



Environment and
Climate Change Canada

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Canada

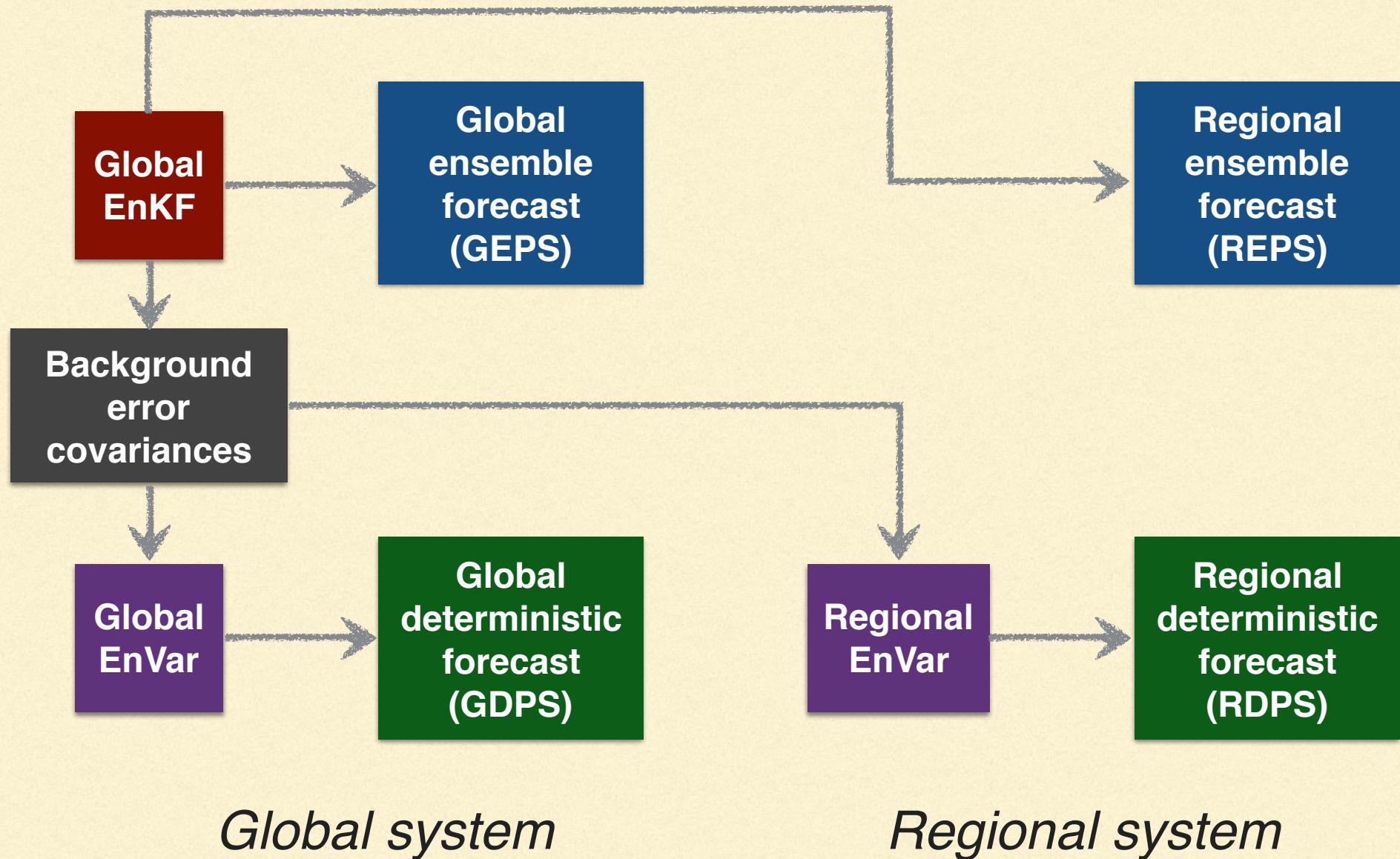


Environment Canada's Regional Ensemble Kalman Filter

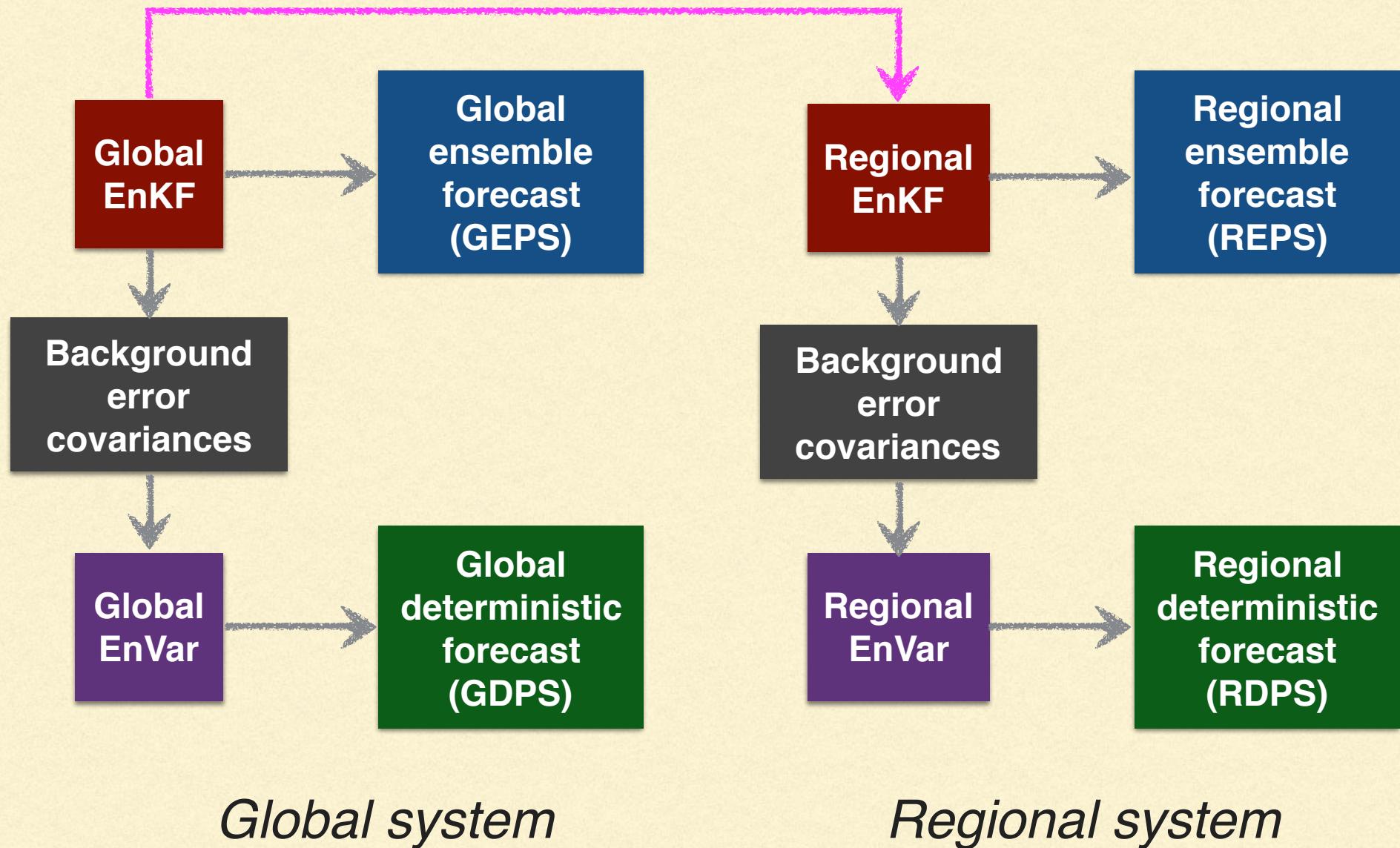
EnKF Workshop 2016

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Meteorological Research Division, Environment and Climate Change Canada

