Probabilistic Thunderstorm Guidance from a Time-Lagged Ensemble of High Resolution Rapid Refresh (HRRR) Forecasts

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MOTIVATION

NOAA requirements of probabilistic rapidly-updated convection forecasts for:

- Improving predictability of the onset, duration, and impact of hazardous and severe weather and water events
- Supporting decisions in aviation, marine, and surface navigation

OVERVIEW

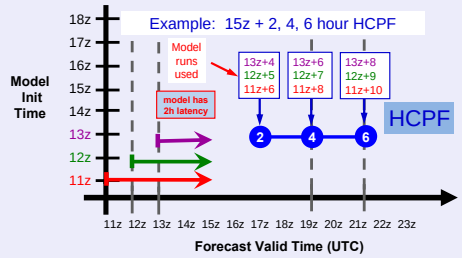
High Resolution Rapid Refresh (HRRR)

- 3 km horizontal grid
- WRF-ARW dynamic core
- 0-12 hr forecasts produced hourly
- Initial conditions from 13 km Rapid Update Cycle (RUC)
- Radar reflectivity assimilation in RUC using DFI

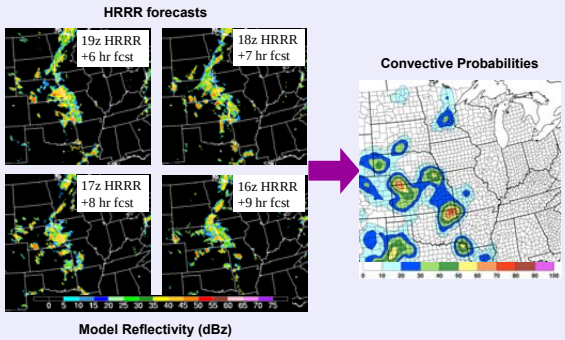
HRRR Convective Probabilistic Forecast (HCPF)

- Uses time-lagged HRRR forecasts
- Estimates thunderstorm likelihood in the form of probabilities
- Builds off of RUC Convective Probabilistic Forecasts (RCPF)
- RCPF currently used by Aviation Weather Center (AWC)

Time-Lagged Ensemble



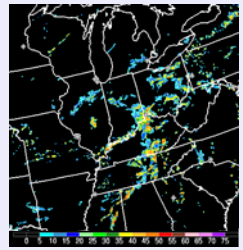
Probabilistic Guidance From Time-Lagged Ensembles



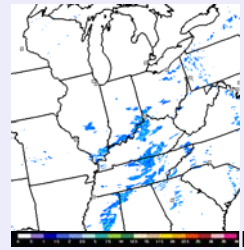
METHODOLOGY

- Identify regions of convection among the time-lagged HRRR ensemble members using a varying detection threshold

  - HRRR vertical velocity and instability fields
  - Maximum values in model column over +/- 1 hr



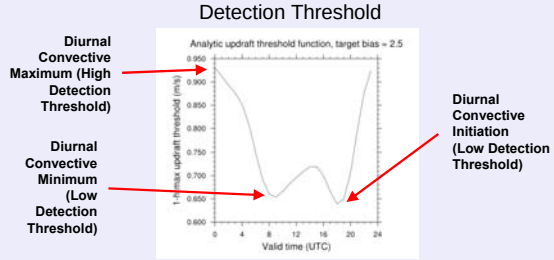
Model Reflectivity (dBz)



1 Hour Column-Maximum Updraft Velocity (m s^{-1})

  - Detection threshold varies diurnally
  - Maintains consistent bias around 2.5
  - Favors probability of detection

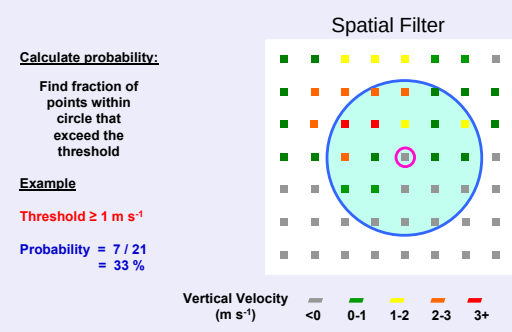
Detection Threshold



- Apply spatial filter over each ensemble member that exceeds vertical velocity and instability thresholds near each grid point

  - Search within 75 km (25 grid points) of each grid point

Spatial Filter



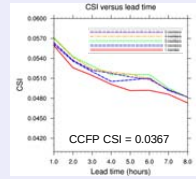
IMPACT

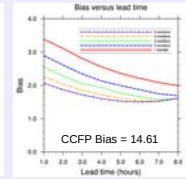
HCPF represents the first hourly-updated probabilistic convection-resolving forecast for the United States:

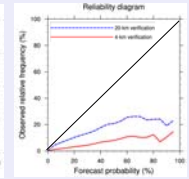
- Using the latest radar observations and hourly NWP
- Anticipating use by FAA/NextGen in Consolidated Storm Prediction for Aviation (CoSPA), Aviation Weather Center, Storm Prediction Center, and others

RESULTS

- HCPF Critical Success Index (CSI) and Bias exhibit values exceeding Collaborative Convective Forecast Product (CCFP)
  - Optimal number of HCFP members around 3 - 4
  - decreasing skill with increasing lead time



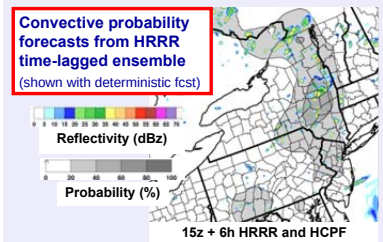


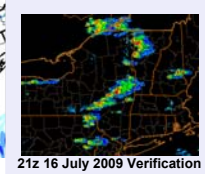


- HCPF tendency to over-forecast higher probabilities, although less so when upscaling verification to a 20 km grid
  - Reliability to be used to calibrate forecasted probabilities
- HCPF verification used:
  - 540 forecasts, August 2009, Eastern United States
  - Varying number of youngest ensemble members
  - Constant filter size (75 km) and detection thresholds
  - HCPF values < 40% considered "yes" forecasts
  - 4 km NCWD VIP level 3 or higher verification grid

ONGOING AND FUTURE WORK

- Introduce ensemble member weighting
- Combine deterministic HRRR forecasts from individual members with ensemble probabilities
- Predict the likelihood of convection in time and location as well as the structure of the convection (isolated cells, line-segments, etc...) to estimate permeability for flights





21z 16 July 2009 Verification