christ Child'). However, some El Niño's have lasted three years (1911-13, 1939-41) and the length of the most recent prior to the current event is not clear at all. Scientists' opinions differ as to whether the event that began in 1991 ended in 1993 or whether it continued into 1995 (Glantz, 1996).

How has US weather been affected by El NiZo?

In the US, various climate events have accompanied El Niño years. Note that these climate events are not necessarily a result of El Niño. Droughts, heavy rains, or severe storms have occurred in many non-El Niño years; for example, among billion dollar US weather disasters reported by NOAA are a drought/heat wave in the summer of 1980 in the central and eastern US, severe flooding in the Pacific northwest in early 1996, and west coast flooding in the winter of 1996-97.

The major effects of El Niño in the US generally occur late in the year in which El Niño begins and continue into the spring of the following year. Precipitation and temperature anomalies from December through May for the 5 events prior to the current one are shown in Tables 1-2 and Figures 1-3 (NOAA, Climate Diagnostics Center).[1] It is evident that climate conditions are not consistent between El Niño years. However, those considered to be strong events (1972-73 and 1982-83) were marked by above normal precipitation in large parts of the country, most notably in the southwest and southeast. Temperatures during these 2 events were above normal for much of the northern part of the country.

The 1972-73 El Niño was accompanied by precipitation 8 to 10 inches above normal for parts of New England and a large section of the southeast and Mississippi valley states (Figure 1). Parts of Arizona and California also had increased precipitation of up to 6 inches above normal. Northcentral and northwestern states, on the other hand, had below normal precipitation, with 8 to 10 inches less than normal along the coast of Washington and Oregon. Much of the northern half of the country from New England to Montana had above-normal temperatures, while much of the west, especially the Rocky Mountain states, experienced below-normal temperatures.

The weather pattern during December through May of the next El Niño, in 1976-77, was very different from the previous episode (Figure 1). Almost the entire country had below normal precipitation, especially east of the Mississippi and along the west coast. Temperatures also averaged below normal east of the Mississippi and in the central and southwestern US. The country's midsection, from Montana through the Dakotas and south to Kansas, had above-normal temperatures

The strongest event in recent times was the El Niño of 1982-83. It is considered to be the strongest because it was associated with the highest pressure readings in Australia, highest rainfall in the central Pacific, reversal in direction of trade winds, and the greatest impact of any El Niño thus far in this century (NOAA, 1994).

---

[1] Precipitation is the total amount in the season (Dec-May); temperature is the average for the season. The value averaged over 1950 to 1995 is subtracted from the value for the year to obtain anomalies.

During the 1982-83 El Niño, north central states experienced drought conditions (Figure 2). Most of the southern half of the US experienced above normal rainfall from September through the following May (FEMA, August 1997). The east coast, gulf states, and the west coast saw precipitation 8 to 10 inches above normal. In addition, California suffered severe storms. Most of the northern US, especially Montana and the Dakotas, had temperatures above normal. Another effect attributed to this El Niño was a decline in hurricanes hitting the southeastern US.

During the winter and early spring of the 1986-87 El Niño, weather patterns were again almost reversed. The west coast and most of the eastern half of the country had severely reduced precipitation (Figure 2). Only parts of the east coast, Florida, and some central sections of the country experienced above normal precipitation. Most of the country had warmer than normal conditions, with temperatures 8-10 degrees above normal for some northcentral states.[2]

The most recent El Niño event prior to the current one began in 1991. During winter and early spring of 1992, most of the US had below normal precipitation (Figure 3). Only the extreme southern US from Texas to the west coast saw increased precipitation, with 8 to 10 inches above normal in much of Texas. Temperatures averaged above normal for most of the US, notably in northwest and northcentral states.

What are the precipitation and temperature outlooks in the US for the first half of 1998?

The current 1997-98 El Niño has had effects similar to the strong event of 1982-83. Specifically, wetter than normal conditions have prevailed over California and throughout the eastern Gulf Coast states and Florida (NOAA, February 1998). In addition, as in the 1982-83 event, the current El Niño has contributed to markedly reduced tropical storm and hurricane activity over the North Atlantic during August-October 1997 (NOAA, December 1997).

From March through May 1998, the outlook for the southwestern US is continued above-normal rainfall (Figure 4; NOAA, February 1998). This includes all of California, Arizona, and New Mexico, as well as sections of Nevada, Utah, Colorado, and Texas. Much of Washington has a slight chance of below-normal precipitation. A large section of the country east of the Mississippi is also expected to be dryer than normal, with highest probabilities of below-normal rainfall centered over Michigan.

From June through August 1998, there are no indications that precipitation probabilities will deviate from historical averages. These predictions take into account effects other than El Niño but were based primarily on past El Niño influences.

Temperatures from March through May 1998 are expected to be above-normal for much of the northern US, in a band from Wisconsin to the west coast and south, including California and Nevada (Figure 5; NOAA, February 1998). The southeastern US and Texas are expected to have below-normal temperatures. From June through August 1998, there exist slight chances of above-normal temperatures in pockets over the extreme northwest, the southwest, southern

[2] Note that the legend for the 1986-87 and 1991-92 seasons increased to 2-degree increments.

