Update on CoSPA Storm Forecasts

Haig Iskenderian

August 2, 2011

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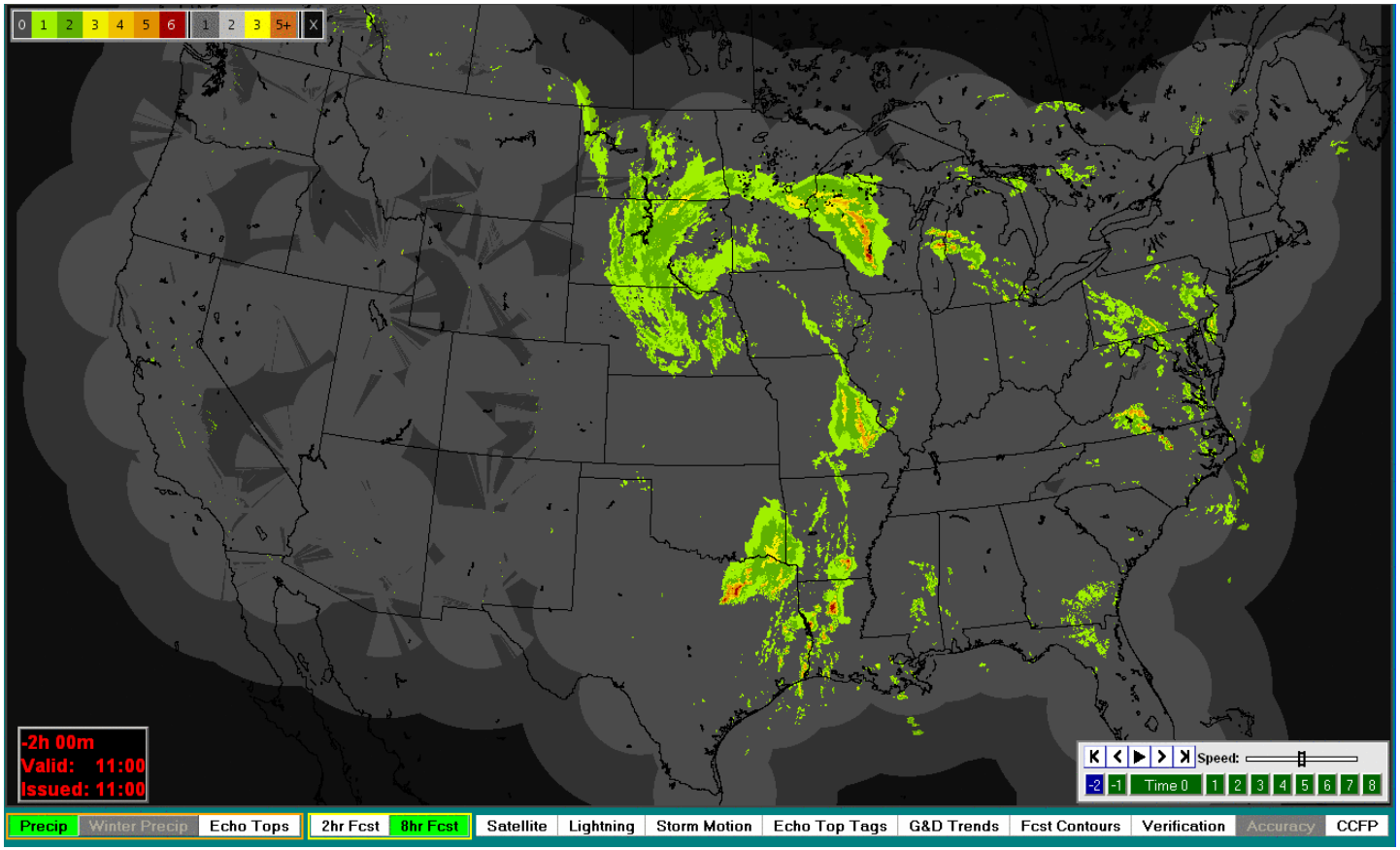
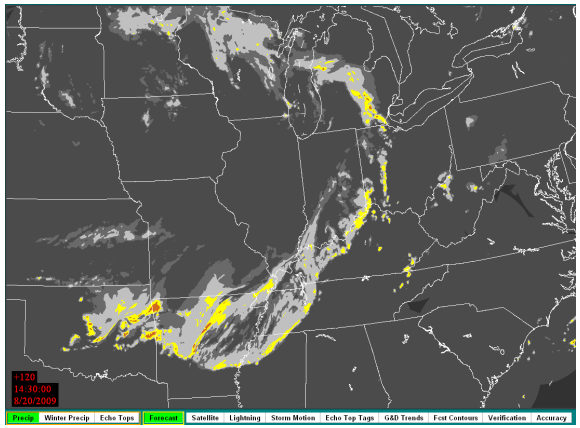
CoSPA Precipitation Forecast



- Deterministic forecast
- Display:
  - Precipitation (VIL)
  - Echo Tops
- Horizontal resolution:
  - 1 km (0-2 hour)
  - 3 km (2-8 hr)
- CONUS coverage
- Forecast out to 8 hours
- Time steps:
  - 5 min (0-2 hr)
  - 15 min (2-8 hr)
- Tactical and strategic planning tool for Traffic Flow Management

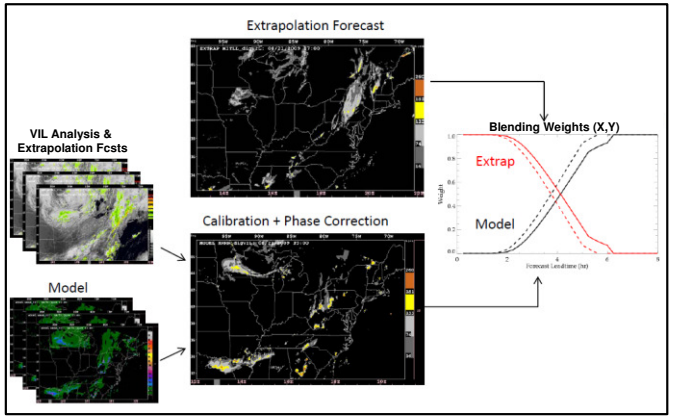
CoSPA 0-8 Hour Forecast
Main Components

Corridor Integrated Weather System (CIWS)



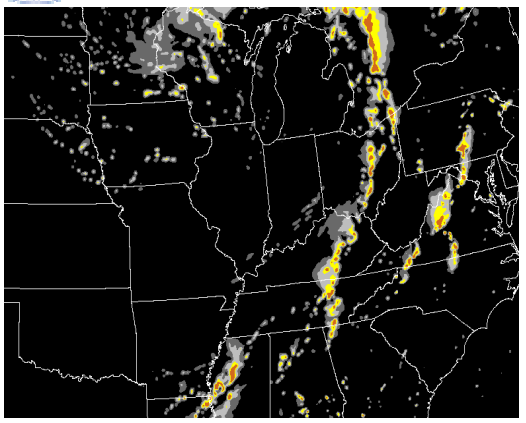
Extrapolation & Nowcast Model

Blending Module



Calibration & Phase Correction

High Resolution Rapid Refresh (HRRR)



Numerical Weather Prediction Model

Outline

- CIWS extrapolation/ nowcast improvements:
  - Improved satellite convective initiation
  - Added Echo Top decay; improved ET growth
  - Improved storm extrapolation
- HRRR improvements:
  - Replaced RUC with Rapid Refresh (RR) as parent model for HRRR
  - Used reduced diffusion and raised pressure top in HRRR
  - Used finer resolution sea surface temperature field
- Blending improvements:
  - Added regionally-varying and continually-updating calibration ("running" climatology)
  - Improved convective initiation
  - Improved methodology for phase correction
- Application of CoSPA to probabilistic forecasts

Nowcast Improvements
Satellite Convective Initiation

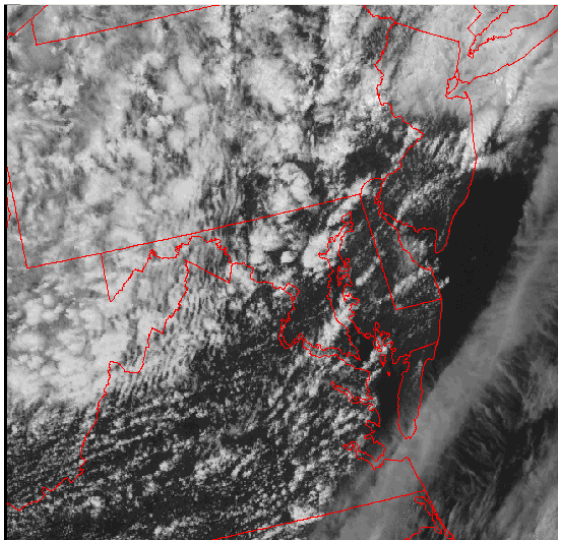
- Incorporated NASA's SATellite Convection AnalysiS and Tracking (SATCAST*) system in FAA CIWS

- SATCAST performs:
  - Cloud classification
  - Cloud tracking
  - Trending of IR channels
  - IR channel differencing

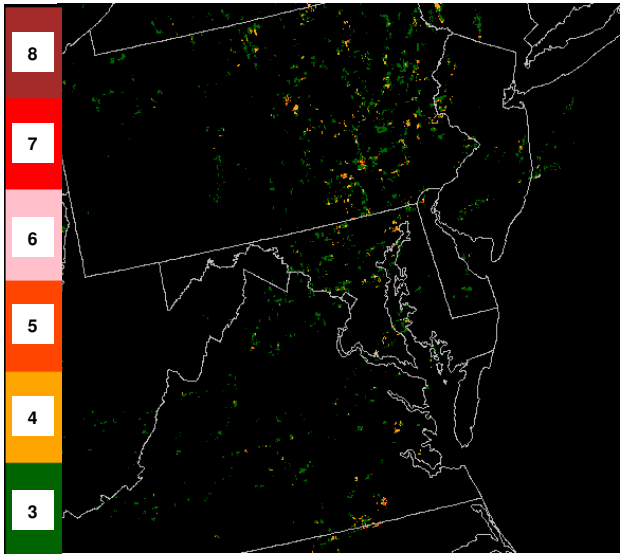
- 8 satellite-based interest fields indicate "confidence" in CI
  - Account for cloud growth, glaciation, cloud top height

