

July 2009: Cold in East and hot in West

By

Richard H. Grumm

National Weather Service Office

State College, PA 16893

1. INTRODUCTION

July of 2009 will be remembered as a cool and wet month in the eastern United States and a bit hot and dusty in the western United States. Figure 1 shows the monthly total precipitation and the mean 500 hPa heights over the United States. These data show the wet conditions over southeastern New England, Florida, and portions of the Mississippi and Ohio Valleys.

The 500 hPa height (Fig. 1) field showed a persistent trough over the eastern

United States and a ridge over the western United States. Dry conditions dominated from Texas to the Pacific coast. It will be shown that below normal temperatures were present at lower levels near the trough axis.

The large scale pattern and ocean circulations changed in the spring of 2009. The ENSO cycle shifted into the [warm phase](#) or an [El Nino](#). The Climate Prediction Center ([CPC](#)) issued an [El Nino Advisory in July](#) related to the El Nino and its projected impacts on the coming winter. Whether the El Nino

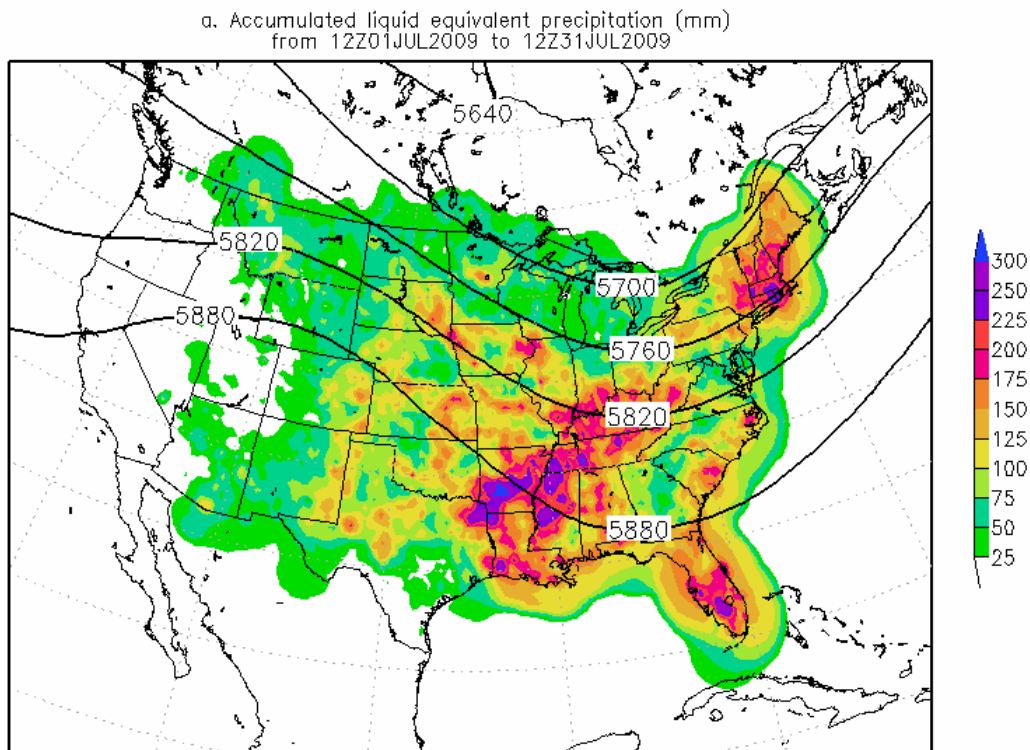


Figure 1. Total QPE (mm) and the mean 500 hPa heights (m) from 1200 UTC 1 to 31 July 2009. Shading is every 25mm for precipitation and heights are contoured every 60m.

played a role in the weather over the United States is a potential avenue of research. Figure 1 clearly shows that the circulation pattern of July 2009 favored a persistent trough in the eastern United States.

Some observations and data suggest that it was abnormally warm in the southwest. Mean temperatures in Austin (89.5), San Antonio (88.7), Corpus Cristi (87.9), and McAllen (92.8) Texas were the warmed on record.

Cooler than normal weather was experienced in the northeastern quadrant of the United States. International Falls, MN had an average temperature of 58.8 which was 7.3F below normal and was the coolest [July on record](#). Sites such as Boston and New York City were abnormally cool too. Central Park had its 2nd coolest June-July period on record and its third wettest June-July period on record. The wettest June-July was 1975 with 19.35 inches compared to 17.17 inches for the same period in 2009.

This document will provide and overview of the large scale pattern and some weather highlights for the month of July 2009. In the east it was cool and wet.

2.METHODS

The unified precipitation data (Shi et al 2002) was used to make the monthly total QPF (Fig.1). These data are normally available about 12 hours after the verifying time and the data are 24 hour data valid at 1200 UTC.

