Towards an Operational
High Resolution Deterministic Prediction System

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Pre-CPOP Seminar, 11 Feb 2011

SPDHR / HRDPS

(i.e. “GEM-LAM-2.5 system)

HRDPS Development Group

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National Laboratories

Ruping Mo (Vancouver)
Ron Goodson (Edmonton)

https://wiki.cmc.ec.gc.ca/wiki/PPS/HRDPS

Outline of Presentation

1. Background
2. Proposal to upgrade HRDPS
3. Tests and evaluations
4. Future work

Just kidding

History of the HRDPS

- 1997: Project initiated by CMC/RPN (**HiMAP**)
- Since 1999: Collaboration with **PNR**
- Summer 2001: **ELBOW** project (**MRB and Ontario region**)
- Since 2002: Collaboration with **PYR**
- Since 2004: Collaboration **Quebec region**

Other related experimental systems:

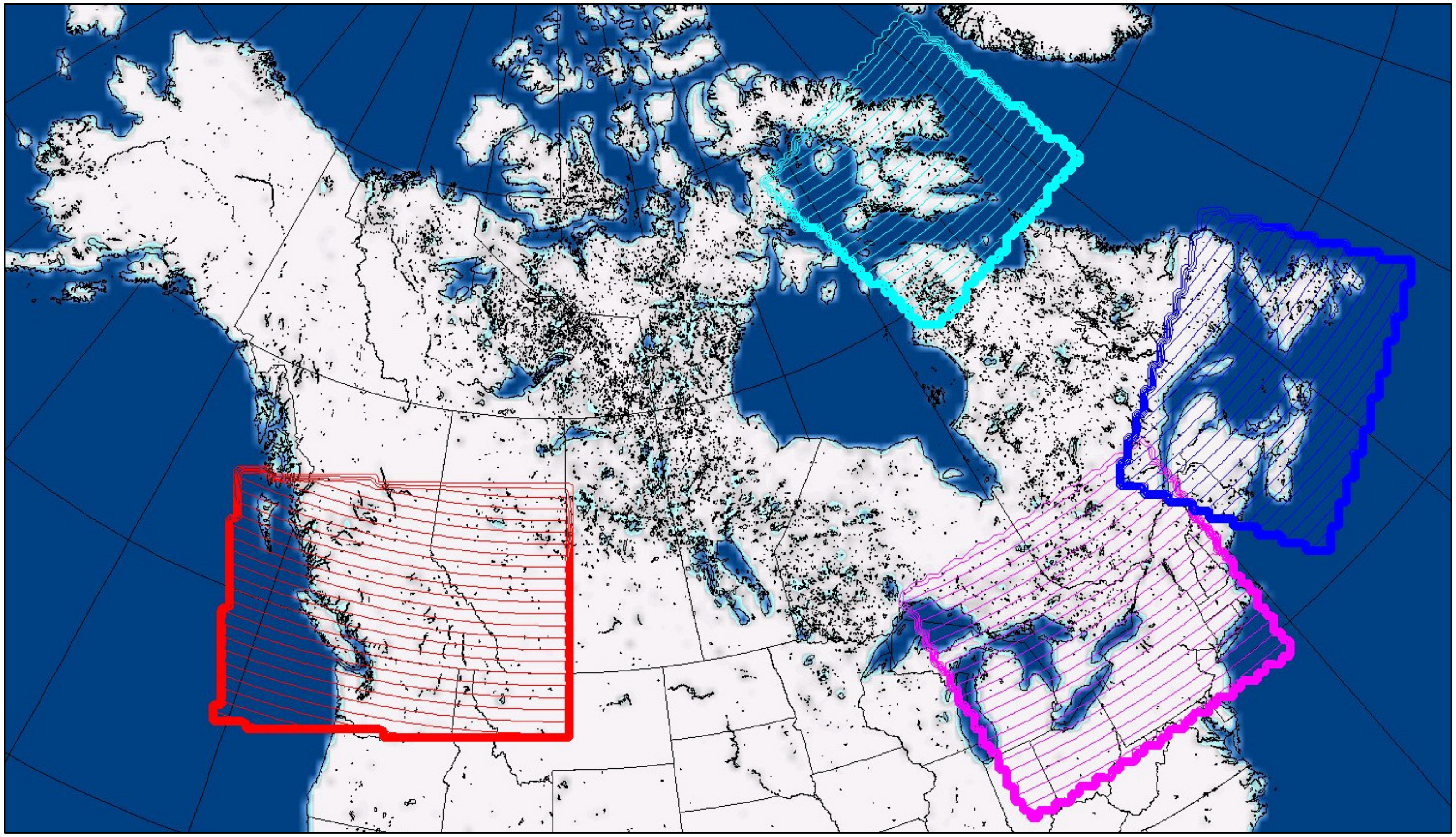
- 2001: MAP
- 2007: MAP-DPHASE
- 2008-09: UNSTABLE
- 2008-10: Lancaster Sound
- 2010: Vancouver 2010 Winter Olympics/Paralympics

Current Status of the HRDPS

- 4 grids
- Horizontal grid spacing: 2.5 km
- 58 vertical levels
- Run 24-h, initialized from 00z Reg-15 run
- For each domain, a 15-km LAM is run first
- GEM_v3.2.2 / PHY_v4.4 + mods
    - Fouquart-Bonnel / Garand radiative transfer scheme
    - 1-moment Milbrandt-Yau microphysics scheme

Current Status of the HRDPS

- 4 grids



Motivation for an Operational HRDPS

1. Environment Canada forecasters already use it regularly
2. There is often added forecast value in high-res DPS
    - Better resolution of weather systems
    - Better physics – (e.g. precipitation scheme)
3. “Operational” status means exposure

Towards an Operational HRDPS

Upgrade-1: (this proposal)

1. Change model version to GEM_v4.2.0
2. Change physics configuration to that of V-10 system
3. Changes to Maritime domain

Upgrade-2:

- Switch to “operational” status
  - CPOP standards
  - formal verification package
- Further developments

Proposed Upgrade

Upgrade-1:

1. Change model version to GEM_v4.2.0

→

- Supported by GEM Development group
- Staggered vertical levels
- More efficient cascading

Proposed Upgrade

Upgrade-1:

1. Change model version to GEM_v4.2.0
2. Change physics configuration to that of V-10 system

→
- Li and Barker (2005) radiative transfer
- Double-moment microphysics

New Radiative Transfer Scheme:

Correlated k-Distribution Scheme (Li and Barker, 2005)

Main impacts: (of scheme change in REG and Global)

- **strong correction to tropical upper troposphere bias**
- **significant reduction in number of false alarms of tropical cyclones**
- **responsible for half of RMSE GZ500 reduction in Gem-Strato implementation**
- **warming of surface related to improved LW fluxes**

Operational in RDPS (Reg-15) since March 2009

Operational in GDPS (Global) since June 2009

Part of Regional Ensembles since fall 2009

Part of next implementation of Global Ensembles

New Microphysics Scheme:

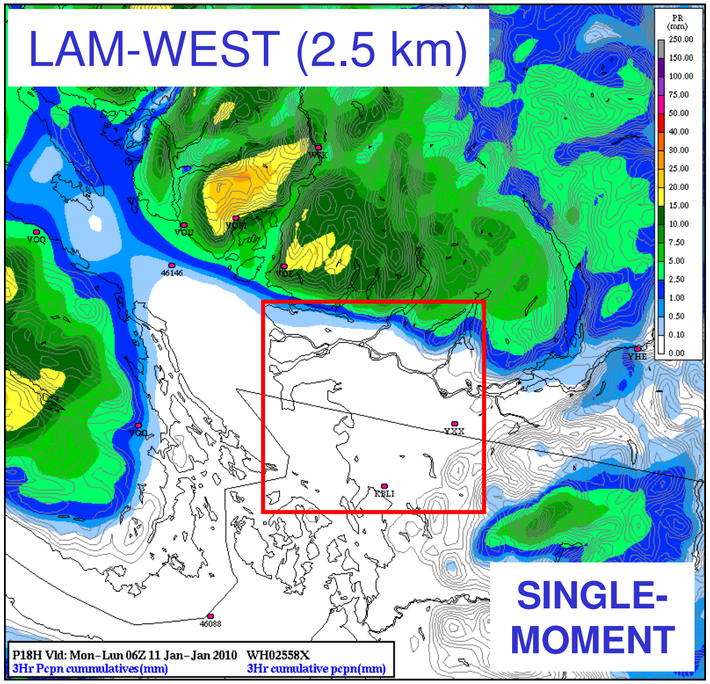
Double-Moment Milbrandt-Yau

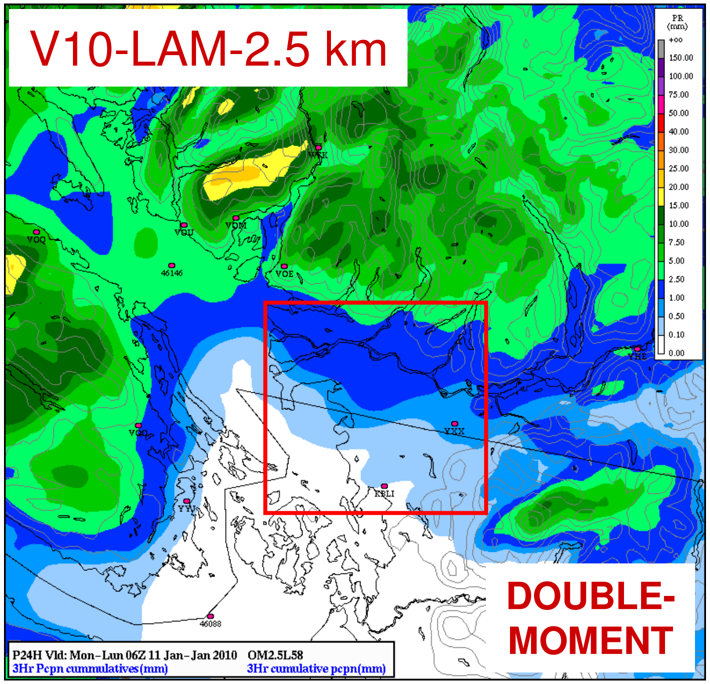
Main differences: (vs. Single-Moment version, current system)

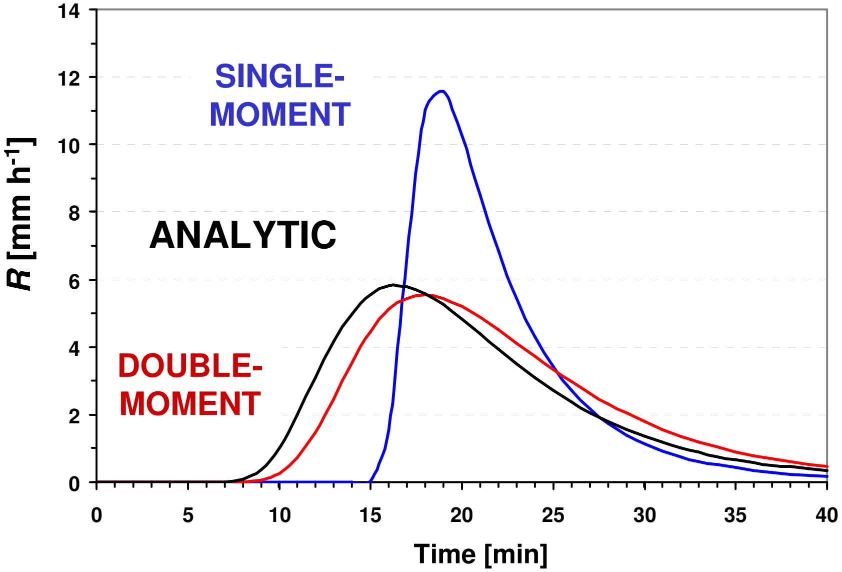
- **several improvements to parameterizations**
- **better precipitation rates (in principle)**
- **new prognostic and diagnostic fields**
- **V10 + bug fixes**

NOTE: New scientific developments (variable graupel density, new hail initiation, etc.) will be proposed for Upgrade-2

Double-Moment Microphysics

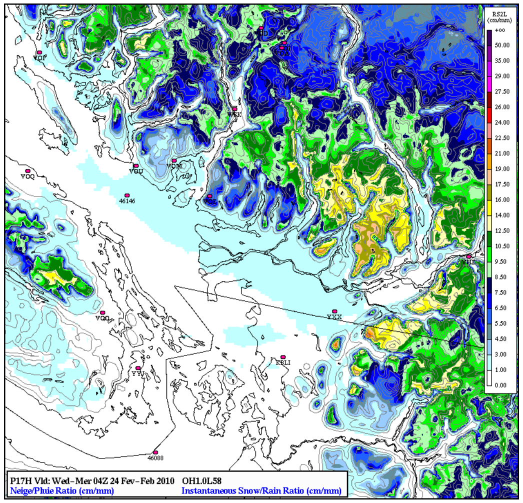


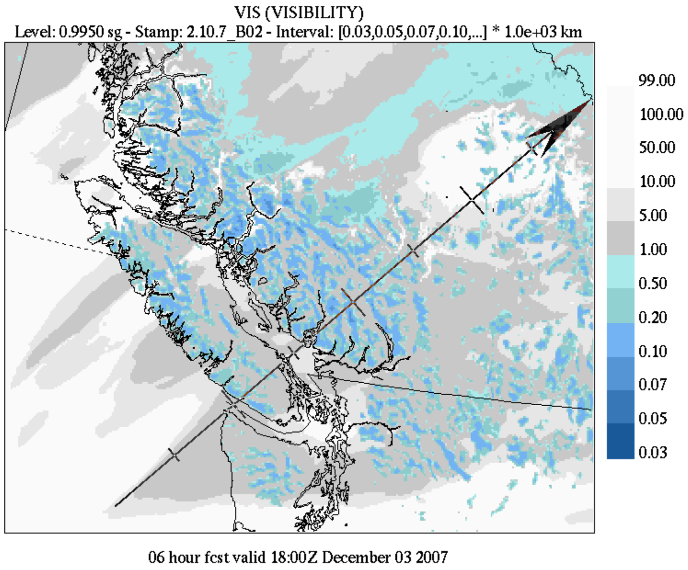


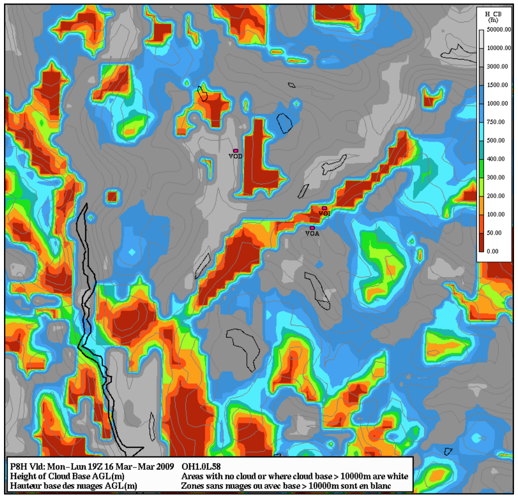


→ Improved prediction of light pcp in the Vancouver region □ with double-moment scheme

Double-Moment Microphysics







Cloud base height

Visibility

- through fog, rain, snow

Solid-to-Liquid Ratio

→ improved forecasts of snow amounts

Proposed Upgrade

Upgrade-1:

1. Change model version to GEM_v4.2.0
2. Change physics configuration to that of V-10 system
3. Changes to Maritime domain

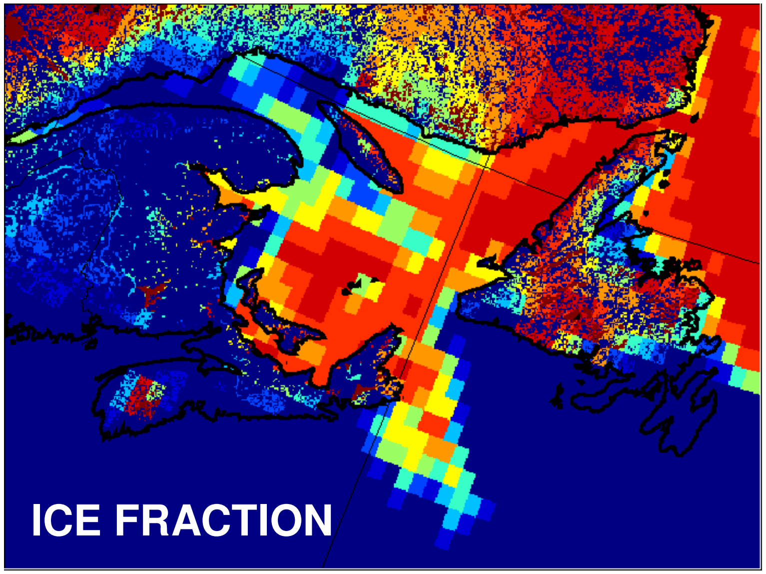
→

- Surface ICs from GSL coupled system
- Expansion of grid

Initialization of the **surface fields** with output from the **GSL coupled system**

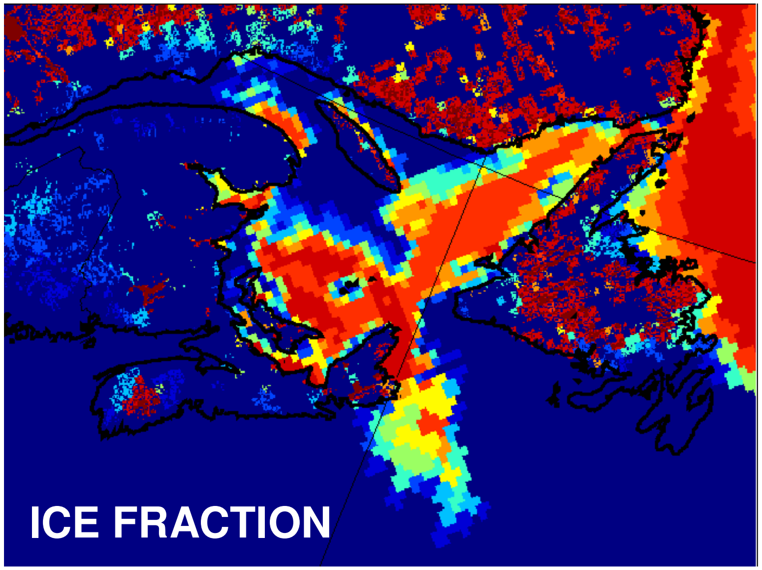
- **SST** (TM)
- **ice fraction** (GL)
- **sea ice temperature** (I7)
- **sea ice thickness** (I8)

REGETA1 → LAM-2.5km



00 UTC 25 March 2009

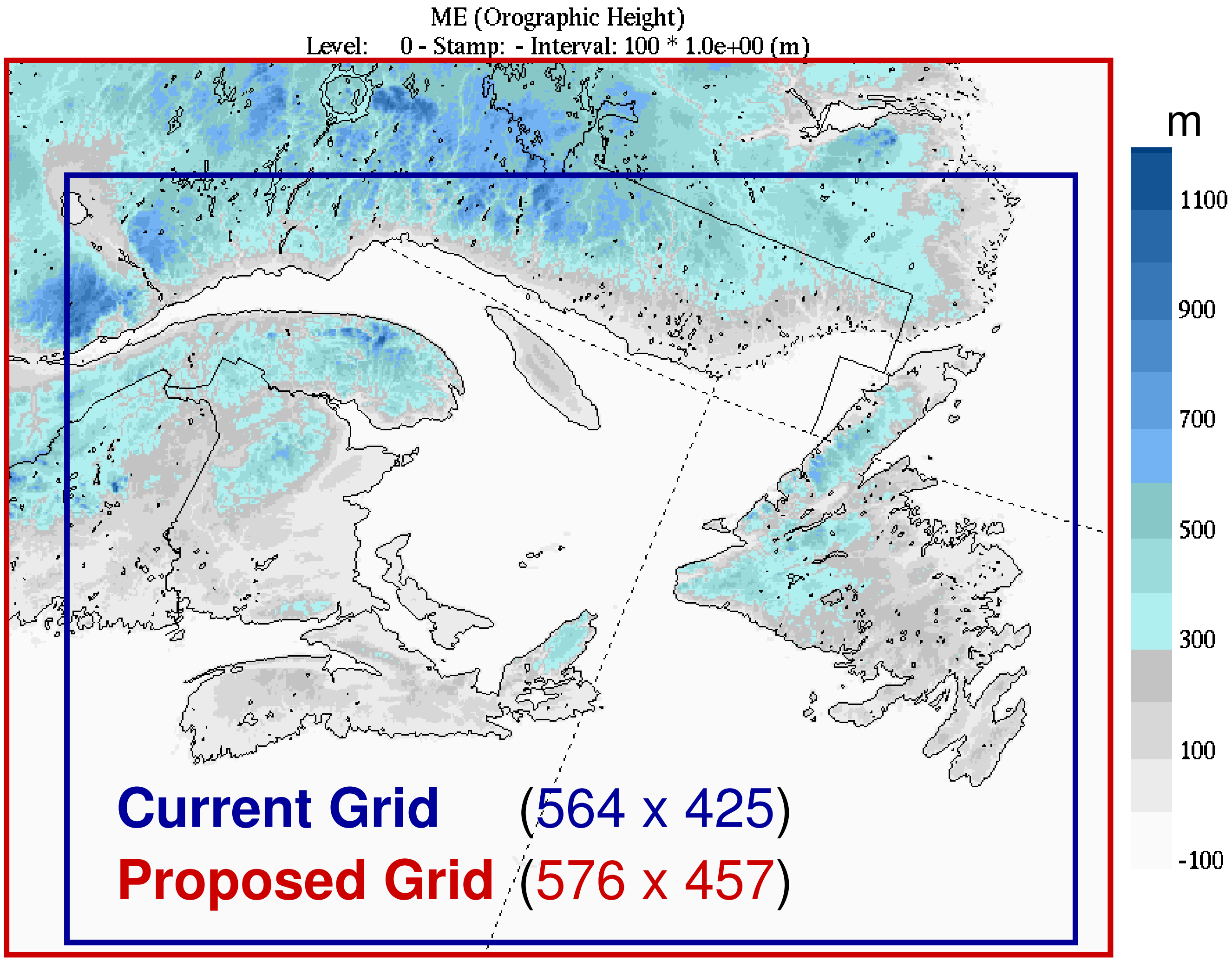
GSL system → LAM2.5km



00 UTC 25 March 2009

Expansion of Grid

MOTIVATION:
- better location of lateral boundaries



Current Grid (564 x 425)

Proposed Grid (576 x 457)

→ Computational domain: **22% larger**

Tests and Evaluations

- All tests done with OCM* (for rapid delivery to CMC operations)
- Only new changes (post-V10) were tested (e.g. use of GSL fields)
- Proposed package of changes was tested and evaluated based on 90 benchmark cases

Benchmark cases:

90 runs – 15 winter, 15 summer, 3 grids (*West*, *East*, *Maritime*)

Winter:	January 1, 4, 7, 10, 13, 16, 19, 22, 25, 28, 31, February 3, 6, 9, 12	(2010)
Summer:	July 1, 4, 7, 10, 13, 16, 19, 22, 25, 28, 31, August 3, 6, 9, 12	(2010)

- plus 8 high-impact summer 2008 weather cases (motivated from a PASPC study)

* Acknowledgments to GEM Development group for help setting up OCM suite

Tests and Evaluations

Verification / Evaluation

- Subjective evaluation
- **T** (2 m), **T_d** (2 m), ***V_speed*** (10 m), ***V_dir*** (10 m) based on EMET verification package
- **6-h QPF**, based on package set up by B. Casati / B. Denis

Benchmark cases:

90 runs – 15 winter, 15 summer, 3 grids (*West*, *East*, *Maritime*)

Winter: January 1, 4, 7, 10, 13, 16, 19, 22, 25, 28, 31, February 3, 6, 9, 12 (2010)
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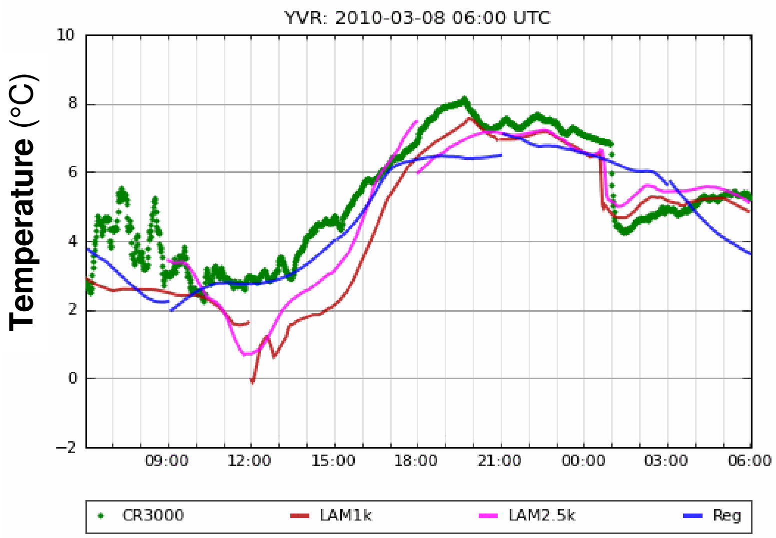
- plus 8 high-impact summer 2008 weather cases (motivated from a PASPC study)

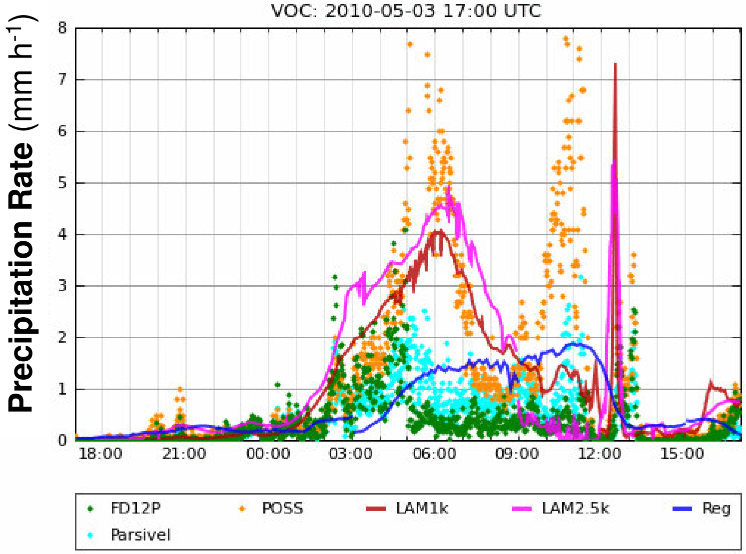
Verification / Evaluation

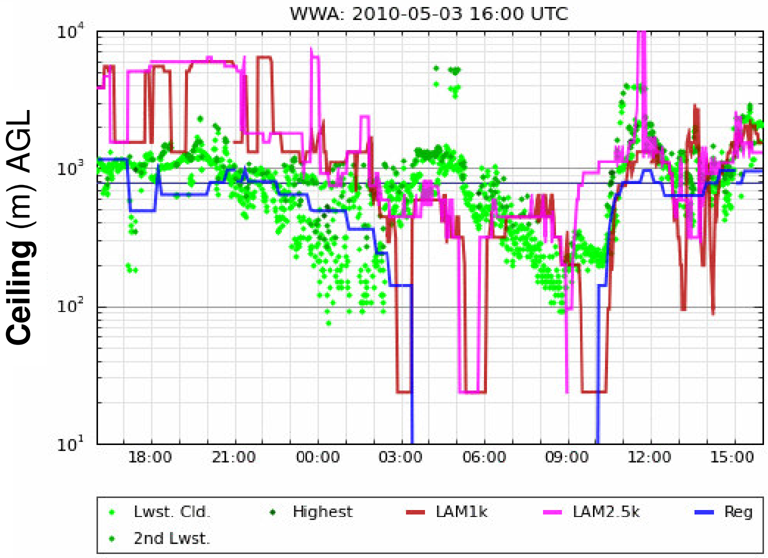
- **Subjective evaluation**

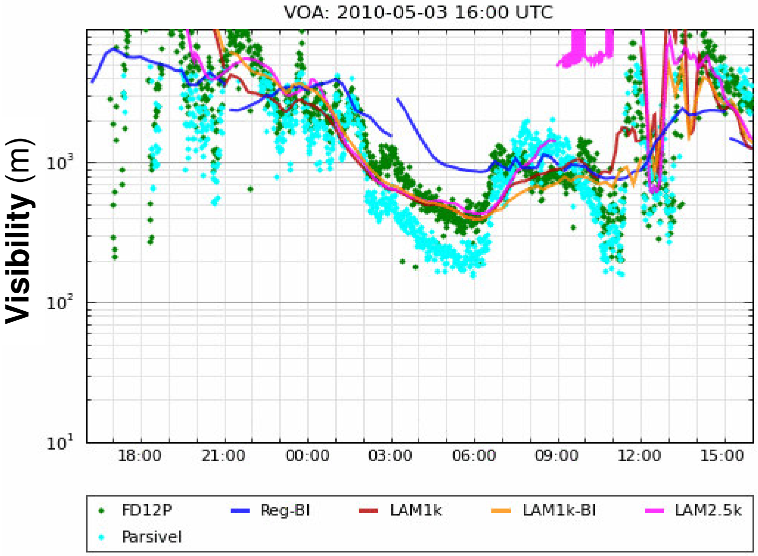
1. V-10 LAM runs scrutinized every day during Olympics and Paralympics

From SNOW-V10 website:









Verification / Evaluation

- **Subjective evaluation**

1. V-10 LAM runs scrutinized every day during Olympics and Paralympics
2. V10-LAM runs examined* during summer 2010 (PYR)

Conclusions, comparing **LAM-V10-2.5km** vs. **LAM-West-2.5**:

- For deep convection, there is no systematic change in skill
- For marine winds, there is a systematic improvement

*Link to Summary Report on wiki

https://wiki.cmc.ec.gc.ca/wiki/PPS/HRDPS

Verification / Evaluation

- **Subjective evaluation**

1. V-10 LAM runs scrutinized every day during Olympics and Paralympics
2. V10-LAM runs examined during summer 2010 (PYR)
3. 8 summer high-impact weather cases were examined

Based on study* conducted for Edmonton PASPC

→What if the LAM-West had been used for the forecast?

