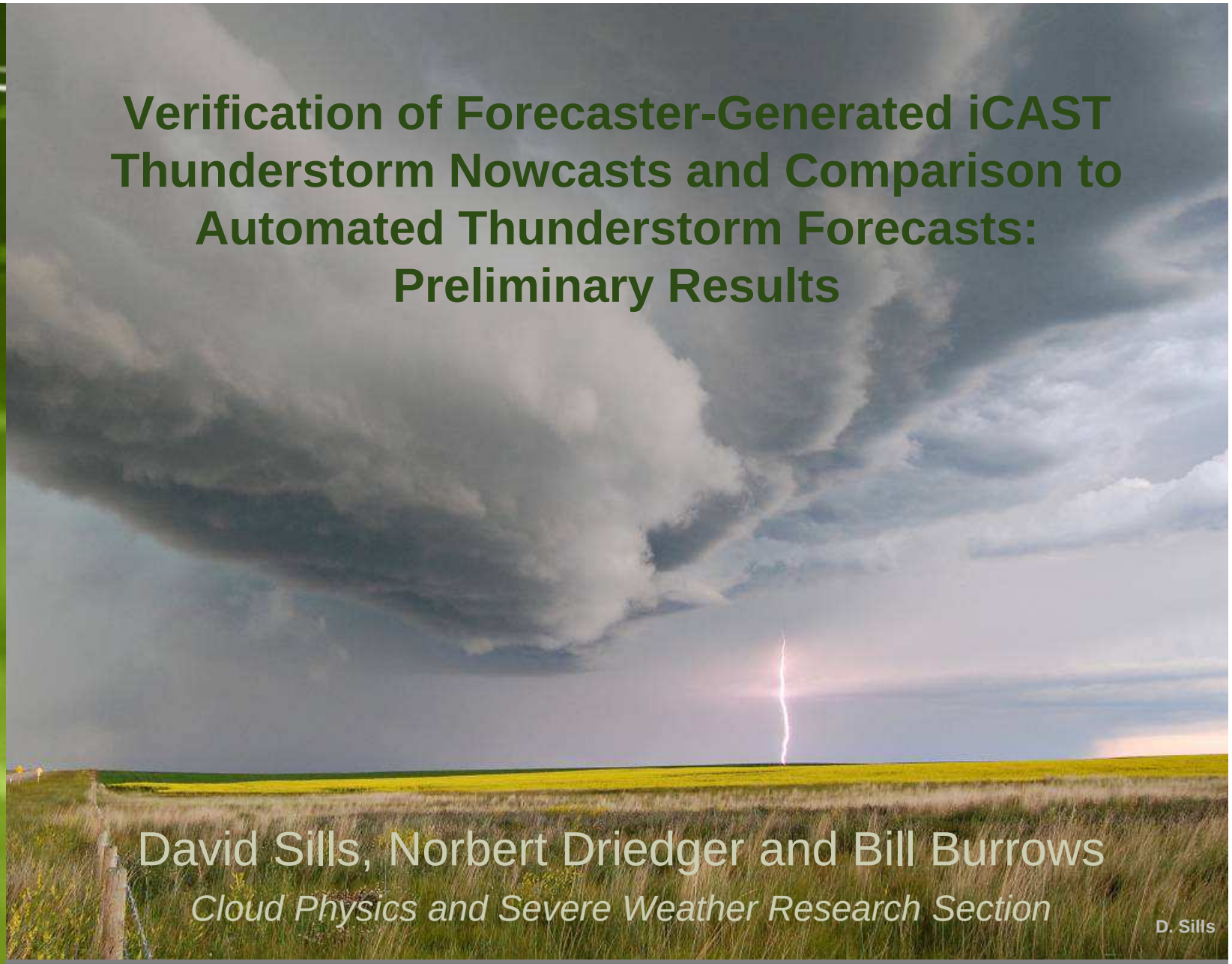
Verification of Forecaster-Generated iCAST Thunderstorm Nowcasts and Comparison to Automated Thunderstorm Forecasts: Preliminary Results



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D. Sills

Environment Canada Environnement Canada

Canada

Motivation

- The human forecaster will continue to have an important role in the forecast process at the Meteorological Service of Canada, particularly for high-impact weather in short term

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"*prototype to make effective use of latest NWP* ***and*** *exploit, maintain and build forecaster expertise*"