The 500 hPa heights, 850 hPa temperatures and other standard level fields were derived from the JMA

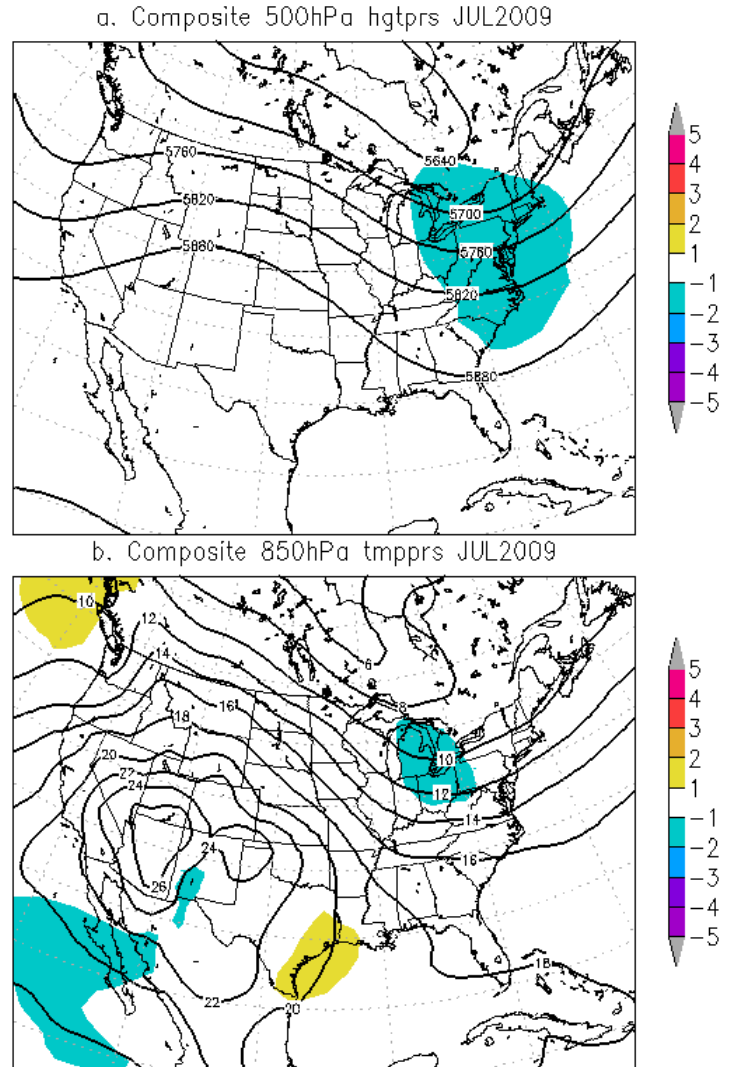


Figure 2. Composite mean from 0000 UTC 1 to 15 July 2009 showing a) 500 hPa heights and anomalies and b) 850 hPa temperatures and anomalies. Means are based on JMA data anomalies are derived using NCEP/NCAR data.

(Onogi et al., 2007) data using the NCEP/NCAR (Kalnay et al. 1996) data as the climatological comparison. The means and standard deviations used to compute the standardized anomalies were from the NCEP/NCAR data.

Some GFS and NAM data is used to show some of the highlight features of interest.

Thunderstorm information and severe reports were gleaned from the [Storm Prediction Centers](#) webpage.

3.RESULTS

Figure 2 shows the mean 500 hPa heights and 850 hPa temperatures over the United States and adjacent Canada for the period of 1-15 July 2009. The monthly values are shown in Figure 3.

Key features in both images include the trough in the eastern United States with -1 to -2SD height anomalies over the eastern United States. The lower-level cold air, as viewed from the 850 hPa isotherms, suggests the coldest area was over the Great Lakes.

Date	Number	Main area	Tornadoes
8 Jul	220	Plains	14
16 Jul	222	OK-AK	2
17 Jul	236	CT-SC and NE-TX	0
20 Jul	231	Plains	6
24 Jul	233	MN-IN	5

Table 1. SPC data for big events. Data include the date, number of reports of all types, the general location of the majority of events and the number of tornadoes.

The monthly means (Fig. 3) and anomalies implied there was not significant change in the overall pattern with the trough over the eastern United States. Difficult to see was the fact that the trough slowly retrograded and the 500 hPa anomaly shifted to the west over the Lakes in close alignment with the cold pocket at 850 hPa. As will be discussed below, the ridge axis also

shifted westward, moving the heat in the west to the Pacific Coast.

With the trough in the east there were several significant severe weather events in the eastern United States. With the relative trough and cold air hail events were common. Several large events in the northeastern United States included 01 July, [7 July](#), 16 July, 21 July, 24 July and 27 July 2009.

Several large severe events were observed in July. All events in which 200 or more total reports were recorded are shown in Table 1. On [17 July](#) there were two comparable events, one in the eastern plains and the other along the East Coast.