*Mecikalski and Bedka, MWR (2006)

Visible Satellite

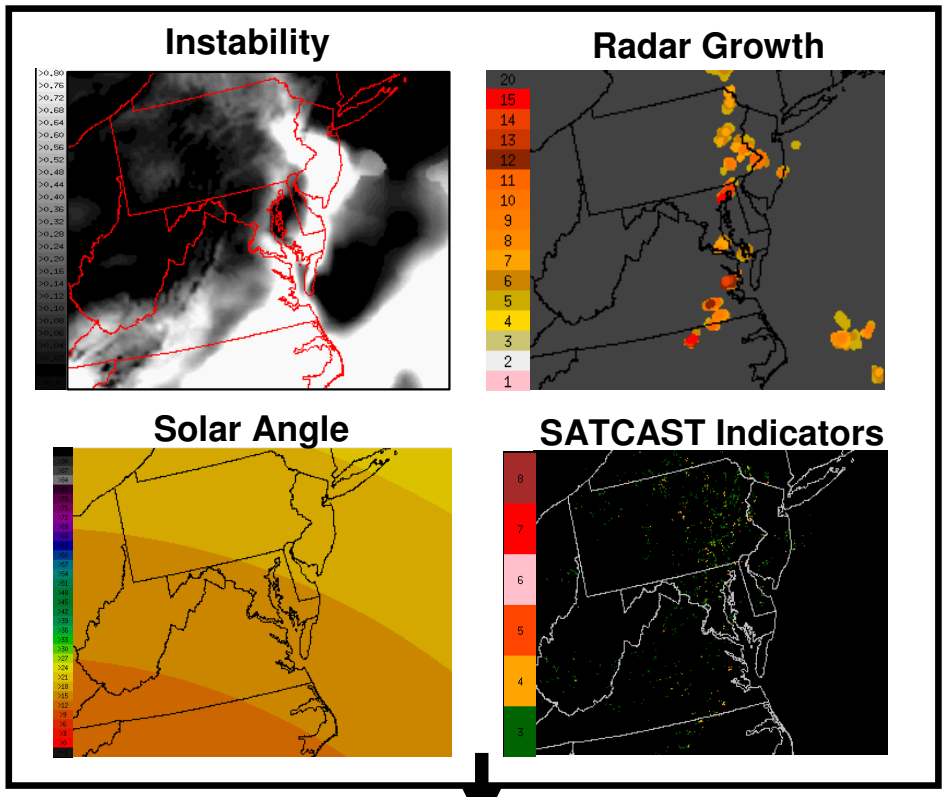


# of SATCAST CI Indicators

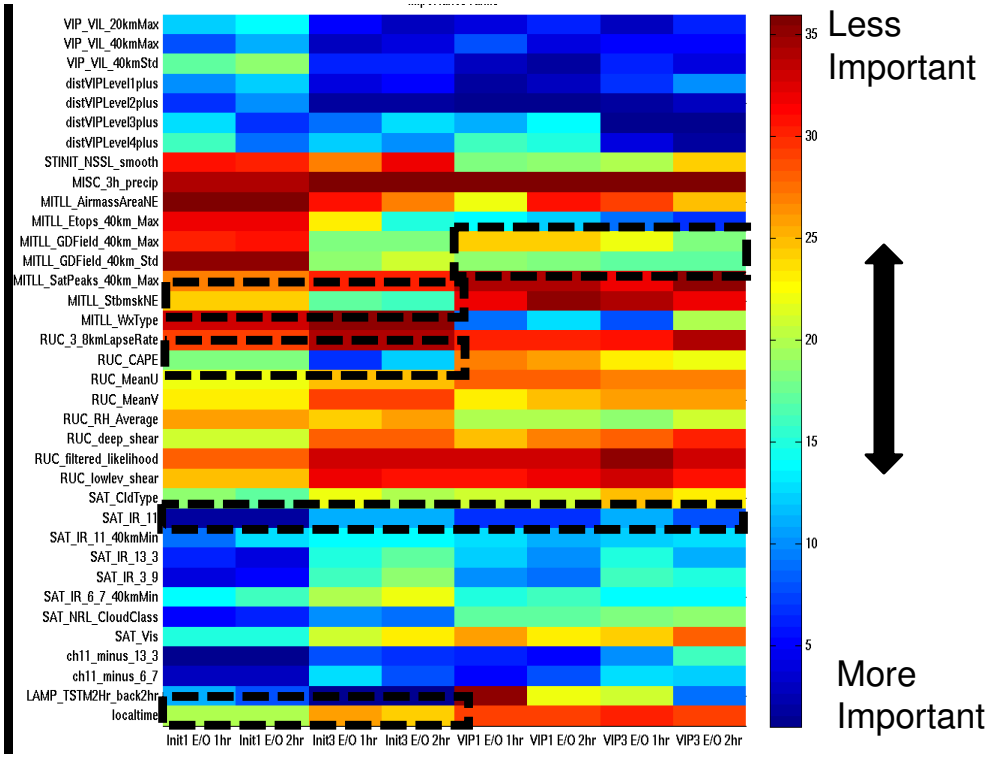


Nowcast Improvements
Satellite Convective Initiation

Fuzzy Logic CI Nowcast Model

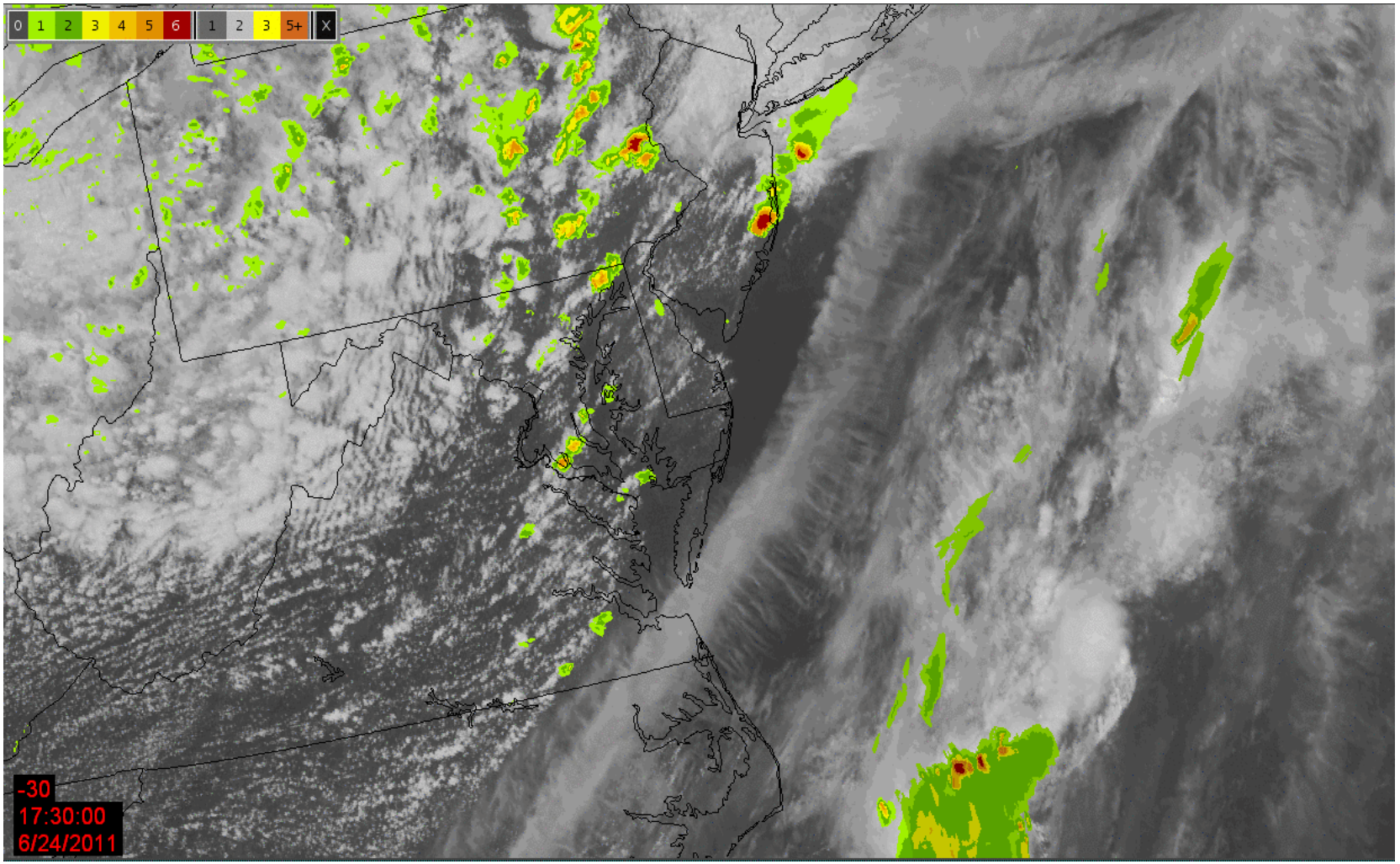


Random Forest Predictor Importance



RF Source: John Williams, NCAR

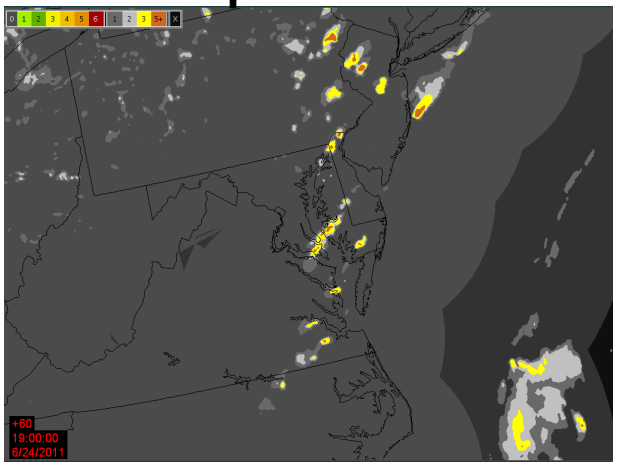
Nowcast Improvements
Convective Initiation Forecast Example