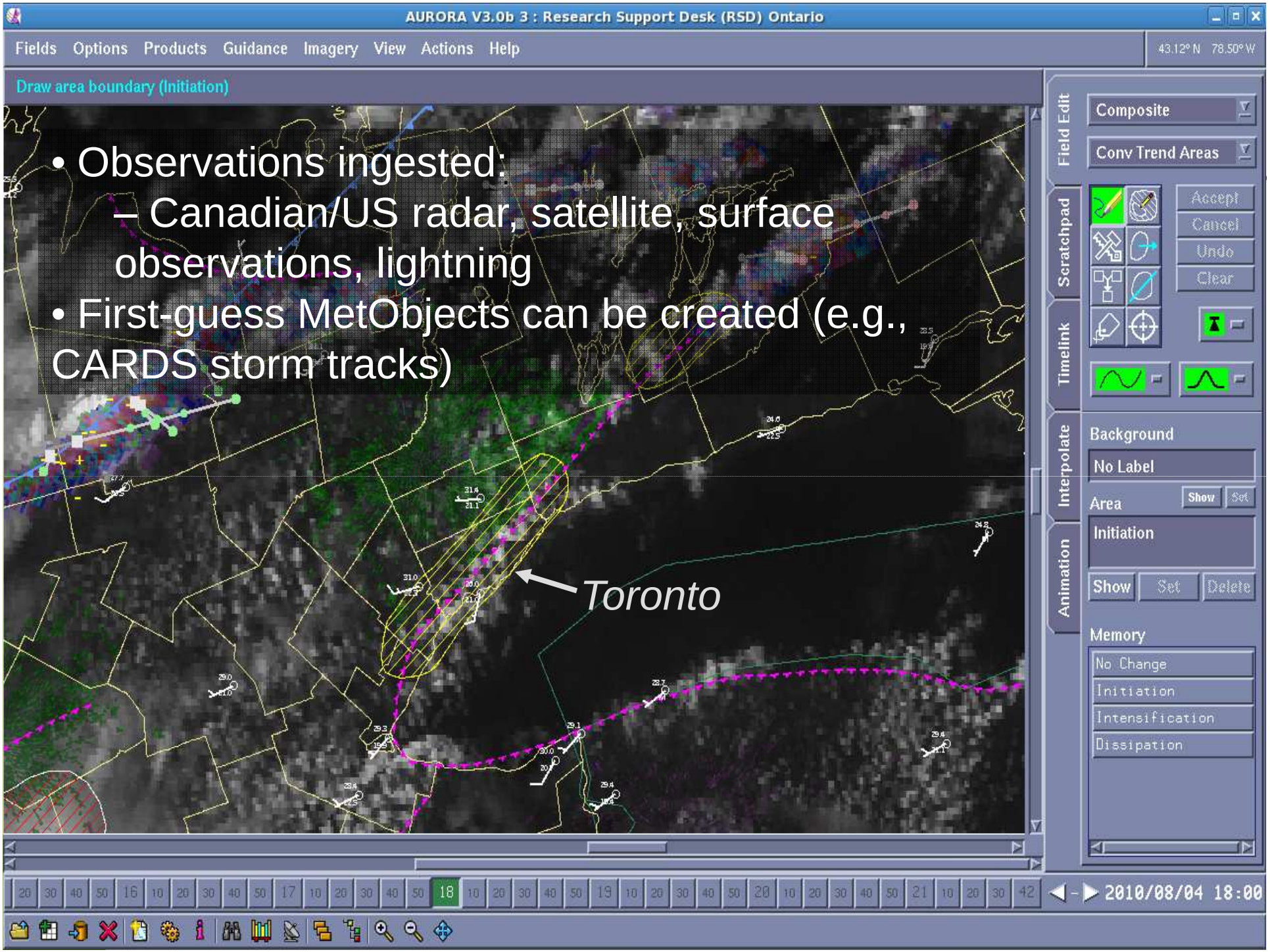
Motivation

- The human forecaster will continue to have an important role in the forecast process at the Meteorological Service of Canada, particularly for high-impact weather in short term
- So need techniques and technology to optimize the human-machine mix for forecasting, nowcasting and alerting
- Also need performance measurement capabilities to demonstrate that the human forecaster remains a valuable part of the forecast process, and to enable continuous improvement

iCAST prototype

interactive Convective Analysis and Storm Tracking

- Integrates alerting, nowcasting and forecasting functions with focus on summer convection
- Multi-scale, area-based approach – allows ADP from synoptic scale down to storm scale
- Also uses an object-oriented approach - ‘MetObjects’ serve as a graphical language interface between human forecaster and computer