The northwest flow produced several convection events over the central United States. Semi-linear areas of locally heavy rain were visible in Figure 1 from South Dakota to Tennessee. The standout wet area was New England where heavy rains impacted the region early in the month and again on the [23th of July](#). Southeastern New England had 50 to 100 mm of rainfall on the 23rd of July as a small cyclone brought heavy rainfall to the region. The same general region had heavy rains on the 3rd and 4th of [July 2009](#).

In the southwestern United States, the subtropical ridge built over the region bringing hot weather to the region. Many locations topped 100F in the southwest as shown for 9 July. The heat moved westward with 100F readings in the Pacific Northwest on the 16th and 17th. The highs for the 17th are shown in Figure 4b. Toward the end of the month the hot weather moved west creating a heat wave with successive days over 90

and 100F. The temperatures topped 100F in the Pacific Northwest at many locations on the 27th, 28th, and 29th. Seattle broke its all-time record high hitting 102.9 (39.4C) on the 29th. Warm temperatures under the ridge extended from California to Alaska (Fig. 5).

The GFS 00-hour forecasts from 0000 UTC 29 July to 1200 UTC 30 July are shown in [Figure 6](#). These data showed the ridge off the West Coast. [Figure 7](#) shows the anomalously high 850 hPa temperatures associated with this strong mid-tropospheric ridge. Equally impressive was the deep trough in the central United States and the significantly cold air over from the Dakotas to Oklahoma. Difficult to see in a North American scale image is the -4 SD thermal anomalies over Wyoming.

4. CONCLUSIONS

The month of July will be remembered as a cool and wet month from the Great Lakes to New England. The persistent trough in the east brought numerous cool and showery days. Many of the severe events were dominated by hail. In New England, the wet weather will likely linger longer than the cool weather as many locations had considerably higher than normal rainfall.

In the southwestern and western United States, the subtropical ridge kept conditions dry and warm. An area of hot weather developed over the southwest pushing daily highs into the 100s. This area of hot weather moved westward as