Texas, and most of the Atlantic coast states. The contour centered over Kansas and Nebraska indicates that below-normal temperatures are somewhat likely.

Are these climatic anomalies expected to have an impact on insect-borne diseases of domestic animals?

If climatic events impact insect populations, then one may speculate that insect-borne diseases of domestic animals are also impacted by climate. Several diseases of concern to Veterinary Services are insect-borne. One of these is equine infectious anemia, which is transmitted between horses by large biting insects such as horse flies and deer flies (Cordes, 1996). Both eastern and western equine encephalomyelitis are transmitted by mosquito species (Morris, 1989; Reisen & Monath, 1989). Vesicular stomatitis virus has been isolated from numerous biting insects, including mosquitos, gnats, midges, and various flies (Webb & Holbrook, 1989). Finally, the insect vectors responsible for transmission of bluetongue are species of biting midges (Gibbs & Greiner, 1989).

In the public health arena, speculation that climatic changes may result in increases in certain insect-borne diseases has received wide publicity (*Time* 7/8/96; *Science* 2/17/95). However, infectious-disease experts maintain that "climate shifts have had minimal impact on disease patterns so far" and that other factors outweigh the effects of climate (*Science* 11/7/97). For example, dengue epidemics in Latin America in 1994 and 1995 have been attributed in part to El Niño and global warming. Others argued that the epidemics occurred because programs to eradicate the mosquito vector broke down.

As a result of the controversy, the Centers for Disease Control and Prevention and the National Research Council are establishing a panel of experts "to set the discussion on a footing of solid science ... and set an agenda for further research". One of the goals is to have a "better understanding of the transmission of disease under different circumstances of temperature and climate" (*Science* 11/7/97).

Looking for an association between climatic events and insect-borne diseases presents numerous difficulties. First, averaging factors such as temperature or precipitation over time and space obscures localized meteorologic events that may be much more important. Second, insects' reproduction and survival is influenced by a number of environmental factors, including temperature, day length, humidity, and precipitation (Reiter, 1989). All of these factors must coincide to provide conditions favorable to insects' varying and specific biology. For example, although insects such as biting midges and mosquitos require moisture for breeding and development, too much rain or severe storms flood out breeding habitat and result in population suppression (Gibbs & Greiner, 1989). Finally, a number of man-induced factors outweigh both the effects of climate and insect biology. These include vaccination, water management and irrigation practices, insect control, and more aggressive disease control policies.

Although these arguments do not rule out an association between climate events and disease occurrence, the complexity of the systems involved has made it difficult to establish a definitive relationship. In the absence of positive evidence, thus, it appears reasonable to conclude that the temperature and precipitation anomalies attributable to El Niño will not have widespread significant impacts on insect-borne diseases of concern to Veterinary Services.

References and Sources

Bridges VE, McCluskey BJ, Salman MD, et al. 1997. Vesicular stomatitis - Review of the 1995 outbreak. Accepted for publication in JAVMA.

Cordes T and Issel C. EIA -- A status report on its control (1996). APHIS, Veterinary Services.

Gibbs EPJ and Greiner EC. Bluetongue and Epizootic Hemorrhagic Disease. In: The Arboviruses: Epidemiology and Ecology, Volume II. TP Monath, editor, CRC Press, Inc, Boca Raton, FL, 1989, pg 39.

Glantz MH. 1996. Currents of change: El Niño's impact on climate and society. Cambridge University Press, Cambridge, England.

Global fever. *Time*, July 8, 1996.

If the mercury soars, so may health hazards. *Science*, February 17, 1995, pg 957.

Morris CD. Eastern Equine Encephalomyelitis. In: The Arboviruses: Epidemiology and Ecology, Volume III. TP Monath, editor, CRC Press, Inc, Boca Raton, FL, 1989, pg 1.

Precipitation and temperature anomalies maps from NOAA, Climate Diagnostics Center.

Reisen WK and Monath TP. Western Equine Encephalomyelitis. In: The Arboviruses: Epidemiology and Ecology, Volume V. TP Monath, editor, CRC Press, Inc, Boca Raton, FL, 1989, pg 89.

Reiter P. Weather, Vector Biology, and Arboviral Recrudescence. In: The Arboviruses: Epidemiology and Ecology, Volume I. TP Monath, editor, CRC Press, Inc, Boca Raton, FL, 1989, pg 245.

Taubes G. Apocalypse not. *Science*, November 7, 1997, pg 1004.

Webb PA and Holbrook FR. Vesicular Stomatitis. In: The Arboviruses: Epidemiology and Ecology, Volume V. TP Monath, editor, CRC Press, Inc, Boca Raton, FL, 1989, pg 2.