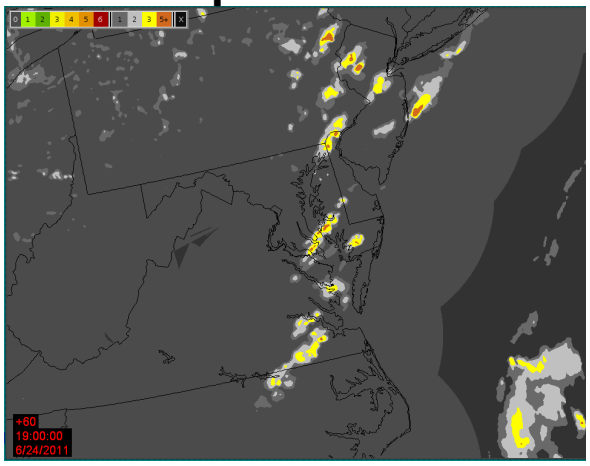
24 June 2011

Nowcast Improvements
Satellite Convective Initiation

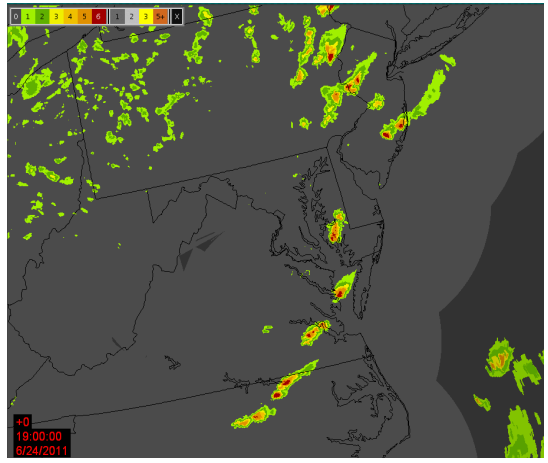
2010 CIWS
1 Hr Precipitation Forecast



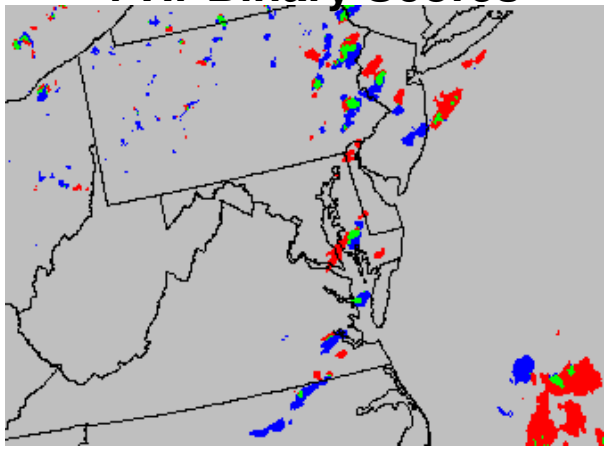
2011 CIWS
1 Hr Precipitation Forecast



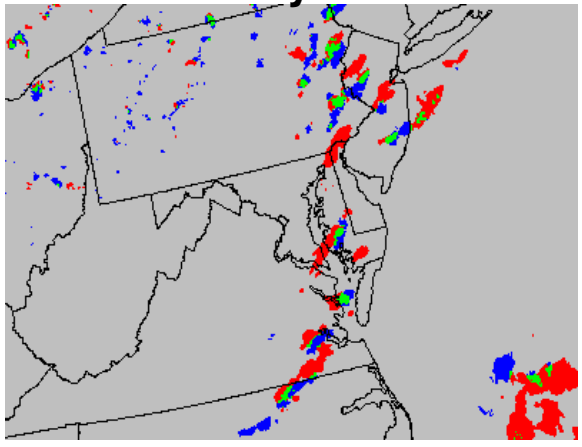
Truth



2010 CIWS
1 Hr Binary Scores



2011 CIWS
1 Hr Binary Scores



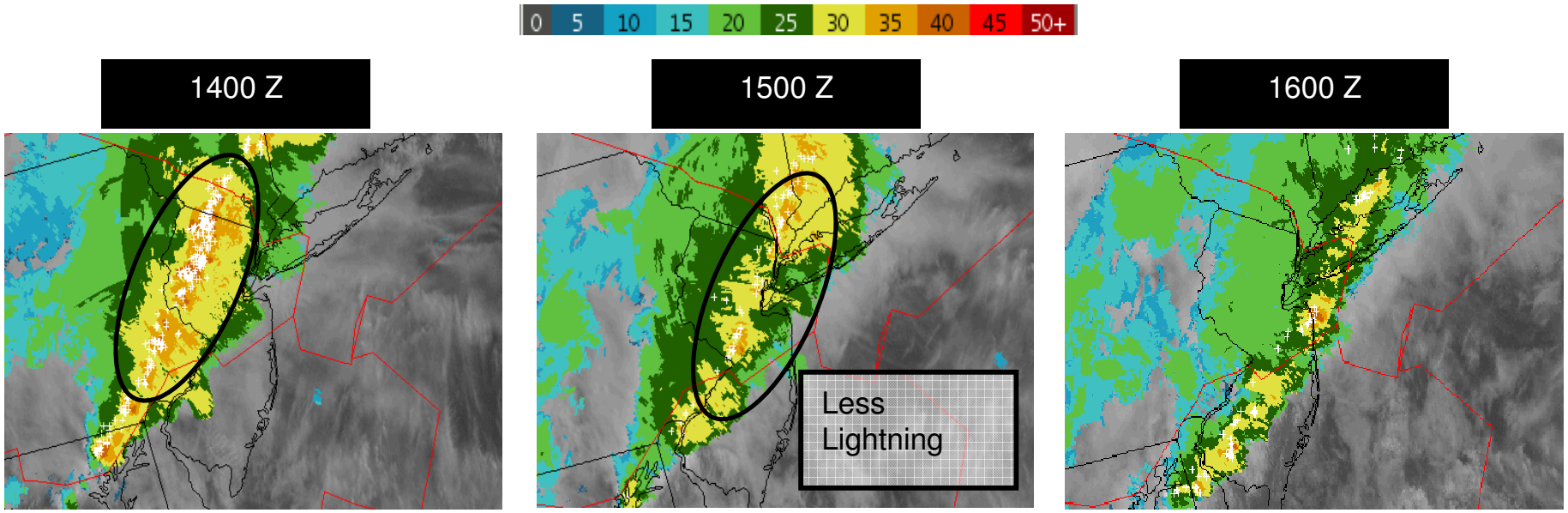
HIT | MISS | FALSE ALARM

VIP Level 2 Scores

	Dulles (IAD) Region	
	CSI	BIAS
2010 CIWS	11.2	0.8
2011 CIWS	12.9	1.5

Valid 19 UTC 24 June 2011

Nowcast Improvements
Echo Top Growth and Decay

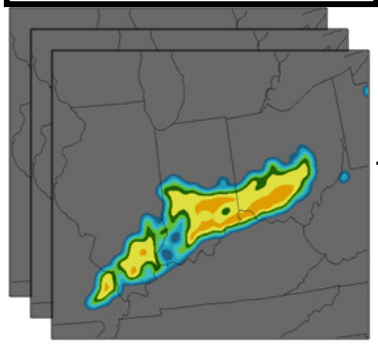


9 September 2008

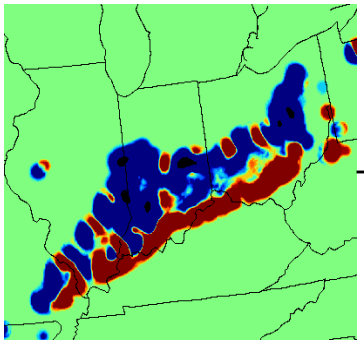
- Combine trends in lightning and ET to improve ET forecasts

ET Growth and Decay Predictor
Interest Images

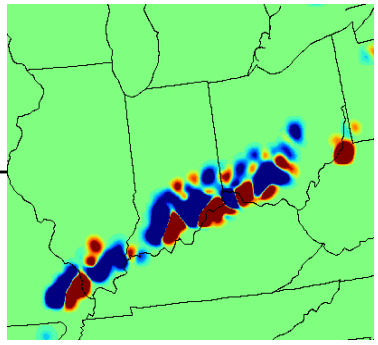
Filtered Echo Tops above 30kft over Time



