Environment Canada Environnement Canada

Canada

Centre report: Recent changes to and plans for the NWP suites of Environment Canada

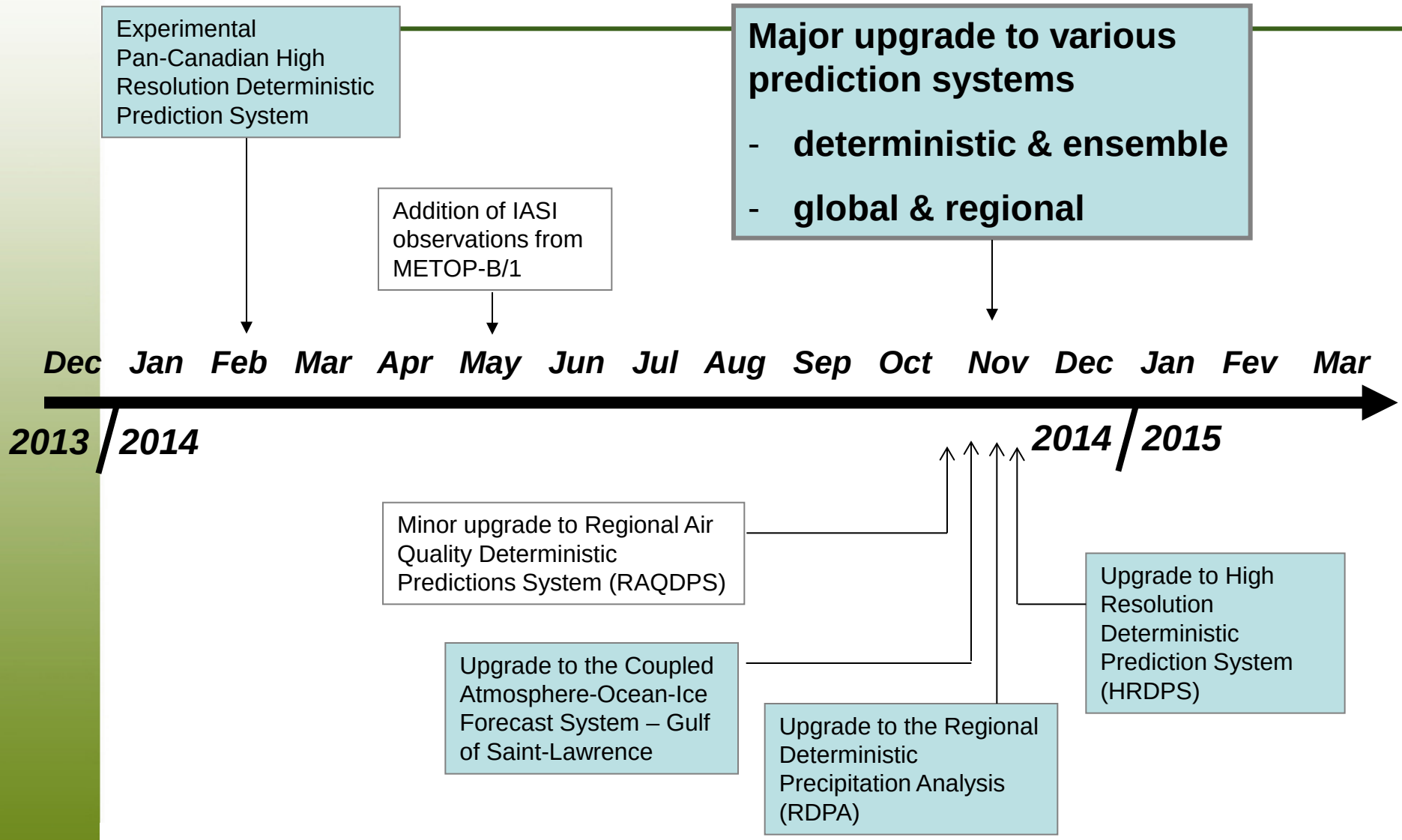
WGNE-30 – College Park, USA

Ayrton Zadra

RPN – Environment Canada

23-26 March 2015

Part 1 - Recent changes



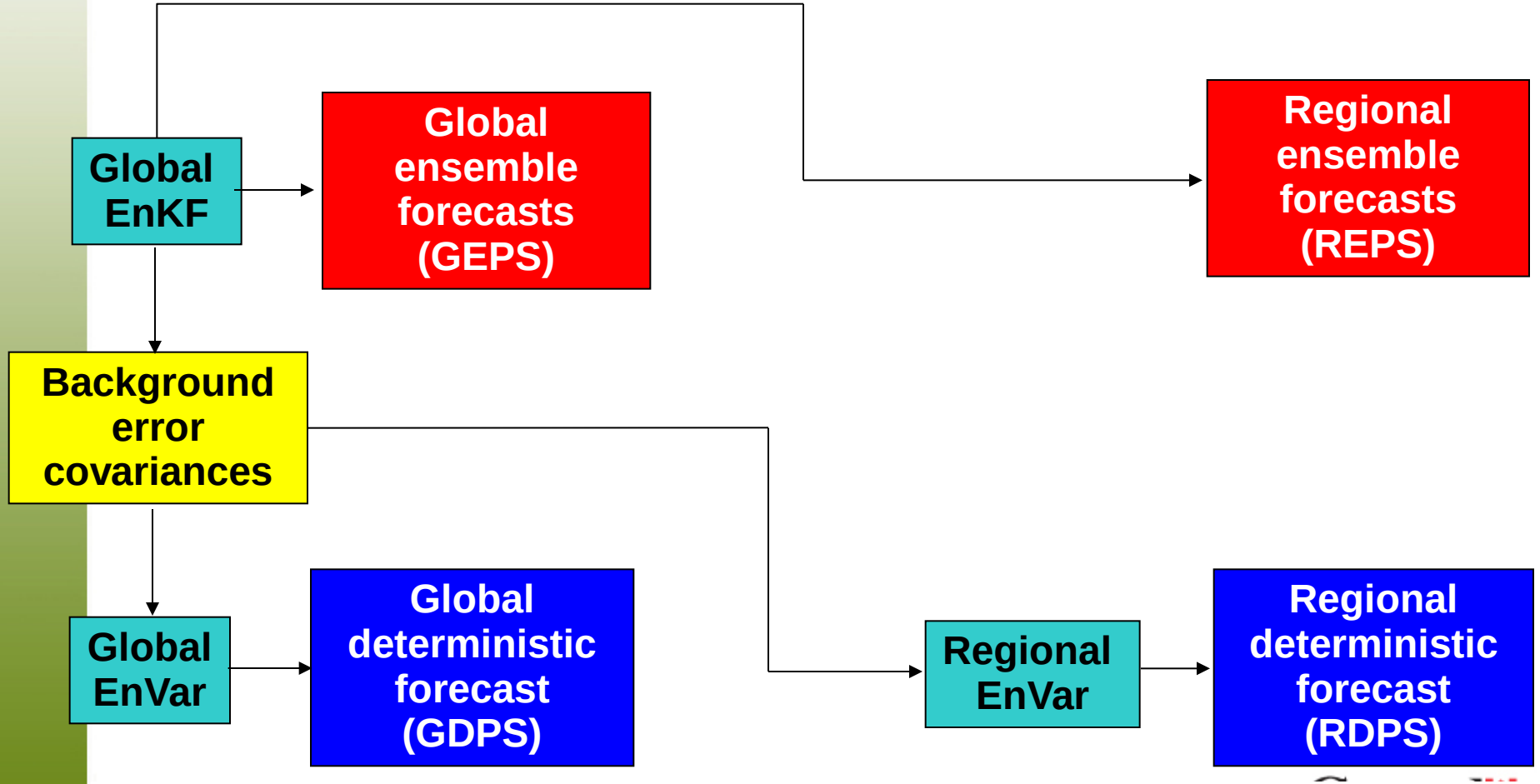
Upgrade to deterministic systems

Changes are to data assimilation system and initialization:

- **4D-EnVar replaces 4D-Var**
- Horizontal grids:
  - Analysis increment: 50km instead of 100km grid spacing
  - Unchanged for background and analysis (GDPS: 25km grid spacing)
- Satellite radiance observations:
  - Improved satellite radiance bias correction scheme
  - Additional AIRS/IASI channels assimilated
  - Upgrade RTTOV8 to RTTOV10
  - Modified obs error stddev for all radiance observations
- Improved treatment of radiosonde (4D), aircraft obs (bias correction)
- Assimilation of ground-based GPS data over N. America
- 4D Incremental Analysis Update replaces digital filter and now recycle several unanalyzed variables (GDPS only)
- Use of new global sea ice concentration analysis