Table 1: Precipitation Anomalies for El NiZo Years Inches less than or greater than normal					
	Dec72-May73	Dec76-May77	Dec82-May83	Dec86-May87	Dec91-May92
Northeast					
CT	8 to 10	0 to 2	8 to 10	0 to 6	-6 to -4
DE	0 to 2	-8 to -6	4 to 8	2 to 6	-4 to -2
IL	2 to 10	-6 to 0	2 to 10	-10 to -2	-8 to -4
IN	-2 to 6	-6 to -2	-2 to 8	-10 to -2	-8 to -2
MA	2 to 10	-2 to 4	8 to 10	0 to 10	-8 to -4
MD	0 to 8	-10 to -4	2 to 8	-2 to 6	-2 to 2
ME	6 to 8	-2 to 2	4 to 10	-6 to 0	-6 to -2
MI	0 to 6	-6 to 0	0 to 8	-8 to -2	-4 to 0
MN	-4 to 8	-2 to 4	-4 to 6	-6 to 2	-4 to 0
NH	2 to 8	-4 to 0	6 to 10	-6 to 0	-6 to -2
NJ	6 to 10	-8 to -2	6 to 10	-2 to 4	-6 to -4
NY	0 to 8	-6 to 2	-2 to 10	-6 to 0	-6 to 2
OH	-2 to 4	-8 to 0	-4 to 4	-8 to -2	-4 to 0
PA	0 to 8	-6 to 0	-2 to 8	-4 to 0	-4 to 2
RI	4 to 10	-2 to 2	8 to 10	4 to 6	-6 to -4
VA	0 to 8	-10 to -2	-2 to 8	2 to 8	-2 to 4
VT	4 to 8	-4 to 2	4 to 10	-6 to -2	-4 to 0
WI	2 to 10	-4 to 4	0 to 6	-6 to 0	-4 to 2
WV	2 to 8	-8 to -4	-4 to 4	-6 to 0	-2 to 4
Southeast					
AL	4 to 10	-4 to 6	8 to 10	-8 to 8	-10 to 0
FL	-4 to 10	-8 to 4	6 to 10	2 to 8	-8 to -2
GA	6 to 10	-6 to 2	2 to 10	-8 to 8	-8 to 2
MS	2 to 10	-10 to 2	6 to 10	-8 to 8	-10 to 2
KY	2 to 10	-10 to -6	-2 to 10	-10 to -2	-6 to 0
NC	2 to 10	-6 to 2	2 to 10	-2 to 8	-4 to 4
SC	4 to 10	-4 to 0	4 to 10	-2 to 6	-6 to 0
TN	8 to 10	-10 to -2	-2 to 10	-10 to -2	-6 to 0
Central					
AR	6 to 10	-10 to -2	2 to 10	-8 to 0	-8 to 2
IA	0 to 10	-4 to 2	0 to 6	-6 to 4	-4 to 2
KS	2 to 10	-2 to 4	0 to 8	2 to 8	-2 to 2
LA	2 to 10	-8 to 2	6 to 10	-6 to 4	-6 to 10
MO	8 to 10	-6 to -2	4 to 10	-10 to 0	-6 to 0
NE	0 to 8	0 to 10	0 to 8	0 to 8	-4 to 2
ND	-4 to 2	-2 to 4	-4 to 2	-2 to 2	-4 to 0
OK	2 to 10	-4 to 6	0 to 6	-6 to 8	-2 to 4
SD	-2 to 4	-2 to 8	-4 to 2	-2 to 4	-4 to 0
TX	-2 to 6	-4 to 4	-2 to 6	-4 to 8	4 to 10

	Dec72-May73	Dec76-May77	Dec82-May83	Dec86-May87	Dec91-May92
Western					
AZ	0 to 6	-6 to 0	0 to 6	-2 to 2	2 to 8
CA	-2 to 6	-10 to 0	4 to 10	-10 to -2	-10 to 6
CO	0 to 4	-4 to 2	0 to 4	-2 to 4	-2 to 2
ID	-6 to 0	-8 to 0	-2 to 6	-6 to 2	-8 to 0
MT	-4 to 2	-6 to 0	-2 to 0	-4 to 2	-4 to 0
NM	0 to 4	-4 to 2	0 to 4	0 to 6	0 to 8
NV	0 to 2	-4 to 0	0 to 4	-2 to 2	-4 to 6
OR	-10 to 0	-10 to -2	0 to 10	-10 to 0	-10 to -2
UT	-2 to 4	-6 to 0	0 to 6	-4 to 2	-6 to 4
WA	-10 to 0	-10 to -2	0 to 10	-10 to 0	-10 to 0
WY	-4 to 2	-6 to 2	-4 to 4	-4 to 2	-8 to 2

Source: NOAA, Climate Diagnostics Center - values read from accompanying maps

Shaded columns represent ‘strong’ El Niño years.