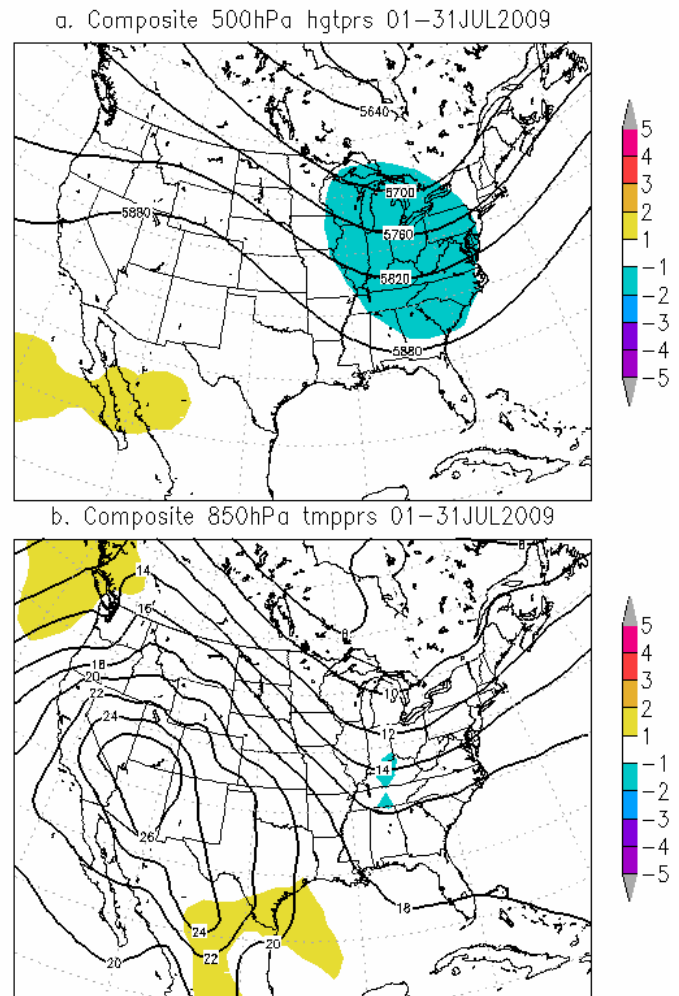


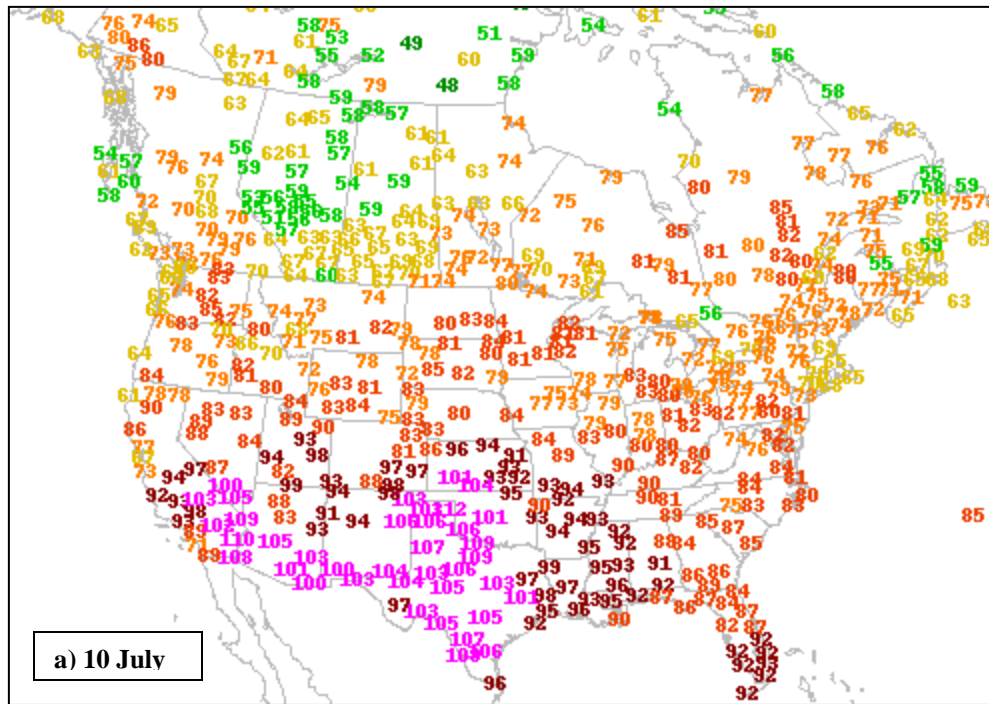
Figure 3. As in Figure 2 except for the period of 0000 UTC 1 to 31 July 2009. Image will be updated in August.

the trough in the east retrograded. The month ended with unseasonably warm air pushing the mercury over 100F in the Pacific Northwest and into the 80s in Alaska. The heat episode will long be remembered in the Seattle region where a new record high was established on the 29th.

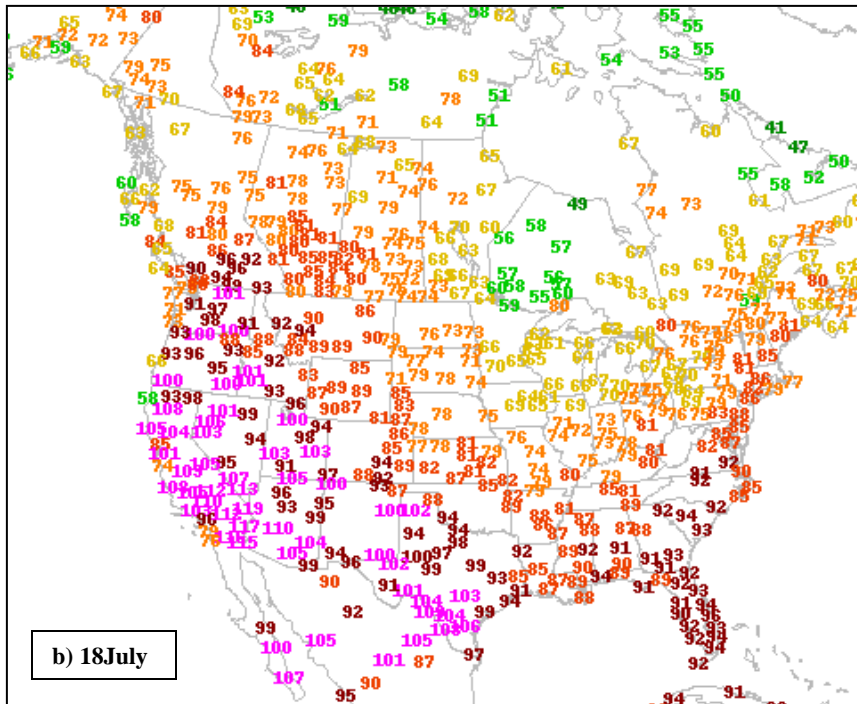
Figure 8 shows how the trough retrogressed and the onset of the hotter weather over the southwestern United States. A closed 5940 m contour was evident in the second half of the month over Arizona and New Mexico. The negative anomalies covered a larger area and penetrated farther south. At 850 hPa the largest negative anomalies were over

the Ohio Valley into the Gulf States with positive anomalies over the western United States. Figures 1 & 8 show the evolution of the pattern with shift of the

heat and cool weather westward as the month progressed.



a) 10 July



b) 18 July

Figure 4 Maximum temperatures a)10 July and b) 18 July 2009. Data is valid at 0600 UTC thus the highs would be for the the 9th and 17th respectively.

