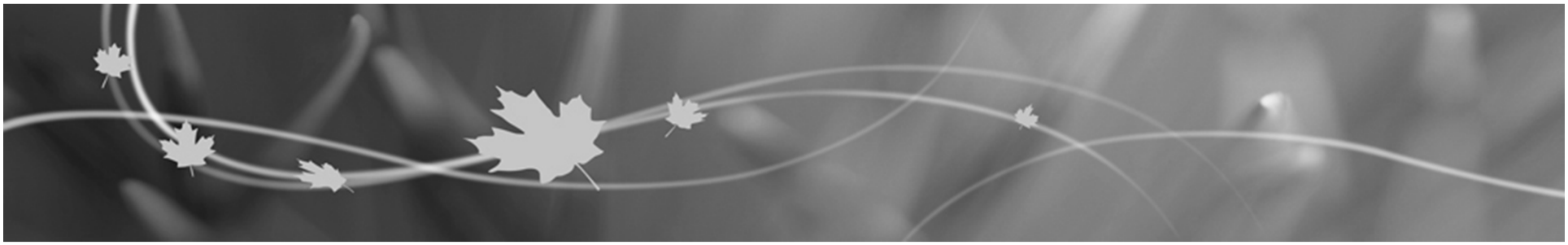
Environment Canada Environnement Canada

Canada



Canadian ensemble forecasts

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6th NCEP Ensemble users workshop
College Park, MD, March 26th 2014

Canadian ensemble forecasts

- Global Ensemble Prediction System (GEPS 3.1.0)
  - Part of the NAEFS multi-ensemble
- GEPS monthly forecasts and reforecasts
- Regional Ensemble Prediction System (REPS 2.0.1)
- Canadian Seasonal and Interannual Prediction System (CanSIPS) *[not presented here in the interest of time]*