Table 2: Temperature Anomalies for El NiZo Years Degrees less than or greater than normal					
	Dec72-May73	Dec76-May77	Dec82-May83	Dec86-May87	Dec91-May92
Northeast					
CT	1 to 2	-2 to 0	2 to 3	0 to 2	0 to 2
DE	1 to 2	-2 to 0	1 to 2	-2 to 0	0 to 2
IL	0 to 2	-2 to 1	0 to 3	0 to 6	2 to 4
IN	0 to 2	-2 to 0	1 to 3	0 to 4	0 to 4
MA	1 to 2	-2 to 0	1 to 3	0 to 2	-2 to 0
MD	1 to 2	-2 to 0	0 to 2	-2 to 2	0 to 2
ME	0 to 1	-2 to 0	1 to 3	0 to 2	-2 to 0
MI	1 to 2	-1 to 1	2 to 3	2 to 6	0 to 4
MN	0 to 3	0 to 3	1 to 5	6 to 10	2 to 6
NH	1 to 2	-1 to 0	2 to 4	0 to 2	-2 to 0
NJ	1 to 2	-2 to 0	1 to 2	0 to 2	0 to 2
NY	1 to 3	-2 to 0	1 to 4	0 to 4	-2 to 2
OH	1 to 3	-3 to -1	1 to 3	0 to 4	0 to 4
PA	0 to 3	-3 to 0	0 to 3	-2 to 2	0 to 2
RI	1 to 2	-2 to -1	1 to 2	0 to 2	-2 to 0
VA	0 to 2	-3 to 0	-1 to 0	-2 to 0	0 to 2
VT	1 to 3	-1 to 1	1 to 3	0 to 2	-2 to 2
WI	0 to 2	-1 to 1	2 to 4	2 to 8	2 to 4
WV	1 to 3	-3 to 0	0 to 2	0 to 2	
Southeast					
AL	-1 to 1	-3 to -1	-2 to 0	-2 to 2	-2 to 2
FL	-1 to 1	-3 to -1	-2 to 0	-2 to 2	-2 to 2
GA	-1 to 1	-3 to -1	-2 to 0	-2 to 2	-2 to 2
MS	-2 to 0	-2 to 0	-2 to 0	-2 to 2	-2 to 2
KY	0 to 2	-3 to 0	-1 to 1	0 to 2	0 to 4
NC	0 to 1	-2 to 0	-2 to 1	-2 to 2	0 to 2
SC	-1 to 1	-2 to -1	-2 to 0	-2 to 0	0 to 2
TN	-1 to 1	-2 to -1	-1 to 0	0 to 2	0 to 2
Central					
AR	-2 to 0	-1 to 0	-2 to 1	0 to 4	0 to 4
IA	-1 to 2	0 to 3	0 to 3	4 to 8	2 to 6
KS	-3 to 0	0 to 3	-2 to 0	0 to 6	2 to 6
LA	-2 to 0	-3 to 0	-2 to -1	-2 to 0	0 to 2
MO	-2 to 0	-1 to 0	-1 to 1	0 to 6	0 to 4
NE	-2 to 1	1 to 3	-1 to 2	2 to 8	4 to 6
ND	1 to 4	2 to 5	2 to 5	6 to 10	4 to 8
OK	-4 to -1	-1 to 2	-3 to 0	0 to 2	0 to 4
SD	-2 to 3	1 to 4	1 to 5	4 to 10	4 to 8
TX	-4 to -1	-3 to 0	-3 to 0	-4 to 0	-2 to 2

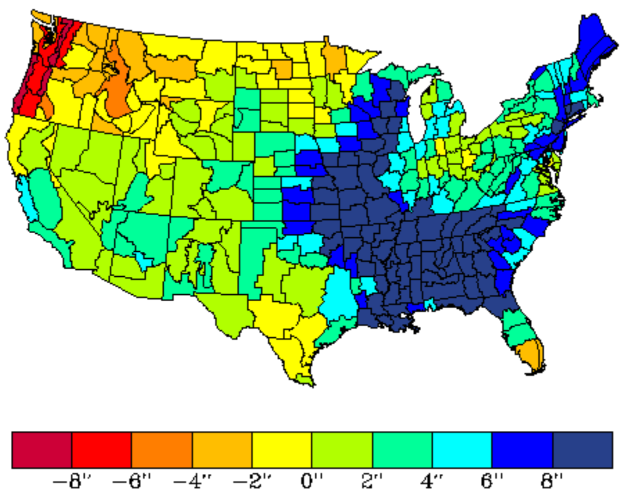
	Dec72-May73	Dec76-May77	Dec82-May83	Dec86-May87	Dec91-May92
Western					
AZ	-4 to -2	-2 to 0	-2 to 0	-2 to 4	0 to 4
CA	-3 to 0	-2 to 0	-2 to 1	0 to 4	2 to 4
CO	-5 to -2	-1 to 1	-2 to 1	-2 to 2	-2 to 4
ID	-4 to 0	-3 to 1	0 to 3	0 to 4	4 to 8
MT	-3 to 3	0 to 5	1 to 5	2 to 10	4 to 10
NM	-4 to -2	-3 to 0	-3 to 0	-2 to 2	-2 to 2
NV	-4 to -1	-2 to 0	-2 to 1	0 to 2	2 to 6
OR	0 to -2	-3 to 0	0 to 3	0 to 4	2 to 6
UT	-5 to -3	-2 to 3	-1 to 1	0 to 4	0 to 4
WA	-1 to 1	-1 to 2	2 to 4	0 to 4	2 to 6
WY	-5 to 0	-1 to 3	-1 to 2	0 to 6	2 to 8

