Evolution of the Canadian EPS

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In the currently operational EPS an ensemble Kalman filter provides the initial conditions for 16 global 10-day forecasts at resolution of 1.2 degrees with two different dynamical models.

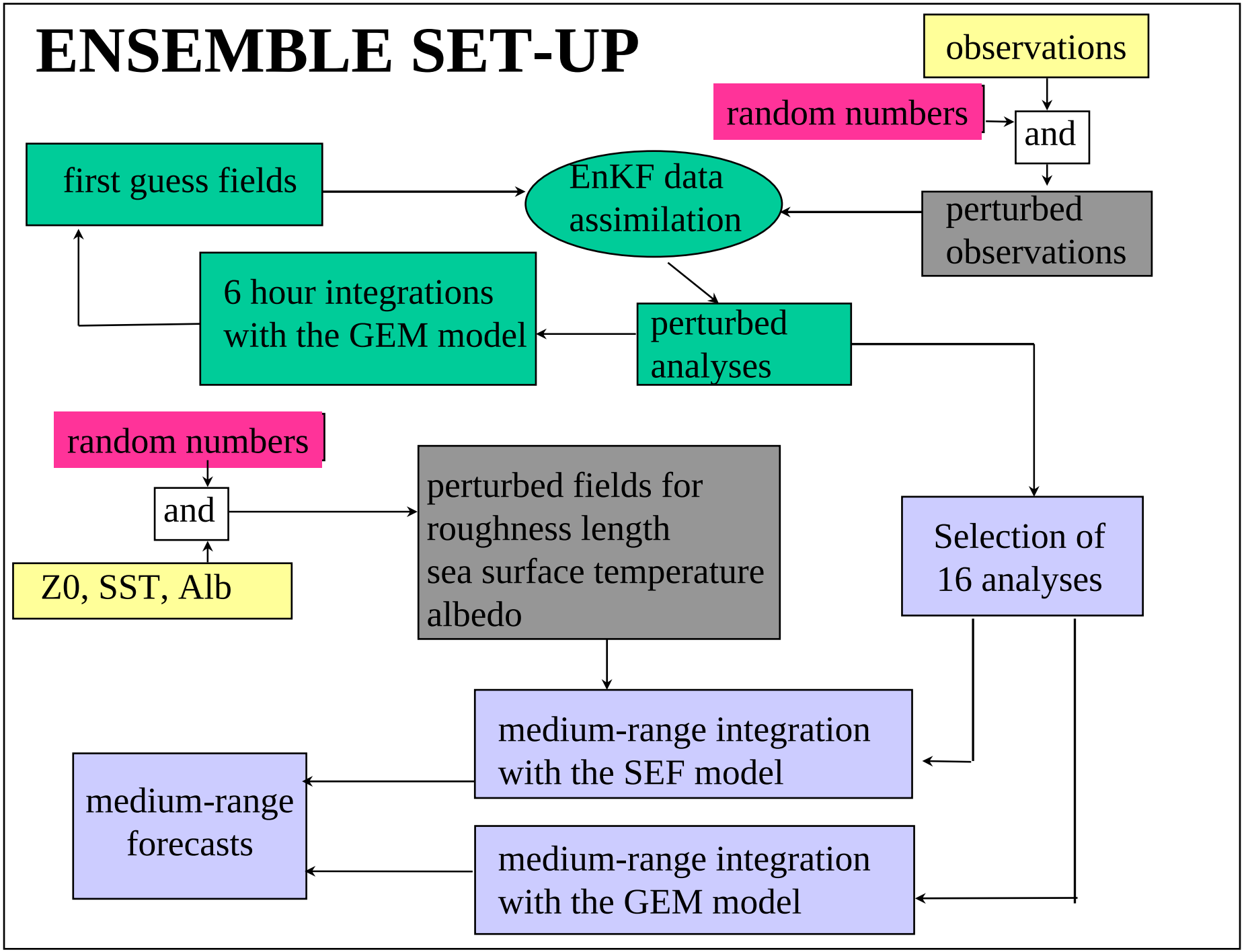
A new configuration in which the lead time is extended to 16 days is being tested since the 2nd of September.

We are planning to increase the number of members to 20.

Plan for the presentation

• description of the different components of the EPS:
- the analyses with the Ensemble Kalman Filter,
- the 16-day medium-range forecasts using 2 models,
• the essence of the changes tested with the parallel run,
• the impact of a new surface algorithm ISBA (Interaction Soil Biosphere Atmosphere),
• verifications of the near surface temperature,
• EPS exchanges with NCEP,
• future changes.

ENSEMBLE SET-UP



Changes to the analysis component

• addition of AMSU/A radiance data from AQUA, of MODIS derived winds from AQUA and TERRA, and of dew-point spread at the surface.

• changes in the assimilation cycles include: the use of a digital filter for the model, the application of model error after the production of the analyses, the breakup into 4 sub-ensembles of 24 members (instead of 2 times 48 members),

• preparation of the code for time-interpolation by the ensemble Kalman filter.

Changes to the forecast component

- motivated by the extension to day 16, required simplified maintenance of model librairies and required coherence of derived variables,

- sharing of same more modern physical parameterizations in both models,

- application of a digital filter for all members,

- introduction of the ISBA surface interaction algorithm.

The operational set of perturbated model configurations

SEF (T149)	Convection/Radiation	GWD version	GWD	Orography of levels	Number	Time level	
1	Kuo/ Garand	Strong	High altitude	0.3	23	3	
2	Manabe/ Sasamori	Strong	Low altitude	0.3	41	3	
3	Kuo/ Garand	Weak	Low altitude	Mean	23	3	
4	Manabe/ Sasamori	Weak	High altitude	Mean	41	3	
5	Manabe/ Sasamori	Strong	Low altitude	Mean	23	2	
6	Kuo/ Garand	Strong	High altitude	Mean	41	2	
7	Manabe/ Sasamori	Weak	High altitude	0.3	23	2	
8	Kuo/ Garand	Weak	Low altitude	0.3	41	2	
control	Kuo/ Garand	Mean	Low altitude	0.15	41	3	
GEM (1.2^0)	**Deep convection**	**Shallow convection**	**Soil moisture**	**Sponge**	**Number of levels**	**Coriolis**	
9	Kuosym	new	Less 20%	global	28	Implicit	
10	RAS	old	Less 20%	equatorial	28	Implicit	
11	RAS	old	Less 20%	global	28	Implicit	
12	Kuosym	old	More 20%	global	28	Implicit	
13	Kuosym	new	More 20%	global	28	Implicit	
14	Kuosym	new	Less 20%	global	28	Implicit	
15	Kuosym	old	Less 20%	global	28	Implicit	
16	OldKuo	new	More 20%	global	28	Implicit	

Review of SEF models:

- removal of envelope orographies,
- use of a hybrid vertical coordinate (27 levels),
- introduction of a non-orographic GWD parametrization,
- replacement of Manabe with RAS convection scheme,
- use of a single condensation scheme (consun),
- use of the same radiation scheme (newrad) as in GEM,
- introduction of a new surface interaction scheme (ISBA),
- adjustment of the coefficients for horizontal diffusion.

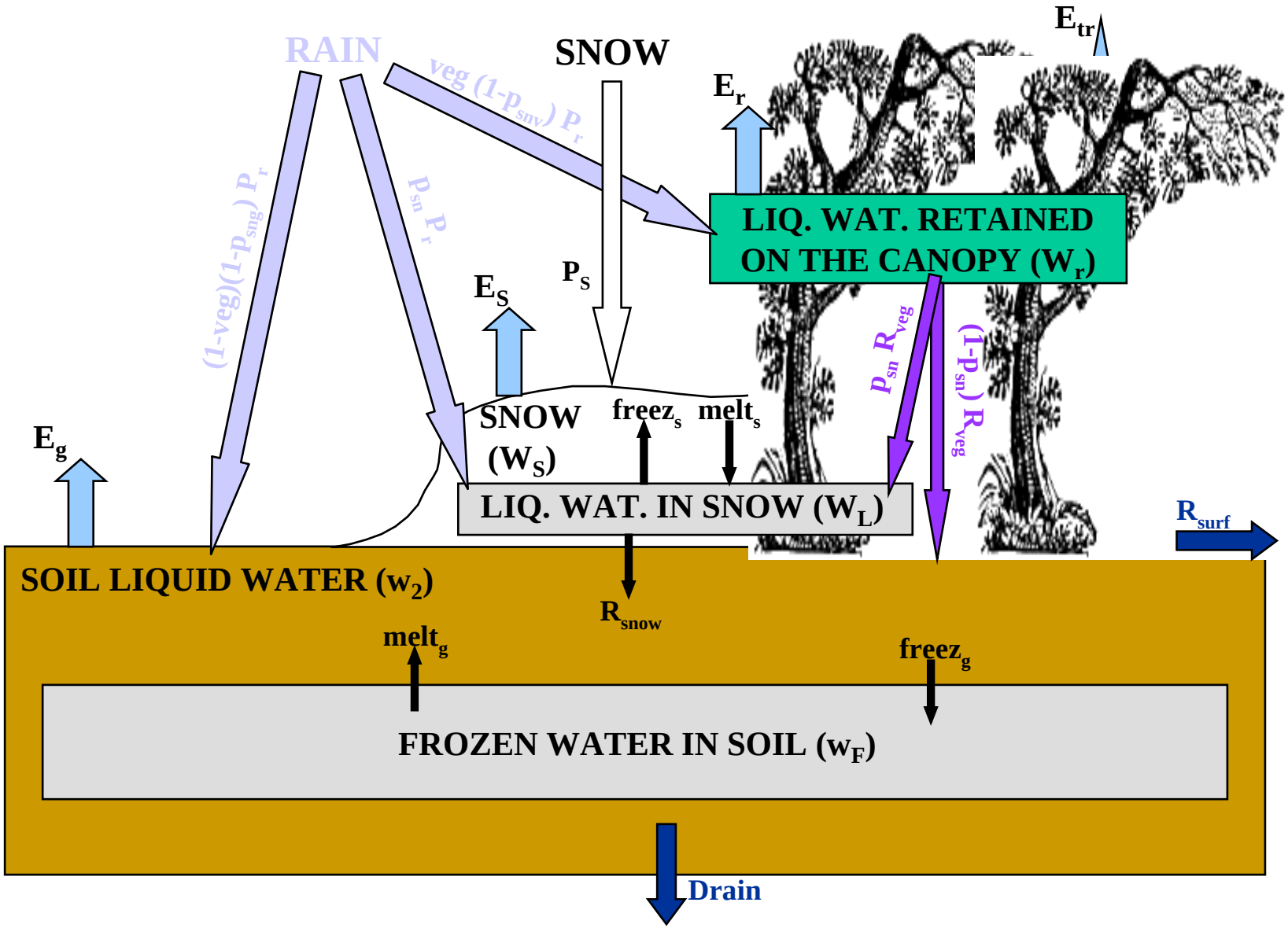
Review of GEM models:

- use of the same climatology as in EnKF model,
- introduction of a non-orographic GWD,
- introduction of new surface interaction scheme (ISBA),
- introduction of digital filter finalization.

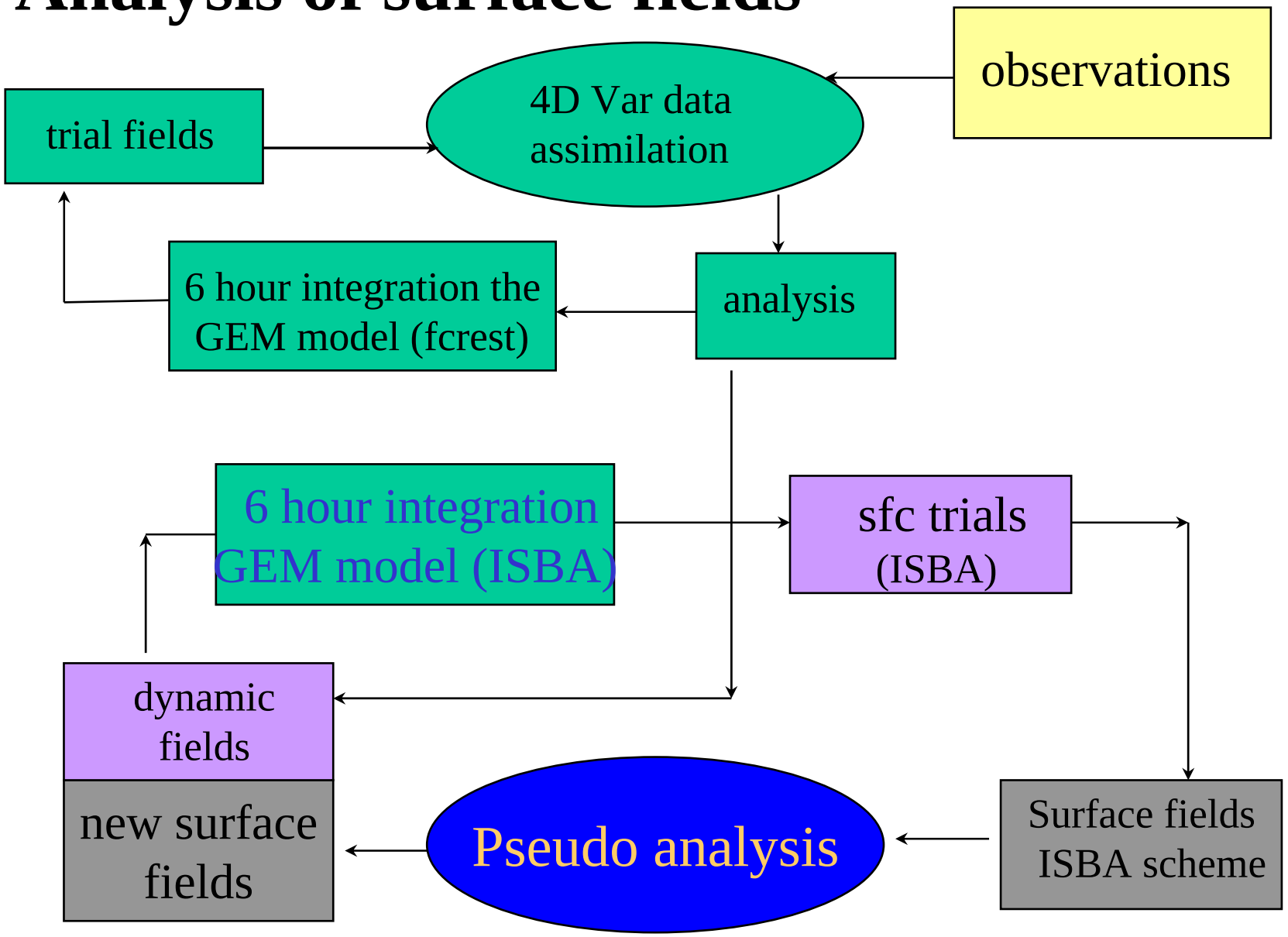
The parallel set of perturbed model configurations

SEF (T149)	GWD taufac	Convection deep	Schemes shallow	Surface scheme	Number of levels	Time level
Control	8.0e-6	Kuo	conres	Fcrest	27	3
1	1.2e-5	Kuo	conres	ISBA	27	3
2	1.2e-5	Ras	turwet	Fcrest	27	3
3	4.0e-6	Kuo	conres	Fcrest	27	3
4	4.0e-6	Ras	turwet	ISBA	27	3
5	1.2e-5	Ras	turwet	Fcrest	27	2
6	1.2e-5	Kuo	conres	ISBA	27	2
7	4.0e-6	Ras	turwet	ISBA	27	2
8	4.0e-6	Kuo	conres	Fcrest	27	2
GEM (1.2)	**GWD taufac**	**Convection deep**	**Schemes shallow**	**Surface scheme**	**Number of levels**	**Time level**
9	8.0e-6	Kuosym	ktrsnt	Fcrest	28	2
10	8.0e-6	Ras	conres	ISBA	28	2
11	8.0e-6	Ras	conres	Fcrest	28	2
12	8.0e-6	Kuosym	ktrsnt	ISBA	28	2
13	8.0e-6	Kuostd	ktrsnt	Fcrest	28	2
14	8.0e-6	Kuostd	ktrsnt	ISBA	28	2
15	8.0-e6	Kuosym	conres	ISBA	28	2
16	8.0e-6	Kuo	conres	Fcrest	28	2

