Summer QPF skill comparisons of the GEM-LAM 2.5 km and the GEM-REG 15 km

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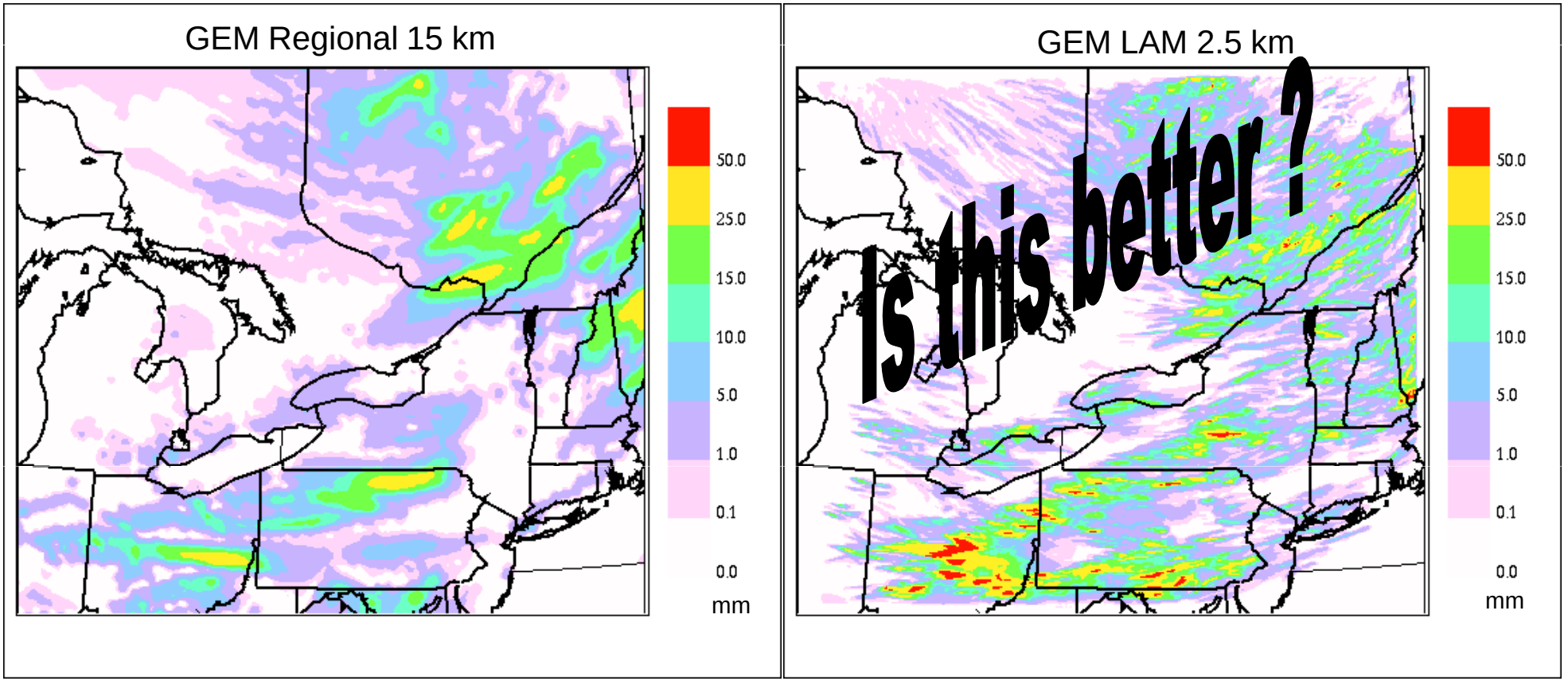
Outline

- Motivations
- Verification methodologies and results
  - Upscaling
  - Neighborhood-based
- Conclusion

Motivations

Higher resolution models gives more details but …



Accumulation of precipitation between 18 and 00 UTC the 4th of July, 2006

Motivations

- Main verification issues
  - Most of common verification metrics are not appropriate for high-resolution fields
  - Excessively sensitive to small displacement and timing errors, especially for QPF
  - Often doesn’t reflect the weather forecaster’s assessment concerning the model usefulness
  - Point observations may still not be representative of the model grid cell values

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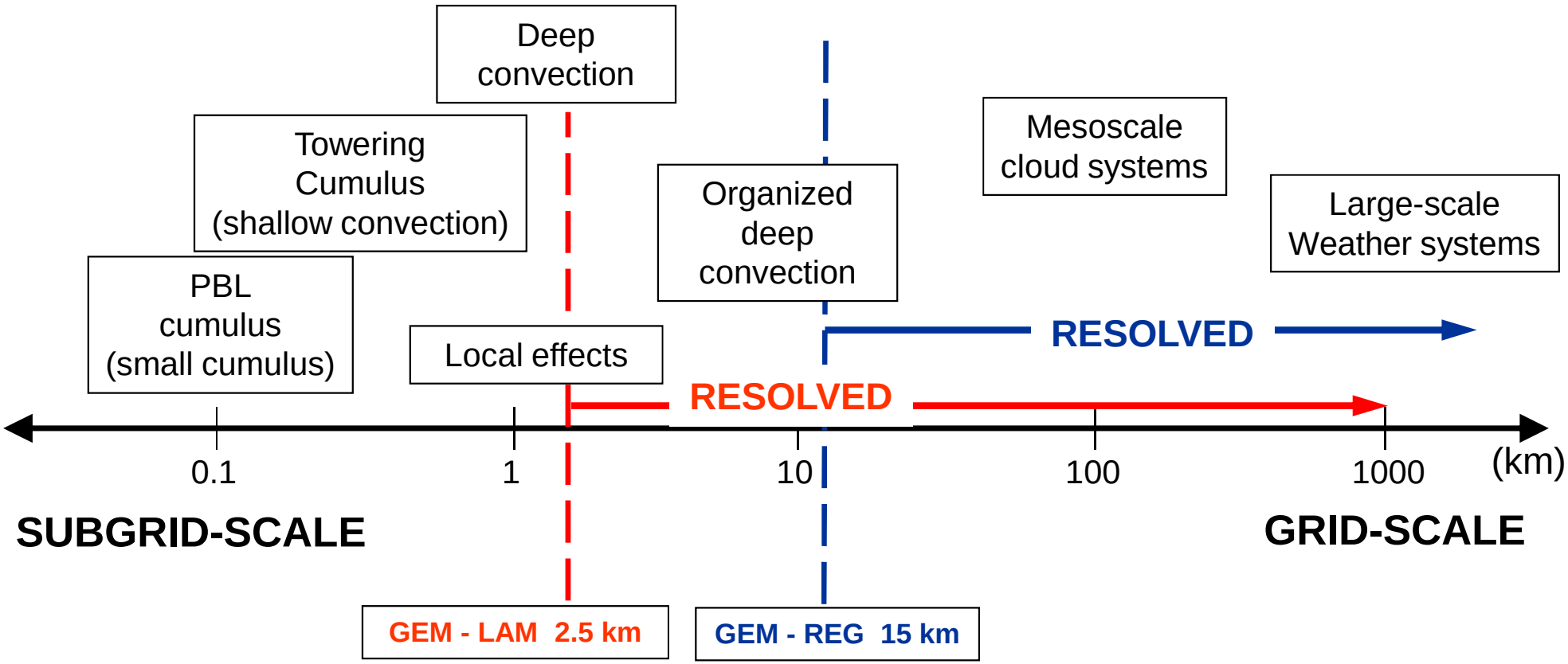
- Verification methodologies
  - PART 1: **Upscaling**
    - Is the LAM 2.5-km QPF as good as the REG-15 km at the 15-km scale ?
  - PART 2: **Neighbourhood-based**
    - Tolerates a certain level of displacement and timing errors
    - Distribution-oriented: Probabilistic verification measures can be used