No explanation is offered as to why July 2009 had such an amplified pattern. This pattern led to a persistent trough over the eastern United States and a ridge over the southwestern United States. The hot weather moved westward as the entire

pattern retrograded. This also moved the focus of the cold air westward as evidenced by the anomalously cold air over the western plains later in the month.

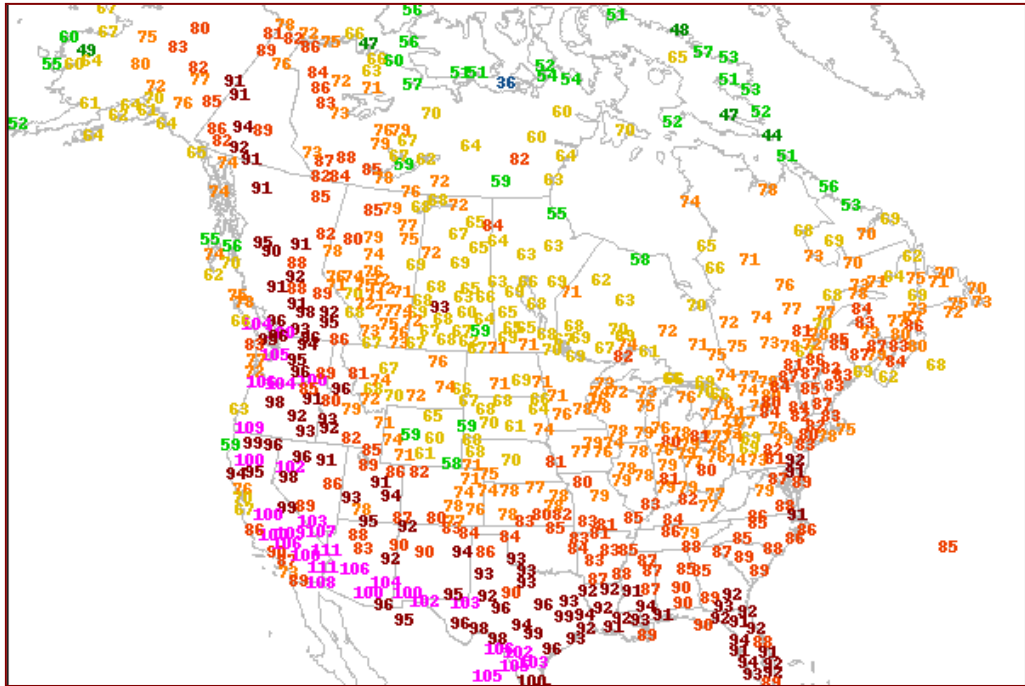


Figure 5. As in Figure 4 except valid at 0600 UTC 30 July 2009.

5. Acknowledgements

Hail and floods in New York and New England were shared with Neil Stuart. The details of the Pacific Northwest heat were provided by Lance Bosart, Greg Hakim, and Gary Lackman on the maproom email threads. Cool eastern US information was provided by Craig Clark, Gary Lackman, Eric Kelsey, Mike Sempa, and Brandon Smith.