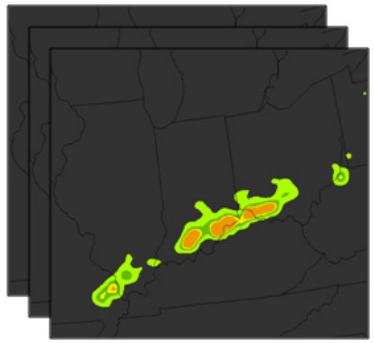
Echo Tops Trends

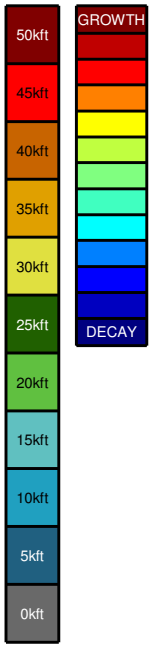


Lightning Trends

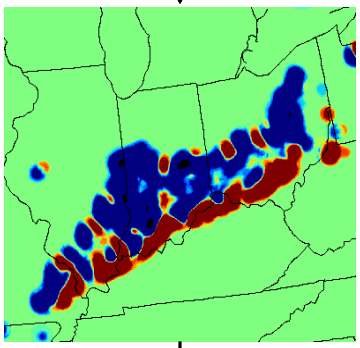


Filtered Lightning Flashes over Time

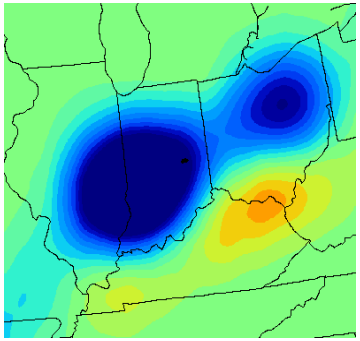




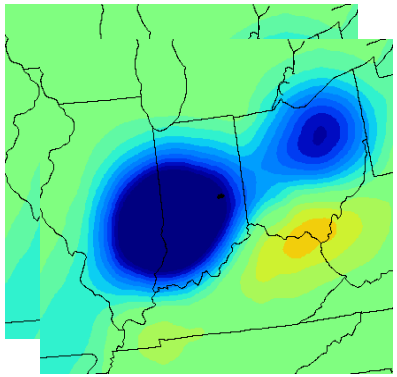
Combined Trends



Filtered Trends



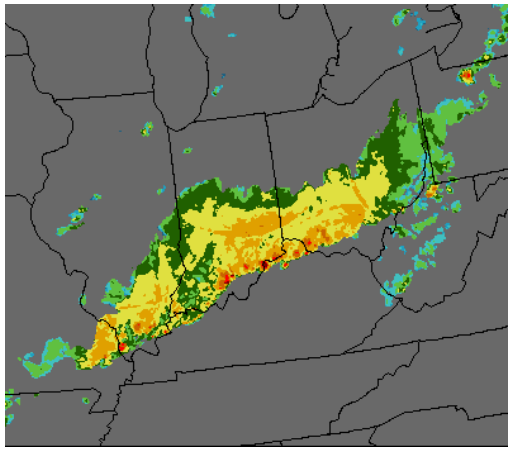
Time Averaged Trends

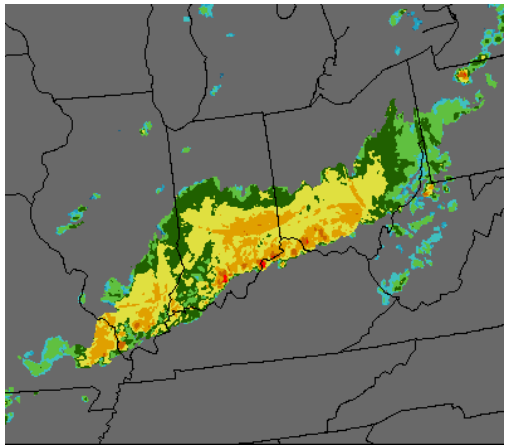


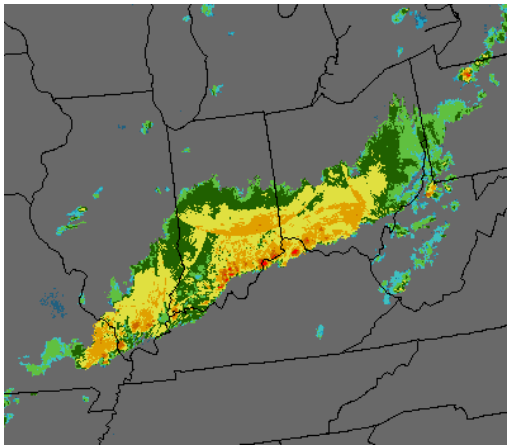
Nowcast Improvements
Echo Top Growth and Decay

2010 CIWS: +2Hr ETF	2011 CIWS: +2Hr ETF	ET Truth

CoSPA EchoTOP

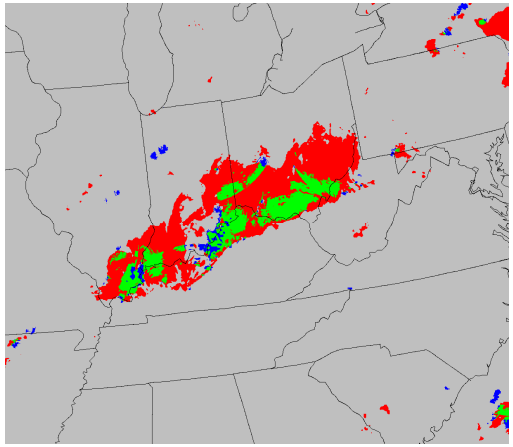


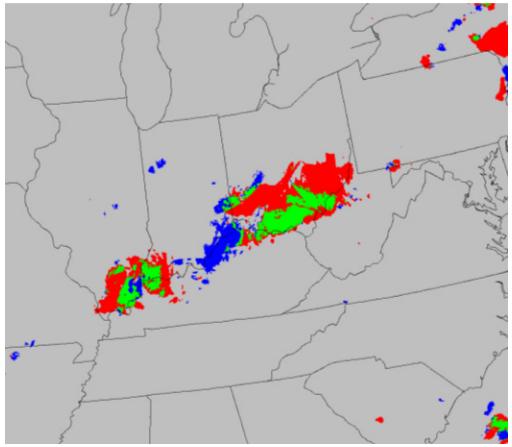


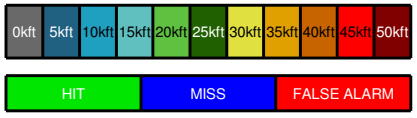


0430 +2Hr	0430+2Hr	0630

Forecast Verification







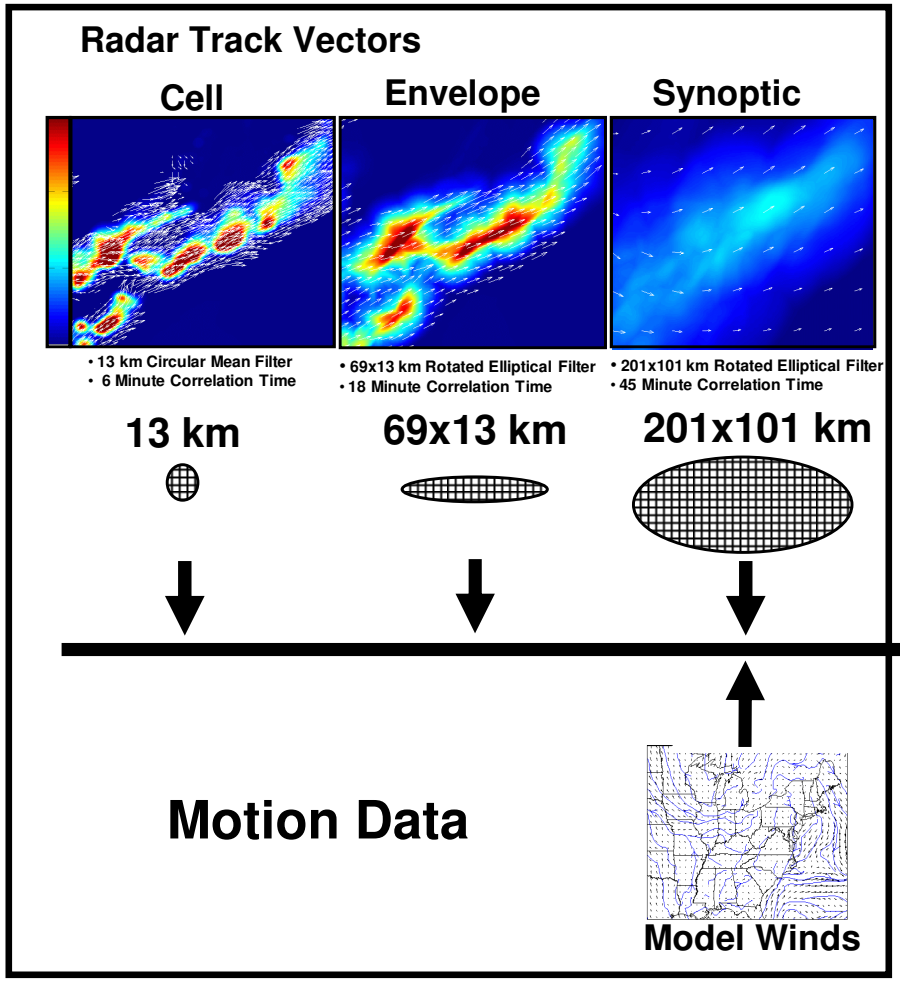
2 hr Verification Statistics

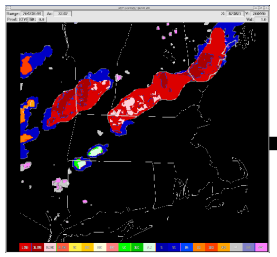
	CONUS		Cincinnati (CVG) Region	
	CSI	BIAS	CSI	BIAS
2010 CIWS ETF	27.2	2.3	27.3	3.1
2011 CIWS ETF	30.3	1.6	29.5	1.6

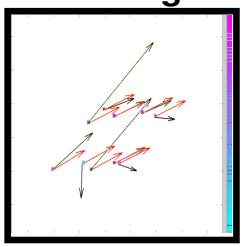
NOTE: Verification Threshold 30 Kft

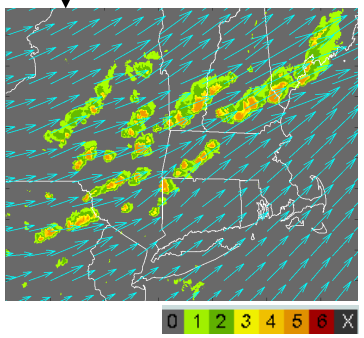
28 June 2010

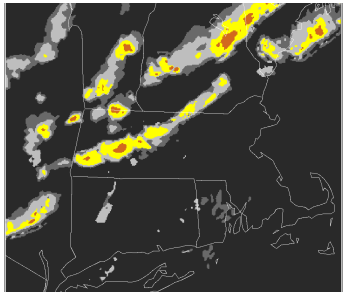
Extrapolation Improvements
Multiscale Storm Advection