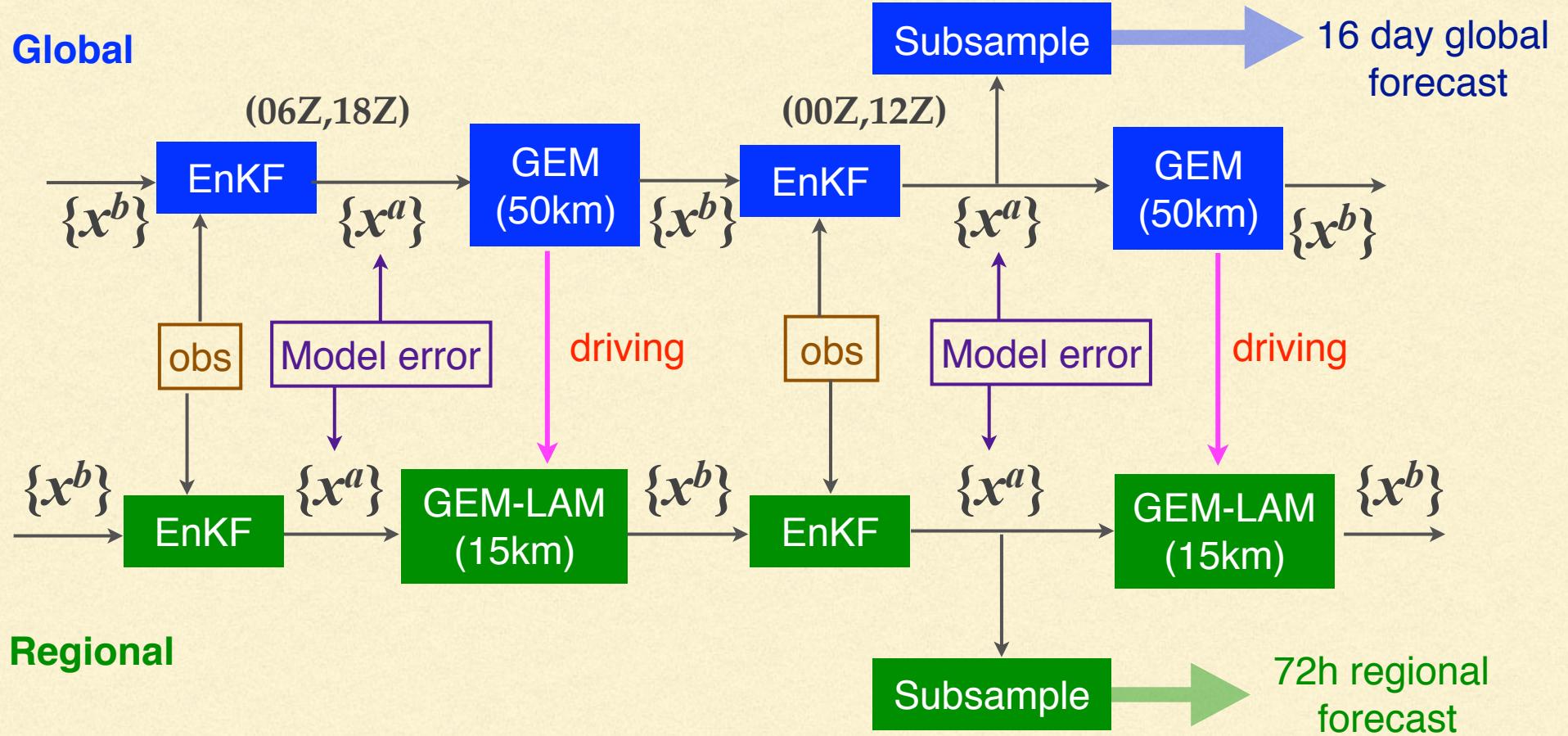
2014 implementation of the NWP suites



2015-2016 implementation of the NWP suites



Autonomous Regional EnKF Driven by the Global



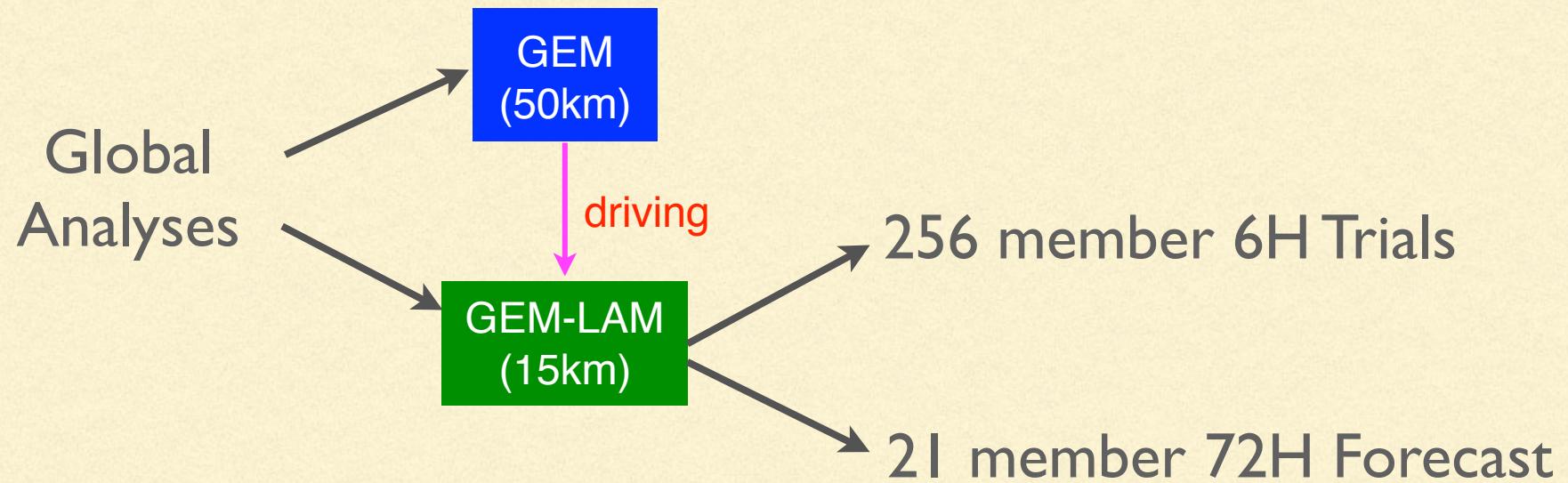
- Regional EnKF starts from global ensemble analyses and then runs autonomously.
- Global Environmental Multi-scale (GEM) model is used for the forecast.

