The Severe Weather Event of 26 June 2009

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1. INTRODUCTION

An upper-level short-wave and cold front triggered convection over the Mid-Atlantic Region and northeastern United States on 26 June 2009 (Fig 1). The majority of the severe weather was in the form of hail (blue squares in Figure 1). There were some isolated wind reports in the northeastern United States, but removed from the upper-level trough wind reports dominated the severe weather over Tennessee and Kentucky and in the southeastern United States.

This event shared many characteristics of eastern hail events, outside a favorable supercell environment. This event was dominated by steep mid-tropospheric lapse rates, a common feature in many eastern US hail events when the shear is relatively week.

With a prolonged period with a deep trough over the eastern United States from mid-June to early July, there were several hail dominated severe weather events in the eastern United States. Dates of particular interest during this period included 15 June (all hail), 25 June, 26 June, 30 June, 1 July, and 7 July 2009.

This note will document the severe weather event in the Mid-Atlantic region on 26 June 2009. This was a day that had some atypically large hail reports in Pennsylvania. This event and

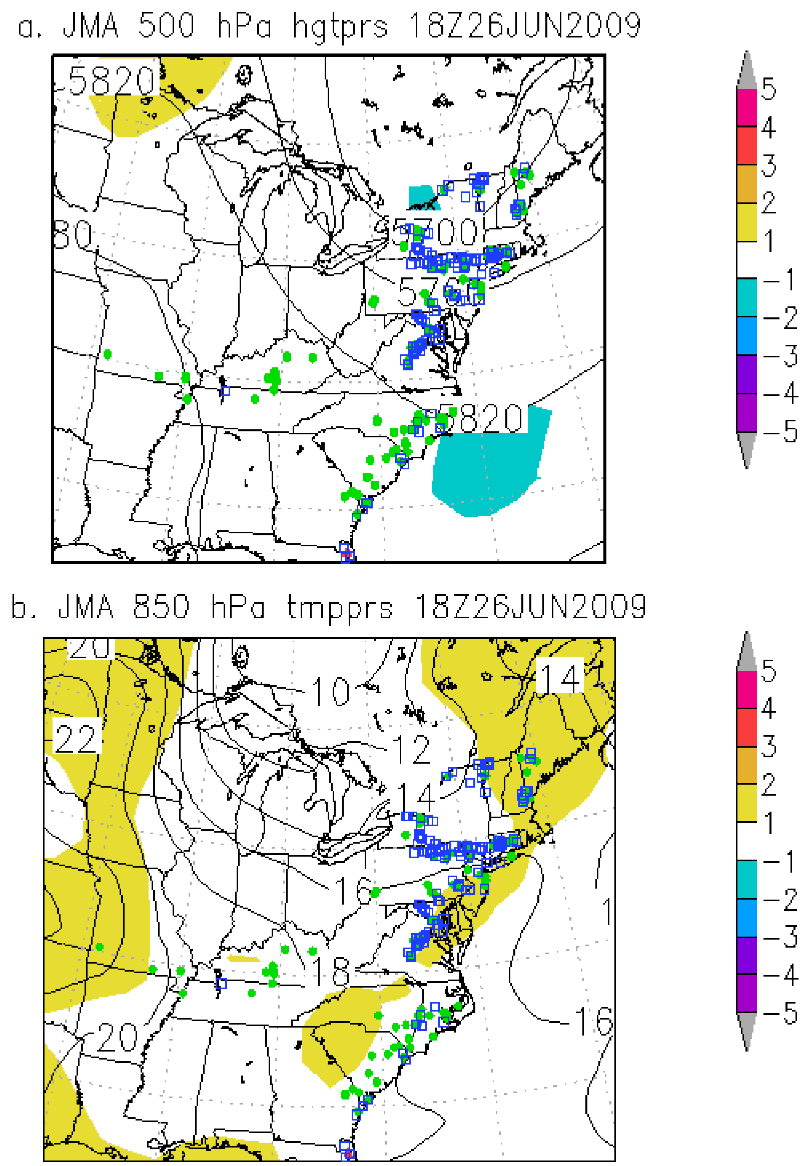

Figure 1. JMA reanalysis valid at 1800 UTC 26 June 2009 showing a) 500 hPa heights (m) and 500 hPa height anomalies (standard deviations and b) 850 hPa temperatures (C) and temperature anomalies. Severe weather for 11 July from the Storm Prediction Centers is plotted by type including blue (hail), green (wind) and red (tornadoes).

the pattern will be compared to other

large hail days during the cold episode of June-July 2009.

2. METHODS

Storm reports were retrieved from the Storm Prediction Center (SPC) website. They were decoded for use in a relational database and for use in GrADS (Doty and Kinter 1995). The data for 26 June were plotted on several images, such as Figure 1 to show the types color coded by type. The data were plotted based on the latitude and longitude of the data point. No time issues were addressed here thus all observed severe weather has been plotted.

The pattern was reconstructed used the JMA 1.25x1.25 data (Onogi et al. 2007) were plotted in GrADS (Doty and Kinter 1995).

The anomalies were computed from the NCEP/NCAR re-analysis data (Kalnay et al 1996) as describe by Hart and Grumm 2001 and Grumm and Hart 2001. Unless otherwise stated, the base data was the NAM and the means and standard deviations were computed by comparing the NAM to the NCEP/NCAR 30-year climatological values.

When available, the Stage-IV rainfall data (Lin and Mitchell 2005) was used to plot the rainfall for the event.