Their conclusion: *Minimal impact* (vs. just using REG-15)

Our question: Would their answer have been different using the **proposed** configuration?

* Presented at CMOS 2010 (Greene et al.)

Verification / Evaluation

- Subjective evaluation
- ***T*** (2 m), $\boldsymbol{T_d}$ (2 m), ***V_speed*** (10 m), ***V_dir*** (10 m) based on objective verification package:

EMET

Benchmark cases:

90 runs – 15 winter, 15 summer, 3 grids (*West*, *East*, *Maritime*)

Winter: January 1, 4, 7, 10, 13, 16, 19, 22, 25, 28, 31, February 3, 6, 9, 12 (2010)
Summer: July 1, 4, 7, 10, 13, 16, 19, 22, 25, 28, 31, August 3, 6, 9, 12 (2010)

EMET

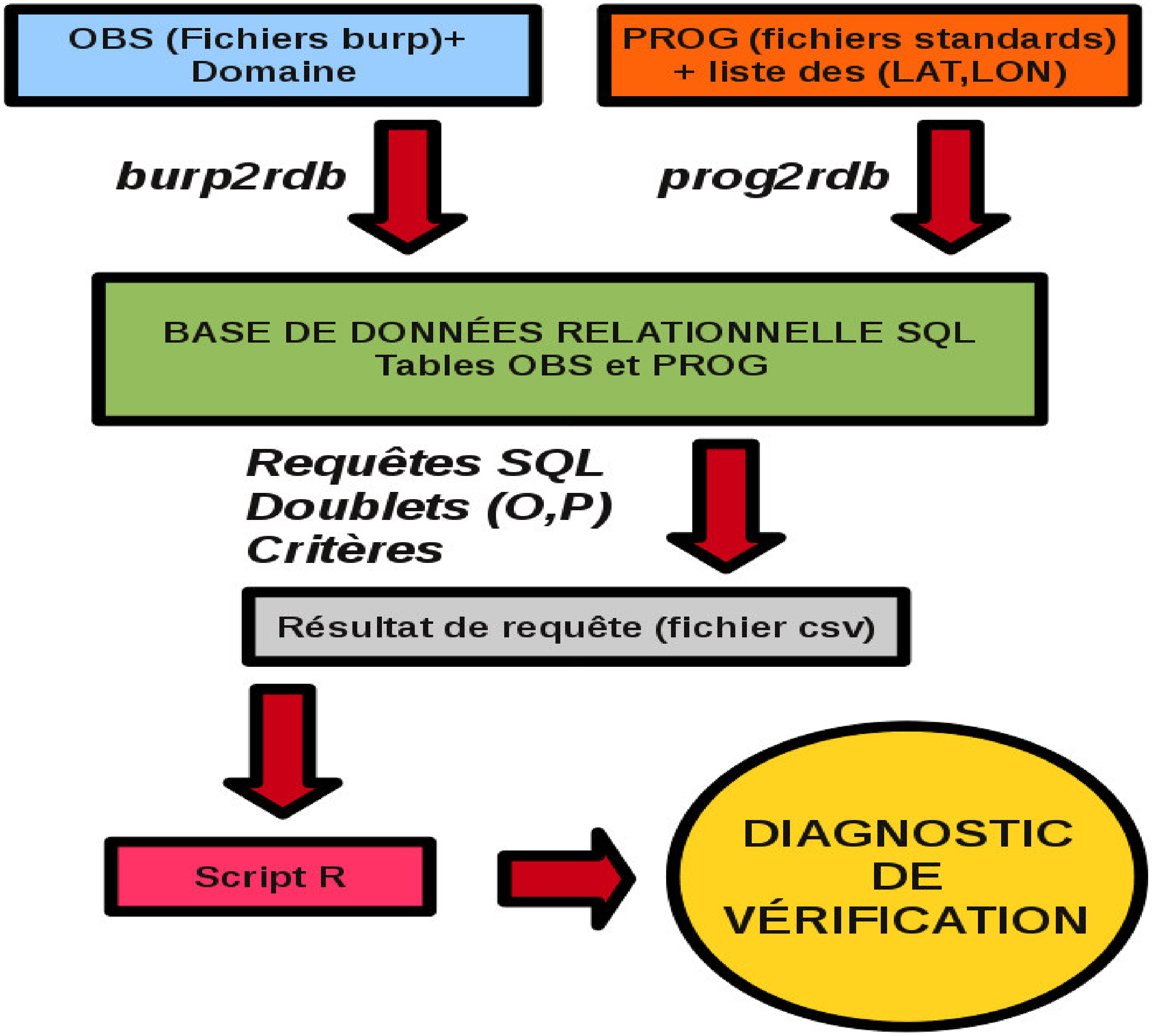
(de l'hébreu `emet = vérité)

suite logicielle de vérification
construite sur SQL et R

François Lemay
Joseph-Pierre Toviessi

EMET

EMET



OBS (Fichiers burp)+
Domaine

PROG (fichiers standards)
+ liste des (LAT,LON)

burp2rdb

prog2rdb

BASE DE DONNÉES RELATIONNELLE SQL
Tables OBS et PROG

Requêtes SQL
Doublets (O,P)
Critères

Résultat de requête (fichier csv)

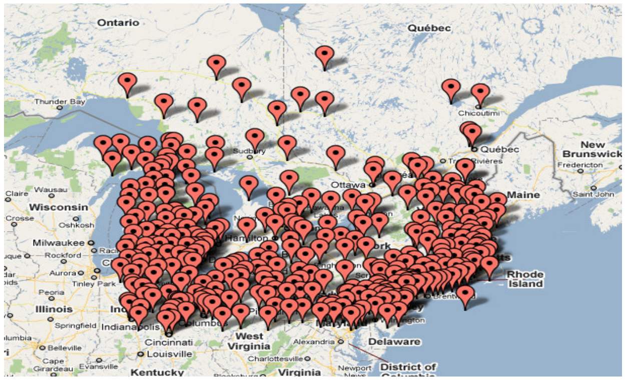
Script R

DIAGNOSTIC
DE
VÉRIFICATION

EMET

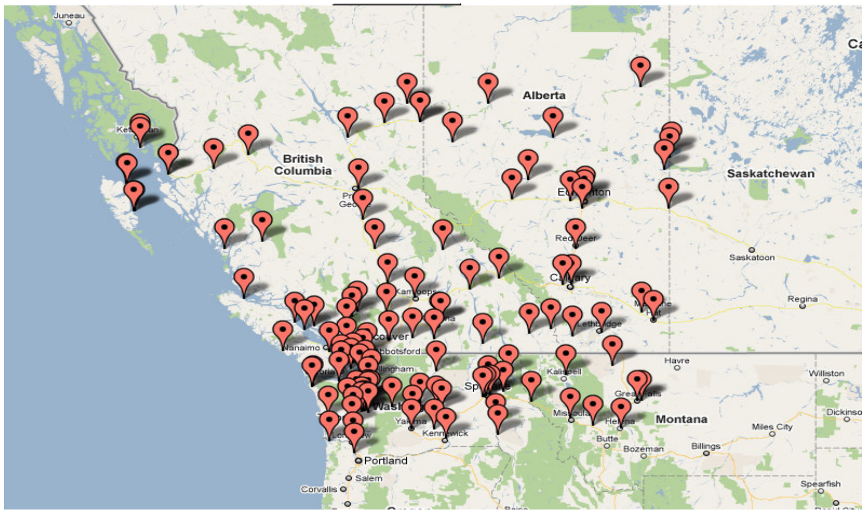
Couverture des données METAR

LAM EST

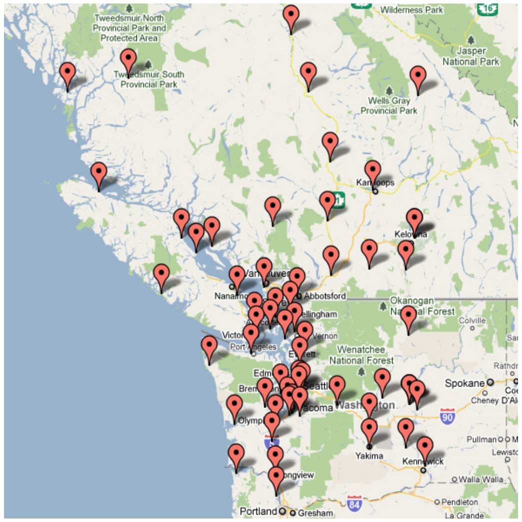


LAM MARITIMES

LAM OUEST



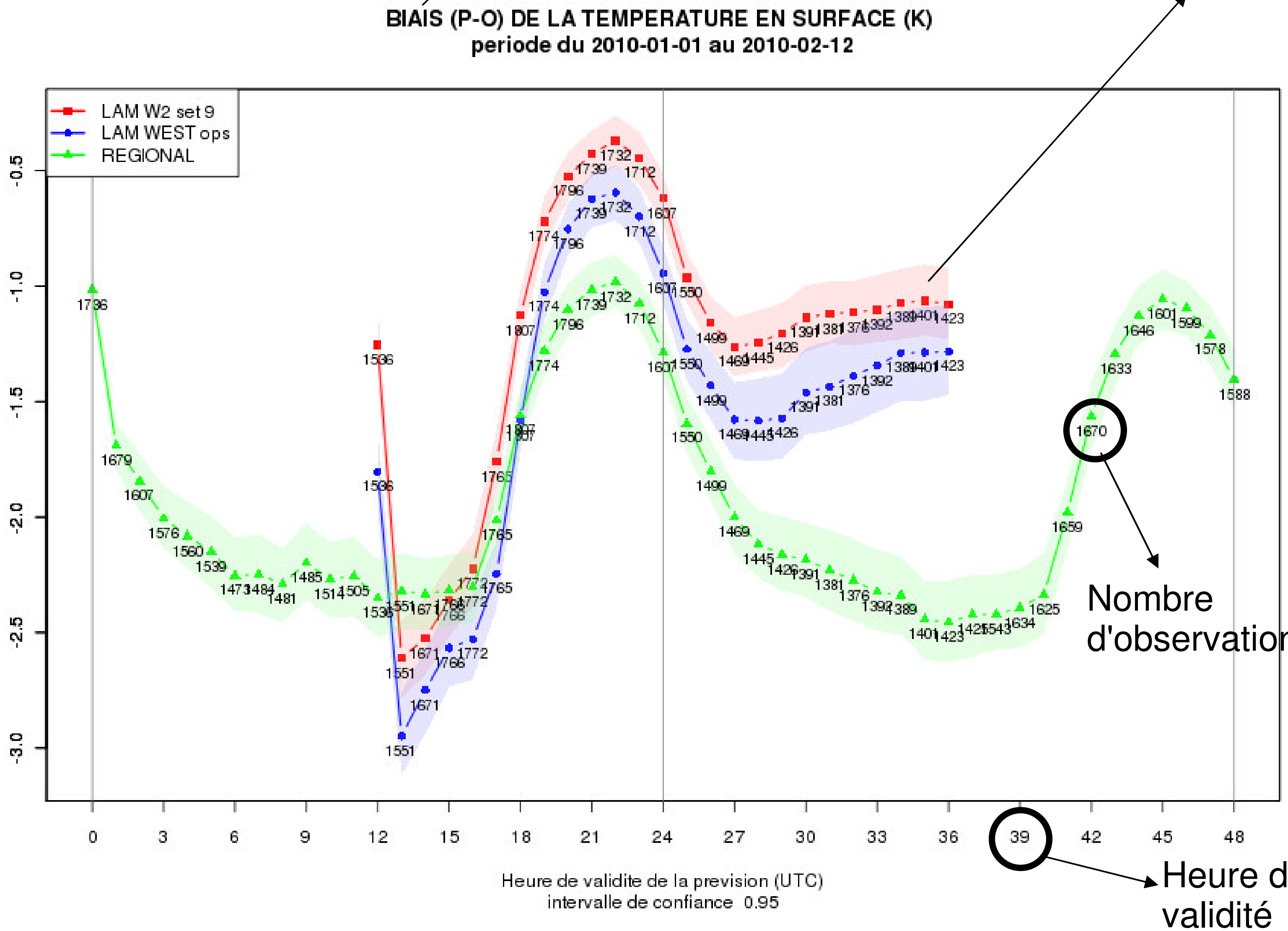
LAM OLYMPIQUE



EMET

aussi : RMSE, RMSE sans biais,
coefficient de corrélation linéaire

Intervalle de
confiance
(*bootstrap*)



Nombre
d'observations

Heure de
validité

EMET

Projets futurs

- Implémentation d'une version opérationnelle
- Publication de la version 1.0 destinée aux usagers
- Recrutement d'usagers
- Utilisation de QC-OBS
- Ajout de nouveaux diagnostics dont scores de précipitation

T (2 m)

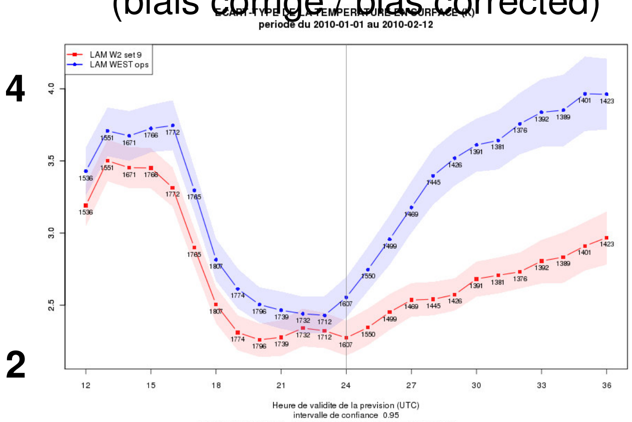
Écart-type / *RMSE*

(biais corrigé / bias corrected)

Biais / *Bias*

Hiver
Winter

Ouest
West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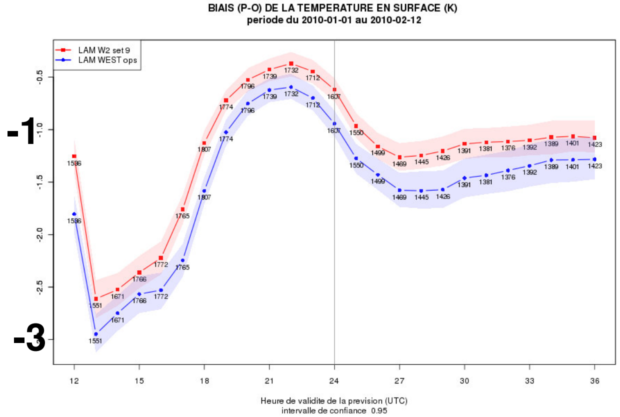
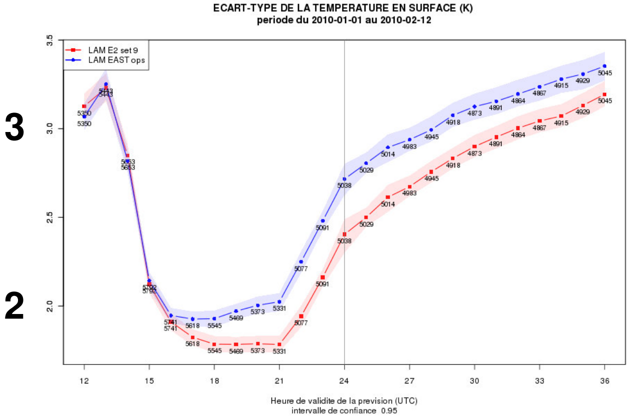
periode du 2010-01-01 au 2010-02-12


BIAIS (P-O) DE LA TEMPERATURE EN SURFACE (K)
periode du 2010-01-01 au 2010-02-12

Est
East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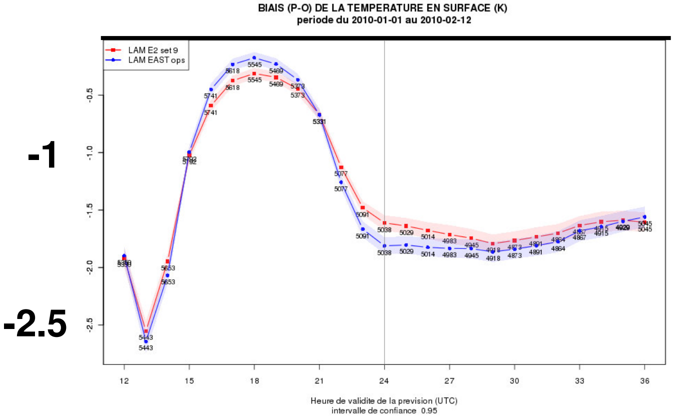
BIAIS (P-O) DE LA TEMPERATURE EN SURFACE (K)
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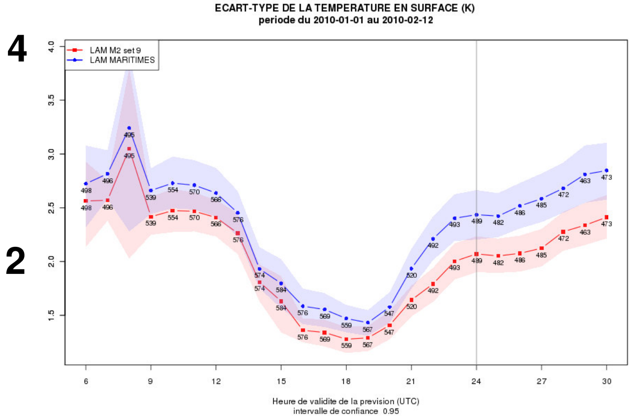
Maritimes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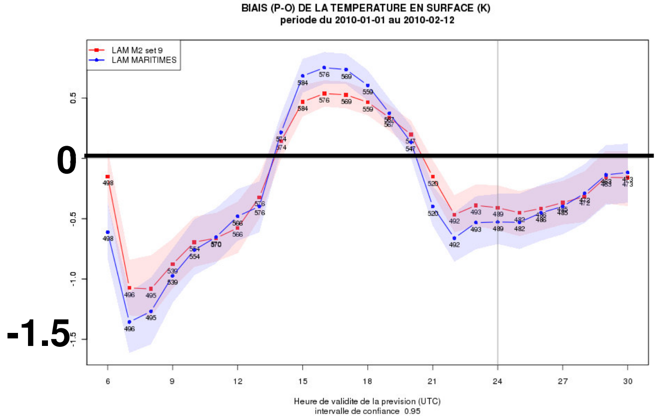
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T (2 m)

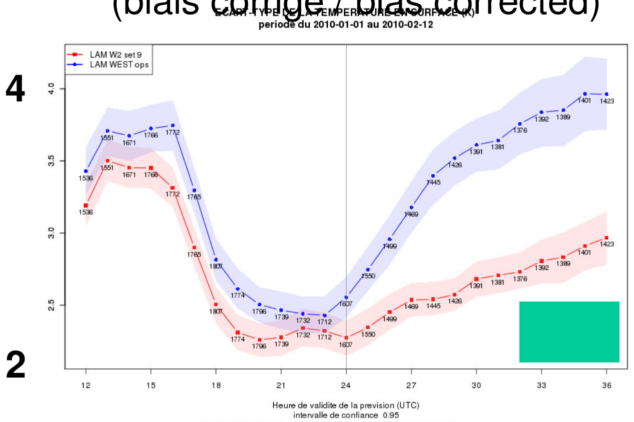
Écart-type / *RMSE*

(biais corrigé / bias corrected)

Biais / *Bias*

Hiver
Winter

Ouest
West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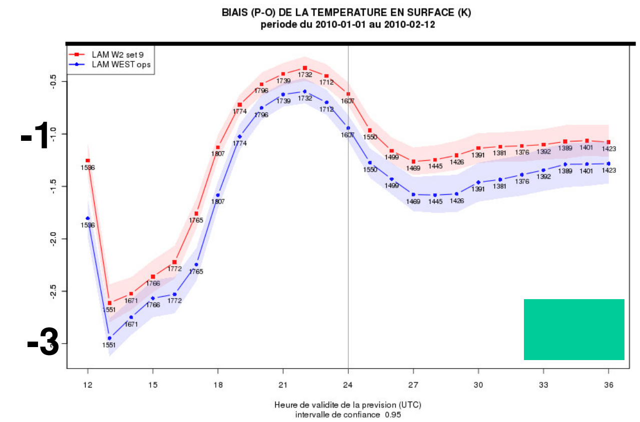
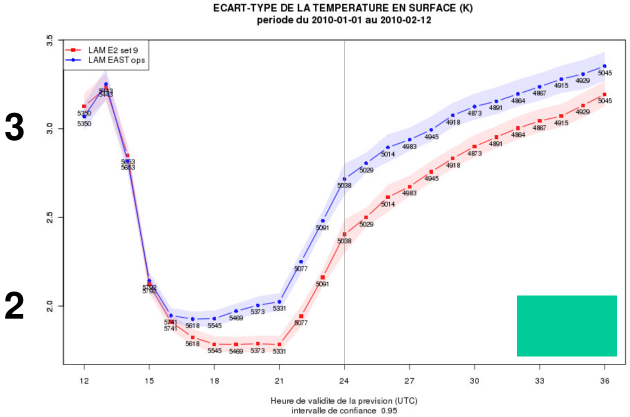

BIAIS (P-O) DE LA TEMPERATURE EN SURFACE (K)
periode du 2010-01-01 au 2010-02-12

Est
East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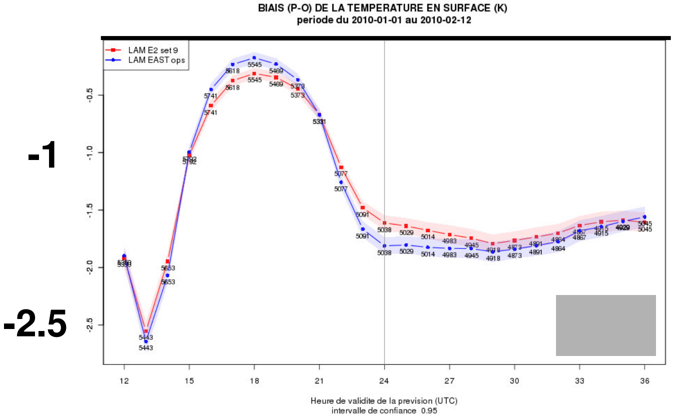
BIAIS (P-O) DE LA TEMPERATURE EN SURFACE (K)
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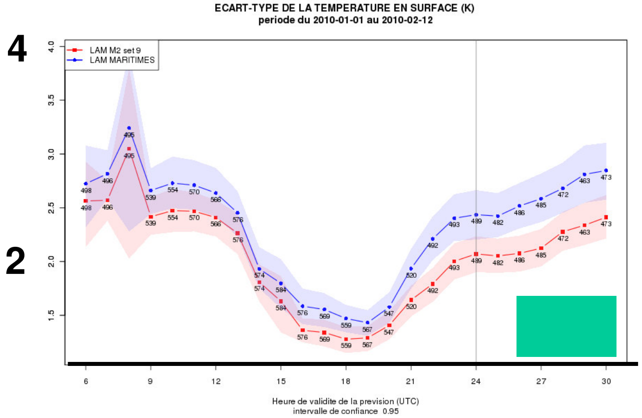
Maritimes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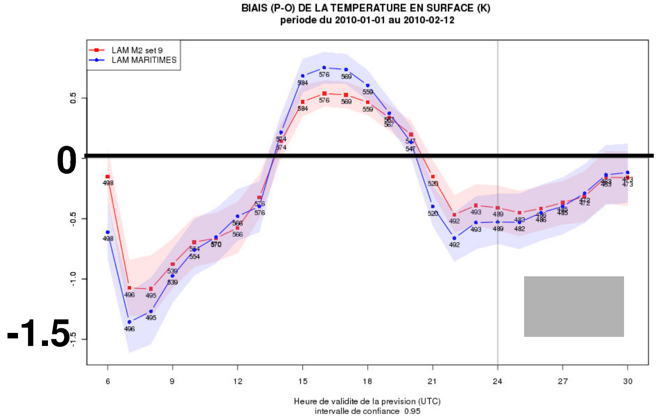

BIAIS (P-O) DE LA TEMPERATURE EN SURFACE (K)
periode du 2010-01-01 au 2010-02-12

BETTER

NEUTRAL

WORSE

Td (2 m)

Écart-type / *RMSE*

(biais corrigé / bias corrected)

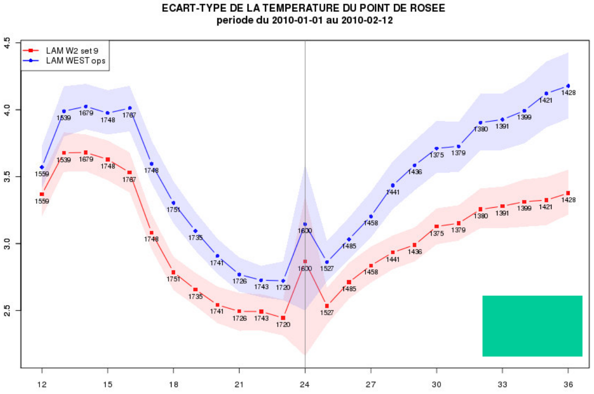
Biais / *Bias*

Hiver
Winter

Ouest
West

4

2.5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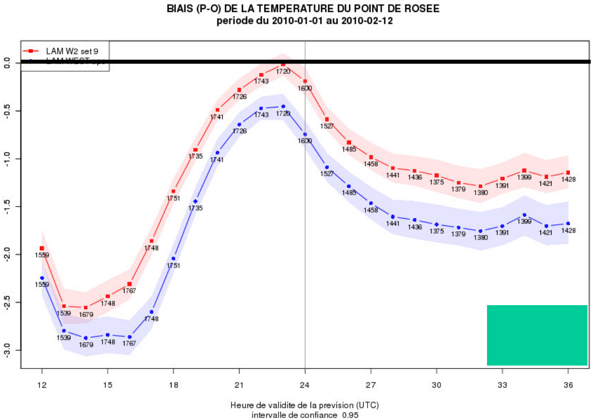
0

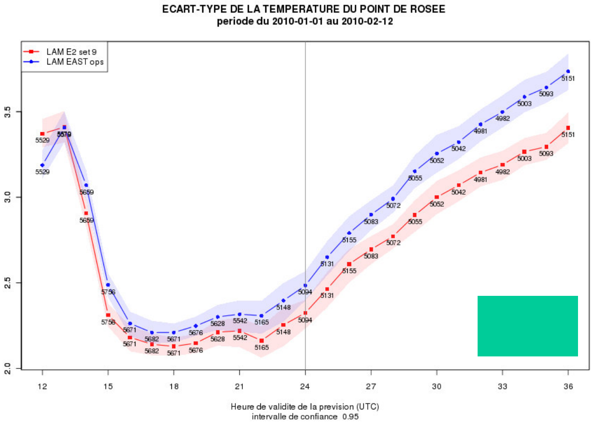
-3


BIAIS (P-O) DE LA TEMPERATURE DU POINT DE ROSEE
periode du 2010-01-01 au 2010-02-12

Est
East

3.5

2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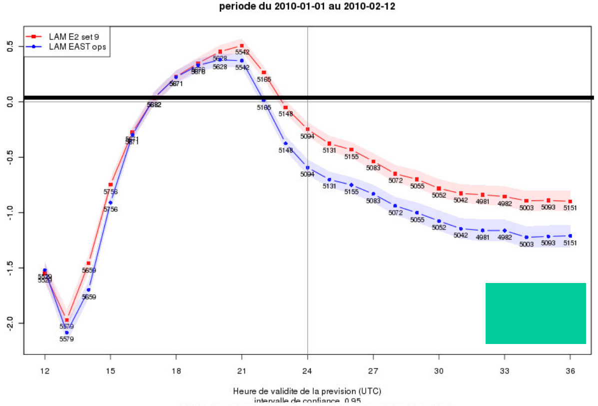
0