Source: NOAA, Climate Diagnostics Center - values read from accompanying maps

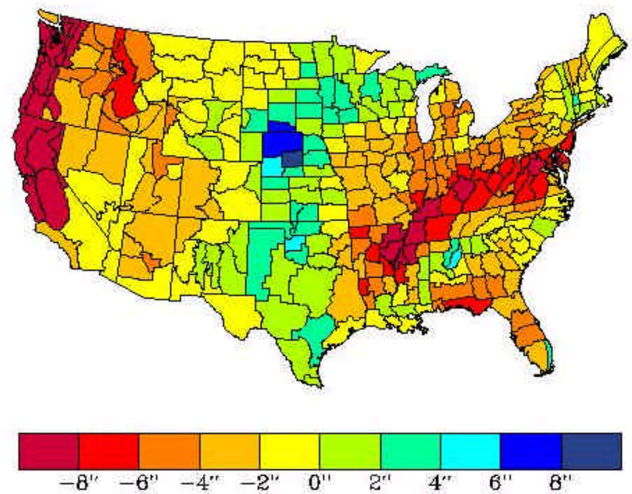
Shaded columns represent ‘strong’ El Niño years.

Figure 1

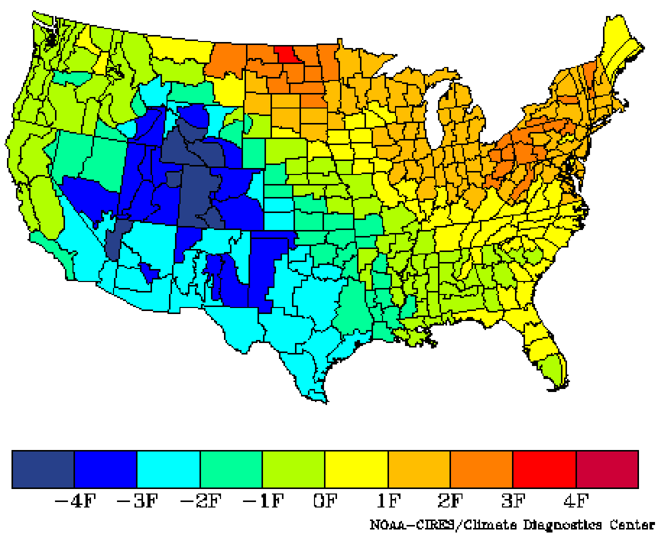
Precipitation Anomalies Dec 1972 to May 1973
Versus 1950 - 1995 longterm average