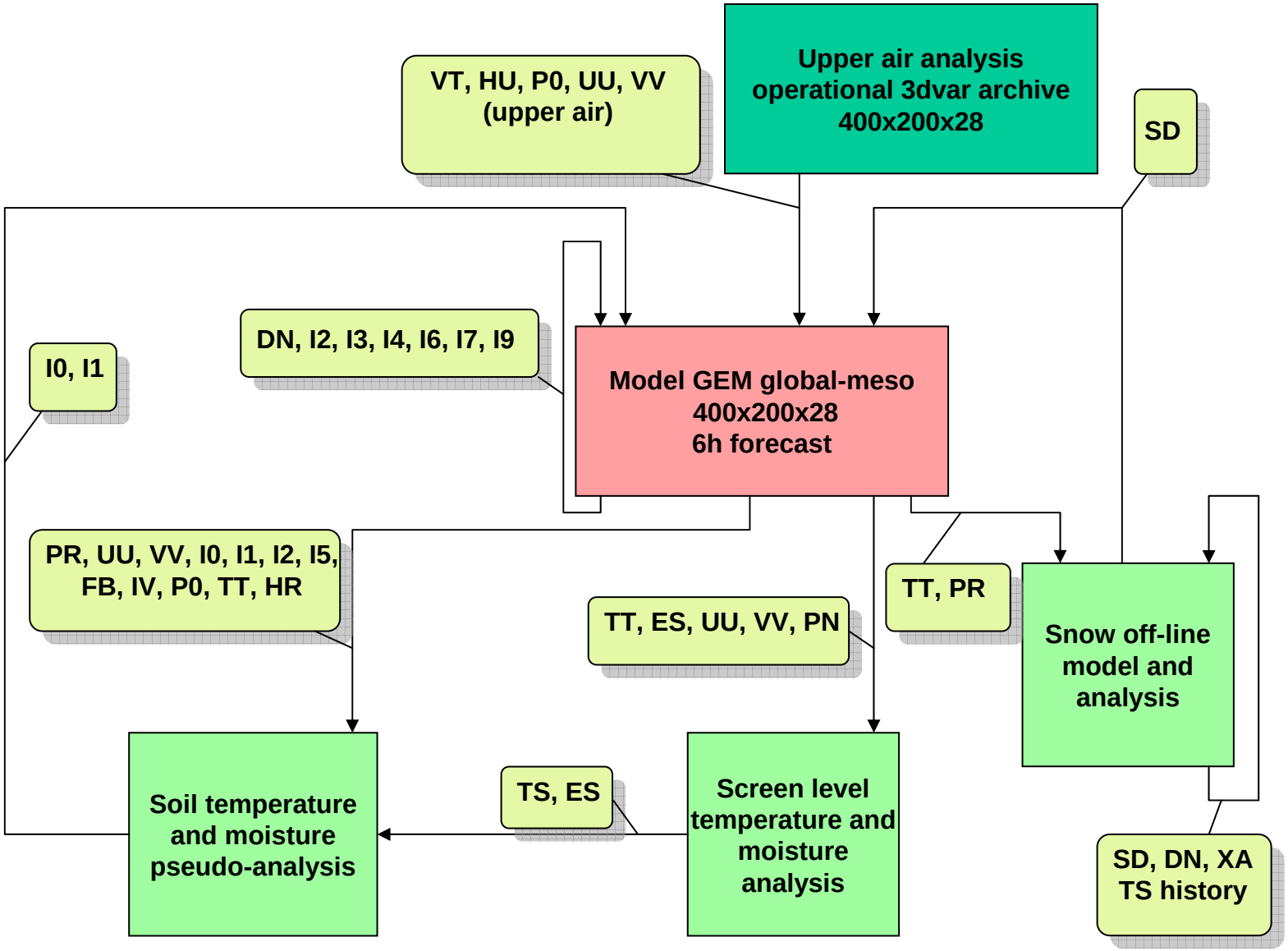
New Hydrological Budget in ISBA



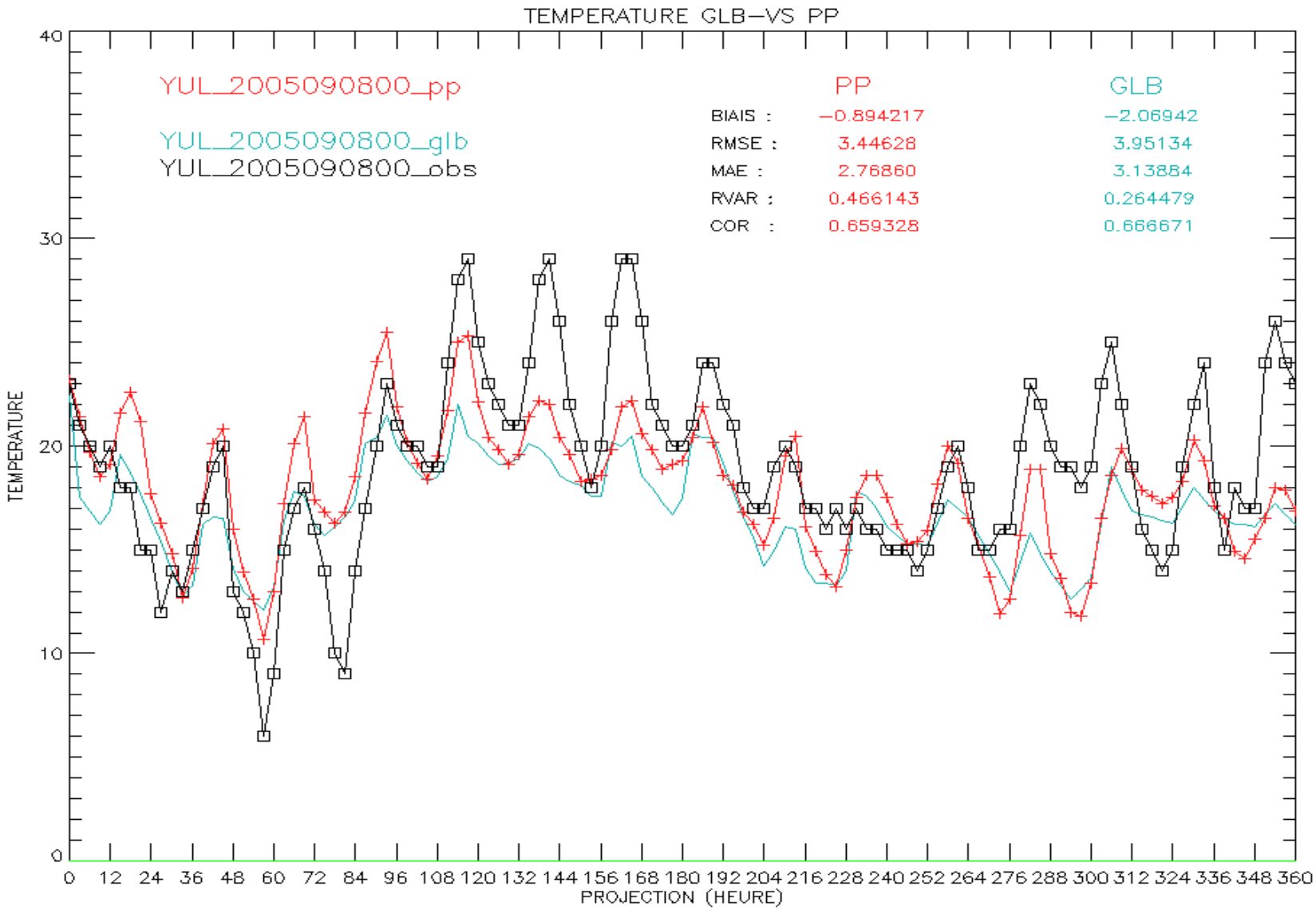
Analysis of surface fields



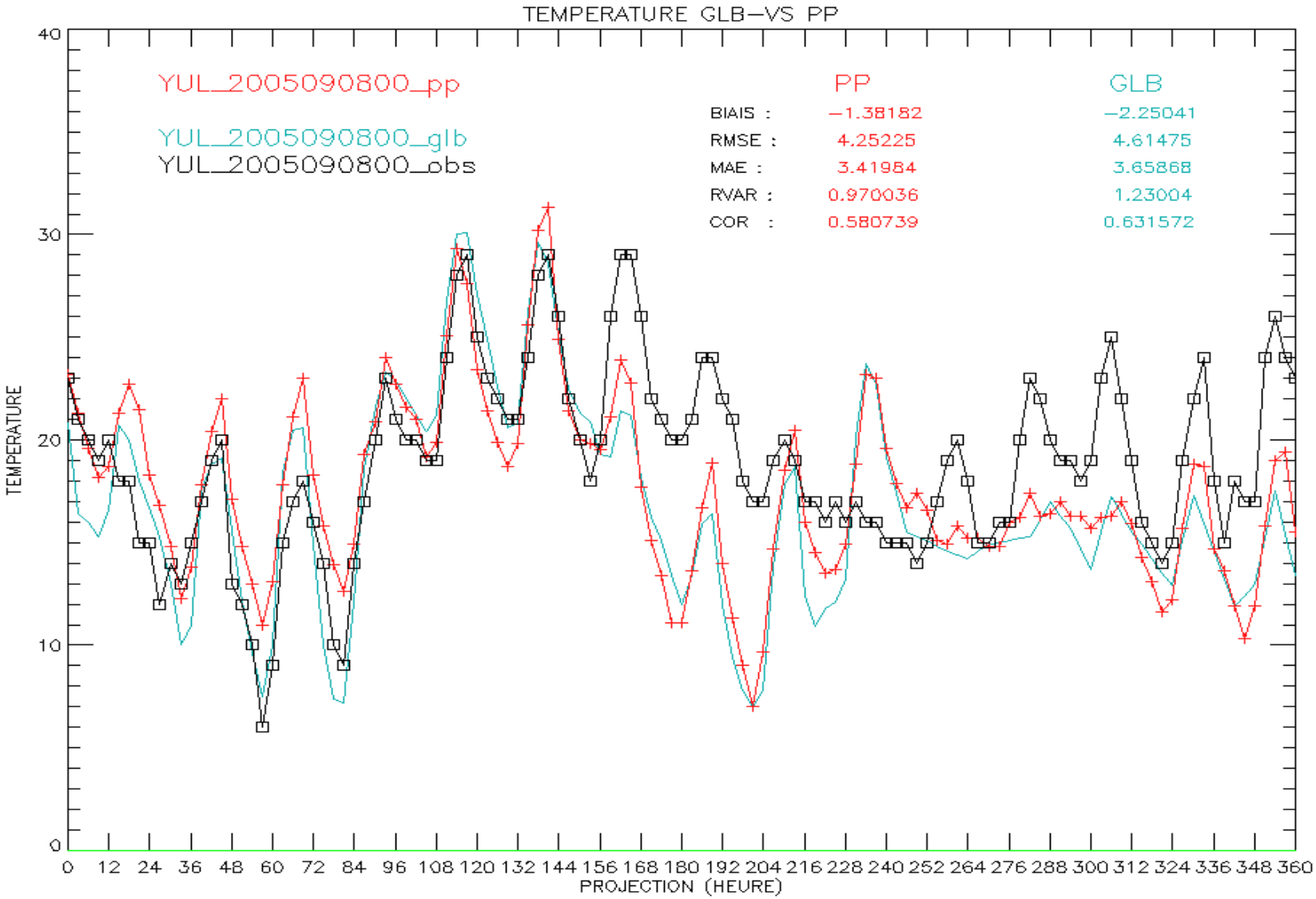
Pseudo-analysis of moisture



Problem with the diurnal cycle (fcrest)