AURORA V3.0b 3 : Research Support Desk (RSD) Ontario
Fields Options Products Guidance Imagery View Actions Help
43.12° N 78.50° W
Draw area boundary (Initiation)
• Observations ingested:
– Canadian/US radar, satellite, surface observations, lightning
• First-guess MetObjects can be created (e.g., CARDS storm tracks)
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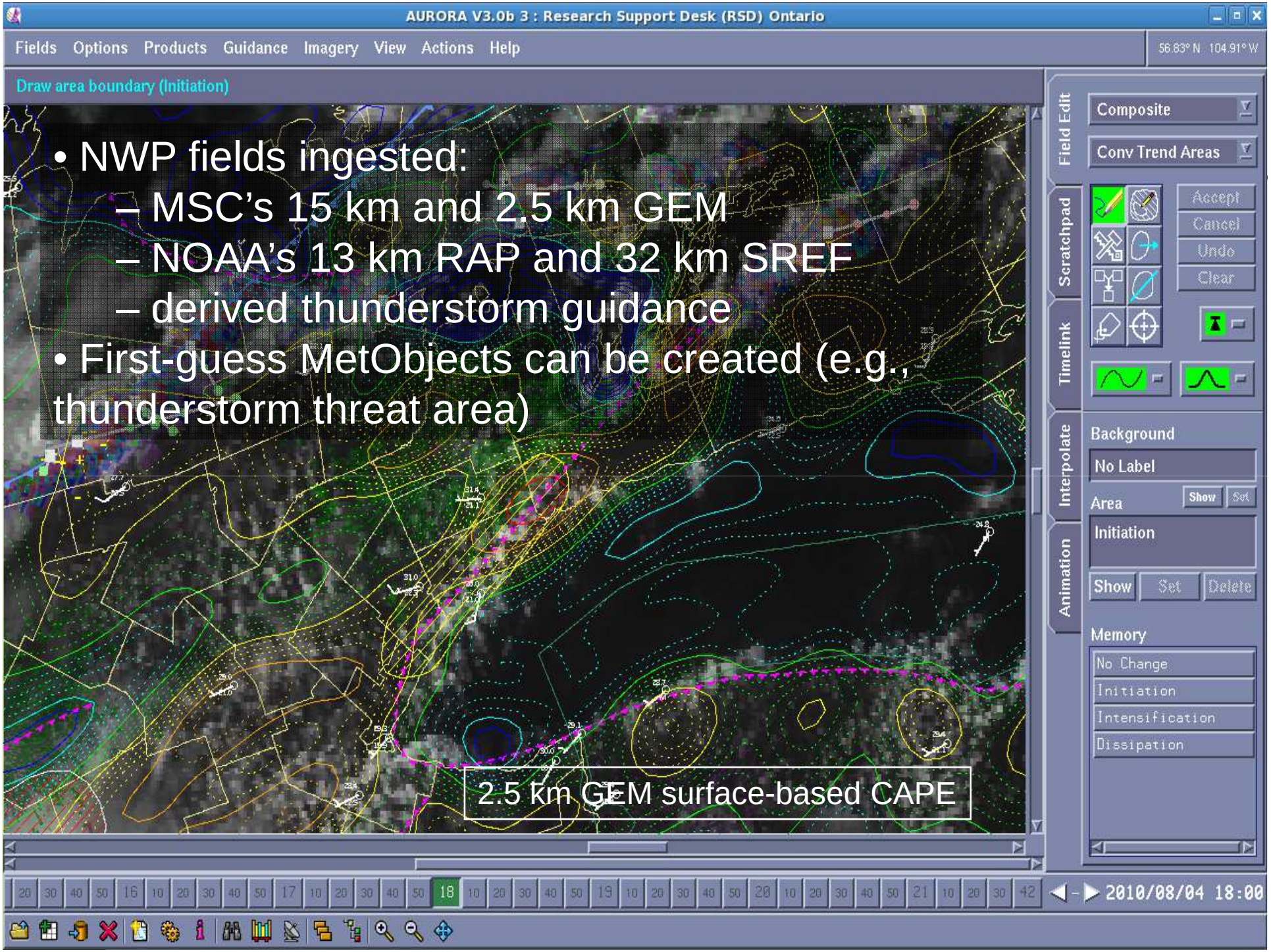
AURORA V3.0b 3 : Research Support Desk (RSD) Ontario
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56.83° N 104.91° W
Draw area boundary (Initiation)
• NWP fields ingested:
– MSC's 15 km and 2.5 km GEM
– NOAA's 13 km RAP and 32 km SREF
– derived thunderstorm guidance
• First-guess MetObjects can be created (e.g., thunderstorm threat area)
2.5 km GEM surface-based CAPE
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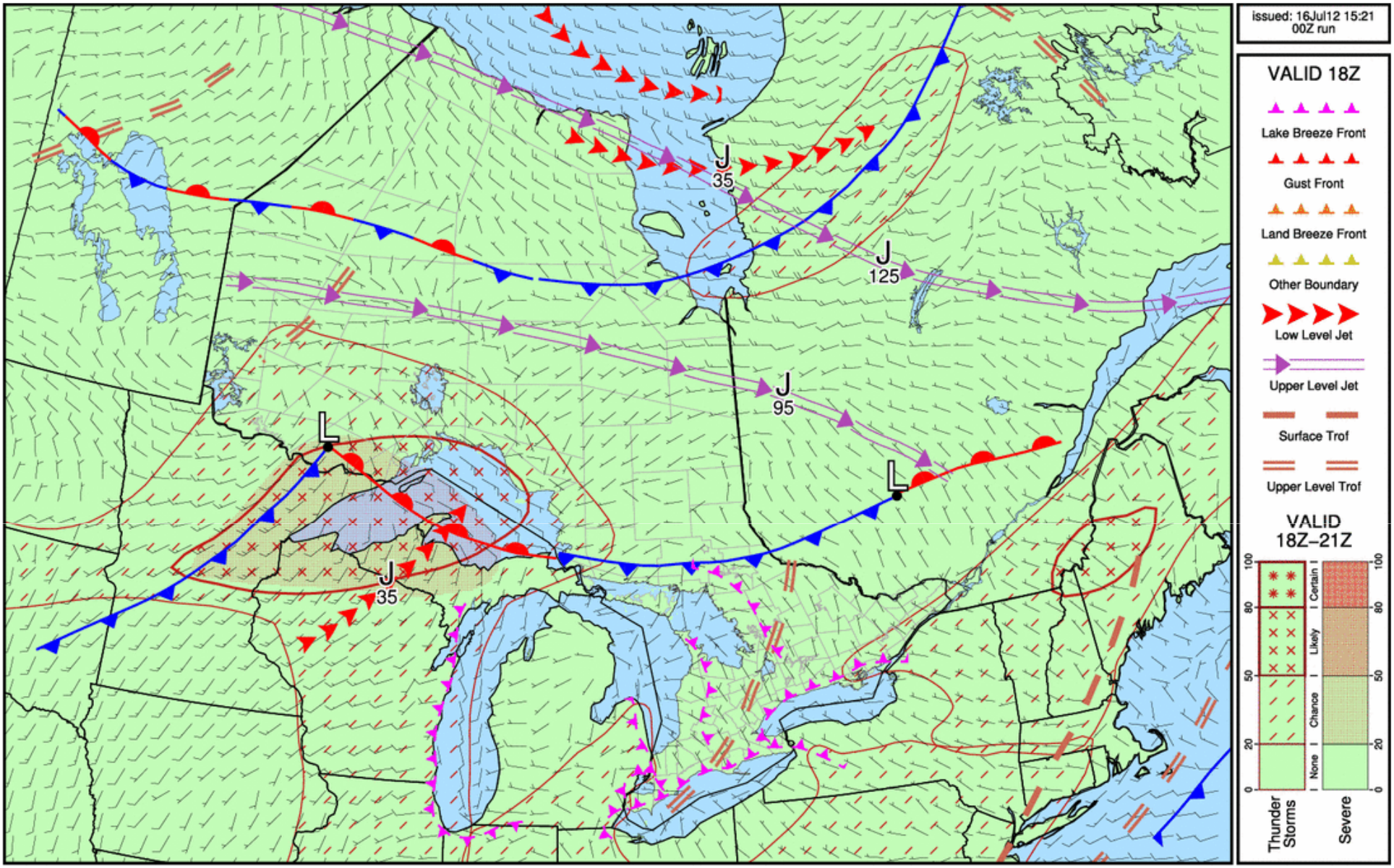
iCAST prototype