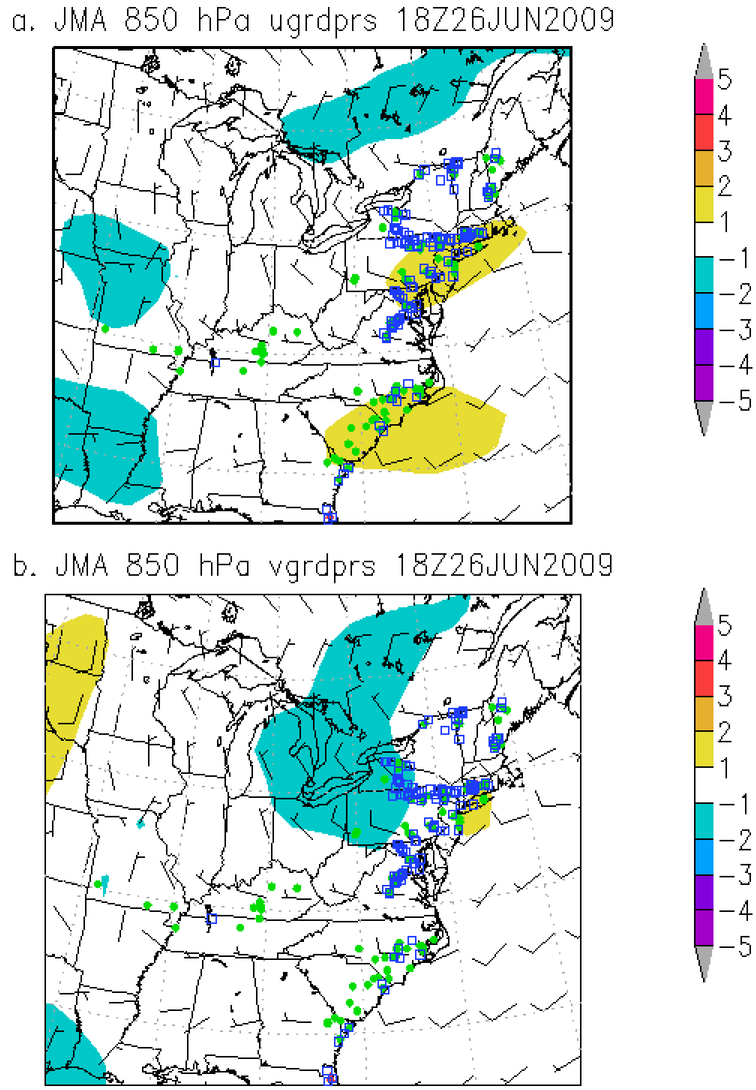

Figure 2. JMA showing 850 hPa winds and severe weather valid at 1800 UTC 26 June 2009 along with a) 850 hPa u-wind anomalies, and b) 850 hPa v-wind anomalies.

3. RESULTS

i. Event overview

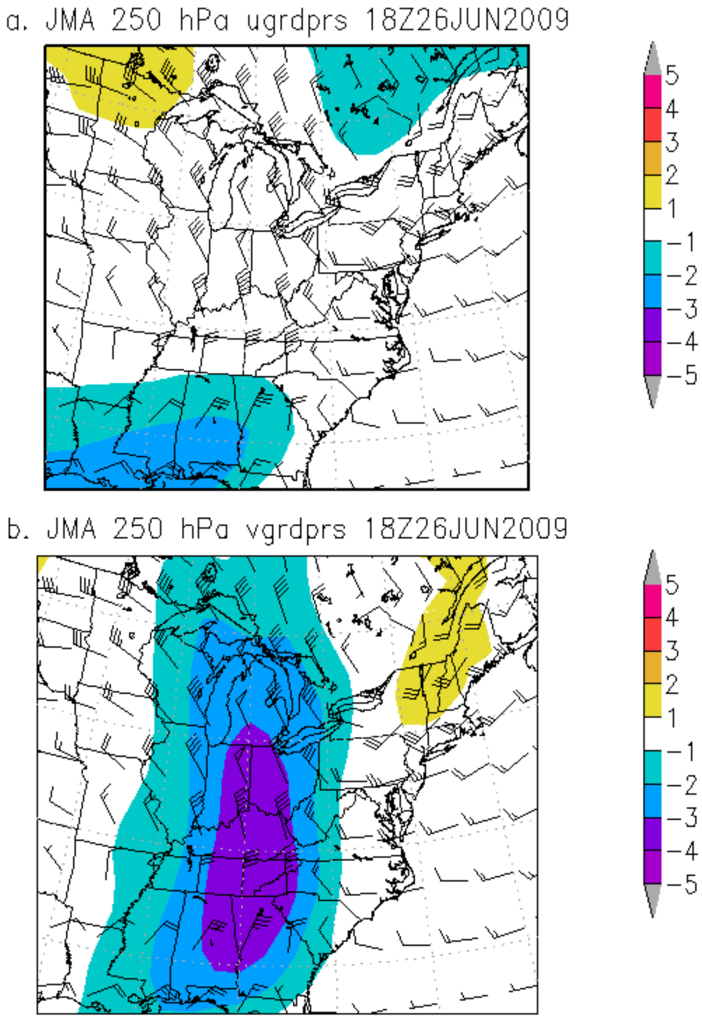

Figure 4. As in Figure 2 except 250 hPa winds and anomalies. The severe weather data is not plotted on this image.

