Analysis and Verification of 1300 UTC Storm Prediction Center Convective Outlooks

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Introduction

Weather researchers, storm spotters, and emergency managers are frequently concerned with the risk for severe weather, particularly tornadoes. One product that is frequently considered is the 1300 UTC Storm Prediction Center (SPC) Convective Outlook. Below is an analysis of cases for which an appreciable risk of tornadoes or severe weather was forecasted but no or few tornadoes occurred in the highest risk area.

Methodology

All SPC Moderate and High Risk Outlooks, along with Slight Risk Outlooks with a 10% or greater tornado probability issued from 3 March 2006 to 3 March 2014 were subjectively examined to determine whether the number of tornado reports within the highest risk region qualitatively corresponded to the highest tornado risk outlined in the Outlook. Cases for which the reports did not correspond well to the risk area (N = 100) were further examined to determine potentially why, and this analysis revealed four primary reasons why the convection was nontornadic:

- The development of linear convection (LC)
- The development of only non-tornadic supercellular convection (NTSC)
- The development of only non-severe convection (NSC)
- The lack of convection initiation (LCI)

For cases with linear storm modes, the 0-6 km shear vector orientation with respect to the initiating boundary was determined using WPC surface maps and SPC mesoanalysis archive. For cases exclusively featuring non-tornadic supercellular convection, the lifting condensation level (LCL) height and 0-1 km storm relative helicity (SRH) were examined.

Results

The plurality of the cases examined were LC (47%), followed by NSC (35%), NTSC (13%), and LCI (4%; Fig. 1, below left). There was also one landfalling tropical cyclone in the dataset. NTSC cases exhibit a decrease with time. Instances of LC display a slight decrease in frequency over time, while instances of NSC and LCI exhibit no apparent trend with time (Fig. 2, below right).

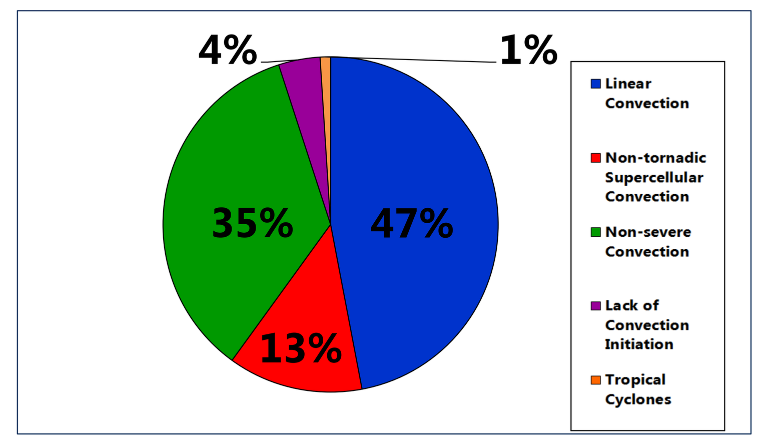


Fig. 1: Variability of modes of nontornadic convection.

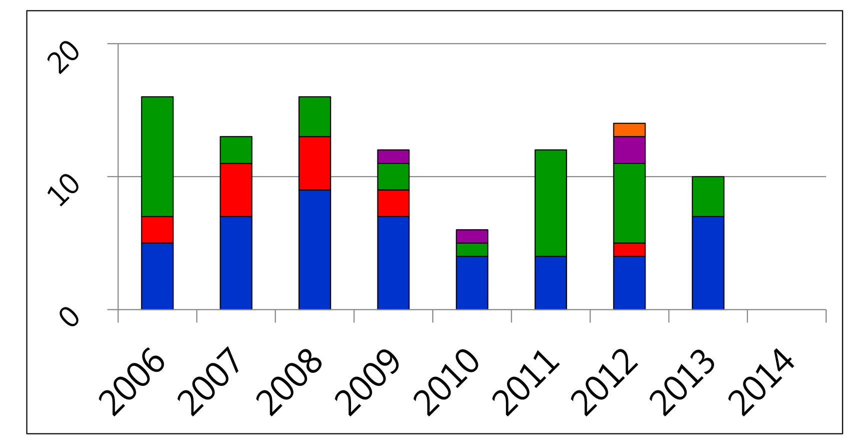


Fig. 2: Variation in modes of nontornadic convection with time.

The most common shear vector orientation with respect to the boundaries in LC cases is between 0-30° (32%). Shear vectors oriented between 31-60° and 61-90° to the boundaries appear much less often (19% and 11%; Fig. 3; below left). Over time, there is a slight increase in the occurrence of 0-30° shear vector angles. No consistent trend is present for the other shear vector angles (Fig. 4; below right).