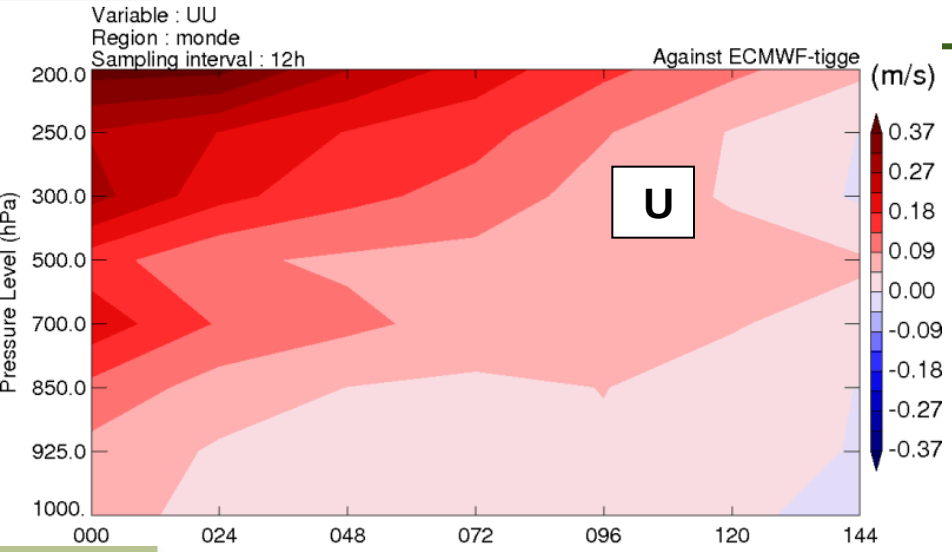
New link between EnKF and GDPS/RDPS

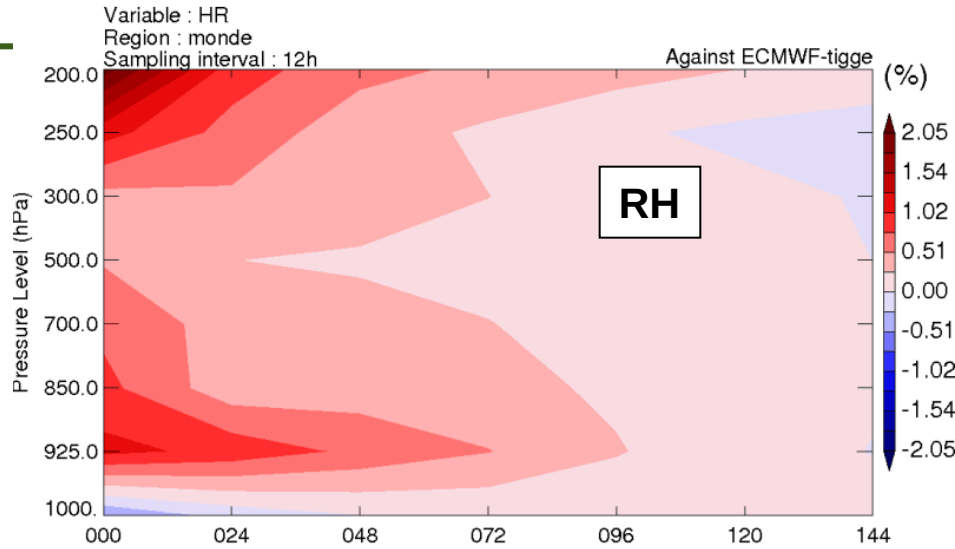
2014 implementation: Increasing role of global ensembles

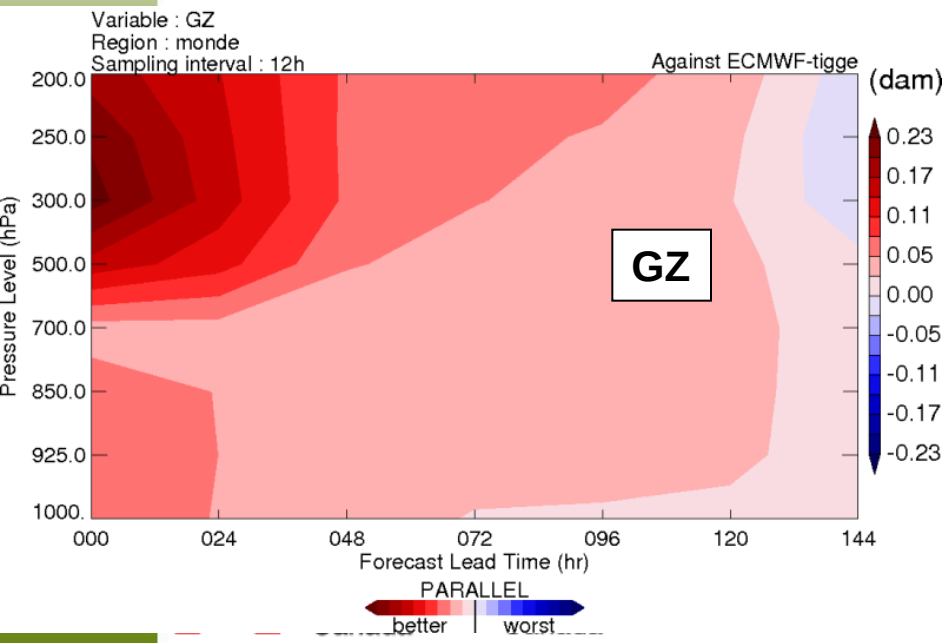


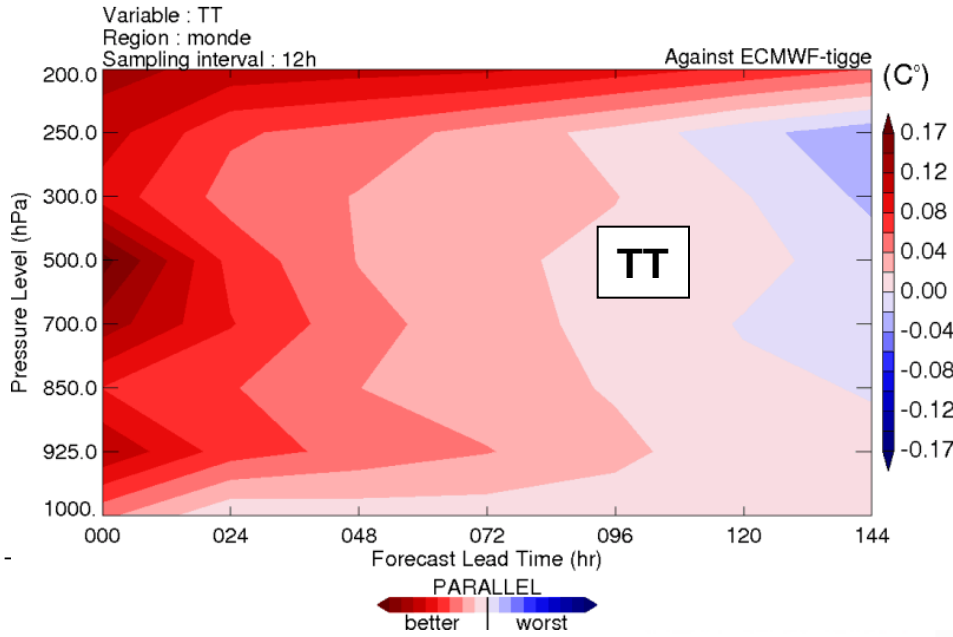
Evaluation of Forecasts: GDPS 4.0.0 vs GDPS 3.0.0

