A Multi-year Evaluation of NSSL-WRF Surrogate Severe Thunderstorm Forecasts

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Introduction

Convection-allowing models (CAMs), such as the Weather Research and Forecasting Model (WRF), provide information which can be used to identify areas of potentially severe weather. Specifically, hourly maximum updraft helicity (UH) has been used as a surrogate for reported severe weather events (e.g. Sobash et al. 2011). These surrogate severe reports are evaluated for accuracy and skill, and are compared to convective outlooks issued by Storm Prediction Center (SPC) forecasters.

NSSL-WRF Configuration

This study uses data from the WRF model run by the National Severe Storms Laboratory (NSSL). Daily runs which include hourly max UH began on 30 January 2008; data were obtained through 2014. Few changes have been made to the model's configuration over this period, with the current configuration including:

- WRF version 3.4.1
- MYJ BL/turbulance
- WSM6 microphysics
- RRTM longwave radiation
- Dudhia shortwave radiation
- Positive definite advection of moisture
- 4 km grid length
- 35 vertical levels
- Time step of 24 s
- IC/BC from 40km NAM

Surrogate Severe Forecasts

To create forecasts comparable to those from the SPC, grid boxes with UH exceeding a threshold value were smoothed using the practically perfect (PP) technique, which uses a 2-D Gaussian kernel (Hitchens et al. 2013). The resulting areas are referred to as surrogate severe probability forecasts (SSPFs), and were plotted on a grid with 80 km grid spacing to approximate the SPC's convective outlooks.

Preliminary Results

	Observed Yes	Observed No	Sum
Forecast Yes	**a**	**b**	a+b
Forecast No	**c**	**d**	c+d
Sum	a+c	b+d	n

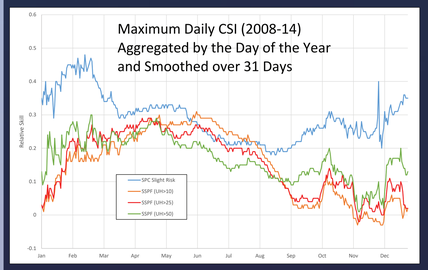
Critical Success Index (CSI)

$$CSI = a / (a+b+c)$$

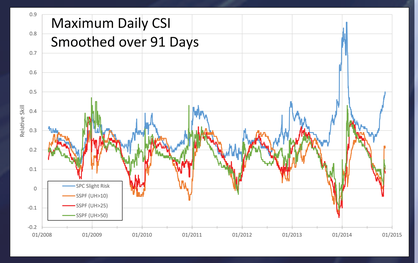
Relative Skill

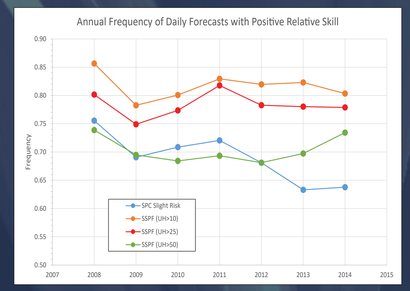
$$\frac{CSI - PP\_CSI_{min}}{PP\_CSI_{max} - PP\_CSI_{min}}$$

- SPC categorical convective outlooks (slight risk area) used for comparison
- Issued daily at 06Z, valid 12Z-12Z
- UH thresholds of 10, 25, & 50 $m^2 s^{-2}$ examined and compared to outlooks
- Max & min PP contours based on CSI

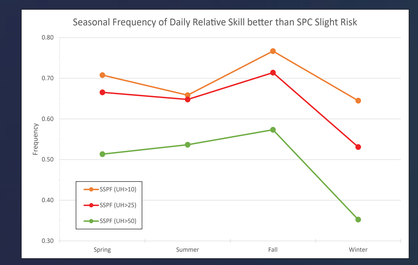


- Maximum CSI determined by SSPF contour that results in the highest CSI value using observed storm reports (OSRs)
- Peak value follows annual cycle, with timing of peak skill varying based on UH threshold
- UH>10 and UH>25 exceed outlook skill in June





- SSPFs based on contour that produces maximum CSI value using OSRs
- Lower UH thresholds (10 & 25 $m^2 s^{-2}$) are skillful on ≥75% of days during 2008-14
- Skill better than Slight Risk is a direct comparison of relative skill values, so both could be positively skilled or both could be negative



- Significant decrease (~20%) in frequencies of skillful daily forecasts from spring and summer to fall and winter among all thresholds
- NSSL-WRF more frequently skillful than Slight Risk areas except in winter for all three thresholds
- Seasonal peak in frequency in fall, although only slightly higher than spring/summer

Concluding Thoughts

- These results are based on the SSPF contours that provide the best CSI values, which is effectively the best case scenario for each day
- Since it is not possible to know which SSPF contour will give the best CSI value ahead of events, continuing work is focused on identifying characteristics of these forecasts that can provide useful information in real-time