-2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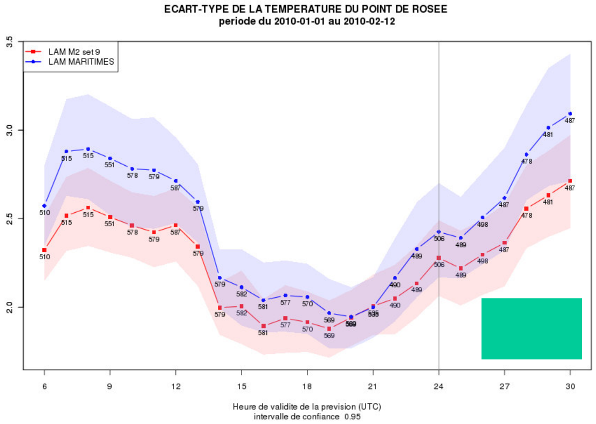
Maritimes

3

2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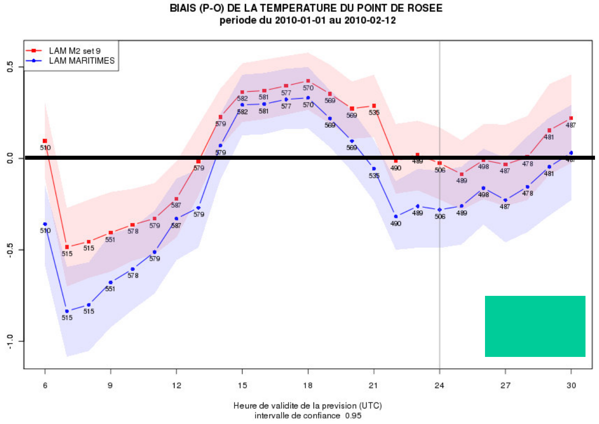
0.5

0

-1


BIAIS (P-O) DE LA TEMPERATURE DU POINT DE ROSEE
periode du 2010-01-01 au 2010-02-12

UV- dir
(10 m)

Écart-type / *RMSE*

(biais corrigé / bias corrected)

Biais / *Bias*

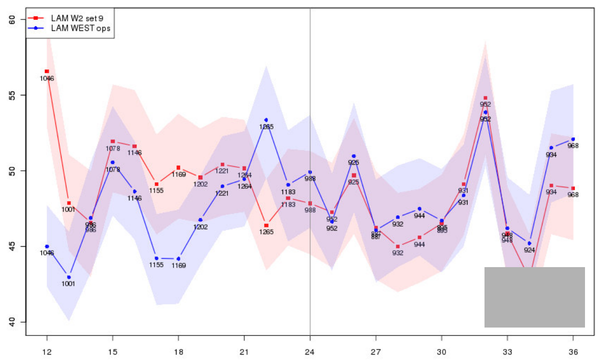
Hiver
Winter

Ouest
West

55

40

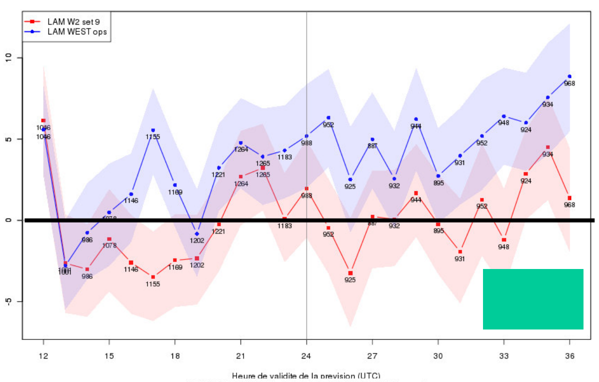
ECART-TYPE DE LA DIRECTION DU VENT (degres)
periode du 2010-01-01 au 2010-02-12



10

-5

BIAIS (P-O) DE LA DIRECTION DU VENT (degres)
periode du 2010-01-01 au 2010-02-12

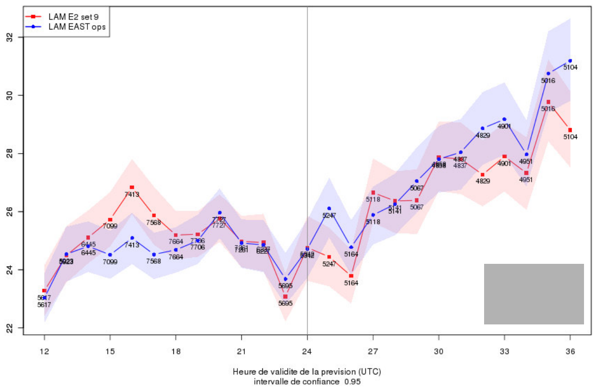


Est
East

32

22

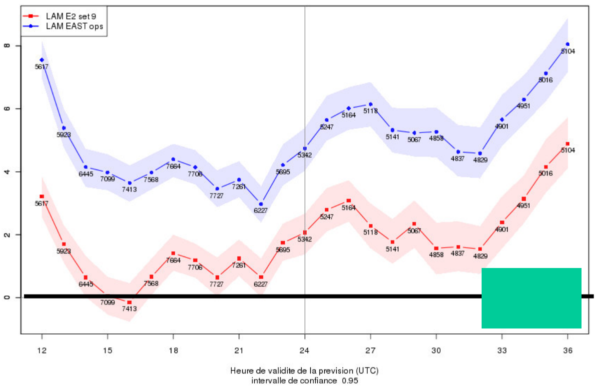
ECART-TYPE DE LA DIRECTION DU VENT (degres)
periode du 2010-01-01 au 2010-02-12



8

0

BIAIS (P-O) DE LA DIRECTION DU VENT (degres)
periode du 2010-01-01 au 2010-02-12

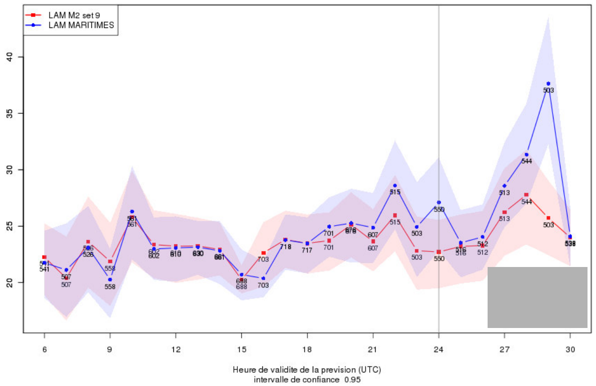


Maritimes

40

20

ECART-TYPE DE LA DIRECTION DU VENT (degres)
periode du 2010-01-01 au 2010-02-12



8

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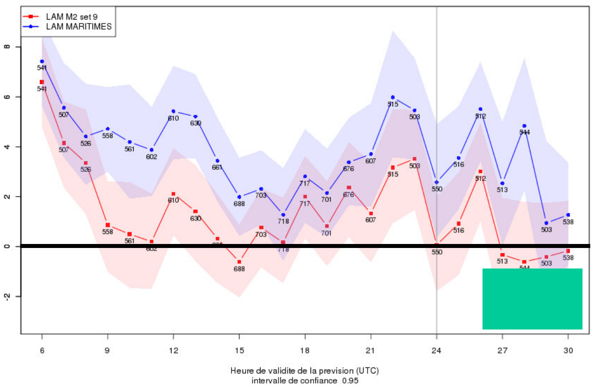
BIAIS (P-O) DE LA DIRECTION DU VENT (degres)
periode du 2010-01-01 au 2010-02-12



UV- spd/vit (10 m)

Écart-type / *RMSE*

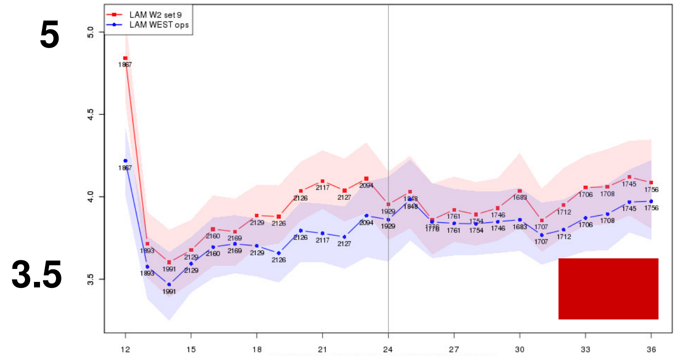
(biais corrigé / bias corrected)

Biais / *Bias*

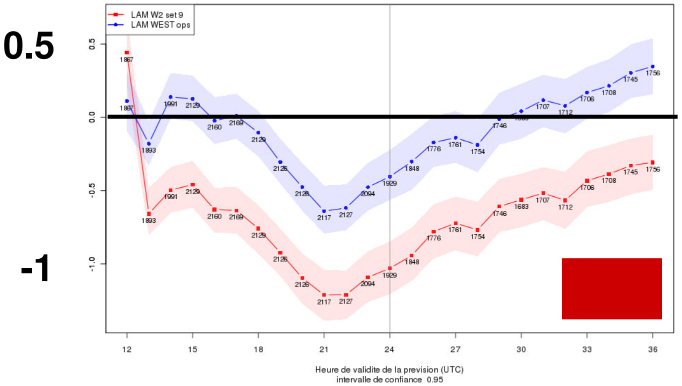
Hiver *Winter*

Ouest ***West***

ECART-TYPE DU MODULE DU VENT (NOEUDS)
periode du 2010-01-01 au 2010-02-12

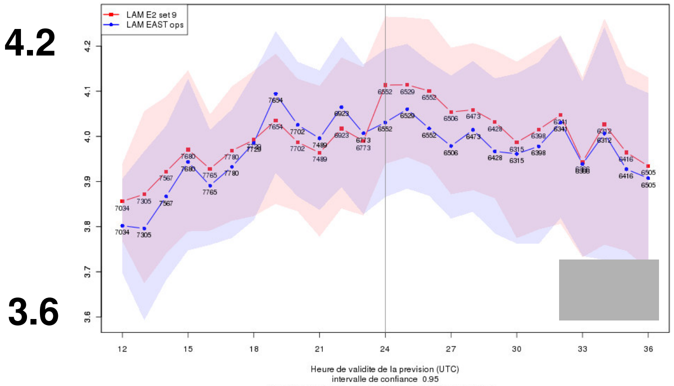


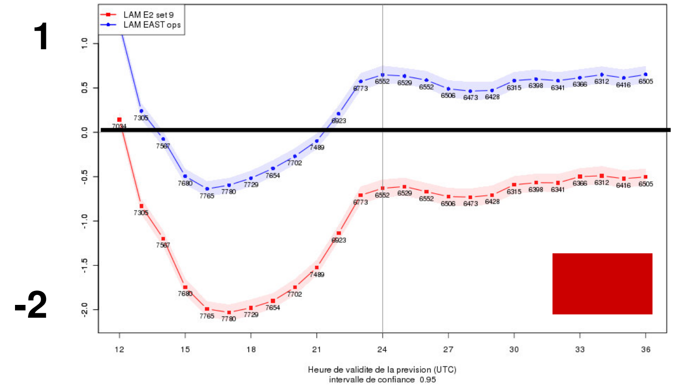
BIAIS (P-O) DU MODULE DU VENT (NOEUDS)
periode du 2010-01-01 au 2010-02-12



Est ***East***

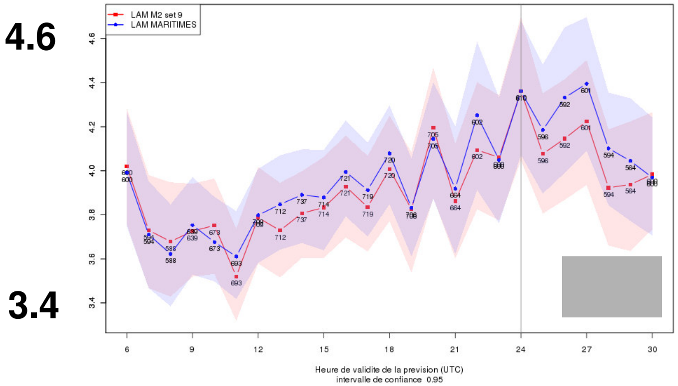
ECART-TYPE DU MODULE DU VENT (NOEUDS)
periode du 2010-01-01 au 2010-02-12



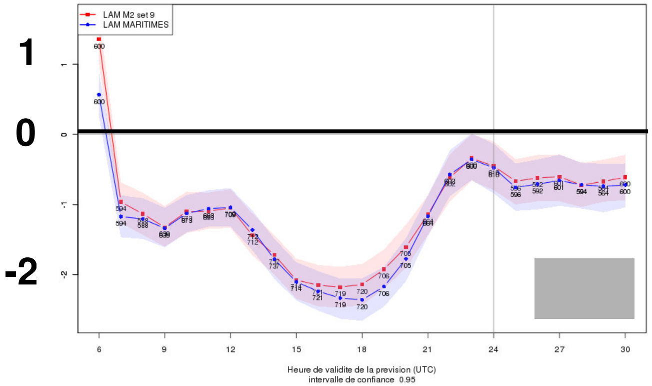


Maritimes

ECART-TYPE DU MODULE DU VENT (NOEUDS)
periode du 2010-01-01 au 2010-02-12



BIAIS (P-O) DU MODULE DU VENT (NOEUDS)
periode du 2010-01-01 au 2010-02-12



T (2 m)

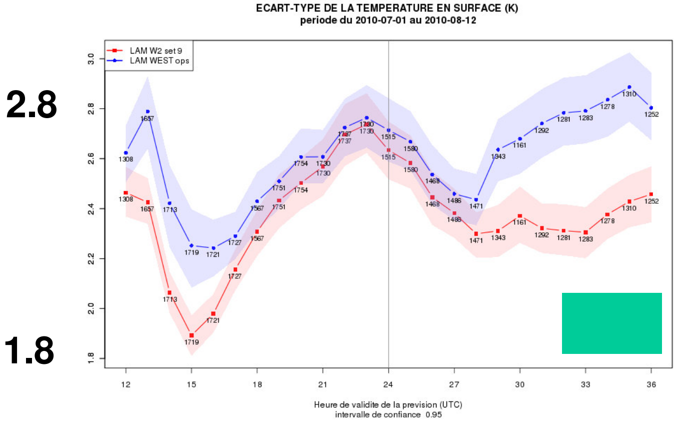
Écart-type / *RMSE*

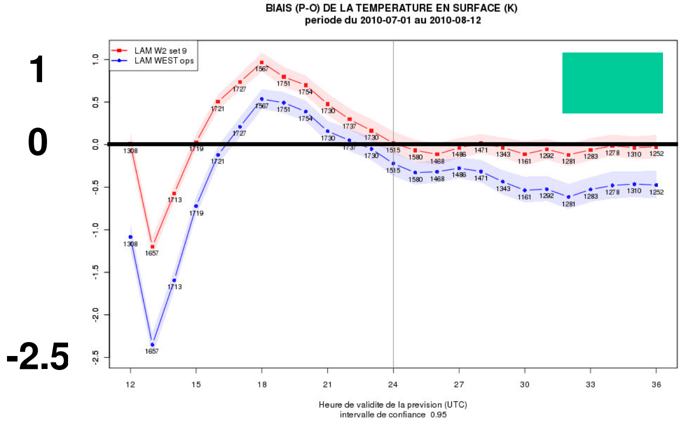
(biais corrigé / bias corrected)

Biais / *Bias*

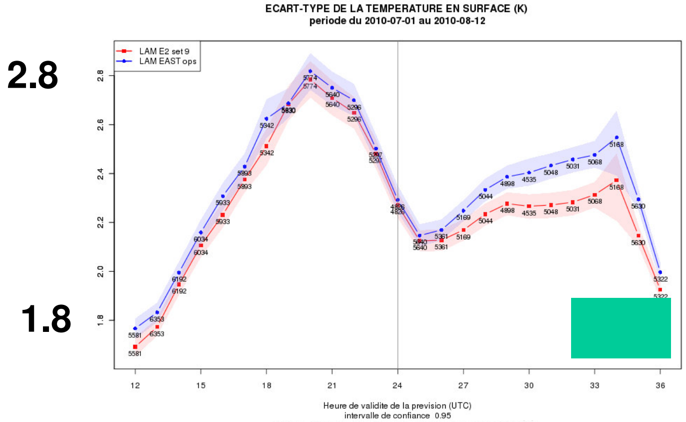
Été
Summer

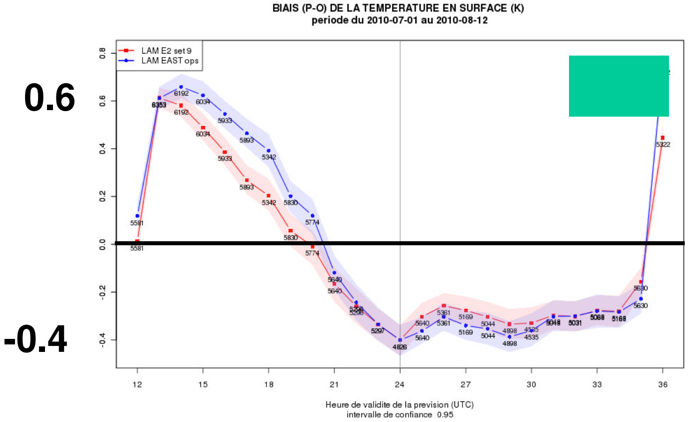
Ouest
West


ECART-TYPE DE LA TEMPERATURE EN SURFACE (K)
periode du 2010-07-01 au 2010-08-12

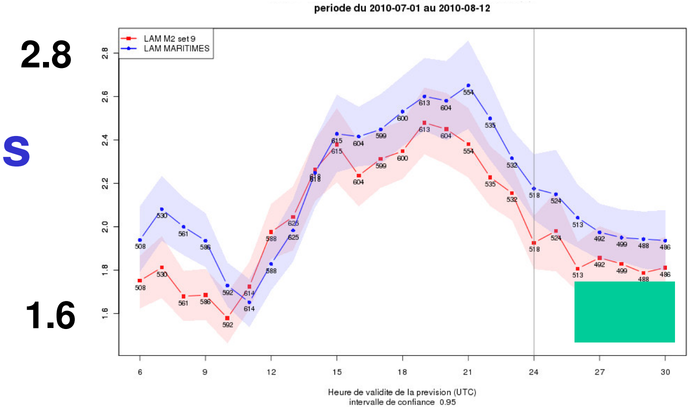

BIAIS (P-O) DE LA TEMPERATURE EN SURFACE (K)
periode du 2010-07-01 au 2010-08-12

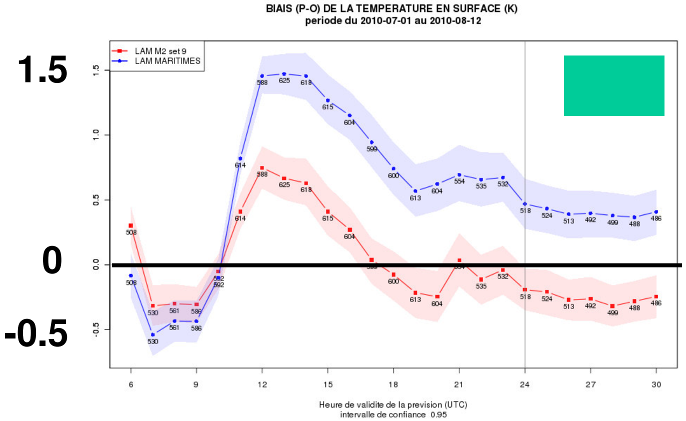
Est
East


ECART-TYPE DE LA TEMPERATURE EN SURFACE (K)
periode du 2010-07-01 au 2010-08-12


BIAIS (P-O) DE LA TEMPERATURE EN SURFACE (K)
periode du 2010-07-01 au 2010-08-12

Maritimes


periode du 2010-07-01 au 2010-08-12


BIAIS (P-O) DE LA TEMPERATURE EN SURFACE (K)
periode du 2010-07-01 au 2010-08-12

Td (2 m)

Écart-type / *RMSE*

(biais corrigé / bias corrected)

Biais / *Bias*

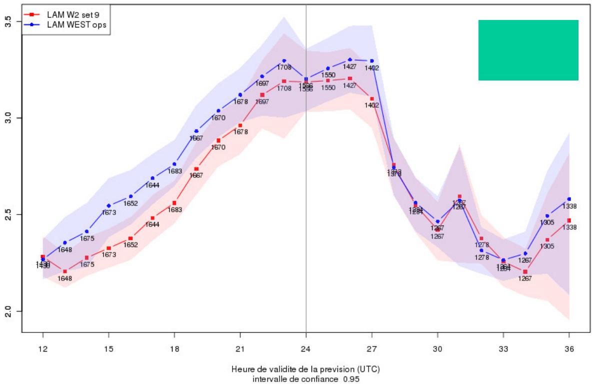
Été
Summer

Ouest
West

3.5

2.0

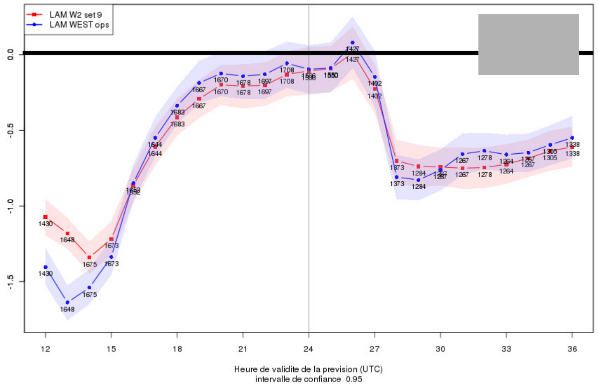
ECART-TYPE DE LA TEMPERATURE DU POINT DE ROSEE
periode du 2010-07-01 au 2010-08-12



0

-1.5

BIAIS (P-O) DE LA TEMPERATURE DU POINT DE ROSEE
periode du 2010-07-01 au 2010-08-12

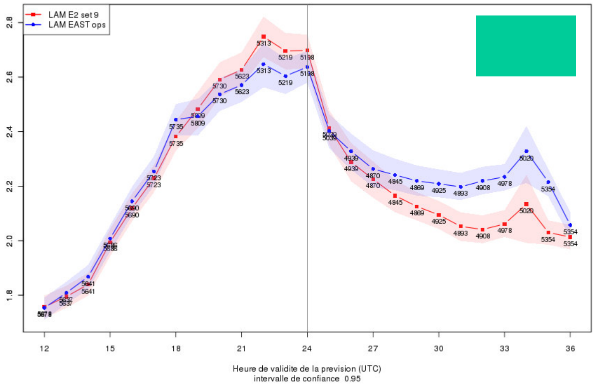


Est
East

2.8

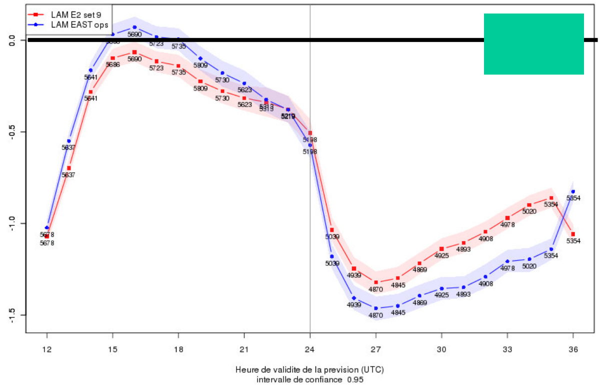
1.8

ECART-TYPE DE LA TEMPERATURE DU POINT DE ROSEE
periode du 2010-07-01 au 2010-08-12



0

-1.5

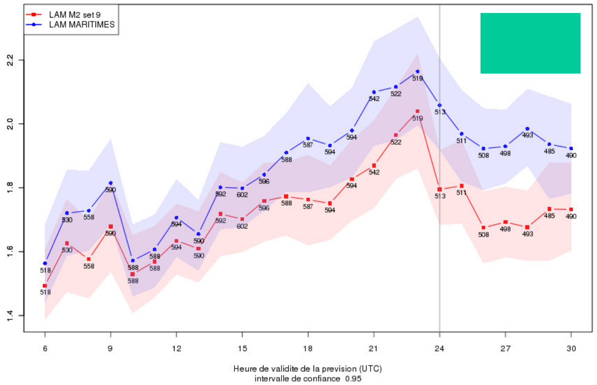


Maritimes

2.2

1.4

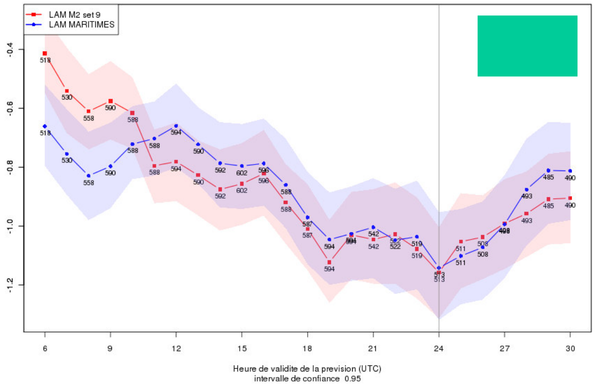
ECART-TYPE DE LA TEMPERATURE DU POINT DE ROSEE
periode du 2010-07-01 au 2010-08-12



-0.4

-1.2

BIAIS (P-O) DE LA TEMPERATURE DU POINT DE ROSEE
periode du 2010-07-01 au 2010-08-12



UV- dir (10 m)

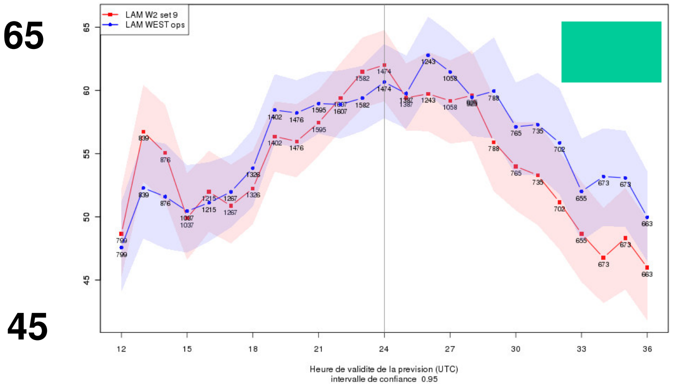
Écart-type / *RMSE*

(biais corrigé / bias corrected)

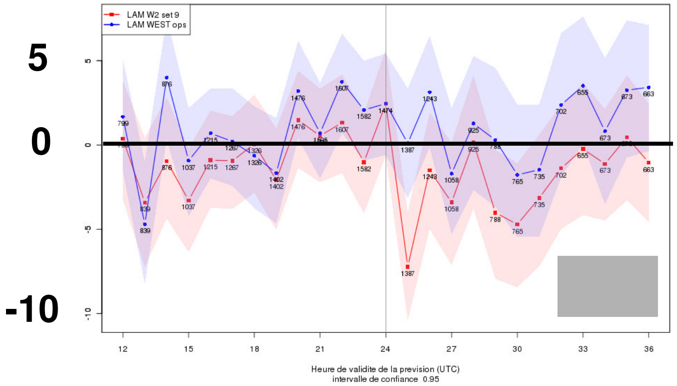
Biais / *Bias*

Été
Summer

Ouest
West

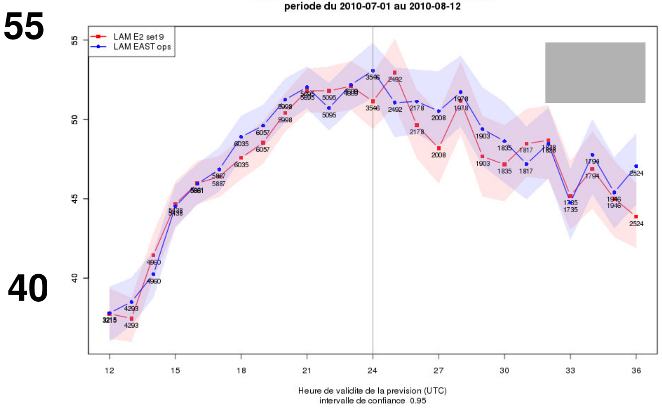


ECART-TYPE DE LA DIRECTION DU VENT (degres)
periode du 2010-07-01 au 2010-08-12

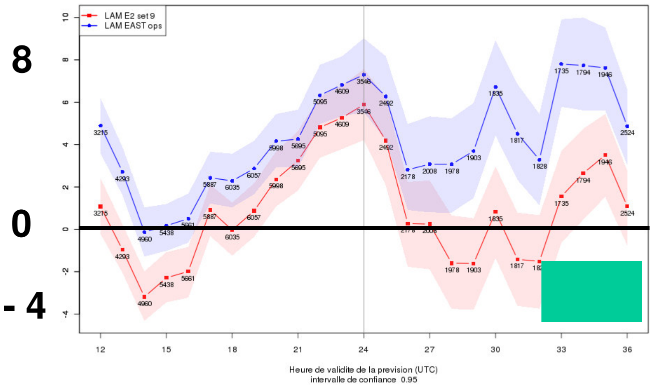


BIAIS (P-O) DE LA DIRECTION DU VENT (degres)
periode du 2010-07-01 au 2010-08-12

Est
East

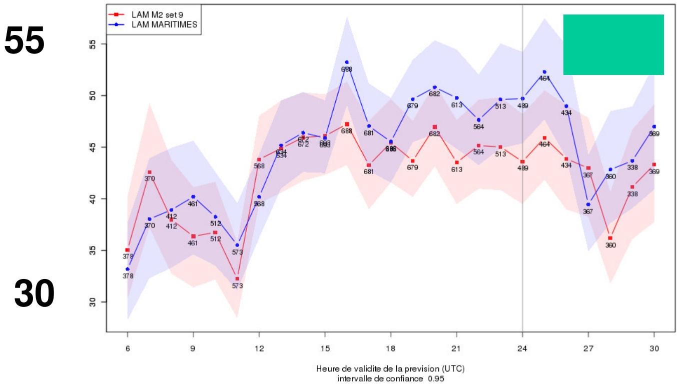


ECART-TYPE DE LA DIRECTION DU VENT (degres)
periode du 2010-07-01 au 2010-08-12

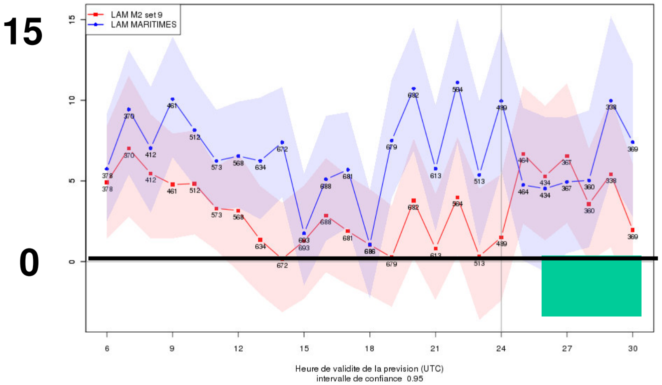


BIAIS (P-O) DE LA DIRECTION DU VENT (degres)
periode du 2010-07-01 au 2010-08-12

Maritimes



ECART-TYPE DE LA DIRECTION DU VENT (degres)
periode du 2010-07-01 au 2010-08-12



BIAIS (P-O) DE LA DIRECTION DU VENT (degres)
periode du 2010-07-01 au 2010-08-12

UV- spd/vit (10 m)

