Verification of mesoscale model quantitative precipitation forecasts for the severe rainfall event over southern Ontario

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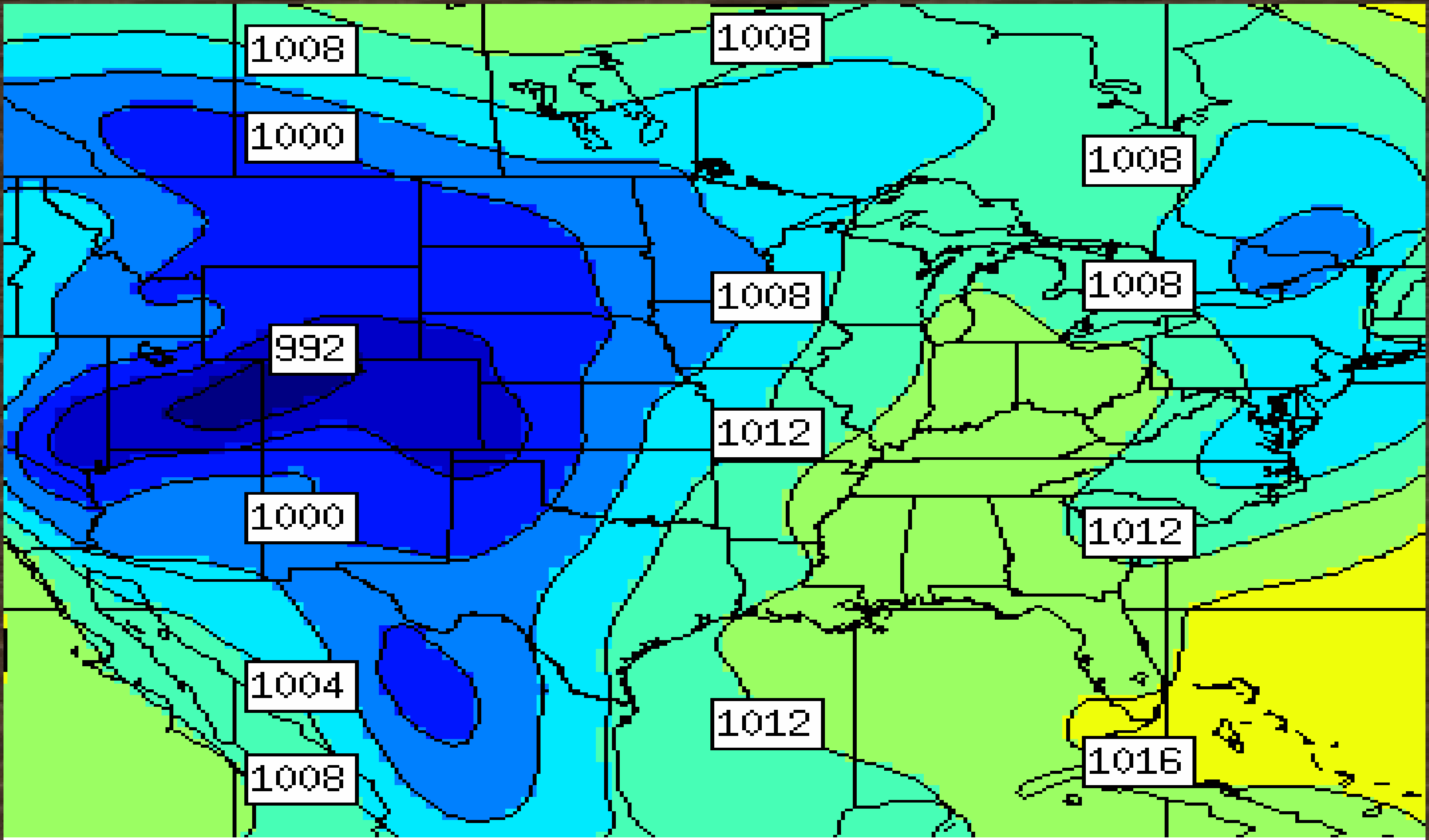
Motivation and Approach

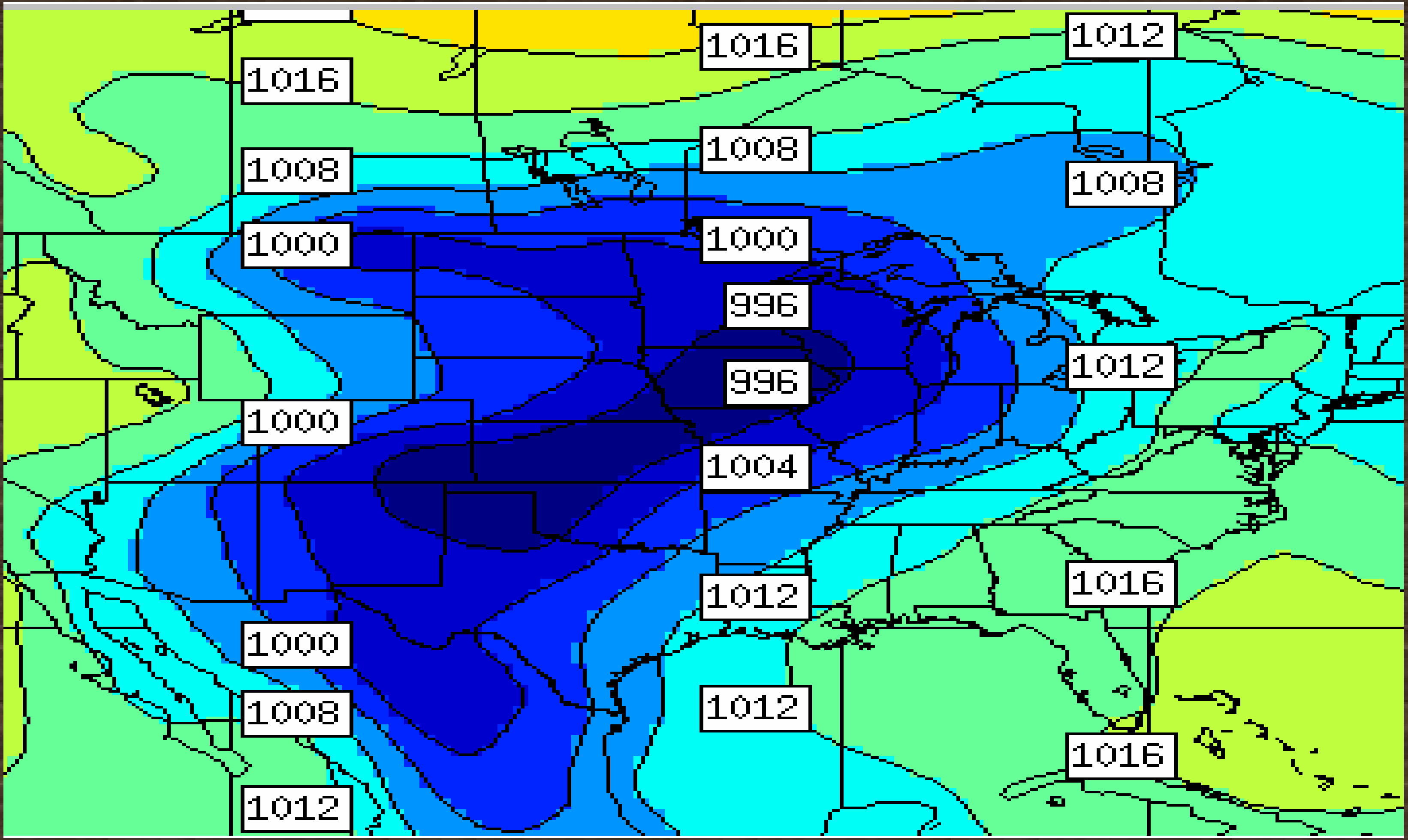
- Scientific Issues
  - One of the key topics for the current weather research programs in Canada, US, and many others
  - High Social and economic impact of precipitation versus low operational accuracy and forecast skill
  - Little knowledge on mesoscale model forecast skill at a high horizontal resolution (< 10 km)

