ECCC Model Description

Name: GEM

The S2S database contains real-time forecasts from ECCC from 1st January 2016, and the associated re-forecasts.

1. Ensemble version

Ensemble identifier code: GEPS

Short Description: Global ensemble prediction system with initial conditions generated with the Ensemble Kalman Filter which receives observations that are background-checked and bias-corrected by the ECCC Global Deterministic Prediction System. Different members have different model configuration perturbations (multi-parametrization physics). GEPS, which has 21 members, is extended to day 32 once a week (Thursday at 00Z).

Research or operational: Operational

Data time of first forecast run: 02/07/2015

2. Configuration of the EPS

Is the model coupled to an ocean model? No, persistent SST anomaly

If yes, please describe ocean model briefly including frequency of coupling and any ensemble perturbation applied:

Is the model coupled to a sea Ice model? No, sea-ice adjusted to SST

If yes, please describe sea-ice model briefly including any ensemble perturbation applied:

Is the model coupled to a wave model? No

If yes, please describe wave model briefly including any ensemble perturbation applied:

Ocean model:

Horizontal resolution of the atmospheric model: 0.45ºx0.45º

Number of model levels: 40

Top of model: 2 hPa

Type of model levels: hybrid, log-hydrostatic pressure, Charney-Phillips grid

Forecast length: maximum 32 days (768 hours)

Run Frequency: once a week (Thursday 00Z)

Is there an unperturbed control forecast included?: Yes

Number of perturbed ensemble members: 20

Integration time step: 15 Minutes

3. Initial conditions and perturbations

Data assimilation method for control analysis: mean of ENKF

Resolution of model used to generate Control Analysis: 0.45ºx0.45º L74

Ensemble initial perturbation strategy: Ensemble Kalman Filter (ENKF)

Horizontal and vertical resolution of perturbations: 0.45ºx0.45º L74

Perturbations in +/- pairs: No

Initialization of land surface:

1. What is the land surface model (LSM) and version used in the forecast model, and what are the current/relevant references for the model? The GEM model a mosaic approach with 4 types: land, water, sea ice and glacier is used. For the land part, a version of the ISBA scheme is used (Noilhan and Planton, 1989; Bélair et al. 2003a and 2003b) to simulate soil variables.

Are there any significant changes/deviations in the operational version of the LSM from the documentation of the LSM? No.

2. How is soil moisture initialized in the forecasts? (climatology / realistic / other) 'Realistic' in the sense that a pseudo-analysis is done using a correction of the 1.5m temperature and relative humidity. It is an indirect analysis since a comparison between the trial field (6 hour forecast and observations at the screen level) are used to correct the soil moisture and temperature (for more detail see Bélair et al. 2003a and 2003b).

Is there horizontal and/or vertical interpolation of initialization data onto the forecast model grid? If so, please give original data resolution(s). Yes the fields are generated on the global deterministic prediction system (GDPS) grid (about 25 km) while the global ensemble prediction system (GEPS) is different and coarser (about 50 km). An interpolation is done to the coarser grid after a filter was applied.

Does the LSM differentiate between liquid and ice content of the soil? Yes

If so, how are each initialized? Liquid soil moisture (I1) is initialized as explained above. Solid soil moisture (I2) is taken from trial fields.

If all model soil layers are not initialized in the same way or from the same source, please describe. Same approach is used for all layers only the amplitude of the correction is different.

3. How is snow initialized in the forecasts? (climatology / realistic / other) 'Realistic', the snow depth analyzed following the Brasnett (1999) method.

Is there horizontal and/or vertical interpolation of data onto the forecast model grid? If so, please give original data resolution(s) Yes the fields are generated on the global deterministic prediction system (GDPS) grid (about 25 km) while the global ensemble prediction system (GEPS) is different and coarser (about 50 km). An interpolation is done to the coarser grid after a filter was applied.

Are snow mass, snow depth or both initialized? What about snow age, albedo, or other snow properties? The LSM is given the analysed snow depth and it compute the snow mass (prognostic variable) with that.

4. How is soil temperature initialized in the forecasts? (climatology / realistic / other) Realistic: with the pseudo-analysis method of Bélair et al. 2003 a and b like the soil moisture

Is the soil temperature initialized consistently with soil moisture (frozen soil water where soil temperature 0°C) and snow cover (top layer soil temperature 0°C under snow)? Yes, some coherency checks are done in the LSM.

Is there horizontal and/or vertical interpolation of data onto the forecast model grid? If so, please give original data resolution (s) Yes the fields are generated on the global deterministic prediction system (GDPS) grid (about 25 km) while the global ensemble prediction system (GEPS) is different and coarser (about 50 km). An interpolation is done to the coarser grid after a filter was applied.