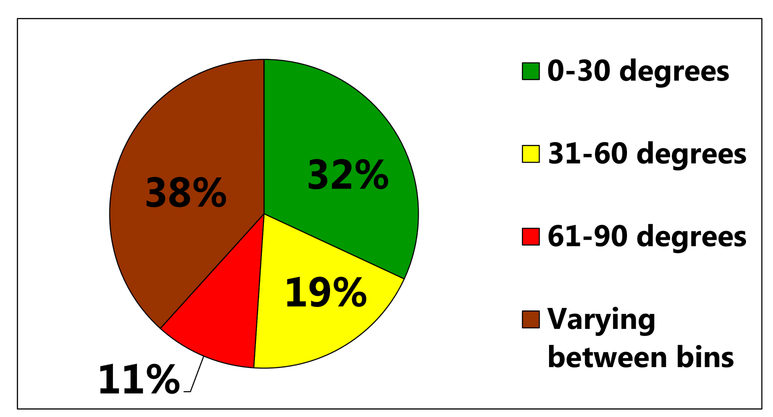


Fig. 3: Ranges of angles of the 0-6 km bulk shear vector with respect to the initiating boundaries.

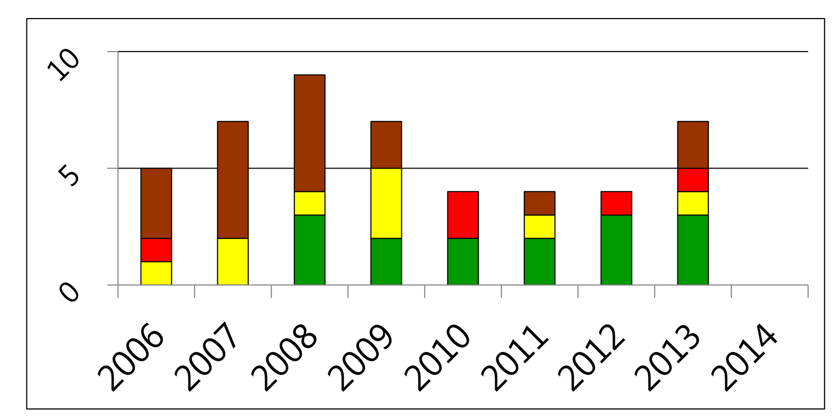


Fig. 4: Variation in boundary-relative shear vector orientation angles with time.

Not surprisingly, cold fronts triggered the majority (79%) of the LC episodes. Drylines (4%), warm fronts (11%), and stationary fronts (6%) constitute similar but significantly less percentages of the boundaries (Fig. 5; below left). The types of initiating boundaries do not exhibit any significant change in frequency over this time period (Fig. 6, below right).

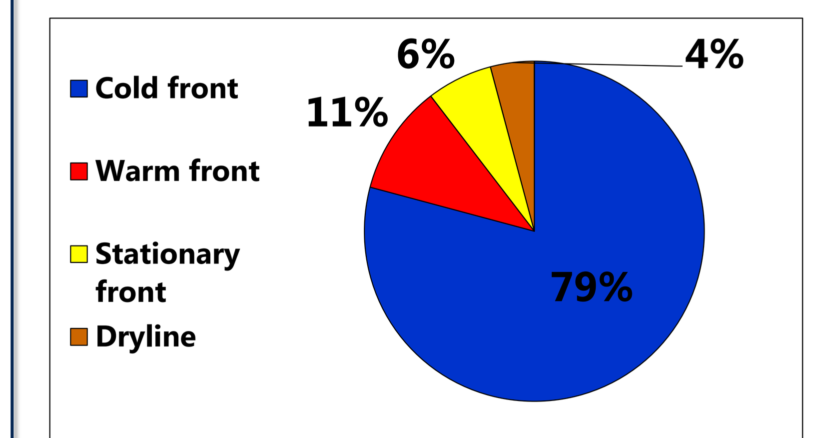


Fig. 5: Boundary types for linear storm mode events.