- Methods
  - Pattern
  - Accuracy and skill
  - A coupling approach

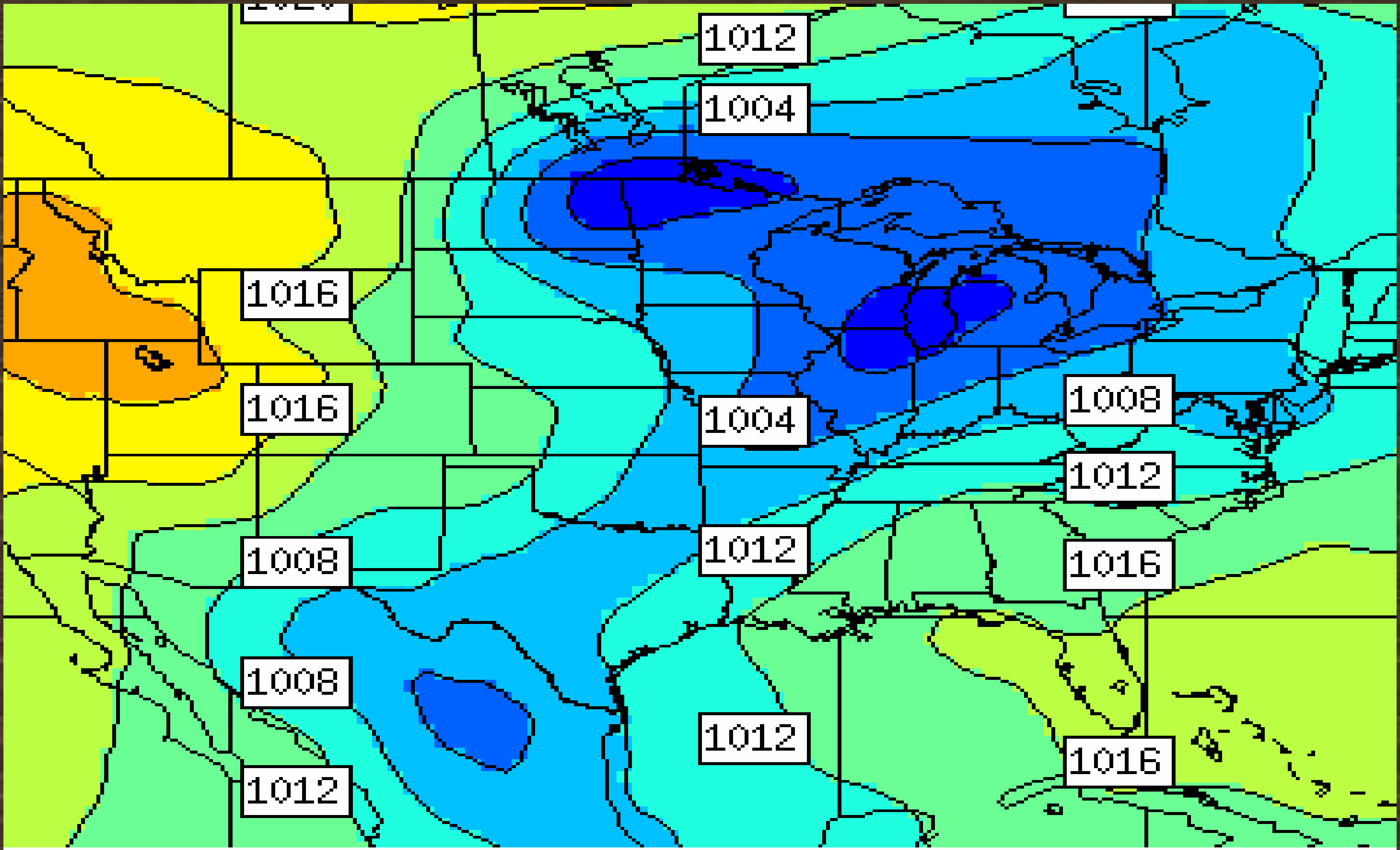
The MSLP at 00 UTC 11 May 2000



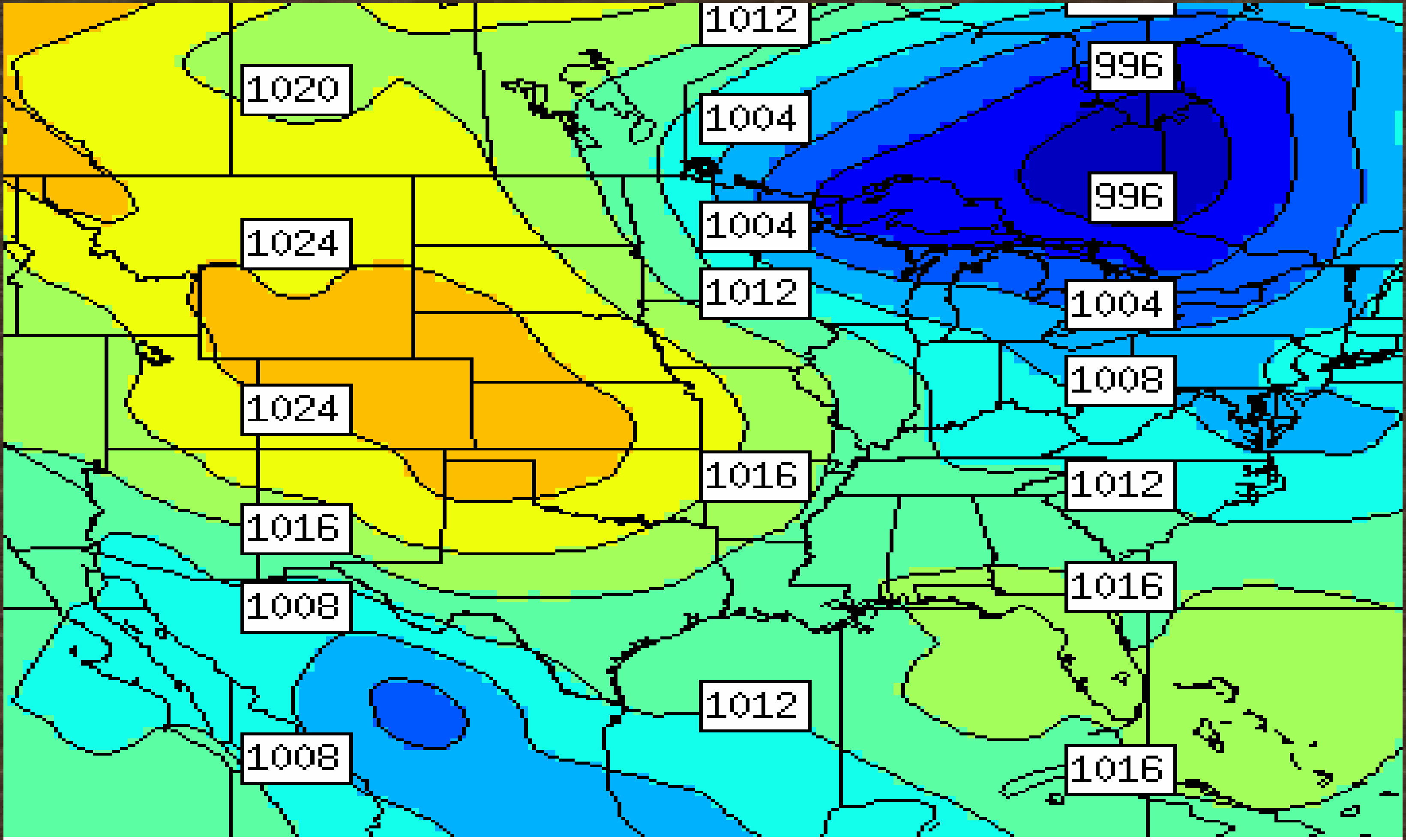