Canadian ensemble forecasts

- Current Global Ensemble Forecast System (GEPS 3.1.0)
  - Ensemble Kalman Filter (EnKF) assimilation
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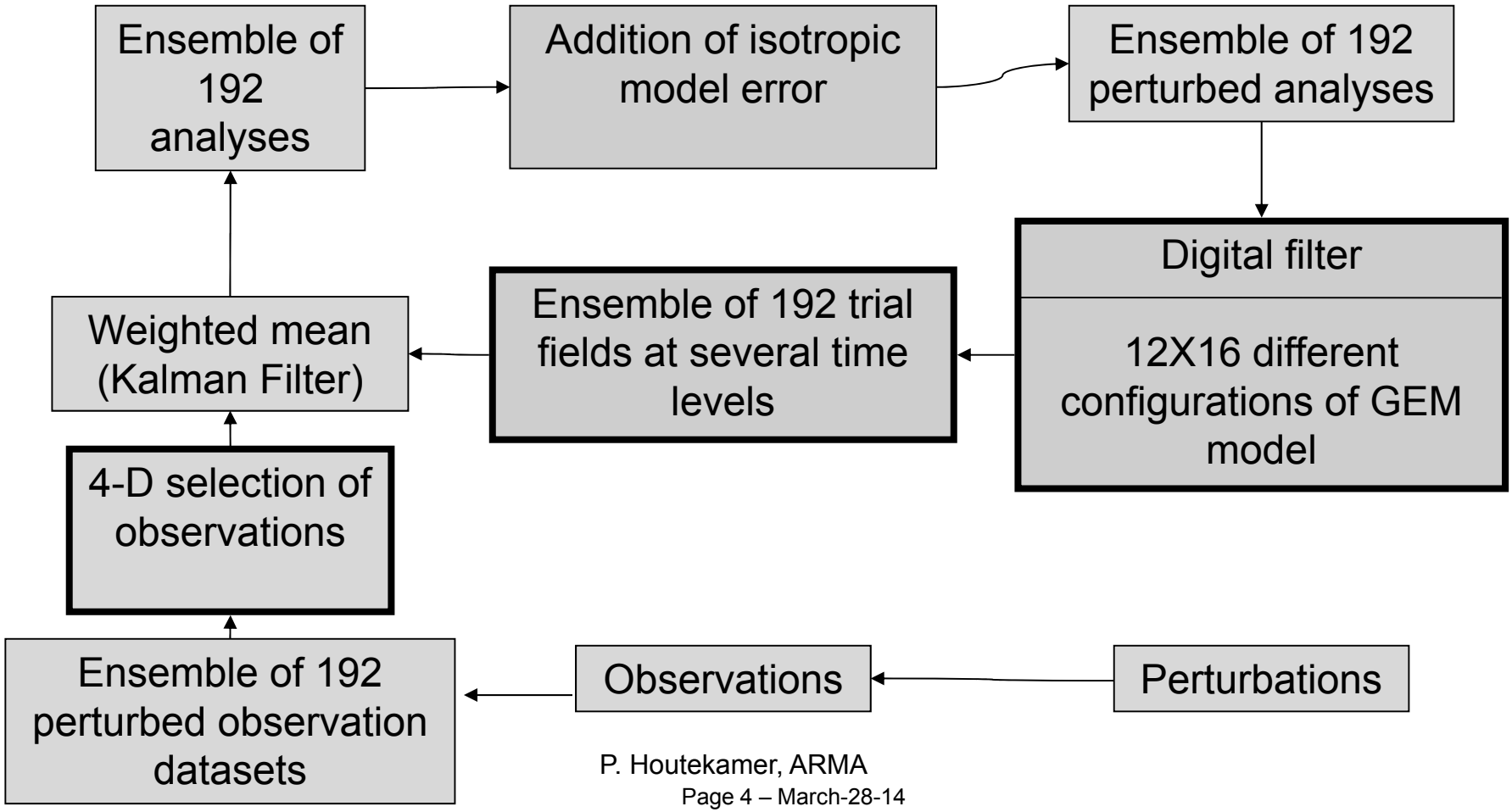
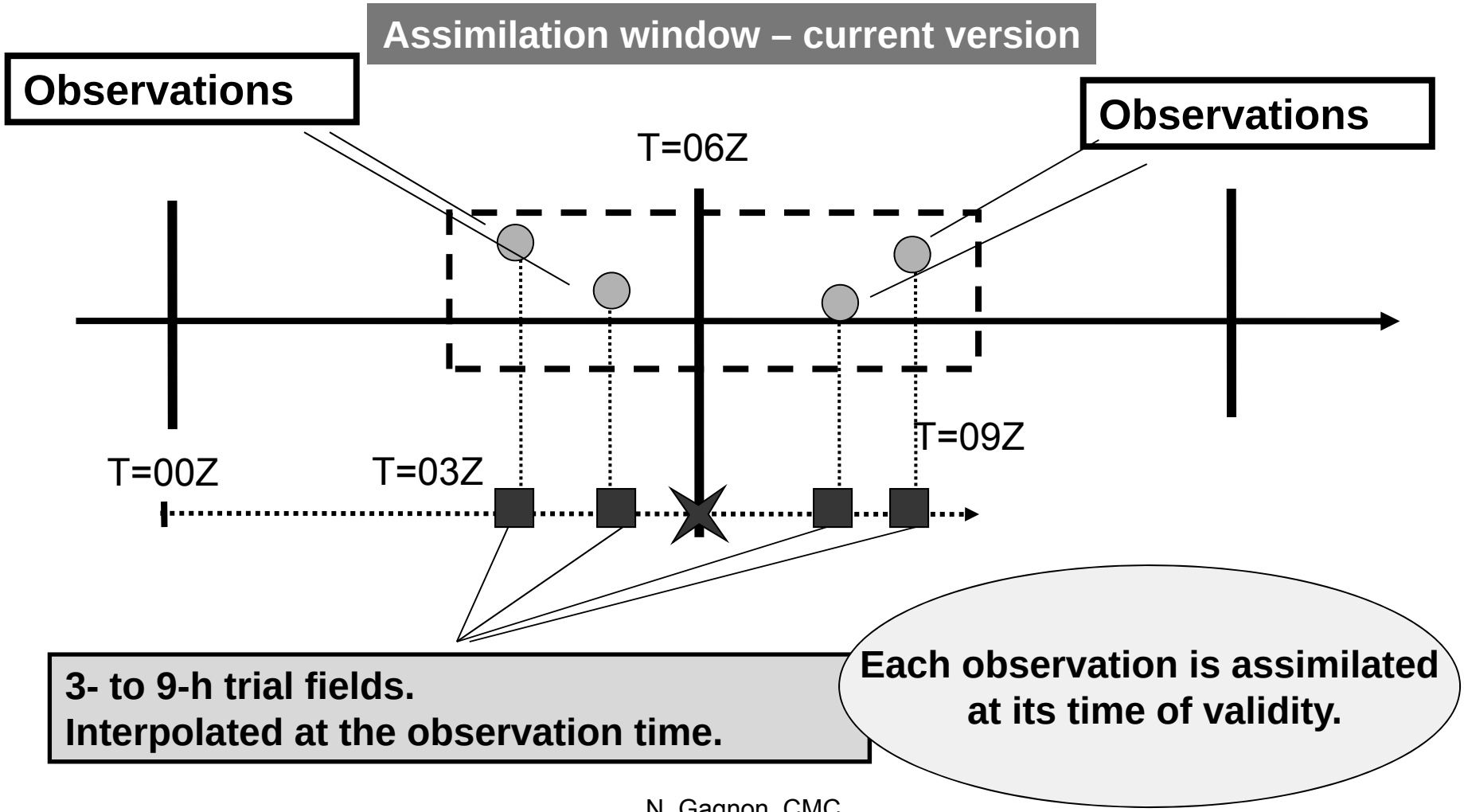
Canadian GEPS EnKF assimilation