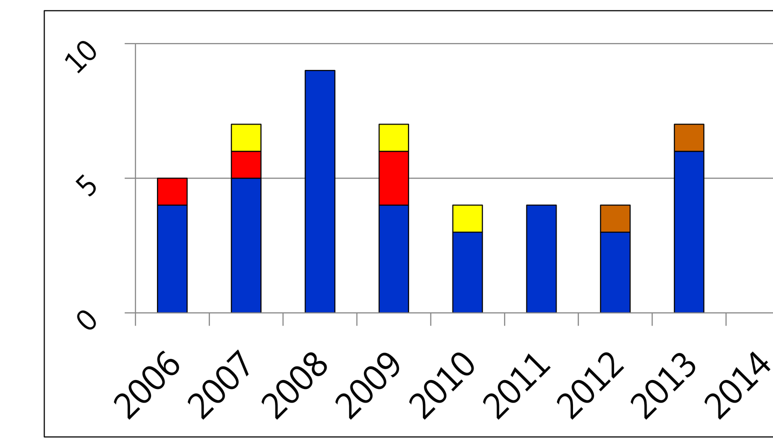


Fig. 6: Variation in boundary types for linear storm modes with time.

NTSC cases with SRH values greater than 200 $m^2 s^{-2}$ constitute 50% of all NTSC events. NTSC cases with SRH less than 100 $m^2 s^{-2}$ and SRH between 100-199 $m^2 s^{-2}$ each account for less than 25% of all NTSC events (Fig. 7, below left). LCLs below 1000 m were found in 41% of NTSC events, LCLs between 1000-1499 m account for 42% of NTSC cases, and LCLs were above 1500 m in the remaining 17% of NTSC events.

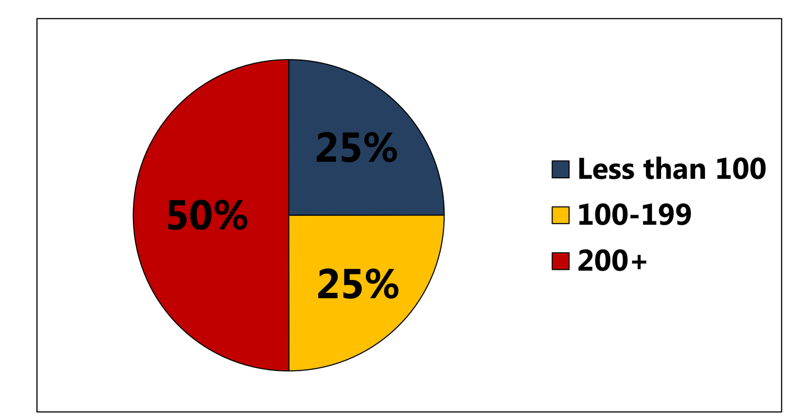


Fig. 7: Storm relative helicity ($m^2 s^{-2}$) for NTSC cases.

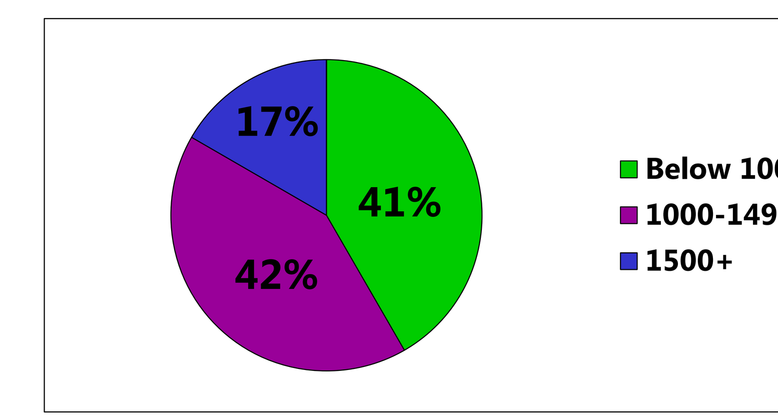


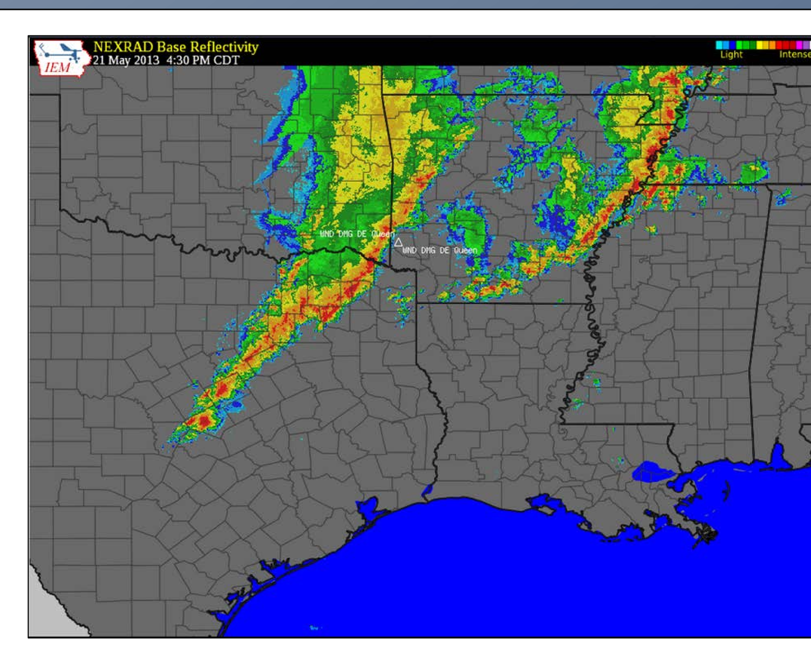
Fig. 8: LCL height (m) for NTSC cases.