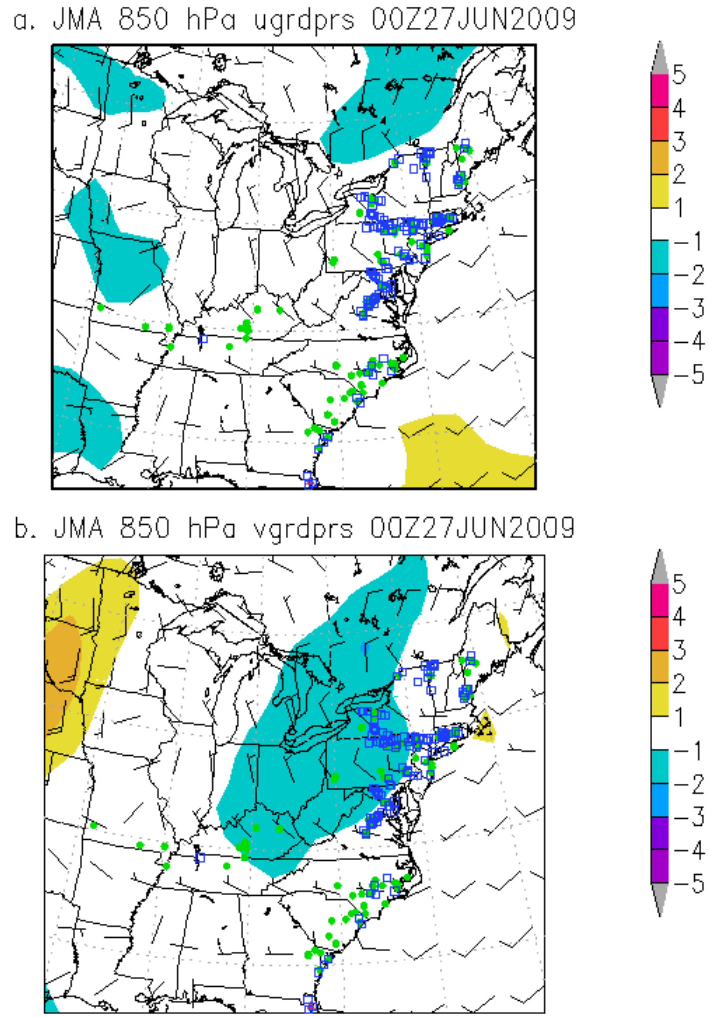

Figure 4. As in Figure 2 except valid at 0000 UTC 27 June 2009.

Figure 1showed the 500 hPa heights and 850 hPa temperatures and anomalies at 26/1800 UTC. The 850 hPa winds and wind anomalies with the severe weather is shown in Figure 2. These data reveal that the winds were not particularly strong and the shear, though present was not very strong. The 250 hPa winds revealed that the strong influences of the upper-level jet were far removed from the region of concern (Fig. 3). The low-level forcing jet moved off quickly as shown in Figure 4.

One of the features of interest was the upper-level trough and the cold air at mid-levels. This area was displayed eastward, over the warmer low-level air mass. Figure 5 shows the 850 to 500 hPa temperature differences[1] at 26/1800 and 27/0000 UTC. These data show how the severe weather tracked with the steeper lapse rates. Lapse rates of -6.2 to -6.6C/km appeared to outline the larger clusters of severe reports.

[1] Lapse rates in C/km were computed too. They showed the same pattern. Generally 6 to 6.6C/km lapse rates in the area of hail.These data are shown in Figure 7.

The precipitation associated with the event is shown in Figure 6. These data show how the convection moved about the upper-level trough with a distinct cyclonic look to the pattern. Rainfall amounts were generally light and under 25 mm. Heavier rainfall was estimated over the ocean and Canada where quality control may not have applied.

ii. Comparative cases

The lapse rates for 1800 and 0000 UTC for the events listed in Table 1 are shown in Figure 7 and Figure 8. These data show that for several events, the association of hail with the steep mid-level. This association is most obvious for the events of 15 June, 26 June, 30 June, and 7 July. A careful examination of the 0000 UTC images for each event shows that at some point during the event, the steep lapse rates aided in defining the hail and severe weather in each of the presented events.

The data inTable 1show that in all of these events there was a significant association with relatively steep mid-level lapse rates with the severe weather and hail events. Many of the events lacked strong upper-level or low-levels winds.

Figure 9 shows the 250 hPa and 850 hPa winds and anomalies at 0000 UTC 15 June 2009. These data show a broad westerly jet aloft and strong northwest flow at 250 hPa. At 850 hPa the low-level winds are close to seasonal values. Instability was clearly the driving mechanism in this event. The far right panel shows the 500 hPa height and 850 hPa temperatures and anomalies. These data suggest that the cyclonic flow and

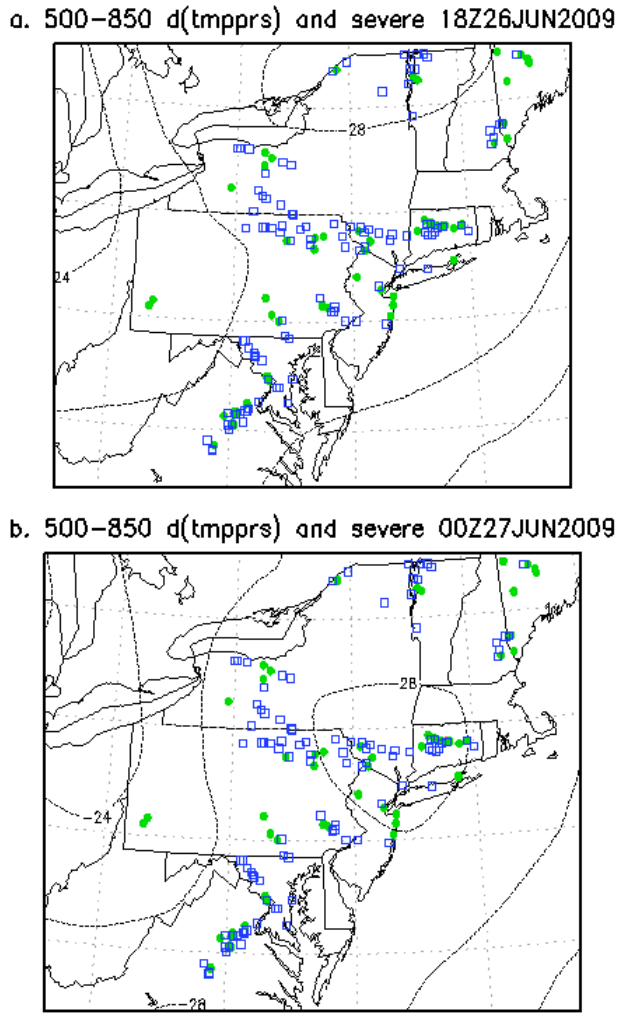

Figure 5. The temperature difference from the JMA in the 500 to 850 hPa level in degrees C valid at a) 1800 UTC 26 June and b) 0000 UC 25 June 2009.

steep lapse rates (Fig. 7) played a critical role in the hail event[2] over New York, New Jersey and southern New England.