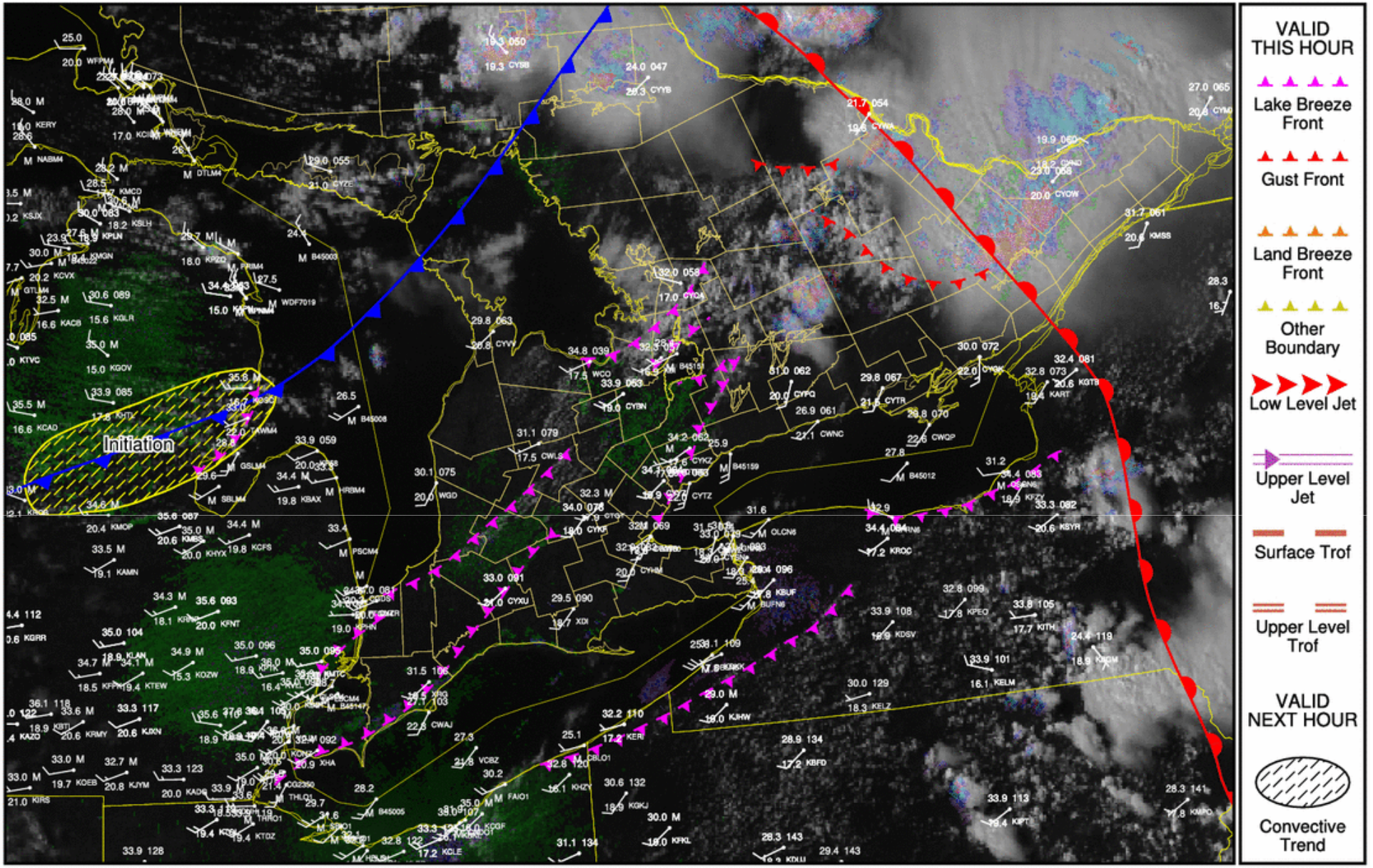
- iCAST employs a three-tiered approach:
  1. regional-scale convective nowcasts/forecasts



• Features and thunderstorm / severe weather areas based on NWP-based guidance, modified 12Z soundings, conceptual models, and history

iCAST prototype

- iCAST employs a three-tiered approach:
  1. regional-scale convective nowcasts/forecasts
  2. hourly analyses of mesoscale features important for thunderstorms / summer severe weather plus nowcast of convective initiation area

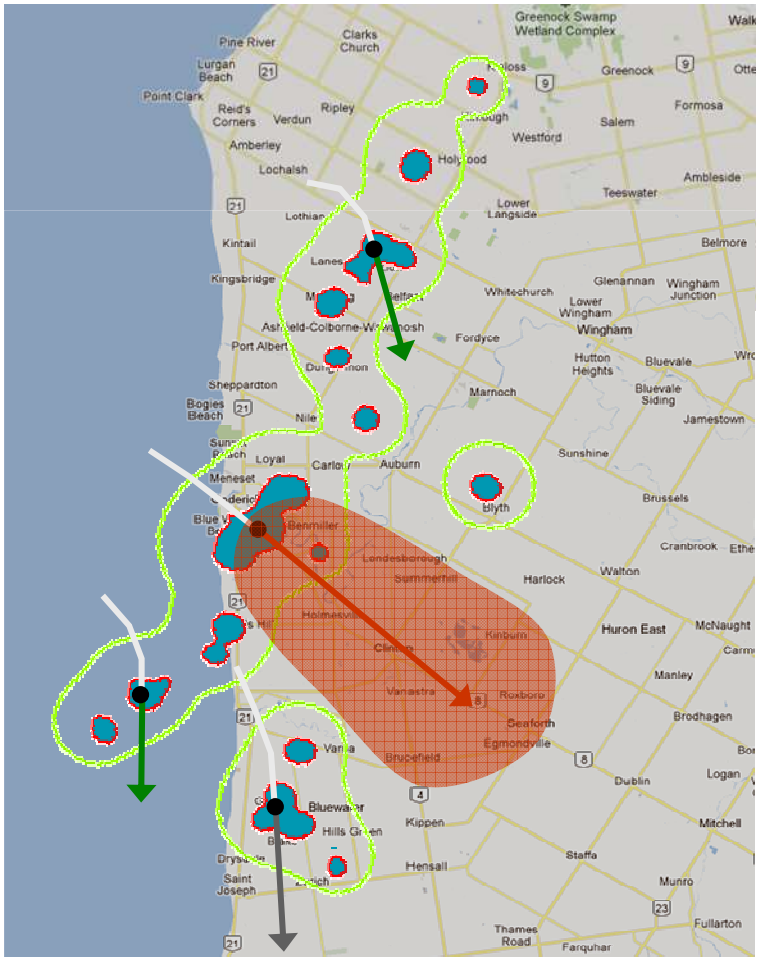


• Features and initiation areas based on surface data, visible satellite, radar, rapid-update NWP fields, conceptual models, and history

iCAST prototype

- iCAST employs a three-tiered approach:
  1. regional-scale convective nowcasts/forecasts
  2. hourly analyses of mesoscale features important for thunderstorms / summer severe weather plus nowcast of convective initiation areas
  3. storm-scale nowcasts focused on the evolution of individual storm cells using forecaster-modified storm tracks and intensity trends

iCAST Warning Generation



SEVERE THUNDERSTORM WARNING FROM ENVIRONMENT CANADA AT 7:10 PM EDT THURSDAY 28 JULY 2012.

SEVERE THUNDERSTORM WARNING FOR: GODERICH – BLUEWATER – SOUTHERN HURON COUNTY

A SEVERE THUNDERSTORM 10 KM SOUTH OF GODERICH IS MOVING SOUTHEAST AT 40 KM/H AND MAY PRODUCE LARGE HAIL, DAMAGING WINDS AND HEAVY RAIN. THIS STORM IS EXPECTED TO REACH SEAFORTH AT 8:05 PM EDT.