The MSLP at 00 UTC 12 May 2000



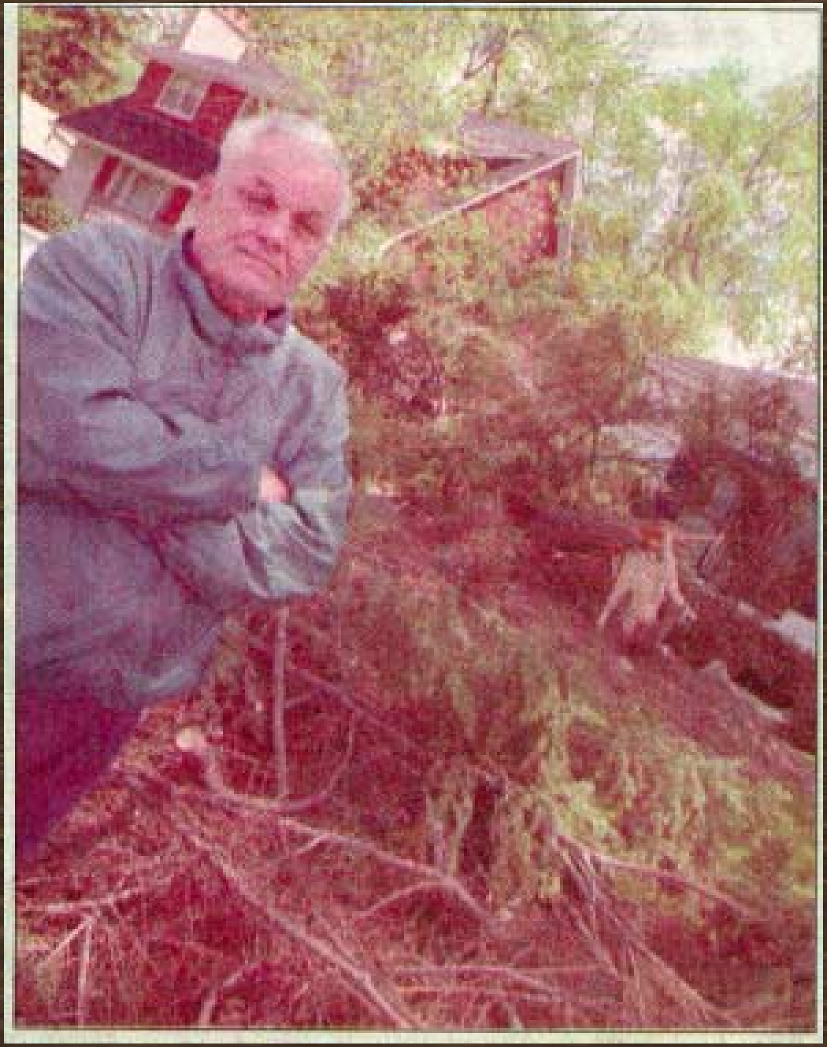
The MSLP at 18 UTC 12 May 2000



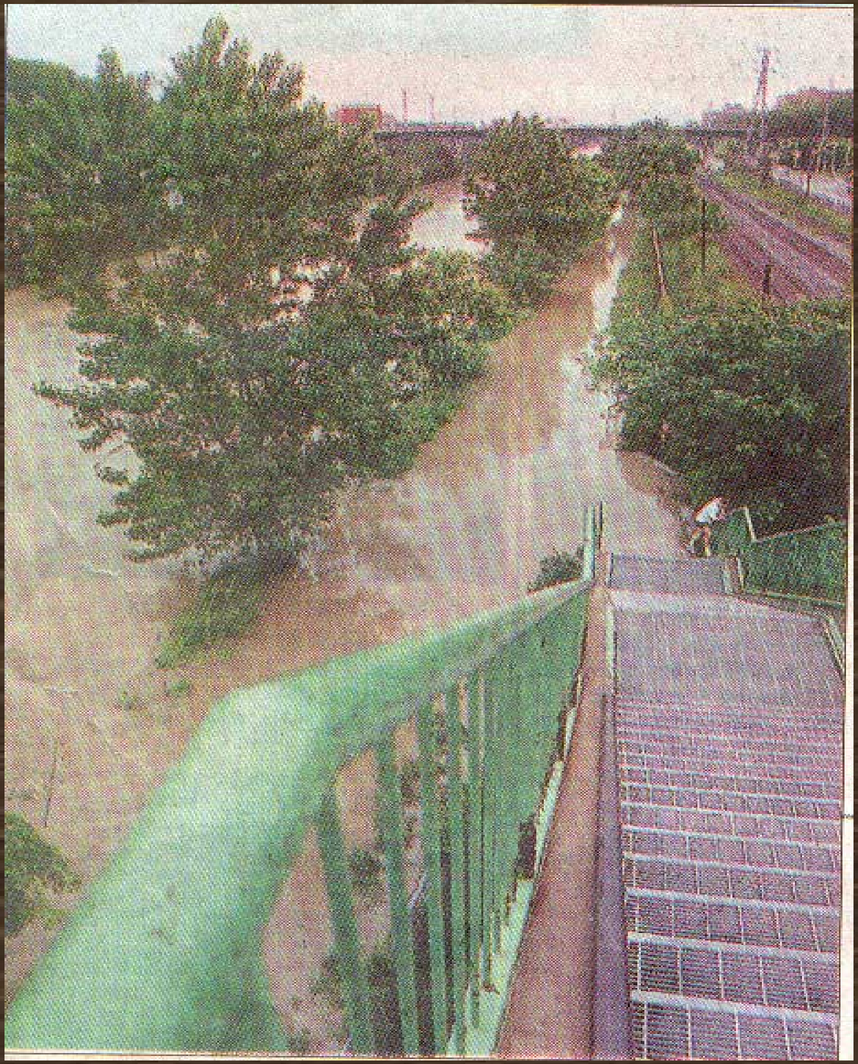
The MSLP at 12 UTC 13 May 2000