Écart-type / *RMSE*

(biais corrigé / bias corrected)

Biais / *Bias*

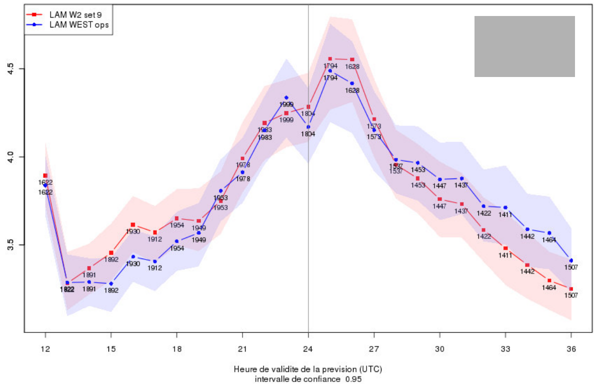
Été
Summer

Ouest
West

4.5

3.5

ECART-TYPE DU MODULE DU VENT (NOEUDS)
periode du 2010-07-01 au 2010-08-12



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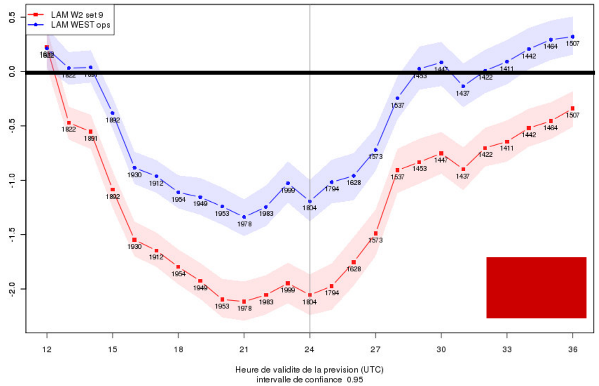
BIAIS (P-O) DU MODULE DU VENT (NOEUDS)
periode du 2010-07-01 au 2010-08-12

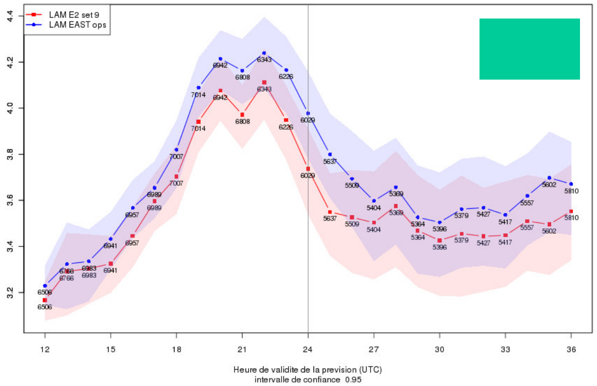


Est
East

4.4

3.2

ECART-TYPE DU MODULE DU VENT (NOEUDS)
periode du 2010-07-01 au 2010-08-12

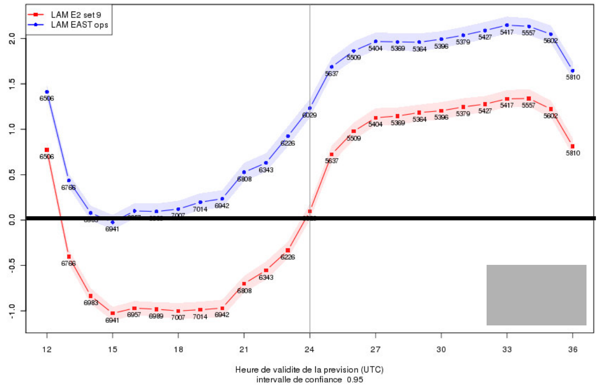


2

0

-1

BIAIS (P-O) DU MODULE DU VENT (NOEUDS)
periode du 2010-07-01 au 2010-08-12

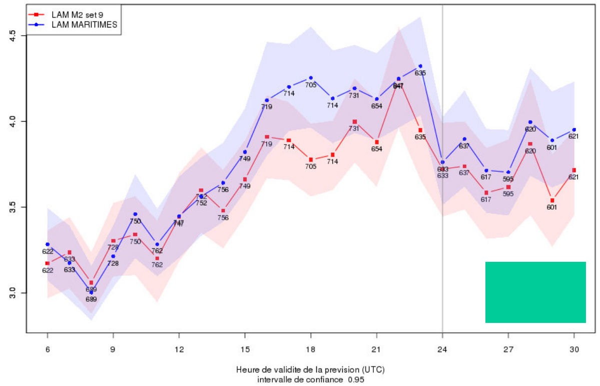


Maritimes

4.5

3.0

ECART-TYPE DU MODULE DU VENT (NOEUDS)
periode du 2010-07-01 au 2010-08-12

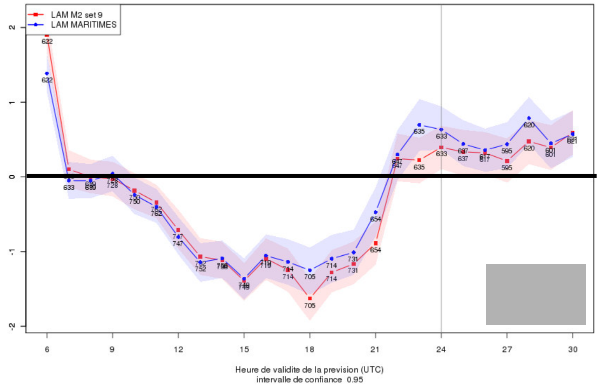


2

0

-2

BIAIS (P-O) DU MODULE DU VENT (NOEUDS)
periode du 2010-07-01 au 2010-08-12



Tests and Evaluations

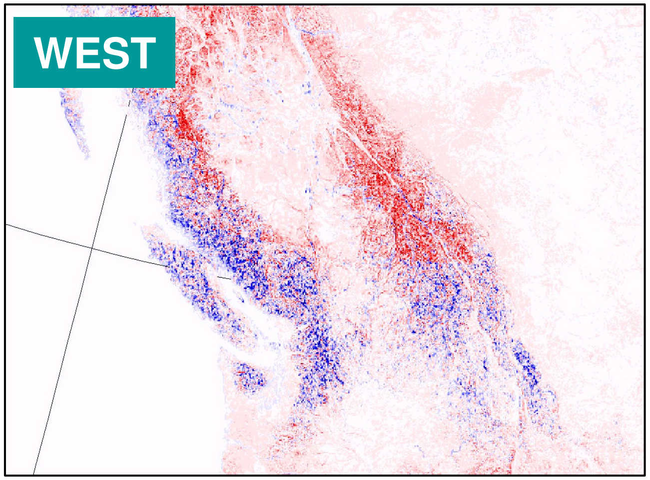
Why the systematic reduction in *V_speed*?

Why did we not see this before (for V10)?

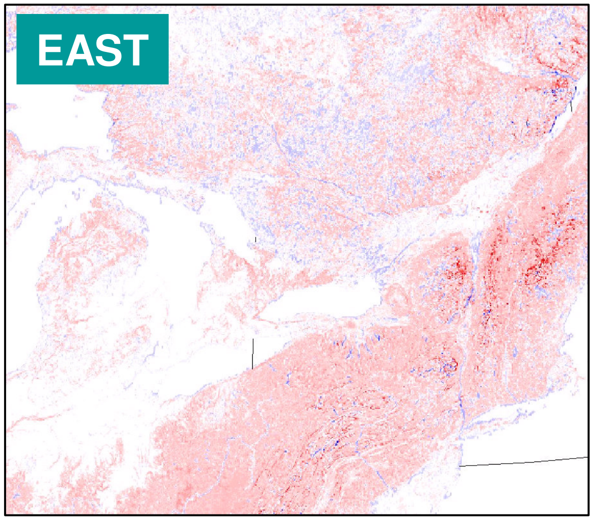
Roughness Length (Z0):

Proposed > Current

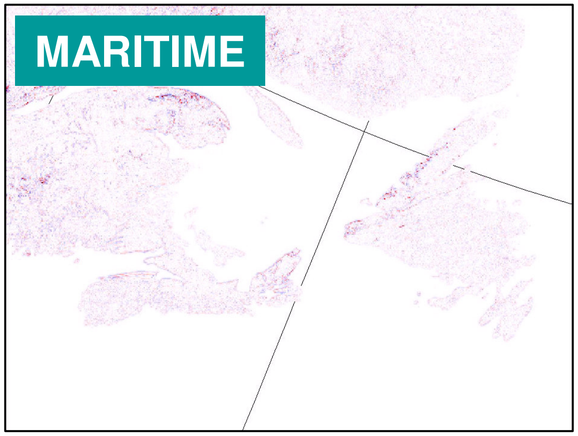
Proposed < Current



GenPhysX (2010) - Genesis (2006)



GenPhysX (2010) - Gengeo (2007)



GenPhysX (2010) - GenPhysX (2009)

Tests and Evaluations

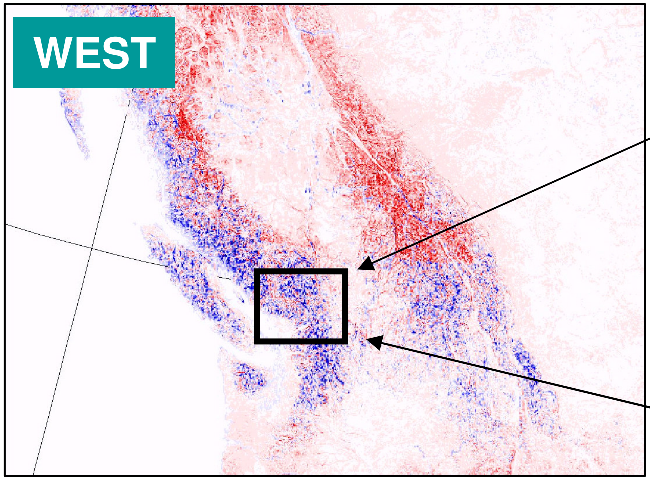
Why the systematic reduction in V_speed?

Why did we not see this before (for V10)?

Roughness Length (Z0):

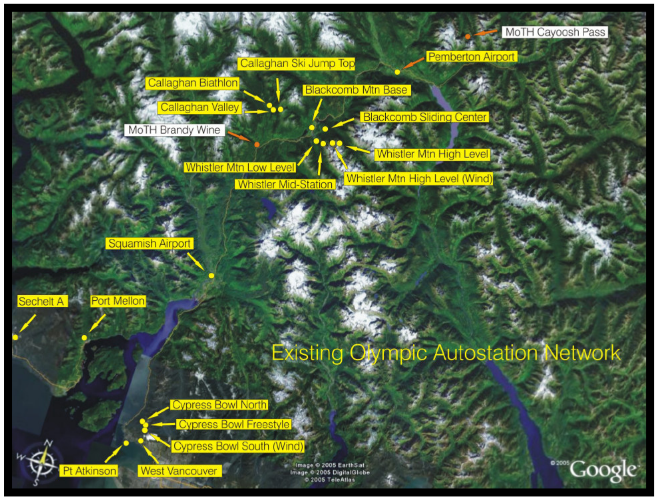
Proposed > Current

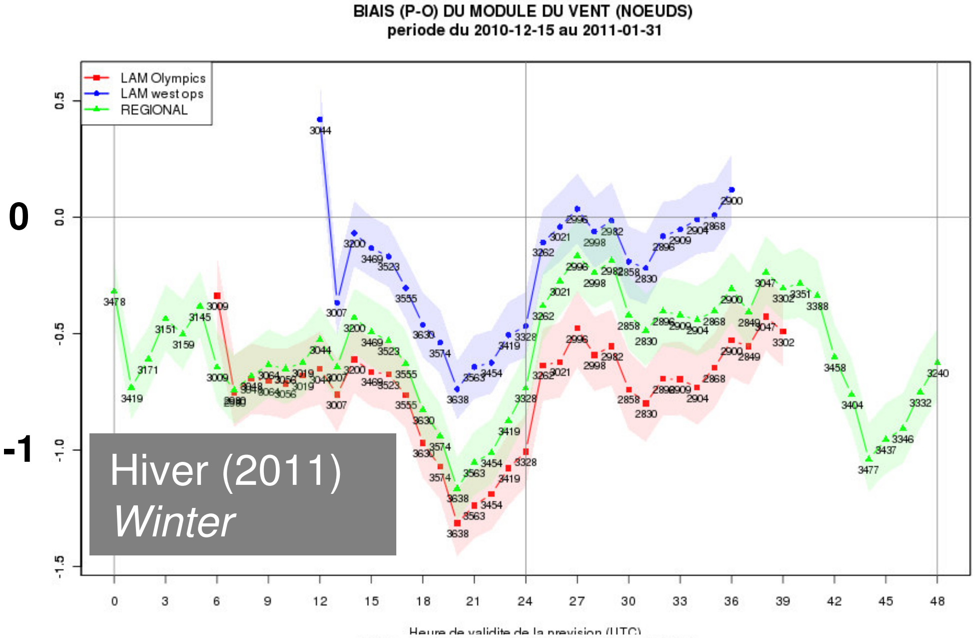
Proposed < Current



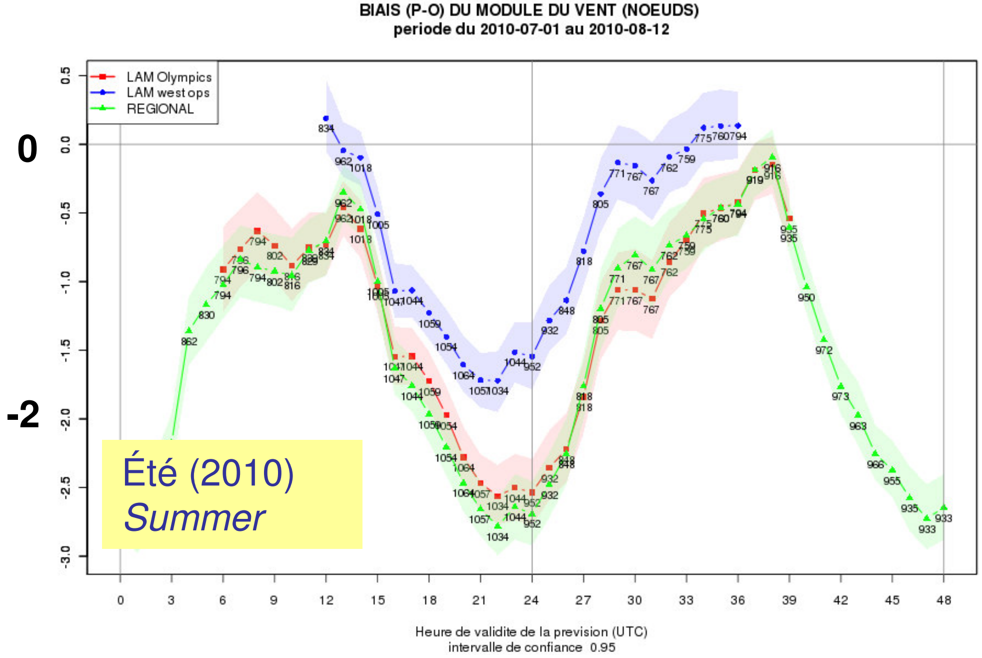
GenPhysX (2010) -

Genesis (2006)





BIAIS (P-O) DU MODULE DU VENT (NOEUDS)
periode du 2010-12-15 au 2011-01-31



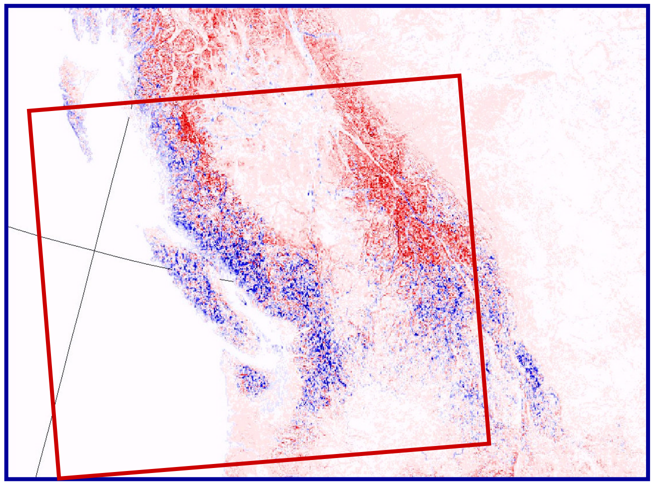
BIAIS (P-O) DU MODULE DU VENT (NOEUDS)
periode du 2010-07-01 au 2010-08-12

Heure de validite de la prevision (UTC)
intervalle de confiance 0.95

LAM-2.5-Olympics

LAM-2.5-West (current)

REG-15

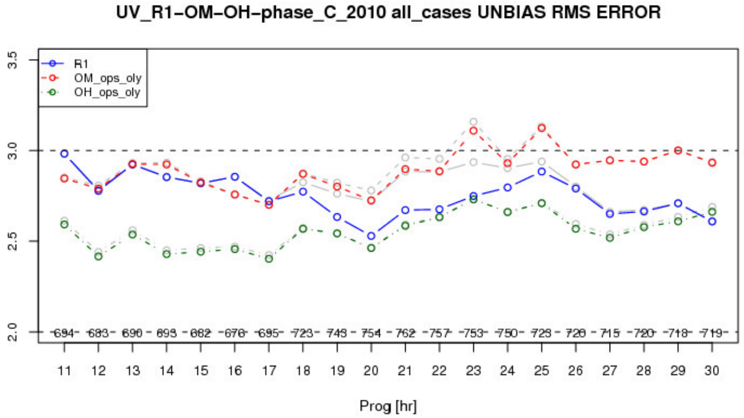


→ The systematic reduction in *V_spd_*2m was always there

Phase C
(Feb. 12 - March 23, 2010)

REG-15km
LAM-2.5 km
LAM-1 km

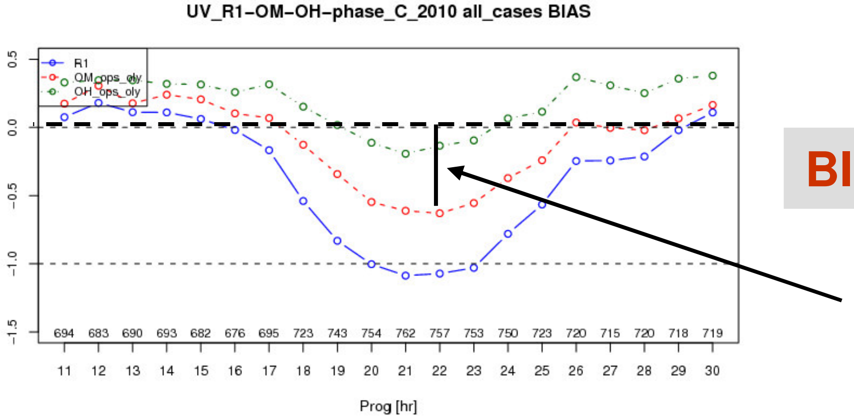
Wind Speeds (10 m)


UV_R1–OM–OH–phase_C_2010 all_cases UNBIAS RMS ERROR

kts

RMSE

c/o M. Vallée


UV_R1–OM–OH–phase_C_2010 all_cases BIAS

kts

BIAS

→ Even during V-10, the wind speed bias was present in the *__V10-LAM-2.5__* (evaluated on the Olympic network)

Tests and Evaluations

Verification / Evaluation

- Subjective evaluation
- ***T*** (2 m), ***T_d*** (2 m), ***V_speed*** (10 m), ***V_dir*** (10 m) based on EMET verification package
- **6-h QPF**, based on package set up by B. Casati / B. Denis

Benchmark cases:

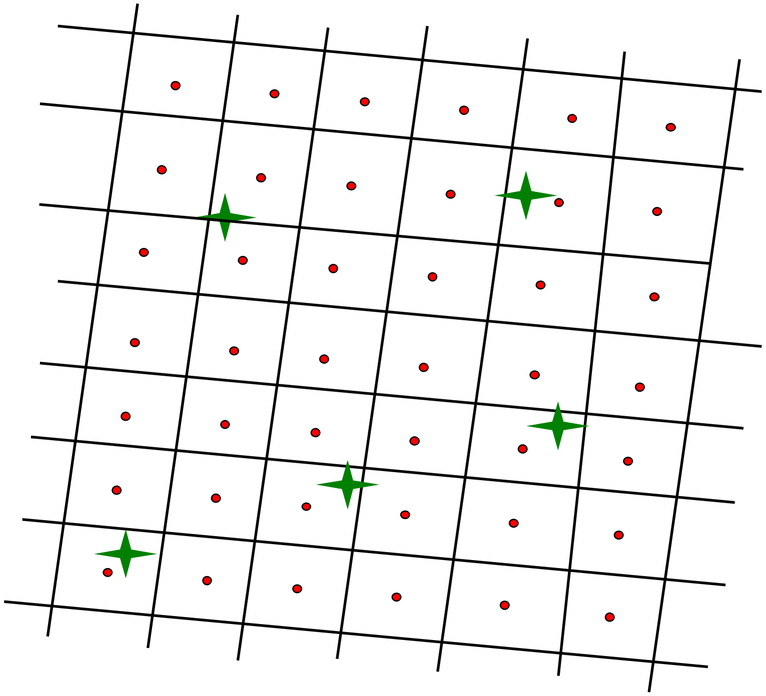
90 runs – 15 winter, 15 summer, 3 grids (*West*, *East*, *Maritime*)

Winter: January 1, 4, 7, 10, 13, 16, 19, 22, 25, 28, 31, February 3, 6, 9, 12 (2010)

Summer: July 1, 4, 7, 10, 13, 16, 19, 22, 25, 28, 31, August 3, 6, 9, 12 (2010)

QPF verification : methodology

- **V**erification at the GEM-LAM 2.5 km grid-scale



LAM 2.5, gauges

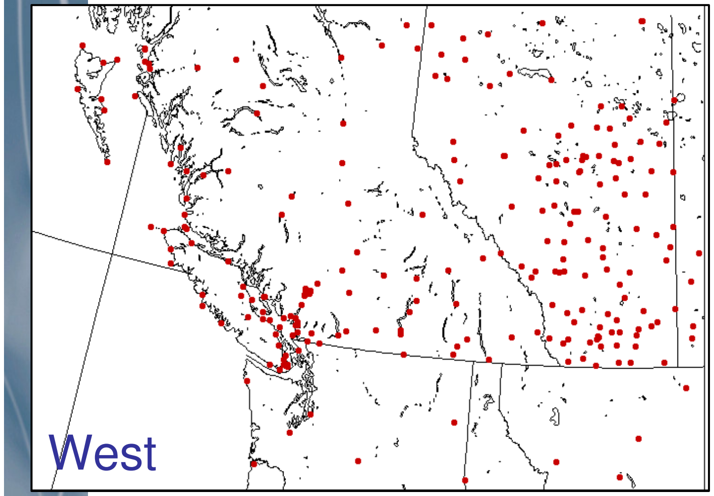
1. Average pcp of gauges within LAM 2.5 km grid-box if more than one gauge
2. Mask out grid-boxes outside LAM and without observation
3. Compute QPF summary scores
4. Compute confidence intervals by bootstraping

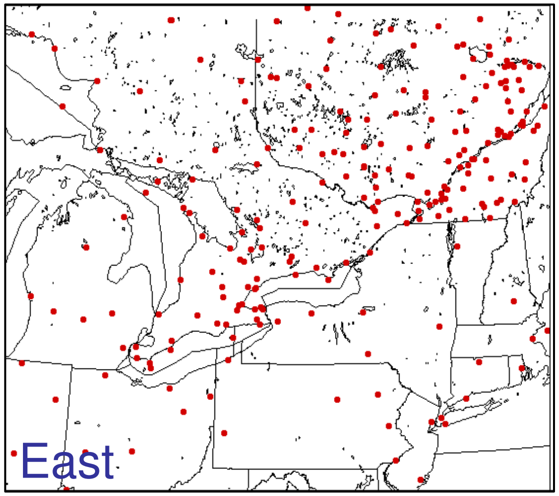
Method from B. Casati / B. Denis

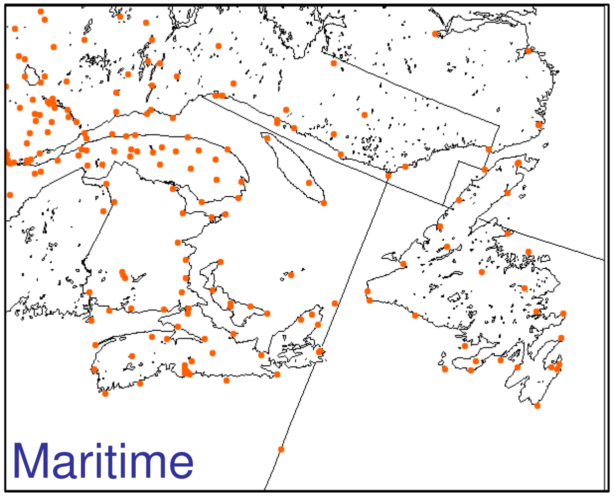
QPF verification: Gauge Distribution

- From the Canadian Precipitation Analysis project (CaPA) (Mahfouf *et al .* 2007)
- Uses SYNOP/METAR and RMCQ (Réseau météo coopératif du Québec)
- Number of stations for sub-domains:

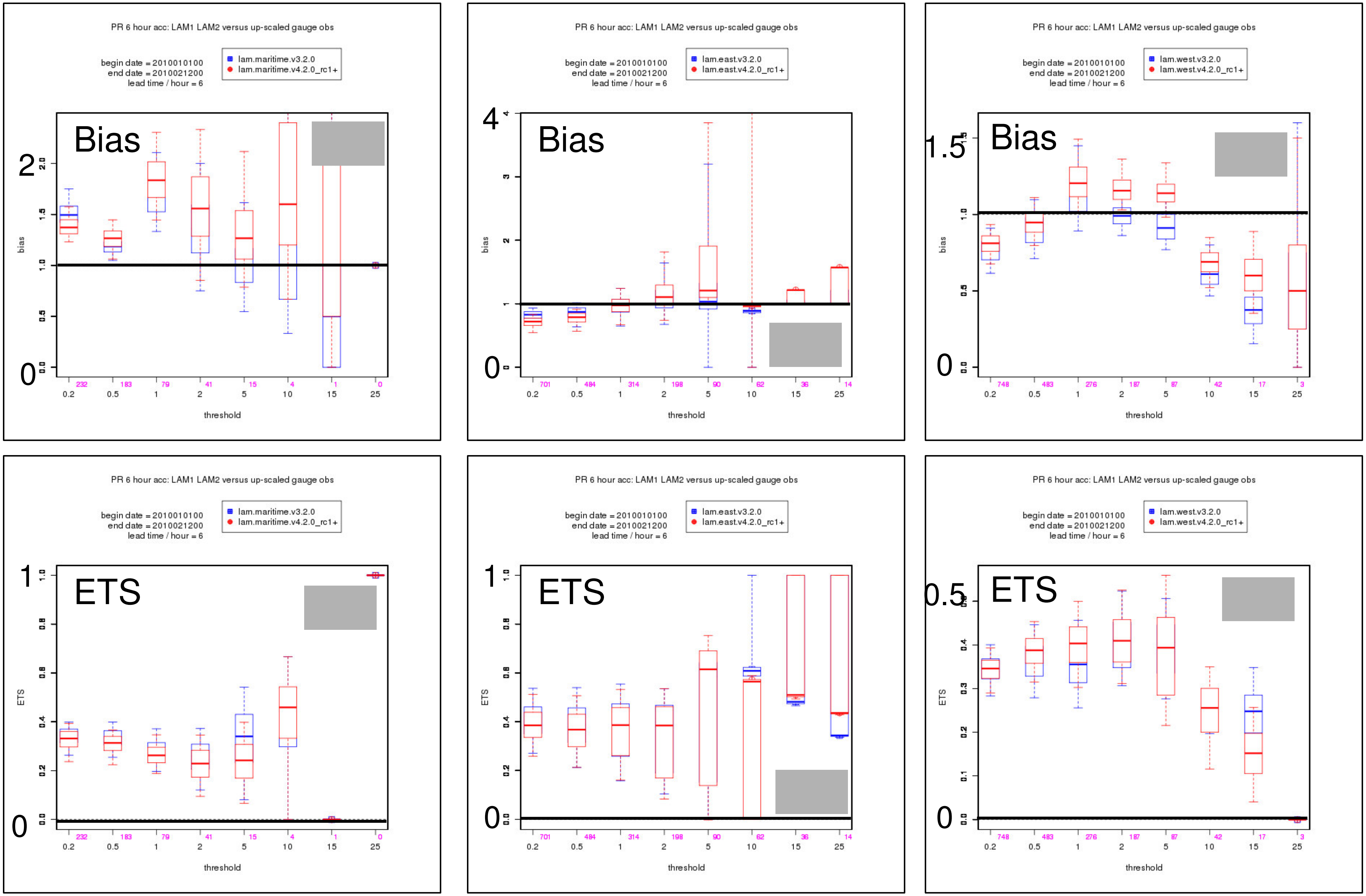
West: **254**, East: **259**, Maritime: **284**







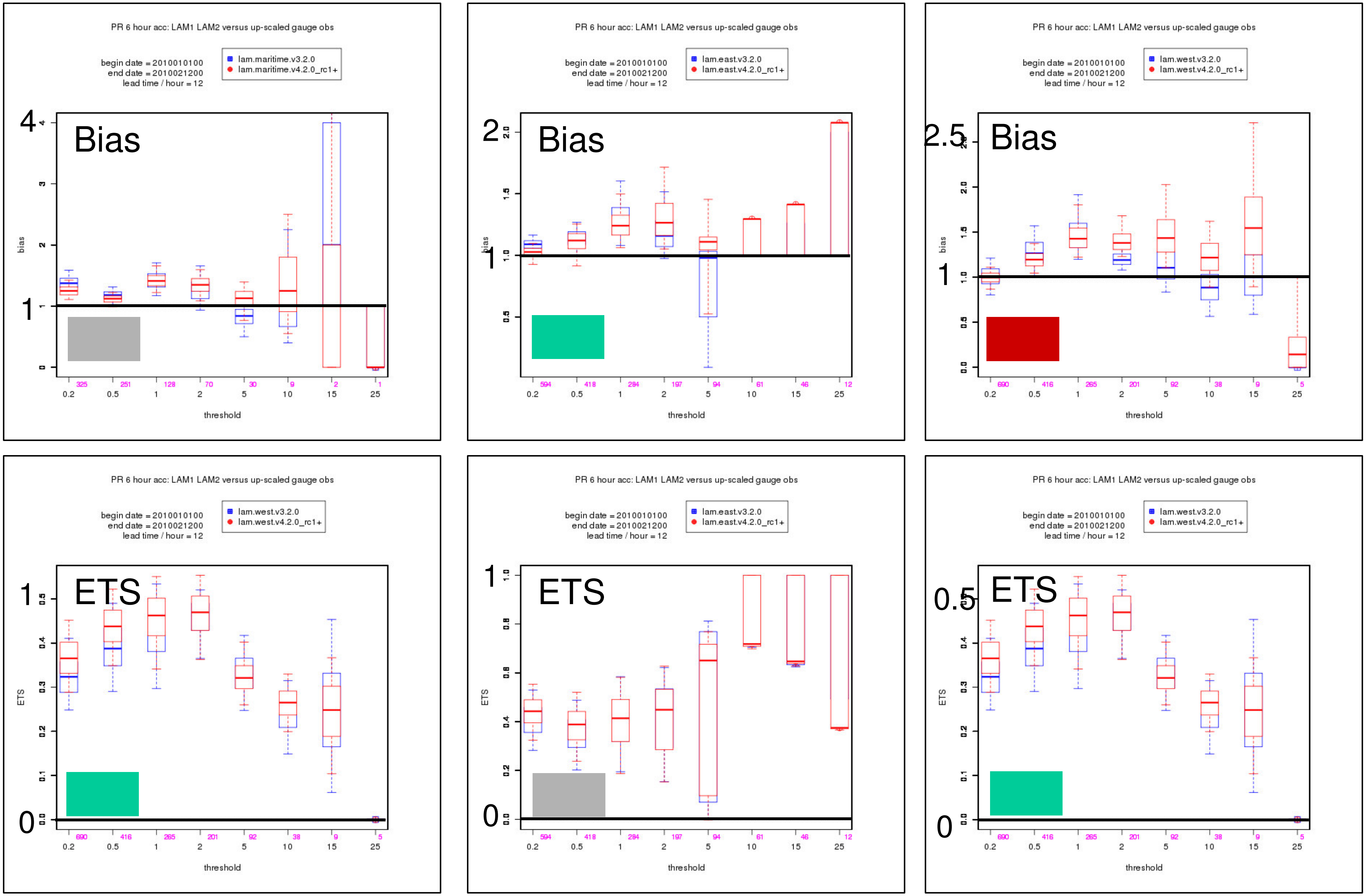
Maritime East West



Winter 2010 – 06h

Current **Proposed**

Maritime East West



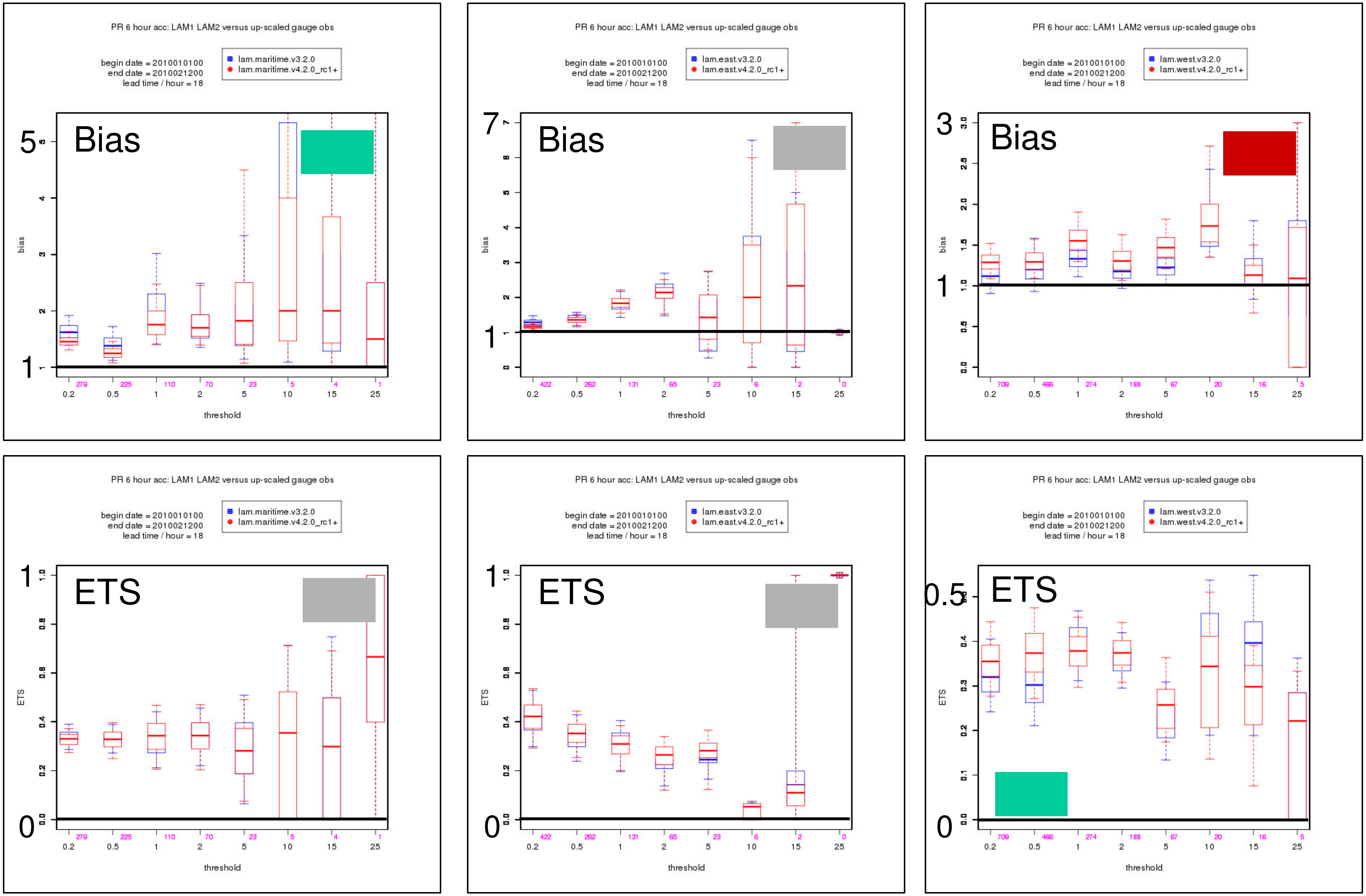
Winter 2010 – 12h

Current **Proposed**

Maritime

East

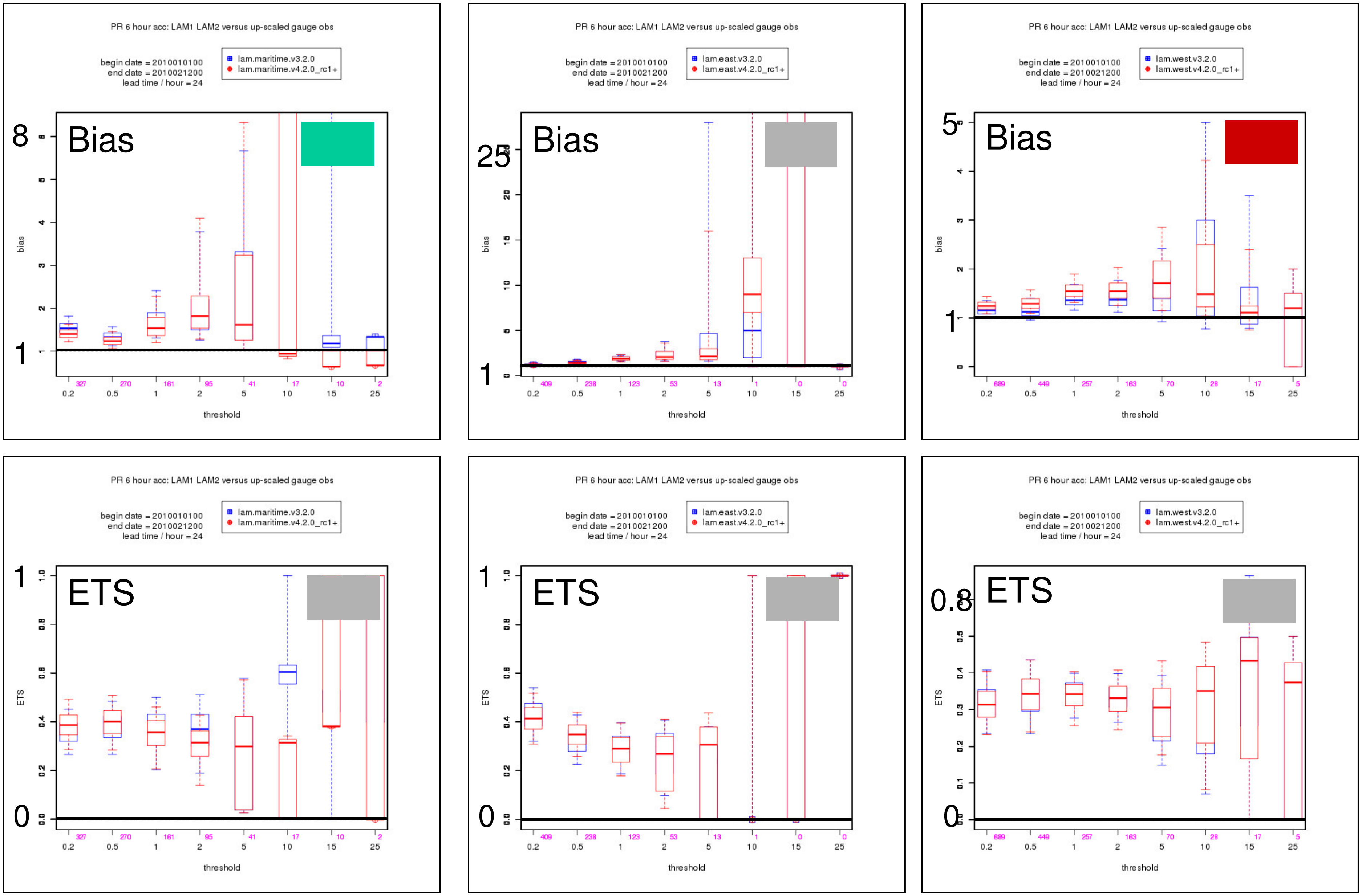
West



Winter 2010 – 18h

Current **Proposed**

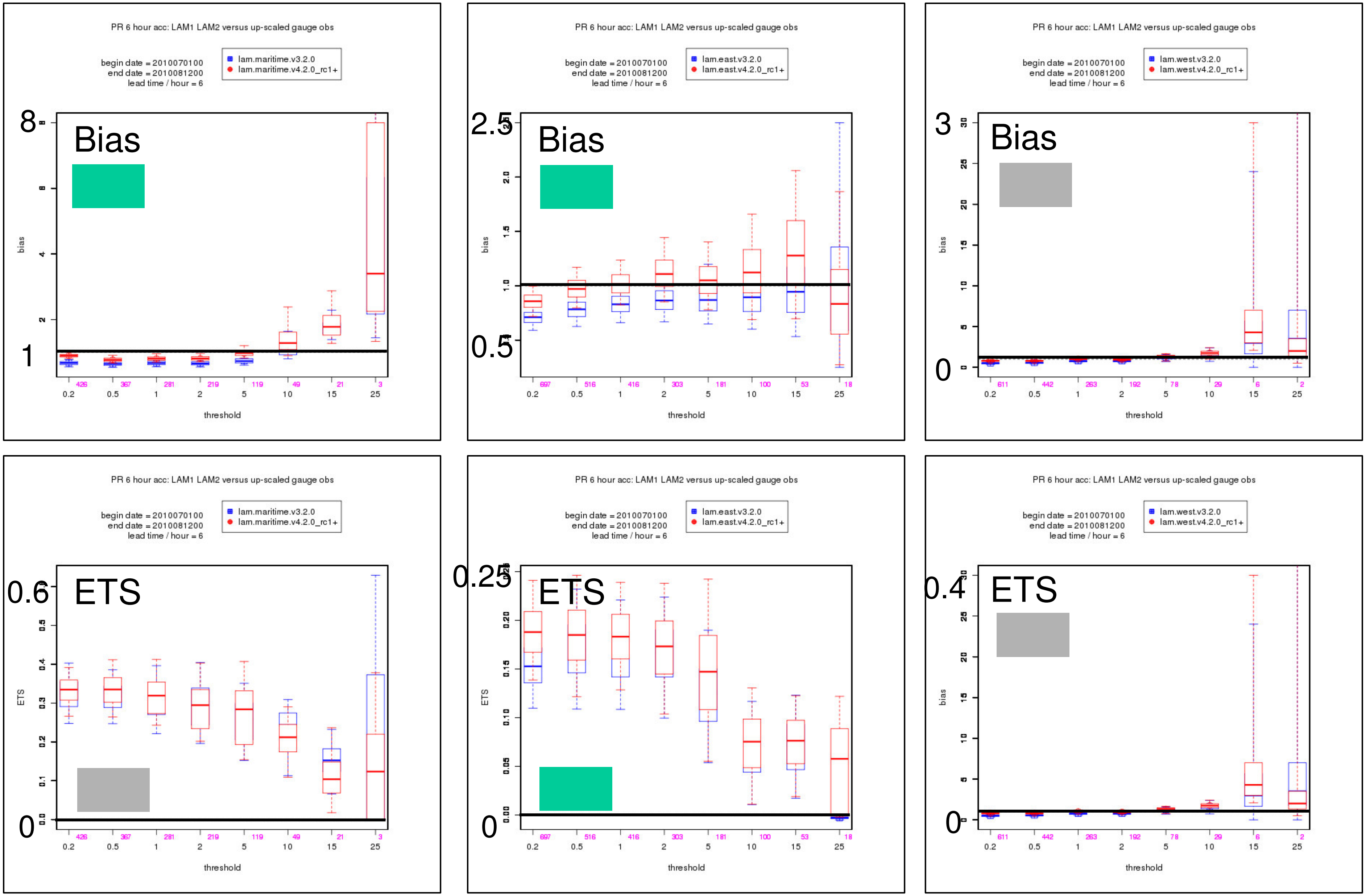
Maritime **East** **West**



Winter 2010 – 24h

Current **Proposed**

Maritime   East   West

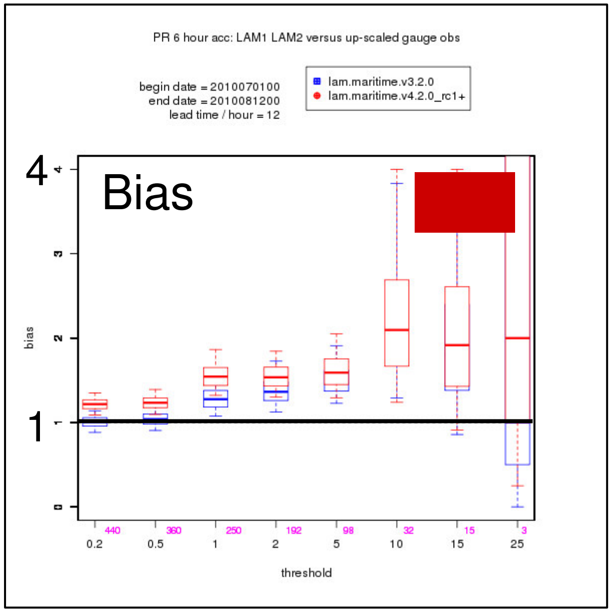


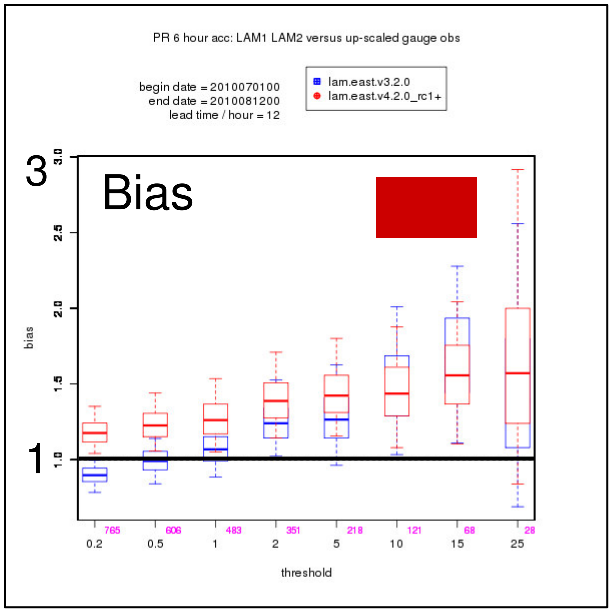
Summer 2010 – 06h **Current** **Proposed**