- In both official languages

iCAST prototype

- iCAST employs a three-tiered approach:
  1. regional-scale convective nowcasts/forecasts
  2. hourly analyses of mesoscale features important for thunderstorms / summer severe weather plus nowcast of convective initiation areas
  3. storm-scale nowcasts focused on the evolution of individual storm cells using forecaster-modified storm tracks and intensity trends
- *Paradigm shift for MSC* – forecasters work on meteorology in database, products are derived from database via automated processes

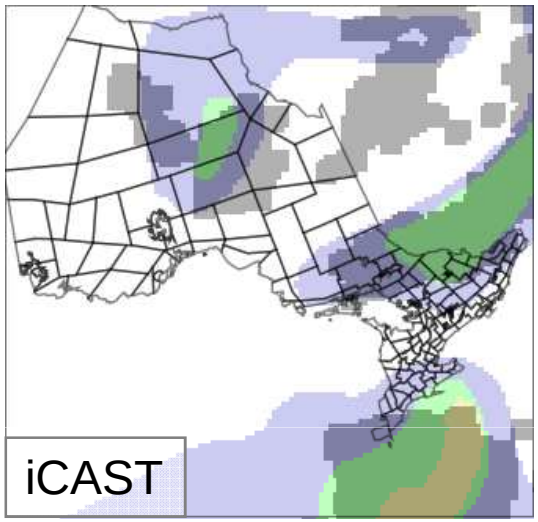
2011 Verification Study

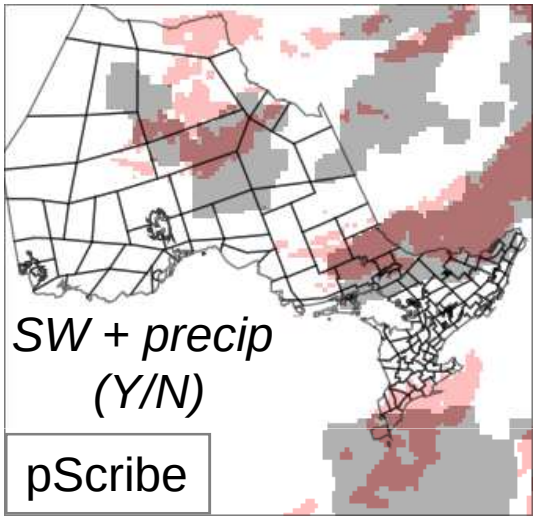
- Measure value that human forecaster contributes to a regional-scale prognoses
- Used NALDN flash data to compare 3-hr iCAST thunderstorm nowcasts with automated forecasts derived from MSC 15-km GEM output
- Three forecasters produced prognoses for the 18-21 UTC (2-5 pm local) period quasi-daily during summer 2011
- 68 days total sample size, gridded on GEM grid (14396 grid points) covering province of Ontario
- More details in extended abstract

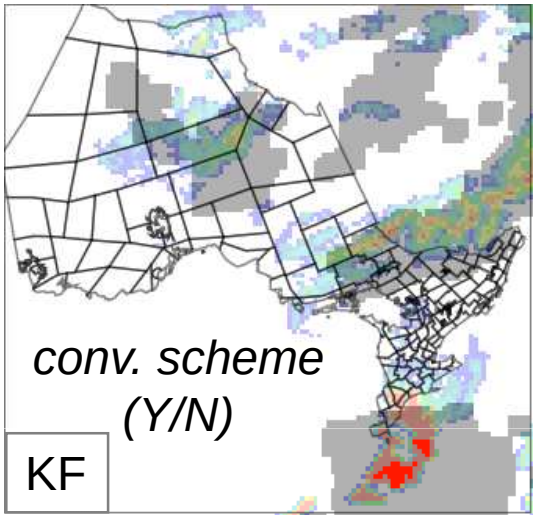
Verification Methodology

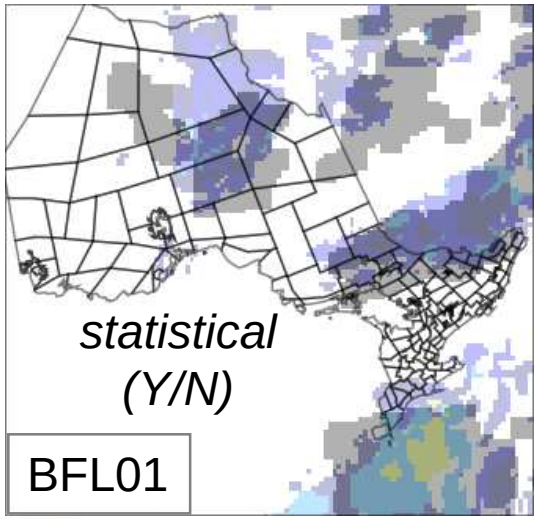
- **Relaxed verification approach in space and time**
  - Thunderstorm occurrence defined by at least one lightning flash within 15 km GEM grid cell
  - Influence of each lightning flash spread over 5 x 5 GEM grid cells (75 km x 75 km box)
  - Boxes can overlap
  - Included one hour of lightning before and another after 18-21 UTC forecast period, so 5-hr period covering 17-22 UTC

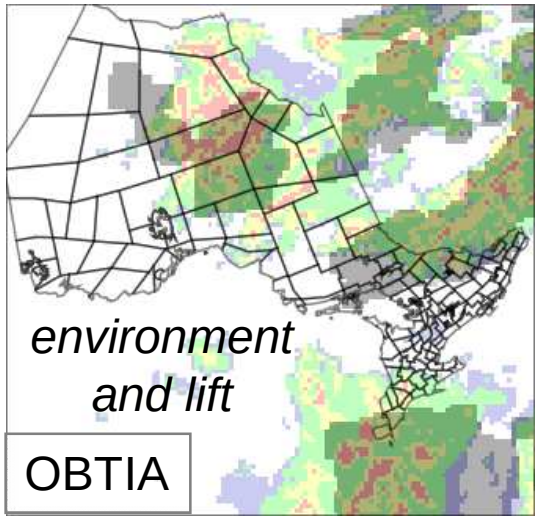
Forecast Methods (11 Jul 2011)