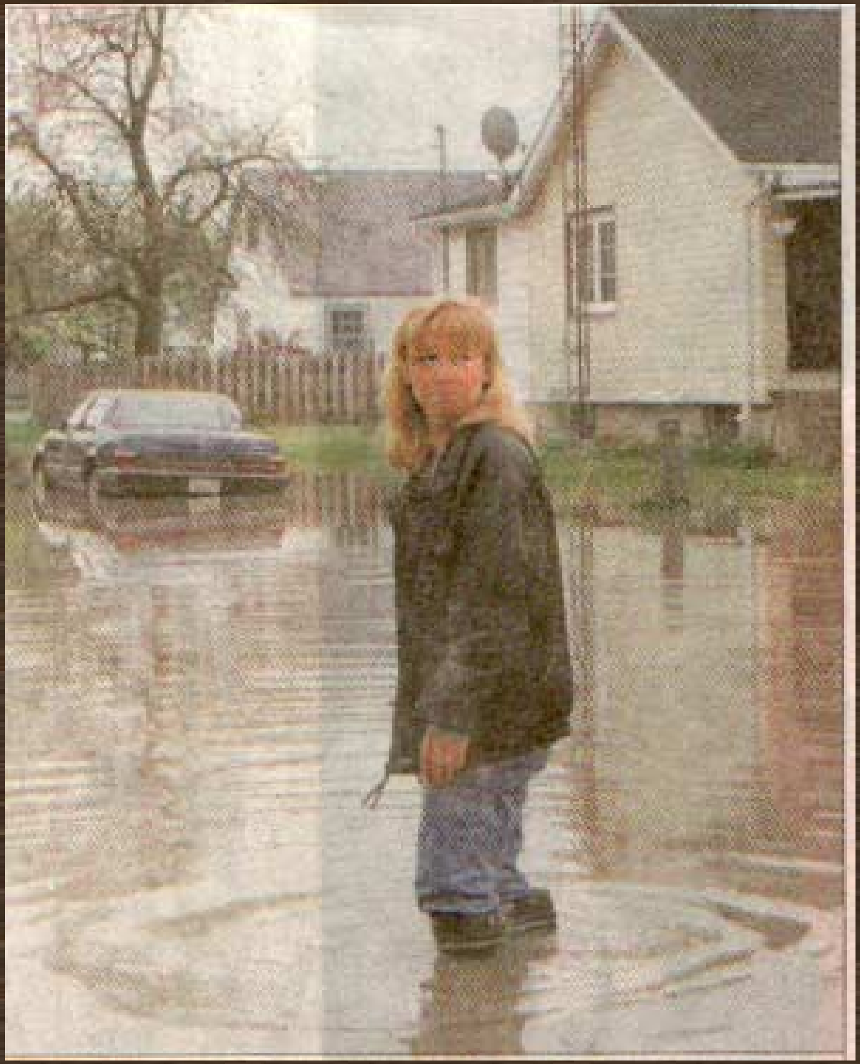


Impacts



Impacts



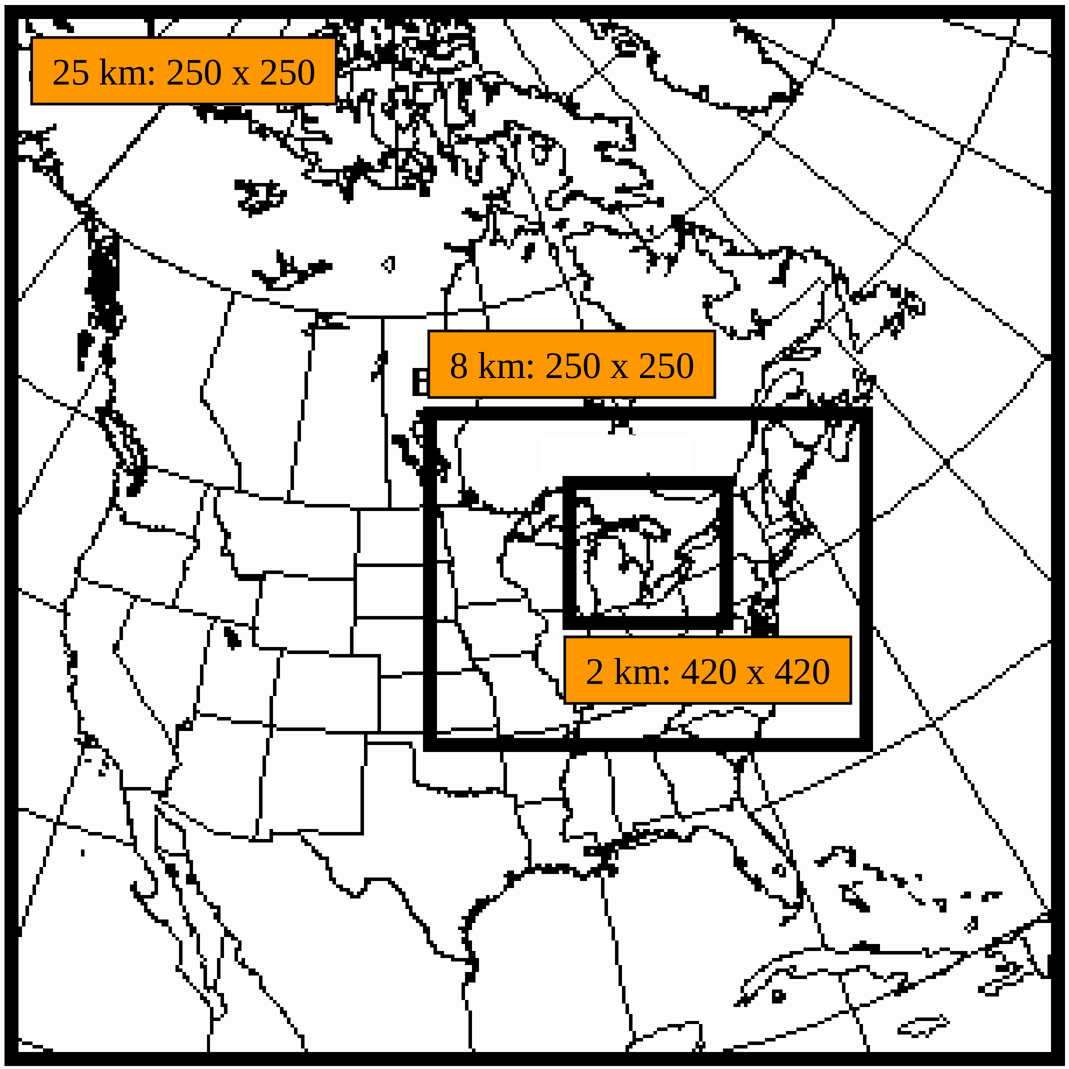


Modeling Strategy

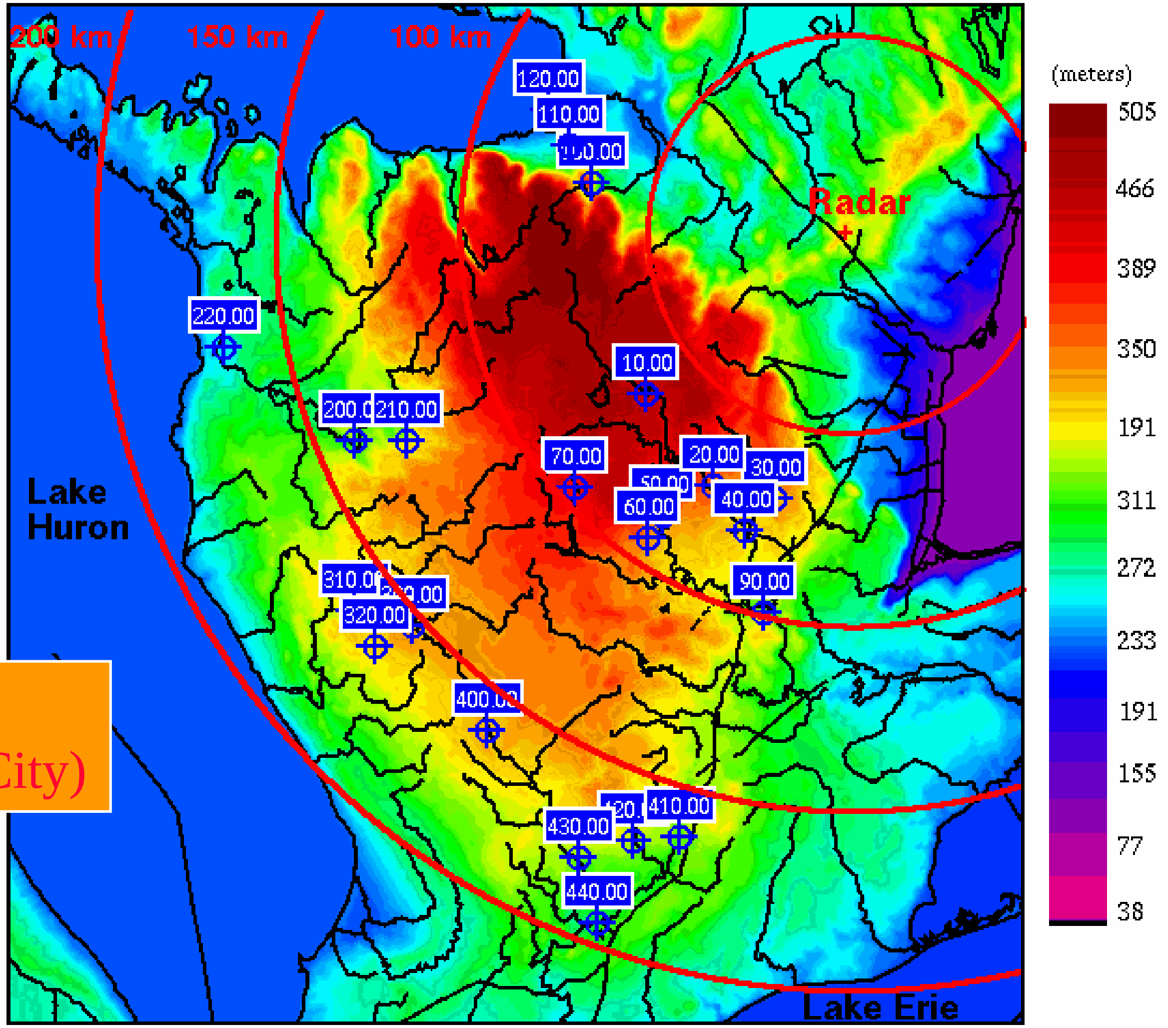
- Models
  - Present: MC2