Verification vs. ECMWF analyses: Global Difference in std dev



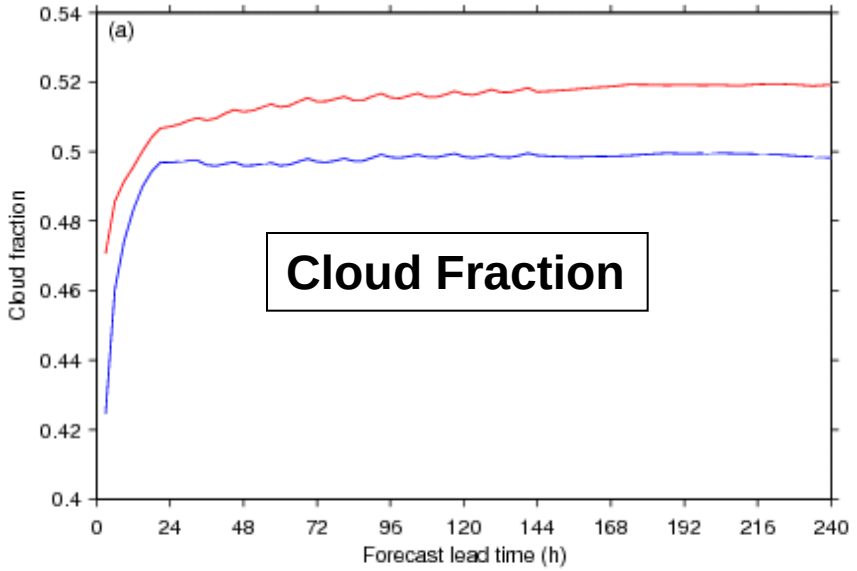


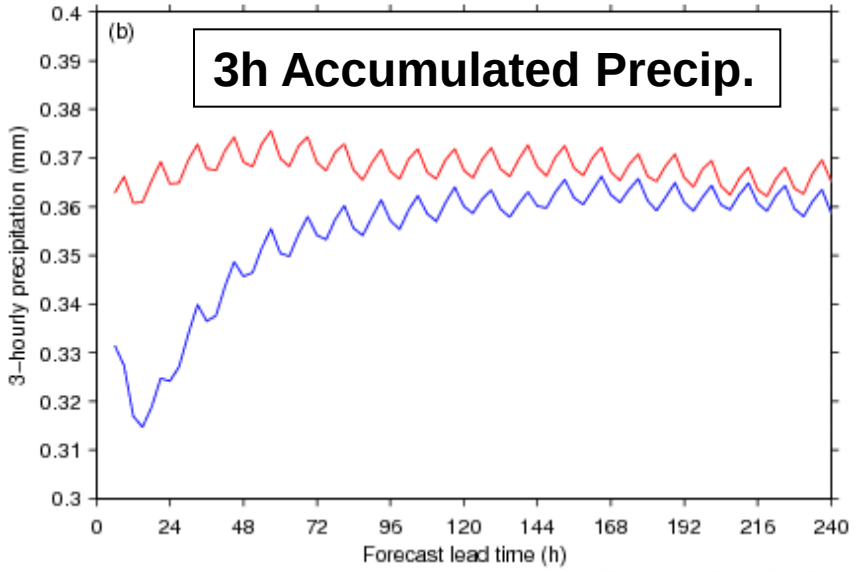




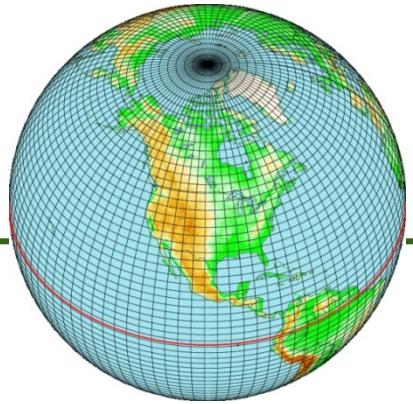
Forecast Results: GDPS 4.0.0 vs GDPS 3.0.0

- Simple comparison of cloud and precip. spin-up **from winter final cycle**
- Several changes in new system affect the spin-up during model forecasts:
  - Recycling of several variables
  - 4DIAU instead of full-field digital filter
  - Elimination of uninitialized 3h forecast needed in 4DVar





