Environment and Climate Change Canada | Environnement et Changement climatique Canada

WGNE-36 CENTRE UPDATE

Canadian Meteorological Centre

4 November 2021

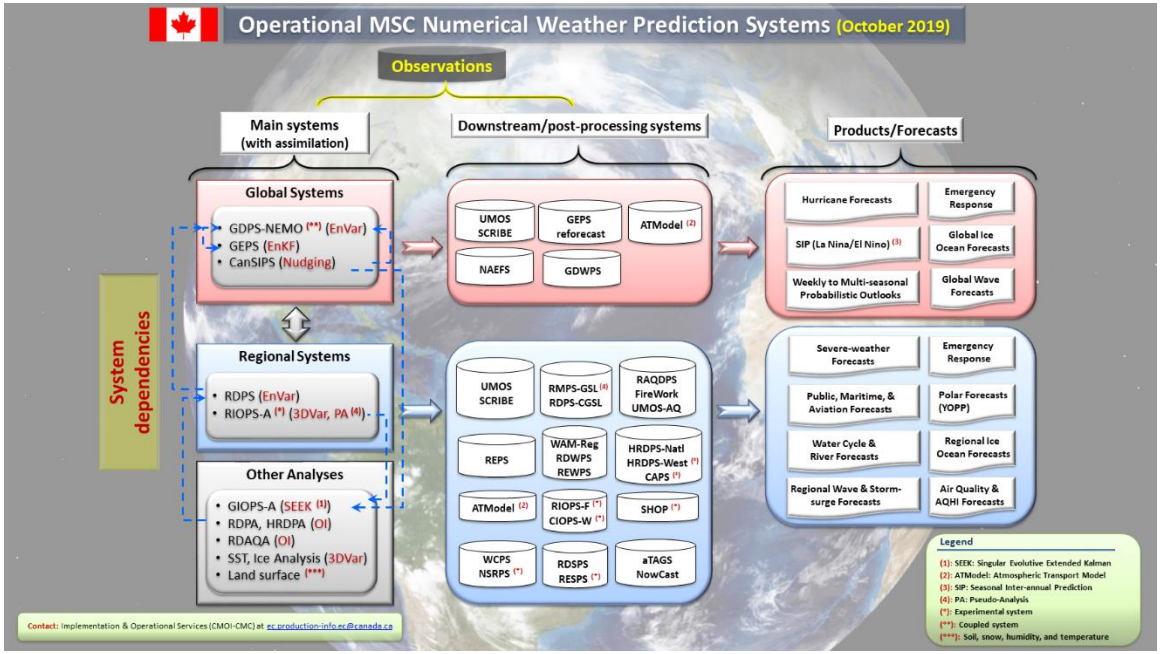
Ron McTaggart-Cowan

Environment and Climate Change Canada's 50th anniversary
50e anniversaire d'Environnement et Changement climatique Canada
Meteorological Service of Canada's 150th anniversary
150e anniversaire du Service météorologique du Canada

Canada

OPERATIONAL CHANGES

- A major development cycle was completed in late 2020, with upgrades planned for all systems
- The Innovation Cycle 3 (IC3) systems have been installed in parallel runs since mid-April 2021
- Planned operationalization date is 30 Nov 2021

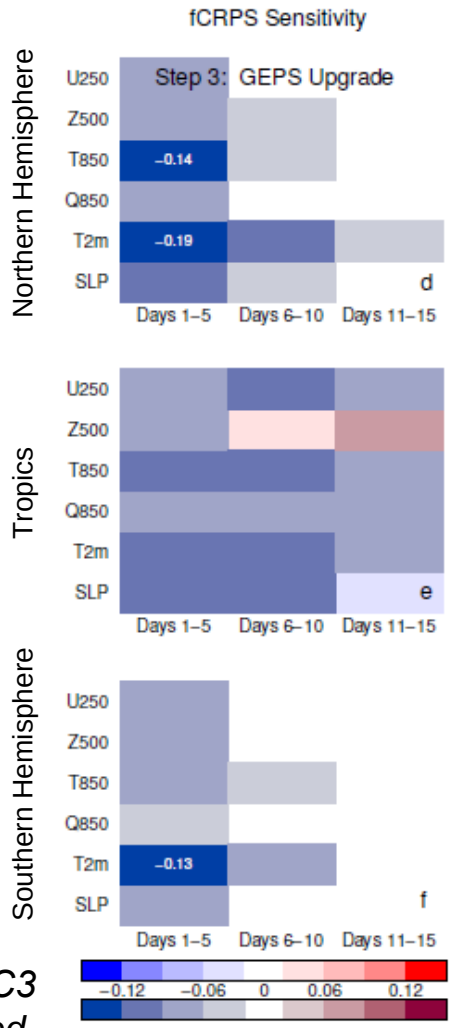


Supporting such a large suite of diverse systems is a risk for current and future development.

