Environment Canada Environnement Canada

Canada

Regional Ensemble Prediction System (REPS) :

Operational Qualitative Evaluation Process

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Overview

1. Regional Ensemble Prediction System REPS 2.0.1 (implemented Dec 4th 2013)
   a. Main changes from previous 1.1 version
   b. A&P evaluation on precipitation forecast

2. Notable cases during subjective evaluation by A&P

REPS 2.0.1 Improvements

- Decreased horizontal grid spacing (33 → 15km)
- Increased number of vertical levels (28 → 48)
- Hysteresis in the onset of turbulence in the boundary layer
- Suppression of the application of **PTP*** in:
  - Convectively unstable areas
  - Areas of strong orographic vertical velocities

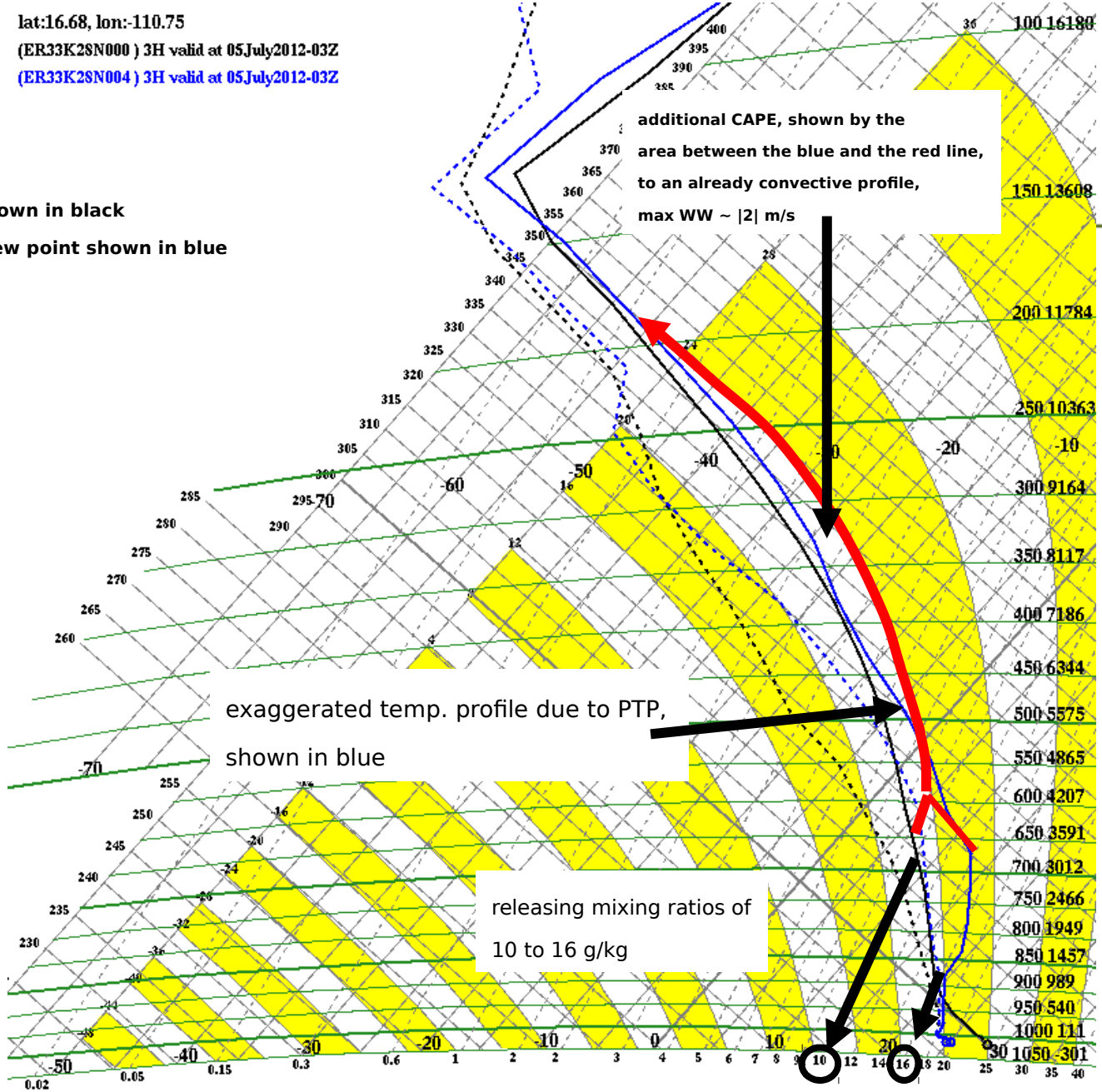
*__P__hysics __T__endency __P__erturbations

PTP issue and resolution

- REPS 1.1 (old) :
  - Localized excessive precip amounts produced in areas of deep convection where temperature perturbed
  - Due to environmental CAPE non-linearly increased (e.g. >1000 mm in 72 hours north of gulf of Mexico)

- REPS 2.0 (new):
  - restriction application of PTP where CAPE exist
  - restriction vertical speed > 0.5 m/s (topo convergence)

➢ More realistic precipitation amounts produced


lat:16.68, lon:-110.75
(ER33K28N000) 3H valid at 05July2012-03Z
(ER33K28N004) 3H valid at 05July2012-03Z
Tephigram of member 4
0 hr temp./dew point shown in black
3 hrs lead time temp./dew point shown in blue
additional CAPE, shown by the
area between the blue and the red line,
to an already convective profile,
max WW ~ |2| m/s
exaggerated temp. profile due to PTP,
shown in blue
releasing mixing ratios of
10 to 16 g/kg
100 16180
150 13608
200 11784
250 10363
300 9164
350 8117
400 7186
450 6344
500 5575
550 4865
600 4207
650 3591
700 3012
750 2466
800 1949
850 1457
900 989
950 540
1000 111
1050 -301

Evaluation by operational meteorologists

- Objective verification in development mode (Brier skill score) not conclusive for > 5 mm events
- Very difficult to validate convective precipitation from objective scores
- A&P was asked to subjectively validate changes made to PTP with new REPS 2.0
  - 41 model runs of summer 2011 (every 36hr)
  - Focus on episodes of QPF >5 mm over 24hr period

A&P evaluation summary

- 7 different meteorologists
- 106 cases spread over 236 periods of 24hr
- REPS products used:
  - Precipitation thresholds
  - Percentiles
- An evaluation grid was devised