Comparison Between Global and Regional EnKF

- Make the regional configuration close to the global.
 - 256 ensemble members.
 - Same localization distance.
 - Same model error perturbation.
 - Same set of observations.
 - Multi-model for the global but single model for the regional.
 - Each member has different configuration for the global.
 - All members have the same configuration for the regional.
 - Regional EnKF performs better than the global EnKF.
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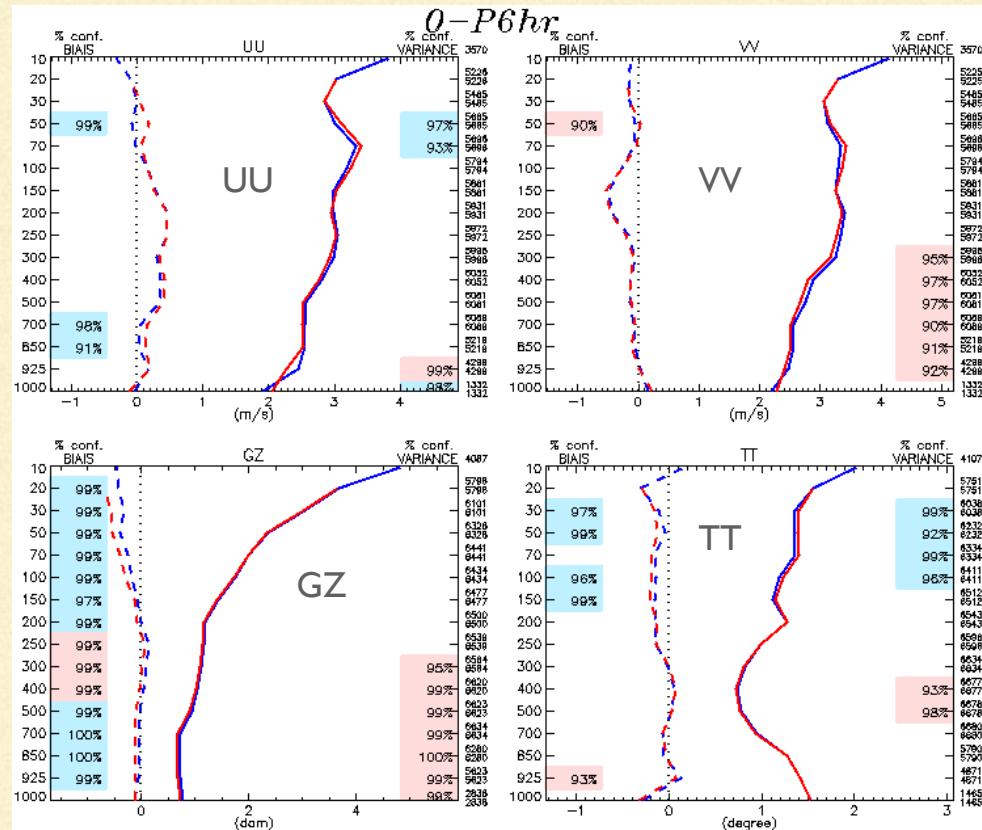
Downscaling the Global EnKF

- Feed GEM-LAM 15km model with the global analyses.
- Compare with the regional EnKF.