6. REFERENCES

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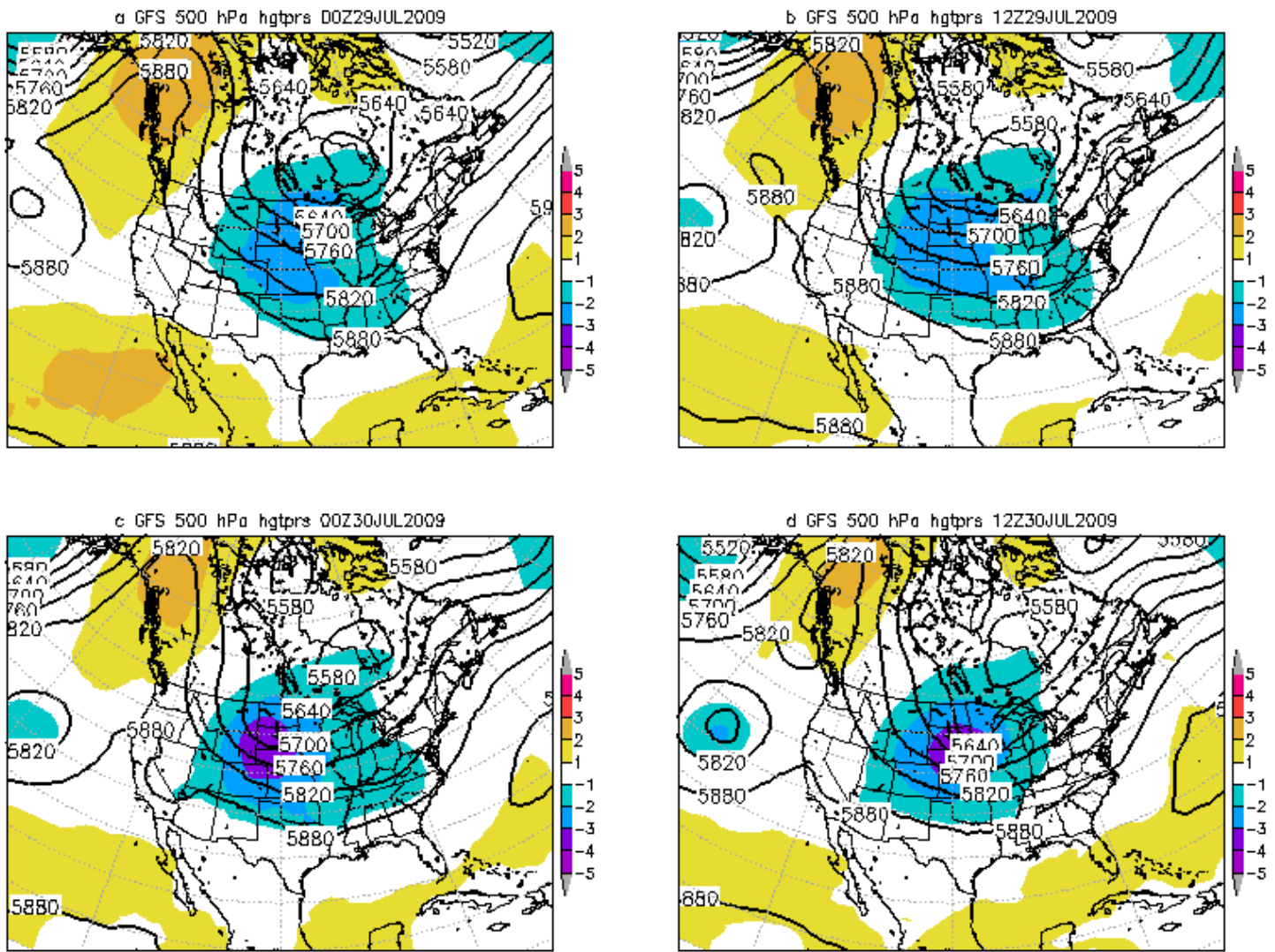


Figure 6. GFS 500 hPa heights and 500 hPa height anomalies valid at a) 0000, b) 1200 UTC 29 and c) 0000 and d) 1200 UTC 30 June 2009. [Return to text.](#)