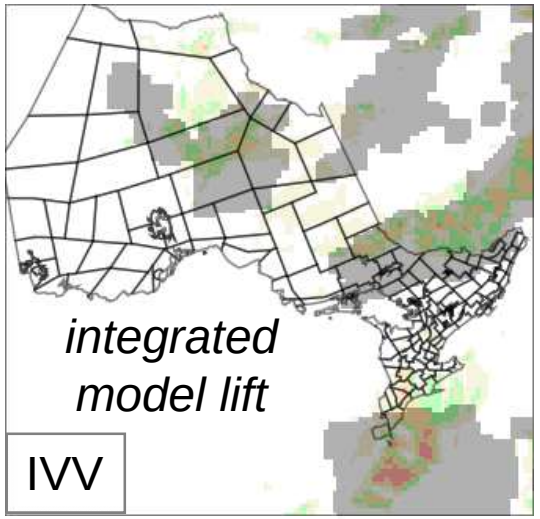












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Categorical Forecast Verification

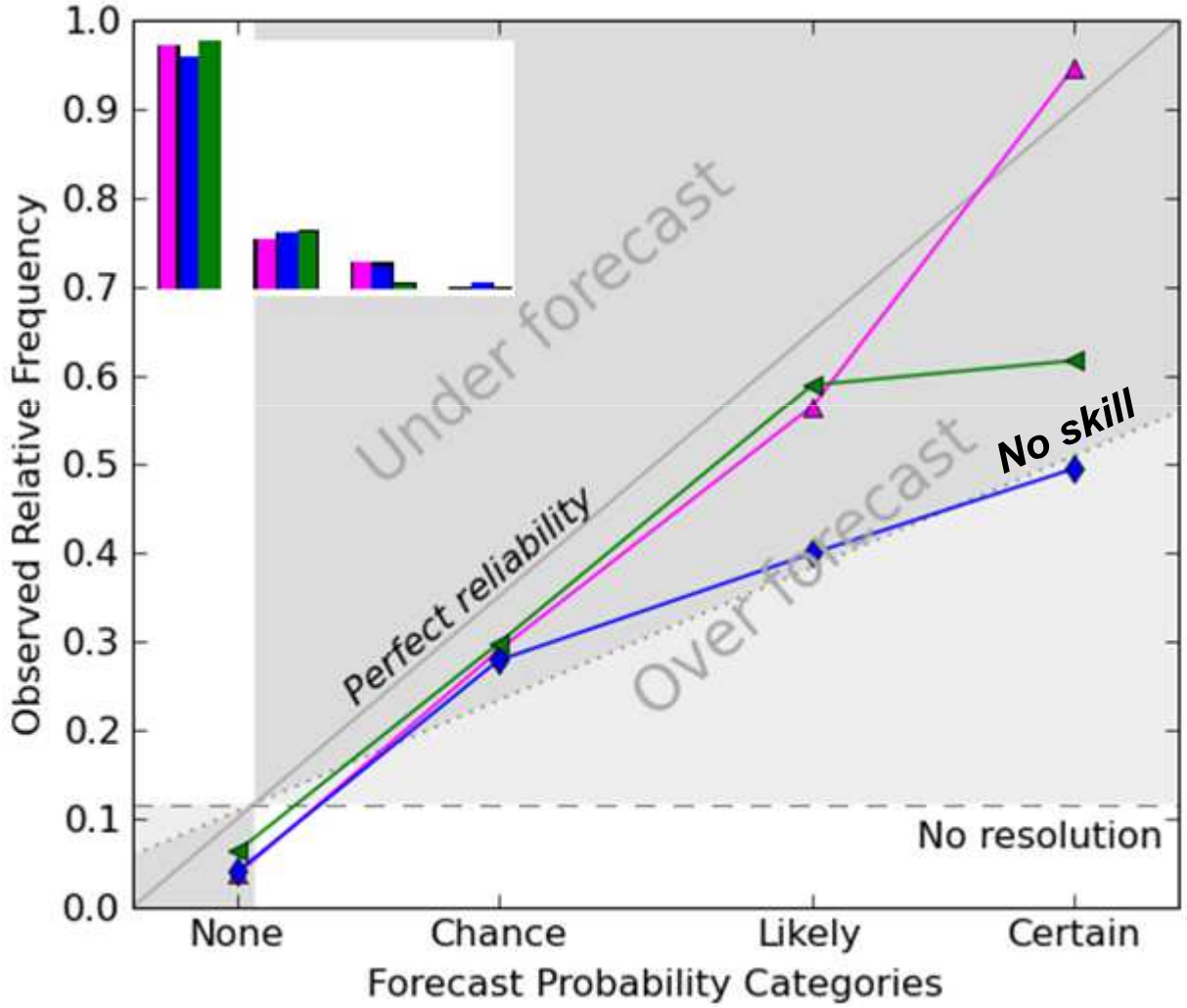
• Looking just at the equivalent of ‘thunderstorms likely’ from each nowcast over season, derived POD, FAR, CSI and HSS using contingency tables

00 UTC	POD	FAR	CSI	HSS
iCAST	0.364	0.421	0.288	0.392
pScribe	0.278	0.458	0.225	0.313
KF	0.319	0.497	0.243	0.330
BFL01	0.417	0.551	0.276	0.362
OBTIA	0.284	0.565	0.208	0.277
IVV	0.104	0.424	0.097	0.146

Probabilistic Forecasts

- Next, made use of full probability forecasts from subset of forecast methods (iCAST, OBTIA, IVV)
- A good probability forecast system has:
  - resolution, reliability, sharpness
  - discrimination
  - skill
- To measure these attributes, we used:
  - Attributes Diagram
  - Relative Operator Characteristic (ROC) score
  - Brier Skill Score
- More details in the extended abstract