[2] There were reports of large hail in NY and NJ and plows were used in NJ to remove accumulated hail on roads.

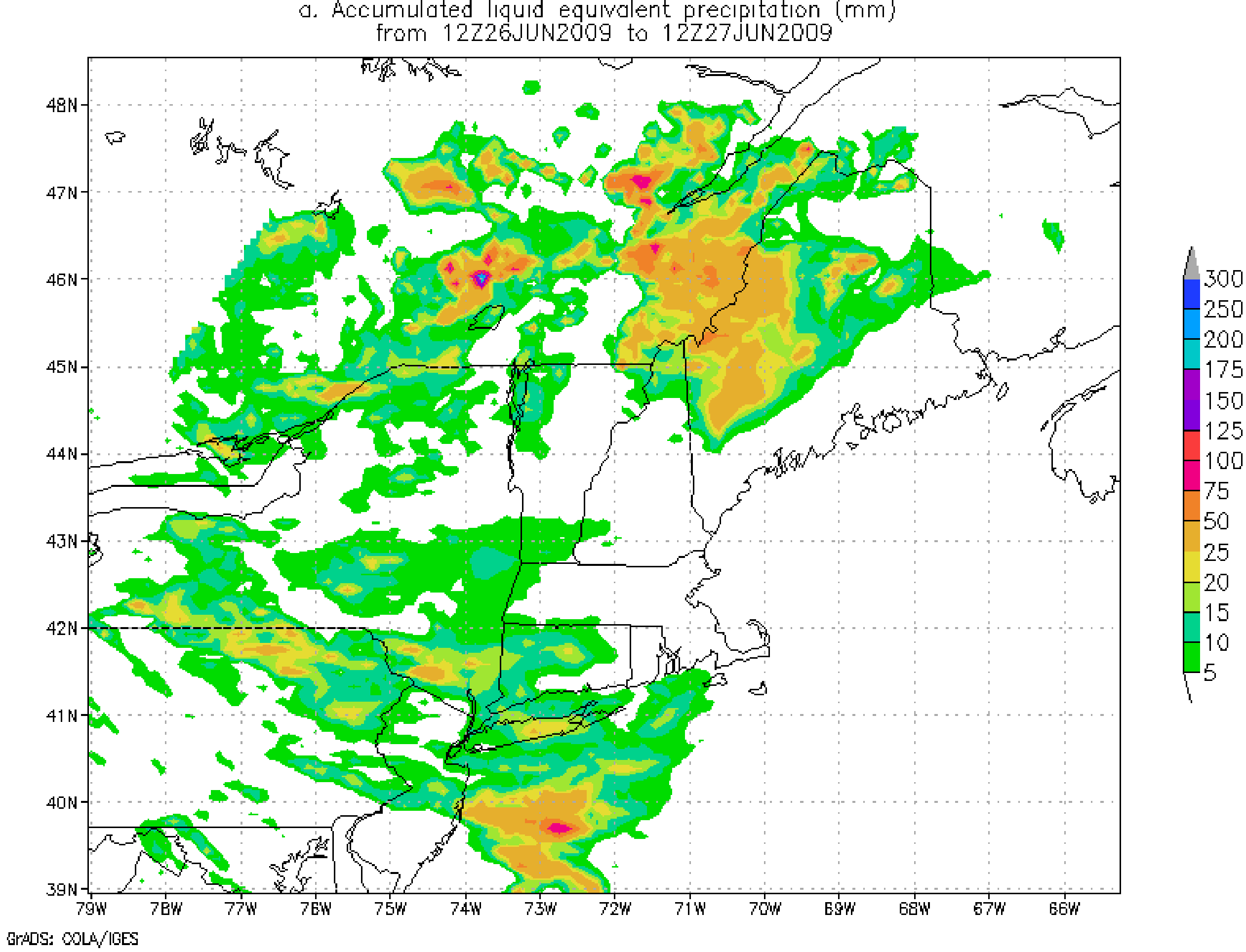

Figure 6. Stage IV rainfall data (mm) for the 24 hour period ending at 1200 UTC 27 June 2009.

It would be exhaustive, if not exhausting to do a complete review of each case. A summary of the 850 hPa winds is for those events with the strongest v-wind anomalies are shown in Figure 10. Several events clearly had stronger low-level winds with may have aided in producing rotating updrafts and more persistent storms.

Additionally, several events, such as 1 July 2009, were associated with anomalous upper-level lows (Fig. 11). The stronger events are displayed in Figure 11. The anomalously deep 500 hPa cyclone of 30 June to 2 July was the strongest feature and produced 2 successive days of hail on the 30 June and 01 July 2009. The 7 July event, shown at 0000 UTC on 8 July was also a close 500 hPa low and produced a widespread hail event.

4. CONCLUSIONS

A severe weather event affect Pennsylvania and the Mid-Atlantic region on 26 June 2009. This event was associated with a large percentage of hail reports. Additionally, the winds were not particular strong on this day. Most of the hail was observed in close proximity to the region of steeper mid-level lapse rates.