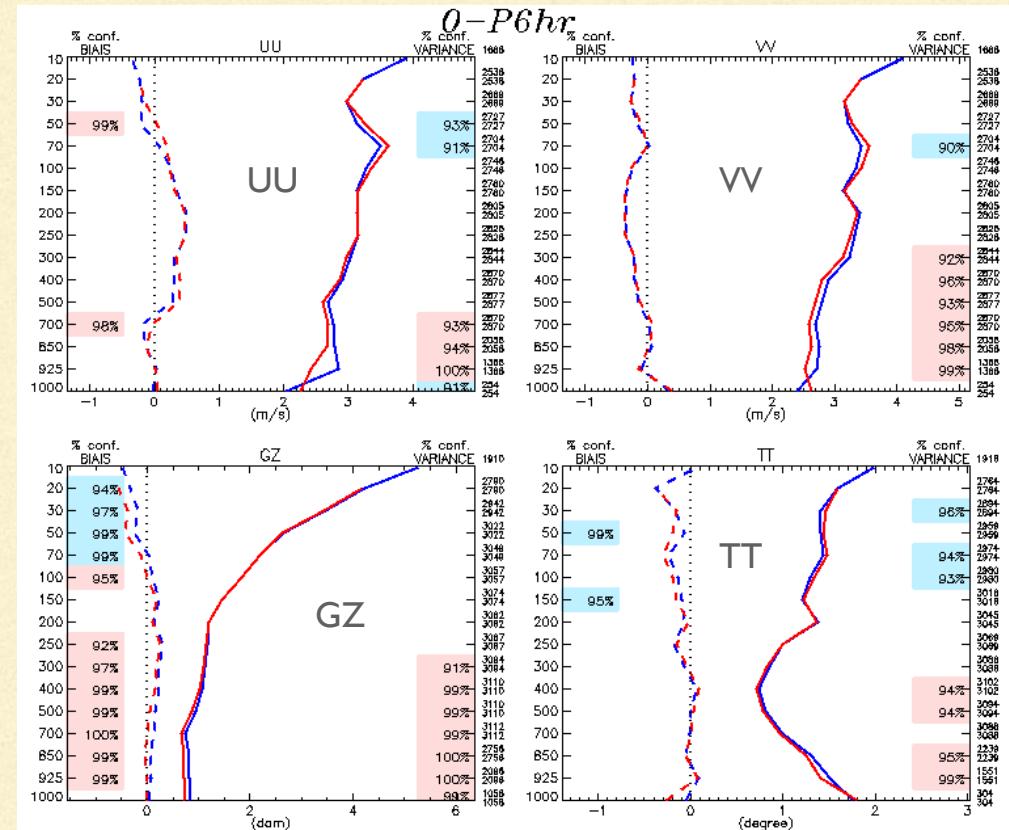


Verification Against Radiosonde: Global .vs. Regional

Northern America

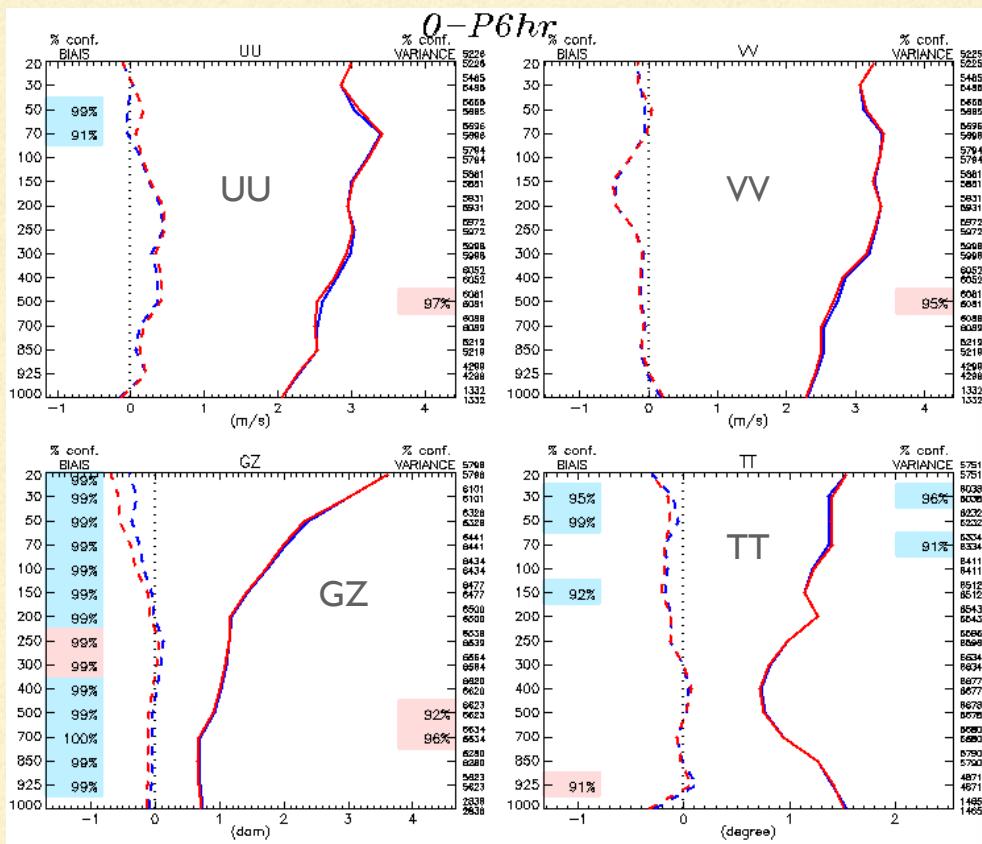


Northern America West

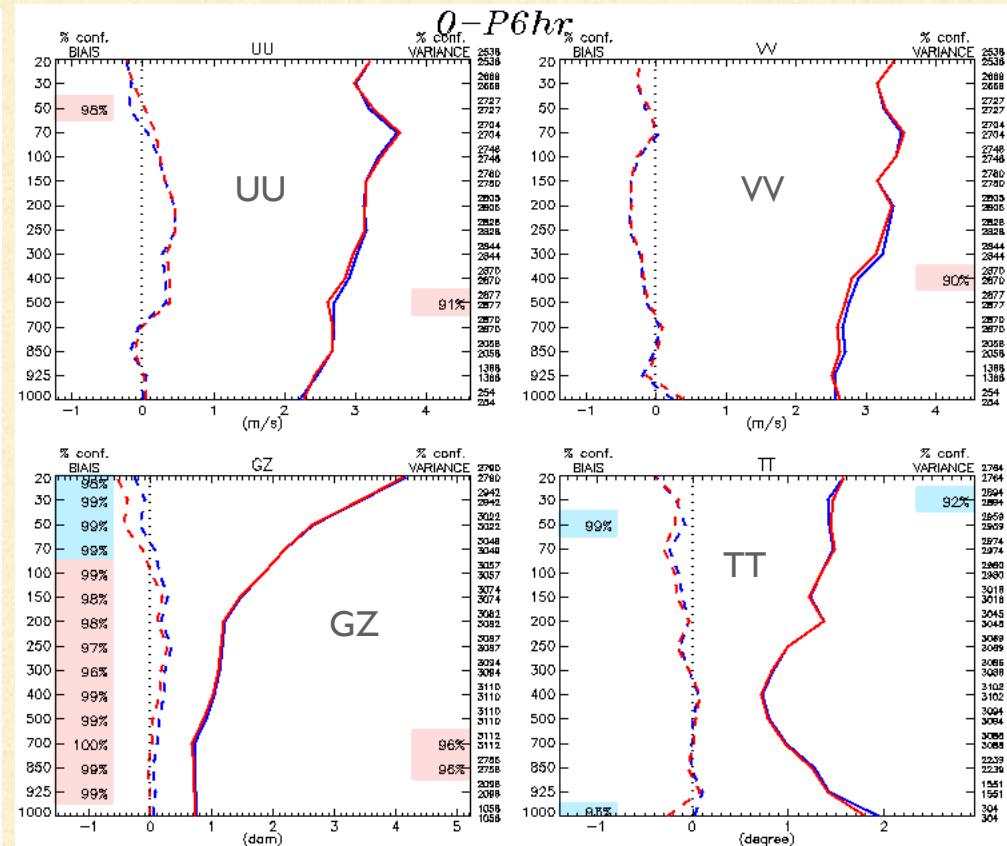