Correcting the diurnal cycle (ISBA)



Some verifications on sample cases

- before the parallel run 2 cycles were done for the summer 2004 and for the winter 2005, using the old and the new configurations,

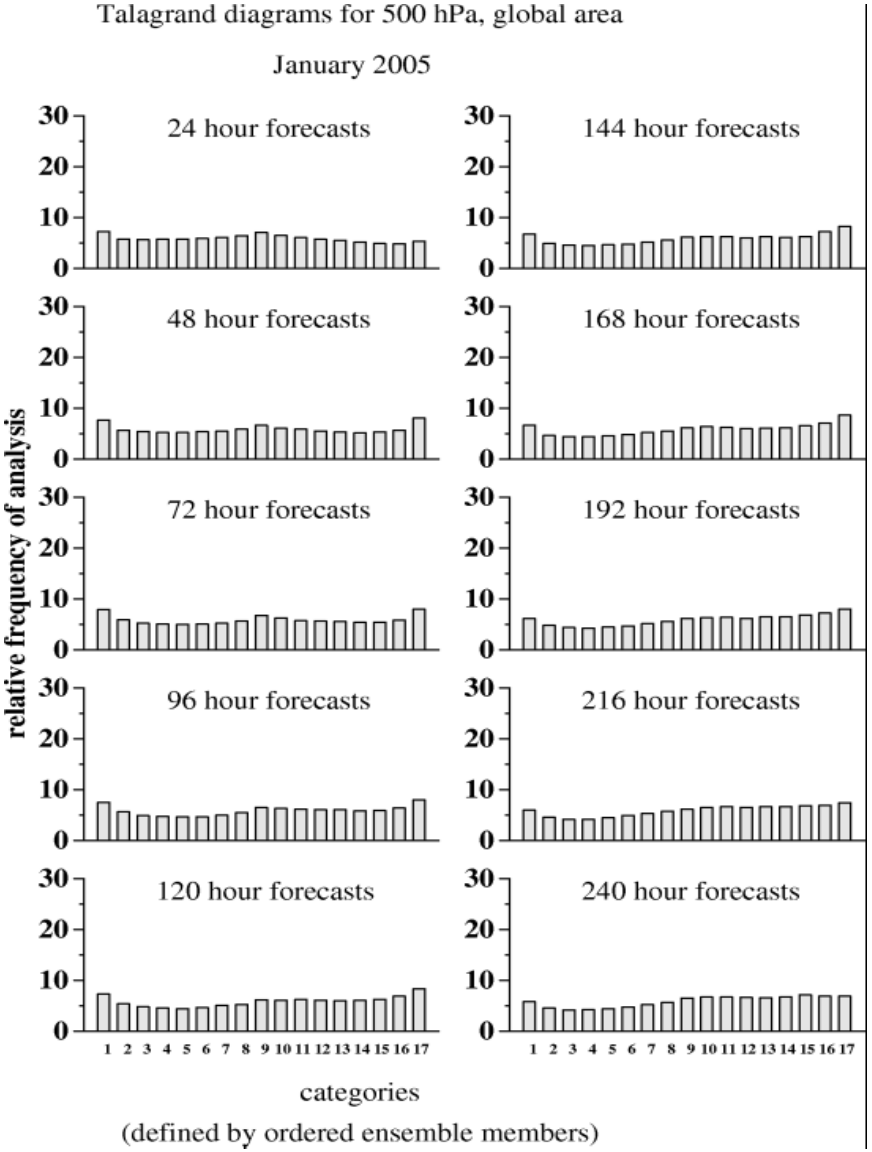
- summer case extends from july 27 - august 30,
  winter case extends from december 27 - january 31,

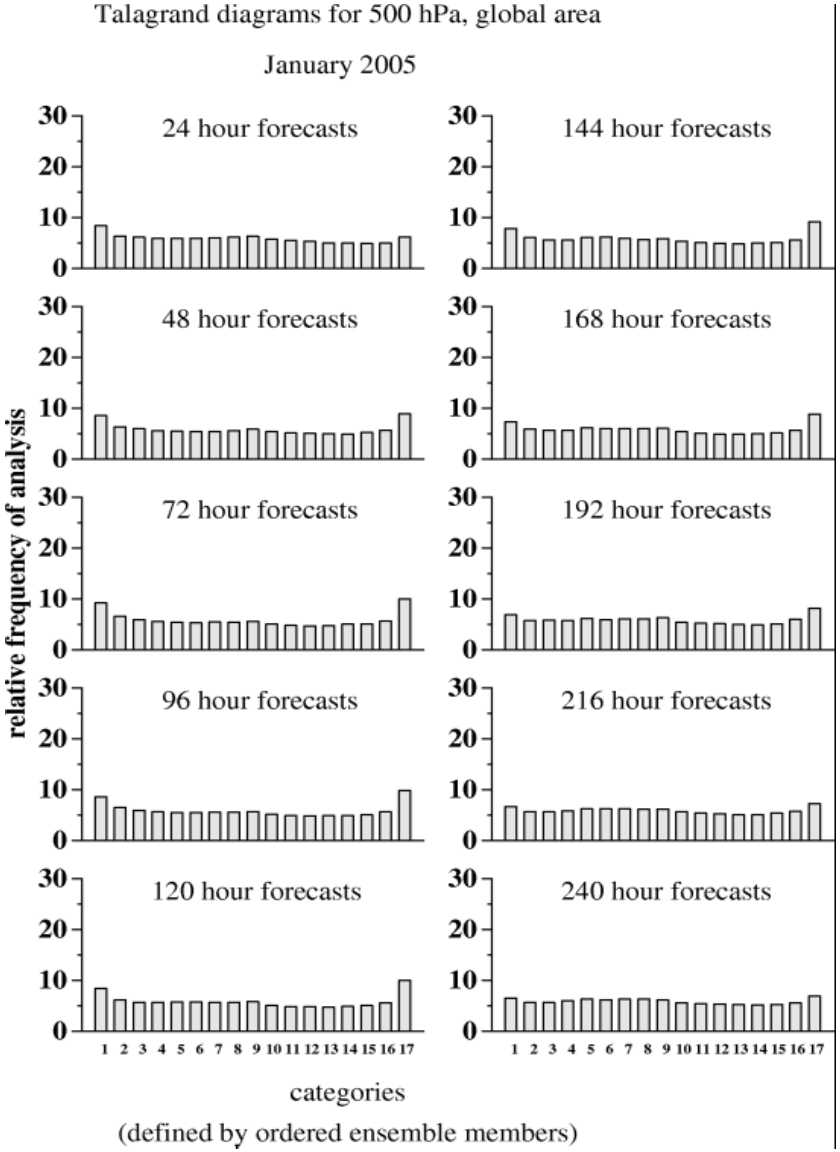
- 10-day forecasts were evaluated with both configurations,

- statitics will now be shown:

Review of EPS at CMC : 500hPa

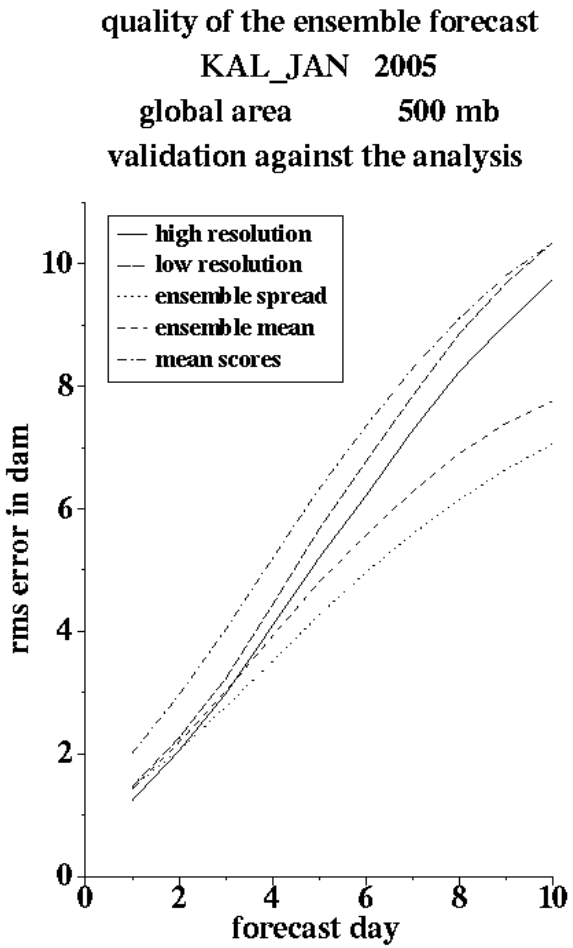
OLD vs NEW

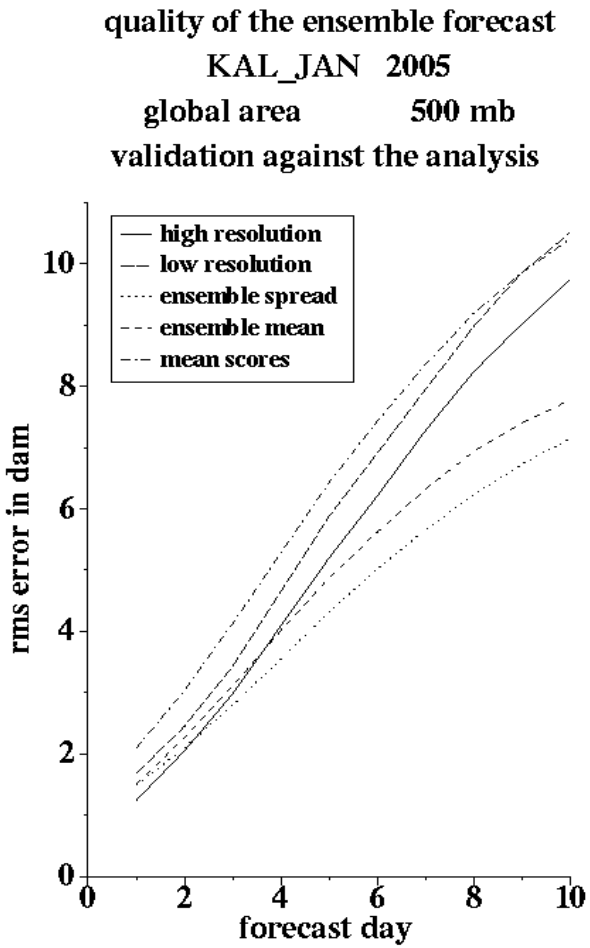




Review of EPS at CMC : 500hPa

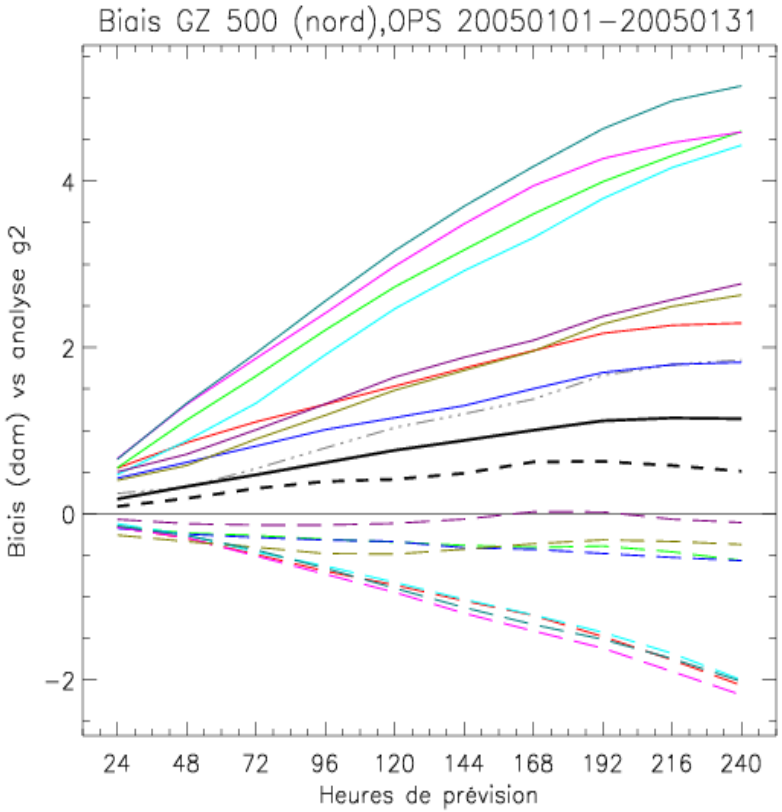
OLD vs NEW

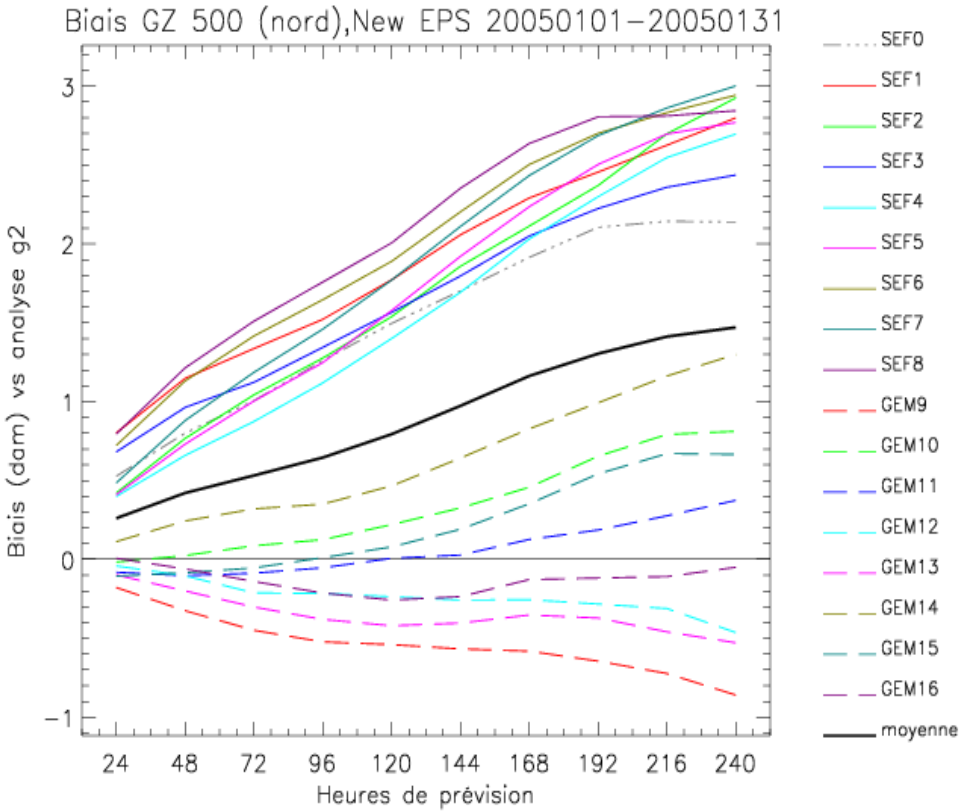




Review of EPS at CMC : GZ500

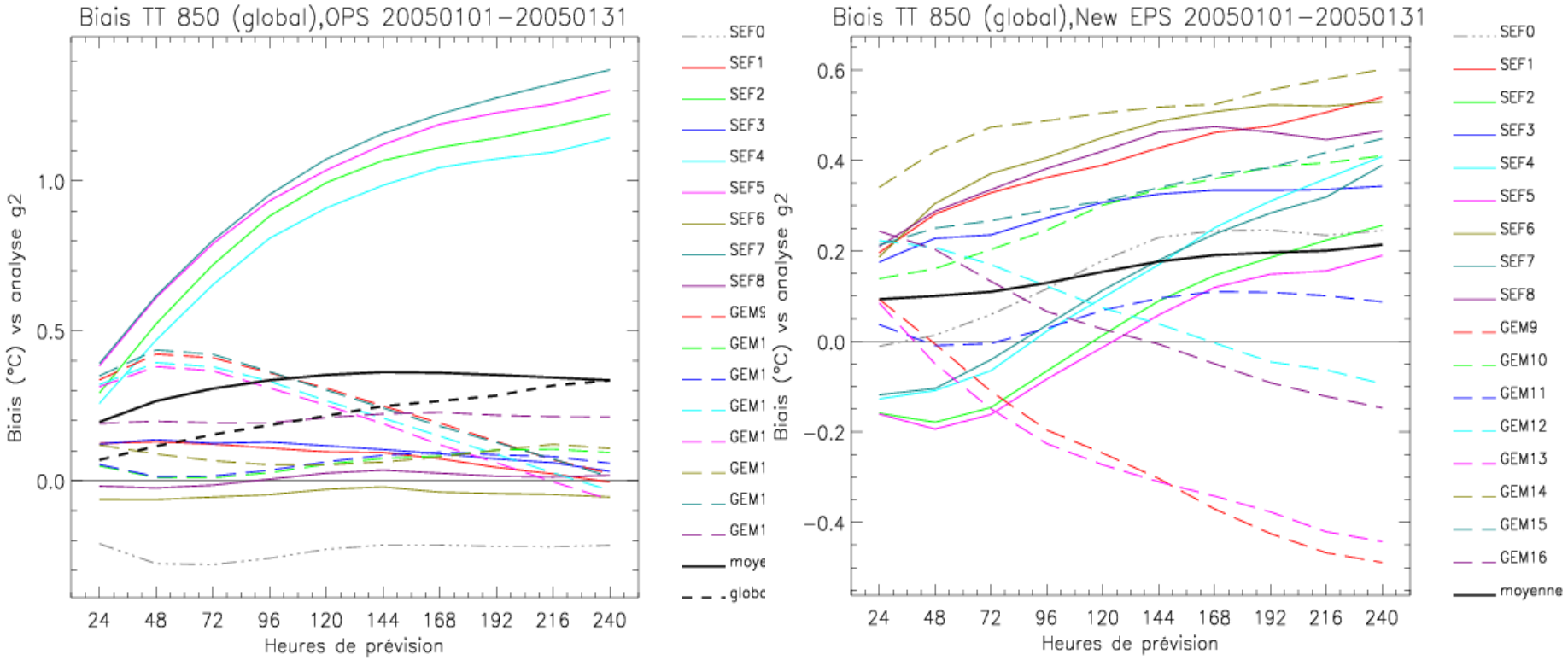
OLD vs NEW



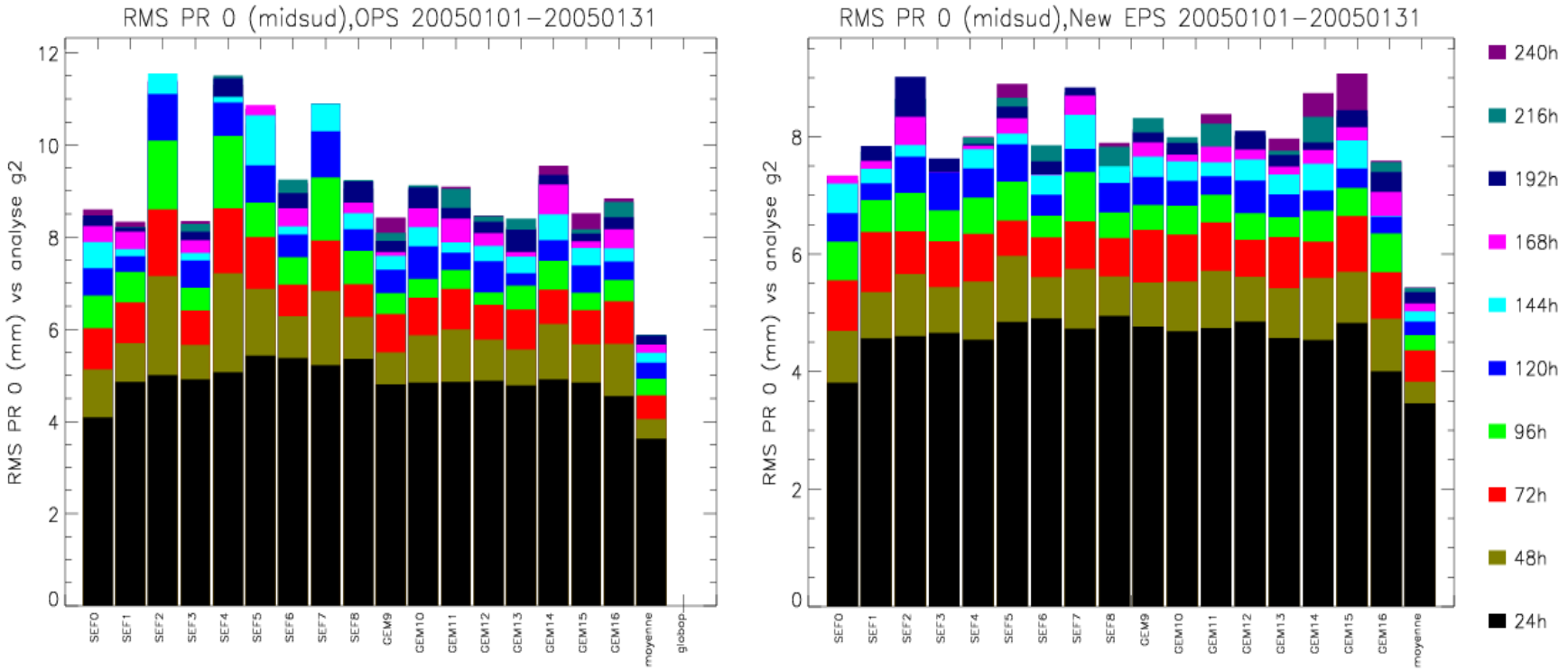


Review of EPS at CMC : TT850

OLD vs NEW



Review of EPS at CMC : rms PR
OLD vs NEW