Data assimilation component – current version



Canadian GEPS assimilation



Canadian GEPS 3.1.0

- Members: current – As of December 2013
  - 20+1 members:
  - GEM 0.6° (~66 km resolution) L40 (forecast), L74(analyses).
  - 16-day integration (32 days on Thursdays at 00Z).
  - Twice a day (00 and 12 UTC).
- Simulation of initial condition uncertainties:
  - Perturbed ensemble Kalman filter data assimilation.
- Simulation of model uncertainties:
  - A multi-parametrization approach, each member having its own physics parameterizations set.
  - Stochastic perturbations added to tendencies in the parameterized physical processes.
  - SKEB backscattering (Shutts 2005)

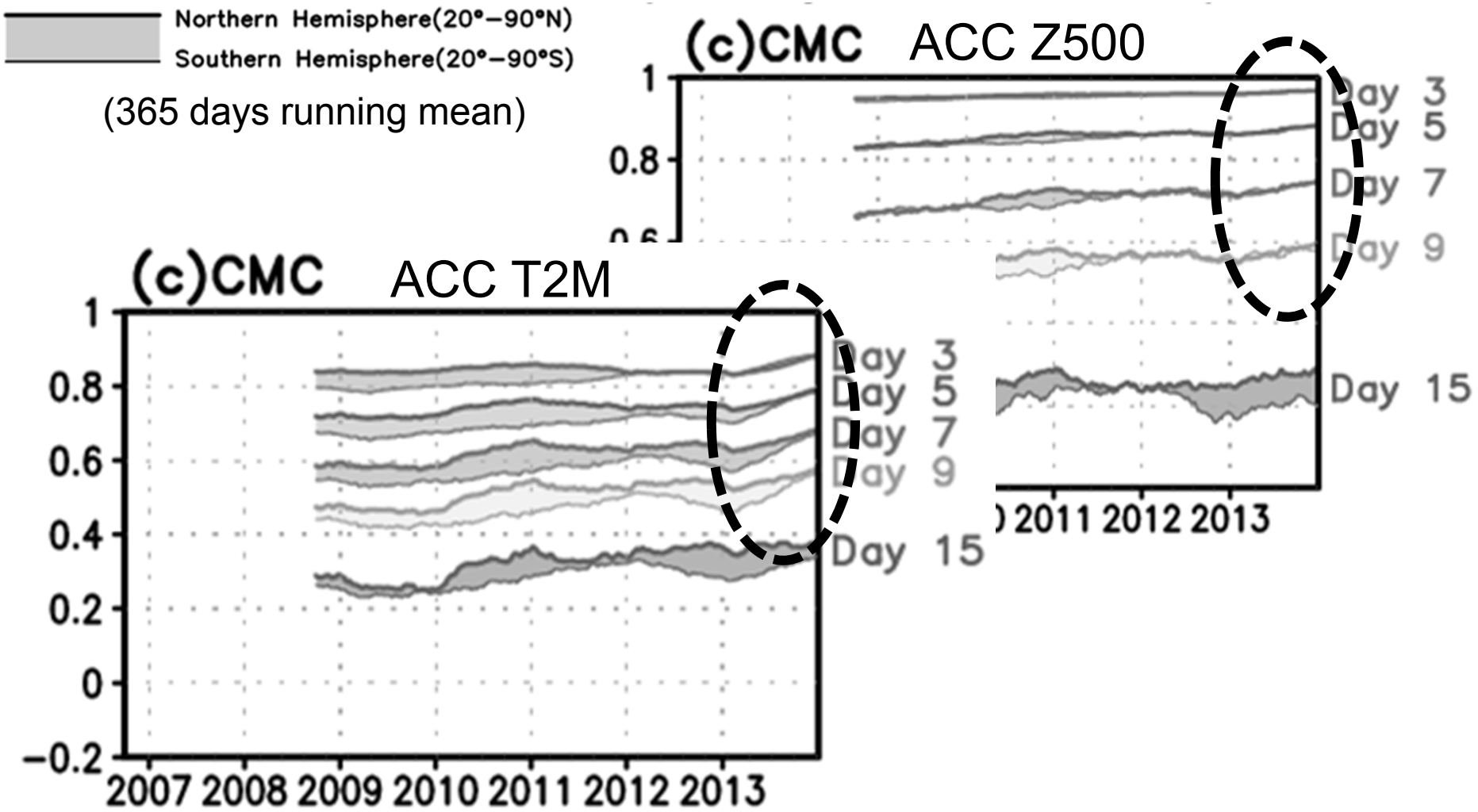
Canadian EPS – forecasts – GEPS3.1.0

No.	Convection	Gravity wave drag	Mixing length	Vertical Diffusion	Orographic blocking	SKEB	PTP
0	Kain&Fritsch	Standard	Bougeault	1.0	1.0	No	No
1	Kain&Fritsch	Strong	Blackadar	1.0	1.5	Yes	Yes
2	OldKuo	Strong	Blackadar	1.0	0.5	Yes	Yes
3	Kain&Fritsch	Weak	Bougeault	0.85	0.5	Yes	Yes
4	OldKuo	Weak	Bougeault	0.85	0.5	Yes	Yes
5	Kain&Fritsch	Weak	Blackadar	1.0	1.5	Yes	Yes
6	OldKuo	Weak	Blackadar	1.0	0.5	Yes	Yes
7	Kain&Fritsch	Weak	Bougeault	1.0	1.5	Yes	Yes
8	OldKuo	Weak	Bougeault	1.0	0.5	Yes	Yes
9	Kain&Fritsch	Strong	Bougeault	1.0	1.5	Yes	Yes
10	OldKuo	Strong	Bougeault	1.0	0.5	Yes	Yes
11	Kain&Fritsch	Strong	Bougeault	0.85	1.5	Yes	Yes
12	OldKuo	Strong	Bougeault	0.85	0.5	Yes	Yes
13	Kain&Fritsch	Weak	Blackadar	0.85	1.5	Yes	Yes
14	OldKuo	Weak	Blackadar	0.85	0.5	Yes	Yes
15	Kain&Fritsch	Strong	Blackadar	0.85	1.5	Yes	Yes
16	OldKuo	Strong	Blackadar	0.85	0.5	Yes	Yes
17	Kain&Fritsch	Strong	Blackadar	1.0	0.5	Yes	Yes
18	OldKuo	Strong	Blackadar	1.0	1.5	Yes	Yes
19	Kain&Fritsch	Weak	Bougeault	0.85	1.5	Yes	Yes
20	OldKuo	Weak	Bougeault	0.85	0.5	Yes	Yes

Improvements to the GEPS in 2013

- February 2013 implementation :
  - Better analyses (higher res, more obs)
  - Only one surface scheme
  - Limitation of PTP when convection occurs
  - See the technical note of Gagnon et al. 2013 :
    - http://collaboration.cmc.ec.gc.ca/cmc/cmoi/product_guide/docs/lib/op_systems/doc_opchanges/technote_geps300_20130213_e.pdf
- December 2013 implementation:
  - Evolutive SST (monthly forecasting on Thursdays)
  - Reforecasting over the last 18 years (4 members)
  - See the technical note of Gagnon et al. 2013:
    - http://collaboration.cmc.ec.gc.ca/cmc/cmoi/product_guide/docs/lib/technote_geps310_20131204_e.pdf