Part 1 : Upscaling



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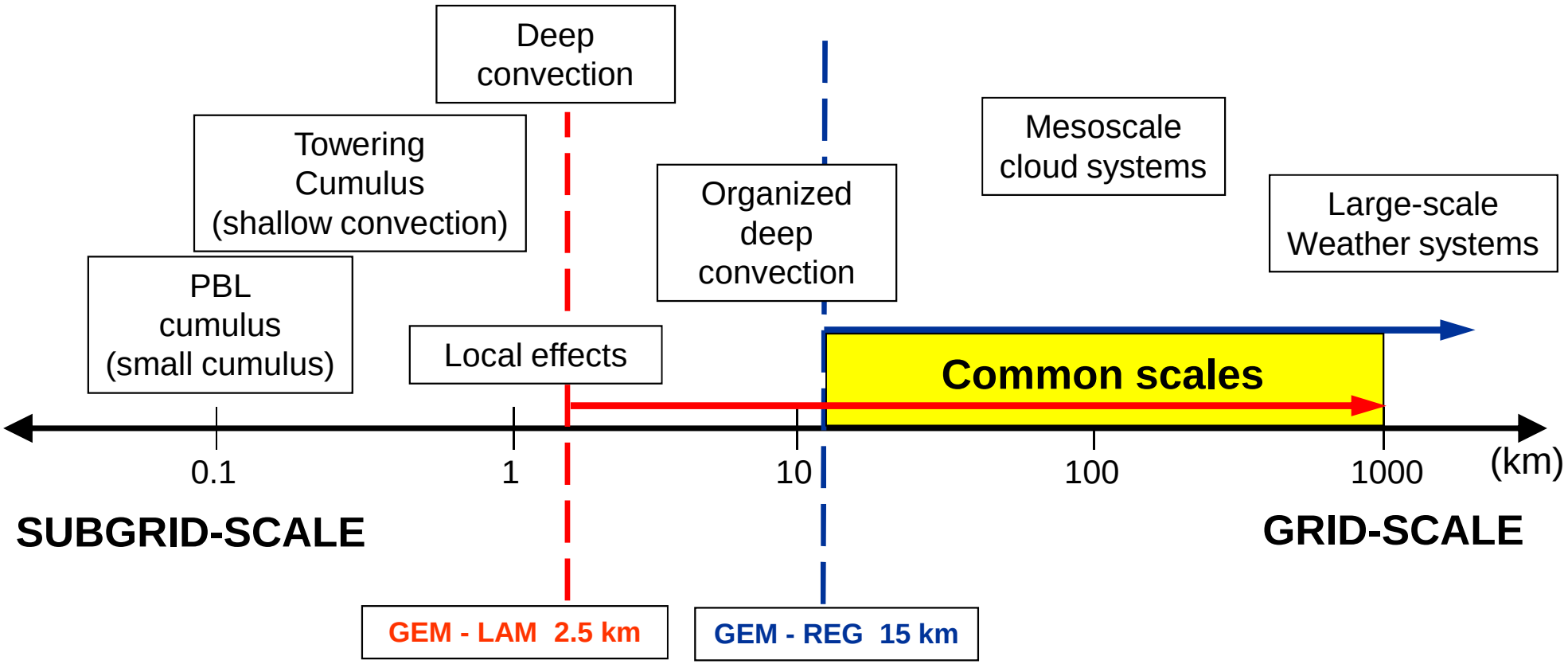
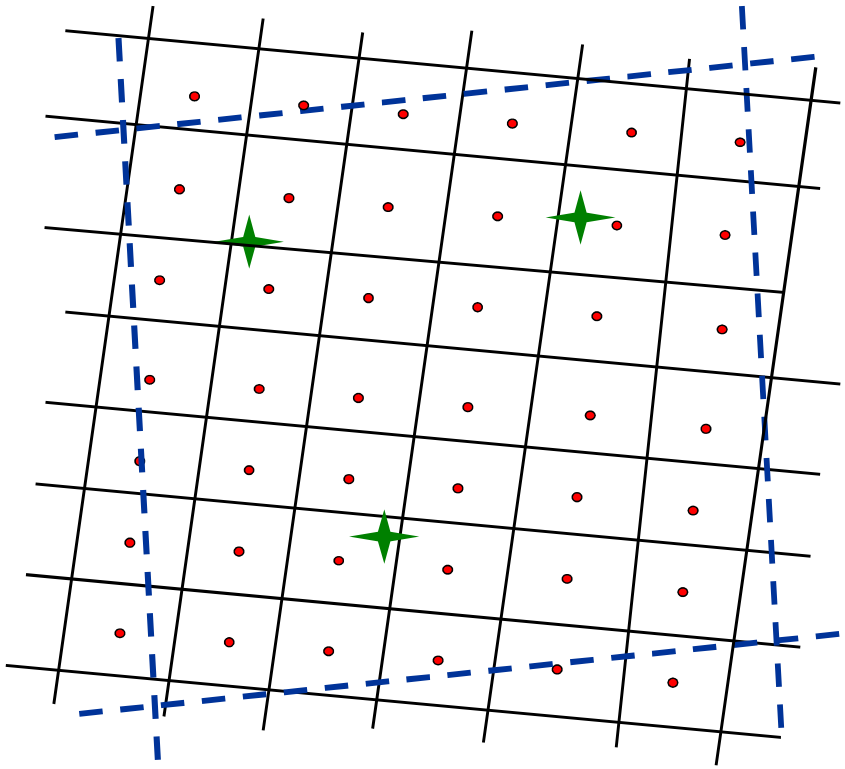


Upscaling : methodology

- **Upscaling : verification at the GEM-REG 15 km grid-scale**

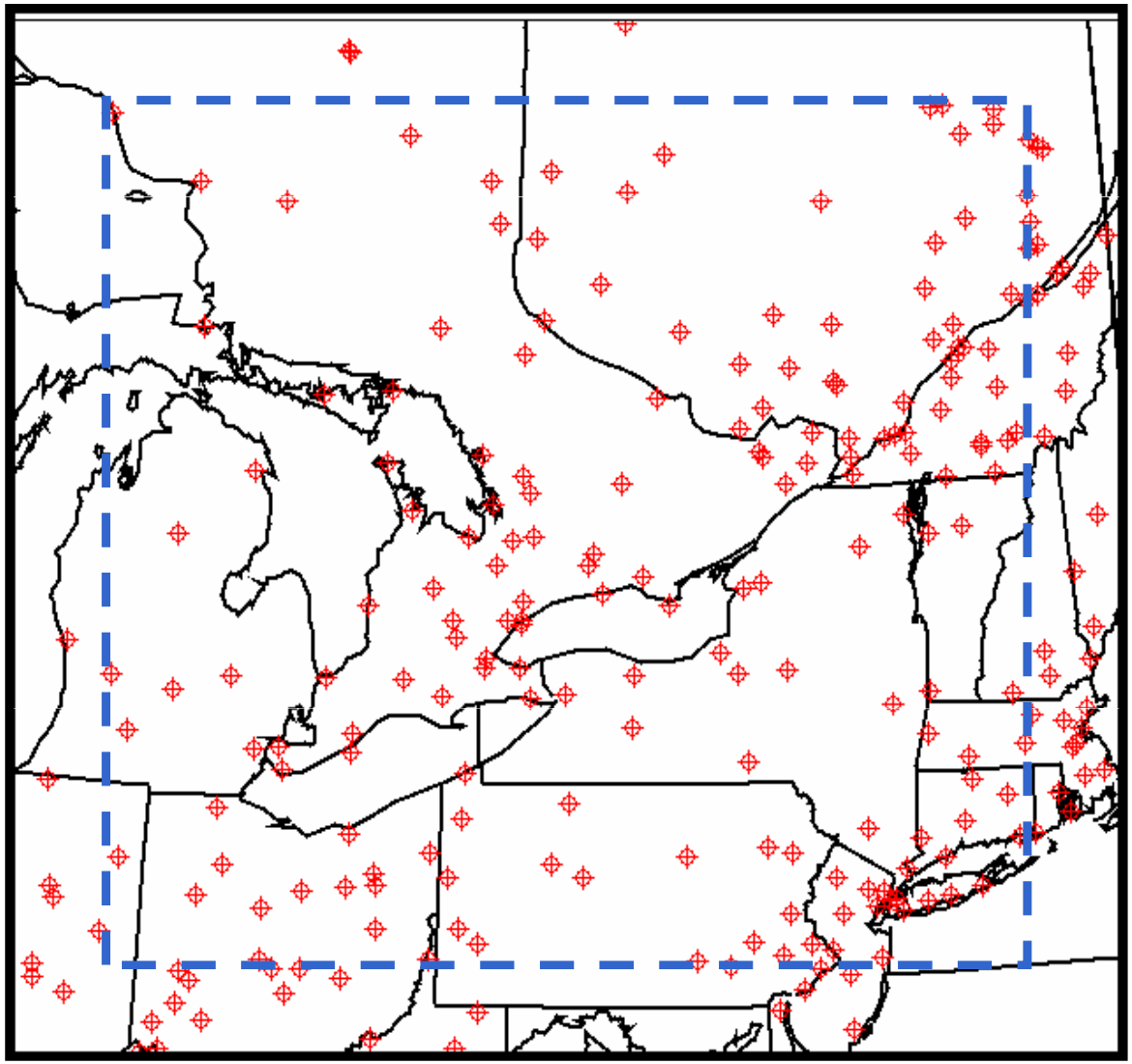


LAM 2.5, GEM 15, gauges

Steps:

1. Average LAM 2.5 km pcp falling within Reg 15 km grid-cell
2. Average pcp of gauges within Reg 15 km grid-box
3. Mask out grid-boxes outside LAM and without observation
4. Compute QPF summary scores
5. Compute confidence intervals by bootstraping

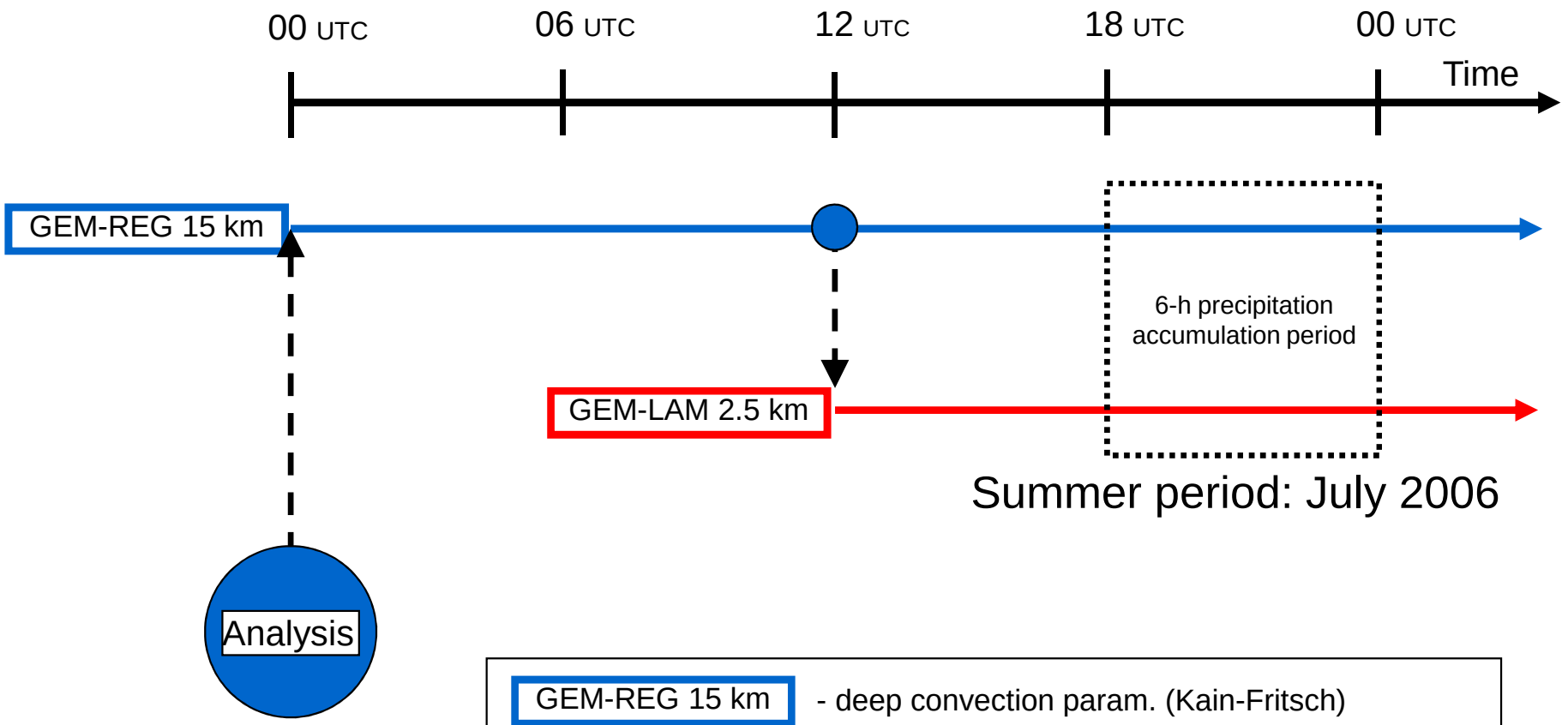
Upscaling : gauges distribution



Gauges distribution

- From the Canadian Precipitation Analysis project (CaPA) (Mahfouf *et al* . 2007)
- Uses SYNOP/METAR and RMCQ (Réseau météo coopératif du Québec)
- Up to 220 stations (160 average) available into the subdomain