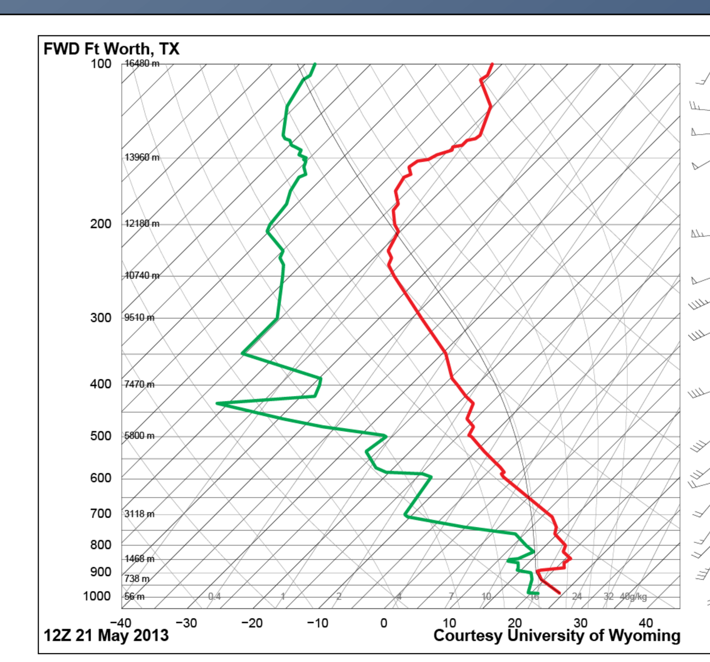
Example Case

21 May 2013: Linear Convection

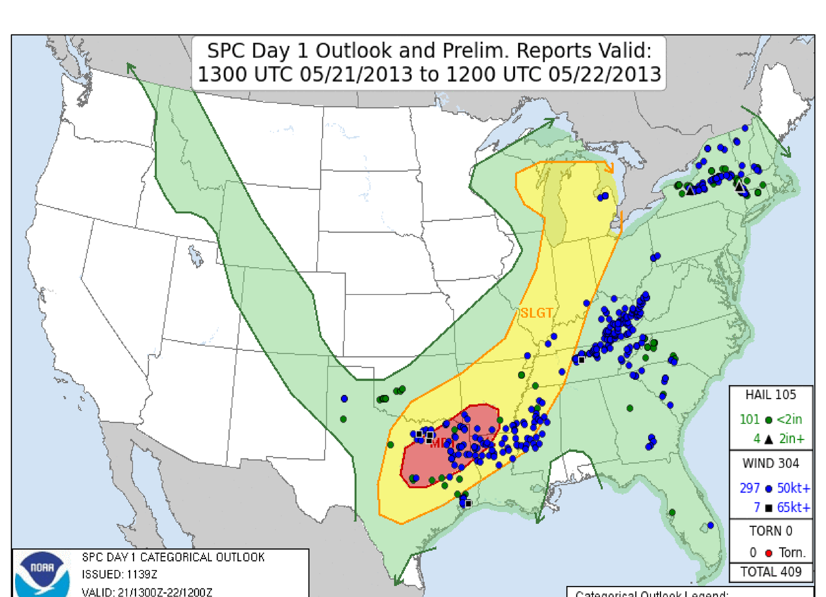
Moderate Risk – 10% Hatched Tornado Probability