Verification Against Radiosonde: Downscale .vs. Regional

Northern America

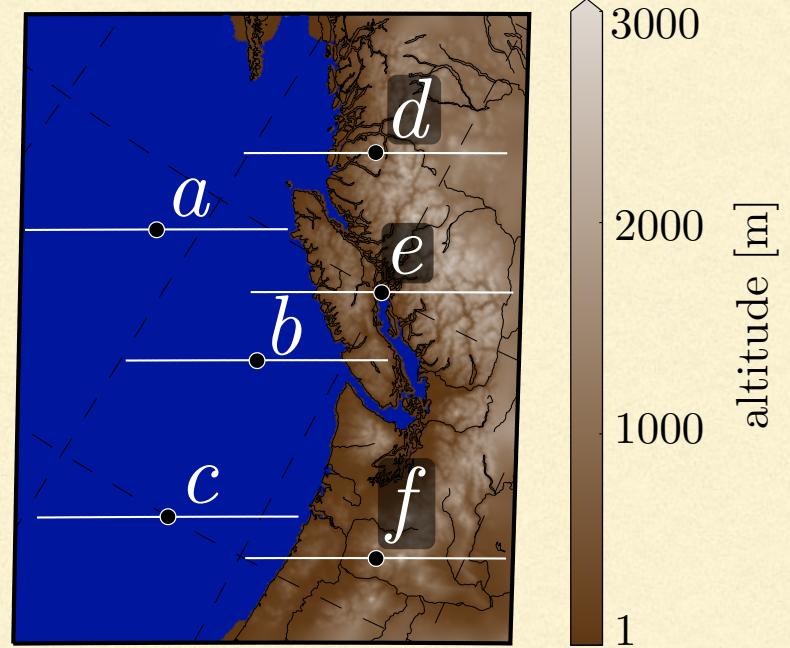


Northern America West



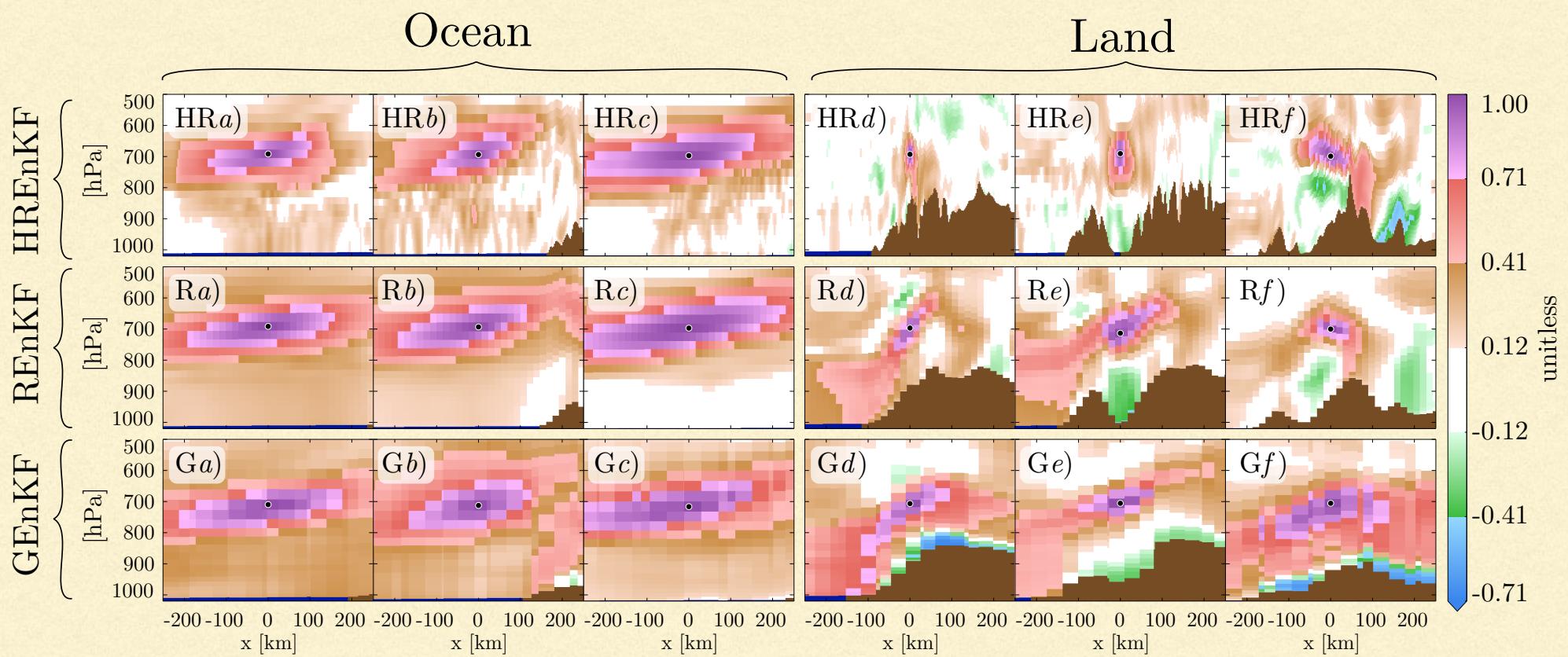
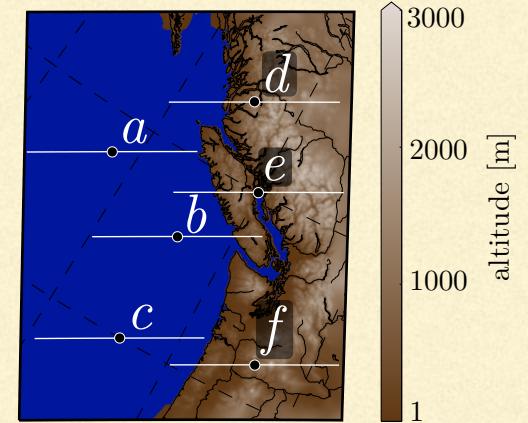
Correlation Structure Comparison