Upscaling : verification period

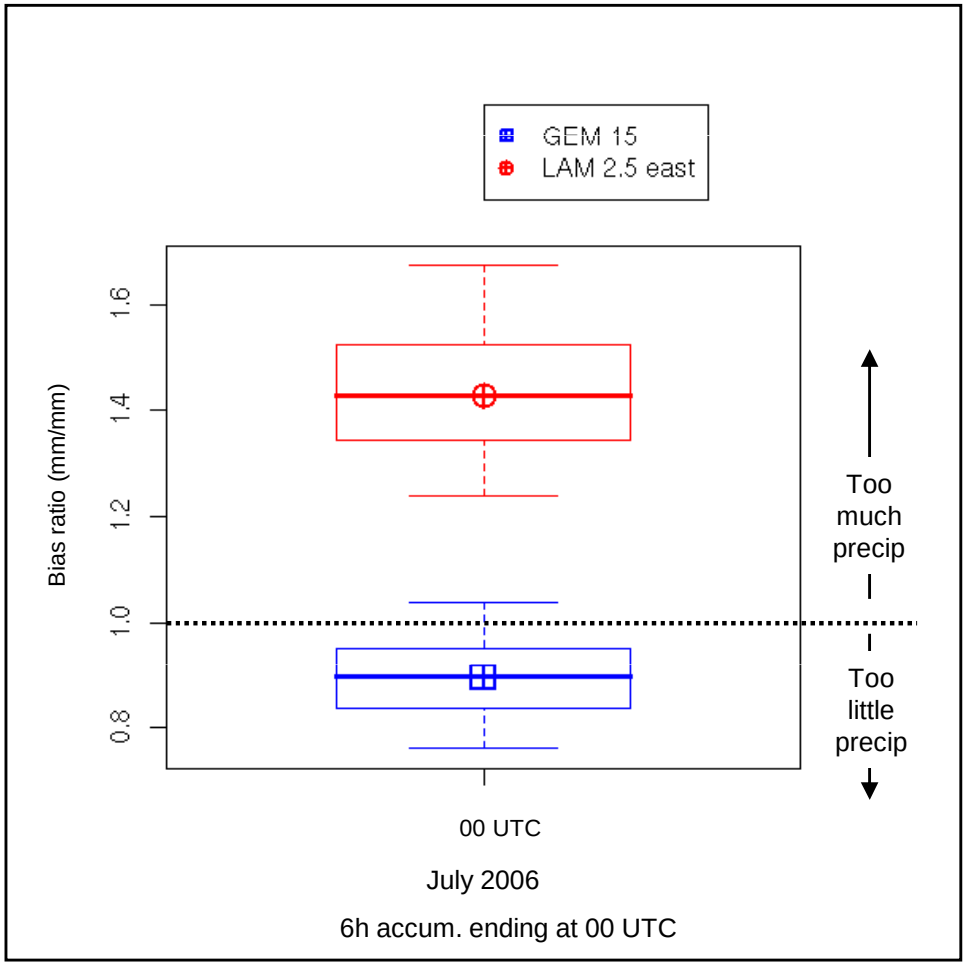


GEM-REG 15 km
- deep convection param. (Kain-Fritsch)
- simple condensation param. (Sundqvist)

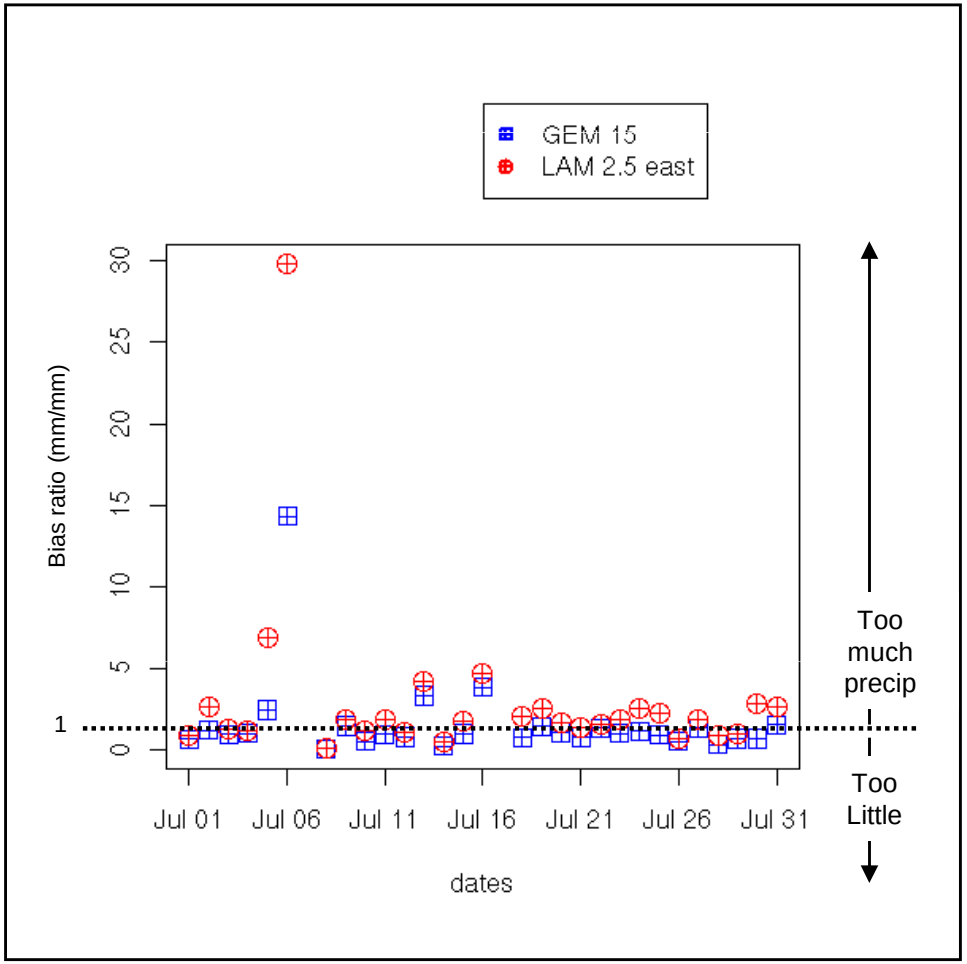
GEM-LAM 2.5 km
- explicit deep convection
- detailed condensation param. (Kong&Yau)

Upscaling : results

Bias

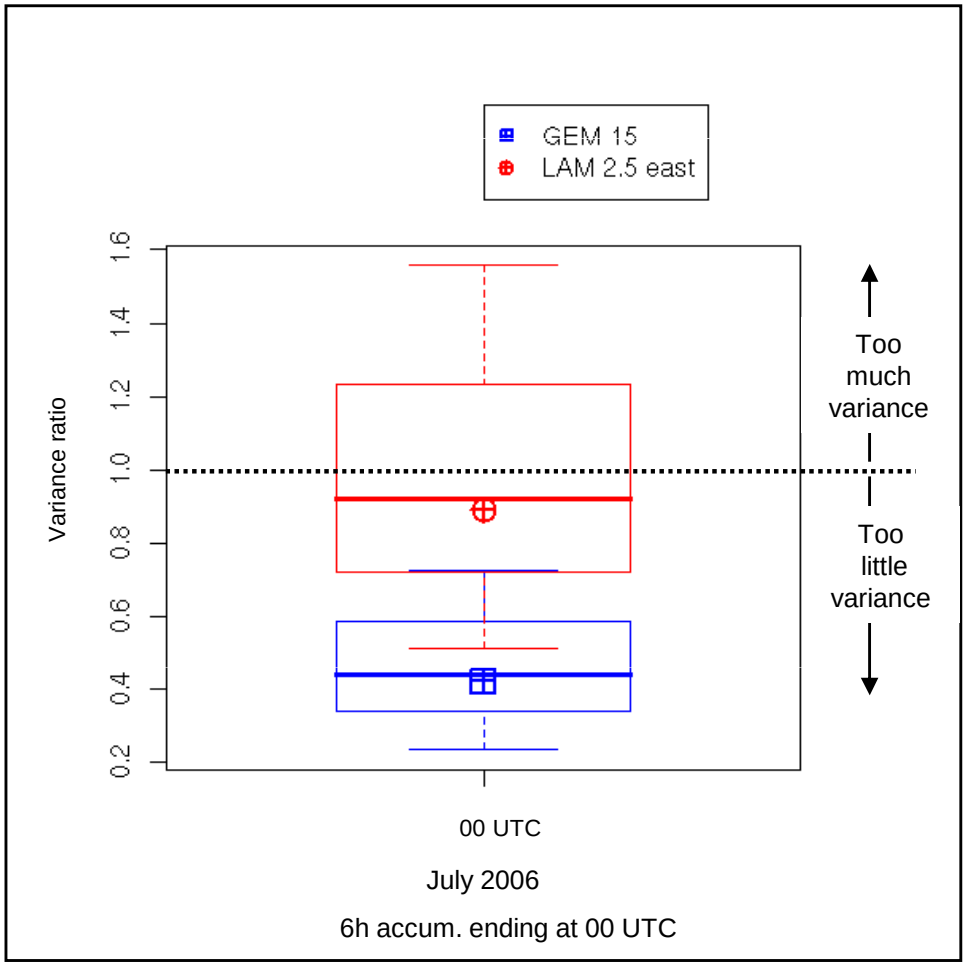


Bias (July time series)