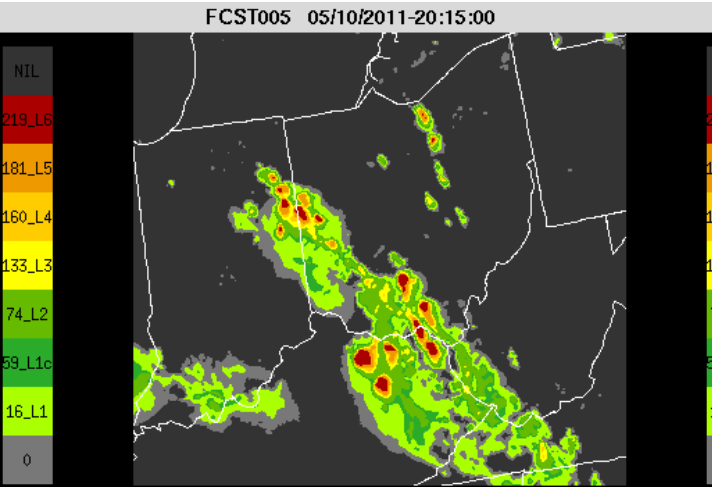




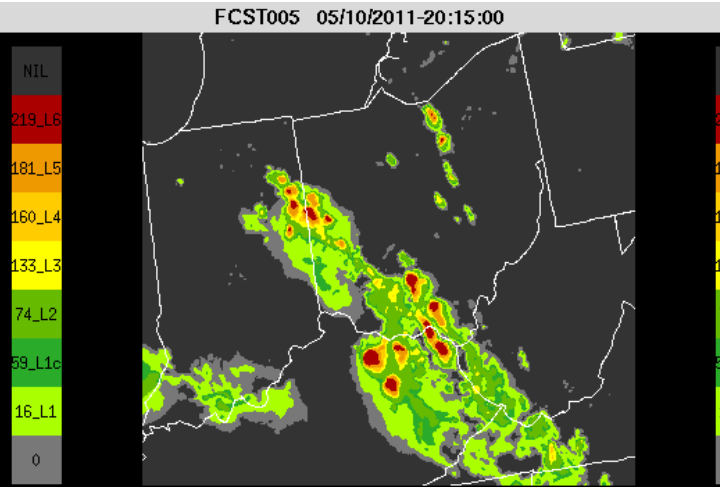
- Multiple scales tracked (cell, envelope, synoptic), rotational & translational motion applied
- CIWS and CoSPA now share the same advection algorithm

Extrapolation Improvements
Multiscale Storm Advection

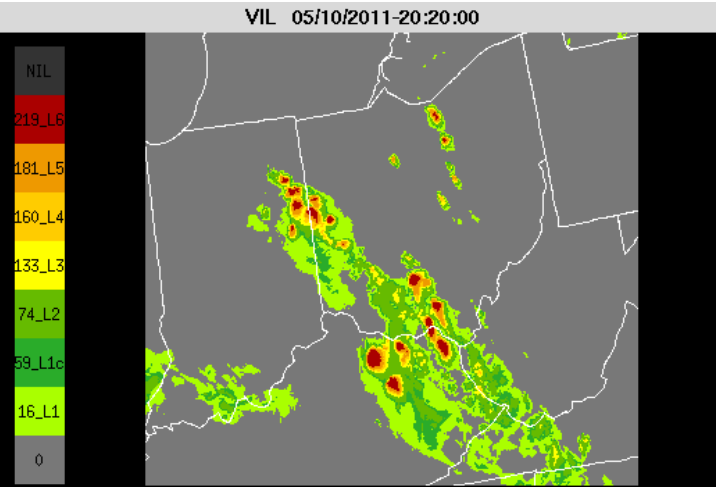
2010 CIWS Forecast



2011 CIWS Forecast

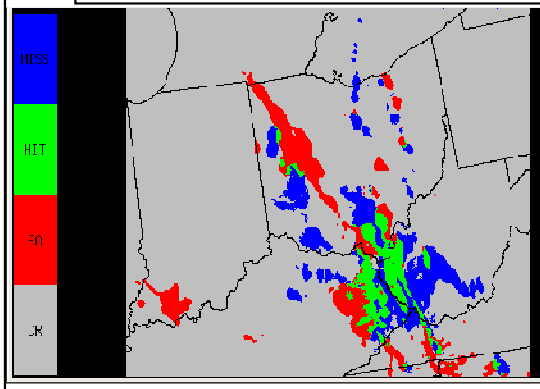


Truth

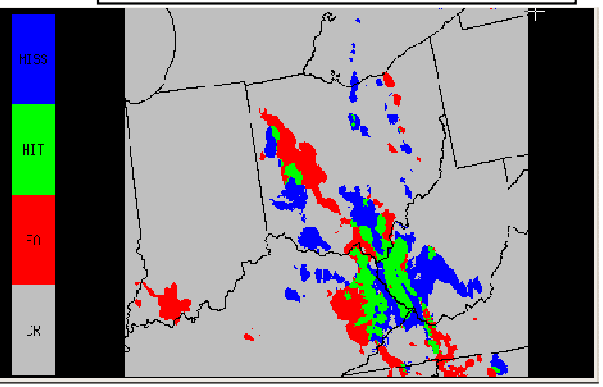


Level 2 Binary Scores

2010 CIWS +120min



2011 CIWS +120min



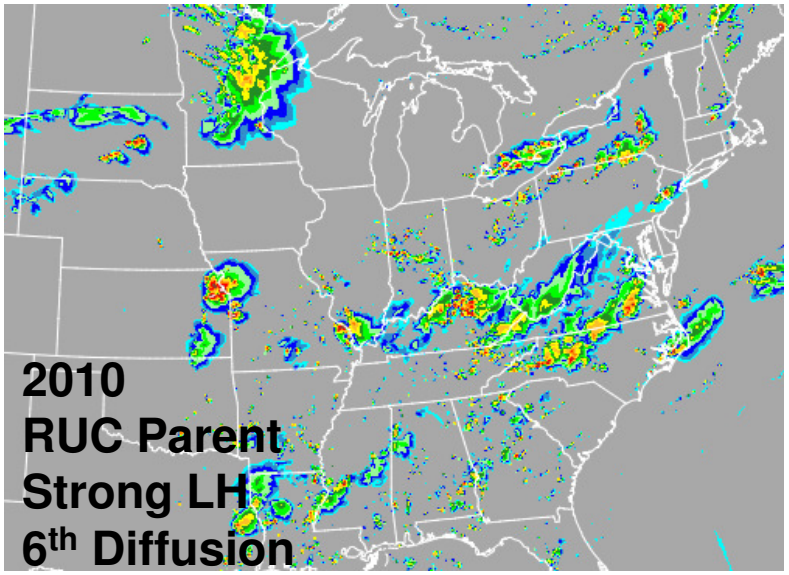
2hr CSI Scores	Dayton Area	CONUS
2010 CIWS	21.5	15.4
2011 CIWS	24.4	16.0

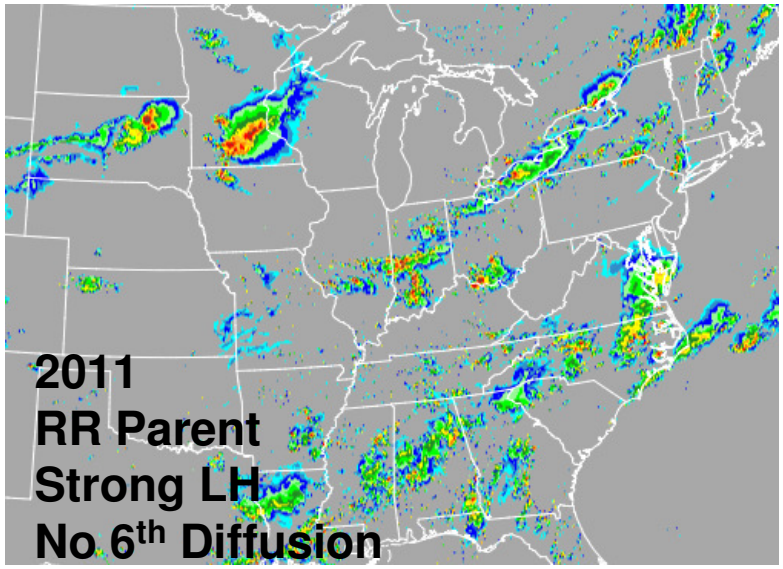
10 May 2011 2015 UTC

Outline

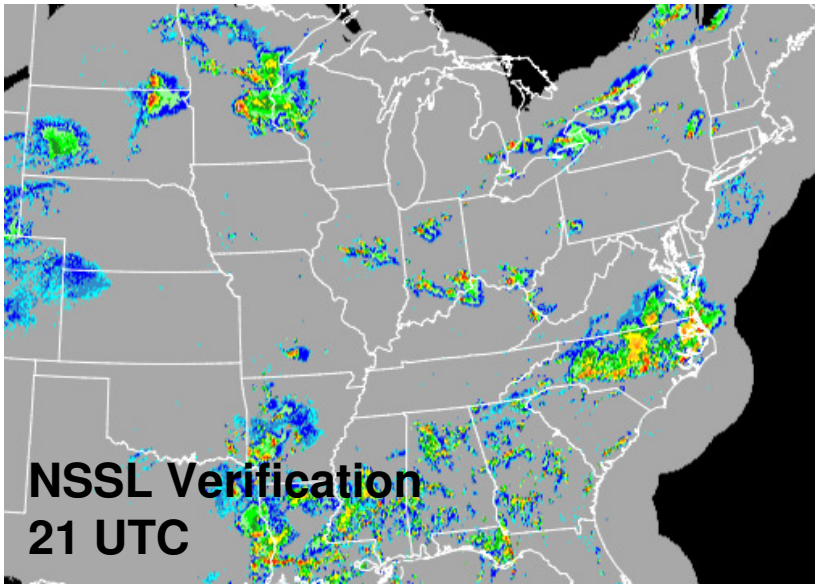
- CIWS extrapolation/ nowcast improvements:
  - Improved satellite convective initiation
  - Added Echo Top decay; improved ET growth
  - Improved storm extrapolation
- HRRR improvements:
  - Replaced RUC with Rapid Refresh (RR) as parent model for HRRR
  - Used reduced diffusion and raised pressure top in HRRR
  - Used finer resolution sea surface temperature field
- Blending improvements:
  - Added regionally-varying and continually-updating calibration ("running" climatology)
  - Improved convective initiation
  - Improved methodology for phase correction
- Application of CoSPA to probabilistic forecasts