TIGGE scores: Ensemble mean



Canadian ensemble forecasts

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Monthly forecasts with GEPS

- The 20 members run for 32 days instead of 16 on Thursdays at 00Z
- The reforecast is run each week in operations over period 1995-2012 (approach based on Hagedorn 2008)
- 4 members run for 32 days on 3 past date on all days except Thursdays
  - 72 members per week
- The cases from 2 weeks before and after are put together with current week to build the reforecast
  - Total of 360 cases in reforecast

These dates are put together to calculate model climate statistics...

Year	June 20	June …	June 27	July 1st	July 2	July 3	July 4	July 5th	July 6th	July 7th	July …	July 11	July …	July 18
2012	4 mem		4 mem	-	-	-	4 mem	-	-	-		4 mem		4 mem
2011	4 mem		4 mem	-	-	-	4 mem	-	-	-		4 mem		4 mem
…	…		…	-	-	-	…	-	-	-		…		…
1995					-	-	4 mem	-	-	-		4 mem		4 mem

...for current forecasts of this week

GEPS monthly forecasts

- Currently run in operations, but not yet used to issue official forecasts
  - CanSIPS still used for official forecasts for now

- Current surface initialisation of reforecast has weaknesses
  - Future improvement to run surface scheme offline on the whole reforecast periods to improve the reforecast surface initialisation
- GEPS monthly forecasts expected to replace current official monthly forecasts with next version

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Canadian Regional Ensemble Prediction System (REPS)

- **Similar domain as the Regional Deterministic Prediction System (RDPS)**

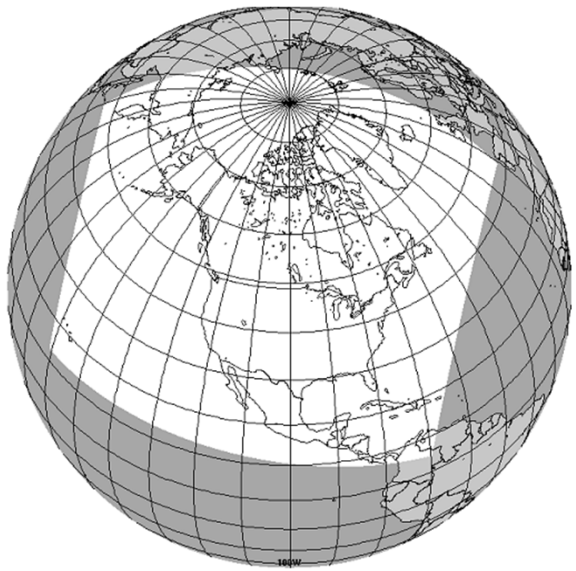
- **Horizontal resolution of 0.15° x 0.15°**
  - **~15 km grid spacing**

- **48 levels in the vertical**

- **Time step of 7.5 mins.**

- **72h forecasts at 00Z and 12Z**

REPS



- **Dynamic core is based on GEM 4.5.2 (vertical staggering)**

- **See the technical note of Erfani et al. 2013:**

http://collaboration.cmc.ec.gc.ca/cmc/cmoi/product_guide/docs/lib/technote_reps201_20131204_e.pdf