  - Future: GEM-LAM
- Domain and resolution
  - North American (25 km)
  - Central Canada (8 km)
  - Southern Ontario (2 km)
- Coupling with hydrological model
  - Present: One-way

    Atm. Model ⟶ Hyd. Model
  - Future: Two-way

Domain for Atmospheric Modeling



SW Ontario watersheds



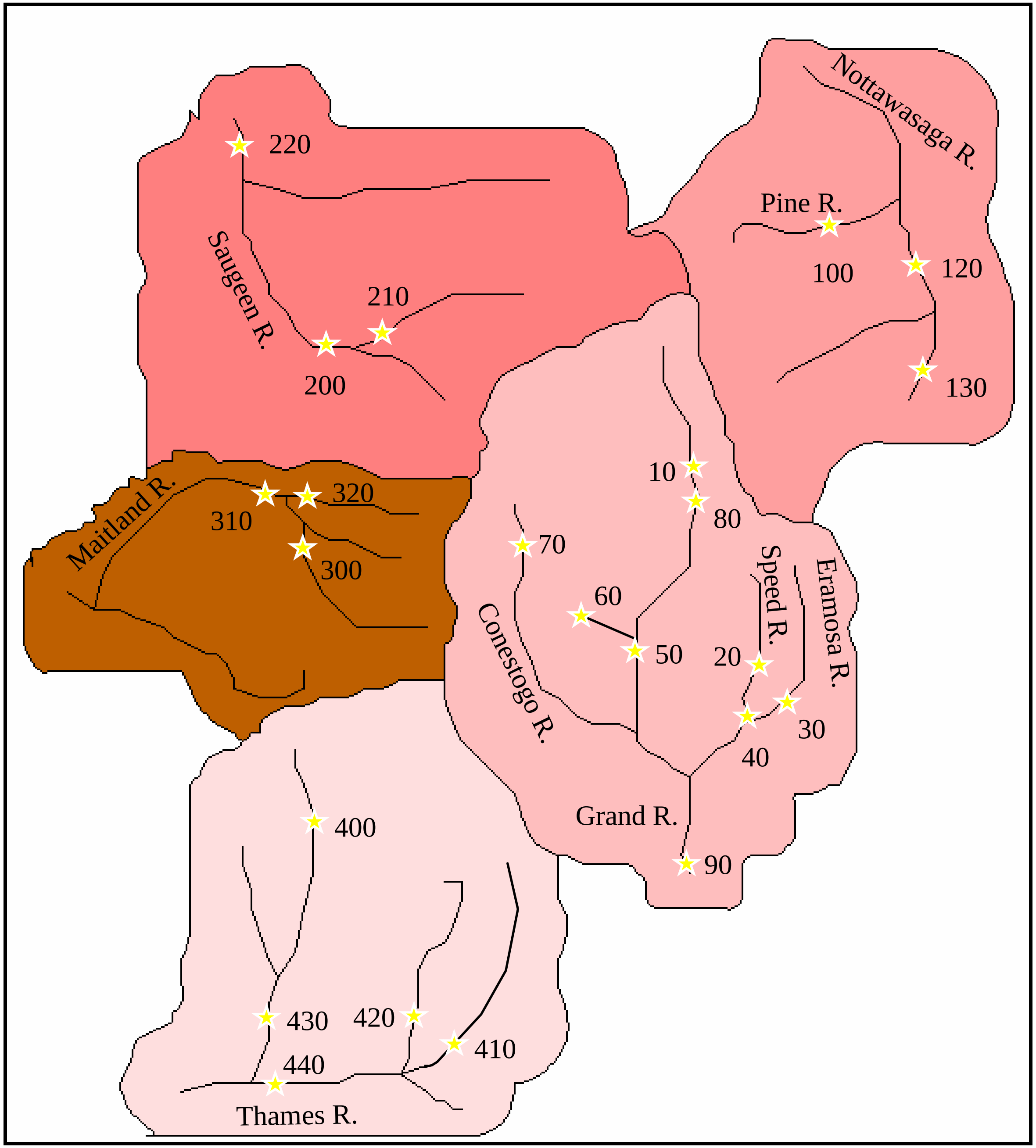
Streamgauges
Radar (King City)