As shown for several comparative widespread hail days in June and July of 2009 steep lapse rates and cyclonic flow at 500 hPa were a common theme (Table 1).
The hail and most of the severe weather in the Mid-Atlantic region and northeastern US appeared to be associated with the steeper mid-tropospheric lapse rates. The northern New York and Vermont area was under

the cold pocket and steep lapse rates at 26/1800 UTC (Fig. 5a) and there was a clear association with the southern New York-New England and northeast Pennsylvania reports later in the day (Fig. 5b). Clearly, it would advantageous to better stratify the severe reports in 6-hour increments and to use the 3-hourly NAM forecasts to show the evolution of this instability pocket. But these 6-hourly data illustrate the point.

As shown in Figure 6, for the 26 June 2009 event, the relatively fast moving and shorter lived cells, led to relatively low precipitation amounts over the region. Some of the stronger storms produced 20 to 25 mm of rainfall. Heavy rainfall over the ocean and Canada is potential non-quality controlled data.

Outside of strongly forced supercell days, it appears that steep mid-level lapse rates and cyclonic flow aloft may provide some insights into the potential for large hail in the Mid-Atlantic region and the northeastern United States.

5. Acknowledgements

6. References

Doty, B. E., and J. L. Kinter III, 1995: Geophysical data and visualization using GrADS. Visualization Techniques Space and Atmospheric Sciences, E. P. Szuszczewicz and Bredekamp, Eds., NASA, 209–219.

Doty, B. E., and J. L. Kinter III, 1995: Geophysical data and visualization using GrADS.

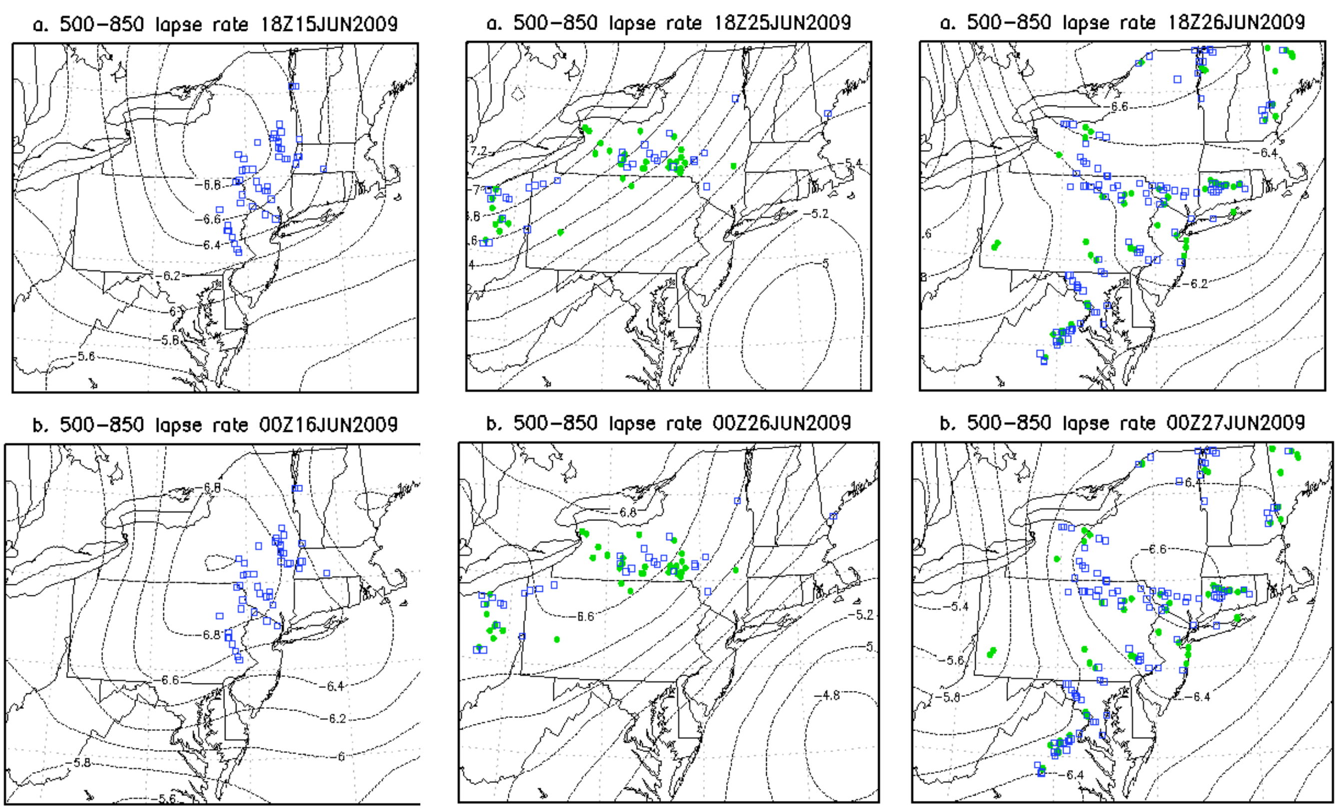

Figure 7. Lapse rates in C/km and severe weather valid at 1800 and 0000 UTC on the specified dates for the cases of left) 15 June 2009, center) 25 June 2009, and 30 June 2009. Return to text.