-Case identification (datestamps, weather system types, regions)

-Observations (drop-down menu to select event and max observed, lightning present or not)

Thresholds: Low, High and Above automatically selected based on observed case

25th and 75th Percentiles and Median compared

Maximum forecast

Identification des Cas				Observations			Prévisions																Initiales	Commentaires: résumé de la situation
								Seuils (mm)						Percentiles						Max		Best		
														25%		Médiane		75%						
#	Émissions	Types	Régions	Obs (CaPA)	Max	Foudre		Bas		Haut		Au-dessus		33k	15k	33k	15k	33k	15k	33k	15k			
1	2011070100	Syst Synoptique	Côte Ouest	25-50 mm	50mm	Non	00-24h	>20	both	>50	15k	>75	N/A	25mm	30mm	30mm	40mm	40mm	mm	75mm	75mm	nil	AP	Depression approchant Haida Gwaii avec onde frontale se d
		Syst Synoptique	Côte Ouest	25-50 mm	50mm	Non	24-48h	>20	both	>50	both	>75	both	40mm	50mm	50mm	75mm	75mm	100mm	100mm	100mm	nil		Les 2 modèles ont générés de trop grandes quantités de pre
		Syst Synoptique	Côte Ouest	10-25 mm	25mm	Non	48-72h	>10	both	>20	both	>30	33k	20mm	25mm	25mm	30mm	30mm	40mm	75mm	75mm	33k -		Le 33k a été légèrement moins alarmiste avec des quantités
2	2011070100						00-24h																AP	Dépression en provennace du nord des Prairies Canadienne
		Syst Synoptique	ON-QC	10-25 mm	25mm	Oui	24-48h	>10	both	>20	33k	>30	nil	5mm	5mm	10mm	10mm	20mm	15mm	50mm	50mm	33k -		Le modèle 33k a eu une meilleure couverture à l'est de baie
		Syst Synoptique	ON-QC	10-25 mm	30mm	Oui	48-72h	>10	both	>20	both	>30	nil	10mm	10mm	15mm	15mm	20mm	20mm	50mm	40mm	nil		Les 2 modèles ont bien performés sans trouver de vainqueu
3	2011070212	Orographie	Côte Ouest	10-25 mm	20mm	Non	00-24h	>10	both	>20	both	>30	33k	25mm	25mm	25mm	40mm	40mm	50mm	50mm	50mm	33k -	EC	Dépression au large de Haida Gawii dont les précipitations
		Orographie	Côte Ouest	10-25 mm	20mm	Non	24-48h	>10	both	>20	both	>30	both	20mm	25mm	25mm	30mm	30mm	40mm	50mm	50mm	nil		Les deux modèles sont presque semblables, difficile de dis
		Orographie	Côte Ouest	25-50 mm	50mm	Non	48-72h	>20	both	>50	nil	>75	nil	25mm	25mm	25mm	40mm	40mm	50mm	50mm	50mm	nil		Les deux modèles sont presque semblables, difficile de dis
4	2011070212						00-24h																EC	Une dépression en provenance du TNO en direction des Pra
		Syst Synoptique	Prairies	5-10 mm	10mm	Oui	24-48h	>5	both	>10	both	>20	33k	10mm	5mm	15mm	10mm	25mm	20mm	50mm	50mm	15k -		Dépression avec un creux sur les Prairies bordure nord de A
		Syst Synoptique	Prairies	25-50 mm	40mm	Oui	48-72h	>20	both	>50	nil	>75	nil	10mm	10mm	15mm	15mm	25mm	25mm	75mm	75mm	nil		Les deux modèles sont presque semblables, difficile de dis
5	2011070212	Syst Synoptique	ON-QC	25-50 mm	40mm	Oui	00-24h	>20	both	>50	nil	>75	nil	25mm	25mm	30mm	30mm	50mm	50mm	75mm	75mm	nil	EC	Les deux modèles sont presque semblables, difficile de dis
		Cvctn organisée	ON-QC	25-50 mm	100mm	Oui	24-48h	>20	both	>50	nil	>75	nil	15mm	15mm	25mm	20mm	25mm	40mm	75mm	50mm	15k -		Le 33k a semblé surprévoir les précipitation associé au front
		Cvctn organisée	Atlantic	10-25 mm	50mm	Oui	48-72h	>10	33k	>20	nil	>30	nil	5mm	10mm	15mm	15mm	25mm	25mm	50mm	30mm	33k -		le 33k a mieux semblé attraper la convection le long du front
6	2011070400	Syst Synoptique	Côte Ouest	10-25 mm	20mm	Non	00-24h	>10	both	>20	both	>30	nil	10mm	15mm	15mm	20mm	20mm	25mm	40mm	40mm	nil	AP	Dépression sur l'est du Pacifique devenant verticale juste à l
		Syst Synoptique	Côte Ouest				24-48h																	(manque d'observation…il y a une obs de 20mm mais la zon
		Syst Synoptique	Côte Ouest	5-10 mm	10mm	Non	48-72h	>5	15k	>10	15k	>20	nil		5mm		5mm	5mm	10mm	10mm	15mm	15k -		Basé sur une seule observation mais située directement dar
7	2011070400	Syst Synoptique	Prairies	10-25 mm	20mm	Oui	00-24h	>10	both	>20	both	>30	33k	15mm	20mm	25mm	25mm	40mm	40mm	75mm	50mm	15k -	AP	Dépression traversant le centre des Prairies Candiennes à t
		Syst Synoptique	ON-QC	10-25 mm	25mm	Oui	24-48h	>10	nil	>20	nil	>30	nil			5mm	5mm	10mm	10mm	25mm	25mm	nil		
		Cvctn organisée	ON-QC	10-25 mm	30mm	Oui	48-72h	>10	both	>20	both	>30	15k				5mm	10mm	15mm	75mm	40mm	15k -		Convection associée à un front froid s'étirant à travers le sud
8	2011070400	Cvctn organisée	Prairies	25-50 mm	30mm	Oui	00-24h	>20	15k	>50	nil	>75	nil			5mm	5mm	5mm	10mm	50mm	50mm	15k -	AP	Convection organisée associée au secteur chaud et front fro
							24-48h																	(rien d'intéressant à vérifier…)
							48-72h																	(données d'obs qpf 24hr valide le 7 juillet 00Z ne sont pas di
9	2011070400	Syst Synoptique	Atlantic	10-25 mm	30mm	Oui	00-24h	>10	both	>20	15k	>30	both	5mm	10mm	20mm	20mm	20mm	25mm	100mm	75mm	15k -	AP	Système frontal traversant l'Est du pays avec front chaud bier
		Syst Synoptique	Atlantic	10-25 mm	20mm	Oui	24-48h	>10	both	>20	nil	>30	nil	10mm	10mm	10mm	10mm	15mm	15mm	40mm	30mm	nil		