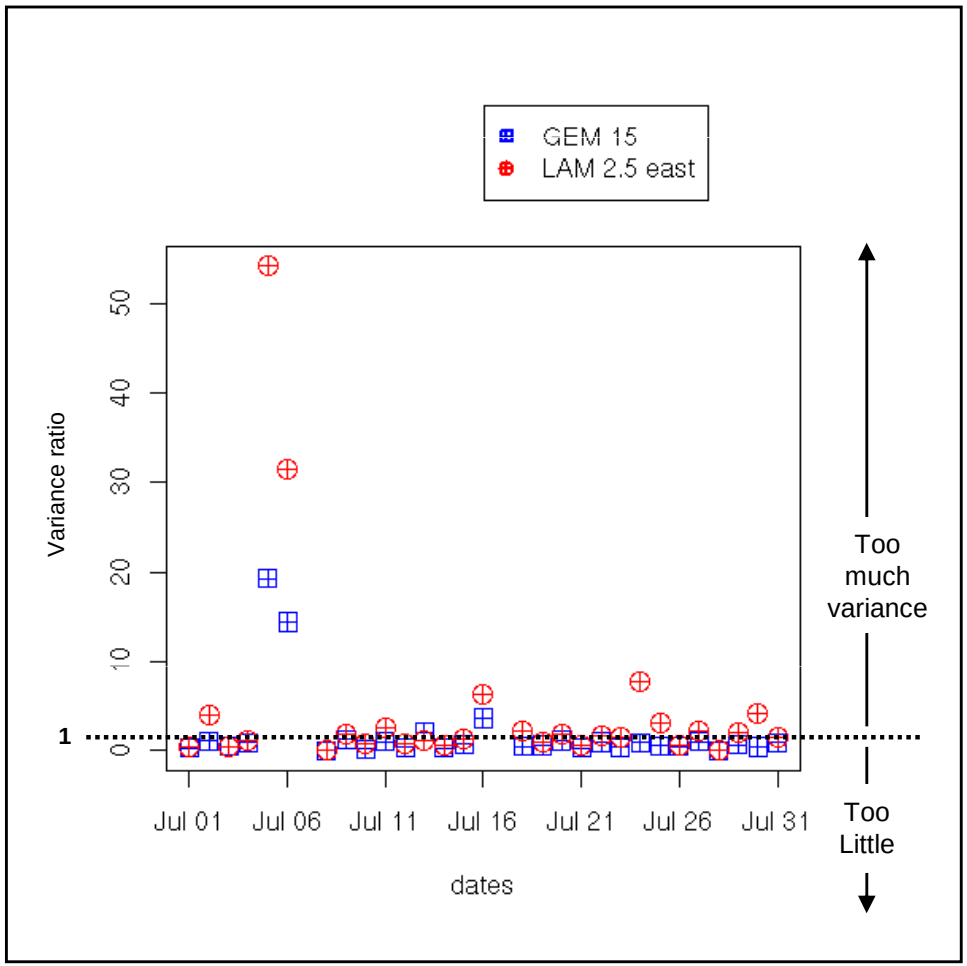


Upscaling : results

Variance

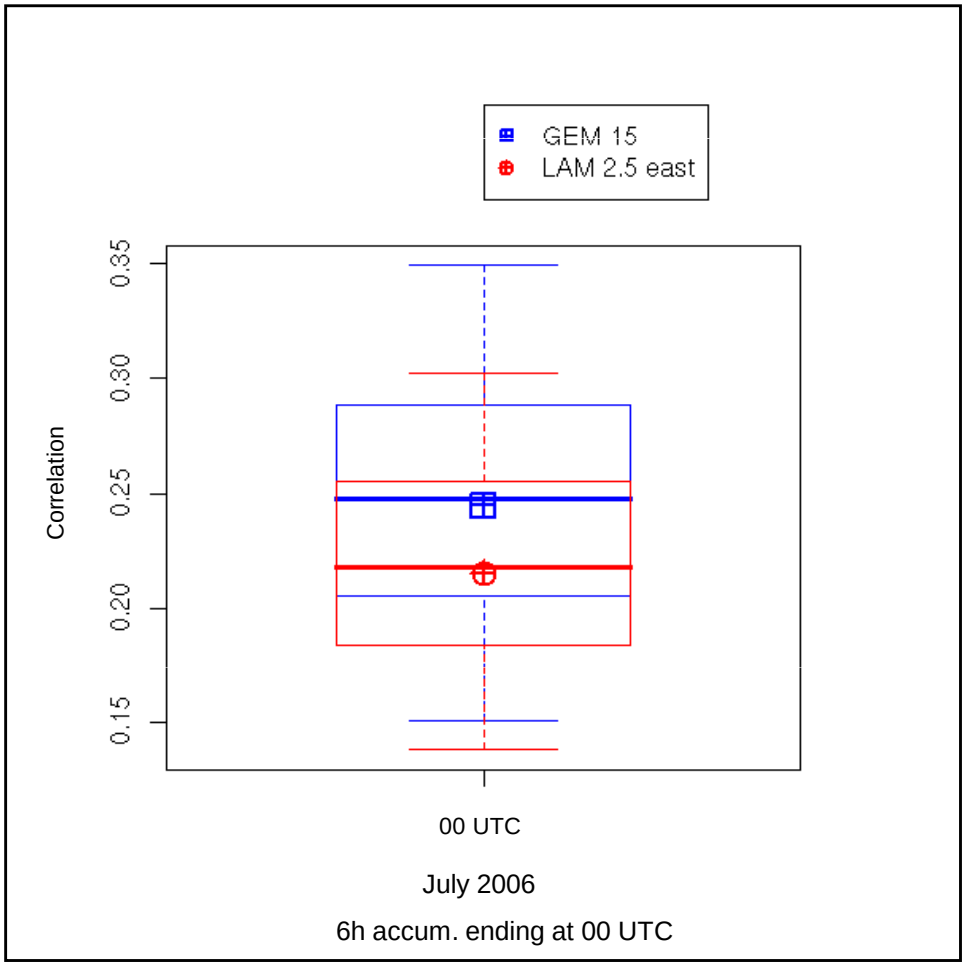


Variance (July time series)

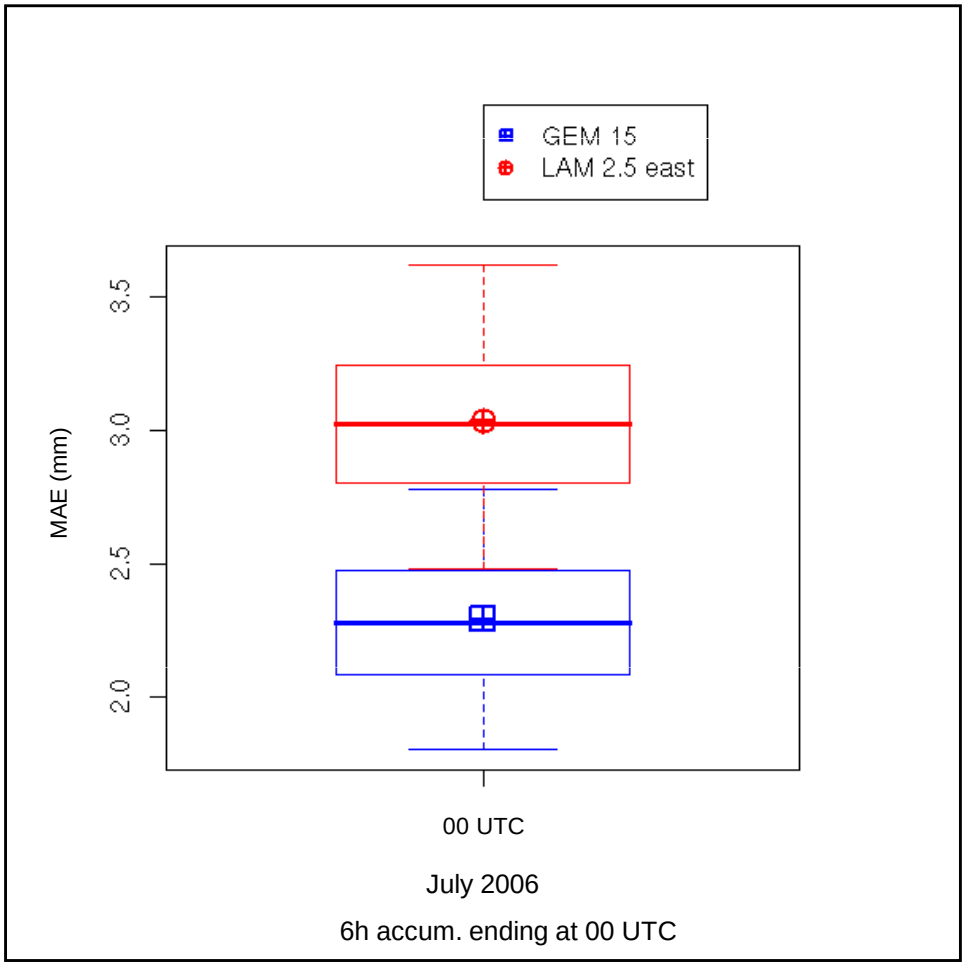


Upscaling : results

Correlation



Mean absolute error



Upscaling : results

Contingency Table

Forecast \ Observed	*Yes*	*No*	
Yes	**Hits**	**False Alarms**	*Forecast yes*
No	**Misses**	**Correct negatives**	Forecast *no*
	Observed yes	*Observed no*	Total

$$\text{Bias} = \frac{\text{hits} + \text{false alarms}}{\text{hits} + \text{misses}}$$