10	WALDERMAR
20	SPD/ARMST MI
30	ERAMOSA/GUEL
40	GUELPH
50	W. MONTROSE
60	ELMIRA
70	CONEST/DRAYT
80	GRND/MARSVIL
90	GRND/GALT

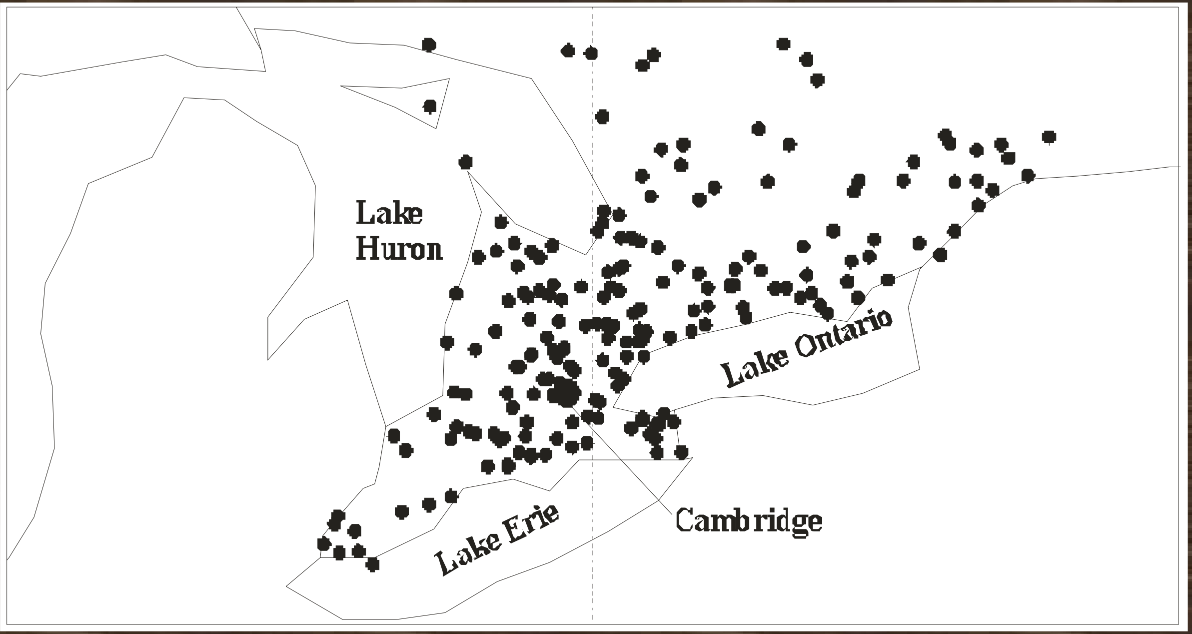
100	PINE R.
110	@ HOCKLEY
120	NR. BAXTER
200	WALKERTON
210	HANOVER
220	PT ELGIN
300	AB. WINGHAM
310	BL. WINGHAM
320	BELGRAVE

400	MITCHEL
410	INGERSOLL
420	THAMESFORD
430	THORNDALE
440	EALING

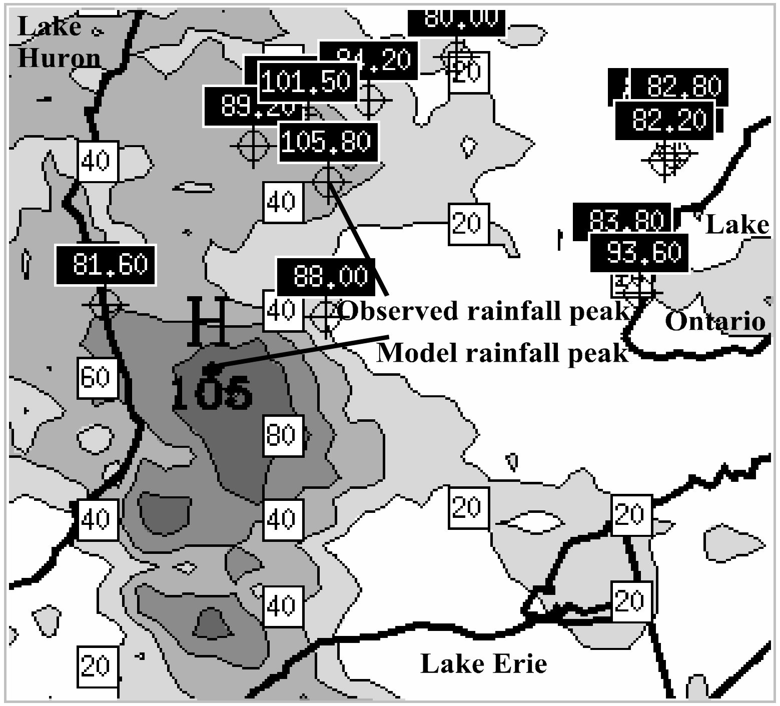
Five watersheds over southern Ontario basin



Geographic locations of 188 raingauges over southern Ontario in May 2000



The 48-h accumulated rainfall (the MC2 simulation versus the raingauge observation)



48-h precipitation accumulation from 06 UTC 11 May to 06 UTC 13 May 2000

8 km model

<u>Precipitation Schemes</u>
Conv: Kain-Fritsch
Strat: Full Microphysics
(explicit scheme by Hsie et al.)