HRRR Improvements
RR Parent and Diffusion



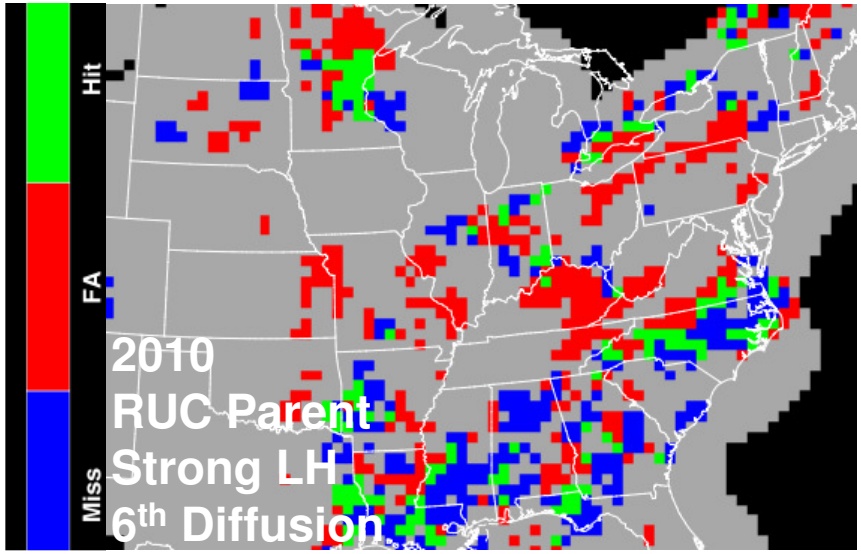


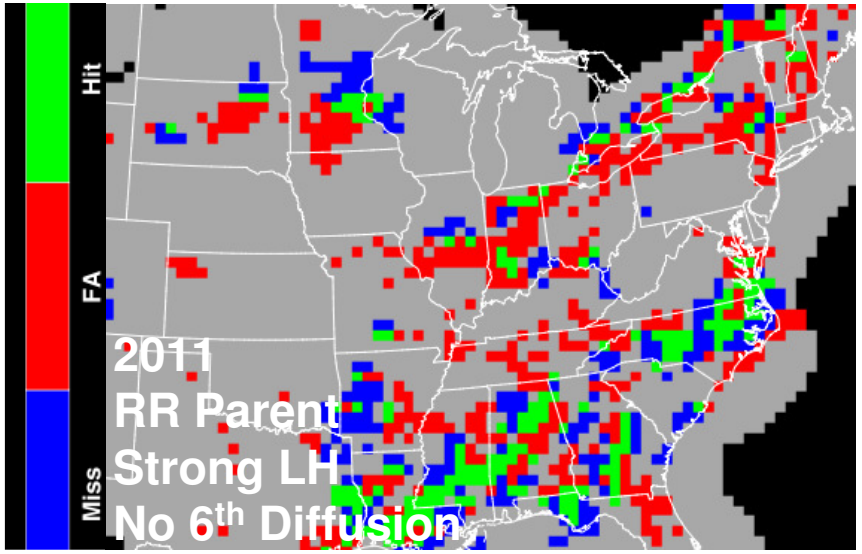
12Z + 9h
forecast
valid 21z
17 July
2010



Better SE coverage for RR parent with no 6th order diffusion

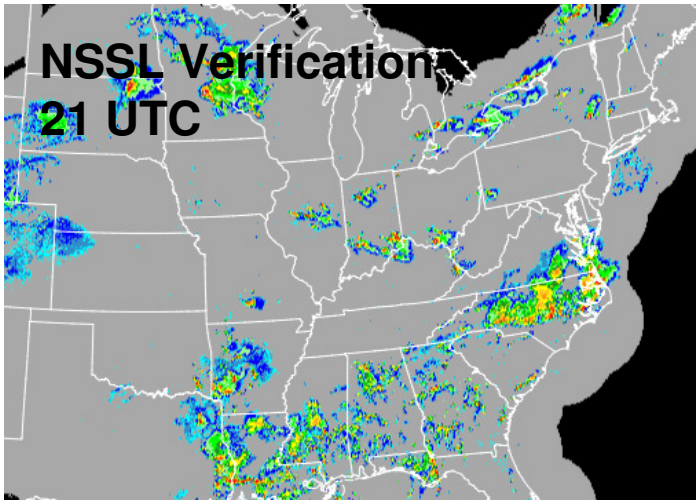
HRRR Improvements
RR Parent and Diffusion





25 dBZ
40-km East
CSI = .16
bias=1.21

25 dBZ
40-km East
CSI = .20
bias=1.50



12Z + 9h
forecast
valid 21z
17 July
2010

HRRR:
Paper 13.2
Alexander, NOAA GSD
10:45AM Thu

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  - Improved storm extrapolation
- HRRR improvements:
  - Replaced RUC with Rapid Refresh (RR) as parent model for HRRR
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- Blending improvements:
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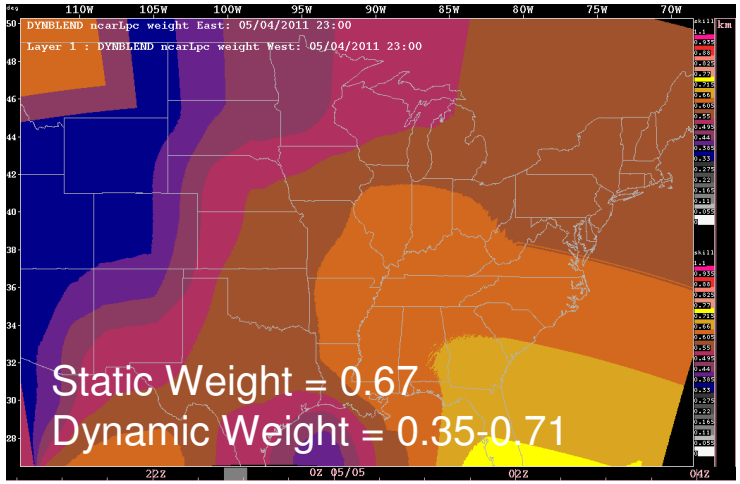
  - Improved convective initiation
  - Improved methodology for phase correction
- Application of CoSPA to probabilistic forecasts

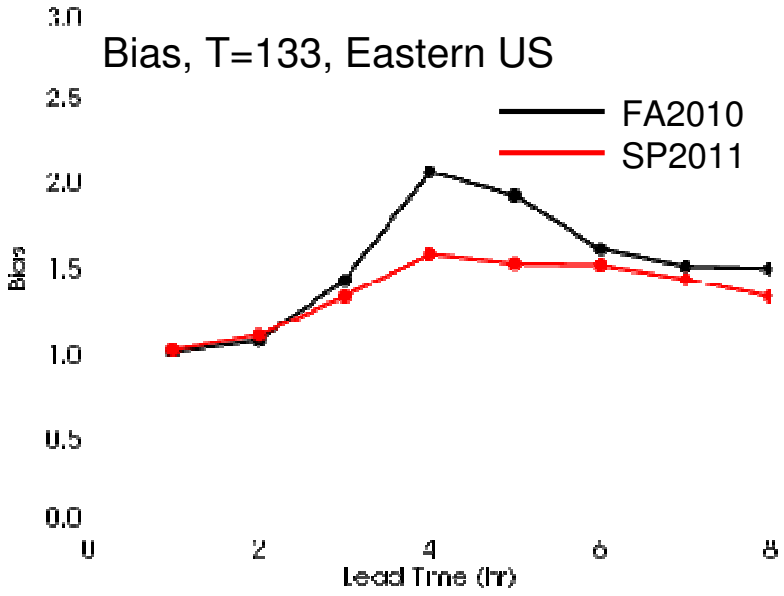
Blending Improvements
Regionally Varying Weights

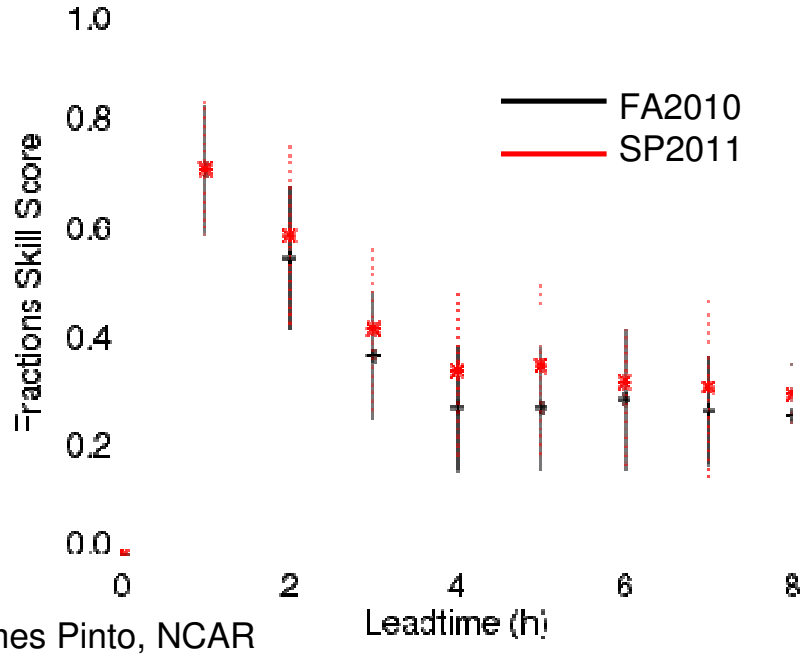
Shifted from static to dynamic weights

- **Accounts for regional variations in relative performance**
- **Adapts to changes in the skill of the inputs on the fly**
- **Improved skill of forecast**