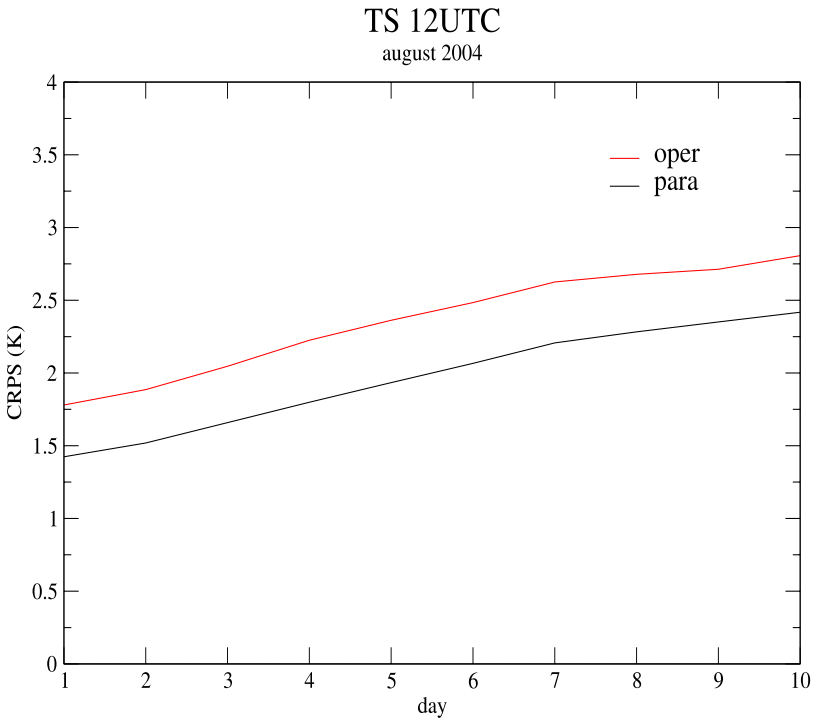


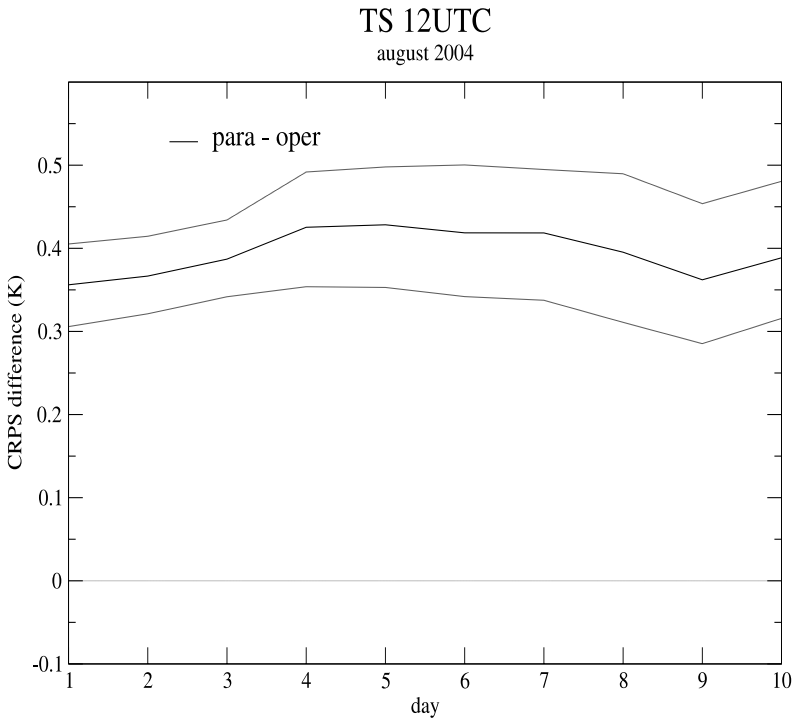
Continuous Ranked Probability Score (CRPS)

- can be used to measure the quality of the EPS,
- can be decomposed in terms of reliability and resolution,
- the boostrap method is used to get the confidence interval from 5% to 95%,

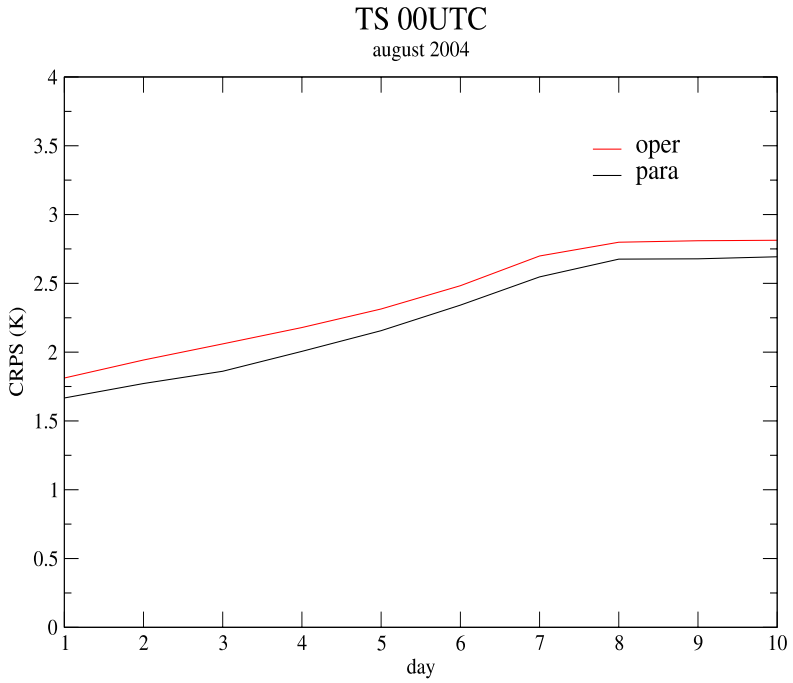
- reference: Herbach, Hans, 2000: Decomposition of the CRPS for ensemble prediction sytems. Weather and Forecasting: vol. 15, No. 5, pp. 559-570.