Probabilistic Forecast Verification



iCAST

OBTIA

IVV

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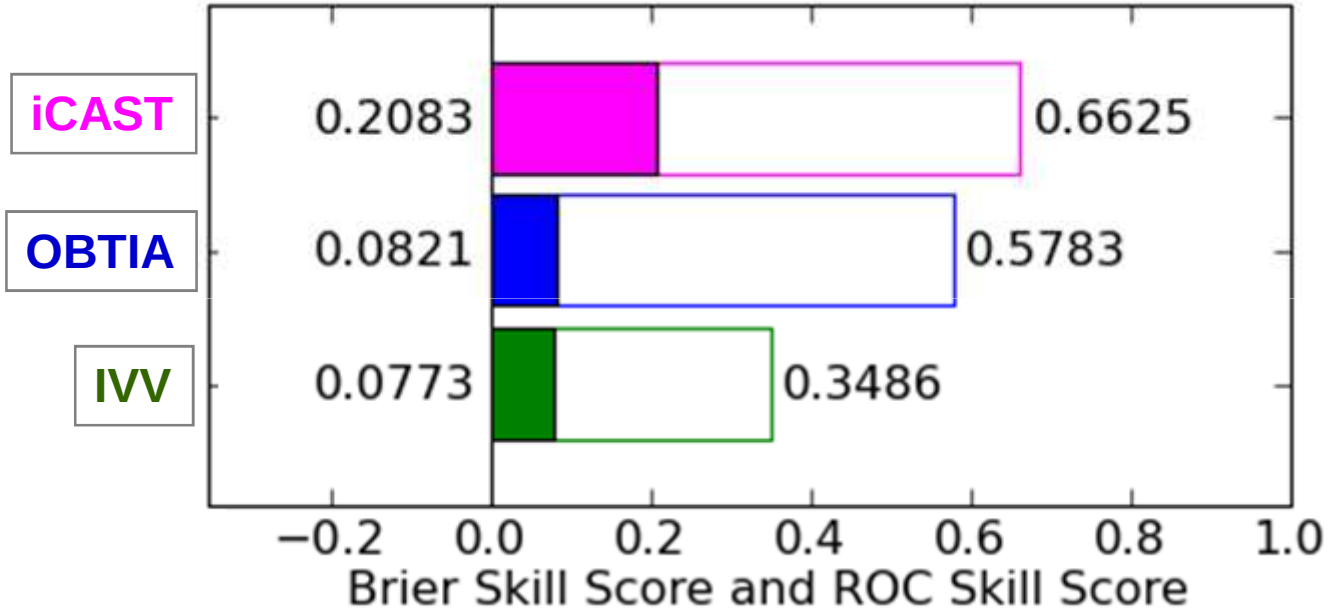
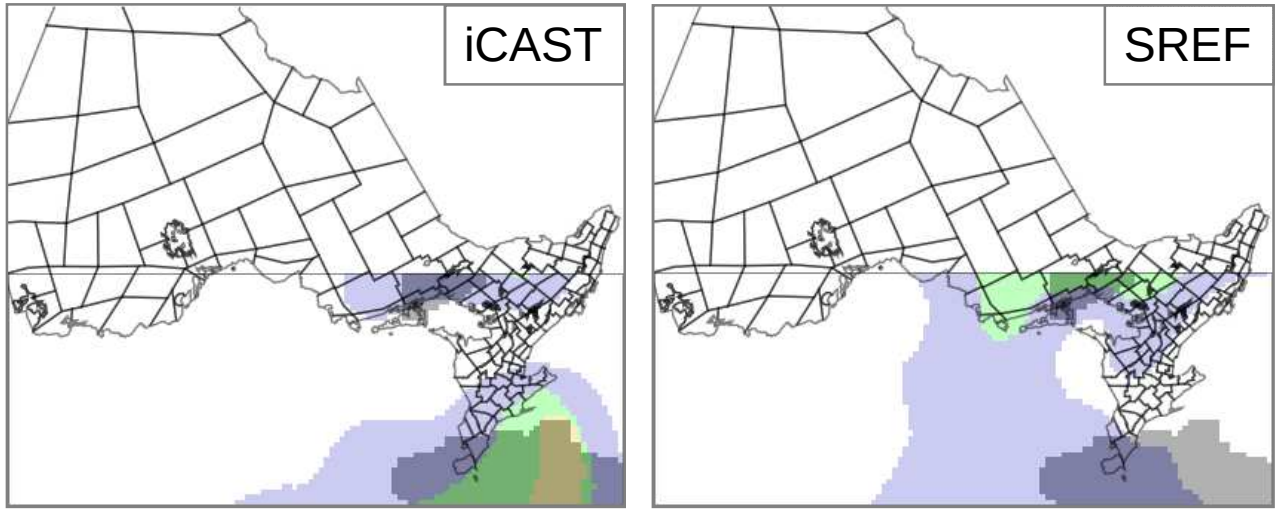
Probabilistic Forecast Verification