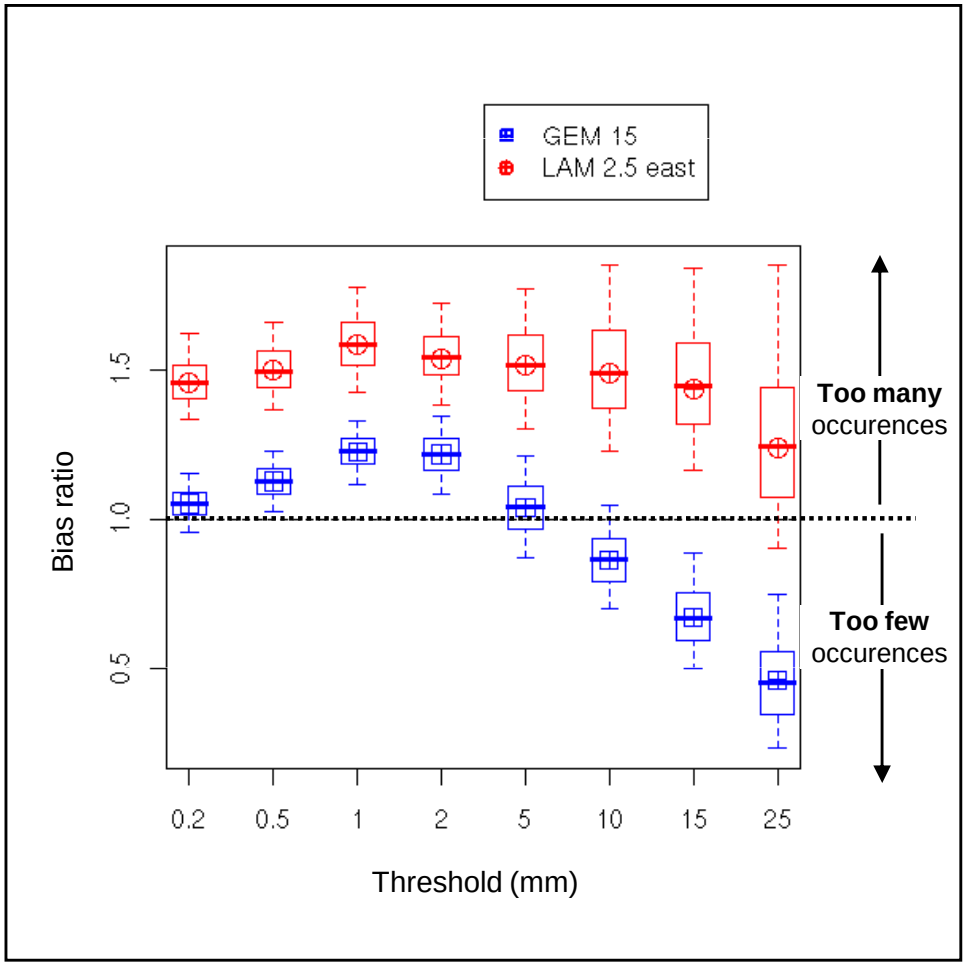
$$\text{POD} = \frac{\text{hits}}{\text{hits} + \text{misses}}$$

$$\text{POFD} = \frac{\text{false alarms}}{\text{correct negatives} + \text{false alarms}}$$

$$\text{Accuracy} = \frac{\text{hits} + \text{correct negatives}}{\text{total}}$$

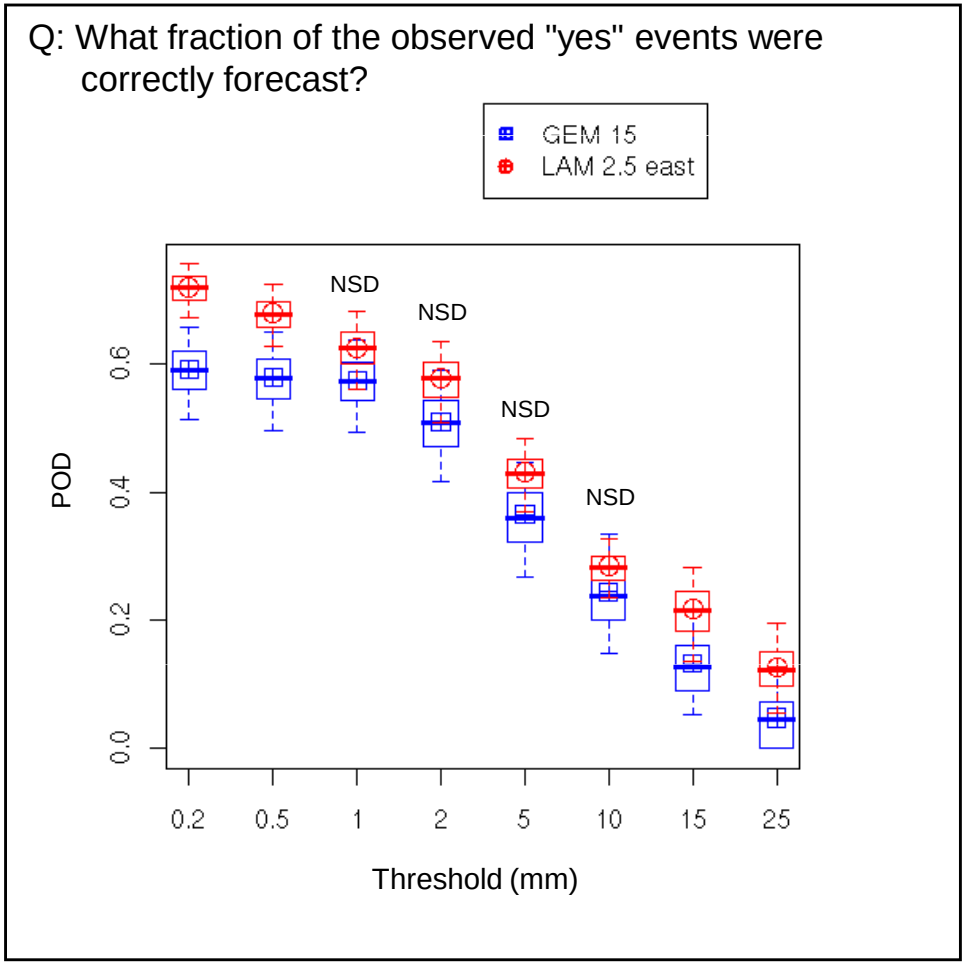
Upscaling : results

Frequency bias



Probability of detection (hit rate)

Q: What fraction of the observed "yes" events were correctly forecast?

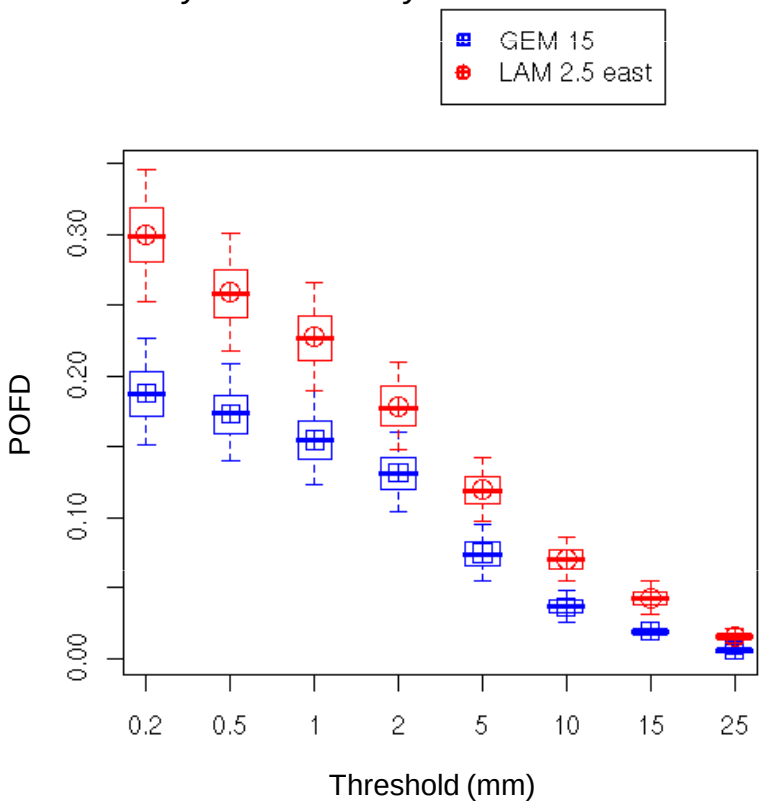


* NSD: not statistically significant

Upscaling : results

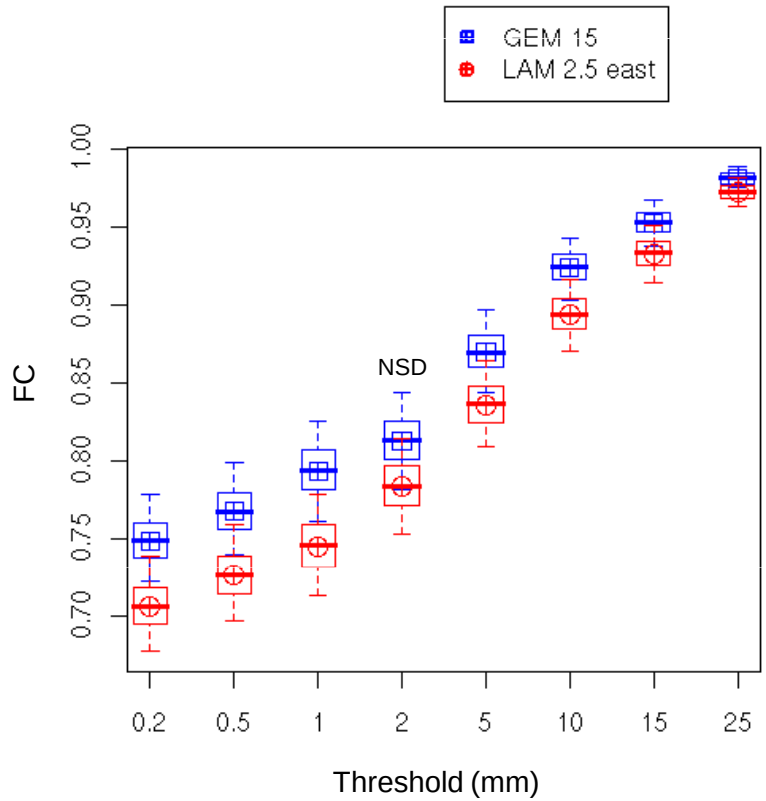
Probability of false detection (FA rate)

Q: What fraction of the observed "no" events were incorrectly forecast as "yes"?



Accuracy (fraction correct)

Q: Overall, what fraction of the forecasts were correct?