Operational systems run at the CMC (>40 total).

ENSEMBLE SYSTEMS

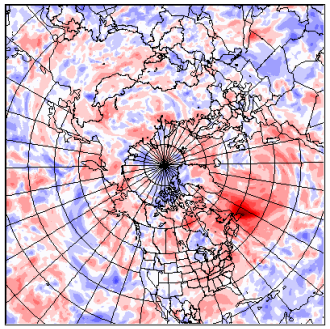
- Model uncertainty representation changed from SPPT+multiphysics to stochastically perturbed parameterizations (SPP)*
- Reduced amplitude of random perturbations because of improved RMSE
- Global system:
  - Major model physics upgrade (McTaggart-Cowan et al. 2019) deprecated multiphysics required SPP transition
  - LETKF replaces EnKF (Buehner 2020)



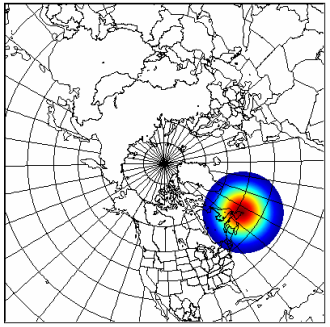
Fractional change in the "fair" CRPS associated with the IC3 upgrade of the global system in regions as indicated.

*SKEB continues to be used, although impact is minimal even with a coefficient increase.

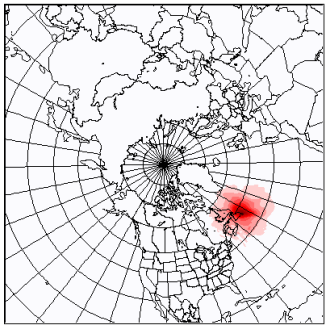
GLOBAL/REGIONAL SYSTEMS



Ensemble Covariance (**B**)



Localization Function (**L**)



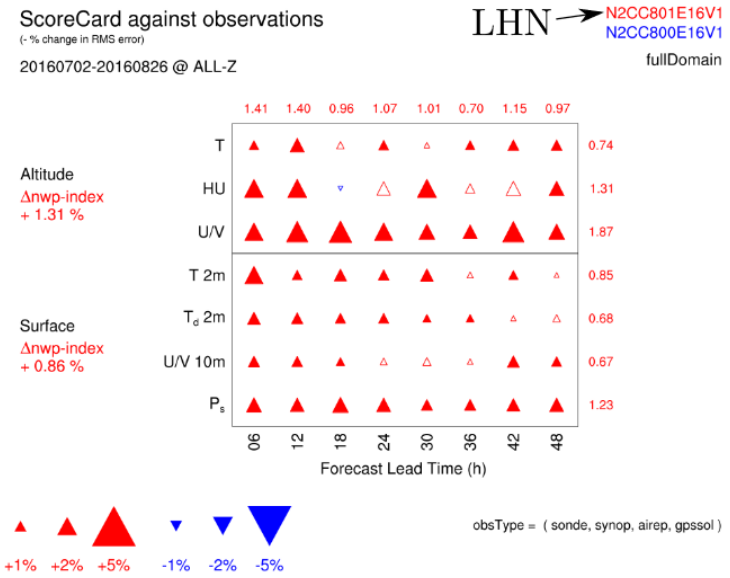
Localized Covariance ($\mathbf{B_L}=\mathbf{B}\circ\mathbf{L}$)

- Major upgrade to global data assimilation:
  - All-sky assimilation for AMSU-A Ch4-5 (Shahabadi et al. 2021)
  - Slant-path radiative transfer calculations for satellite radiance observation operator (Shahabadi et al. 2020) – also to be used in regional system
  - Scale-dependent localization (Caron and Buehner 2018) and increased weight on ensemble covariances in 4DEnVar
- Minor model updates:
  - Increased trigger for low-CAPE convective scheme in the subtropics (McTaggart-Cowan et al. 2020)
  - Minimum Obukhov length used over all surfaces
  - Sea ice roughness increased for consistency with coupled sea ice model
  - Interactive stratospheric ozone

Example of 2D localization using the current 2800 km radius. Three scales are now used: 3300 km (scales > 3000 km), 2400 km and 1000 km (scales < 800 km).