Conclusions for the new global deterministic system



- Forecasts either improved or similar in quality to operational system
- **Biggest improvements at short lead times and in the tropics and southern extratropics**
- More modest impact in northern extratropics
- TT/GZ bias significantly different in new system (due to: radiance BC, aircraft BC, recycling, 4DIAU), better vs ECMWF, sometimes worse vs radiosonde (e.g. N. America)
- Possibility of more frequent and/or larger forecast busts when rapid development originates from lower troposphere over the ocean (focus of current research)

Upgrade to the Global Ensemble Prediction System (GEPS)

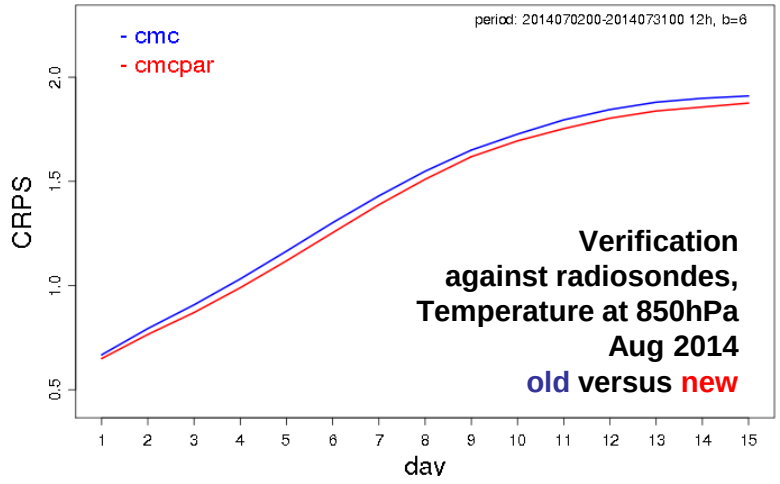
Analysis component (EnKF)

- *ensemble size: 192 → 256 members*
- *horizontal resolution: 66 → 50 km*
- *time step: 20 → 15 min*
- *data assimilation:*
  - *RTTOV-10*
  - *4D assimilation of radiosondes*
  - *new bias correction method*
  - *GPS-RO from 1km*
- *further perturbations to the physics (e.g. orographic blocking bulk drag coefficient, thermal roughness length over oceans)*

Forecast component

- *Increased resolution + further perturbations in physics (as in analysis component)*
- *new method to evolve SST and sea-ice fields*

Overall 6-h improvement in forecast skill for atmospheric variables.



Part 2: Ongoing/future projects etc.

1. **Global deterministic system**:
   - *Yin-Yang grid*
   - *improved dynamics*
   - *additional data assimilated*

2. High resolution system: **Pan Am Games** (summer 2015)

3. **Increase in vertical resolution**

4. Improvements to the **parametrization of moist processes** (convection, PBL, etc.)

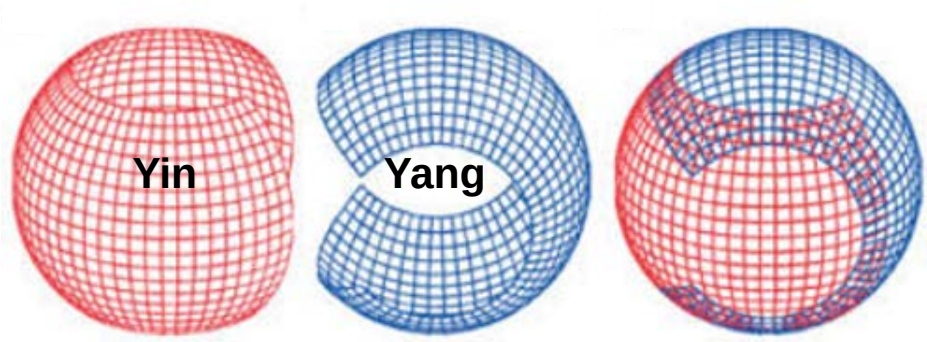
5. **Supercomputer upgrade** (2015-2016)

6. ***Comment on precipitation verification***

Upcoming changes to the Global Deterministic Prediction System (GDPS)