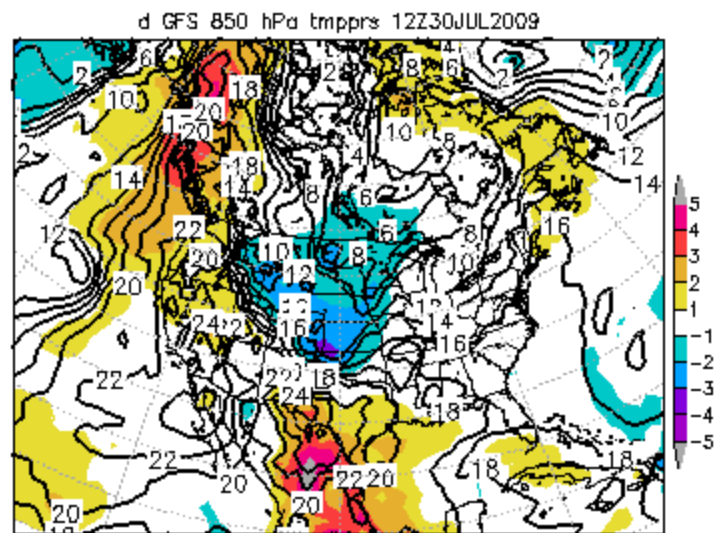
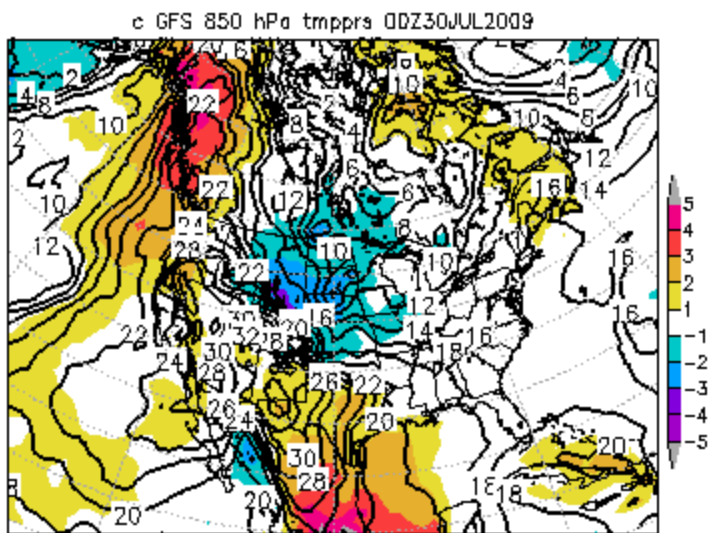
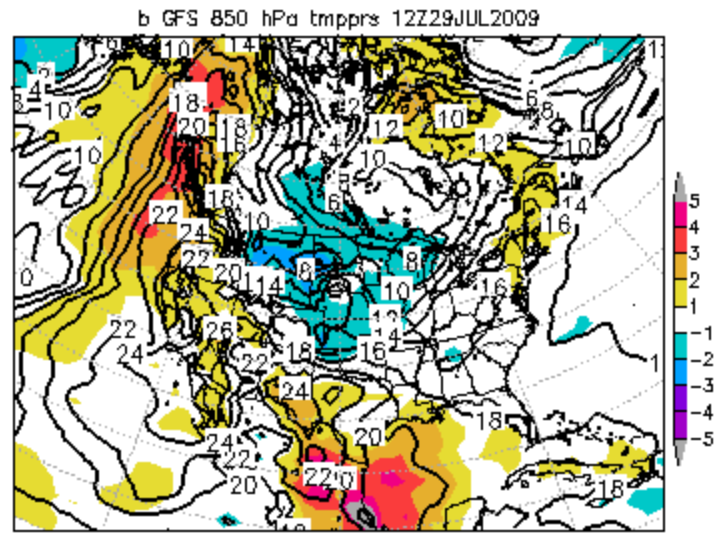
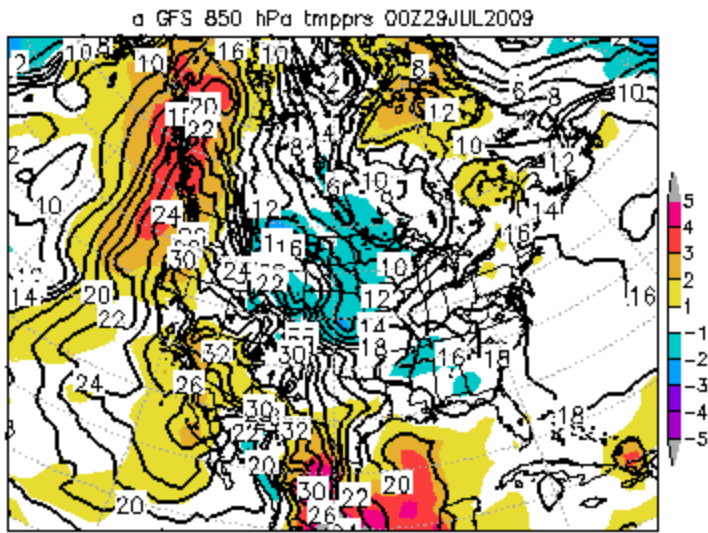
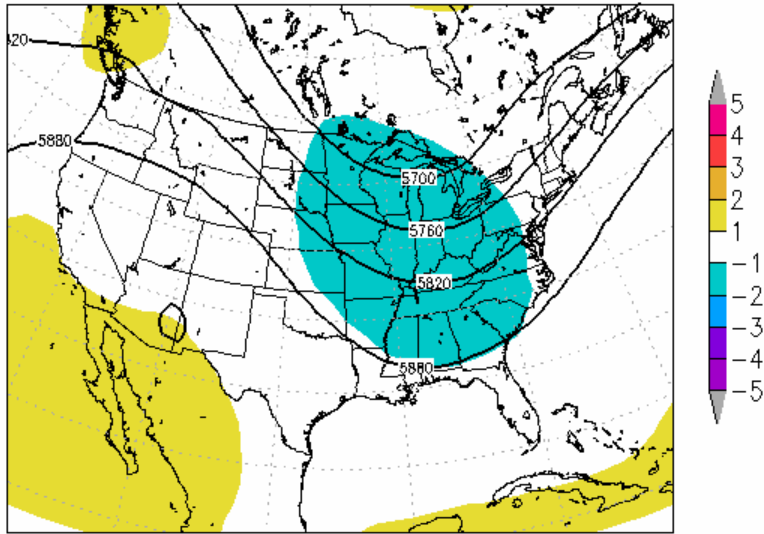


Figure 7. As in Figure 6 except for 850 hPa temperatures and temperature anomalies. [Return to text.](#)

