

CMA Model Description BCC-CPS-S2Sv2

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1. Ensemble version

Ensemble identifier code: BCC-CPS-S2Sv2

Short Description: Beijing Climate Center (BCC) Climate Prediction System version 2 for S2S is based on lagged average forecasting (LAF) method using a fully-coupled BCC Climate System Model BCC-CSM2-HR. The S2S Forecasts are running on fixed date (3-day interval during 1 Jan to 31 Dec) and end with a 60-day integration. Each forecast consists of 4 LAF ensemble members, which are initialized at 00 UTC of the first forecast day and 18, 12 and 06 UTC of the previous day, respectively.

Research or operational: Operational

Data time of first forecast run: 01/11/2019

2. Configuration of the EPS

Is the model coupled to an ocean model ? Yes from day 0

If yes, please describe ocean model briefly including frequency of coupling and any ensemble perturbation applied: Ocean model is MOM5 with a 1°/4 horizontal resolution, 50 vertical levels, initialized from the BCC coupled assimilation system analysis. Frequency of coupling is hourly.

Is the model coupled to a sea ice model? Yes from day 0.

If yes, please describe sea-ice model briefly including any ensemble perturbation applied: Sea ice model is the GFDL Sea Ice Simulator (SIS) with a same horizontal resolution as the ocean model. Sea ice initial conditions come from the BCC coupled assimilation system analysis.

Is the model coupled to a wave model? No

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

Ocean model: MOM5 with 1°/4 horizontal resolution and 50 vertical levels

Horizontal resolution of the atmospheric model: T266 (about 45 km)

Number of model levels: 56

Top of model: 0.1 hPa

Type of model levels: sigma-pressure hybrid coordinate

Forecast length: 60 days (1440 hours)

Run Frequency: once every 3 days

Is there an unperturbed control forecast included?: Yes

Number of perturbed ensemble members: 3

Integration time step: 2 minutes

3. Initial conditions and perturbations

Data assimilation method for control analysis: The control analysis is produced by a coupled data assimilation system, in which an ensemble optimum interpolation (EnOI) scheme for oceanic analysis, optimum interpolation (OI) scheme for sea ice analysis, and nudging technique for atmospheric analysis are adopted. The coupled assimilation system uses the same model as the prediction system, and it provides a long-term assimilation analysis and thus produces model initial conditions for the S2S forecast.

Resolution of model used to generate Control Analysis: T266L56 resolution for atmospheric model component, and 1°/4 horizontal resolution and 50 vertical levels for oceanic model component

Ensemble initial perturbation strategy: LAF perturbations added to control analysis

Horizontal and vertical resolution of perturbations: same as the control analysis

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? BCC_AVIM2 land surface model was used in the forecast model. It was originated from the Atmosphere and Vegetation Interaction Model version 2 (AVIM2, Ji, 1995; Ji, et al. 2008) and the NCAR Community Land Model version 3.0 (CLM3, Oleson et al., 2004). An overview on the development of this model is given in Li et al. (2019) and Wu et al. (2013, 2014).

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

2. How is soil moisture initialized in the forecasts? (climatology / realistic / other): Soil moisture is not directly initialized using the climatology or realistic analysis in the forecasts. Nevertheless, in the air-sea-land-ice coupled model, the assimilation of ocean, sea ice and atmosphere components can provide an indirect impact on the state of land component.

Is there horizontal and/or vertical interpolation of initialization data onto the forecast model grid? If so, please give original data resolution (s). No initialization data about soil moisture is interpolated onto the model grid.

Does the LSM differentiate between liquid and ice content of the soil? If so, how are each initialized? Yes, liquid and ice content of soil are different in BCC_AVIM model, but they were not initialized in the forecasts.

If all model soil layers are not initialized in the same way or from the same source, please describe. No, all soil layers are treated in same way.

3. How is snow initialized in the forecasts? (climatology / realistic / other) It is similar as the above mentioned for question 2.

Is there horizontal and/or vertical interpolation of data onto the forecast model grid? If so, please give original data resolution(s) No initialization data about snow is interpolated onto the model grid.

Are snow mass, snow depth or both initialized? What about snow age, albedo, or other snow properties? They were not directly initialized in the forecasts. The initial conditions are produced by a long-term coupled assimilation. The method is similar as the above mentioned for question 2.

4. How is soil temperature initialized in the forecasts? (climatology / realistic / other) It is similar as the above mentioned for question 2.

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)? These variables are not initialized directly and they are connected with each other by model physics.