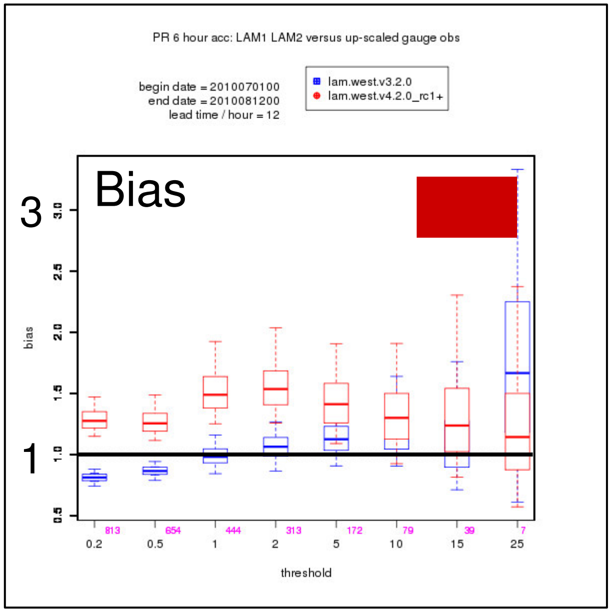
Maritime

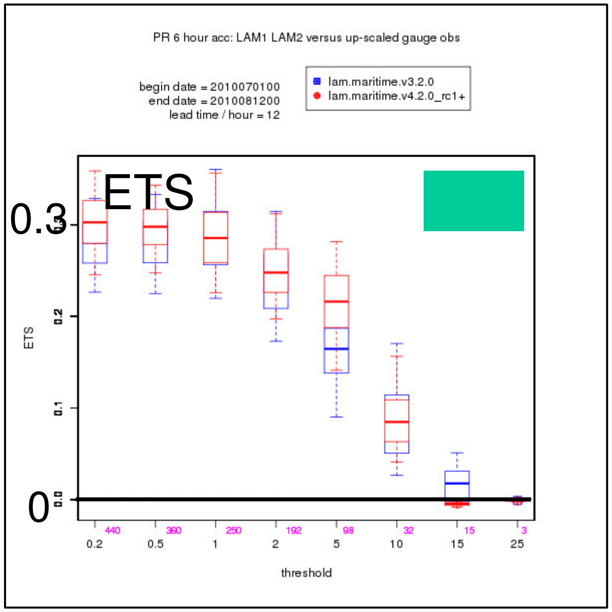
East

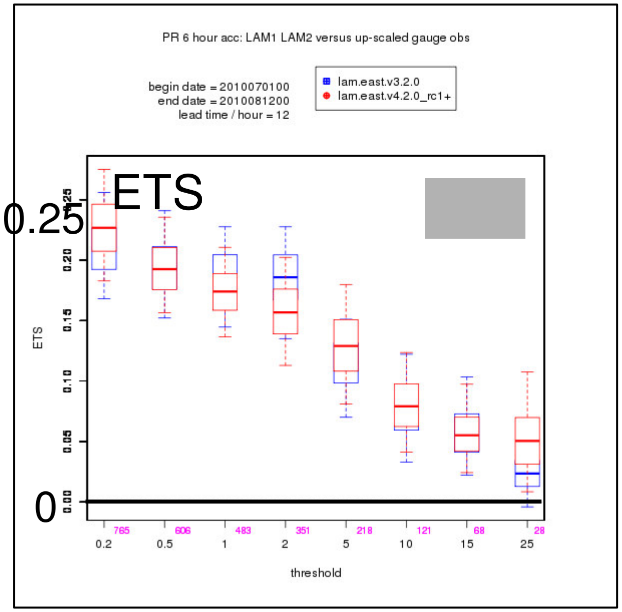
West

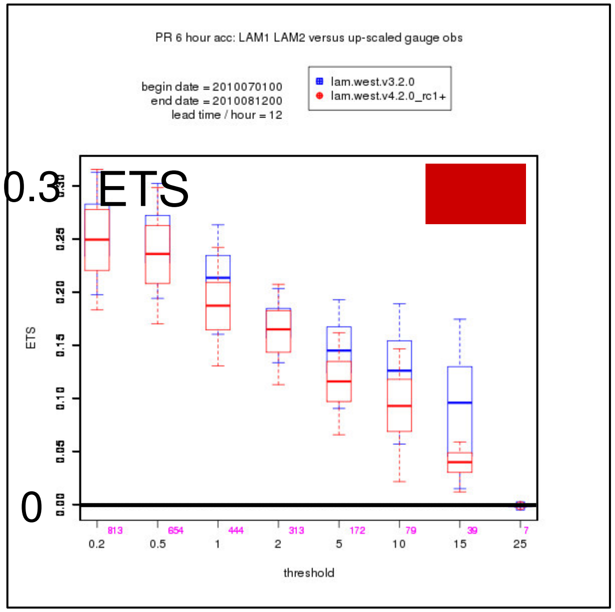






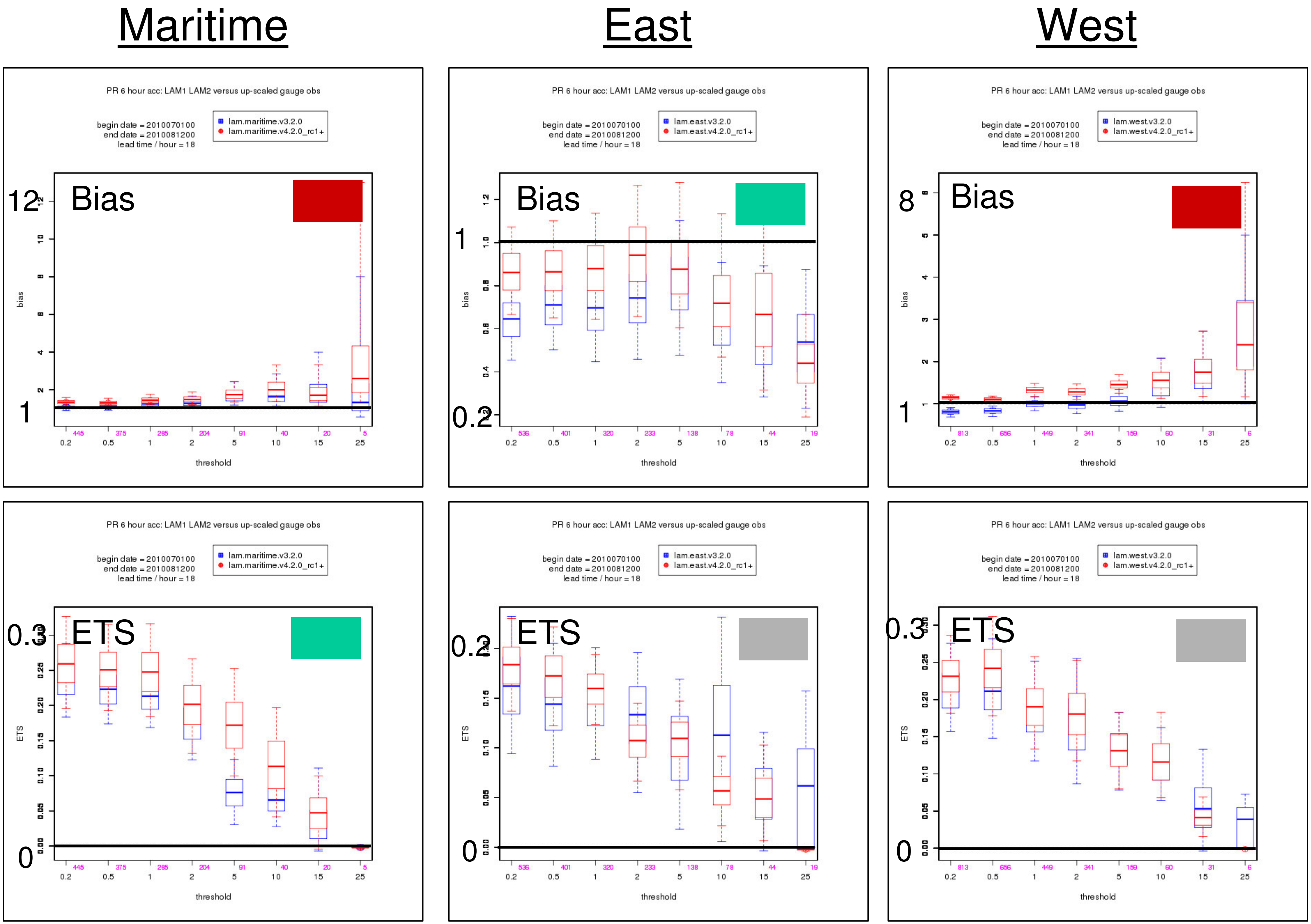






Summer 2010 – 12h

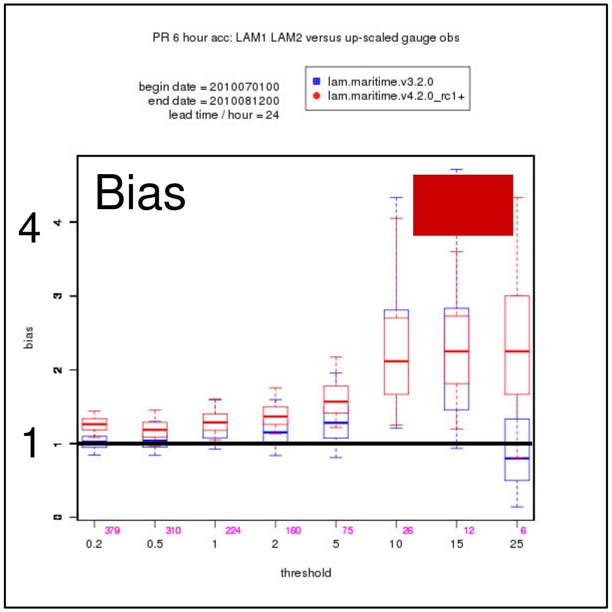
Current **Proposed**

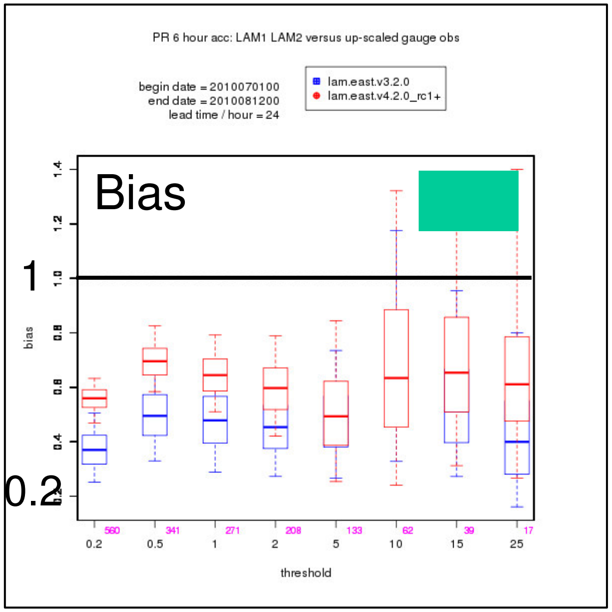


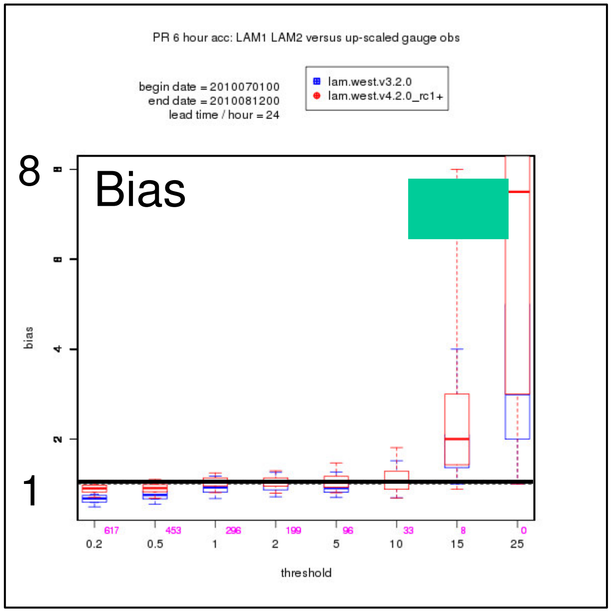
Summer 2010 – 18h

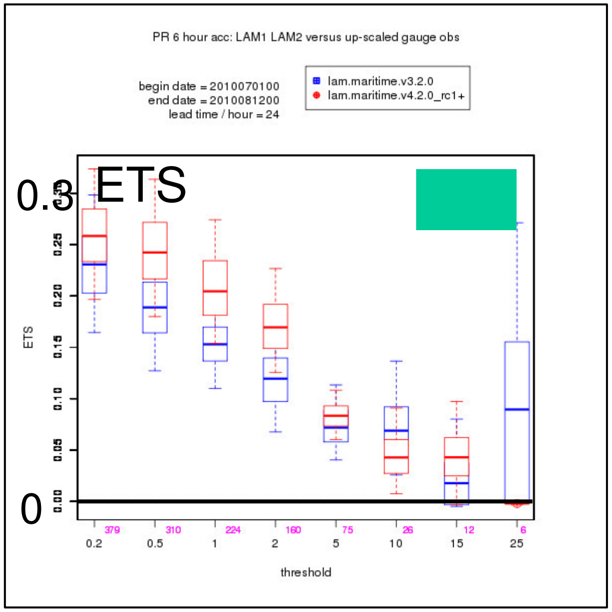
Current **Proposed**

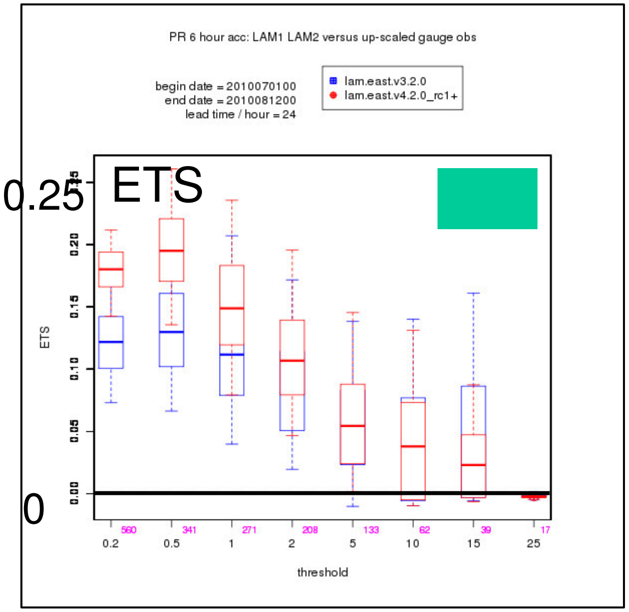
Maritime East West

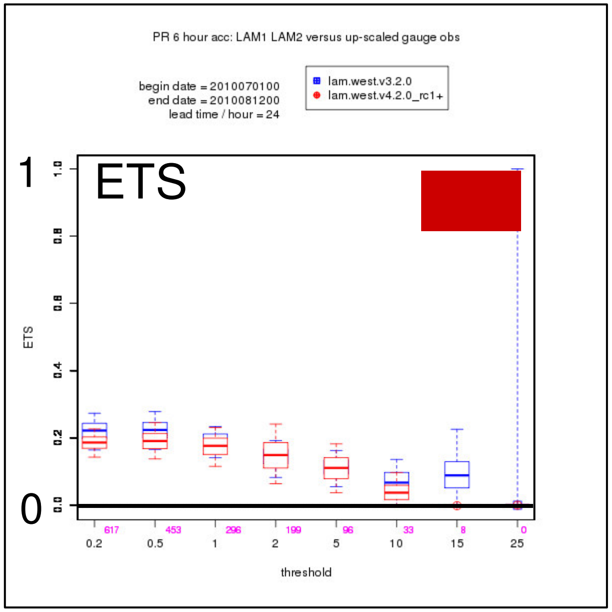












Summer 2010 – 24h **Current** **Proposed**

Having said that,

These are <u>not</u> the appropriate metrics to evaluate a high-resolution NWP model precipitation

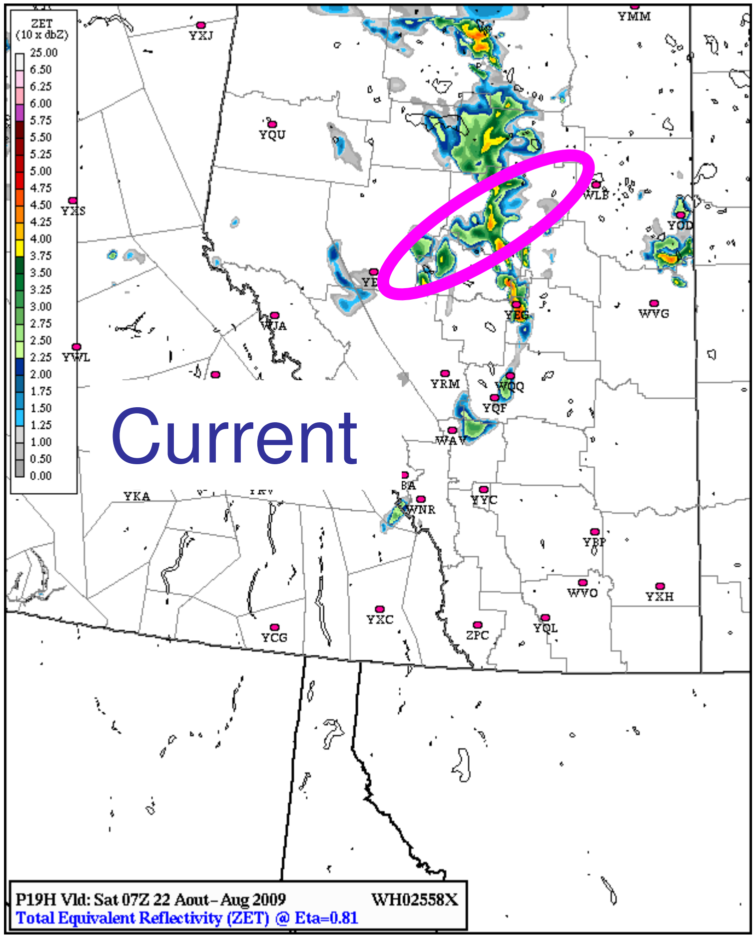
- gauge density and temporal resolution is insufficient
- small timing errors can heavily penalize model
- measuring snow precipitation quantity is very problematic

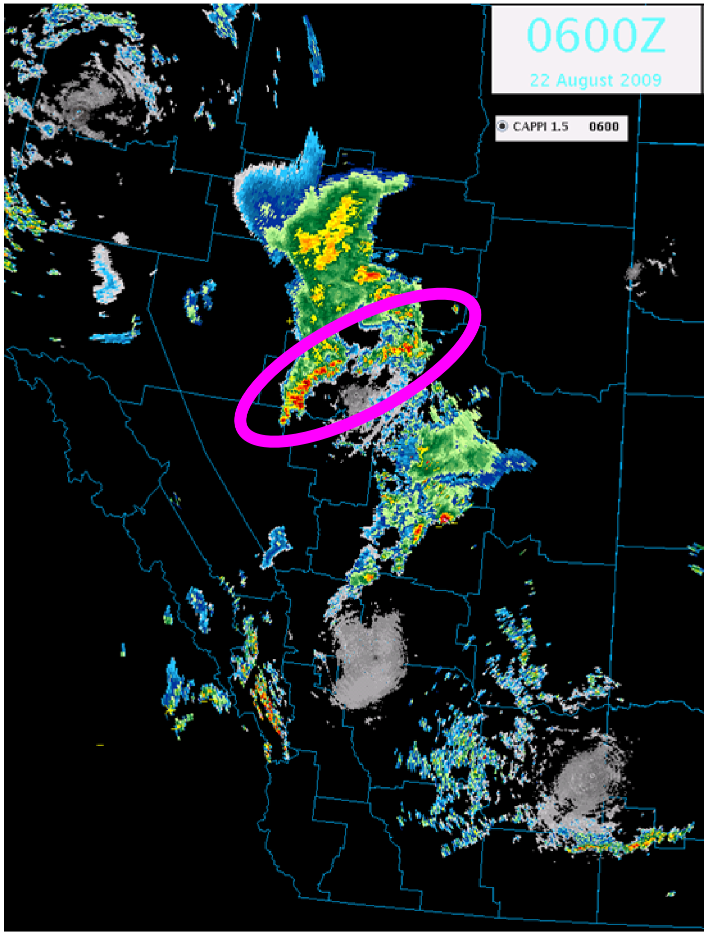
BUT:

- Major problems with proposed configuration would probably have been spotted
- This is a step towards proper QPF verification (for high-res)

21 August 2008 – “**Marginal Success**”

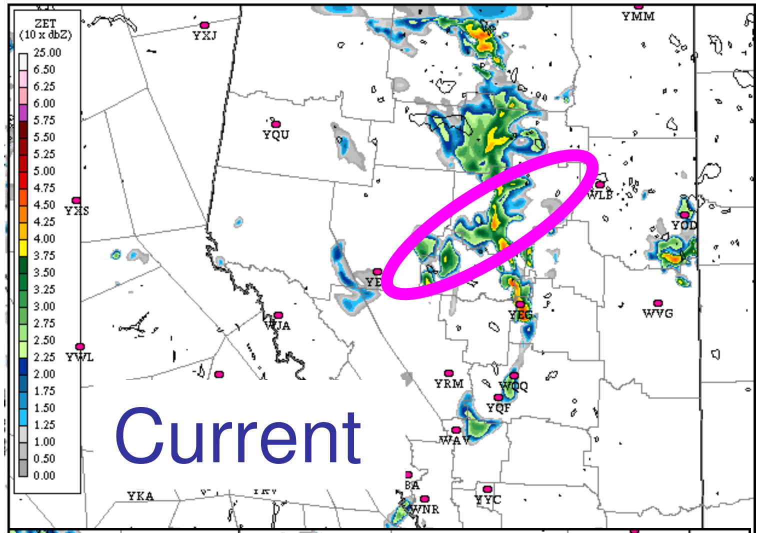
(PASPC presentation, CMOS 2010)

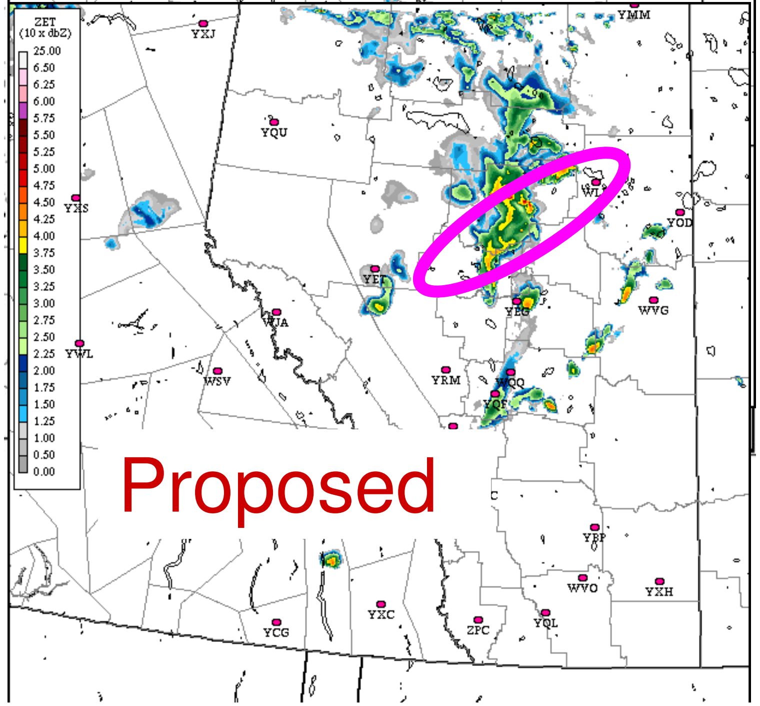


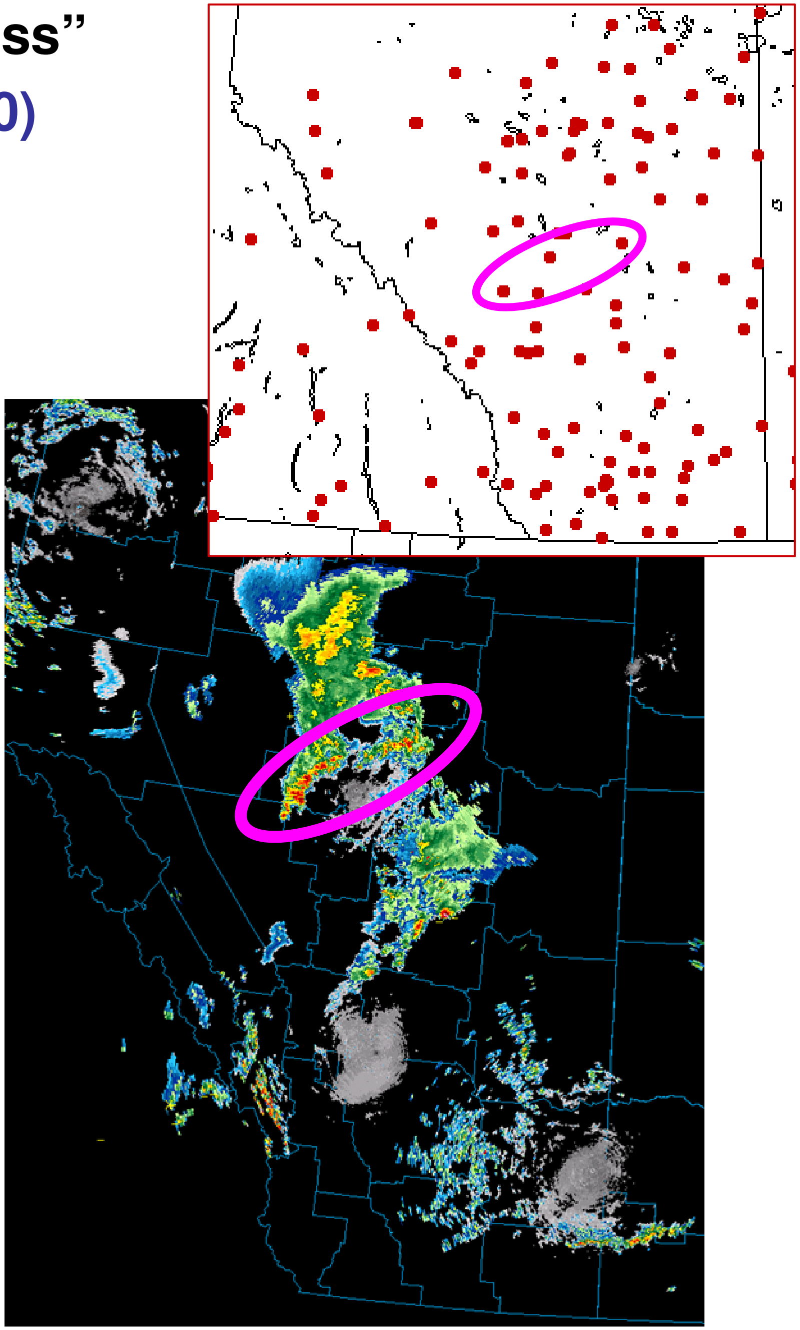


21 August 2008 – “**Marginal Success**”

(PASPC presentation, CMOS 2010)







Verification / Evaluation

- **Subjective evaluation**

1. V-10 LAM runs scrutinized every day during Olympics and Paralympics
2. V10-LAM runs examined during summer 2010 (PYR)
3. 8 summer high-impact weather cases were examined (PASPC)

What is the change in the forecast value between the **current** and the **proposed** configuration?

Ruping Mo's (BC National Lab; experienced forecaster) conclusion:

→ Though somewhat different, **there is no real change in the forecast value**

Computational Cost

Proposed vs. Current configuration:

- Total run time (start of LAM-15 to end of LAM-2.5): **Reduced by ~ 45%** (no GEMNTR for 2.5-km run)
- Change in computational cost*: **~25% extra**
- Topology yet to be optimized (→ *time/cost will improve*)
- Maritime grid: 22% extra → **4% extra for entire system**

* Estimated from wall clock time for GEMDM task on East-2.5 km grid (identical computational domain), with the same processor topology (6x12x4)

Summary of Proposal

Upgrade-1

1. Change model version to GEM_v4.2.0
2. Change to V-10 physics configuration
    - CKD radiative transfer scheme
    - Double-moment microphysics scheme
3. Changes to Maritime domain
    - \- Sfc ICs from GSL coupled system
    - \- Expansion of grid

Towards an Operational HRDPS

Upgrade-1: (this proposal)

- Change model version to GEM_v4.2.0
- Change to V-10 physics configuration
- Changes to Maritime domain

Upgrade-2: *FUTURE*

- Switch to "operational" status
  - CPOP standards
  - formal verification package
- Further developments to improve system

Towards an Operational HRDPS

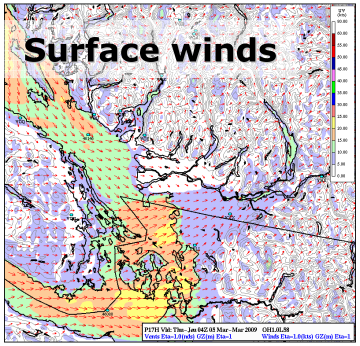
Further developments to improve system:

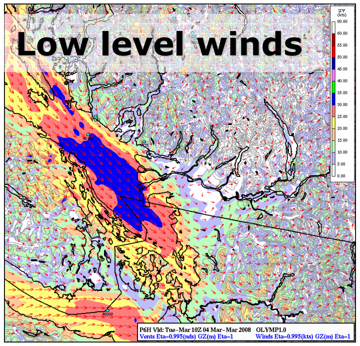
- Improvements to image production
- Redistribution of vertical levels
- Lid-nesting
- Forcing from GSL model (not just ICs)
- Grids configuration (appropriate to needs)
- Improvements to microphysics (e.g. graupel and hail)
- Sloped-surfaces for radiation scheme
- Etc.

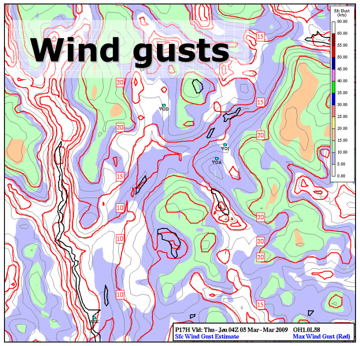
2-D maps

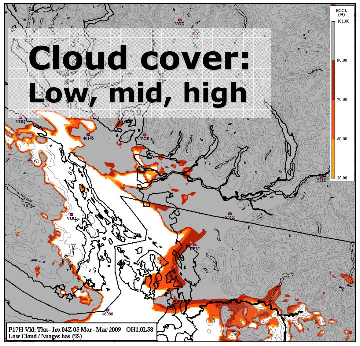
vancouver 2010

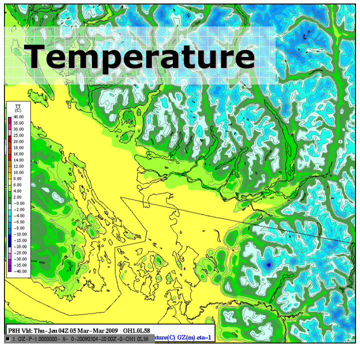
CANADA
Host Country
Pays hôte

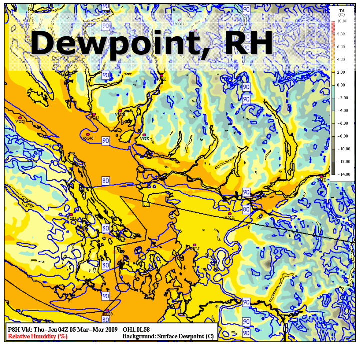

Surface winds

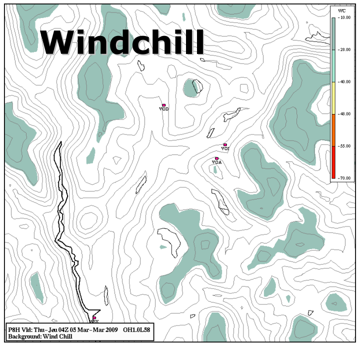

Low level winds

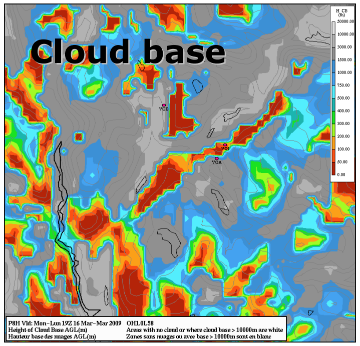

Wind gusts

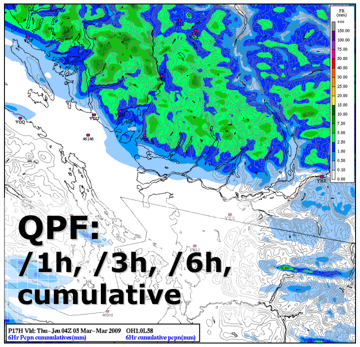

Cloud cover:
Low, mid, high

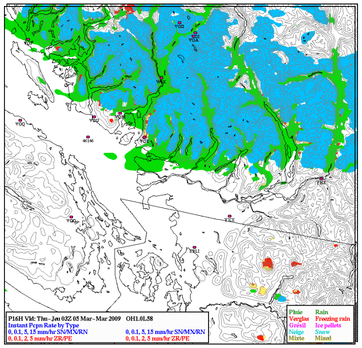

Temperature

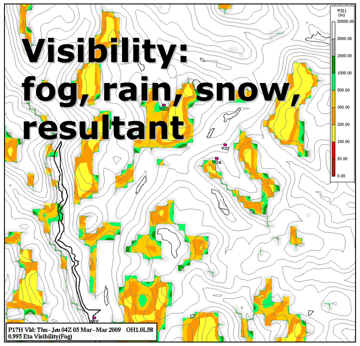

Dewpoint, RH


Windchill


Cloud base

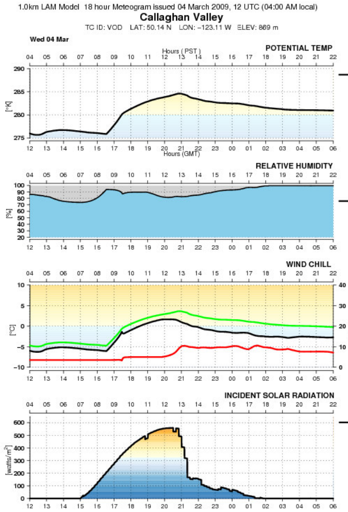

QPF:
/1h, /3h, /6h,
cumulative



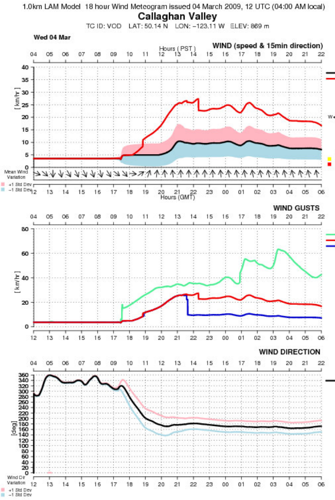

Visibility:
fog, rain, snow,
resultant

Meteograms

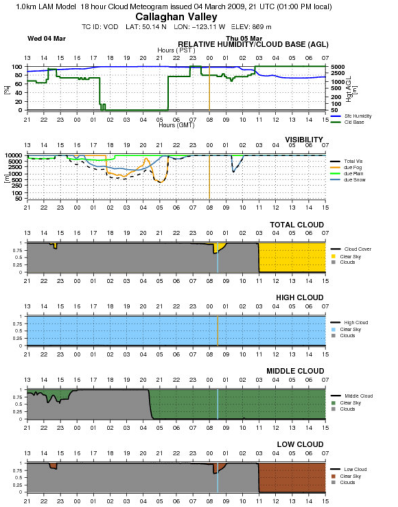
→ VIZAWEB



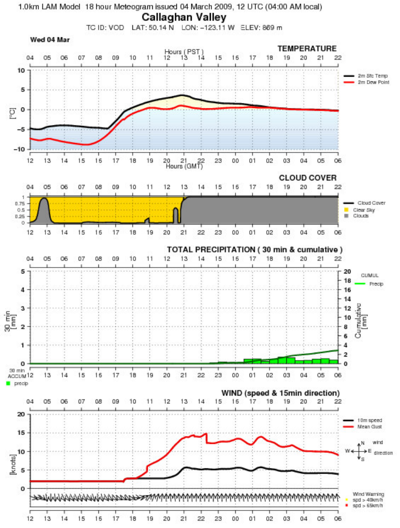
T, T_d etc.