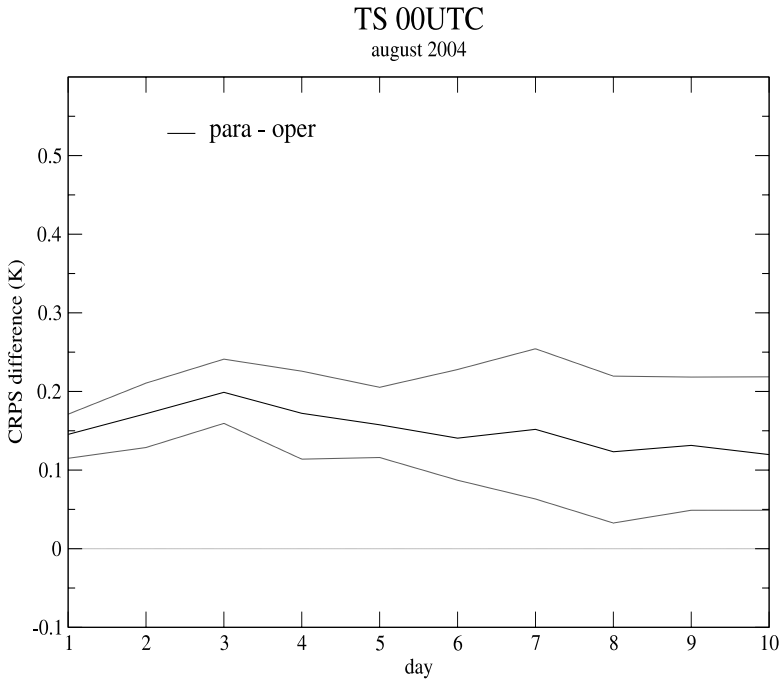
Surface temperature
CRPS verification at 12 UTC





Surface temperature
CRPS verification at 00 UTC





North American Ensemble Forecasting System

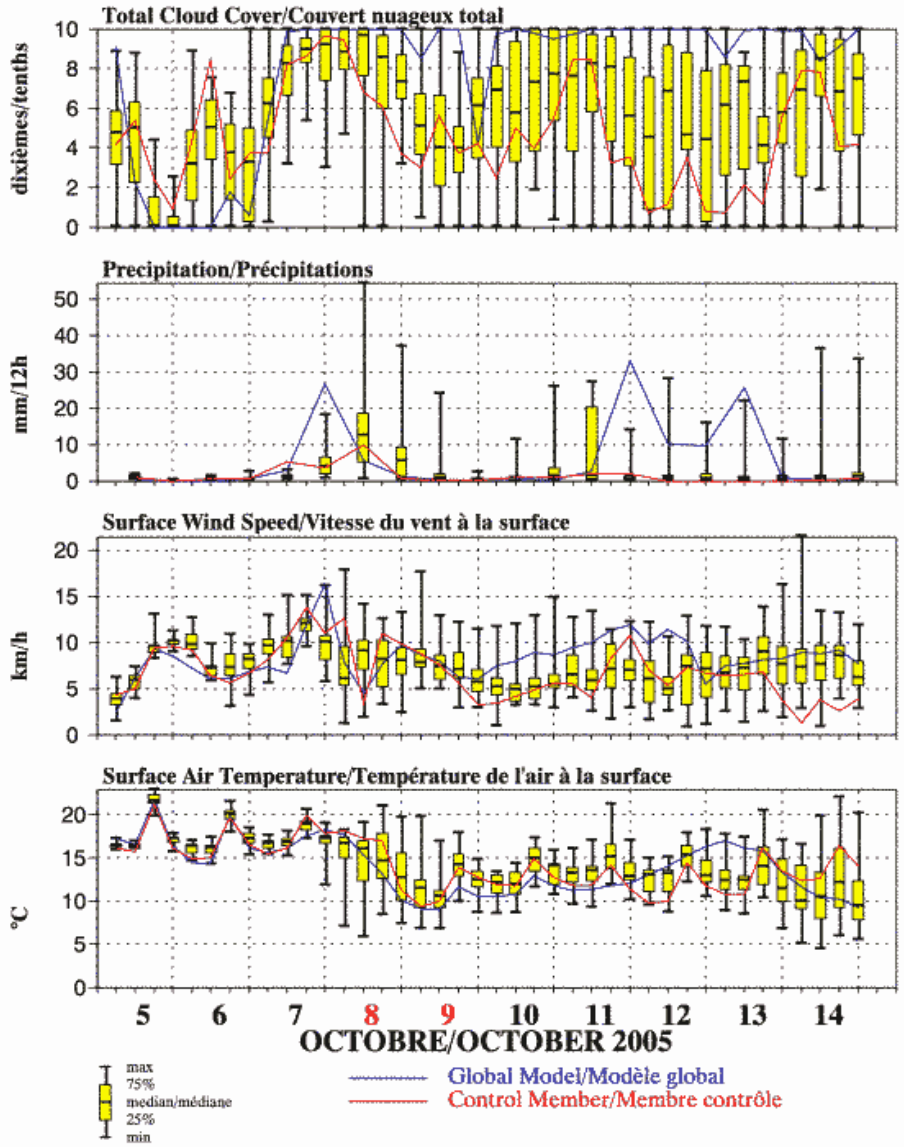
- on november 16th 2004, the high management from the Meteorological Service of Canada, from the US National Weather Service and from the Service Nationale Meteorological of Mexico introduced the NAEFS,
- to conform to U.S. requirement, want to run our EPS twice a day to day 16,
- we started exchanging our model outputs with NCEP,
- but starting april 2006, we should have operational EPS products based on the combination of both ensembles.

Environnement Canada
Centre Météorologique Canadien

Environment Canada
Canadian Meteorological Centre

Ensemble and Deterministic Forecasts issued 5 OCTOBER 2005 0 UTC
Prévisions d'ensembles et déterministe émises le 5 OCTOBRE 2005 0 UTC
pour / for (Ensemble CMC)

QUEBEC (YQB) 46.80 N 71.40 W/O



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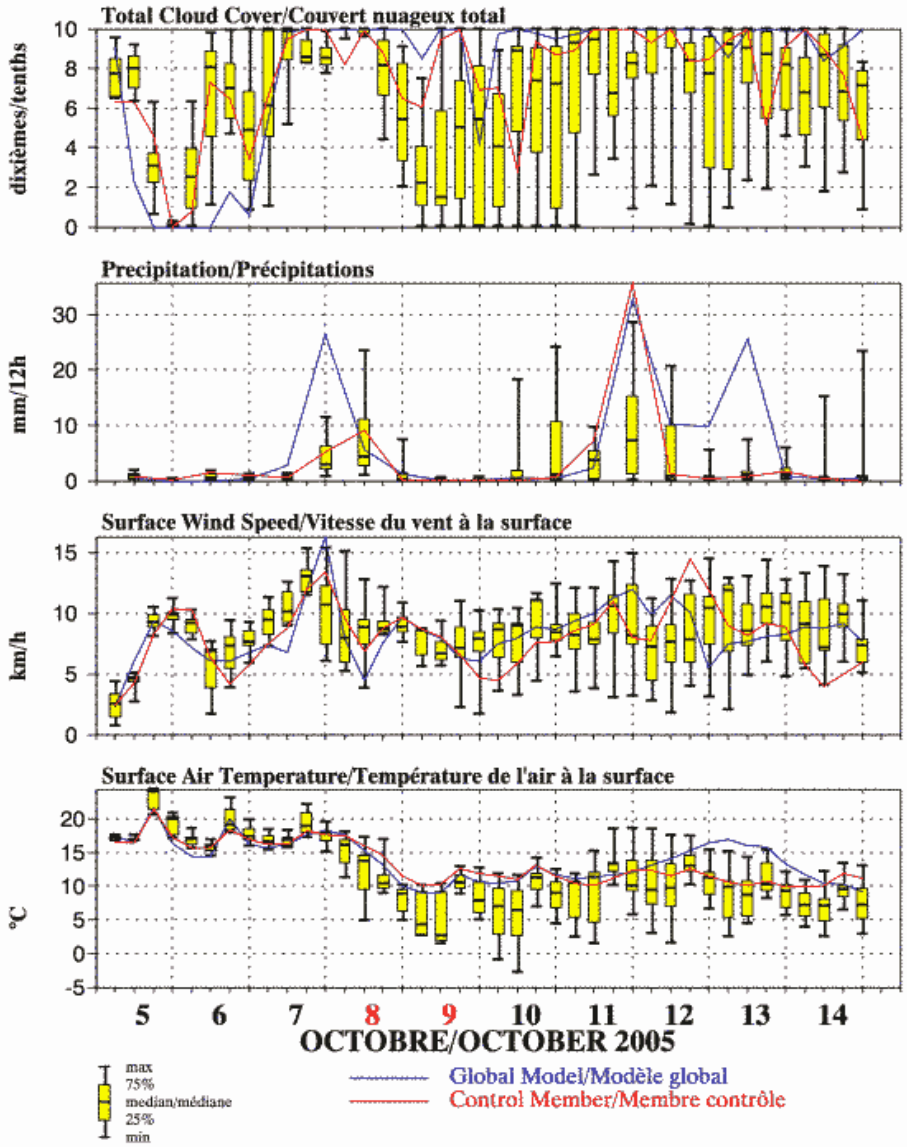
Ensemble and Deterministic Forecasts issued 5 OCTOBER 2005 0 UTC
Prévisions d'ensembles et déterministe émises le 5 OCTOBRE 2005 0 UTC
pour / for (Ensemble CMC - parallel)