Is there horizontal and/or vertical interpolation of data onto the forecast model grid? If so, please give original data resolution(s) No initialization data about soil temperature is interpolated onto the model grid.

If all model soil layers are not initialized in the same way or from the same source, please describe. No, all soil layers are treated in same way.

5. How are time-varying vegetation properties represented in the LSM? Is phenology predicted by the LSM? If so, how is it initialized? If not, what is the source of vegetation parameters used by the LSM? Which time-varying vegetation parameters are specified (e.g., LAI, greenness, vegetation cover fraction) and how (e.g., near-real-time satellite observations? Mean annual cycle climatology? Monthly, weekly or other interval?) The phenology (LAI) was predicted by the LSM. It is also not directly initialized in forecasts. The initial value is given by a long-term coupled assimilation. The vegetation parameters such as vegetation type, vegetation cover fraction and vegetation height are used by the LSM. They are all monthly climatology values.

6. What is the source of soil properties (texture, porosity, conductivity, etc.) used by the LSM? The soil properties in BCC_AVIM are same as those in NCAR CLM3.0 model (Bonan, 2002). The soil texture (percent sand and clay) varies with depth according to the IGBP soil dataset (Global Soil Data Task 2000).

7. If the initialization of the LSM for re-forecasts deviates from the procedure for forecasts, please describe the differences. The initialization of the LSM in reforecasts is similar as that in forecasts.

4. Model Uncertainties perturbations

Is model physics perturbed? No.

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

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: T266 global Gaussian grid

List of model levels in appropriate coordinates: 56 vertical layers at 0.156, 0.35, 0.72, 1.35, 2.22, 3.27, 4.42, 5.50, 6.42, 7.27, 8.17, 9.16, 10.27, 11.52, 12.91, 14.47, 16.22, 18.19, 20.39, 22.86, 25.63, 28.73, 32.21, 36.11, 40.48, 45.38, 50.88, 57.04, 63.94, 71.68, 80.36, 90.09, 101.0, 113.23, 126.93, 142.30, 159.53, 178.85, 200.5, 224.78, 251.99, 282.5, 316.7, 354.78, 396.86, 443.31, 494.49, 550.37, 610.82, 674.46, 739.43, 803.72, 868.51, 932.57, 976.34, 994.64 mbar

What kind of large scale dynamics is used? Spectral Eulerian dynamics core for vorticity, diversity, temperature, and surface pressure; semi-lagrangian dynamics core for specific humidity and cloud waters other tracers [Wu et al., 2008]

What kind of boundary layer parameterization is used? University of Washington Moist Turbulence parameterization scheme [Bretherton and Park, 2009]

What kind of convective parameterization is used? a mass-flux cumulus parameterization scheme [Wu, 2012; Wu et al. 2019]

What kind of large-scale precipitation scheme is used? The scheme used in NCAR Community Atmosphere Model (CAM3, Collins et al., 2004).

What cloud scheme is used? Diagnostic cloud fraction depending on relative humidity, and convective mass fluxes.

What kind of land-surface scheme is used? Beijing Climate Center Atmospheric Vegetation Interactive Model version 2 (BCC-AVIM2). [Li et al., 2019]

How is radiation parameterized? The radiation code originates from the CAM3 (Collins et al., 2004)

Other relevant details? The version 2 of the High-Resolution Beijing Climate Center Climate System Model (BCC-CSM2-HR) is developed at the Beijing Climate Center (BCC), China Meteorological Administration (CMA). It is a fully coupled global climate-carbon model including interactive vegetation and global carbon cycle, in which the atmospheric component BCC Atmospheric General Model version 3 (BCC-AGCM3-HR), ocean component Modular Ocean Model version 5 (MOM5)-L50, land component BCC Atmosphere and Vegetation Interaction Model version 2 (BCC_AVIM2), and sea ice component [sea ice simulator (SIS)] are fully coupled and interact with each other through fluxes of momentum, energy, water, and carbon at their interfaces. Information between the atmosphere and the ocean is exchanged hourly. The exchange of atmospheric carbon with the land biosphere is calculated at each model time step (2 min).

7. Re-forecast Configuration

Number of years covered: 15 past years (from 1 Jan 2004 to 31 Dec 2018)

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

Frequency: Once every three days.

Ensemble size: 4 members

Initial conditions: atmospheric initial conditions from ECMWF analysis, and ocean, sea ice, and land initial conditions from the BCC coupled data assimilation system.

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

If not, what are the differences: NA

Is the ensemble generation the same as for real-time forecasts? Yes

If not, what are the differences: NA

8. References

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