24-hour periods evaluated (00-24h, 24-48h, 48-72h)

Best model as a probabilistic tool

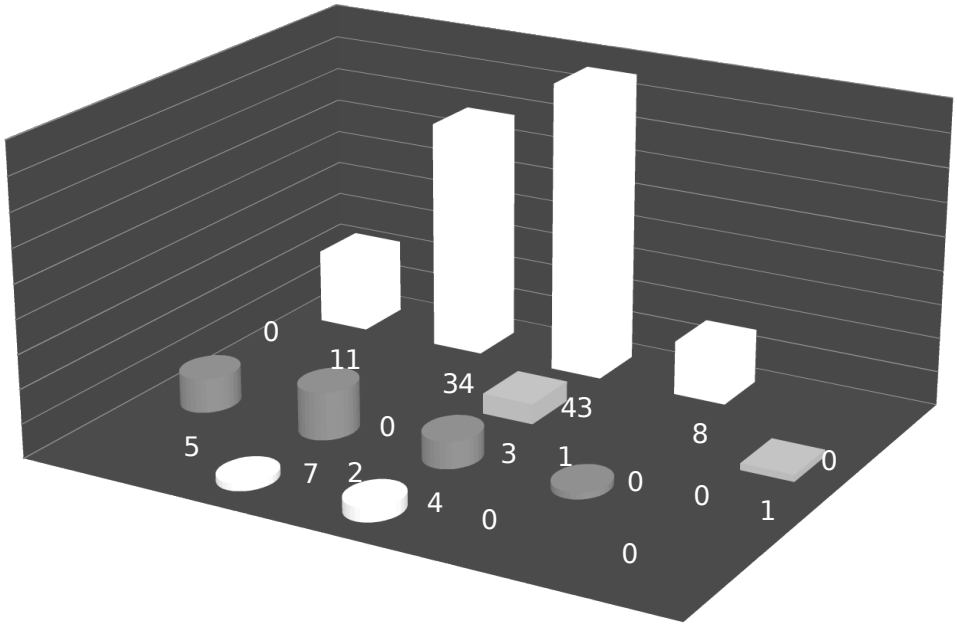
Comments

Meteorologists initials

Results

> 236 evaluated periods: 100 versus 20 in favor of 15km (5:1 ratio)

Best					
nil	15k -	15k +	33k -	33k +	total
116	96	4	17	3	236
49%	41%	2%	7%	1%	



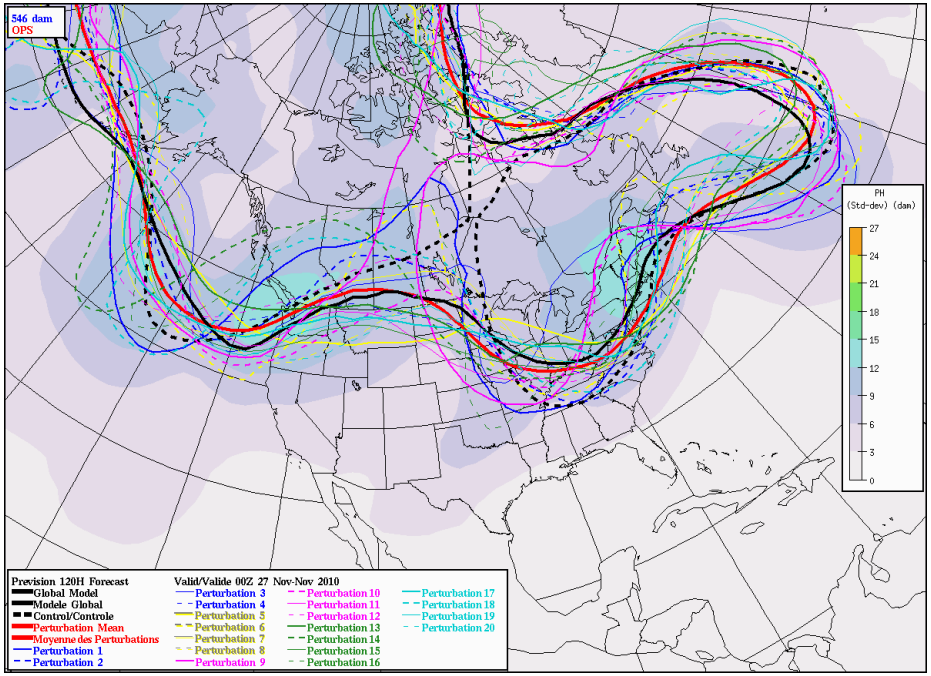
Evaluation conclusions

- ✓ REPS 2.0 showed a ratio of 5:1 subjective improvement over REPS 1.1 for precipitation amounts for all weather systems over all periods and across North America.

- ✓ Correction to PTP verified positively regarding exagerated precipitation amounts. New REPS 2.0 maximum QPF value (single member) was consistenly lower compared to REPS 1.1 without compromising the ensemble spread.