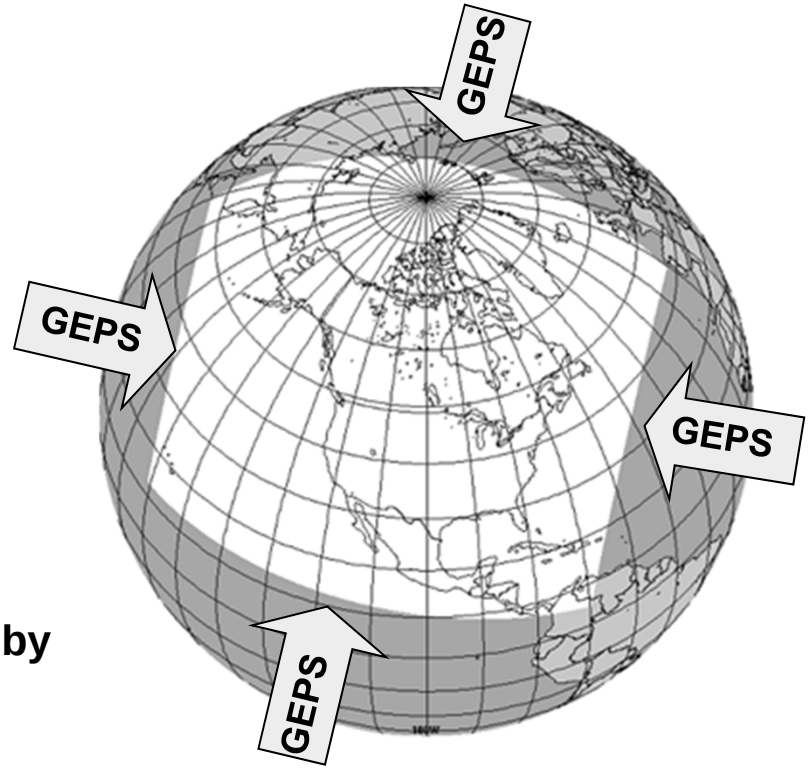
REPS boundary conditions

- **REPS model lid near 10 hPa**
  - **No sponge at the top**

- **Use lid nesting technique**
  - **Piloted from the top by the GEPS**
  - **Piloting at 10 to 35 hPa (3 levels)**
  - **Blending at 35 to 100 hPa (3 levels)**

- **Initial conditions from the global EnKF (same as the GEPS)**

- **Horizontal boundary conditions provided by the GEPS with a 1 hour intervals**



- **The ensemble is made of 20 members stochastic perturbations of physical tendencies. One control member is not perturbed.**

Canadian EPS – forecasts – REPS 2.0.1

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0	Kain&Fritsch	Standard	Bougeault	1.0	No	No
1	Kain&Fritsch	Standard	Bougeault	1.0	No	Yes
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20	Kain&Fritsch	Standard	Bougeault	1.0	No	Yes

Canadian REPS vs Canadian GEPS

	REPS	GEPS
Orographic blocking	One parameter	Multi-parameter
Deep convection	Kain-Fritsch	Kain-Fritsch, Kuo
Gravity wave drag	One parameter	Multi-parameter
Mixing length	Bougeault	Bougeault, Blackadar
SKEB	No	Yes
Physical tendency perturbations	[0.7 , 1.3]	[0.5 , 1.5]
Grid spacing	15 km	66 km
Time step	7.5 min	20 min

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Future plans for Canadian EPS

GEPS

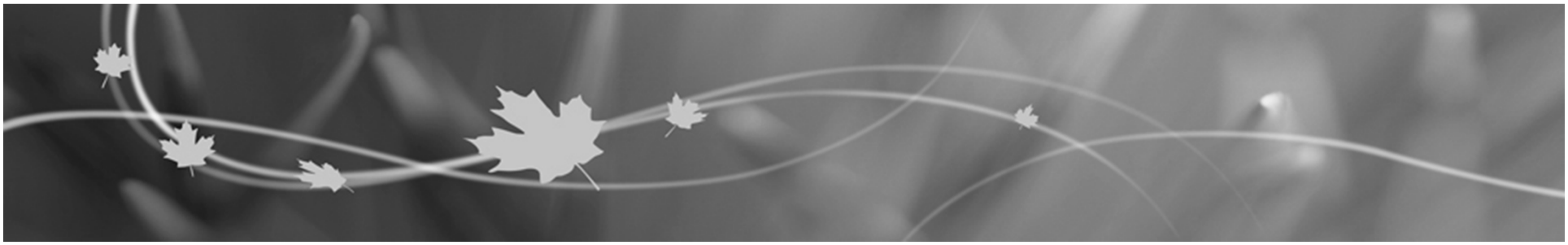
- GEPS horizontal resolution to 50 km
- GEPS to provide trial fields error statistics for EnVAR

GEPS-reforecast

- Improvements to surface initialization

REPS

- NAEFS-LAM: data exchange of REPS and SREF
- Regional EnKF assimilation



Thank you!

Questions?