- 2.5km EnKF over Vancouver (MEOPAR).
- Driven by the regional EnKF.
- Compare correlations between global 50km, regional 15km and high resolution 2.5km EnKF.
- 3 points (a,b,c) on the ocean and 3 points (d,e,f) on the land at 700hPa height are selected.
- Correlations along the zonal and vertical directions are computed.

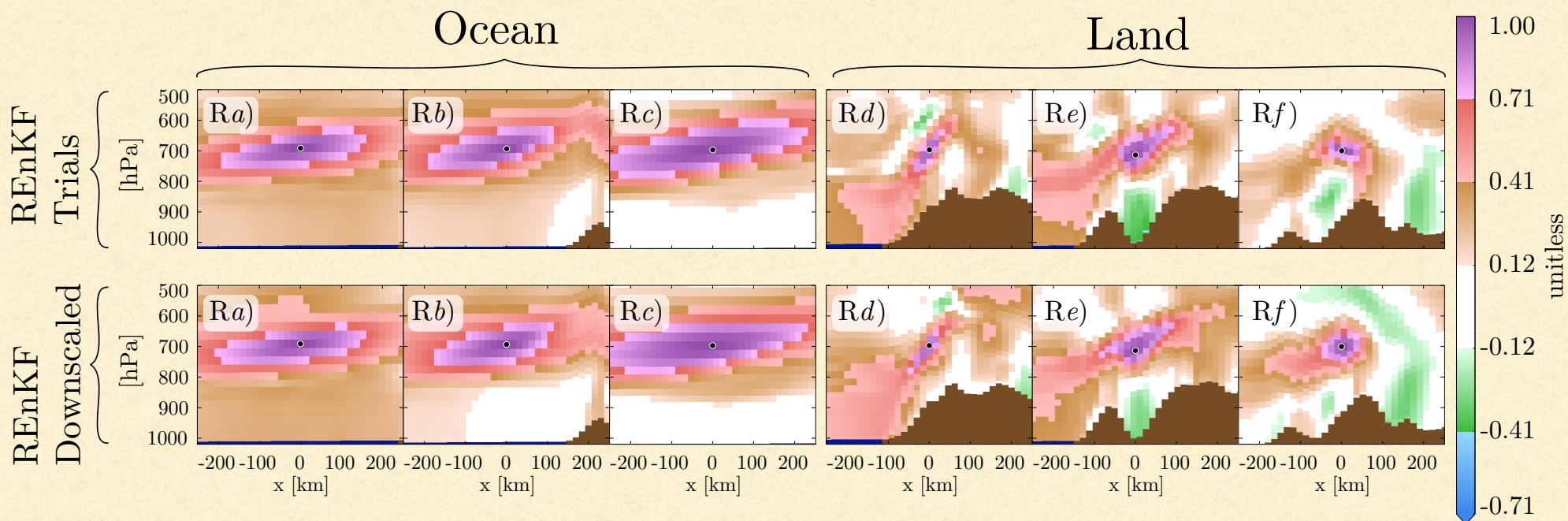
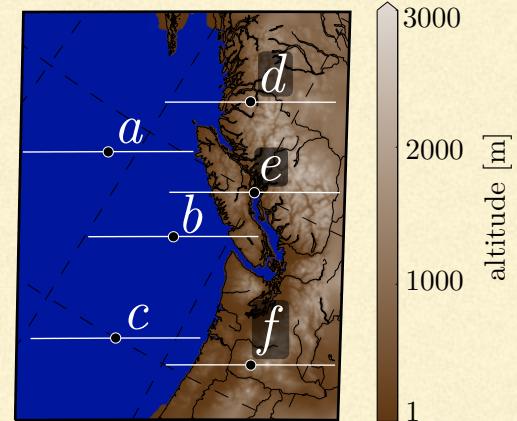


U-Wind Correlation:

