Verification of NOAA/NWS/SPC 4-hourly Probabilistic Severe Timing Guidance

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Introduction

- SPC forecasters have demonstrated skill over the past decade in generating probabilistic Convective Outlooks for the *entire convective day* (i.e., 12-12 UTC)
- However, SPC outlooks currently do not provide graphical information on the *timing* of the severe weather threat
- Not feasible for forecasters to manually draw probabilistic outlooks for all hazards (tornado, hail, and wind) with high temporal resolution (and frequent updates) given workload and technical concerns

What is the SPC Severe Timing Guidance?

- Leverages the *High Resolution Ensemble Forecast (HREF)* to add *hourly probabilistic information* regarding the temporal evolution of the severe weather threat that is consistent with the SPC forecaster outlook
- There are two inputs required to generate the probabilistic severe timing guidance:
  - Experimental SPC Day 1 Convective Outlook in continuous-probability form
  - Hourly 4-h calibrated probabilistic hazard guidance from the HREF/SREF
- SPC Severe Timing Guidance attempts to merge the best aspects of human input with automation (i.e., optimize man-machine mix, human in/over-the-loop)

Data & Methods

Guidance Data & Observations

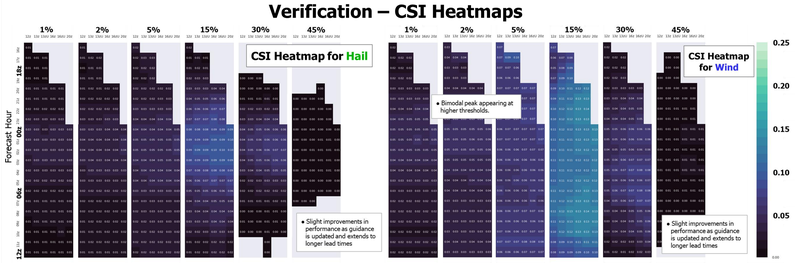
- *Analyzed over 5-year period:* ***15 April 2018 - 15 April 2023***
- *Guidance output:*
  - Hourly 4-hour probabilities within CONUS/SPC forecast bounds
  - 6 forecast initialization times:
    - 1200z **(valid 16z-12z)**
    - 1300z and 1300z with updated HREF output **(valid 17z-12z)**
    - 1630z and 1630z with updated SREF output **(valid 20z-12z)**
    - 2000z **(valid 00z-12z)**
  - Gridded continuous data on 40-km spacings
- *Filtered preliminary local storm reports (LSRs)*
  - Converted to 40-km gridpoint spacings to match that of the guidance output
  - Binned to match guidance output's 4-hourly windows
  - Gridded binary fields (0 = no LSR, 1 = LSR)

Verification & Temporal Analysis

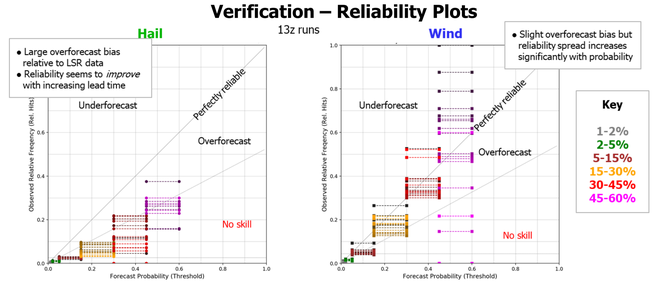
- *Performance Diagrams*
  - Probability of detection (POD) vs. success ratio (1-false alarm ratio (FAR))
  - Bias and critical success index (CSI) contours
  - Plotted for all forecast runs and lead times (16z-12z) at sets of probability thresholds
    - 8 thresholds for tornado risk, 7 for wind and hail
- *CSI Heatmaps*
  - Visualization of CSI with respect to forecast initialization time and their respective lead times
- *How to compare LSR data to probabilities per gridpoint?*
  - Practically perfect hindcasts (PPH)
  - Find hours where PPH and guidance probability are maximum
  - Difference between these hours is the *temporal error*
- *Caveats*
  - Only can exist where both variables are nonzero
  - Multiple peaks or a plateau - take midpoint if possible