a. Composite 500hPa hgtprs 15–31Jul2009



b. Composite 850hPa tmpprs 15–31Jul2009

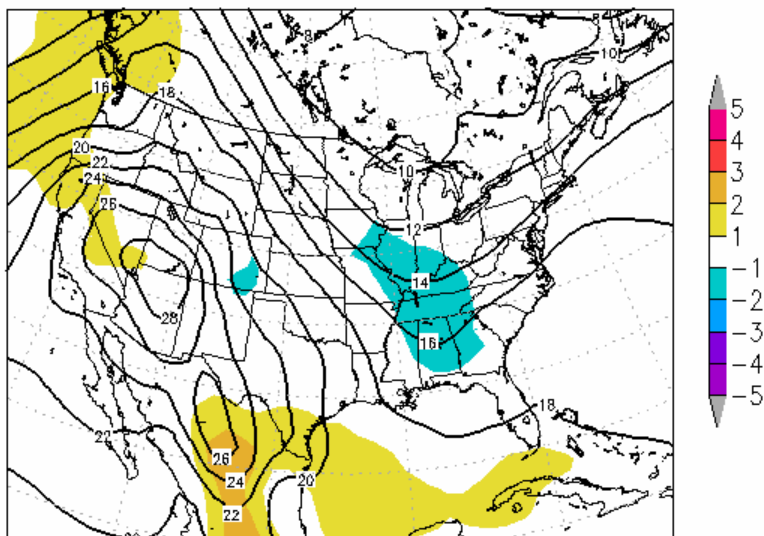


Figure 8. As in Figure 1 except for the period of 15-29 July 2009.

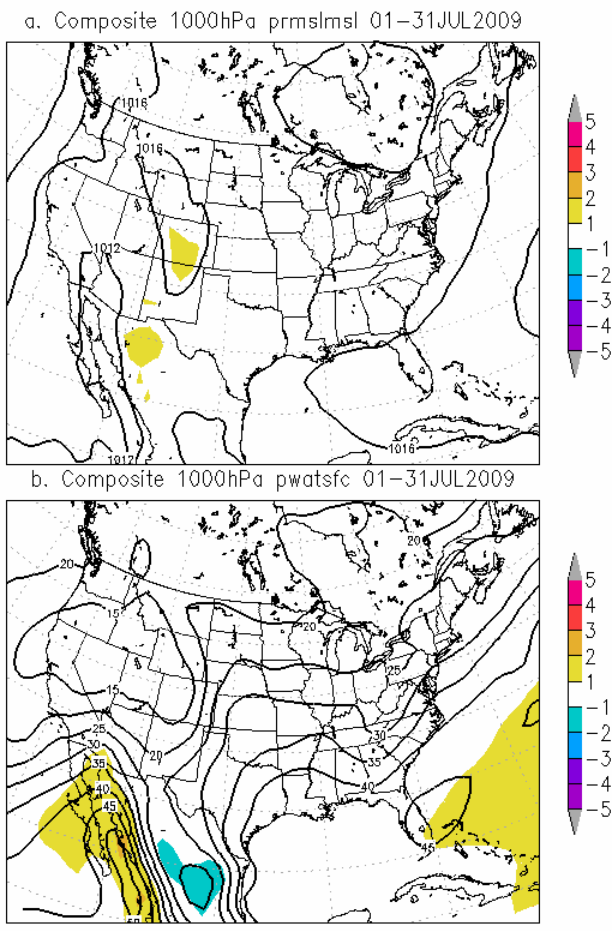


Figure 9. MSLP and PW with anomalies for 01-31 July 2009.

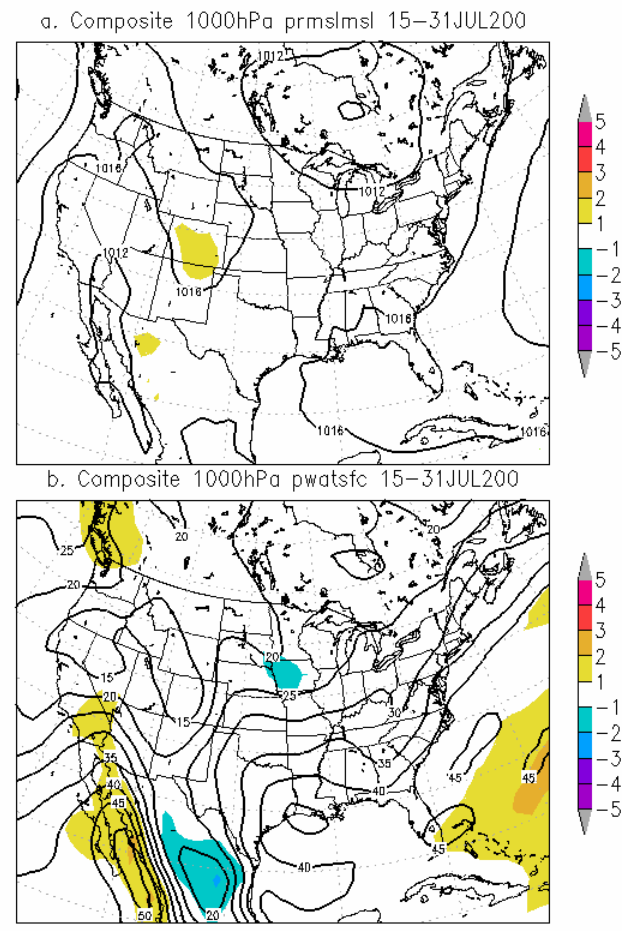


Figure 10 As in Figure 9 except valid for the period of 15-31 July 2009.