2.5km, 15km and 50km

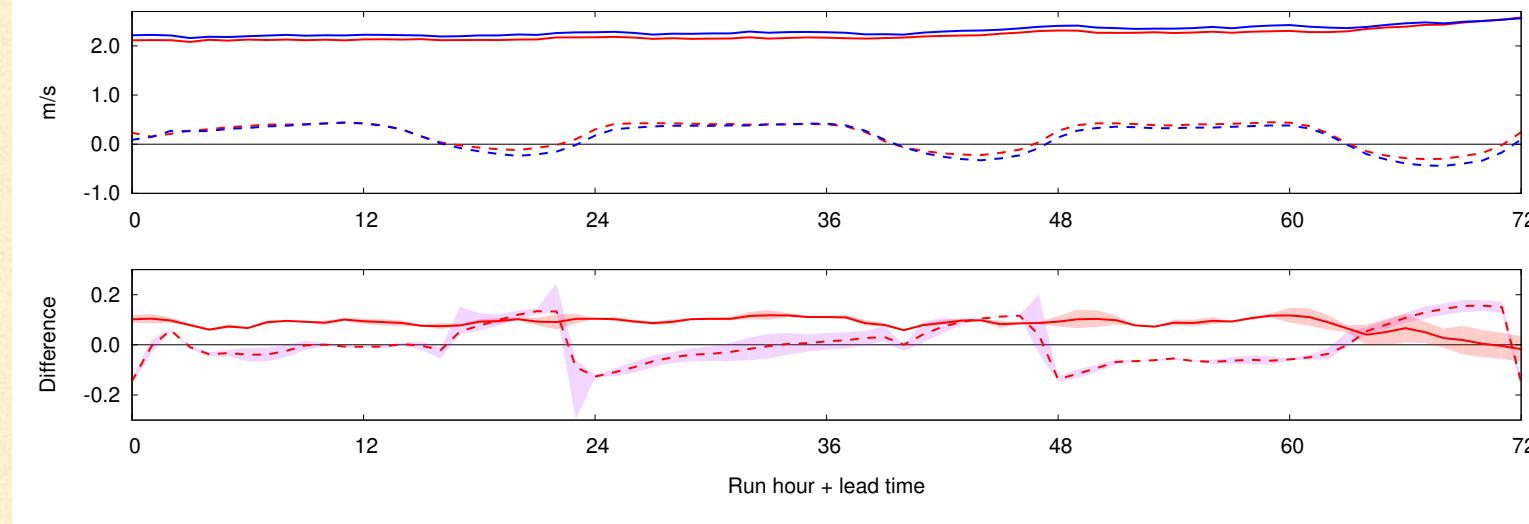


U-Wind Correlation: 15km Regional EnKF and Downscale

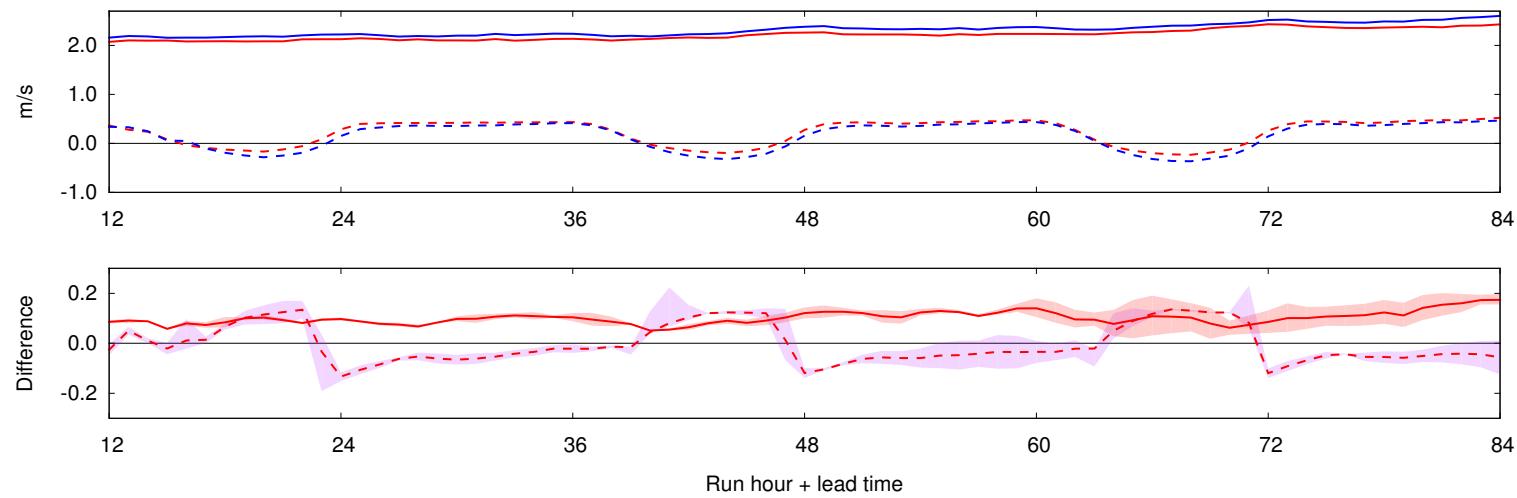


10m Wind Forecast Error (METAR): Global vs Regional

Forecast from 00Z



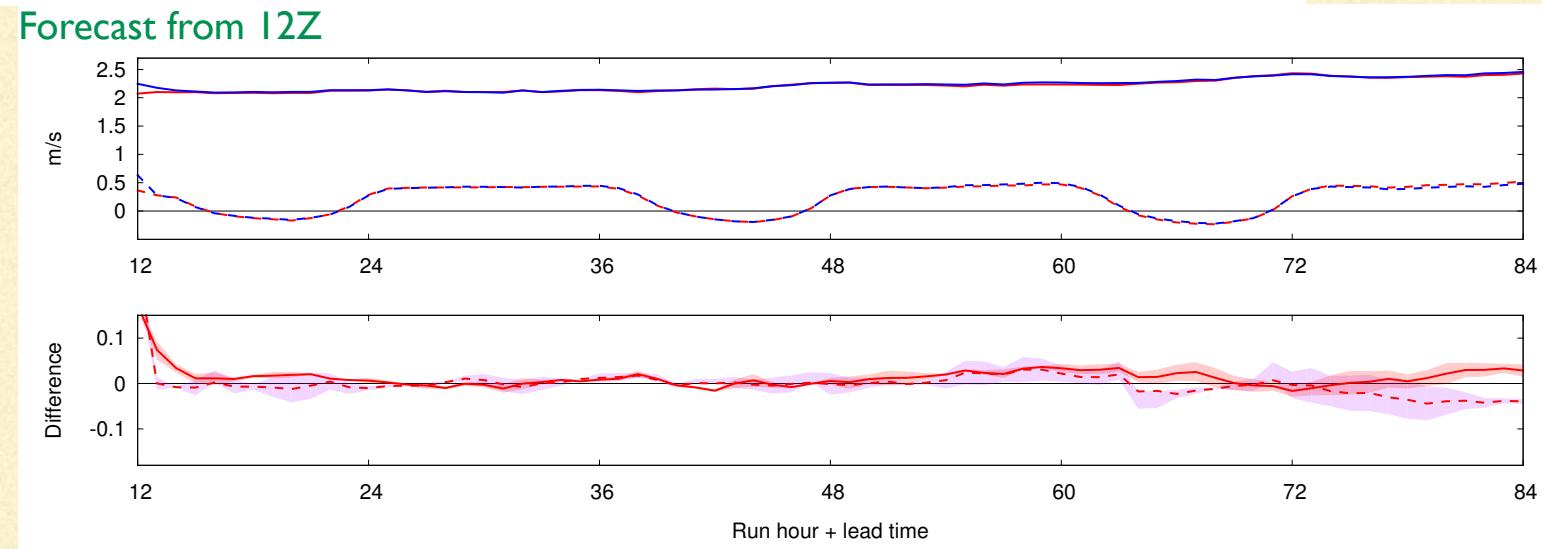
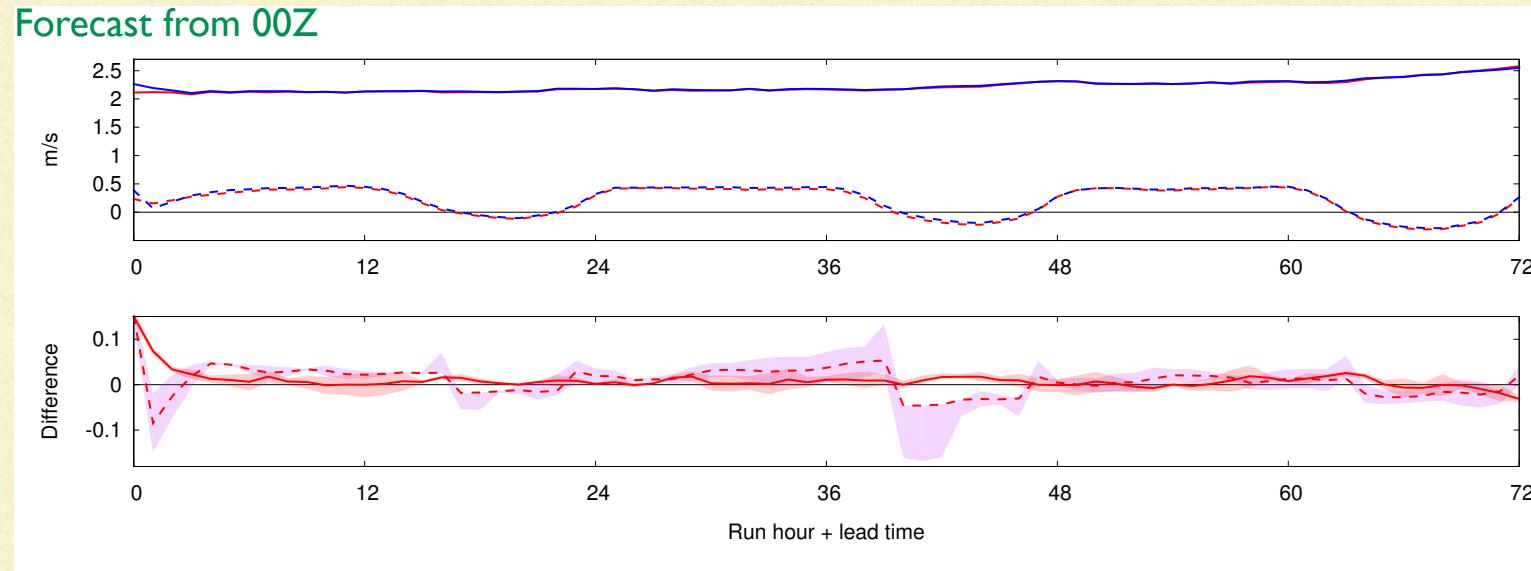
Forecast from 12Z