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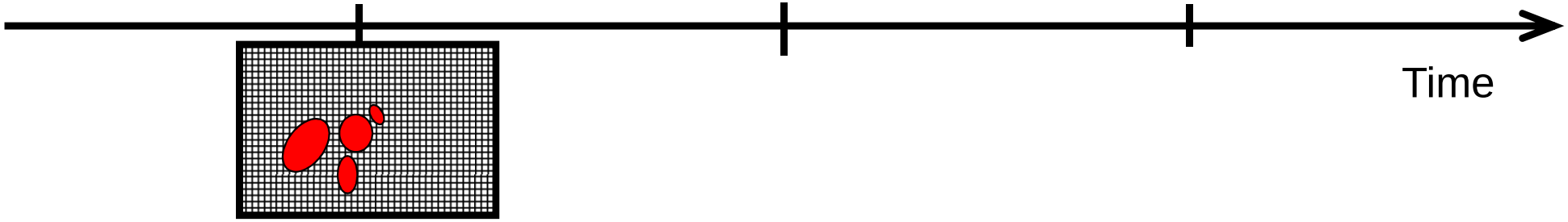
Conclusion with upscaling verification

- LAM 2.5 km produces too much pcp
- LAM 2.5 km generally shouts “WOLF” too often (large FA rate)
  - But has better POD than regional 15 km for precip amount >15 mm/6h
- Has good variance level but worst correlation
- LAM 2.5 km accuracy (fraction correct) lower than REG 15 km, even with the upscaling

Part 2: Neighborhood-based approach

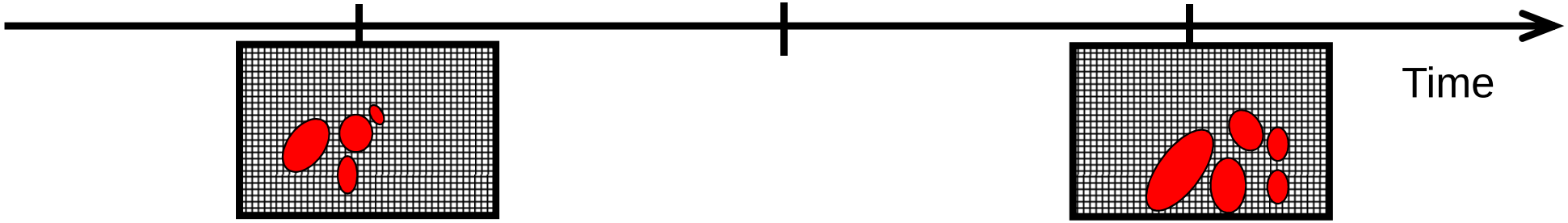
- Tolerates a certain level of displacement and timing errors
- Reflects the forecaster’s way-of-thinking
- Distribution-oriented: Probabilistic verification scores can be used
- Can be used in risk analysis model (cost-loss model)