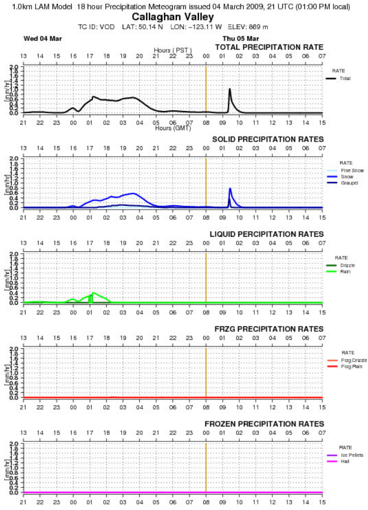
Wind and Gusts



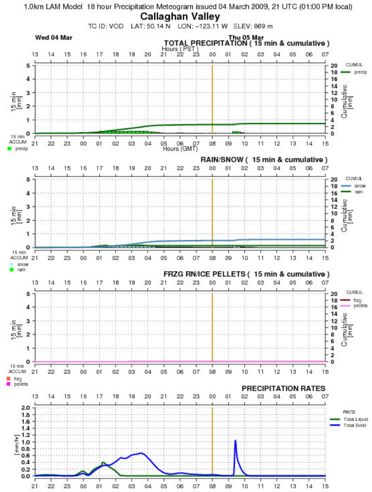
Clouds and visibility



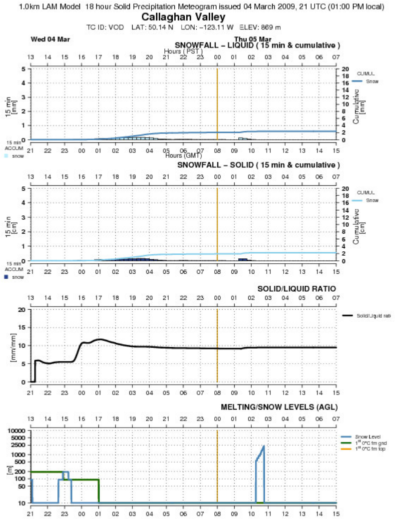
General Wx



PCP Rates



Precipitation



Snow

Towards an Operational HRDPS

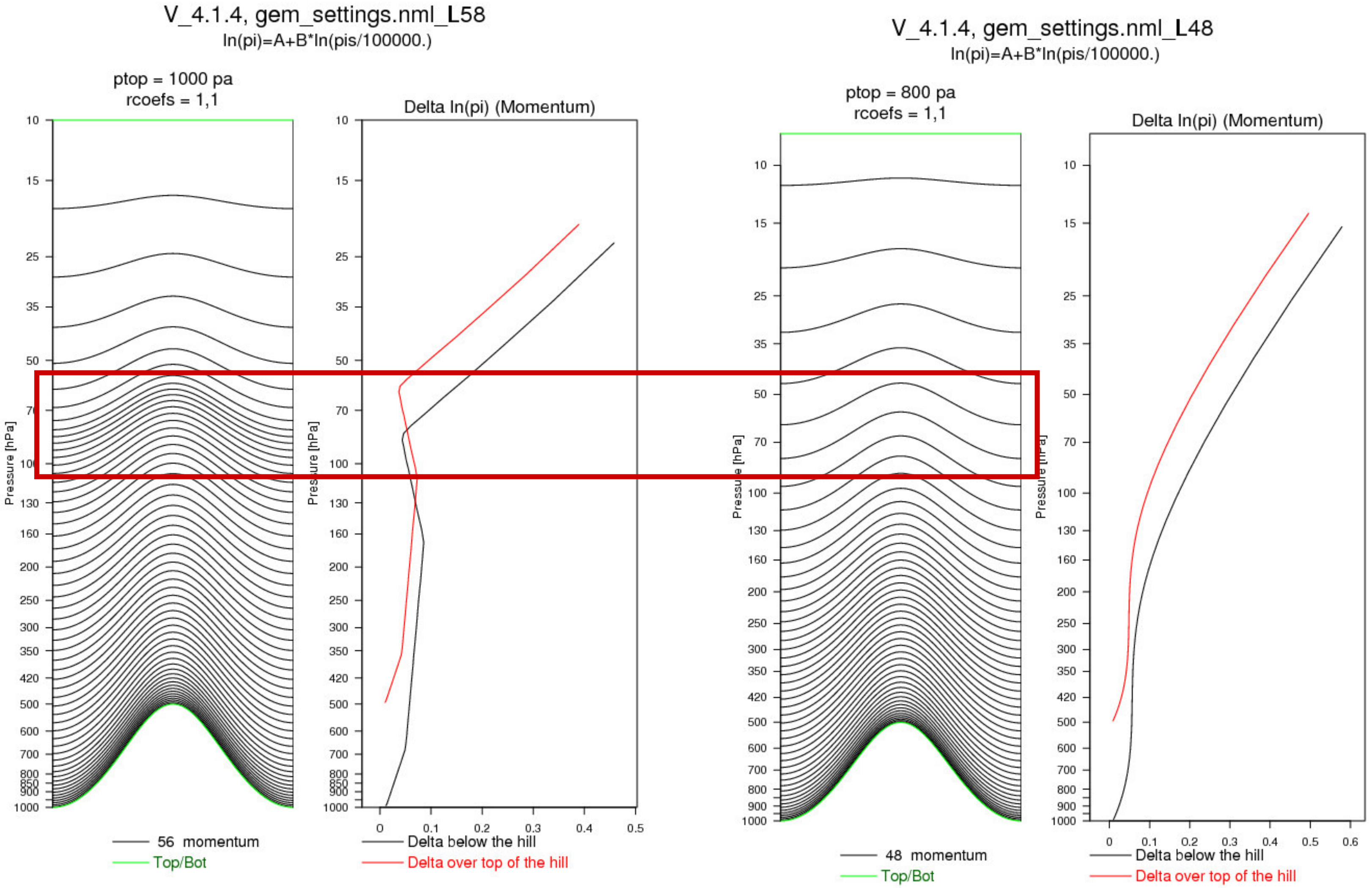
Further developments to improve system:

- Improvements to image production
- **Redistribution of vertical levels**
- **Lid-nesting**
- Forcing from GSL model (not just ICs)
- Grids configuration (appropriate to needs)
- Improvements to microphysics (e.g. graupel and hail)
- Sloped-surfaces for radiation scheme
- Etc.

Examining alternative configurations of vertical levels

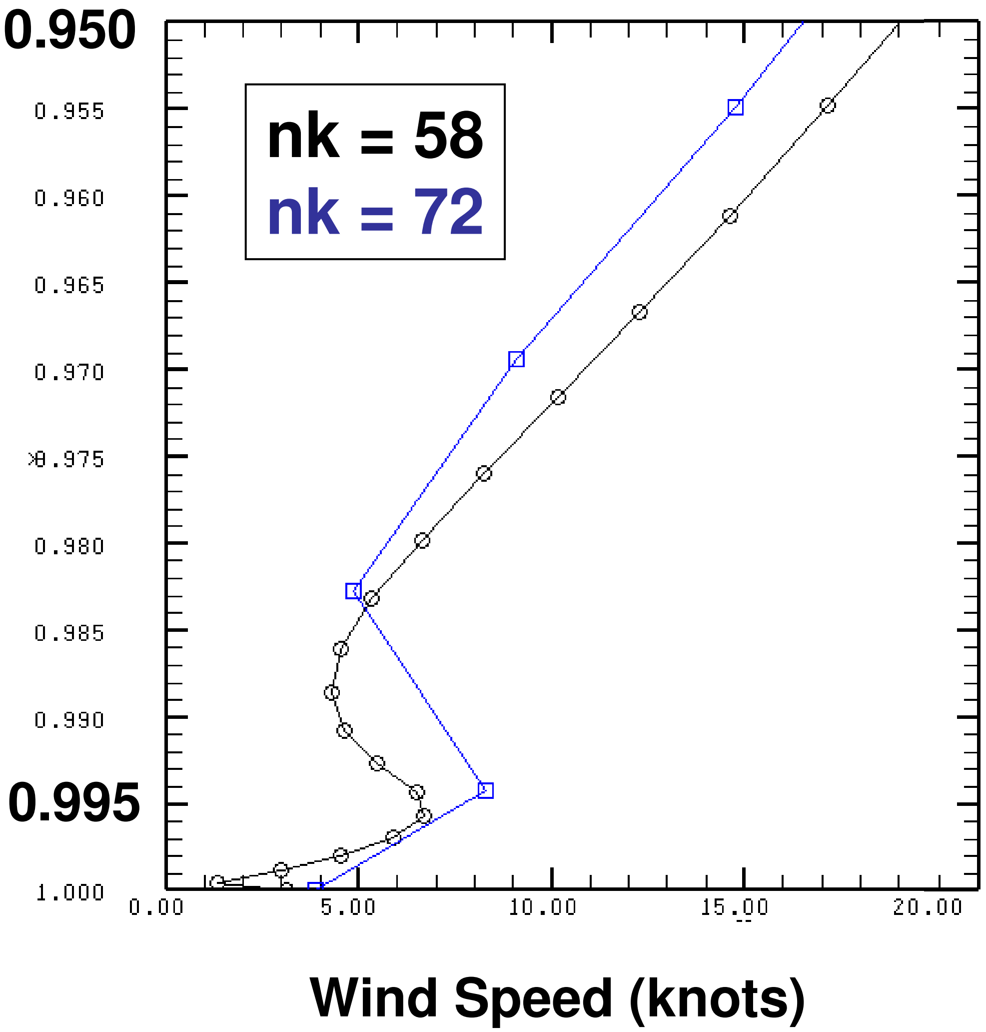
Current Levels (58):

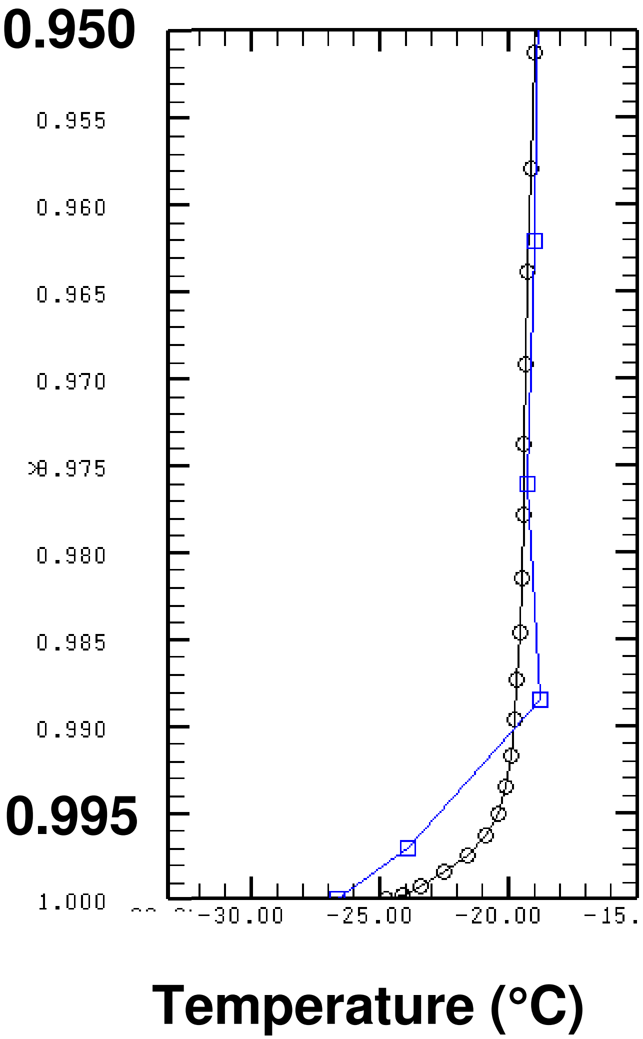
Alternative Configuration (48):



Testing increased vertical resolution in PBL:

→ Possible improvements to winds and temperature





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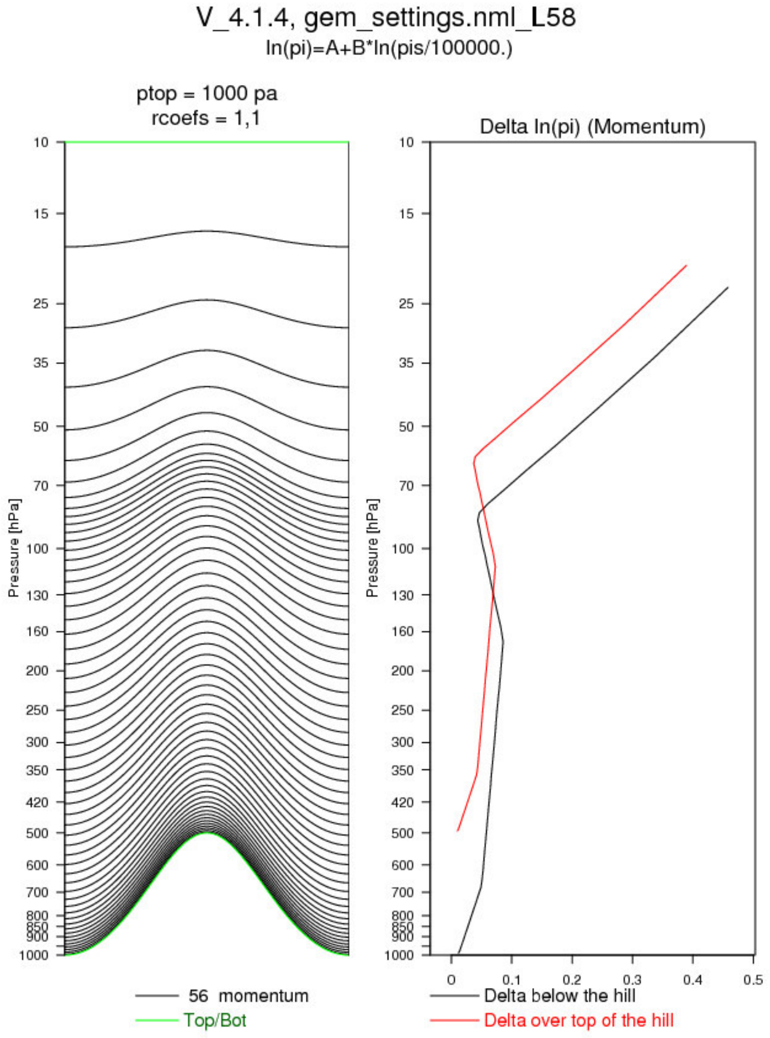
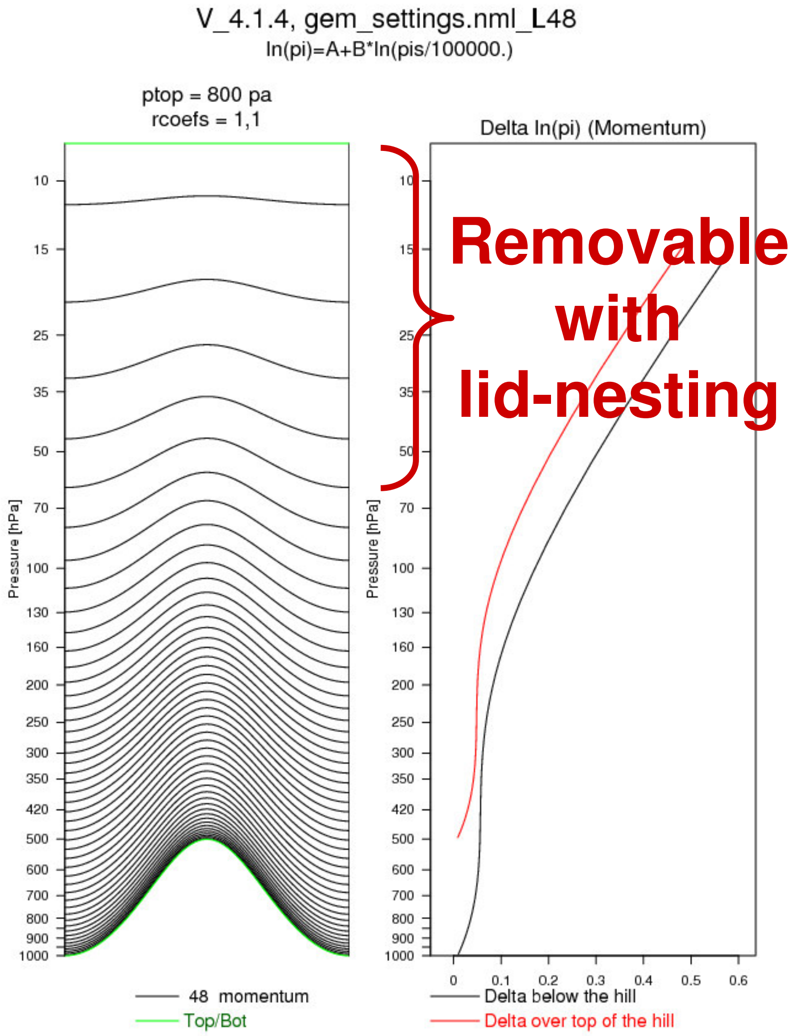


Alternative Configuration (48):



Removable with lid-nesting

Towards an Operational HRDPS

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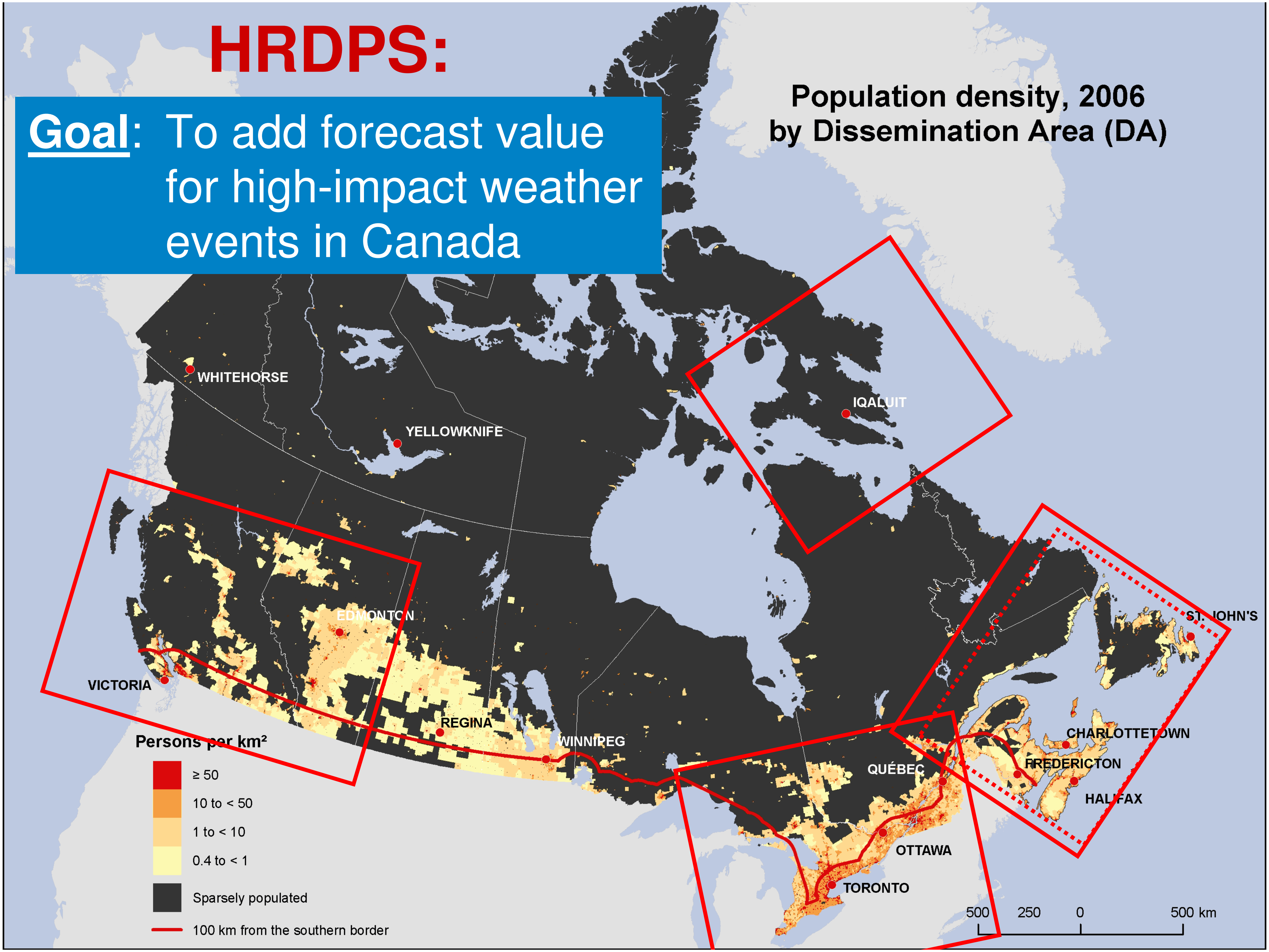
HRDPS:

<u>Goal</u>: To add forecast value for high-impact weather events in Canada



Population density, 2006
by Dissemination Area (DA)

Towards an Operational HRDPS

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- **Etc.**

Towards an Operational HRDPS

Upgrade-1: (this proposal)

1. Change model version to GEM_v4.2.0
2. Change to V-10 physics configuration
3. Changes to Maritime domain

Upgrade-2: *(future)*

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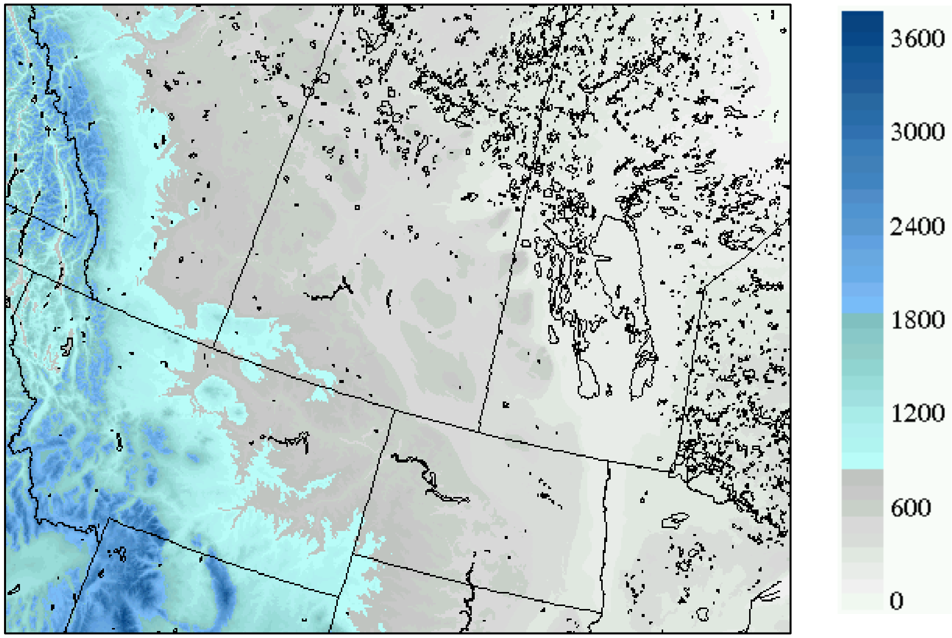
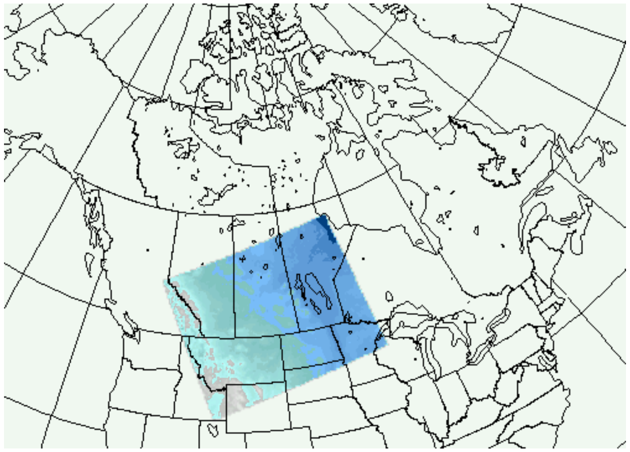
  - CPOP standards
  - formal verification package
- further developments to improve system

EXTRA SLIDES

Examining usefulness of a Prairie deterministic grid

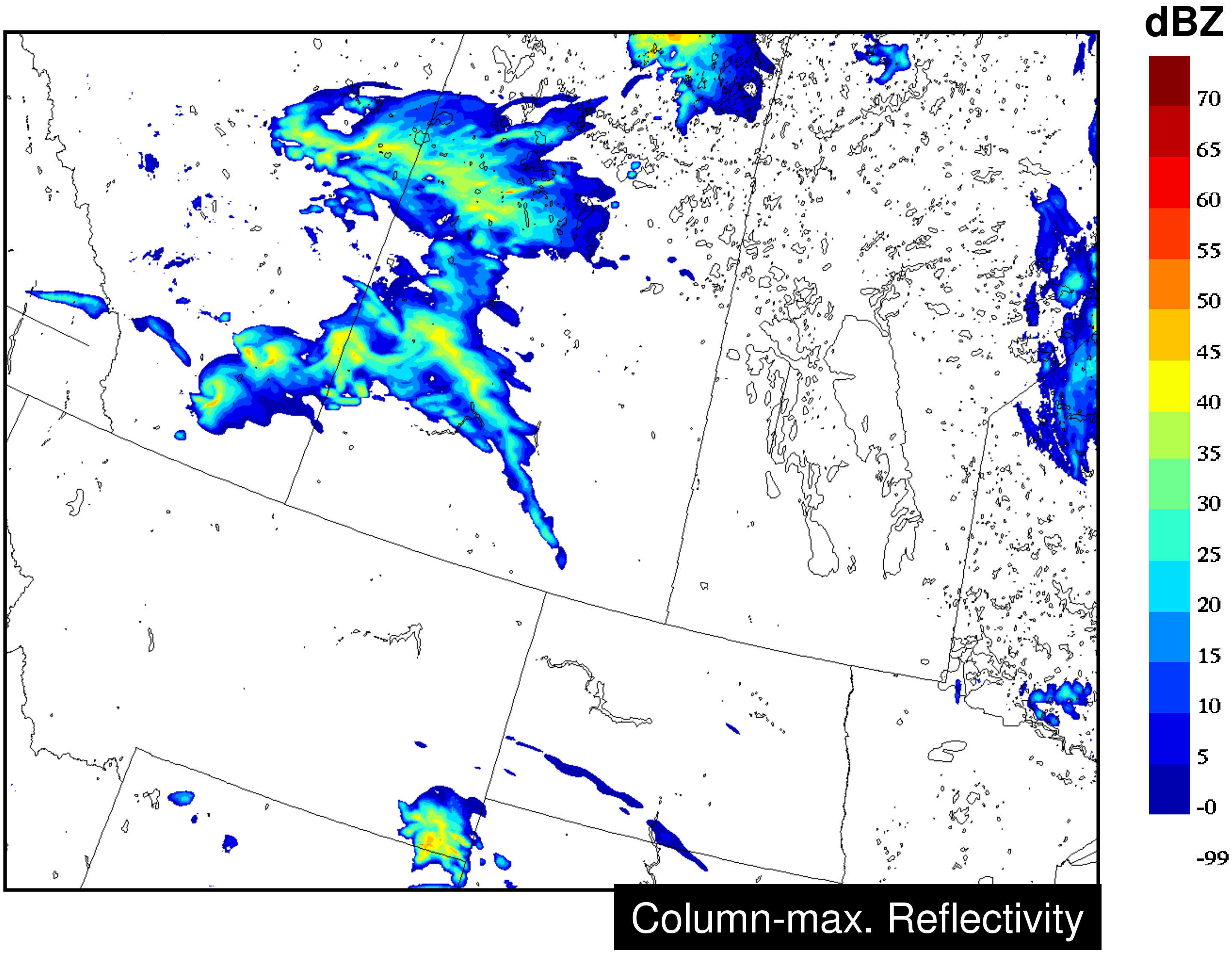




- To be run in user account (Ron Goodson), starting very soon
- Images will be available on VIZAWEB
- **Feedback from users requested! Is this grid useful?**