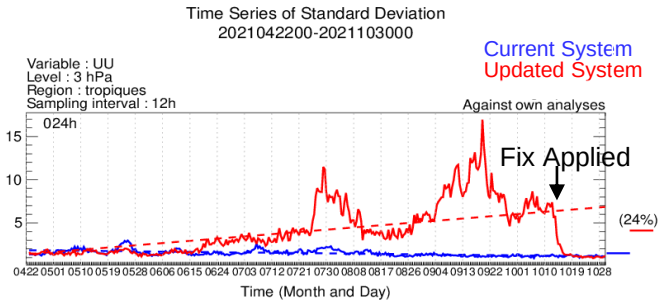
HIGH RESOLUTION SYSTEM

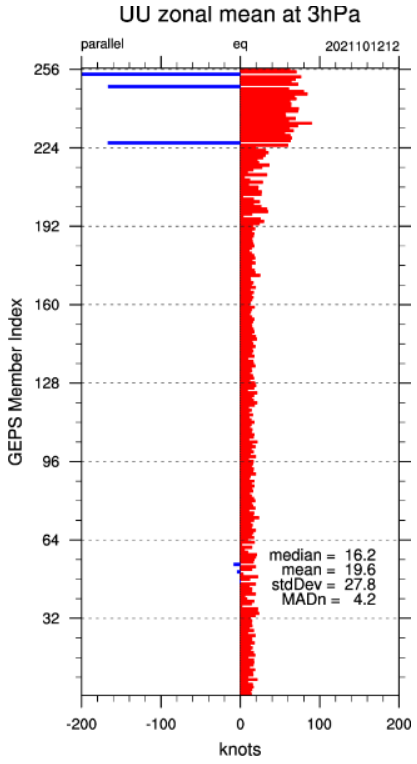
- An analysis cycle is introduced (6h window) based on 4DEnVar using global ensemble covariances (39 km increments)
- Assimilation of North American radar data using latent heat nudging (Jacques et al 2018)
- Transition to updated physics configuration was withdrawn after subjective evaluation showed a possible degradation in precipitation structure



Impact of latent heat nudging on upper-air (top) and near-surface (bottom) forecasts for a summer-2016 test period.

STRATOSPHERIC PROBLEM





- A significant degradation in upper-stratospheric scores (1-5 hPa) noted in the parallel run of the global system
- Source is bad ensemble covariances
- A subset of members diverge, with SAO mode driven by bad analysis increments static cross-validation technique
- Implementation of randomized cross-validation eliminates subensemble divergence and corrects the error

Time series of 3-hPa zonal wind errors in the tropics in the global system (top). Zonal mean zonal wind speed within 10o of the equator in members of the global ensemble (bottom).

REFERENCES

Buehner, M. (2020). Local Ensemble Transform Kalman Filter with Cross Validation, *Monthly Weather Review*, **148**, 2265-2282.

Caron, J., and M. Buehner, 2018: Scale-Dependent Background Error Covariance Localization: Evaluation in a Global Deterministic Weather Forecasting System, *Monthly Weather Review*, **146**, 1367-1381.

Jacques, D., Michelson, D., Caron, J., and Fillion, L., 2018: Latent Heat Nudging in the Canadian Regional Deterministic Prediction System, *Monthly Weather Review*, **146**, 3995-4014.

McTaggart-Cowan, R., and Coauthors, 2019: Modernization of atmospheric physics parameterization in Canadian NWP. *Journal of Advances in Modeling Earth Systems*, **11**, 3593– 3635.

McTaggart-Cowan, R., Vaillancourt, P. A., Separovic, L., Corvec, S., & Zadra, A., 2020: A Convection Parameterization for Low-CAPE Environments, *Monthly Weather Review*, **148**, 4917-4941.

Shahabadi, M. B., and M. Buehner, 2021: Toward All-Sky Assimilation of Microwave Temperature Sounding Channels in Environment Canada's Global Deterministic Weather Prediction System, *Monthly Weather Review*, **149**, 3725-3738.

Shahabadi, M. B., Buehner, M., Aparicio, J., and Garand, L., 2020: Implementation of Slant-Path Radiative Transfer in Environment Canada's Global Deterministic Weather Prediction System, *Monthly Weather Review*, **148**, 4231-4245.