Operational Case Studies

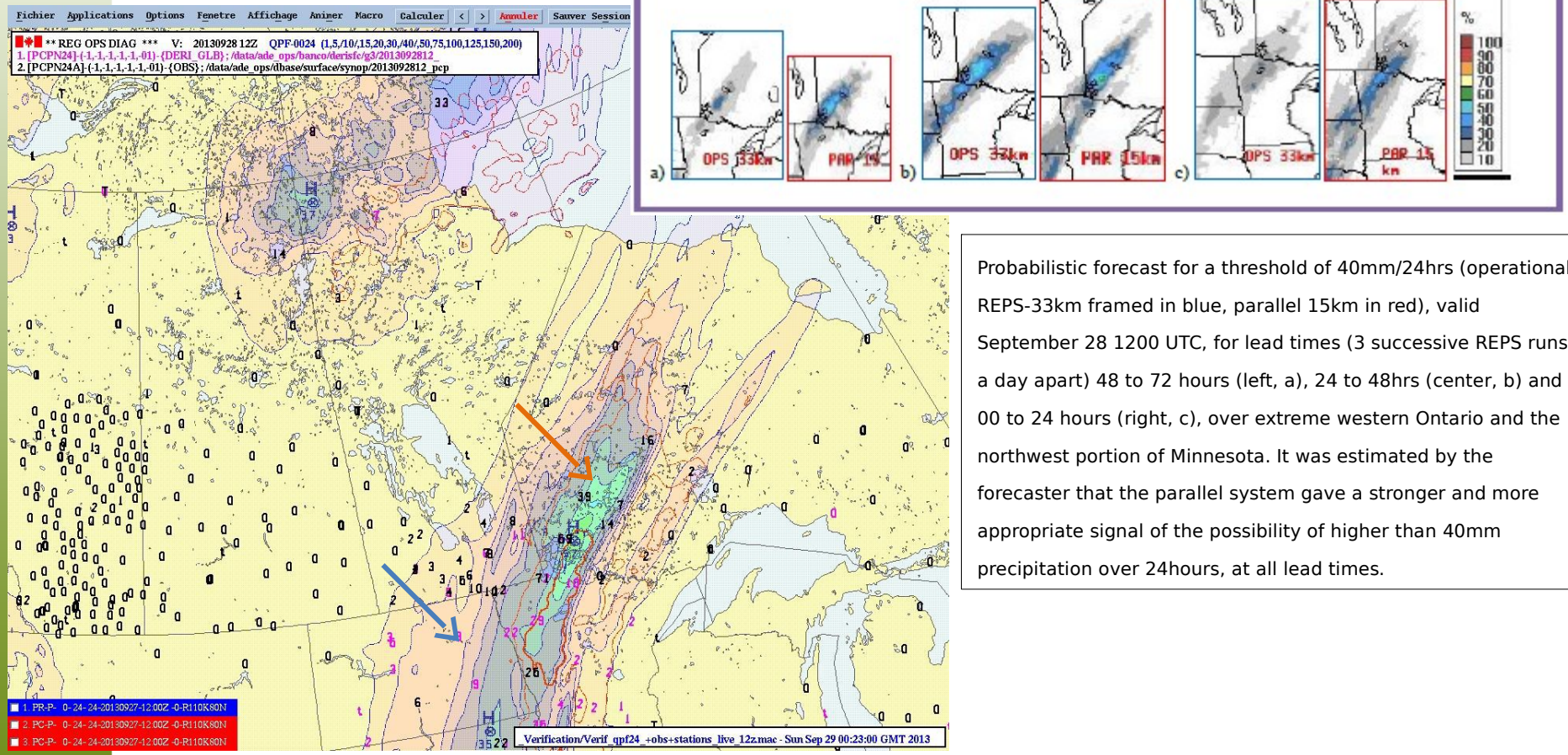
Examples taken among Graphical FX (GFX) produced by A&P meteorologists during parallel phase of REPS 2.0 and GEPS 3.1



28 September 2013, 1200 UTC. 24 hour precipitation SYNOP observations in black with superimposed 00-24 hours QPF forecast (arrows indicate **10** and **40** mm contours) from the operational Regional Deterministic Prediction System (GEM-Regional-10km). Several reports near or above 40mm in 24 hours. Red contours in the forecast are the convective scheme contribution.

Case 1:

Significant precipitation amounts with deep convection embedded

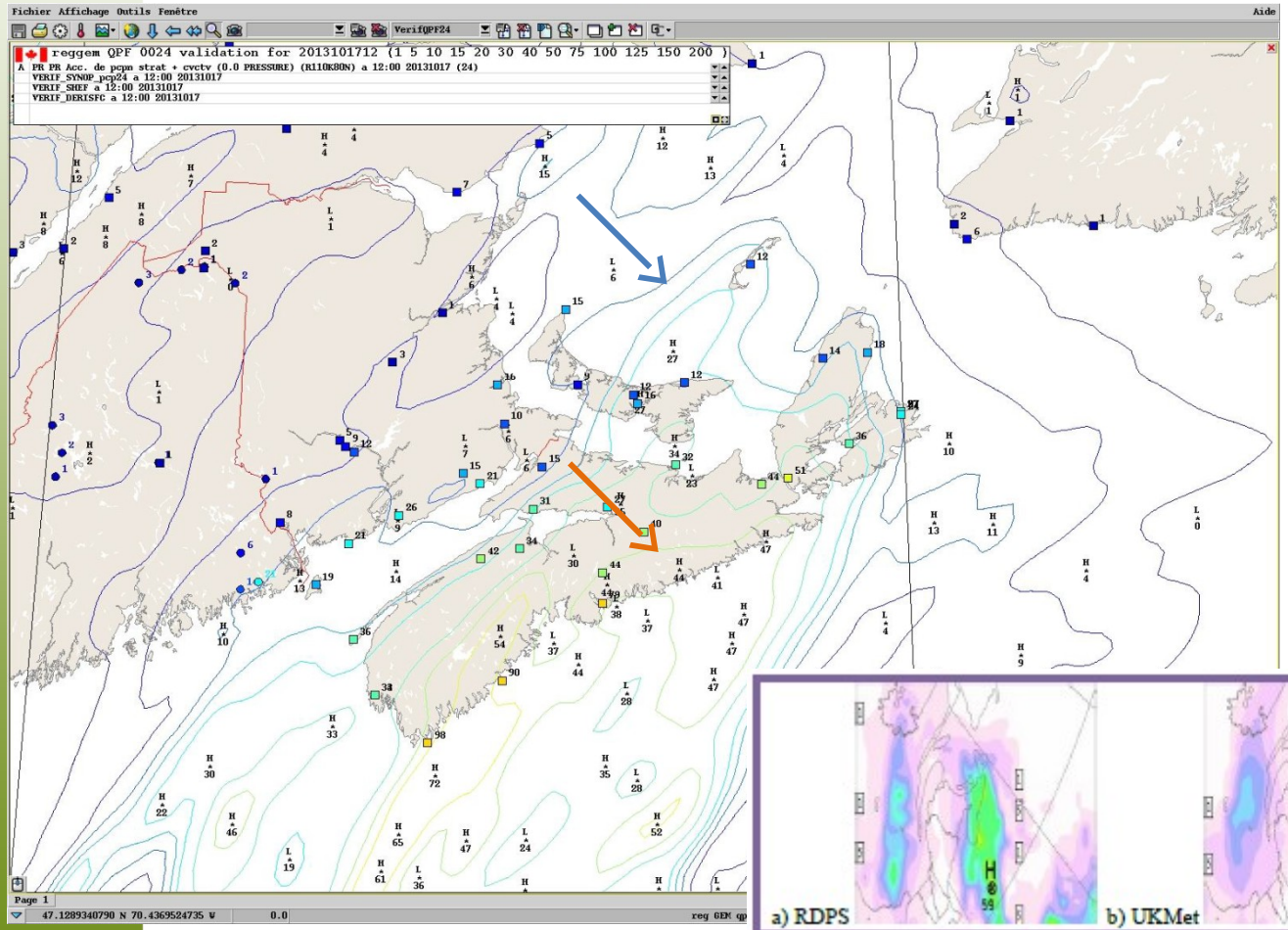


Probabilistic forecast for a threshold of 40mm/24hrs (operational REPS-33km framed in blue, parallel 15km in red), valid September 28 1200 UTC, for lead times (3 successive REPS runs a day apart) 48 to 72 hours (left, a), 24 to 48hrs (center, b) and 00 to 24 hours (right, c), over extreme western Ontario and the northwest portion of Minnesota. It was estimated by the forecaster that the parallel system gave a stronger and more appropriate signal of the possibility of higher than 40mm precipitation over 24hours, at all lead times.

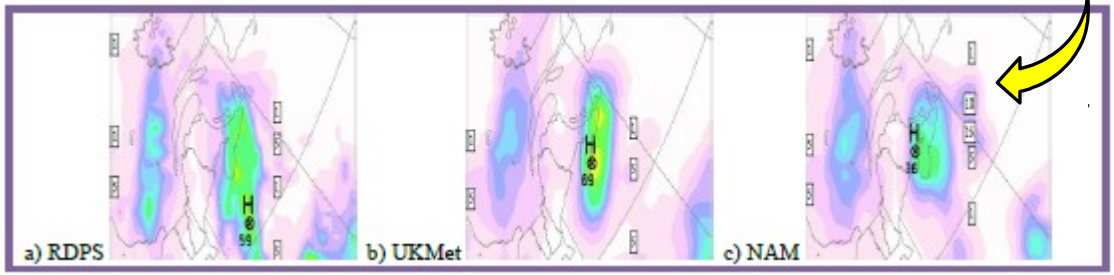
24 hour precipitation SYNOP observations (colored squares with black digits), valid 17 October 2013, 1200 UTC, with superimposed 00-24 hours QPF (10 and 40 mm contours indicated by arrows, maxima and minima QPF indicated by H's and L's) from the operational RDPS. Several observations near or above 40mm in 24 hours over southwestern Nova Scotia.

Case 2:

Atlantic depression giving significant rainfall across Nova Scotia



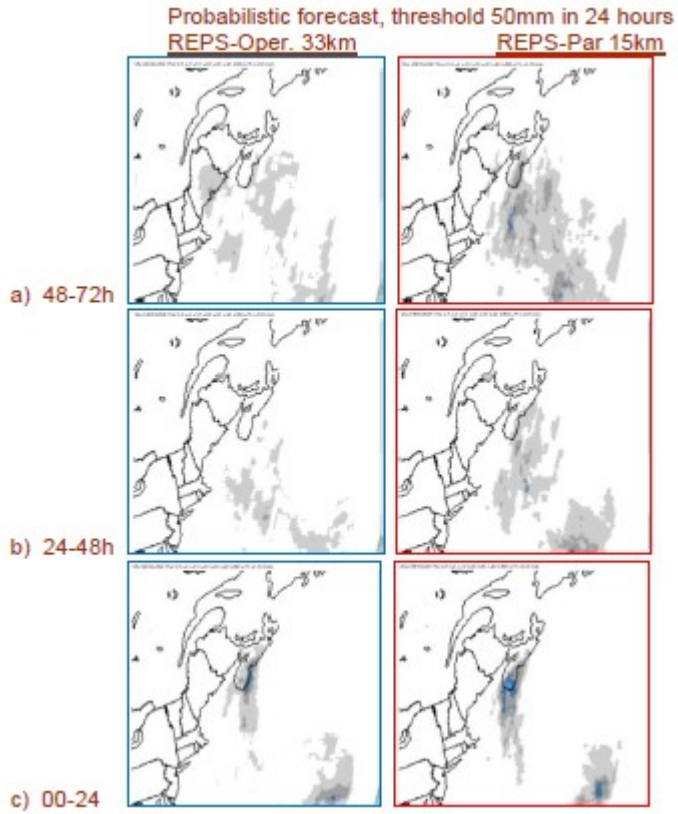
24 hours QPF forecast at 00-24 hours lead time, over Nova Scotia, valid 17 October 2013, 1200 UTC, with maxima in black, from the 10 km operational CMC-RDPS (a, left), the 25 km UKMet (b, centre) and the 12 km NCEP-NAM. Deterministic models (including CMC's GEM-Global and NCEP-GFS, not shown) were showing fairly different solutions even at short lead-time, making this case a good candidate to compare with probabilistic forecasts.



(continued...)