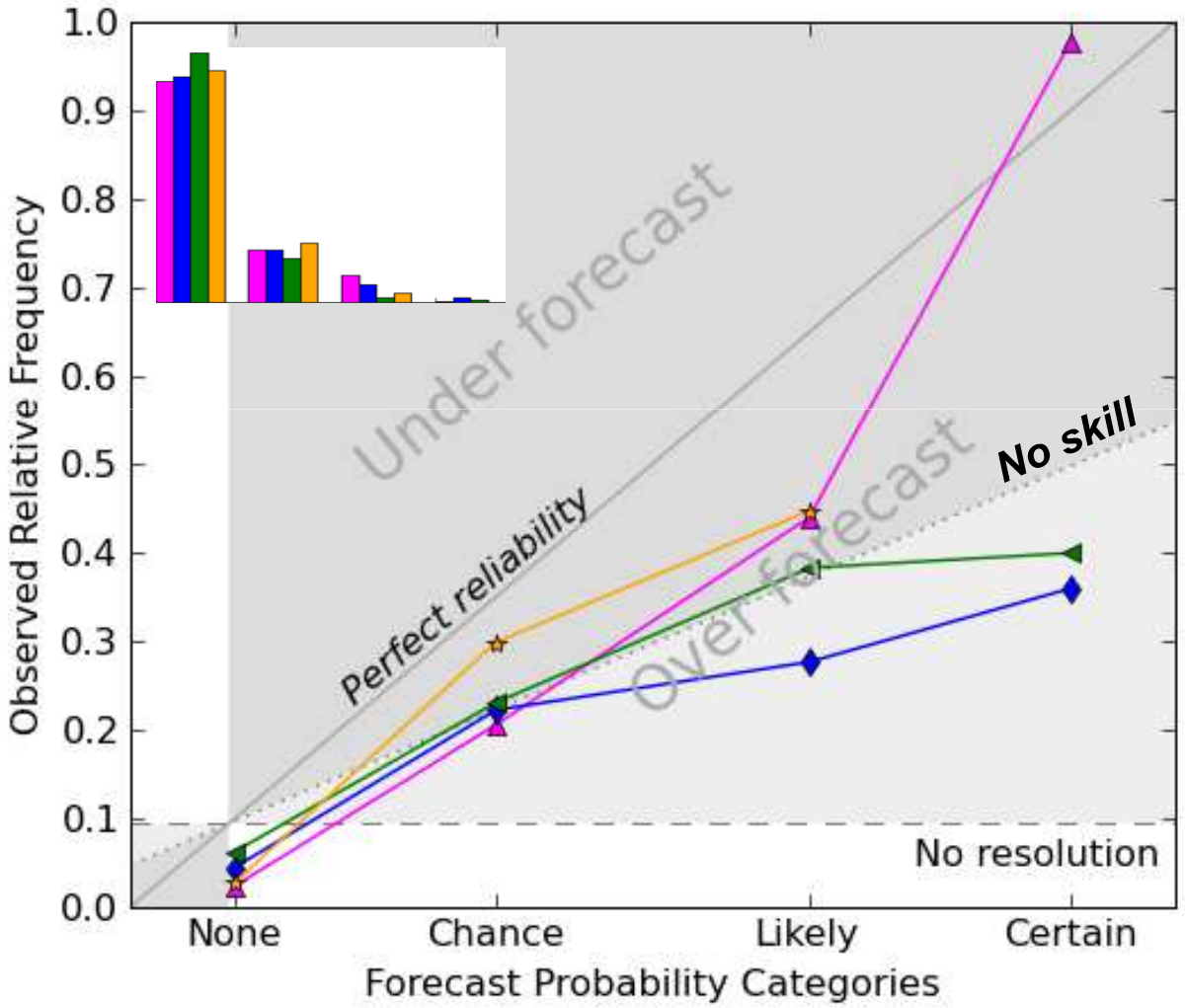


SREF Ensemble Forecasts

- Also compared probabilistic forecasts to 3-hr calibrated probabilistic thunderstorm forecasts based on SREF output (via US SPC)
- Domain covers only parts of Ontario near US, 03 UTC SREF output used, sample size 37 days



Probabilistic Forecast Verification



iCAST

OBTIA

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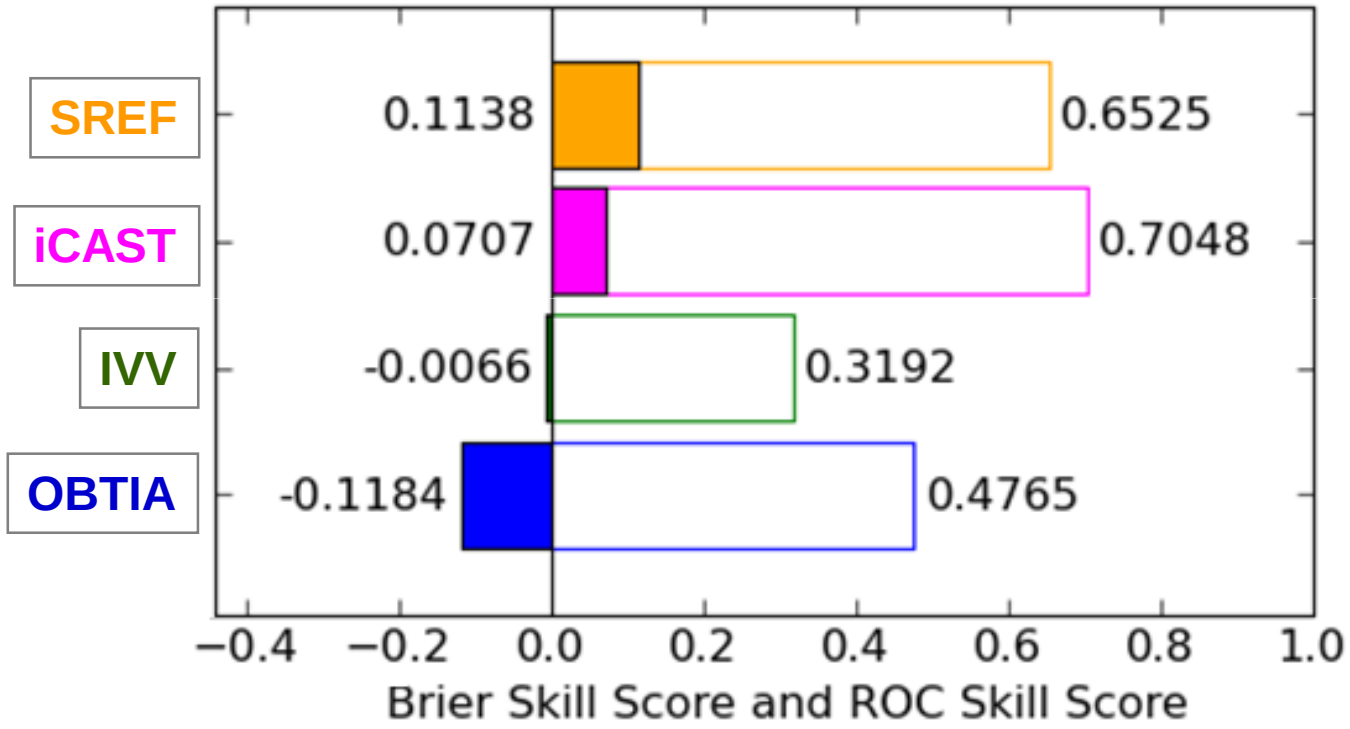
SREF

Probabilistic Forecast Verification



Significance of Results

- Human thunderstorm nowcasts showed skill and added value over automated forecasts - *not previously measured at MSC*
- Multi-scale / MetObject approach *likely* contributed, but 'MetObject' approach *certainly* made such objective measurement much less difficult (i.e. possible)
- Calibrated ensemble approach for automated thunderstorm forecasts appears to be superior guidance – MSC developing a system similar to SREF

Future Work

- Add confidence intervals to preliminary results using ‘bootstrap’ method
- Investigate object-oriented verification
- iCAST demonstration planned for 2015 Pan Am Games in Toronto

Summary

- An area-based, object-oriented iCAST prototype used for real-time thunderstorm nowcasts during summer 2011
- Verification results show that thunderstorm nowcasts by human forecasters added value to automated GEM-derived forecasts
- Results also show that a calibrated ensemble approach provided more competitive automated forecasts

Acknowledgments

- Arnold Ashton, Robert Kuhn
- Emma Hung, Brian Greaves
- Neil Taylor
- Laurie Wilson, Martin Charron

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