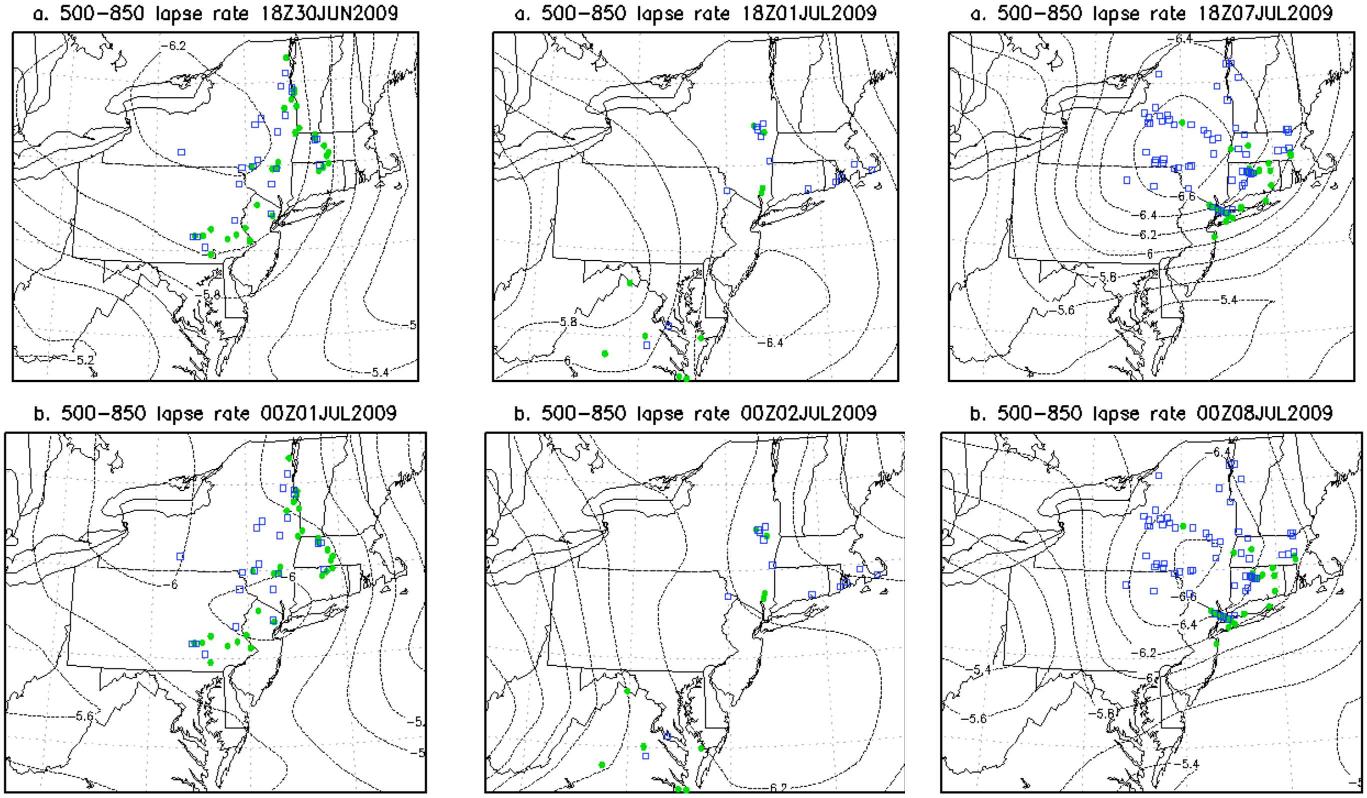

Figure 8. As in Figure 7 except for the events of left) 30 June, center) 01 July and right) 07 July 2009. Return to text.

Visualization Techniques Space and Atmospheric Sciences, E. P. Szuszczewicz and Bredekamp, Eds., NASA, 209–219.

Grumm, R.H. and R. Hart. 2001: **Standardized** Anomalies Applied to Significant Cold Season Weather Events: Preliminary Findings. *Wea. and Fore.*, **16,736**–754.

Hart, R. E., and R. H. Grumm, 2001: Using normalized climatological anomalies to rank synoptic scale events objectively. *Mon. Wea. Rev.*, **129,** 2426–2442.

Junker, N. W., R. H. Grumm, R. Hart, L. F. Bosart, K. M. Bell, and F. J. Pereira, 2008: Use of standardized anomaly fields to anticipate extreme rainfall in the mountains of northern California. *Wea. Forecasting*,**23,** 336–356.

Kalnay, E., and Coauthors, 1996: The NCEP/NCAR 40-Year Reanalysis Project. *Bull. Amer. Meteor. Soc.*, **77,**437–471.

Onogi, K., J. Tsutsui, H. Koide, M. Sakamoto, S. Kobayashi, H. Hatsushika, T. Matsumoto, N. Yamazaki, H. Kamahori, K. Takahashi, S. Kadokura, K. Wada, K. Kato, R. Oyama, T. Ose, N. Mannoji and R. Taira (2007) : The JRA-25