Case 2:

Atlantic depression giving significant rainfall across Nova Scotia



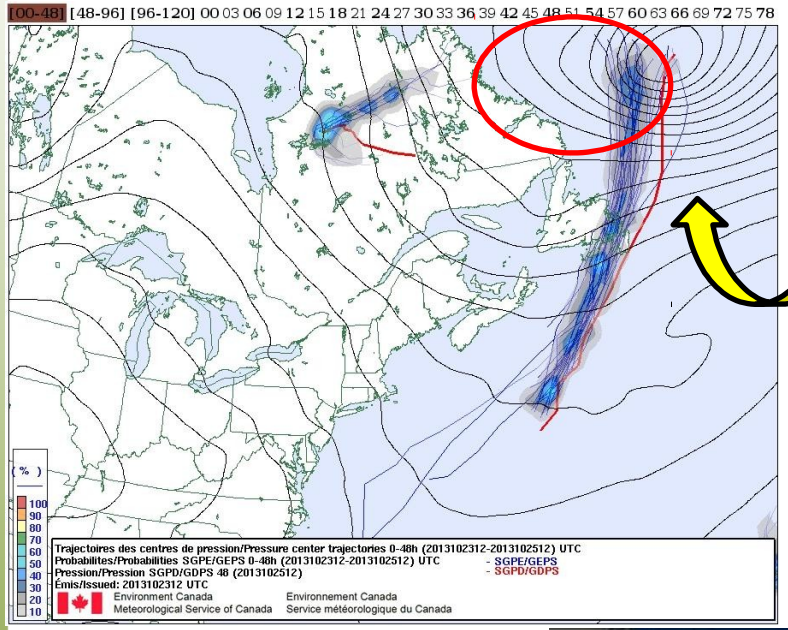
Probabilistic forecast for a threshold of 50 mm/24hrs (operational REPS-33km framed in blue, left, parallel-15km framed in red, right) valid October 17 1200 UTC, for the lead times (3 successive REPS runs a day apart) 48 to 72 hours (top, a), 24 to 48hrs (center, b) and 00 to 24 hours (bottom, c), over Nova Scotia and adjacent waters.

It was estimated by the forecaster that the parallel system gave a stronger and more appropriate signal of the possibility of higher than 50mm precipitation over 24hours, at lead times 48-72h and 24-48h.

1. Case data shows that Cdn deterministic global model made pretty good 120 h forecast of a deepening depression tracking toward Labrador sea. Verifying track in white on lower center image.

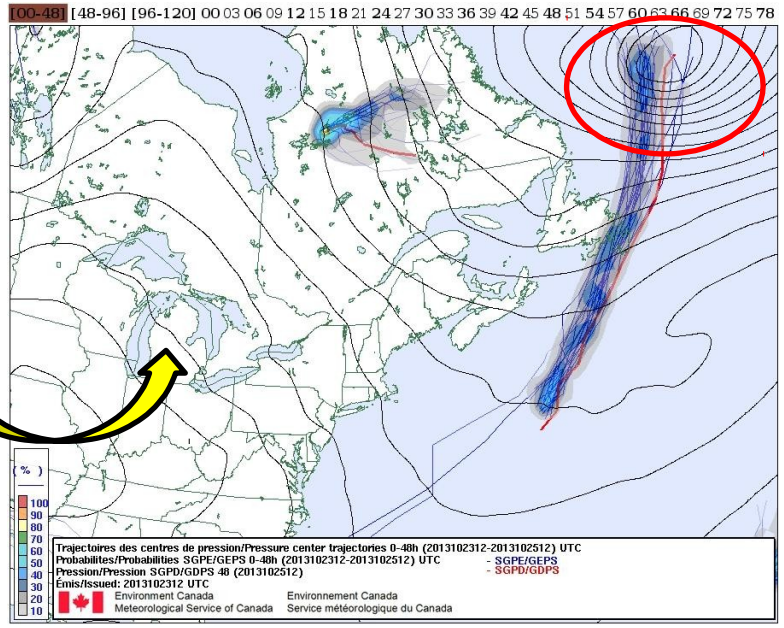
Case 3:

Trajectory of an Atlantic bomb

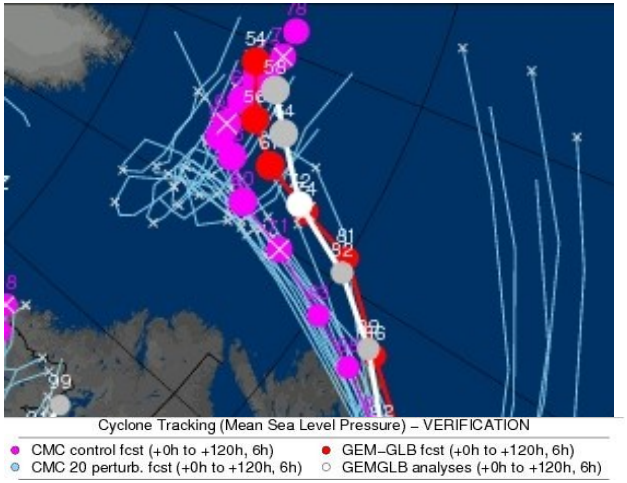


OPS

PAR



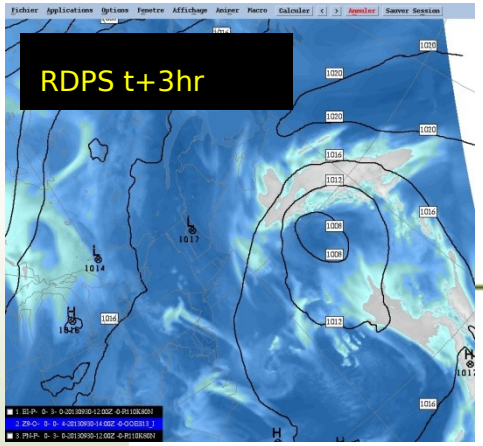
2. Global Ensemble (GEPS) sent the wrong signal, tracking the low further west!

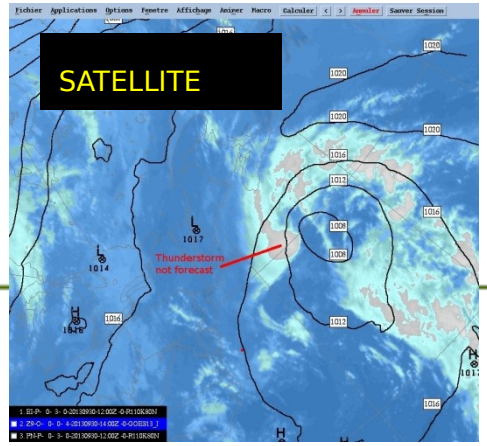


3. GEPS parallel run was <u>less mistaken,</u> with several members tracking to the east of GDPS track, showing a <u>better spread</u> that included the truth.