Precipitation Anomalies Dec 1976 to May 1977
Versus 1950 - 1995 longterm average



Temperatuture Anomalies Dec 1972 to May 1973
Versus 1950 - 1995 longterm average



Temperature Anomalies Dec 1976 to May 1977
Versus 1950 - 1995 longterm average

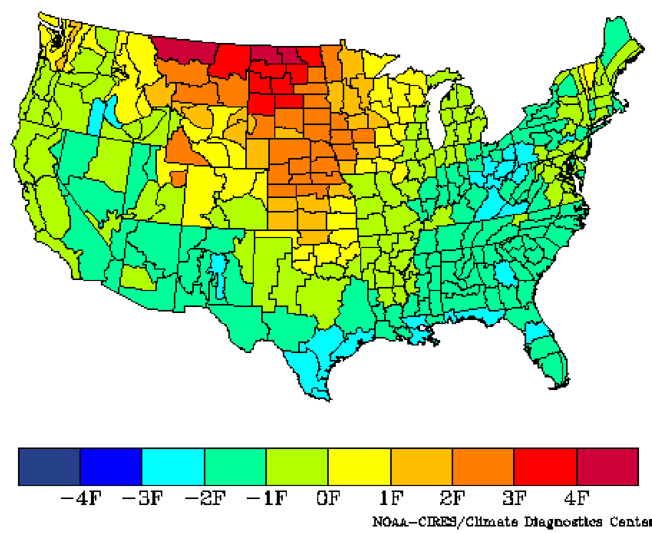
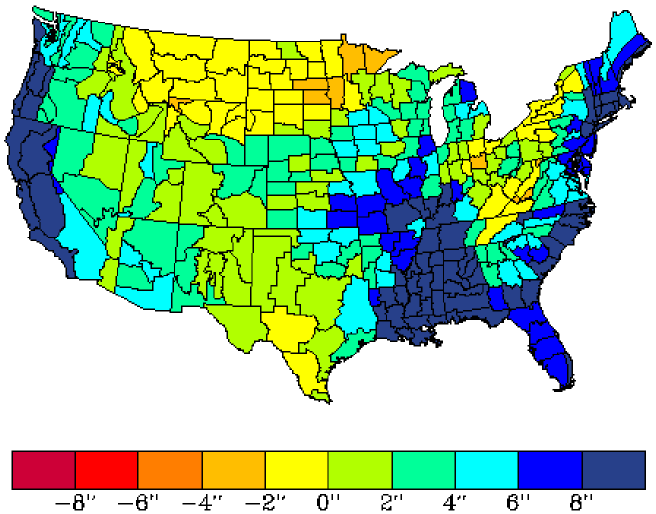
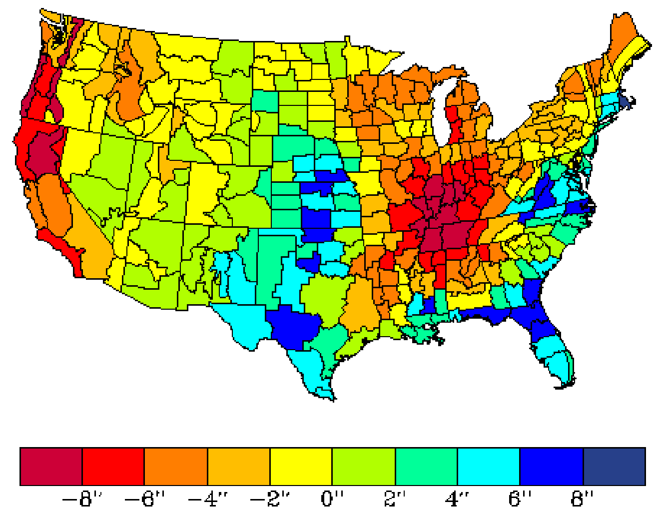


Figure 2

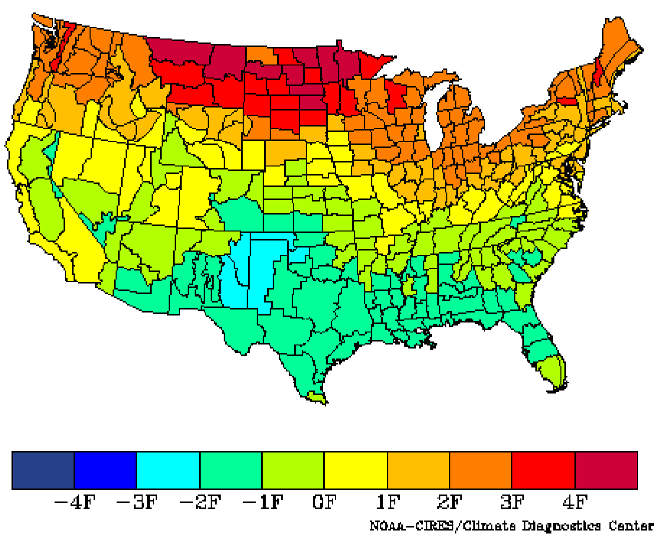
Precipitation Anomalies Dec 1982 to May 1983
Versus 1950 - 1995 longterm average



Precipitation Anomalies Dec 1986 to May 1987
Versus 1950 - 1995 longterm average



Temperature Anomalies Dec 1982 to May 1983
Versus 1950 - 1995 longterm average



Temperature Anomalies Dec 1986 to May 1987
Versus 1950 - 1995 longterm average

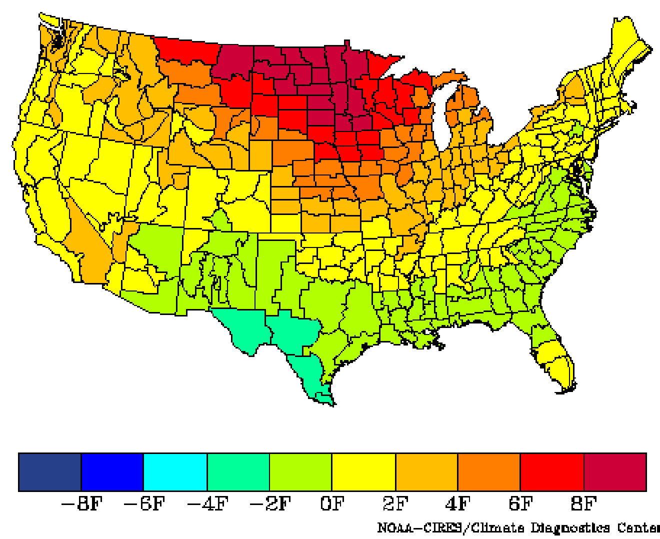
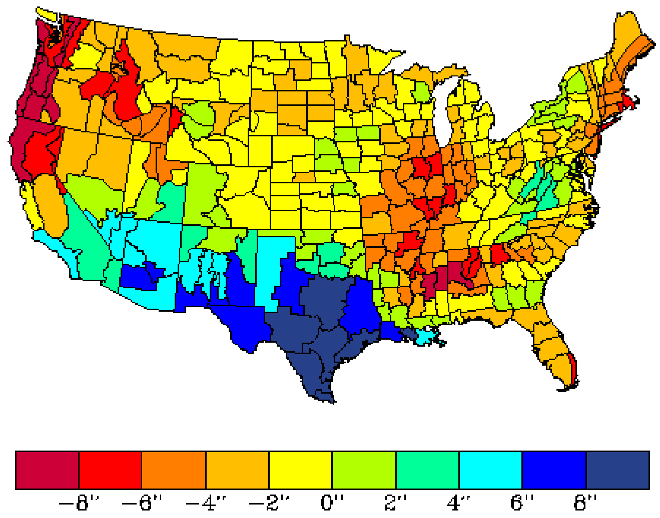