Model_WT Gen1300_Fcst05h = v1800utc





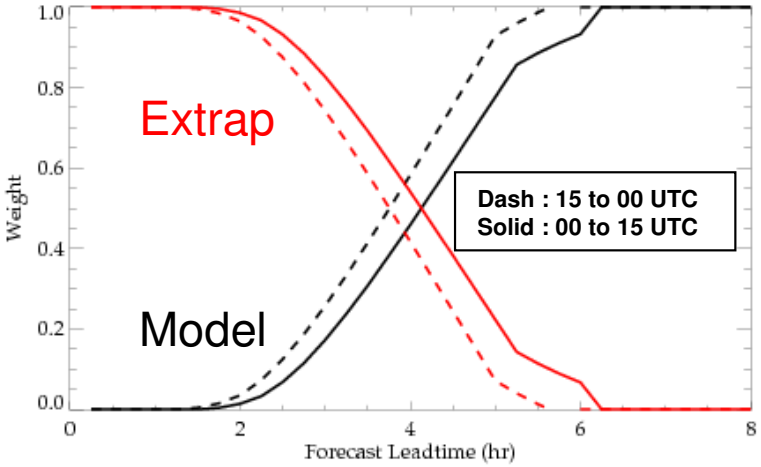


Blending Source: James Pinto, NCAR

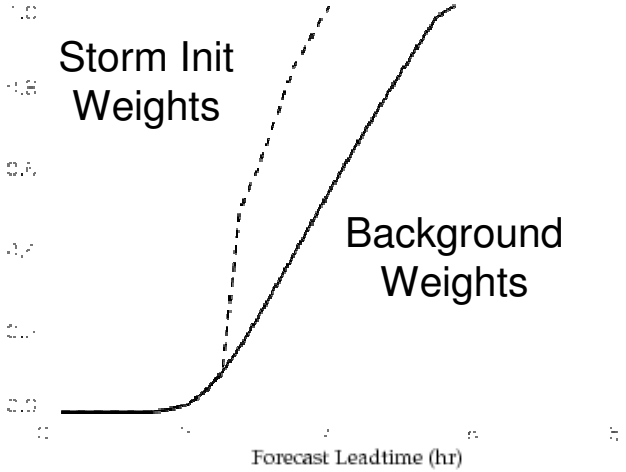
Blending Improvements
Scale Dependent Merging

- **Weights are a function of time of day, leadtime, and region (where storm initiation is indicated)**
  - **Identify model initiation areas**
  - **Implement storm initiation weighting functions**

Background Weights



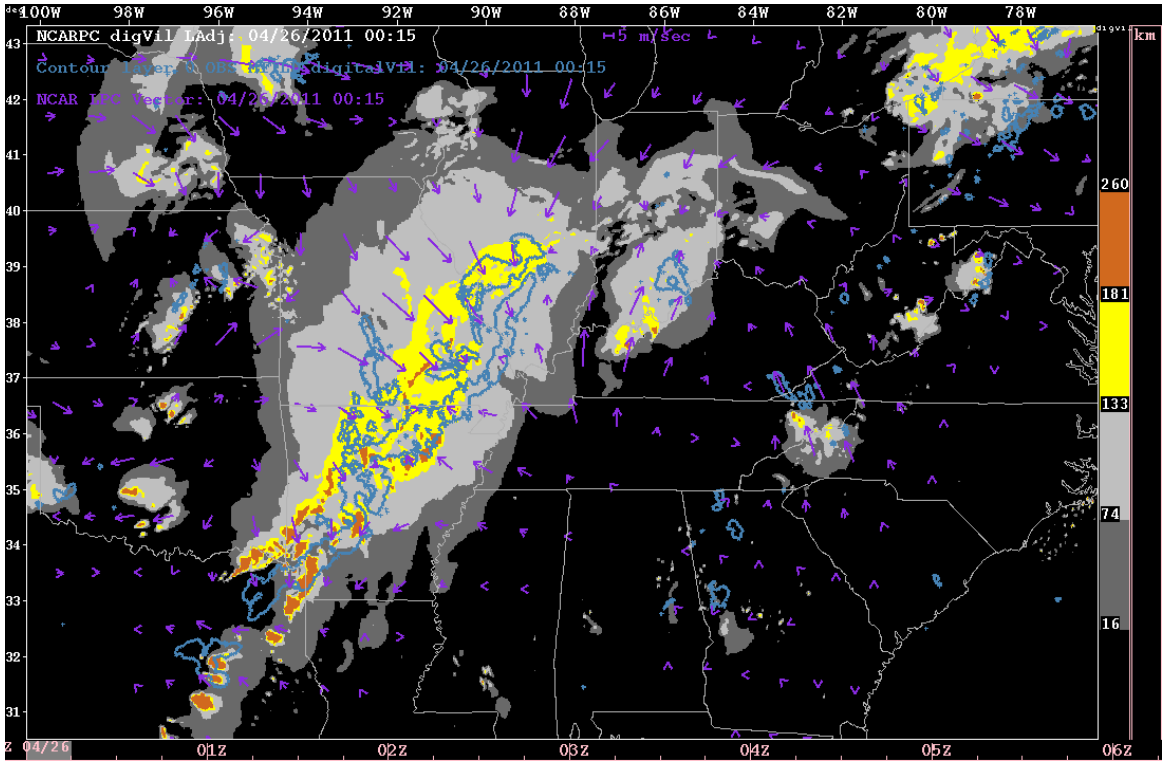
Model Weights: Storm Init

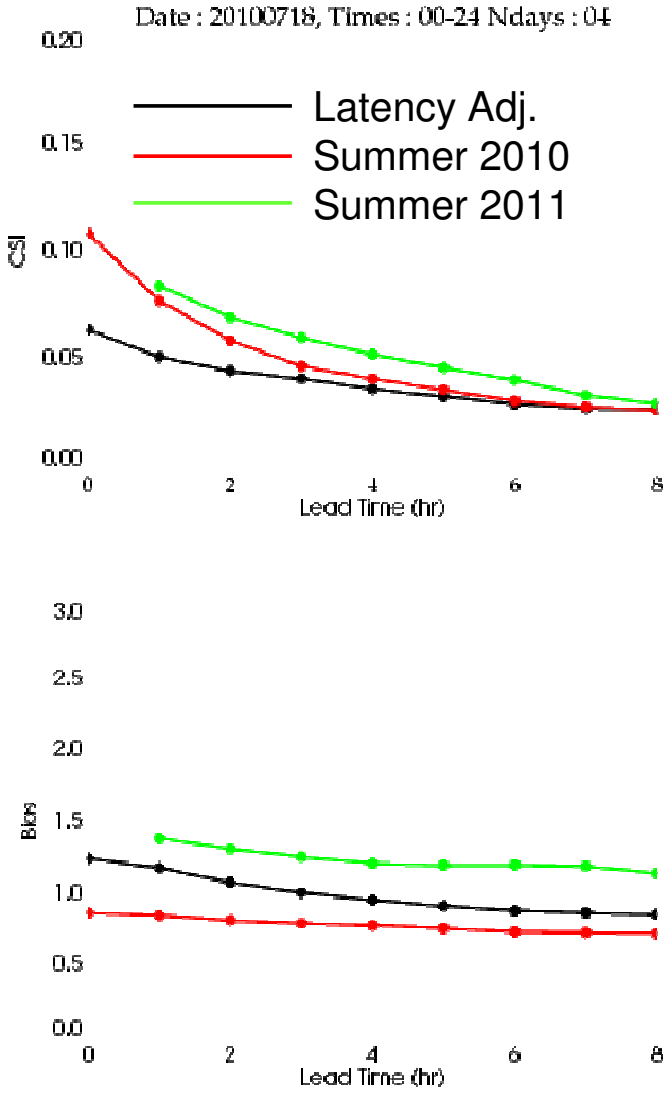


Blending Improvements
Phase Correction

Position errors determined using extrapolation forecasts instead of observations

- **Less distortion of storm shapes**
- **Improved skill**



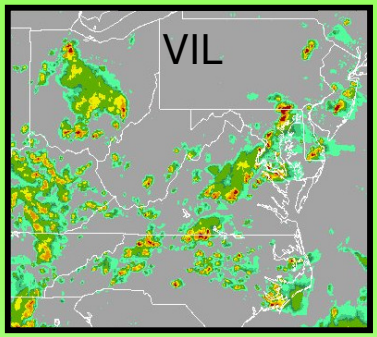


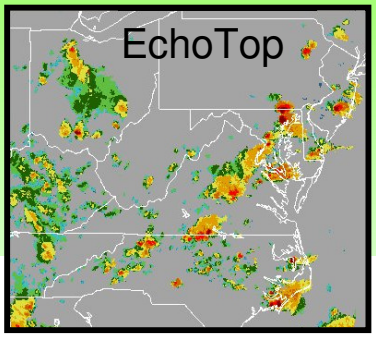
Outline

- CIWS extrapolation/ nowcast improvements:
  - Improved satellite convective initiation
  - Added Echo Top decay; improved ET growth
  - Improved storm extrapolation
- HRRR improvements:
  - Replaced RUC with Rapid Refresh (RR) as parent model for HRRR
  - Used reduced diffusion and raised pressure top in HRRR
  - Used finer resolution sea surface temperature field
- Blending improvements:
  - Added regionally-varying and continually-updating calibration ("running" climatology)
  - Improved convective initiation
  - Improved methodology for phase correction
- Application of CoSPA to probabilistic forecasts

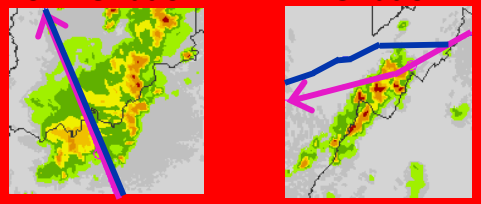
Probabilistic Forecast
Based on Weather Avoidance Field