QUEBEC (YQB) 46.80 N 71.40 W/O



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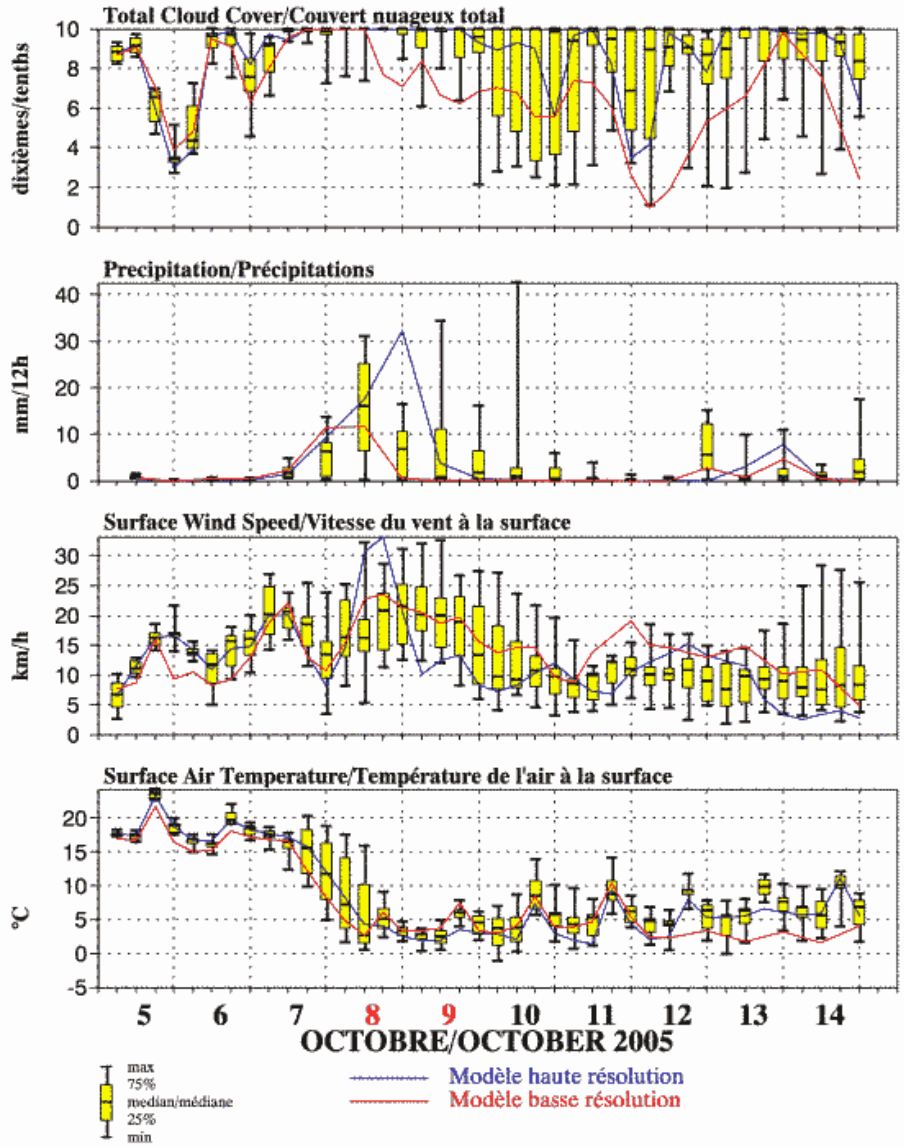
Ensemble and Deterministic Forecasts issued 5 OCTOBER 2005 0 UTC
Prévisions d'ensembles et déterministe émises le 5 OCTOBRE 2005 0 UTC
pour / for (Ensemble NCEP)

QUEBEC (YQB) 46.80 N 71.40 W/O



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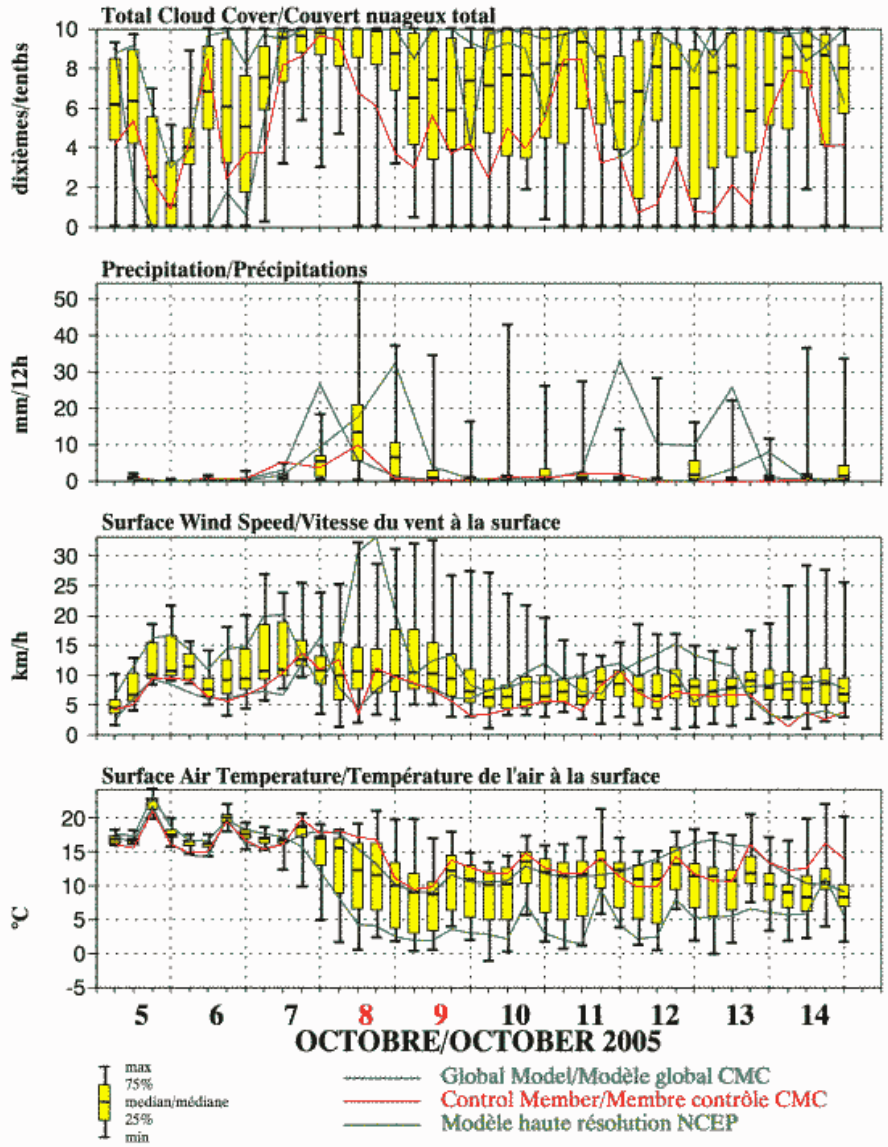
Centre Météorologique Canadien

Environment Canada
Canadian Meteorological Centre

Ensemble and Deterministic Forecasts issued 5 OCTOBER 2005 0 UTC
Prévisions d'ensembles et déterministe émises le 5 OCTOBRE 2005 0 UTC
pour / for (Ensemble CMC & NCEP)

QUEBEC (YQB) 46.80 N 71.40 W/O



Conclusions

- global GEM model is in continuous development,
- want to use recent algorithms in the EPS,
- improve performance of *individual* models ,
- support development of week two products,
- continue to support NAEFS,
- want less parameterizations and more stochastic physics.

Global Ensemble

- **(implemented in June 2001)**

  Perturbed analyses obtained from 8 SEF assimilation cycles
  16 members (Multi-model: SEF T149 and GEM 1.2º)
  Different model options used for both models
  Forecasts done once a day up to 10 days

- **(implemented in January 2005)**

  Perturbed analyses obtained from 96 GEM assimilation cycles using Ensemble Kalman Filter
  16 members (Multi-model: SEF T149 and GEM 1.2º)
  Different model options used for both models
  Forecasts done once a day up to 10 days

- **(implementation in January 2006)**

  20 members (Multi-model: SEF T149 and GEM 1.2º)
  Less model options used for both models
  Forecasts twice a day up to 16 days