Figure 3

Precipitation Anomalies Dec 1991 to May 1992
Versus 1950 - 1995 longterm average



Temperature Anomalies Dec 1991 to May 1992
Versus 1950 - 1995 longterm average

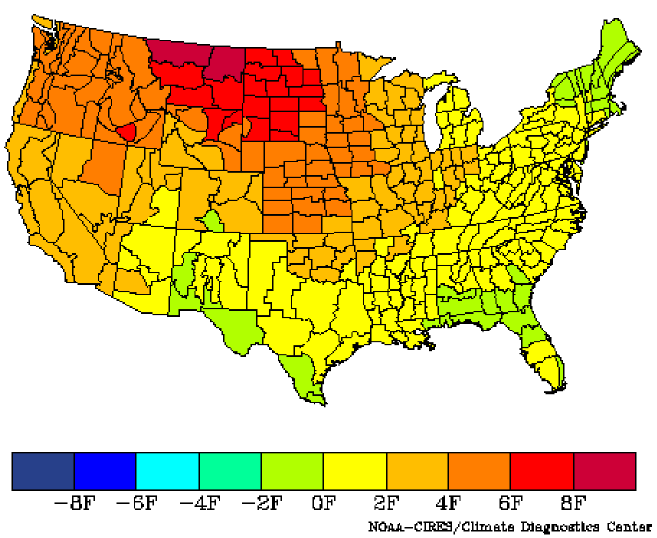
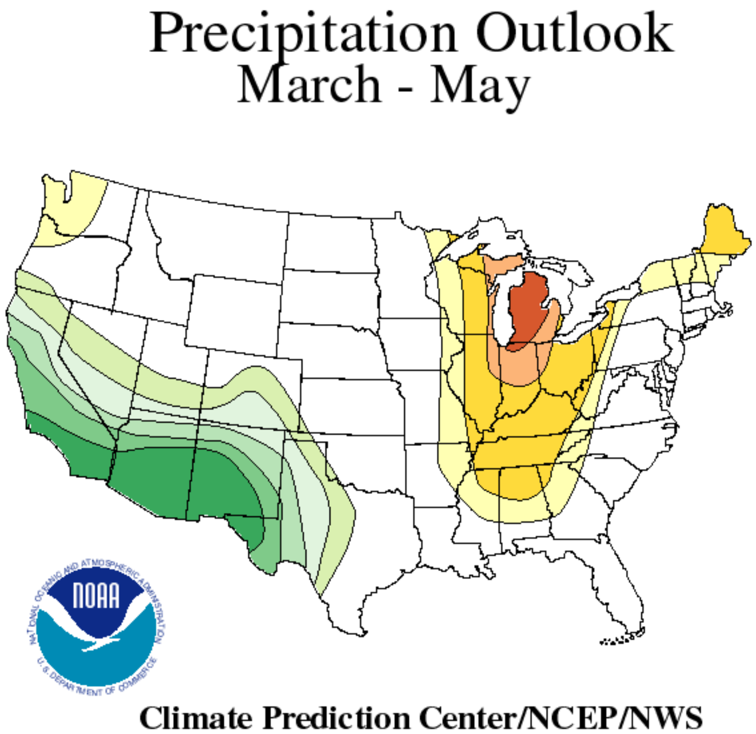
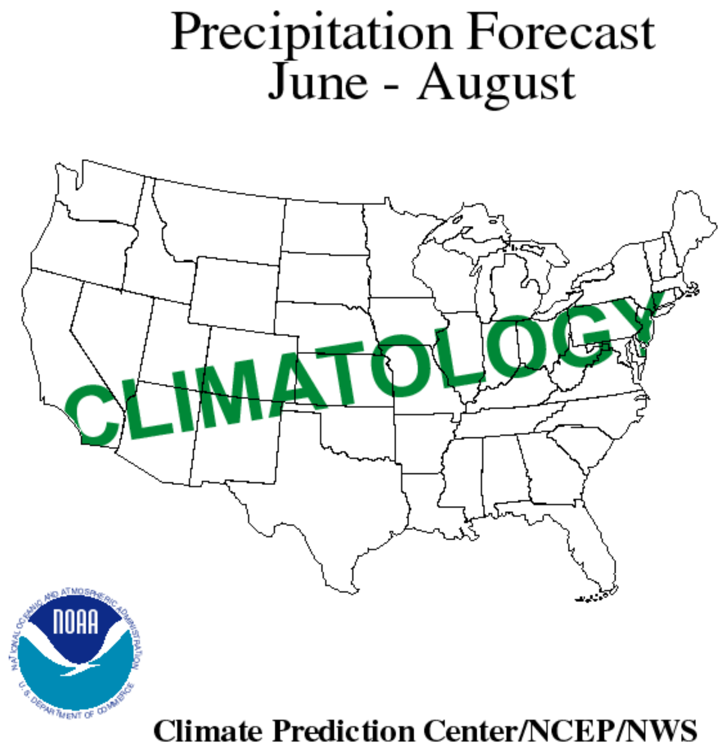