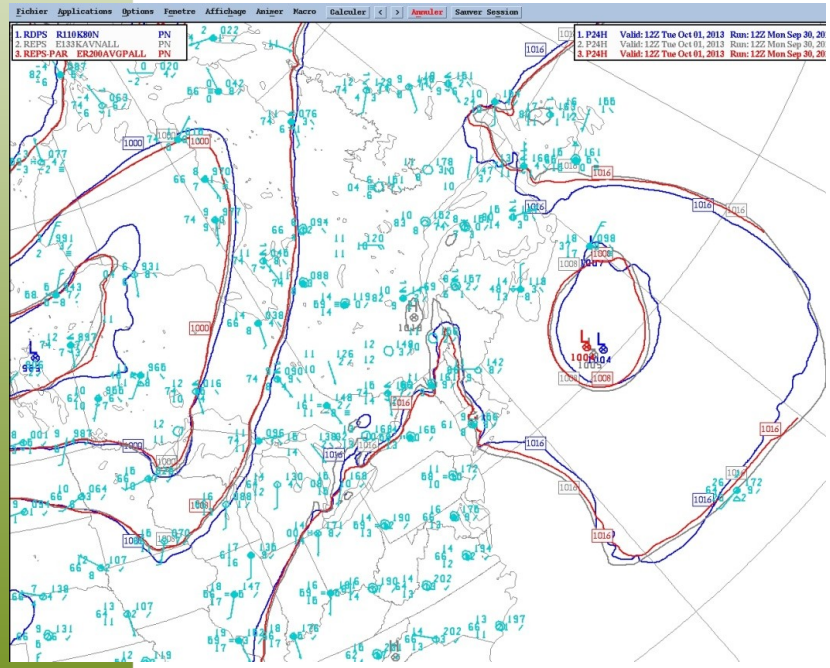
Case 4:

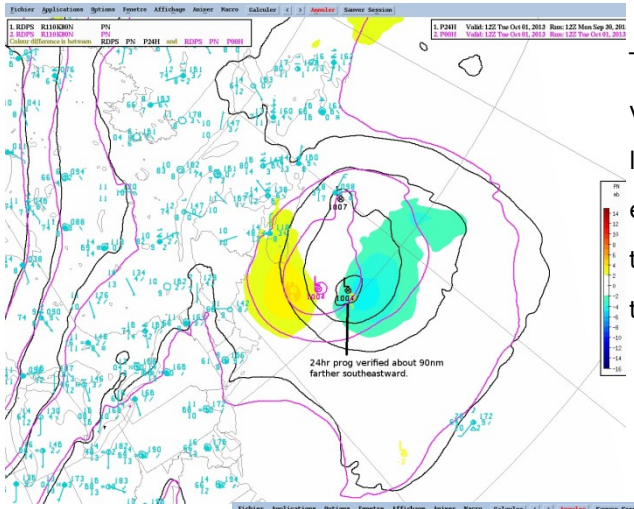
Slow moving tropical system





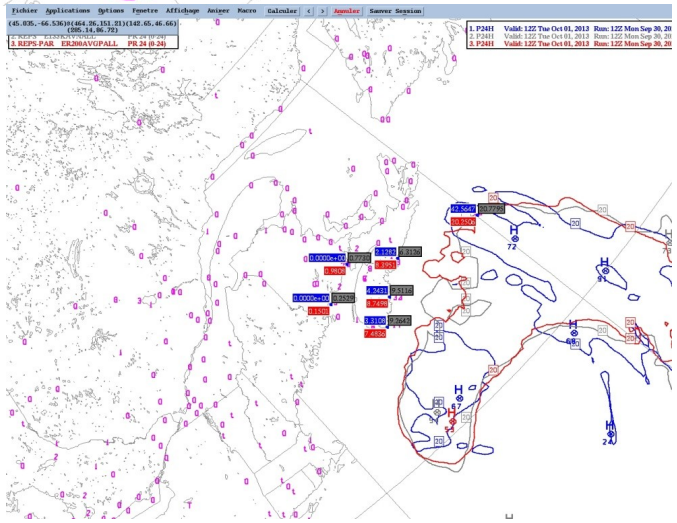
Moisture initialisation had problems over northwest quadrant: missing deep convection





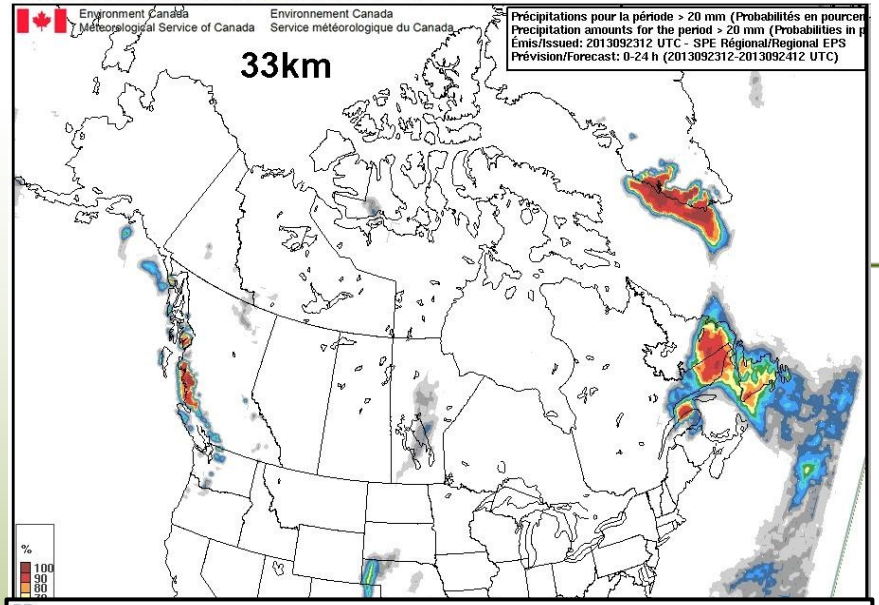
This type of system is very sensitive to latent heat: we could expect its trajectory to be further west than forecast.