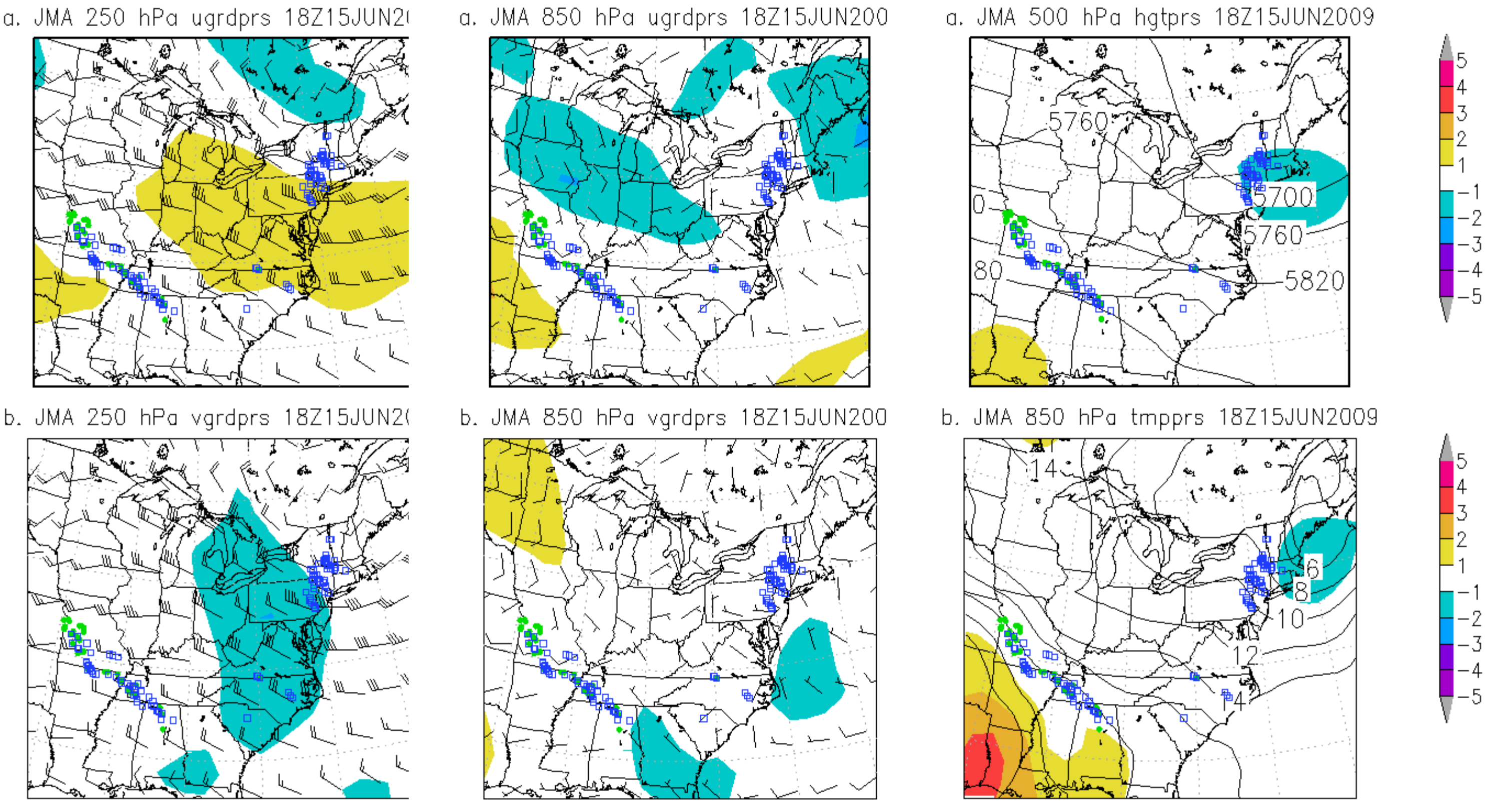

Figure 9. JMA data valid at 1800 UTC 15 June 2009 showing left) 250 hPa winds and u- and v-wind anomalies, center) 850 hPa winds and u- and v-wind anomalies, and right) 500 hPa heights and 850 hPa temperatures with anomalies. Return to text.

Reanalysis. J. Meteor. Soc. Japan,85,369-432.

Lin, Y. and K. E. Mitchell, 2005: The NCEP Stage II/IV hourly precipitation analyses: development and applications. Preprints, 19th Conf. on Hydrology, American Meteorological Society, San Diego, CA, 9-13 January 2005, Paper 1.2.