CIWS WEATHER DATA



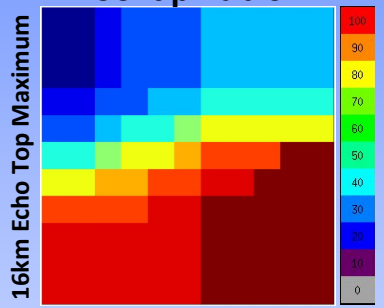


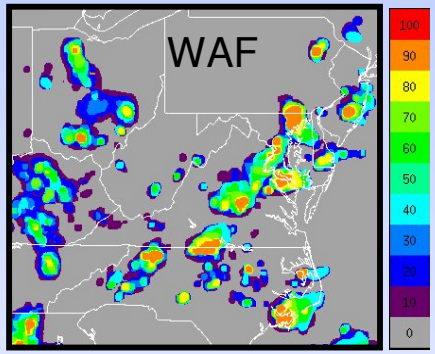
DEVIATION DATABASE



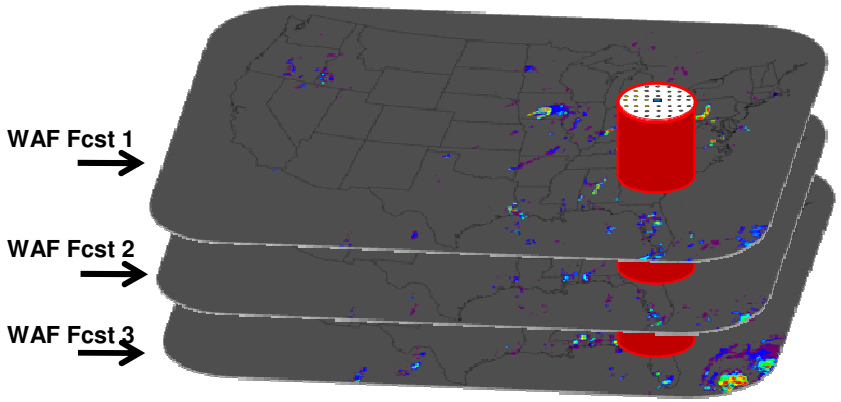
WEATHER AVOIDANCE FIELD

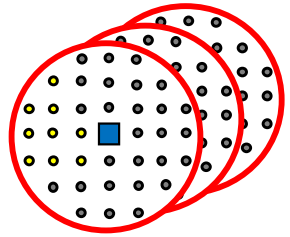
Deviation Probability
Lookup Table





CoSPA-based WAF Forecast Time-lagged Ensemble



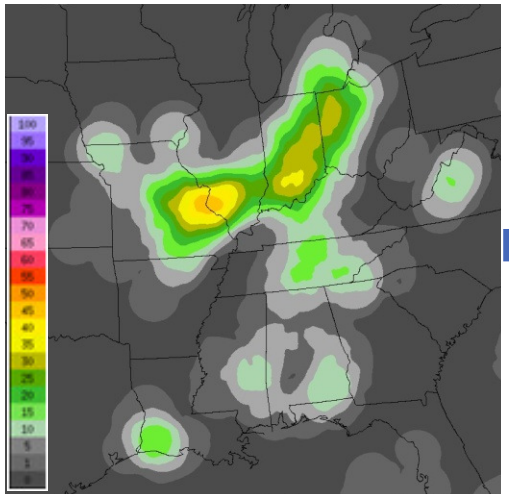


Data > Threshold
Data < Threshold
Center pixel location

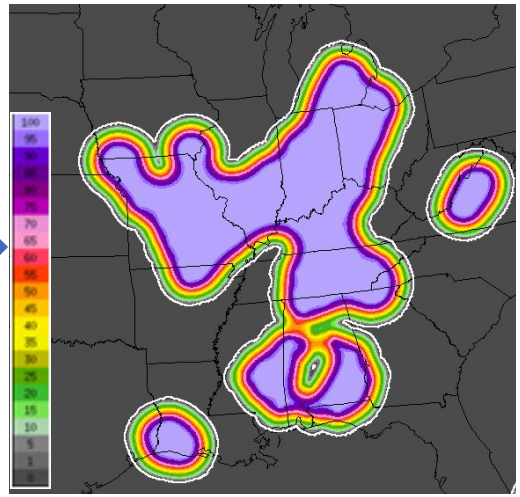
$$\text{Probability} = \frac{\text{\# Pixels above threshold}}{\text{Total \# pixels in cylinder}}$$

Probabilistic Forecast
Display Concepts

Probability of
WAF > 30%



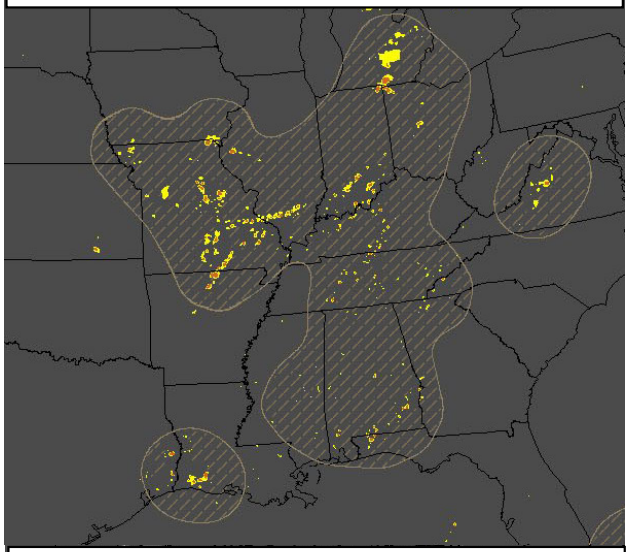
Spatial Smoothing



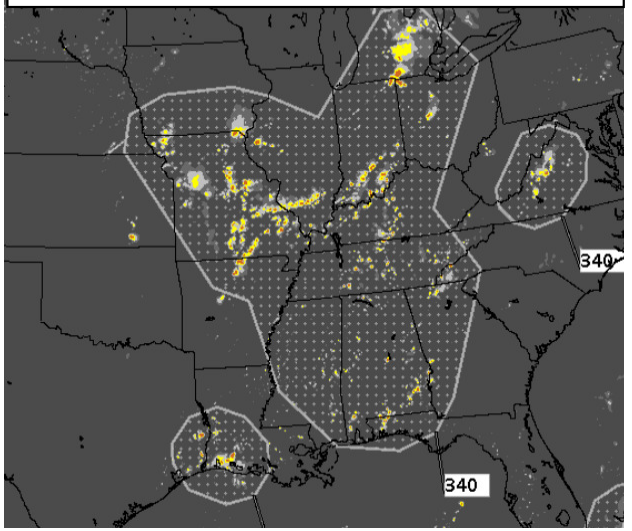
Sub-Sampled and Smoothed

Processed to Approximate Human Drawn

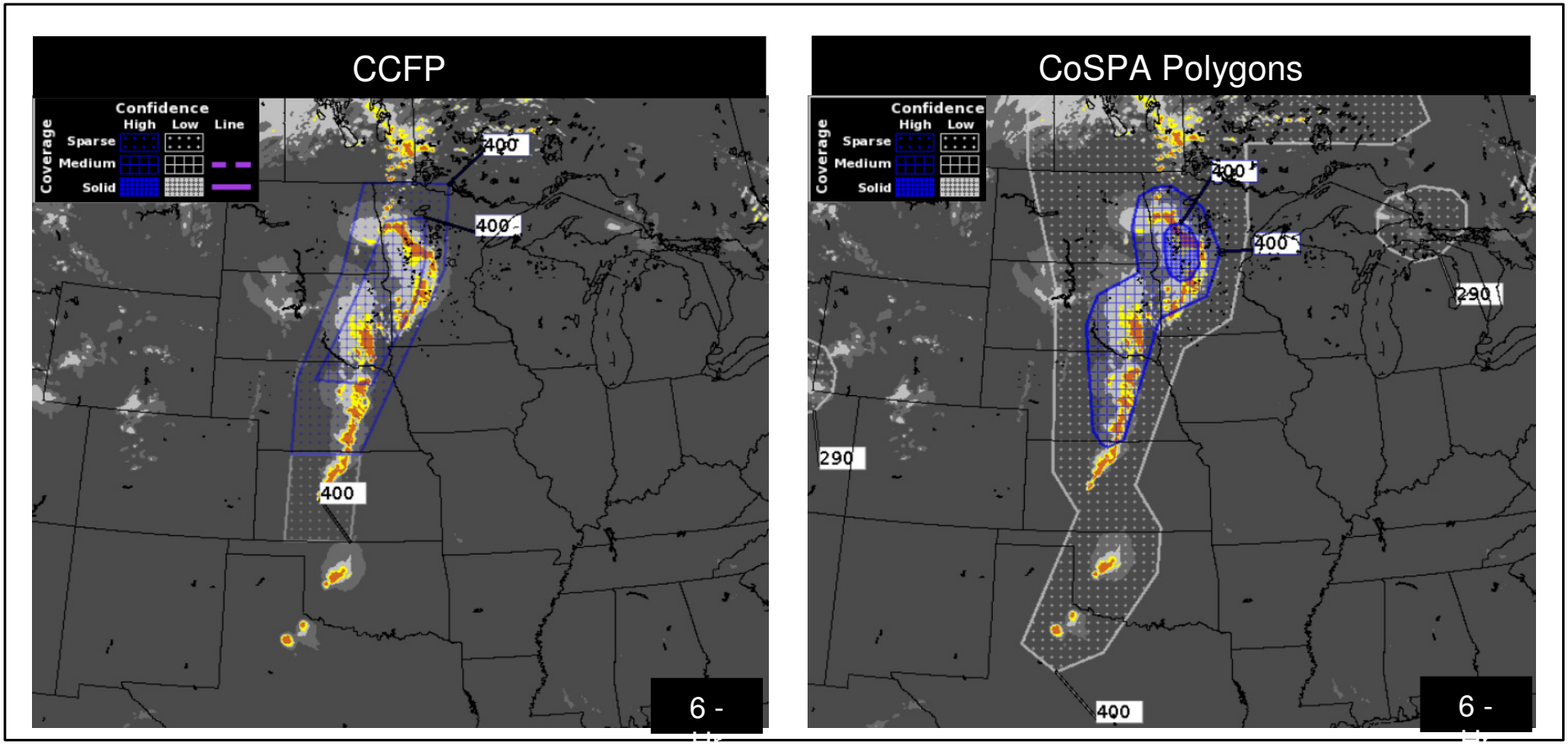
Probabilistic Contour Underlay



Convective Weather Polygons



Probabilistic Forecast
Convective Weather Polygons



- May provide first guess for CCFP
- CoSPA polygons being evaluated as part of 2011 Aviation Weather Center Testbed Summer Experiment

Summary

- CoSPA received upgrades to all three of its components:
  CIWS extrapolation, HRRR model, and blending module
- Upgrades included improved convective initiation, storm decay, storm motion, storm structures
- Evaluation of CoSPA is taking place this summer
- Probabilistic convective polygons based on CoSPA forecasts are being evaluated as part of the AWC 2011 Testbed Summer Experiment

Acknowledgements:

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