If all model soil layers are not initialized in the same way or from the same source, please describe. Not the case.

5. How are time-varying vegetation properties represented in the LSM? Is phenology predicted by the LSM? If so, how is it initialized? From monthly values form a look-up table interpolated daily following the values of Appendix A of Giard and Bazile (2000) paper.

6. What is the source of soil properties (texture, porosity, conductivity, etc.) used by the LSM? Agriculture Canada for the Canadian region, USDA for the USA and FAO for the rest of the world.

7. If the initialization of the LSM for re-forecasts deviates from the procedure for forecasts, please describe the differences. In the reforecast the land surface scheme was run for 30 years forced with ERA-interim re-analysis fields (screen-level temperature and dew-point as well as precipitation amount) at the resolution of the GEPS (50 km). For more details, see Gagnon et al. 2014 and Lin et al. 2016.

4. Model Uncertainties perturbations:

Is model physics perturbed? If yes, briefly describe methods: multi-parameterization, stochastic perturbations, stochastic kinetic energy backscattering scheme

Do all ensemble members use exactly the same model version? Yes

Is model dynamics perturbed? No

Are the above model perturbations applied to the control forecast? No

5. Surface Boundary perturbations:

Perturbations to sea surface temperature? No

Perturbation to soil moisture? No

Perturbation to surface stress or roughness? No

Any other surface perturbation? No

Are the above surface perturbations applied to the Control forecast? NA

Additional comments

6. Other details of the models:

Description of model grid: Arakawa-C grid

What kind of large scale dynamics is used? Implicit semi-Lagrangian

What kind of boundary layer parameterization is used? 1.5 order closure E-L

What kind of convective parameterization is used? Kain-Fritsch + Kuo-type

What kind of large-scale precipitation scheme is used? : Sundqvist et al (1989)

What cloud scheme is used? : Sundqvist + Kain-Fritsch + Kuo-type

What kind of land-surface scheme is used? : ISBA

How is radiation parametrized? : Li and Barker (2005)

Other relevant details? :

7. Re-forecast Configuration

Number of years covered: 20 past years (1995~2014)

Produced on the fly or fix re-forecasts? On the fly

Frequency: Produced on the fly once a week to calibrate the Thursday 00Z real-time forecasts. The re-forecasts consist of a 4-member ensemble starting the same day and month as the Thursday real-time forecasts for the 20 years of 1995-2014.

Ensemble size: 4 members

Initial conditions: ERA interim + Land surface initial condition from an off-line run of the surface prediction system (SPS) cycle driven by near-surface atmospheric ERA-interim reanalysis and its associated precipitation

Is the model physics and resolution the same as for the real-time forecasts: Yes

If not, what are the differences:

Is the ensemble generation the same as for real-time forecasts? No

If not, what are the differences: homogenous and isotropic perturbations using the algorithm from the ENKF

8. References:

Bélair, S., L.-P. Crevier, J. Mailhot, B. Bilodeau, and Y. Delage, 2003a: Operational implementation of the ISBA land surface scheme in the Canadian regional weather forecast model. Part I: Warm season results. J. Hydromet., 4, 352-370.

Bélair, S., R. Brown, J. Mailhot, B. Bilodeau, and L.-P. Crevier, 2003b: Operational implementation of the ISBA land surface scheme in the Canadian regional weather forecast model. Part II: Cold season results. J. Hydromet., 4, 371-386.

Brasnett, B. 1999: A global analysis of Snow Depth for Numerical Weather Prediction. J. Appl. Meteor., 38, 726-740.

Gagnon, N., and Co-authors, 2014: Improvements to the Global Ensemble Prediction System (GEPS) reforecast system from version 3.1.0 to version 4.0.0. Canadian Meteorological Centre Technical Note. [Available on request from Environment Canada, Centre Météorologique Canadien, division du développement, 2121 route Transcanadienne, 4e étage, Dorval, Québec, H9P1J3 or via the following web site: http://collaboration.cmc.ec.gc.ca/cmc/CMOI/product_guide/docs/changes_e.html#20141118_geps_4.0.0

Giard D. and Bazile E. 2000: Implementation of a new assimilation scheme for soil and surface variables in a global NWP model. *Mon. Wea. Rev.* **128,** 997-1015.

Lin H, N. Gagnon, S. Beauregard, R. Muncaster, M. Markovic, B. Denis and M. Charron, 2016: GEPS based Monthly Prediction at the Canadian Meteorological Centre. Mon. Wea. Rev., DOI: http://dx.doi.org/10.1175/MWR-D-16-0138.1

Noilhan, J. and S. Planton, 1989: A simple parameterization of land surface processes for meteorological models. Mon. Wea. Rev., 117, 536-549