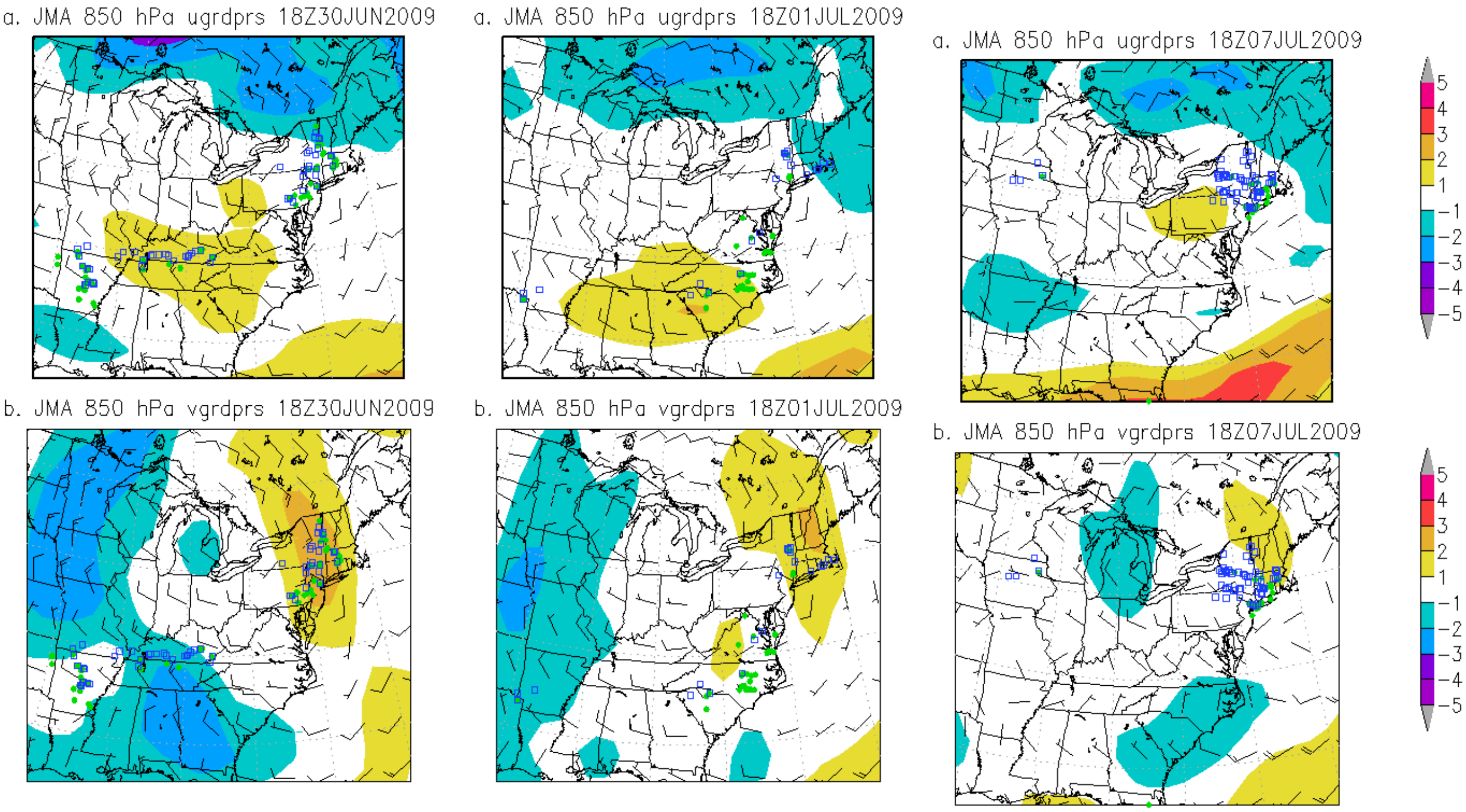

Figure 10. As in Figure 3 except 850 hPa winds valid at 1800 UTC left) 30 June, center) 01 July and right) 07 July 2009.

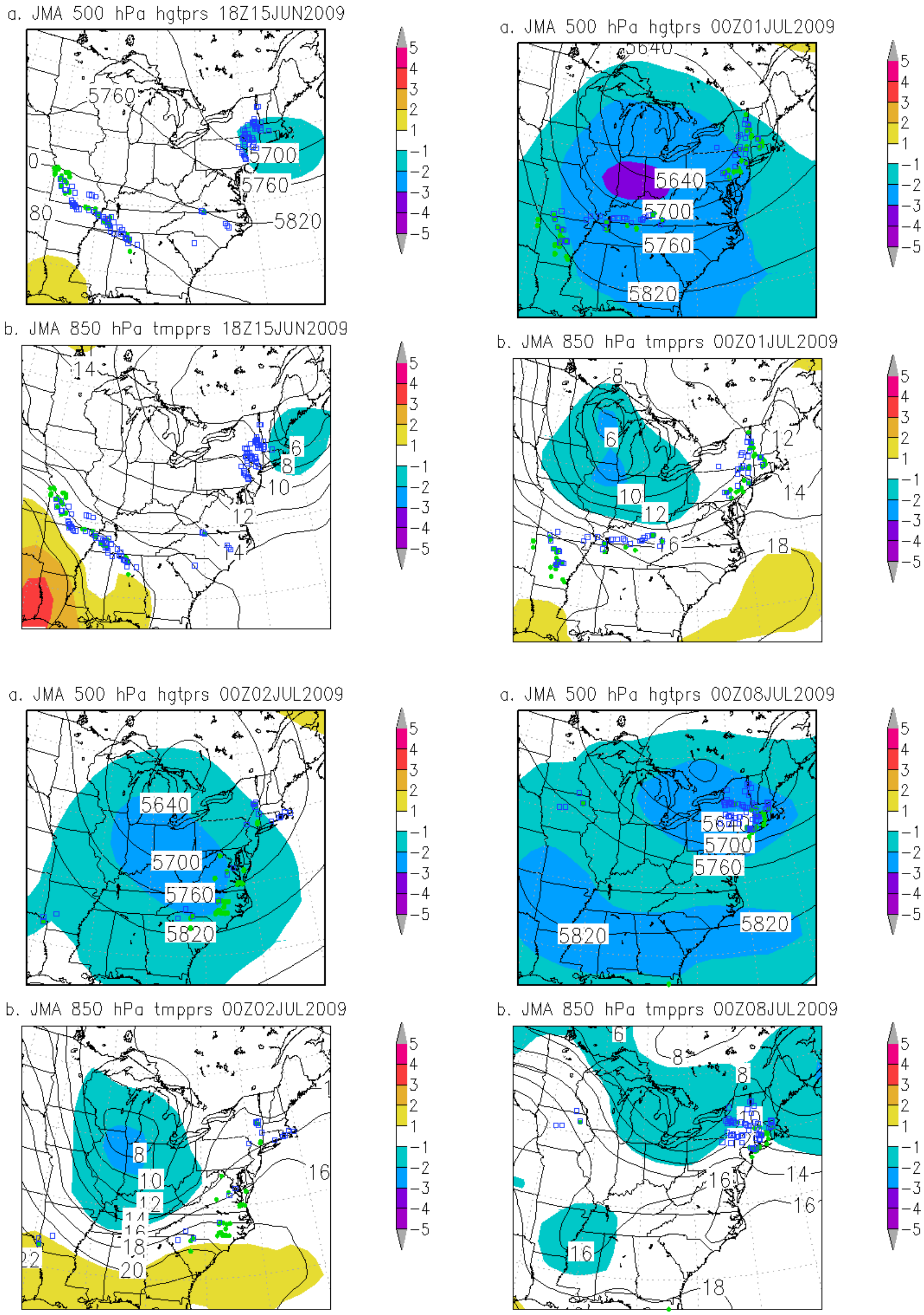

Figure 11. As in Figure 1 except valid for the 4 dates of 1800 UTC 15 June, 0000 UTC 1,2, and 8 July 2009.

Cold core severe events 2009				
Date	**Max Lapse rate**	**Min Lapse rate**	**850 v-wind anomaly**	**500 hPa height anomaly**
15 June	-7.0	-6.6	NA	-1
25 June	-7.0	-6.1	NA	-0.5
26 June	-6.6	-6.1	1 SD	-1.0
30 June	-6.2	-5.8	2.5 SD	-3.0
01 July	-6.3	-6.0	2 SD	-2.5
07 July	-6.7	-6.2	1 SD	-2.5

Table 1. A summary of 500-850 hPa lapse rates for the specified severe weather dates. Date include the date, the approximate maximum lapse rate and minimum lapse rate, and 850 hPa v-wind anomalies if greater than 0.50, and 500 hPa height anomalies. Return to text.