QPF accuracy and skill

- The Bias
  - Bias = $\frac{1}{\mathrm{N}}\sum_{i=1}^{N}(F_i - O_i)$
- The root-mean-squared error (RMSE)
  - RMSE = $\sqrt{\frac{1}{\mathrm{N}}\sum_{i=1}^{N}(F_i - O_i)^2}$
- Bias Score (BS)
  - BS = $\frac{\mathrm{F}}{\mathrm{O}} = \frac{\text{"Yes" forecasts}}{\text{"Yes" observations}}$

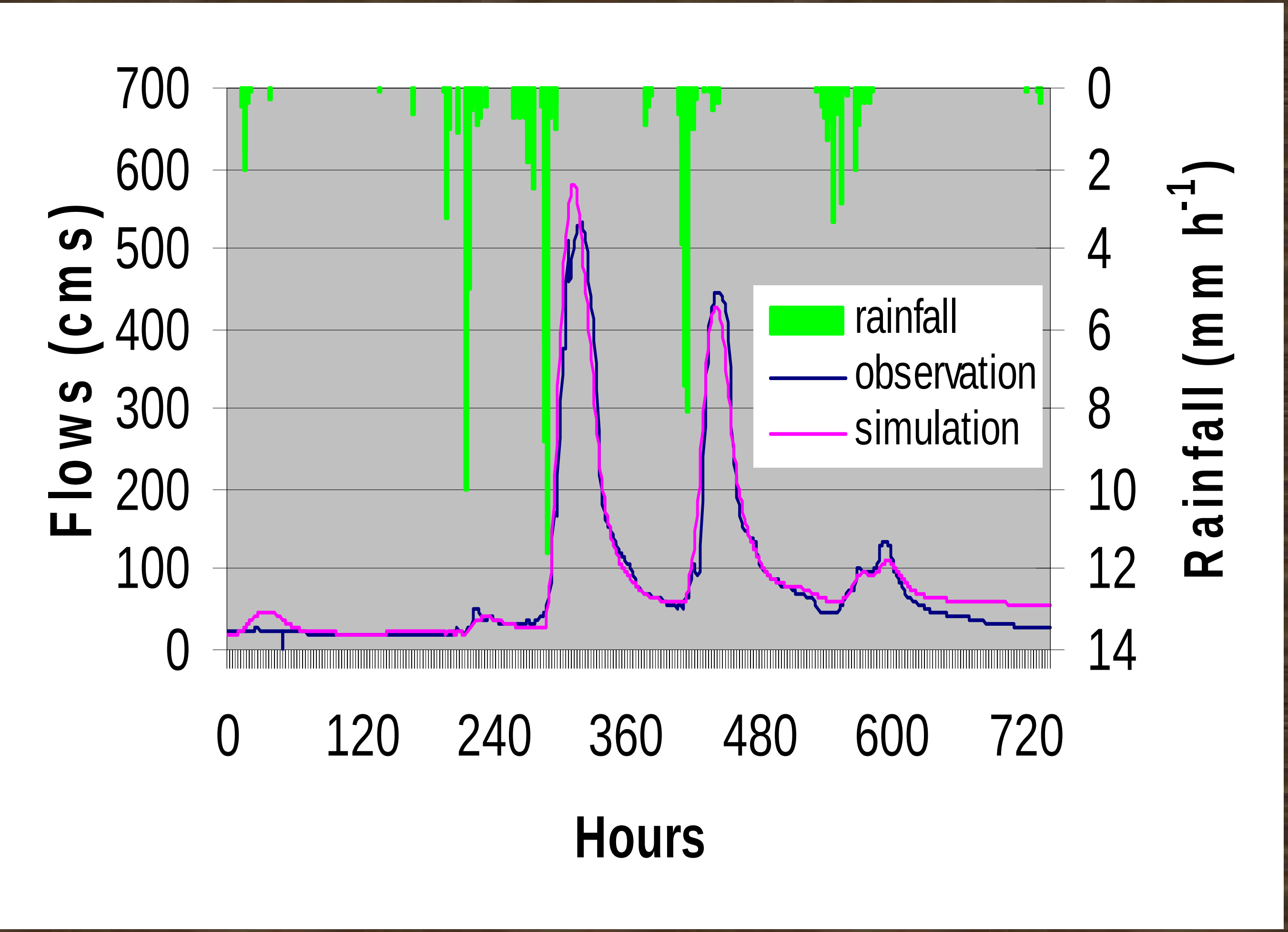
The accuracies of the MC2 simulated accumulated precipitation

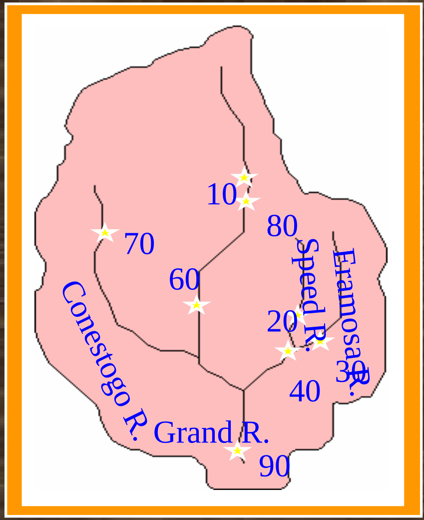
	Max. PR48	Bias	Bias	RMSE	RMSE
		1st 24 hours	2nd 24 hours	1st 24 hours	2nd 24 hours
Observation	105.8	-	-	-	-
MC2 25 km	79	2.7	-14.2	12.4	27.7
MC2 8 km	105	-3.1	-7.4	9.7	25.8

The skills of the MC2 simulated accumulated precipitation

	MC2 25 km	MC2 8 km
BS	0.3	0.6

The independent verification using the coupled model





Simulated streamflow (in red) v.s. observed streamflow (in blue) for Grand River at Cambridge for May 2000, with a bias of 6.9 cms

Conclusions

- The mesoscale model simulated 48-h accumulated peak precipitation successfully captures the observed peak rainfall.
- There is s systematic improvement in terms of the accuracies and skills when the model resolution is increased.
- The independent verification has been conducted by comparing the streamflow simulated by the coupled model with the observed streamflow. The excellent agreement between the simulations and observations in terms of magnitudes and timing of peak streamflows indicates that precipitation fields are well simulated by the mesoscale model.
- The agreement between the coupled atmospheric-hydrological model simulated precipitation and streamflow and the observations also indicates that this coupled modeling system can be potentially used for severe precipitation and flash flood forecasts.