Part 2 : Neighborhood-based



6h-accumulation ending at time t

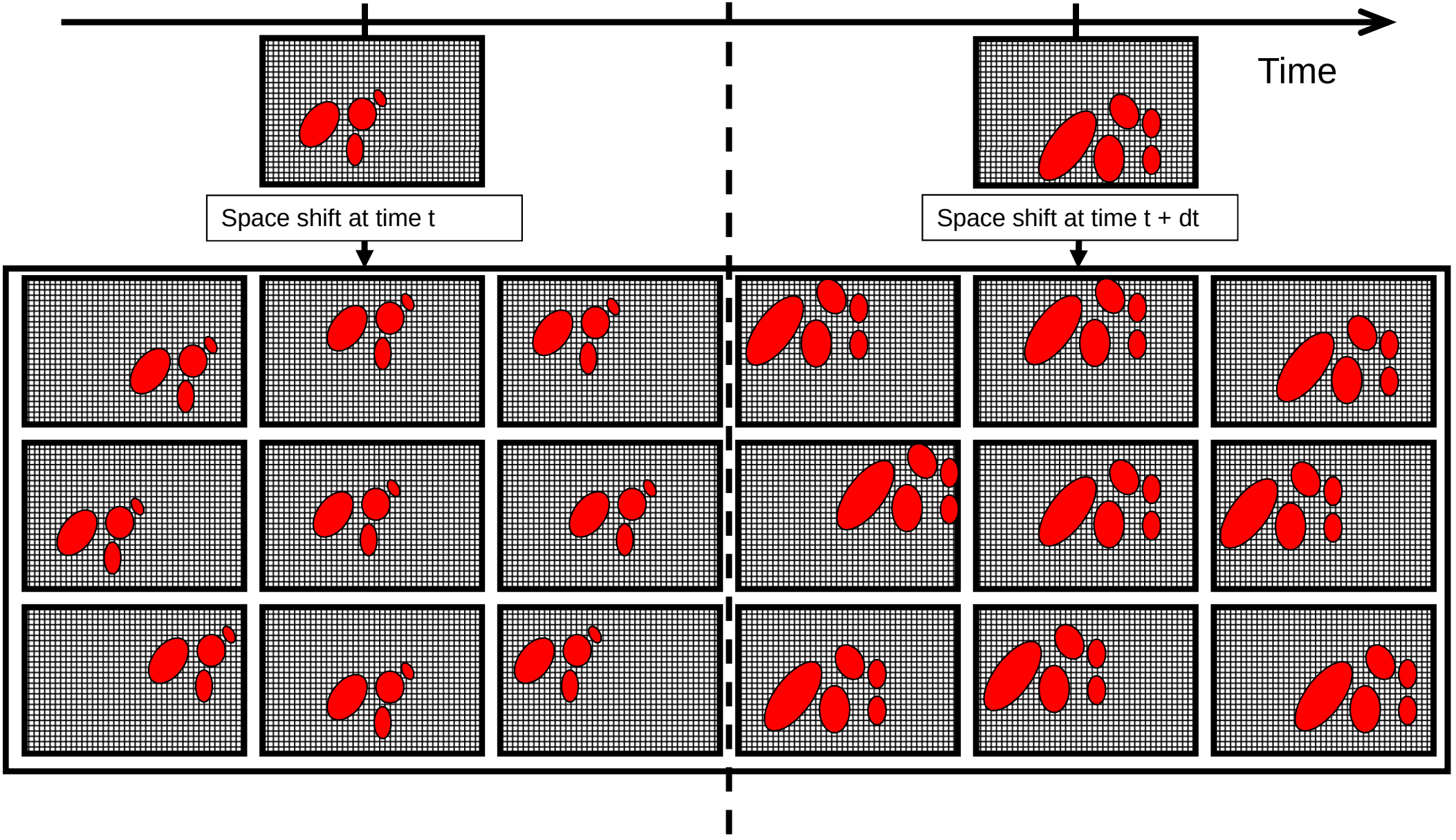
Neighborhood-based: ensemble generation



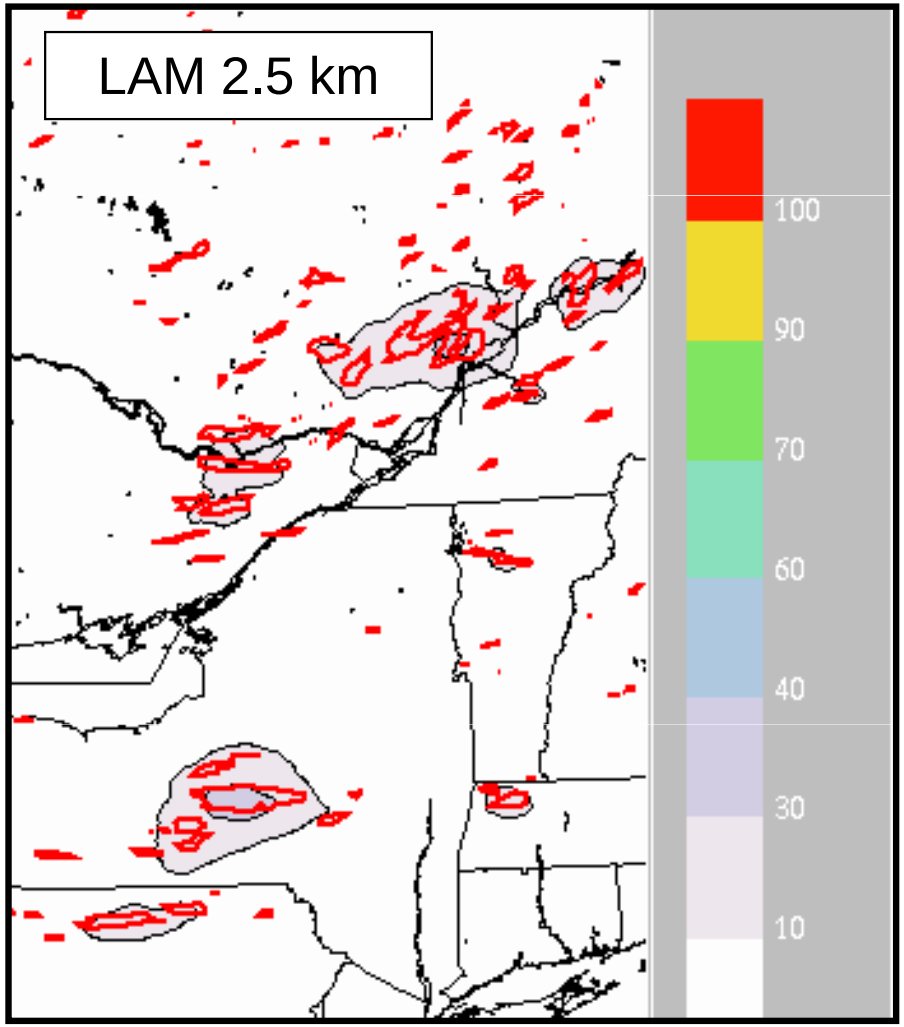
6h-accumulation ending at time t

6h-accumulation ending at time t + δt

Neighborhood-based: ensemble generation



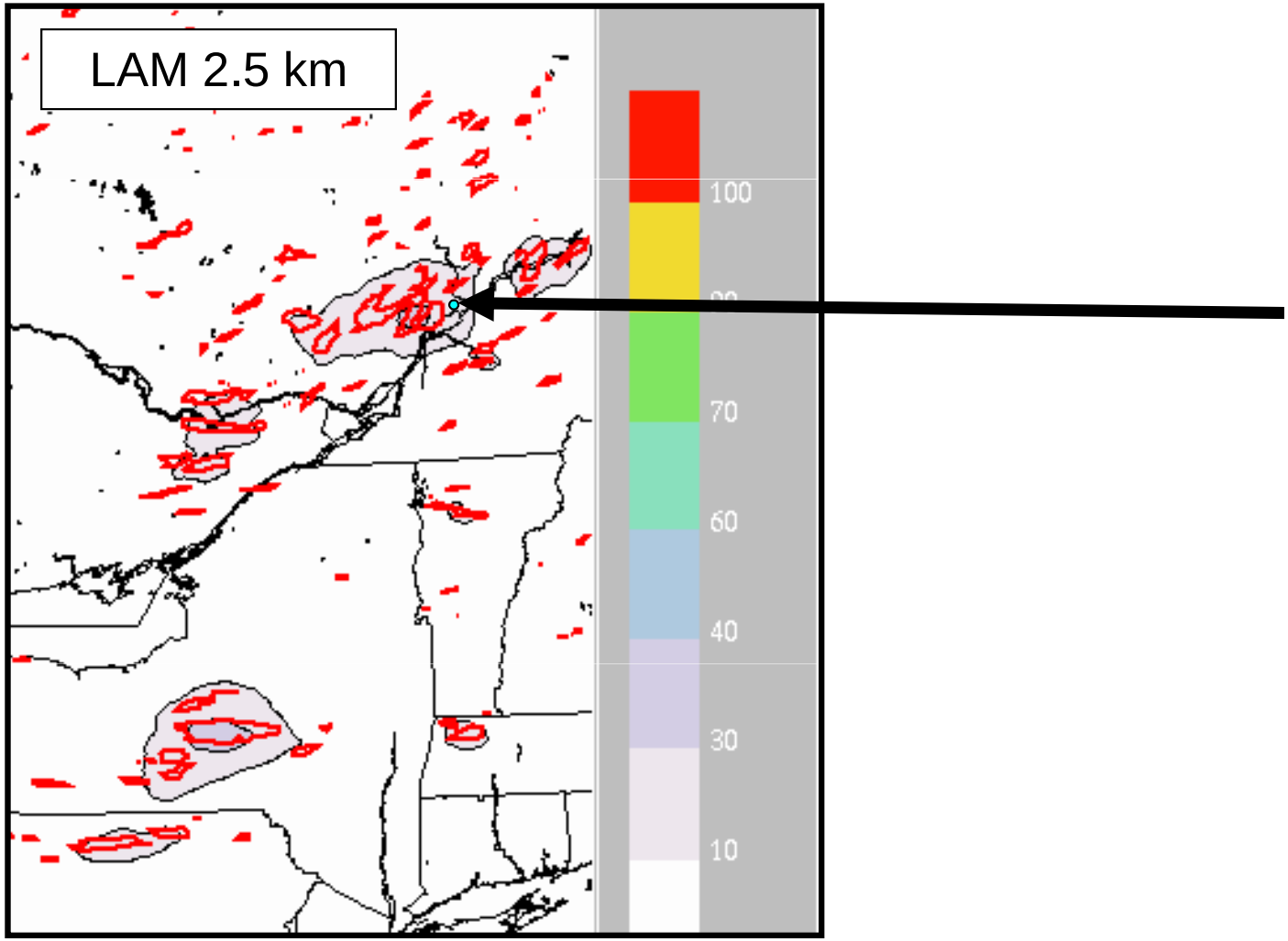
Neighborhood-based: PDF at stations



Red contours: deterministic 6-hour accumulation ; 25 mm threshold

Colored areas: Probability of exceeding 25 mm / 6h (%)

Neighborhood-based: PDF at stations



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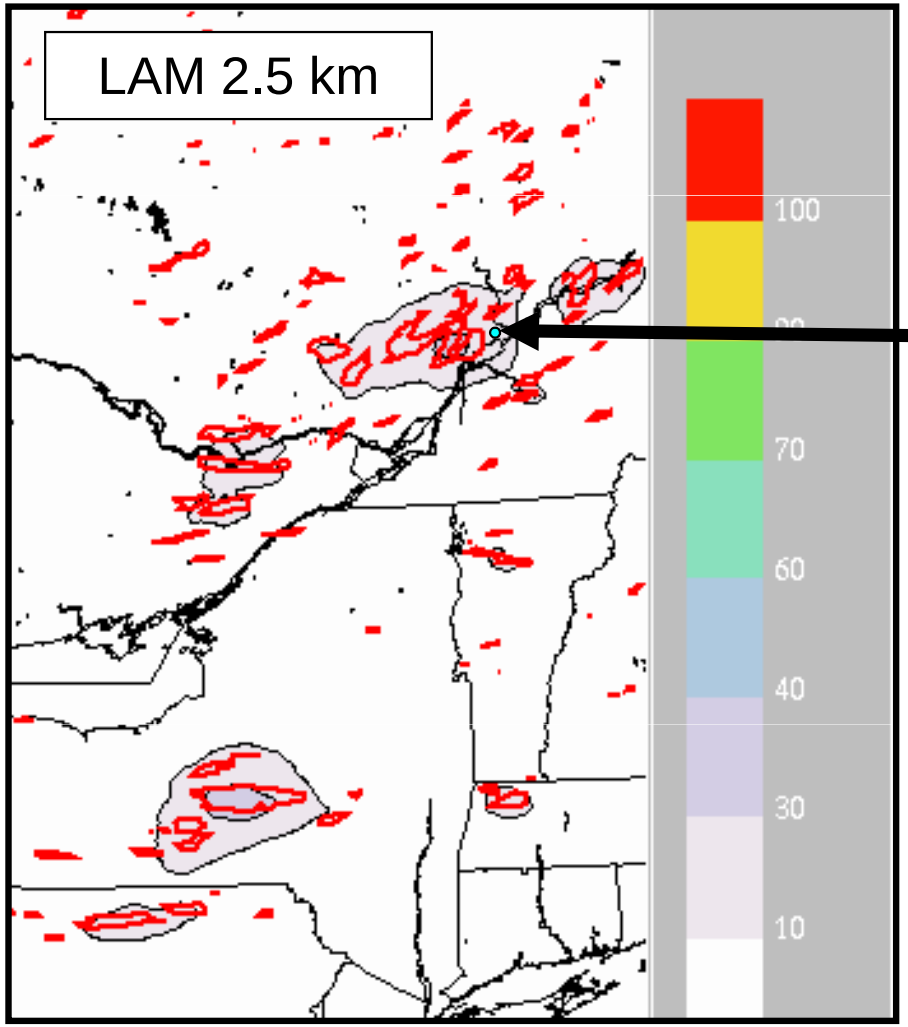

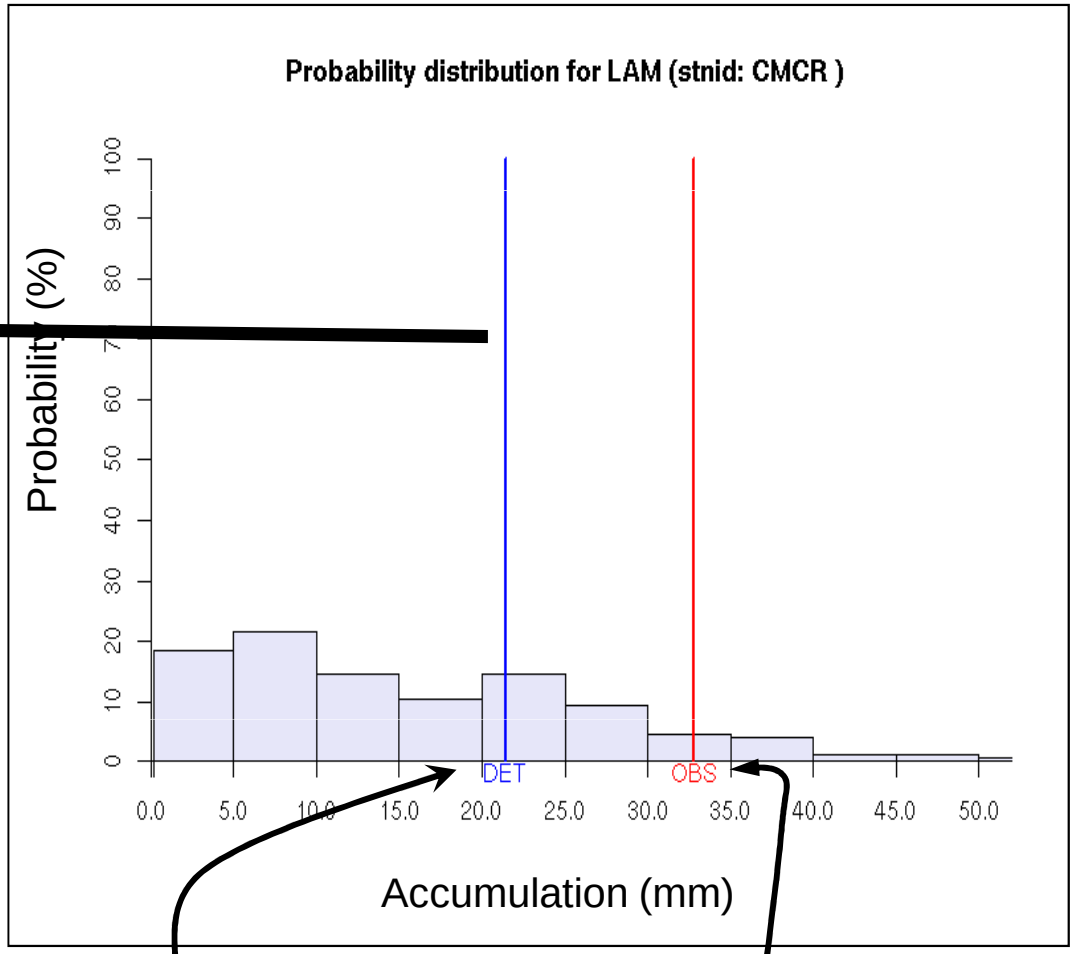

LAM DET.: 21.4 mm

OBS: 32.8 mm

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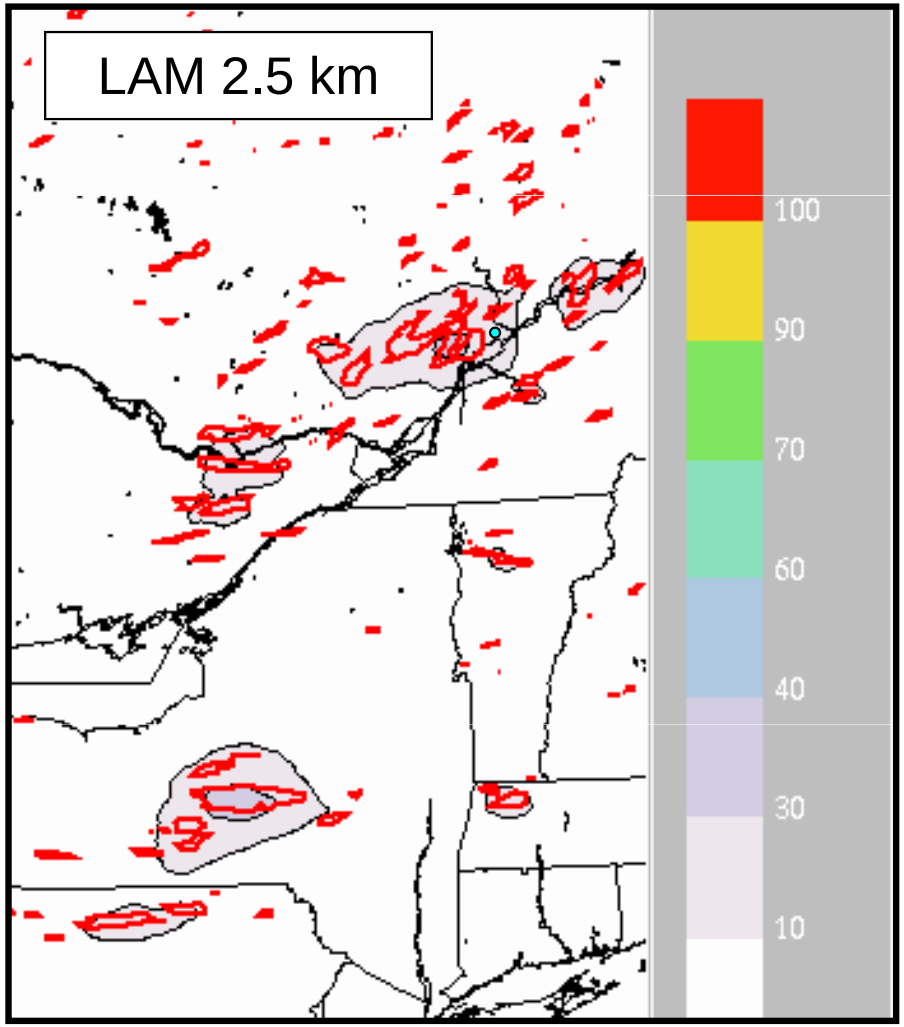