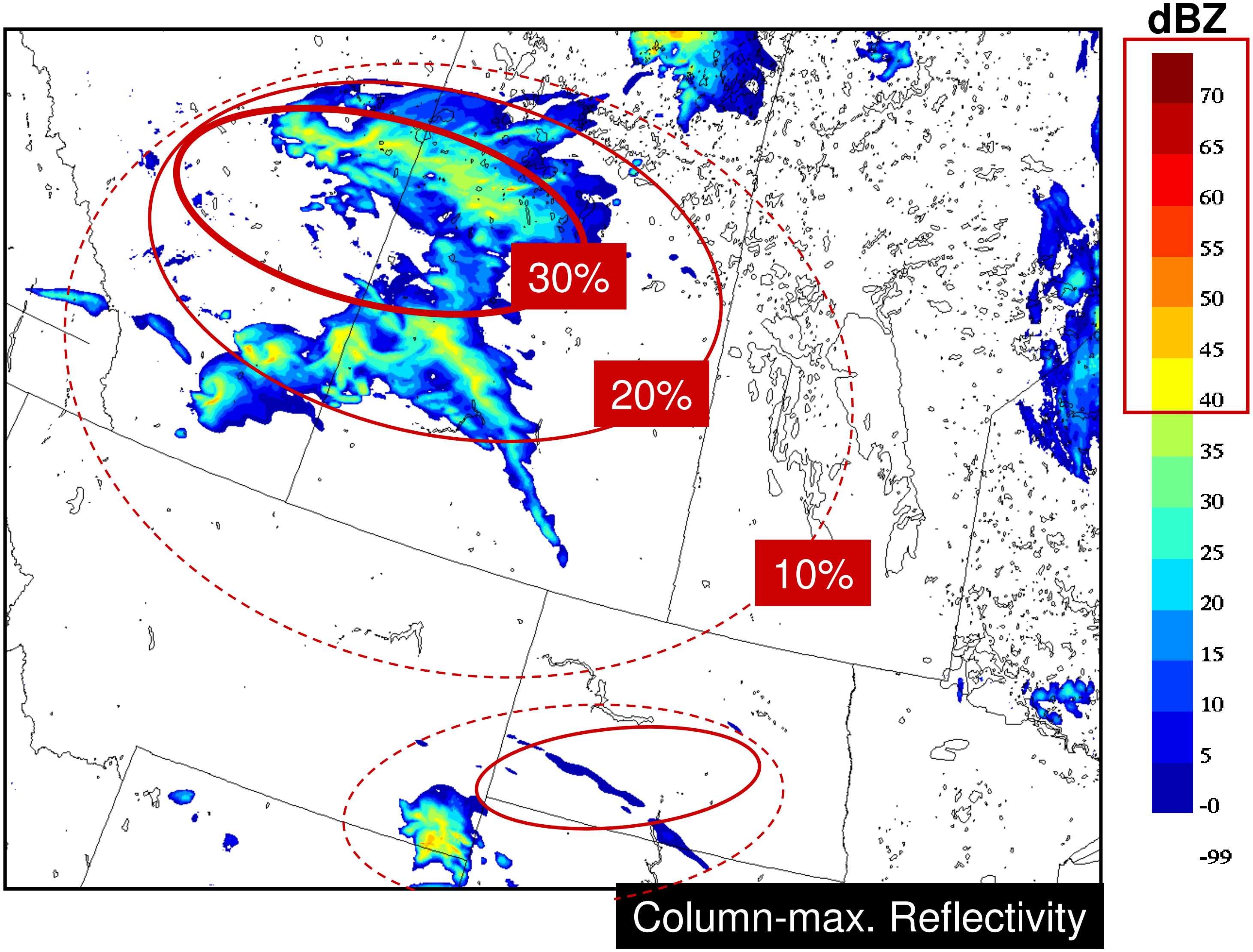
Deterministic vs. Ensemble

for prediction of severe weather elements w/ deep convection



Deterministic vs. **Ensemble**

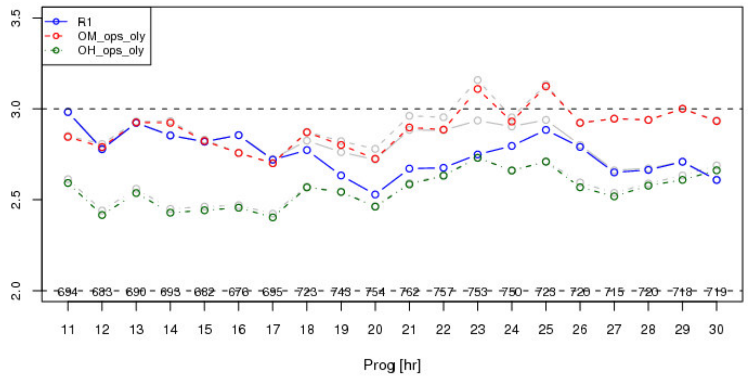
for prediction of severe weather elements w/ deep convection



Wind Speeds (10 m)

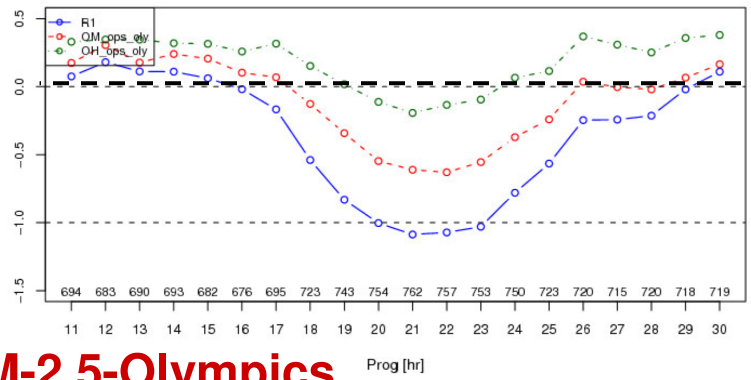
UV_R1–OM–OH–phase_C_2010 all_cases UNBIAS RMS ERROR

kts



UV_R1–OM–OH–phase_C_2010 all_cases BIAS

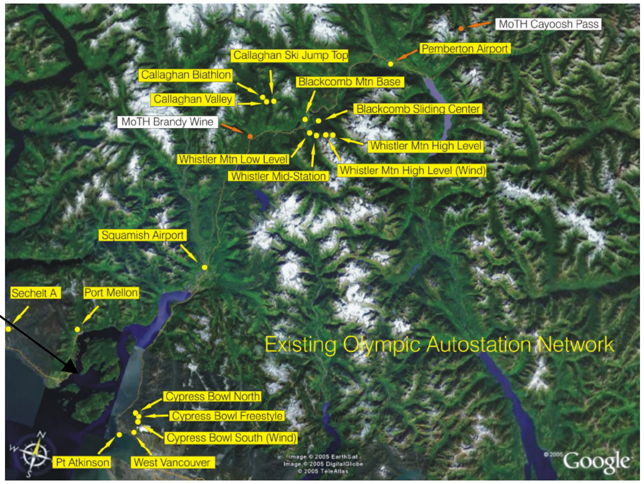
kts



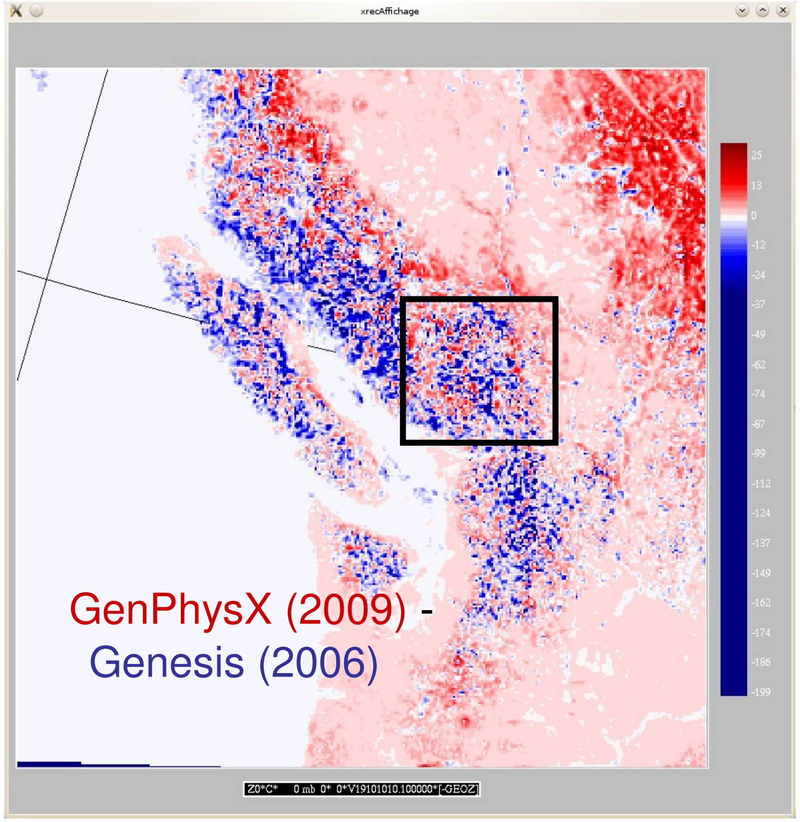
LAM-2.5-Olympics

Phase C
(Feb. 12 - March 23, 2010)

Howe Sound



°C

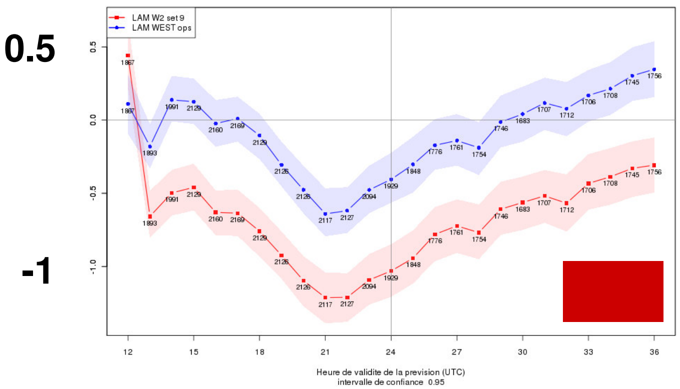


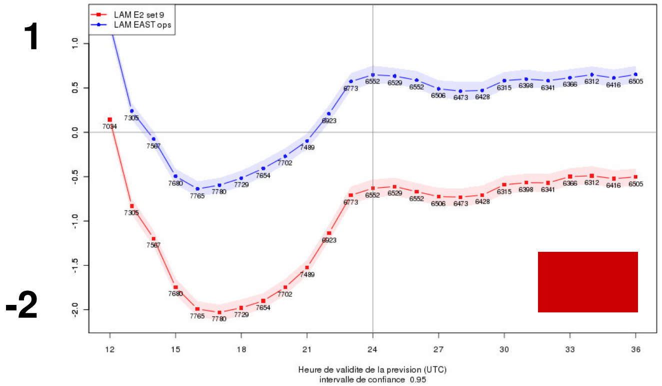
GenPhysX (2009) - Genesis (2006)

Biais / *Bias*

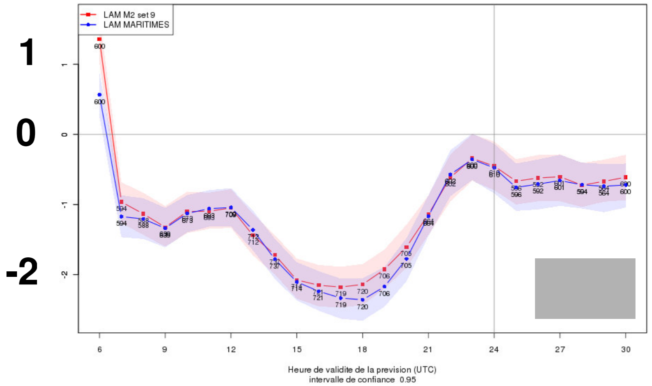
Hiver
Winter

BIAIS (P-O) DU MODULE DU VENT (NOEUDS)
periode du 2010-01-01 au 2010-02-12





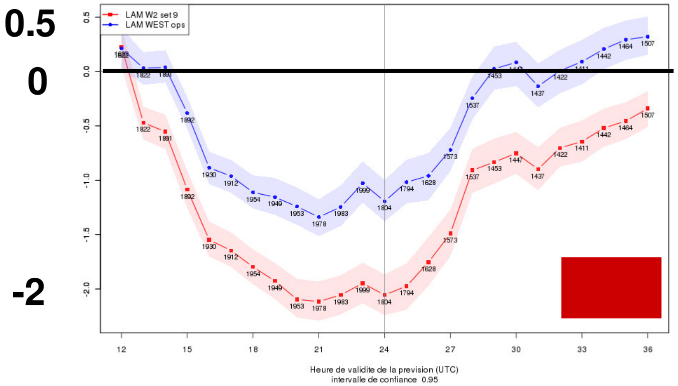
BIAIS (P-O) DU MODULE DU VENT (NOEUDS)
periode du 2010-01-01 au 2010-02-12



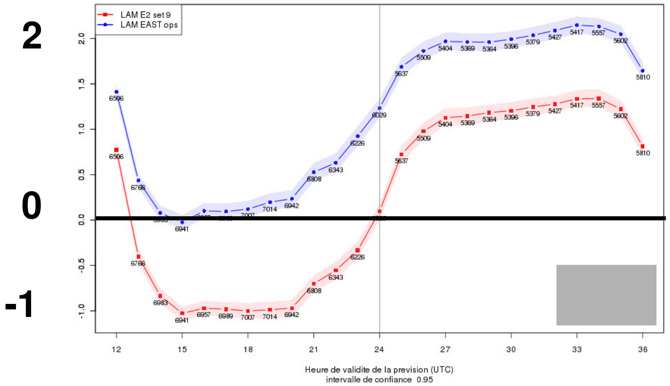
Biais / *Bias*

Été
Summer

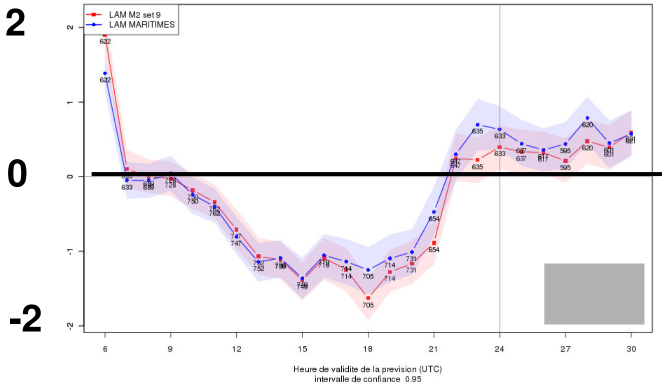
BIAIS (P-O) DU MODULE DU VENT (NOEUDS)
periode du 2010-07-01 au 2010-08-12



BIAIS (P-O) DU MODULE DU VENT (NOEUDS)
periode du 2010-07-01 au 2010-08-12



BIAIS (P-O) DU MODULE DU VENT (NOEUDS)
periode du 2010-07-01 au 2010-08-12

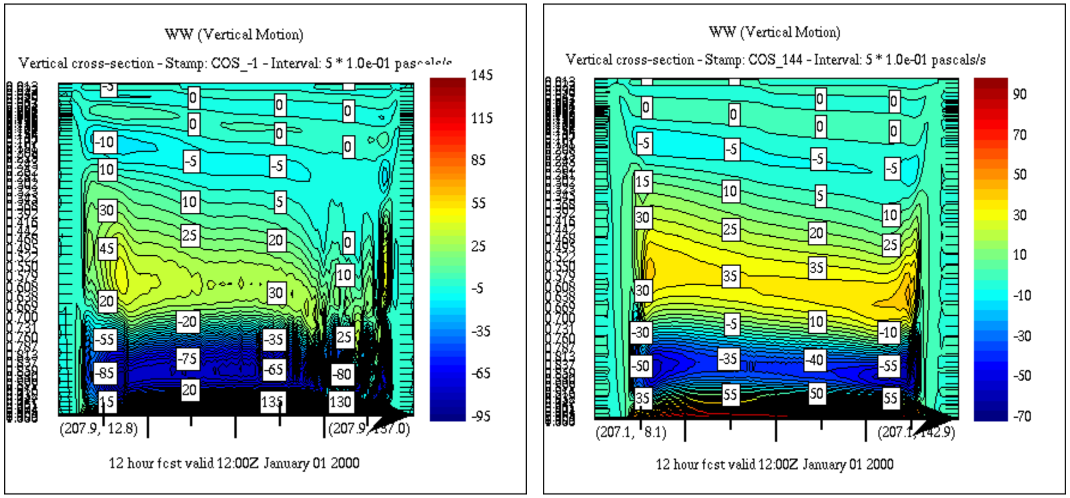


Growing Orography

Nesting increments 15km : 2.5km (<1800 m) and 2.5km : 1km (<600 m) involve orographic changes that cause imbalances during nesting:

Gravity waves are generated as the dynamics come into balance (left)

Effects of subterranean extrapolation can be long-lived (right)


WW (Vertical Motion)

Vertical cross-section - Stamp: COS_-1 - Interval: 5 * 1.0e-01 pascals/s

12 hour fcst valid 12:00Z January 01 2000

WW (Vertical Motion)

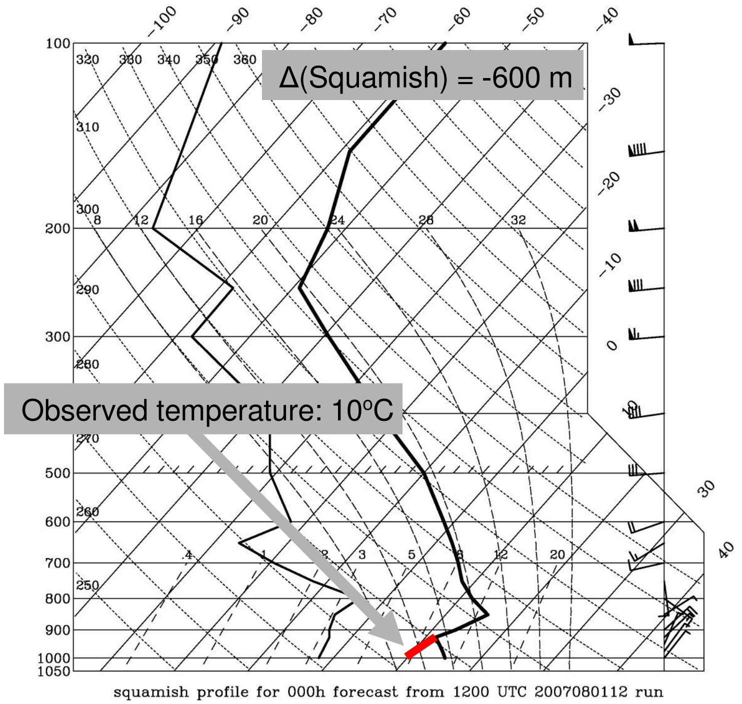
Vertical cross-section - Stamp: COS_144 - Interval: 5 * 1.0e-01 pascals/s

12 hour fcst valid 12:00Z January 01 2000

Vertical motion (different colour scales) along an isolated ridge in an idealized simulation. No growing orography (left) is compared with the final step of a 12-h growth period (right).

c/o Ron McTaggart-Cowan

Extrapolated 6.5oC/km lapse rate and constant winds cause an initial error of 6-7ºC at Squamish on the OM grid. This noctural inversion cannot be re-established before sunrise in the model.

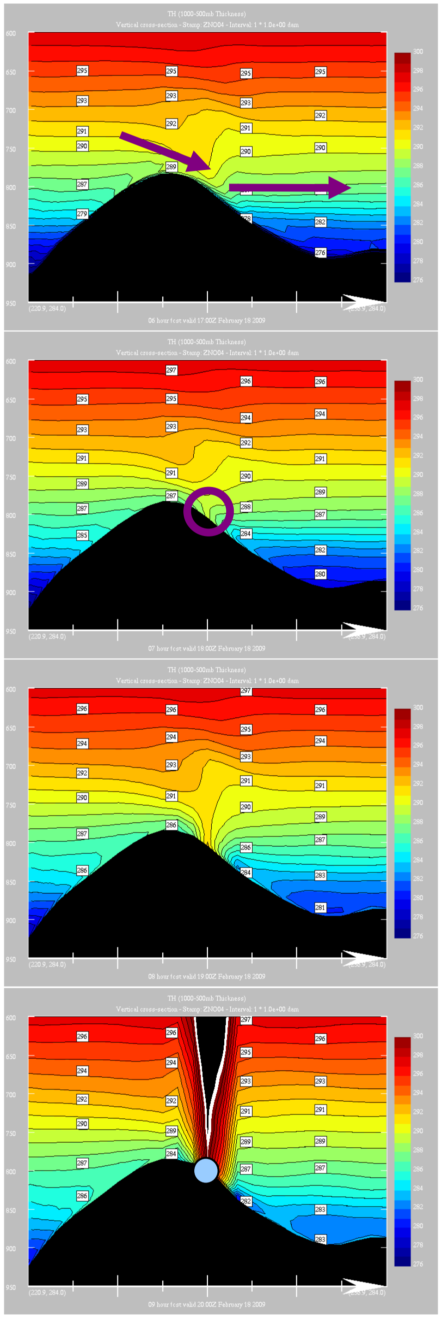

Δ(Squamish) = -600 m

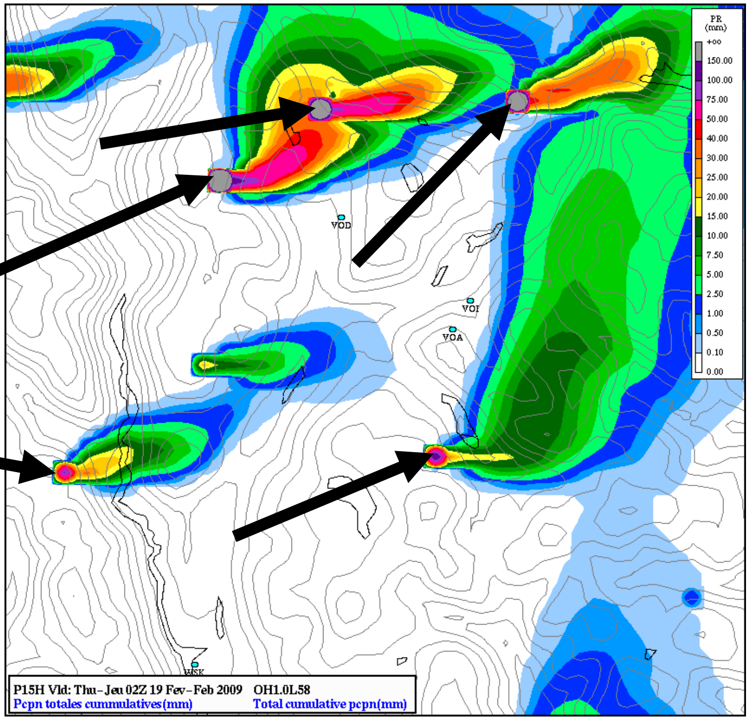
Observed temperature: 10ºC

squamish profile for 000h forecast from 1200 UTC 2007080112 run

Gridpoint Storms

- Gridpoint storms occurred occasionally on the 1 km domain (OH) during the 2009 Practicum period:
- under light wind conditions (downwind slopes) with strong nocturnal inversions in the valleys
- progressive warming of the lowest model layers leads to static instability at isolated gridpoints
- GEM v4 (“staggering”) with prognostic thermodynamic level near the surface eliminates the source of instability

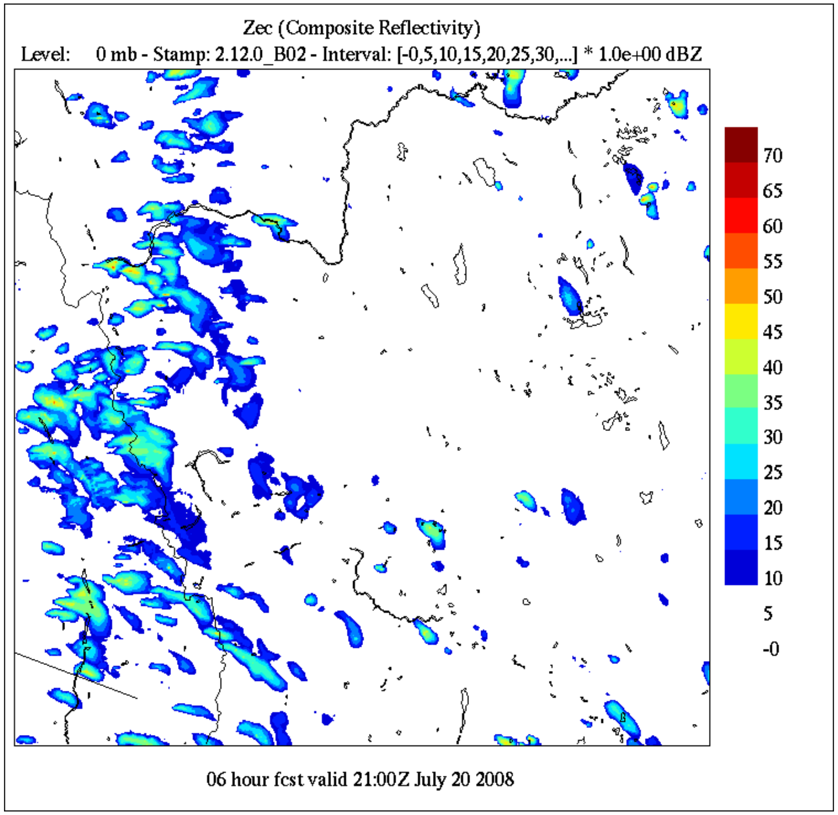




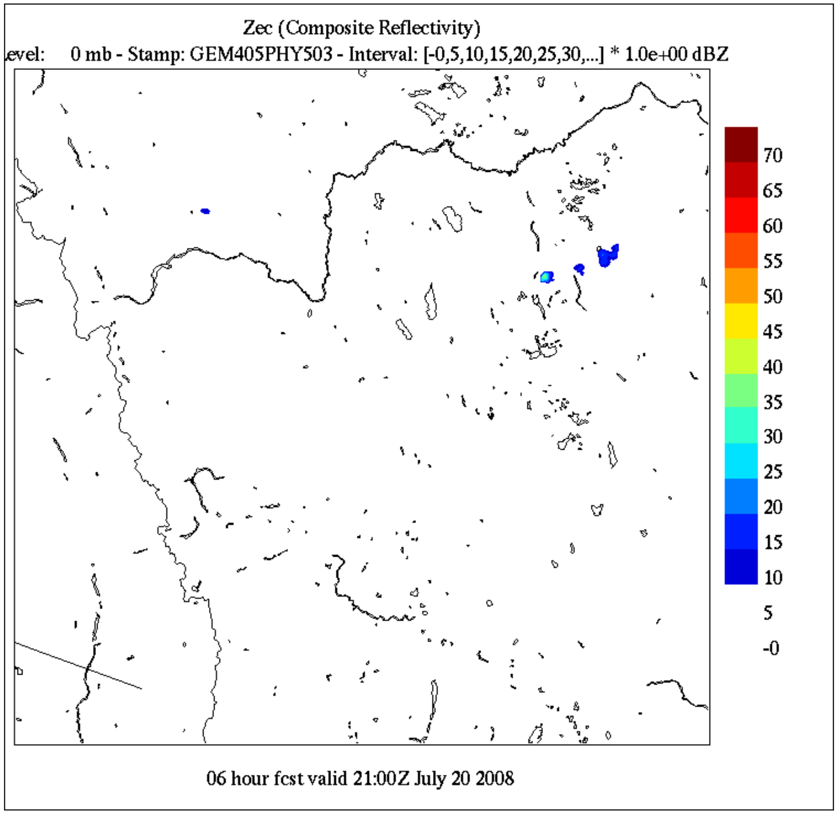
15-hr accumulation of the precipitation field (points with accumulation in excess of 150mm)

1-km runs from UNSTABLE

GEM_v3.3.0



GEM_v4.0.5



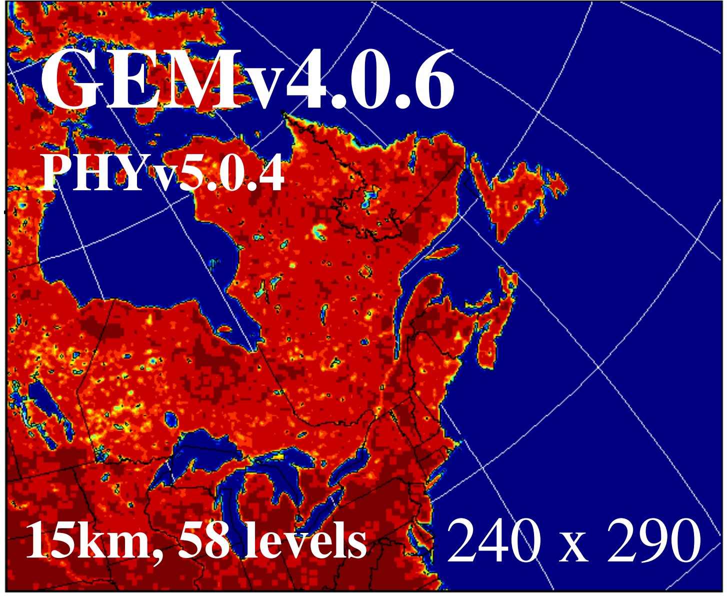
Observed: It was a very clear day, no storms

Soon to be operational – CONSIDER DELETING!

The GSL coupled system

Gossip2 - P2G_MV
SST, ice fraction, mask
ice temperature & thickness

IBM: power5



Timestep = 450s

Coupling
timestep = 450s

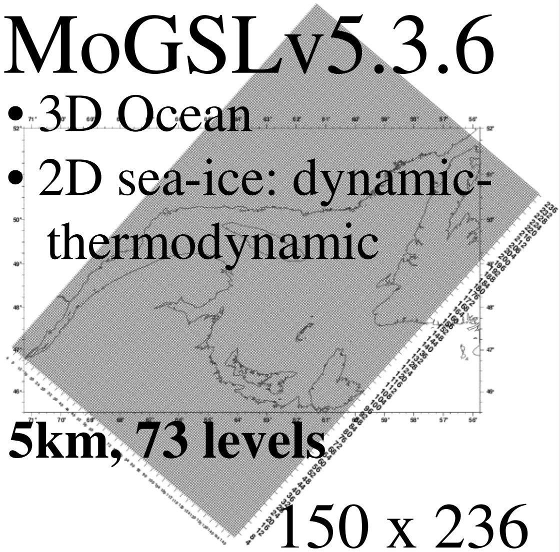
Gossip2 - P2G_MV

Air & dew point temp., wind
solar & IR flux, precipitation

IBM: power5

MoGSLv5.3.6

- 3D Ocean
- 2D sea-ice: dynamic-thermodynamic



Timestep = 225s