Results

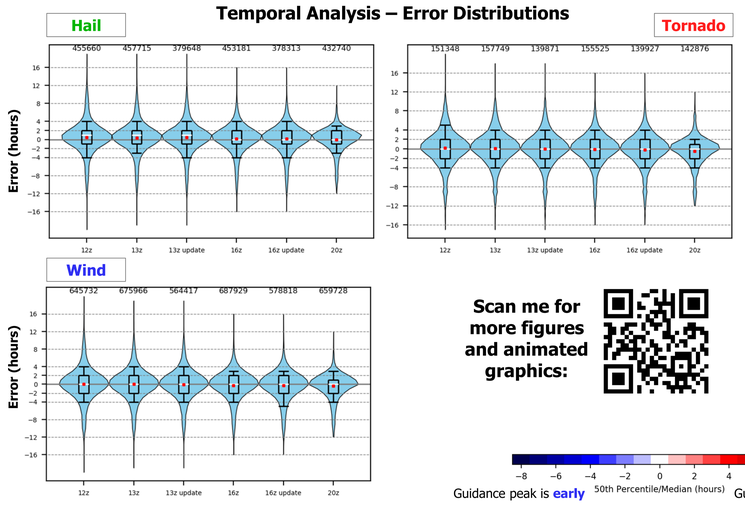
Verification – CSI Heatmaps



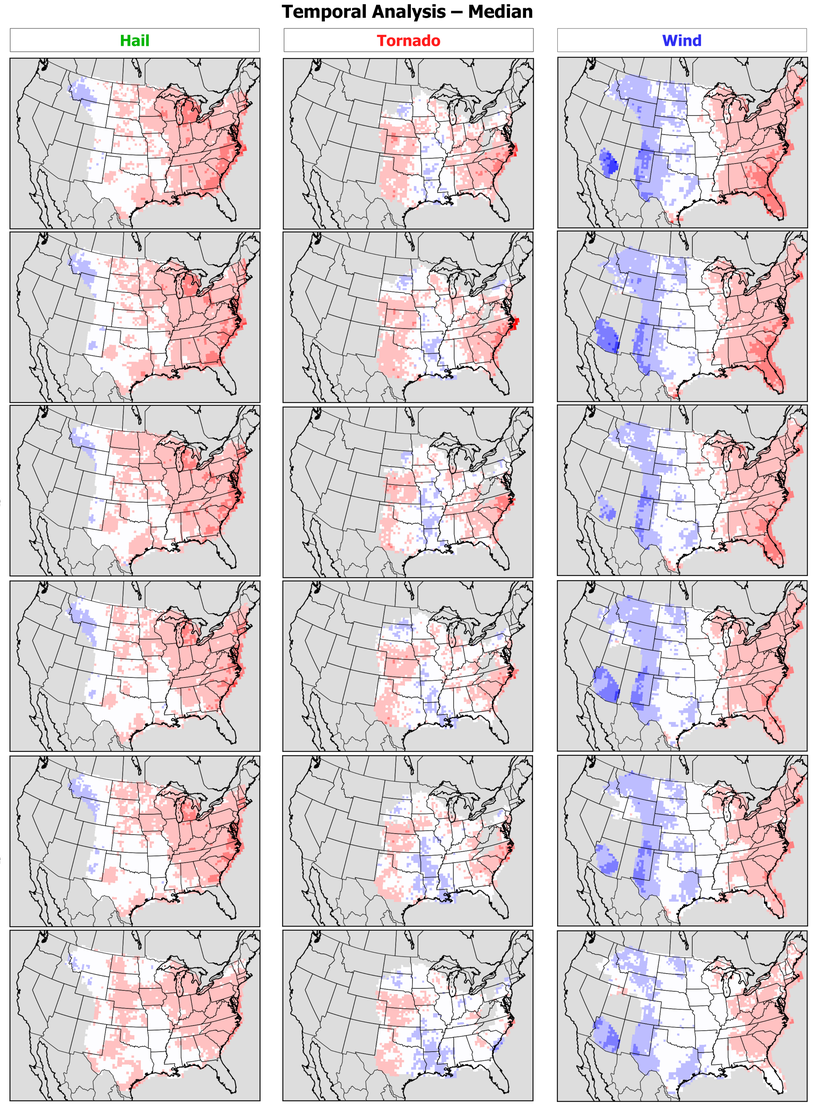
Verification – Reliability Plots



Temporal Analysis – Error Distributions



Temporal Analysis – Median



Verification Conclusions

- *Performance Diagrams/CSI Heatmaps:*
  - Performance generally had the smallest bias at the 15% thresholds for wind and hail, and 5-10% for tornado.
  - CSI values peaked in the late evening and improved with each guidance update.
- *Reliability Plots:*
  - Wind risk followed fairly close to the perfect line, whereas hail had an overforecast bias and tornado risk had an underforecast bias.
    - Hail and tornado biases may be related to forecaster adjustment for reporting issues.

Temporal Analysis Conclusions

- *A minor late bias exists in all initial convective day forecasts of each hazard, which diminishes with initialization time.*
  - The earlier (12z, 13z, 13z update) forecasts have a greater late bias than the 20z forecasts, of which sometimes had an early bias.
  - The strongest effect occurs with the hail risk forecast.
- *Wind and hail risks have an increasing temporal bias from west to east.*
  - Timing bias is earliest along the Rockies, and latest along the east coast.
  - The effect is less apparent in the tornado risk forecast.

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