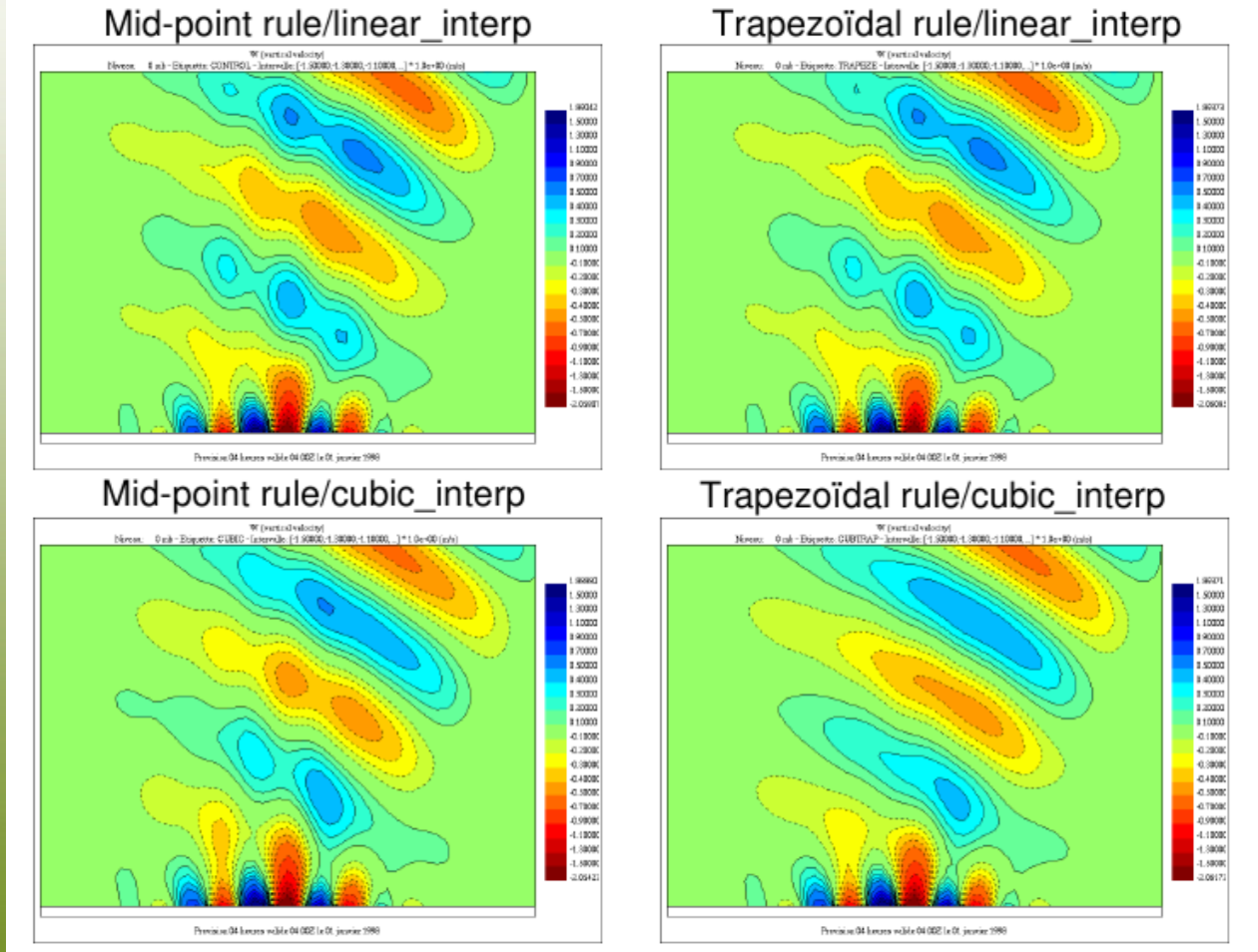
- **Yin-Yang** grid* at 25-km resolution

  * *Qaddouri & Lee 2011, QJRMS 137, 1913-1926*



- **Changes to the model dynamics**
  - *Use trapezoidal averaging for trajectories in the semi-Lagrangian advection*
  - *Use cubic interpolation in the thermodynamic equation*
  - *Global surface pressure adjustment for conservation of dry air mass*

Impact of Cubic/Trapezoidal



Idealized Flow past Topography (Schär's case): Trajectory calculations using

Vertical motion in a 500 m 2D slab integration of GEM for the Schar case with 250 m maximum mountain height (from Claude Girard).

The **2D Schar mountain case** has a smooth ideal solution that represents vertically propagating gravity waves created by the sinusoidal mountain below.

This test is particularly sensitive to inconsistencies in the dynamics.

The **consistent treatment of terms in the thermodynamic equation via the combination of the trapezoidal trajectory calculations and cubic interpolations** leads to an excellent solution for this case.