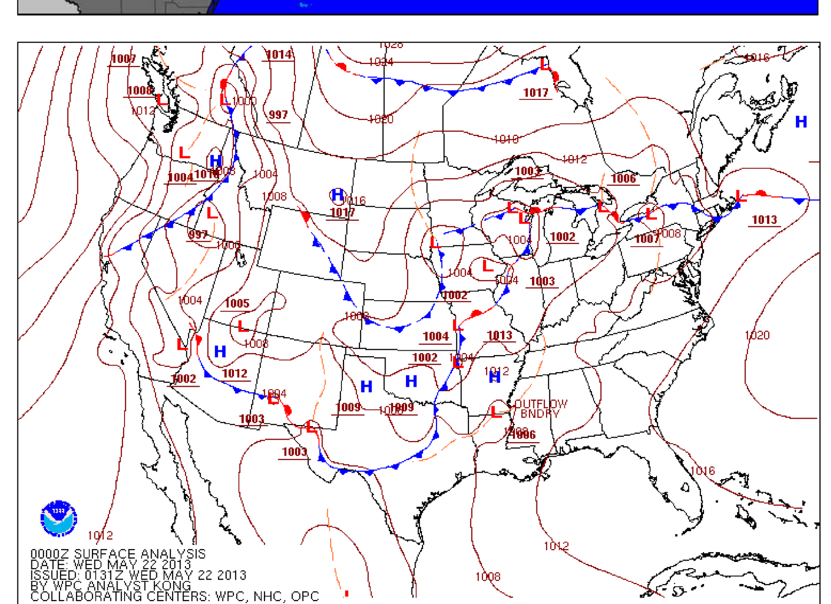
Convection initiated along a cold front over Texas in the morning and formed a line. This line persisted across the outlook region during the day. The shear vector orientation with respect to the cold front ranged from 30° to the N and 55° to the S. No tornado reports were received.

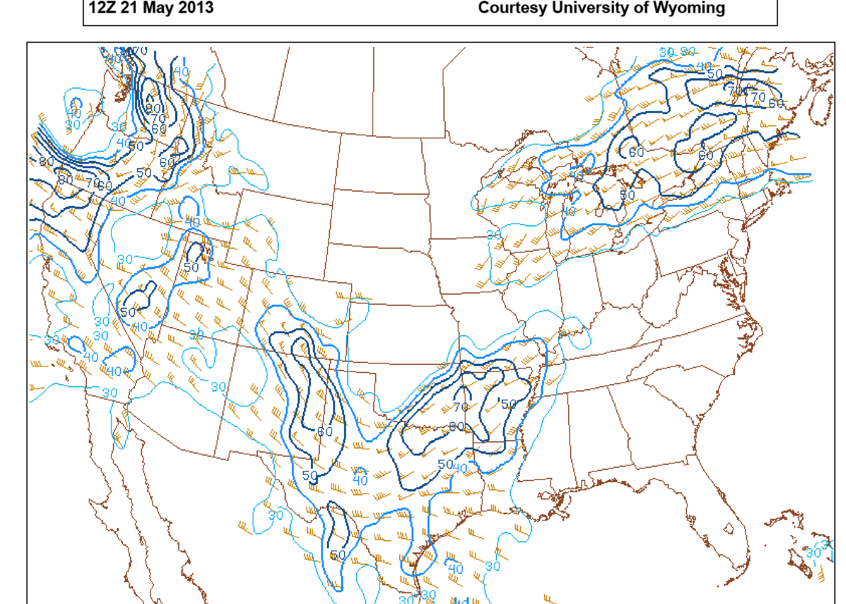




Top, Left: Radar image of Outlook regions at 2130 UTC.
Top, Right: Sounding for Ft. Worth, TX on 21 May 2013 at 1200 UTC.
Bottom, Left: SPC Convective Outlook and Storm Reports.
Bottom, Middle: HPC Surface analysis.
Bottom, Right: Mesoanalysis of 0-6 km Bulk Shear (knots).







Conclusions and Further Analysis

- Instances of only non-tornadic supercellular convection when tornadoes were forecasted have decreased over time.
- There was no noticeable temporal trend with other convective modes.
- Shear vectors oriented from 0-60° with respect to the boundaries constitute the majority of linear convection cases (as expected), and the number of forecasts with those angles has increased over time.
- Cold fronts are responsible for the majority of linear convective modes (as expected); the forecasting of tornadoes in association with cold fronts remains a challenge.
- Occurrences of non-tornadic supercells when tornadoes were forecasted in environments with high SRH (greater than 200 $m^2 s^{-2}$) account for half of all NTSC forecasts, and LCLs below 1500 meters occur in most of these cases.
- Further analysis of specific cases is necessary to discern specific causes why tornadoes did not occur in these instances.

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