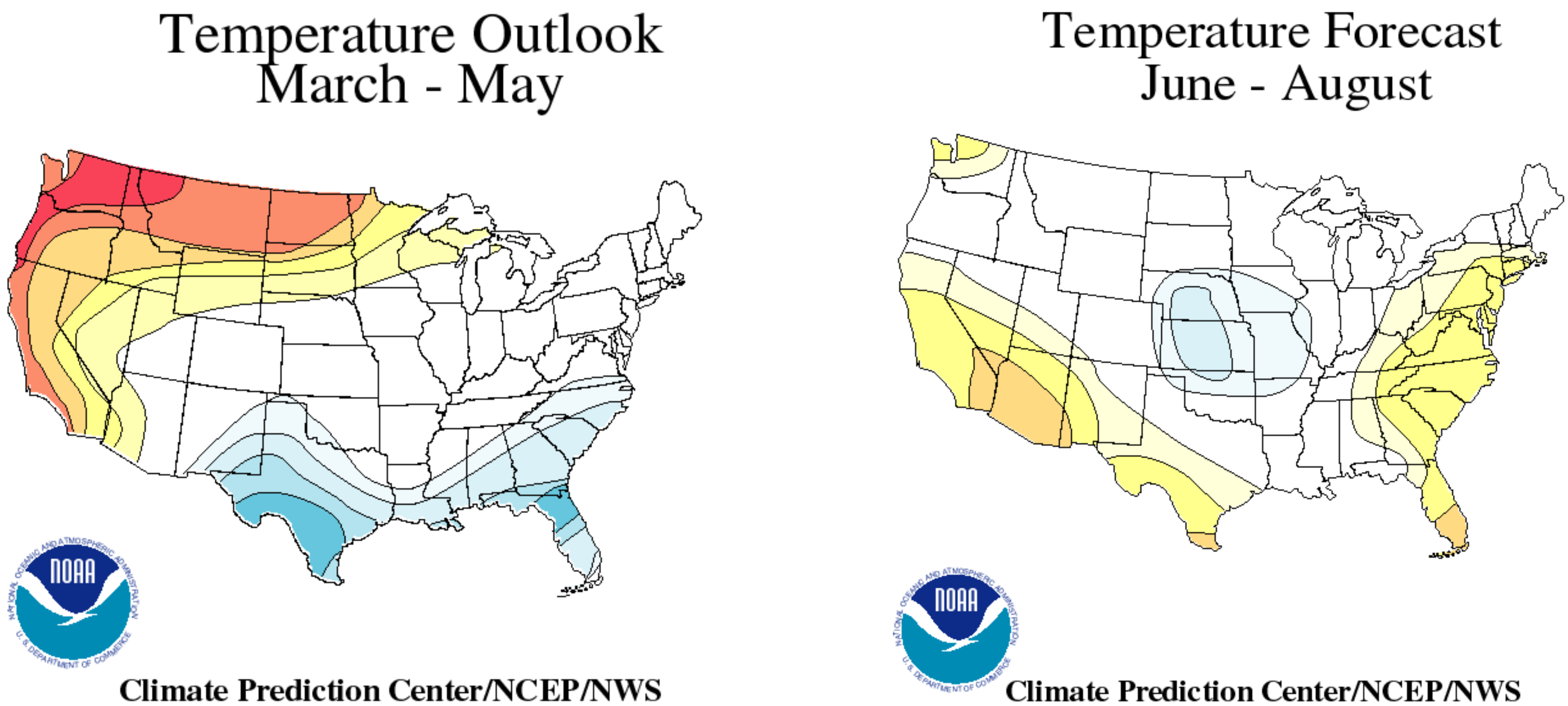
Figure 4





Greens represent increasing probabilities of above-normal precipitation, the darker the green, the higher the probability. Yellows and oranges represent probabilities of below-normal precipitation. White indicates that above-, near-, and below-normal precipitation is equally likely.

Figure 5



Yellows and reds represent increasing probabilities of above-normal temperatures, darker reds indicating higher probabilities. Blues represent probabilities of below-normal temperatures. White indicates that above-, near-, and below-normal temperatures are equally likely.