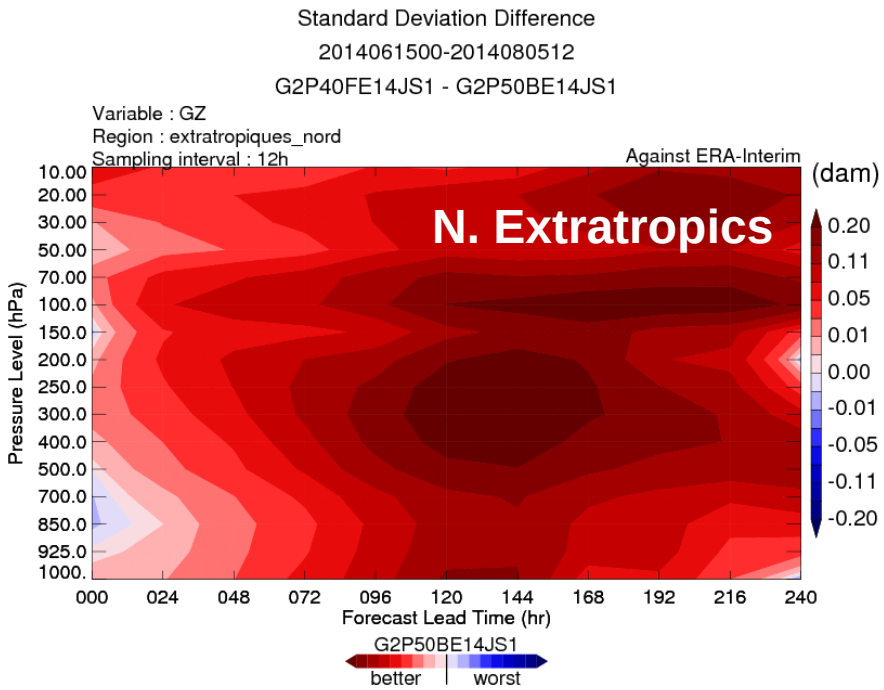
Evaluation of Forecasts

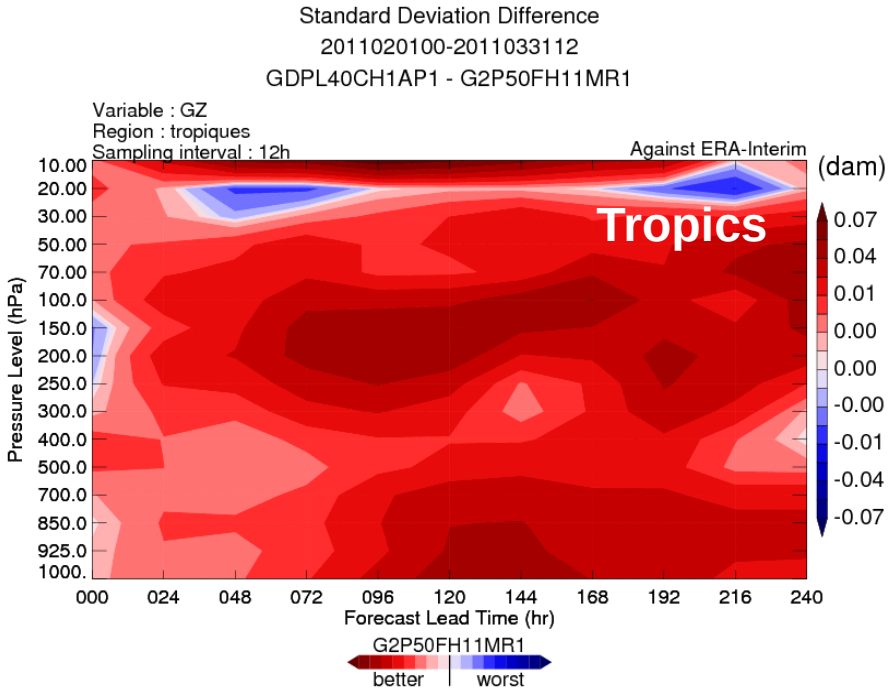
summer cycle

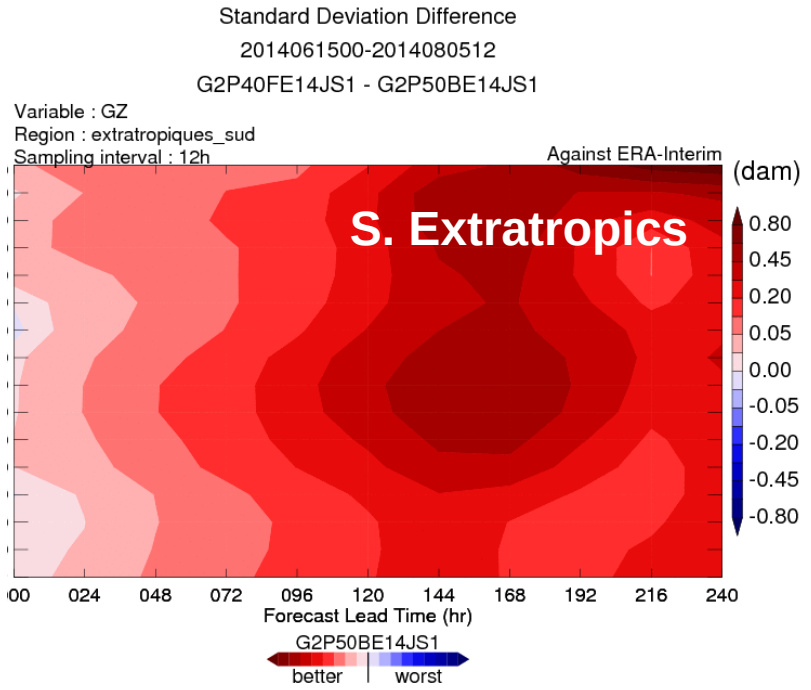
New vs Oper

Verification vs. ECMWF analyses

Difference in error std dev of GZ-500hPa

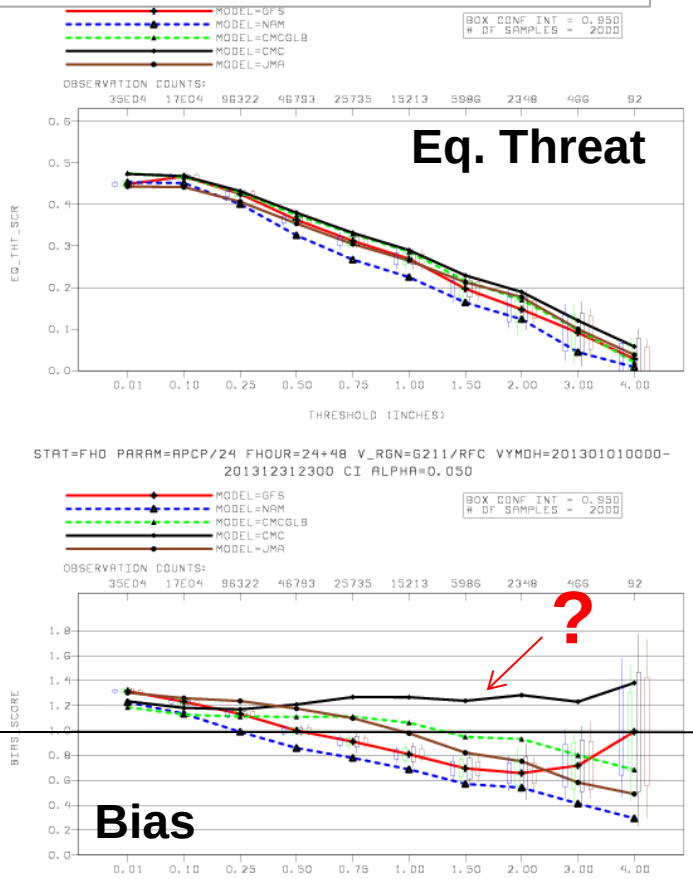






Comment on precipitation verification

QPF Skill Scores over ConUS
Jan – Dec 2013, 1 &2 day fcsts
(as presented in WGNE-29)



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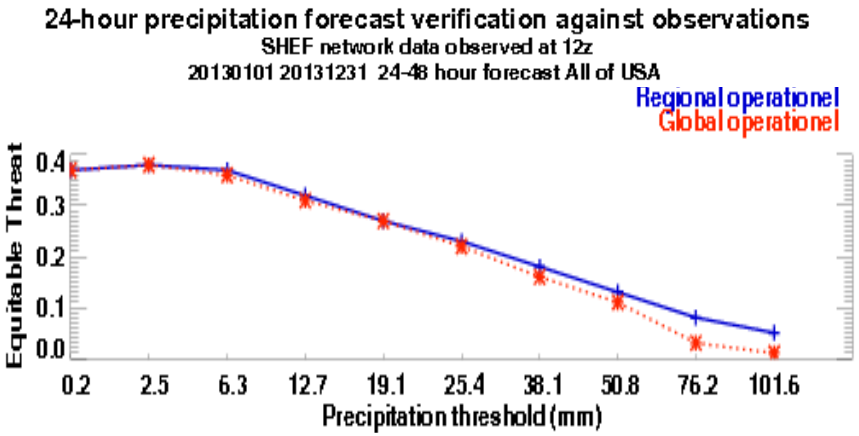
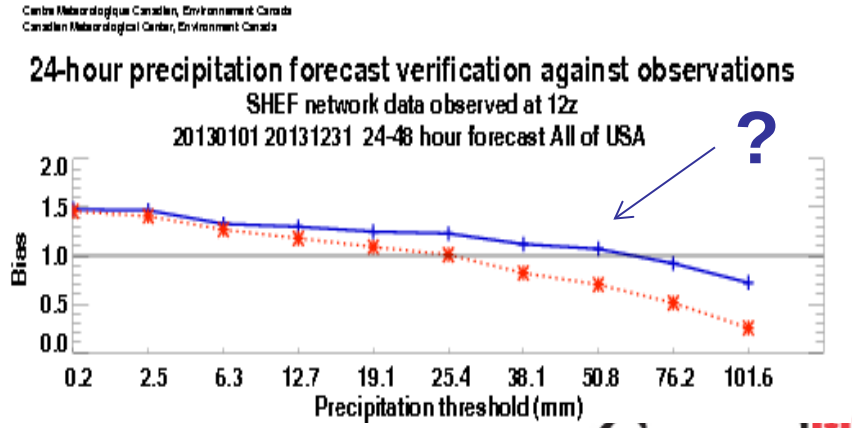
QPF Skill Scores over ConUS
similar period
generated at CMC





GFS,NAM,CMCGLB,**CMC**,JMA

Canada

Comment on precipitation verification

After some emails and results exchanged with Ying Lin (NCEP/EMC) – many thanks to Mike Ek for the contact info – we believe we found the source of the differences:

- the current resolution of the CMC regional model (RDPS) is **10km (limited area, uniform grid over N. America)**
- the CMC precip files transferred to NCEP are on a **35km polar stereographic grid**
- the script used (by the CMC) to generate those files cause a **sampling problem**
- CMC-operations has been informed and is working on a solution

Acknowledgements

Weather Prediction: Martin Charron, Ron Mctaggart-Cowan, Jason Milbrandt, Claude Girard

Environmental Prediction: Greg Smith, Pierre Pellerin, Vincent Fortin, Stephane Belair, Natacha Bernier

Data Assimilation: Mark Buehner, Peter Houtekamer

CMC-Development: Normand Gagnon, Amin Erfani