Standard deviation ———

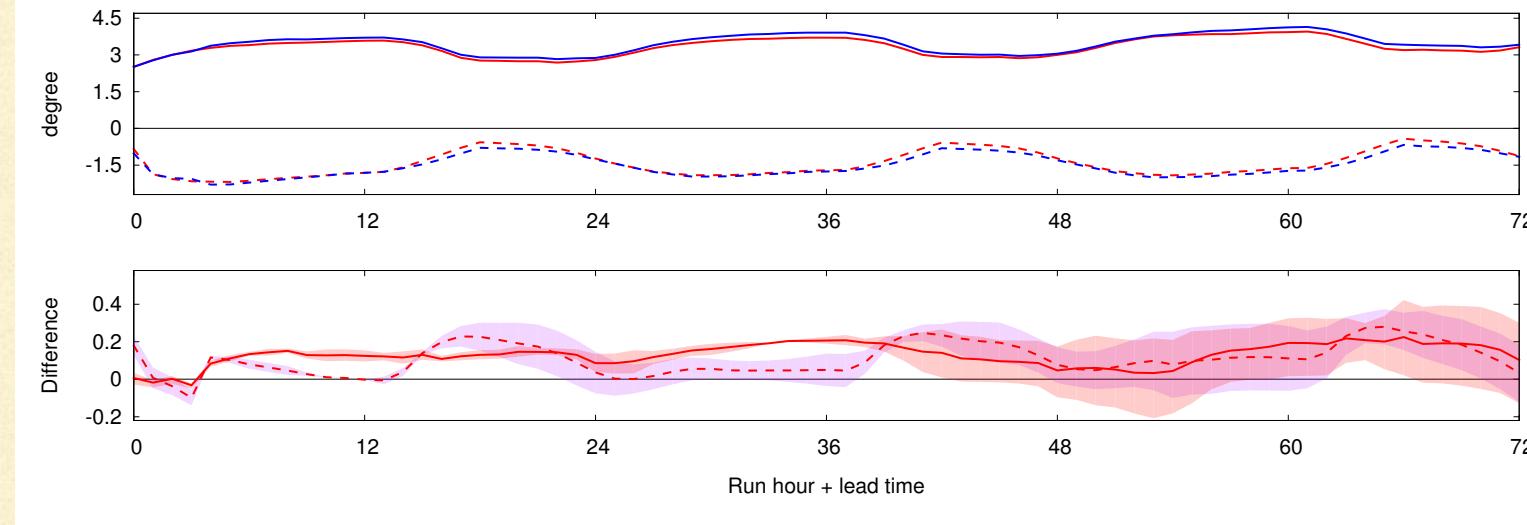
Bias -----

10m Wind Forecast Error (METAR): Downscale vs Regional

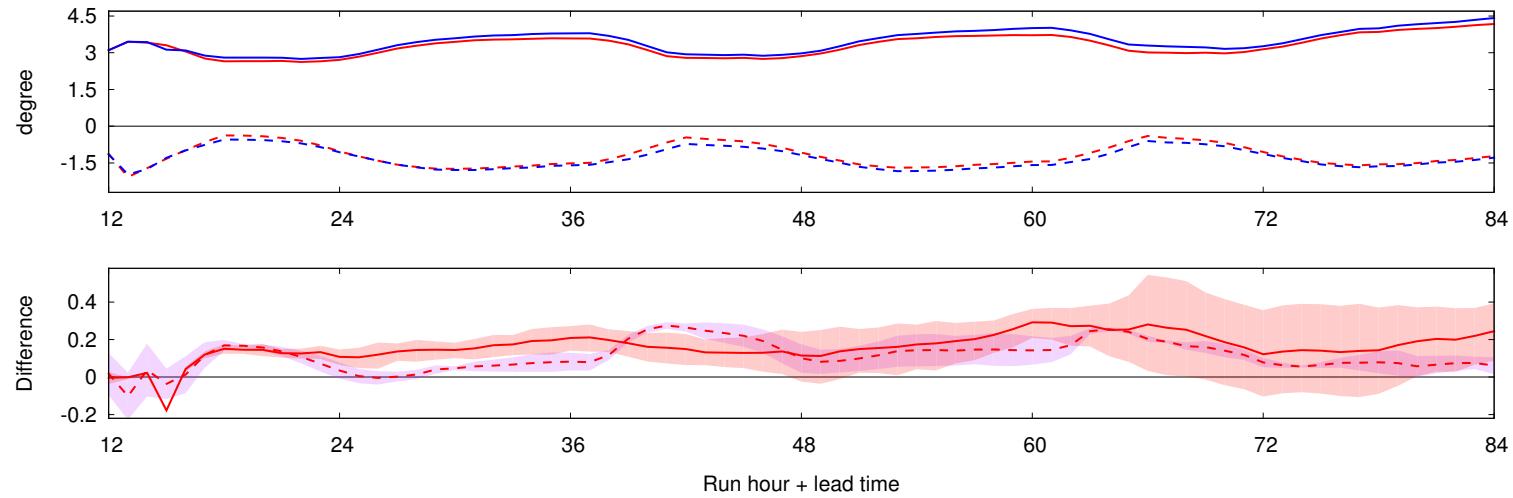


2m Temperature Forecast Error (METAR): Global vs Regional

Forecast from 00Z

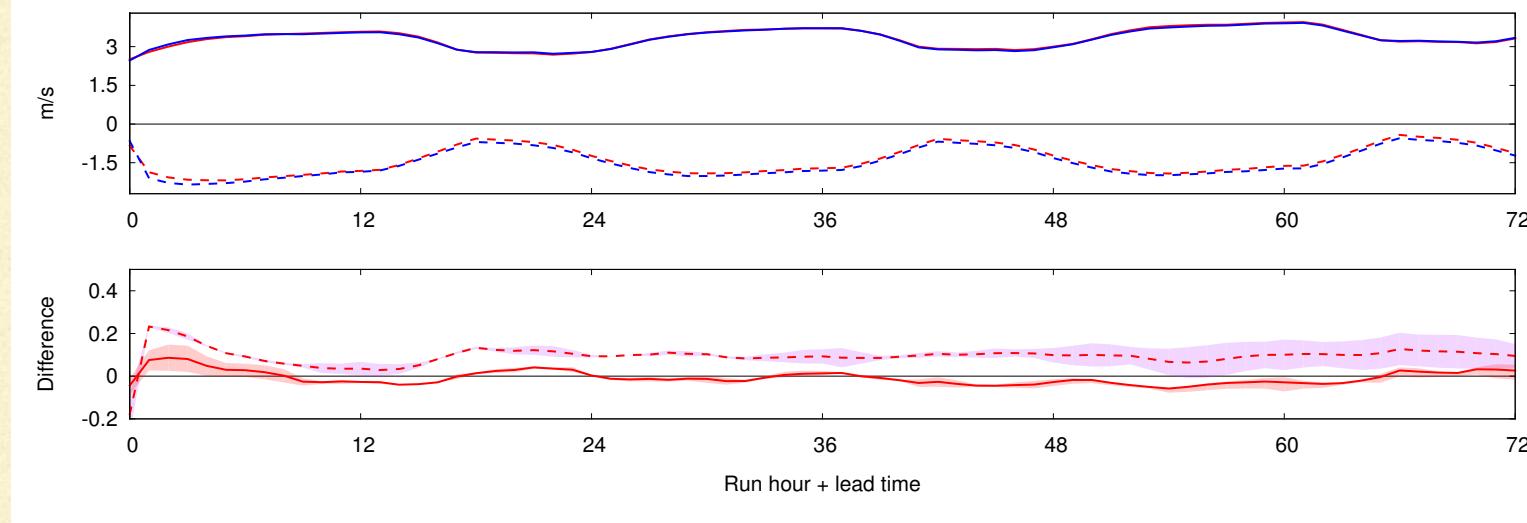


Forecast from 12Z

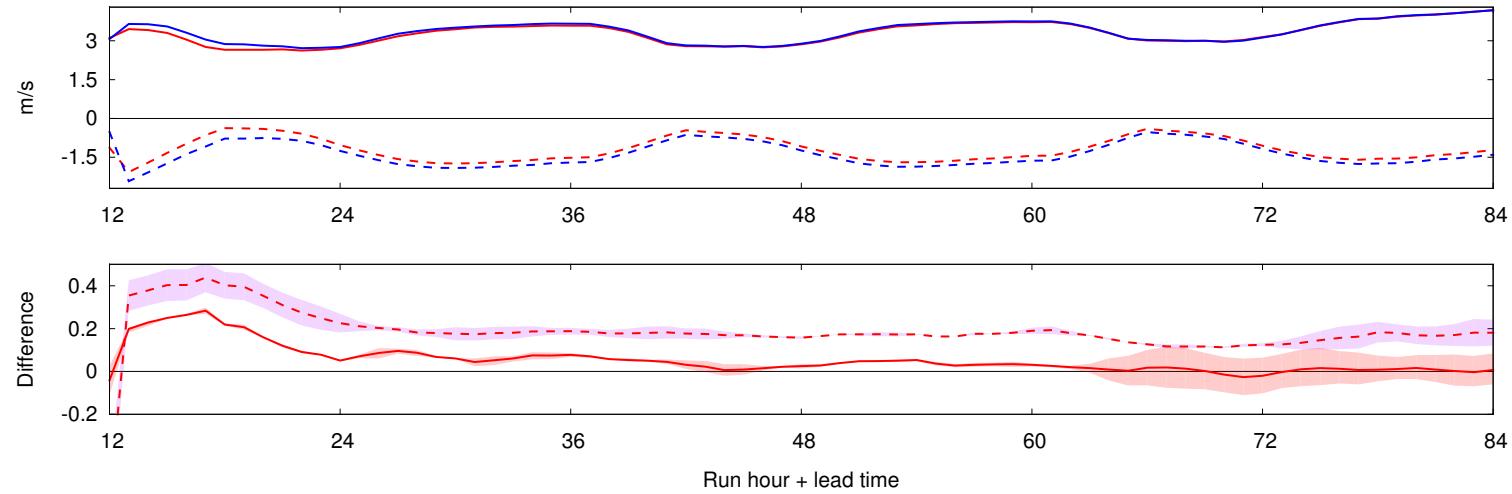


2m Temperature Forecast Error (METAR): Downscale vs Regional

Forecast from 00Z



Forecast from 12Z



Standard deviation —————

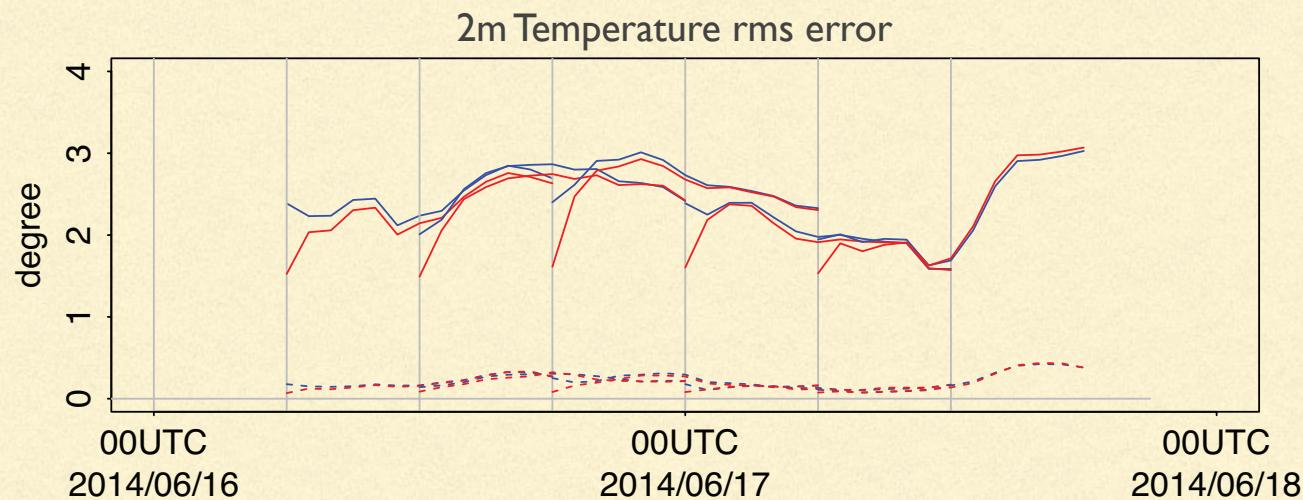
Bias -----

Downscaling is enough

- Regional EnKF is almost twice expensive than global EnKF.
- Limited improvement against downscaled forecasts.
- 72 hour regional forecasts for upper air and precipitation also neutral.
- Need high density observation network to fully exploit high resolution model.
 - METAR, Mesonet, Radar, SWOB, etc.

METAR Data Assimilation with 2.5km EnKF

- Forecast for the Pan Am Games in Toronto up to 250m resolution.
- Coupled with CaLDAS (Canadian Land Data Assimilation System).
 - CaLDAS produces ensemble surface fields (soil temperature/moisture).
- Assimilate 2m temperature and humidity with 1 hour cycle.
- 12 hour forecast for every 6 hours.
- Precipitation pattern improved.
- 2m temperature and humidity improved up to 3 hours.



New Direction of the EnKF Development

- Put more efforts on improving the global EnKF.
 - Coupled with CaLDAS.
 - Reduce assimilation time window: 6H → 3H → 1H.
 - Apply IAU (Incremental Analysis Update) instead of digital filter.
 - Adaptive localization
- Higher resolution (10km) regional EnKF with reduced domain.
 - Cover 2.5km national domain.
 - Adopt the features of the global EnKF.
 - Assimilate high resolution high frequency data: METAR, Radar, SWOB, etc.
 - Provide ensemble trials for 2.5km EnVar analysis.

Regional 10km Domain over Canada