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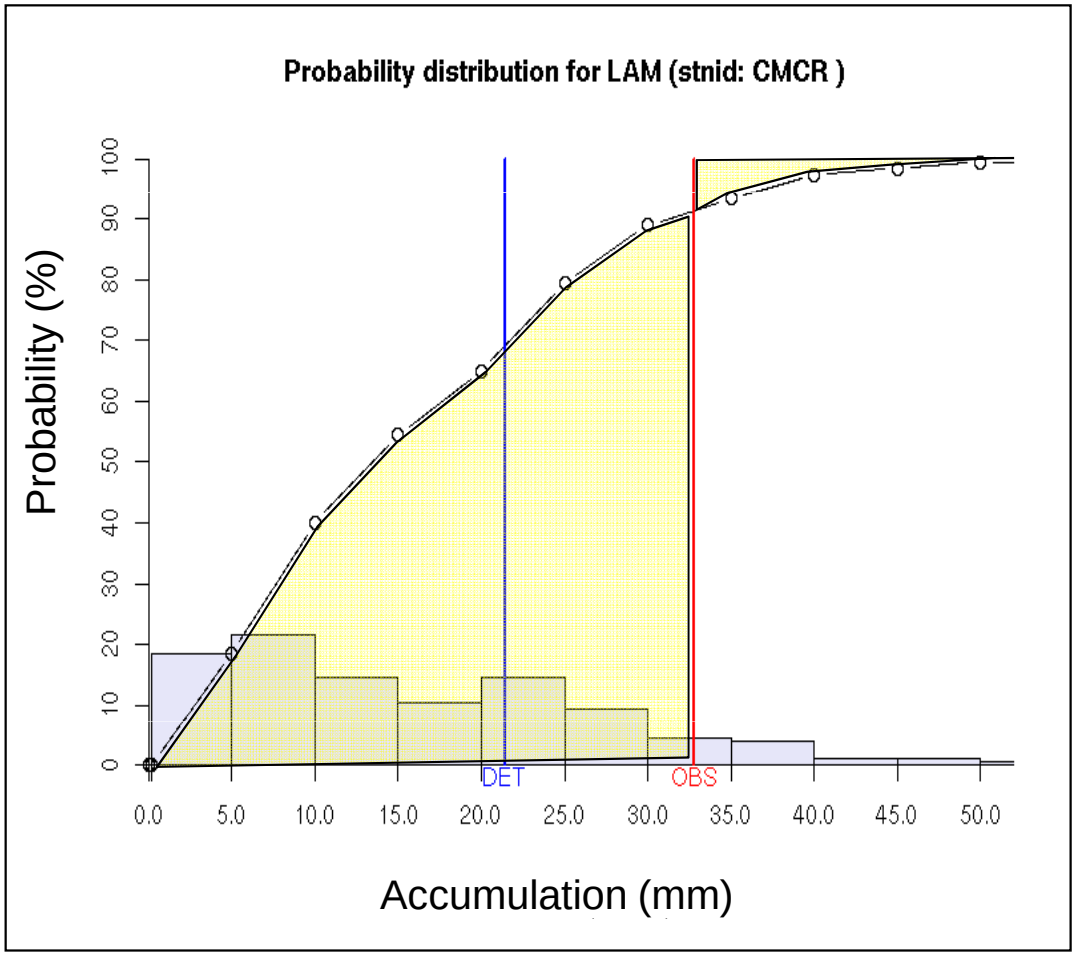


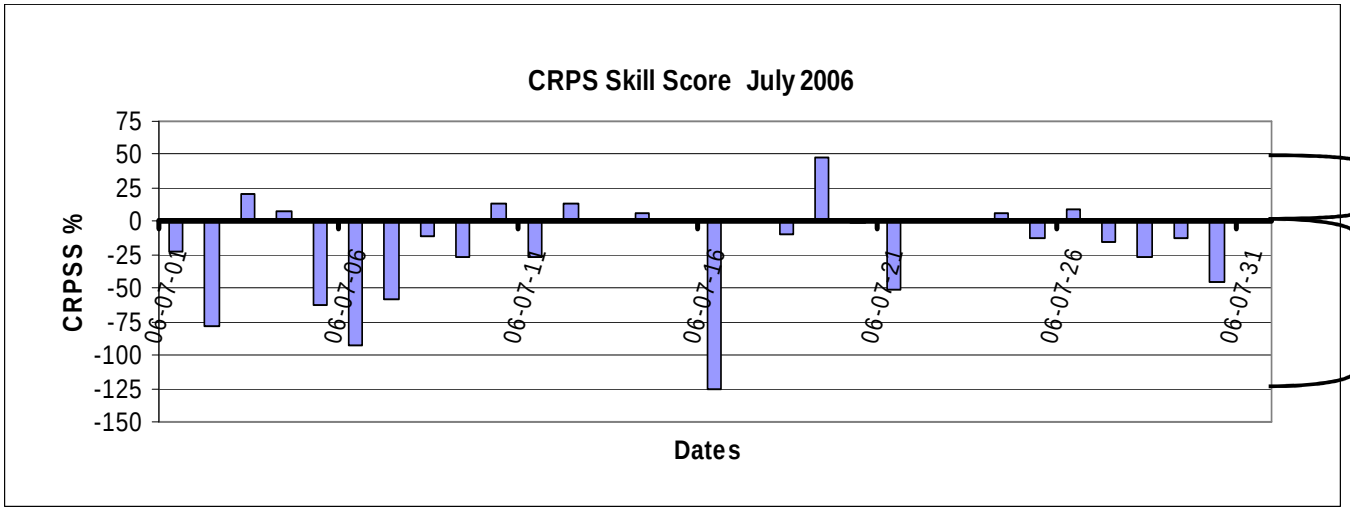
CRPS

Continuous ranked probability score

(Hersbach, 2000, *Wea. Forecasting)*

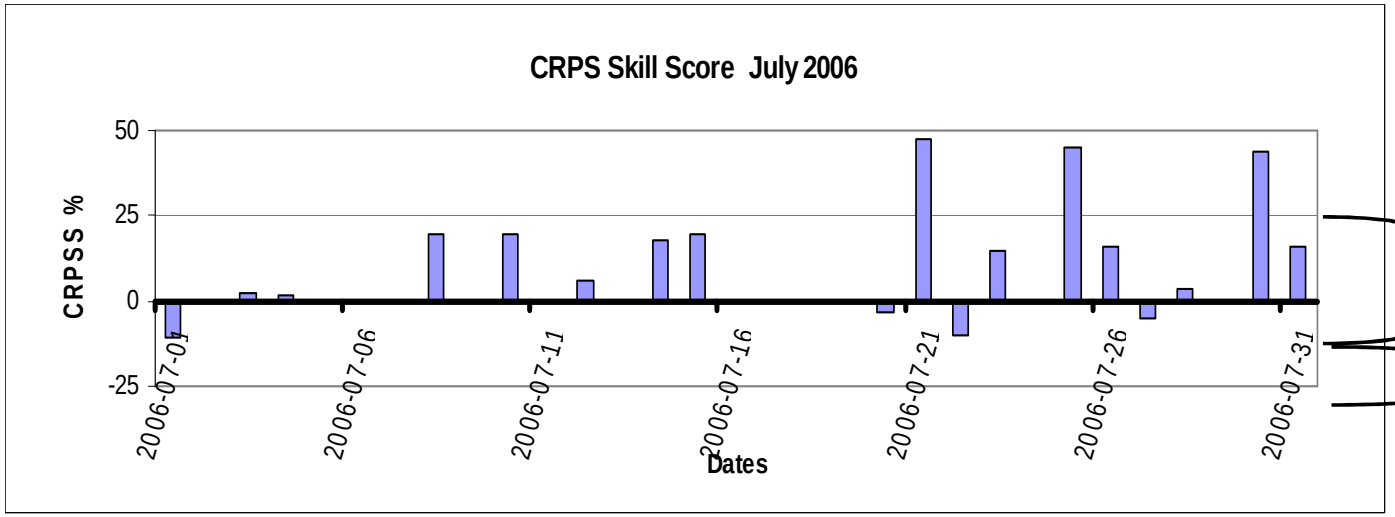
Neighborhood-based : Results

How close to the observations the distributions were ?



LAM better than Regional

LAM worst than Regional



Conditional to observed events > 15 mm/6h

LAM better than Regional !!

LAM worst than Regional

Conclusion

Is the LAM 2.5 km summer QPF better than the REG 15 km?

- **Verifications using upscaling show that LAM 2.5 km**
  - Over predict pcp amount
  - As good variance level but bad correlation
  - Accuracy (fraction correct) lower than REG 15 km

  => should we upscale both model pcp to a lower resolution grid ?

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  - But LAM 2.5 km is better than REG 15 km for significant events > 15 mm

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=> LAM 2.5 km QPF needed to be improved:

Milbrandt & Yau condensations scheme (single-moment) implemented in 2008 did reduce the gap.

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Thank you!

Environment Canada Environnement Canada

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