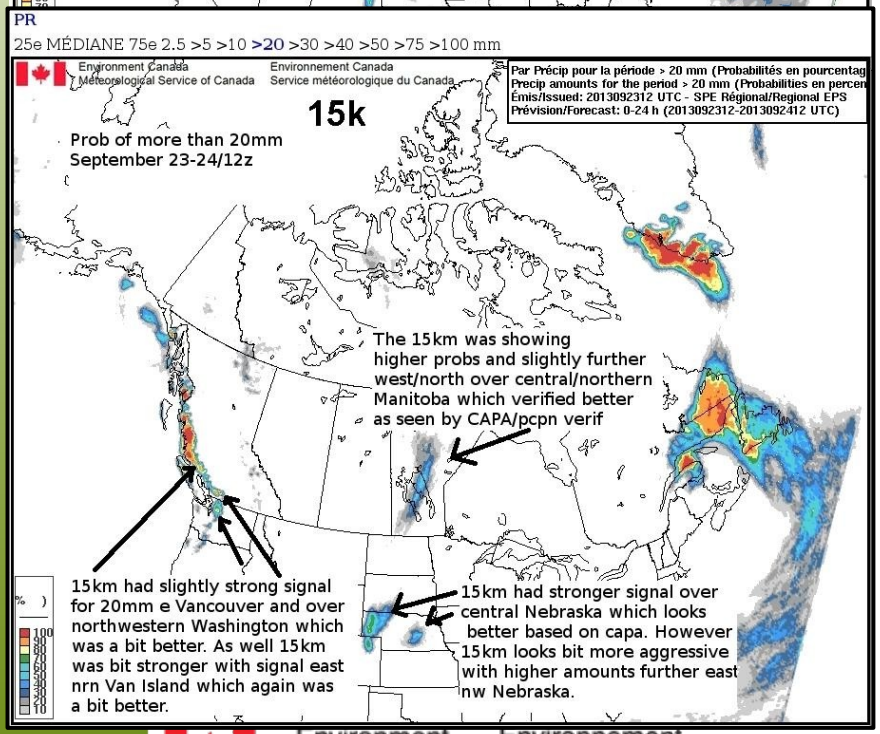
Interesting to see that REPS (Ops and Par) did better not only with depression track but also with QPF compared to RDPS

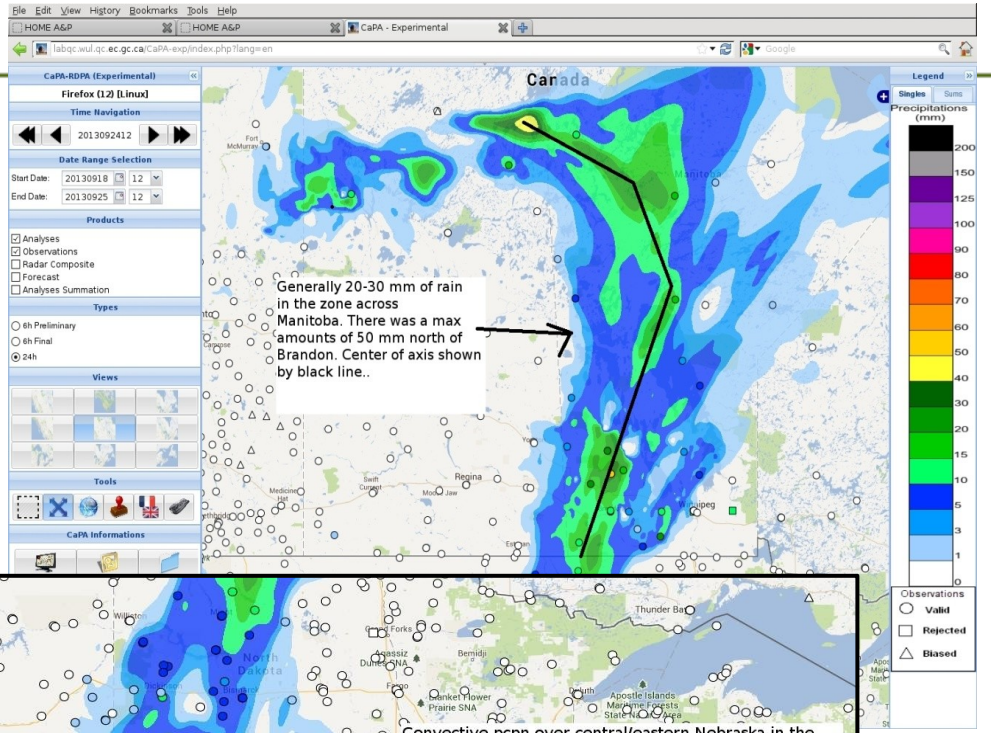


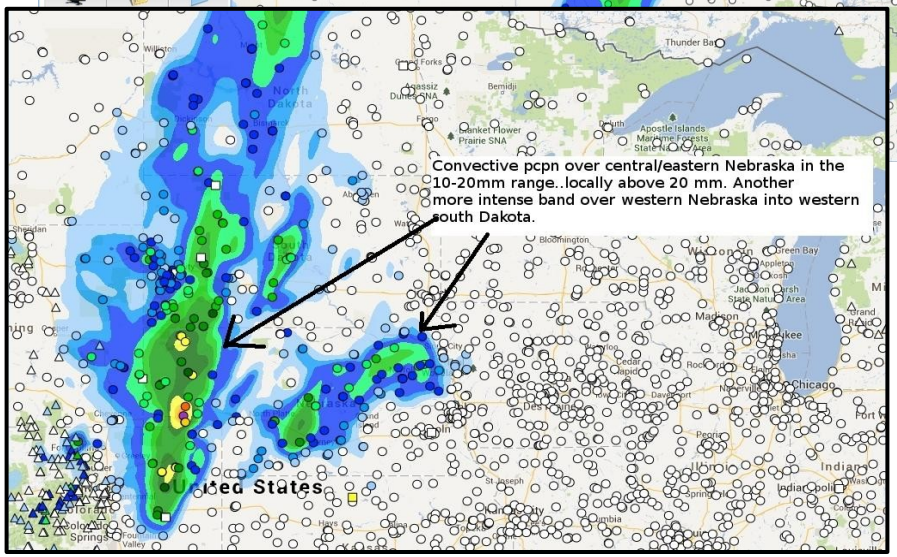
Case 5:

Prairies deep convection









Documentation

- Technical note REPS 2.0.1 :
  http://collaboration.cmc.ec.gc.ca/cmc/cmoi/product_guide/docs/lib/technote_reps201_20131204_e.pdf

- R&D seminar (PPT presentation):
  http://labqc.wul.qc.ec.gc.ca/eps/doc/seminar03.pptx

- REPS products of the *High Impact Weather Laboratory:*
  http://labqc.wul.qc.ec.gc.ca/eps/index.html

  - Including quilt of REPS products:
    http://labqc.wul.qc.ec.gc.ca/eps/quiltEn.html