CMA Model Description BCC-CPS-S2Sv1

1. Ensemble version

Ensemble identifier code: BCC-CPS-S2Sv1

Short Description: Beijing Climate Center (BCC) Climate Prediction System version 1 for S2S is based on lagged average forecasting (LAF) method using a fully-coupled BCC Climate System Model BCC-CSM1.2. The S2S Forecasts are running on every day since 1 Jan 1994 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: 01/01/2015*

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 MOM4 with a 1°/3-1° horizontal resolution, 40 vertical levels, initialized from BCC Global Ocean Data **Assimilation System analysis.** Frequency of coupling is 2-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 a Coordinated Initialization System (CIS) that is to use BCC-CSM1.2 integrating one month before forecast time to create a coordinated initial state in each component of BCC-CSM1.2 using nudging technique for atmospheric analyses.
Is the model coupled to a wave model? No
If yes, please describe wave model briefly including any ensemble perturbation applied: -
Ocean model: MOM4 with 1°/3-1° horizontal resolution and 40 vertical levels
Horizontal resolution of the atmospheric model: T106 (about 110 km)
Number of model levels: 40
Top of model: 0.5 hPa
Type of model levels: sigma-pressure hybrid coordinate
Forecast length: 60 days (1440 hours)
Run Frequency: once daily
Is there an unperturbed control forecast included?: Yes
Number of perturbed ensemble members: 3
Integration time step: 7.5 minutes

3. Initial conditions and perturbations

Data assimilation method for control analysis: 3D Var method for oceanic analysis and nudging technique for atmospheric analysis used in BCC Coordinated Initialization System (CIS). The CIS is to use BCC-CSM1.2 integrating a period time before forecast time to create a coordinated initial state in each component of BCC-CSM1.2 under the forcing of the NCEP air temperature and U- and V-velocity reanalyses, BCC merged precipitation observations, and BCC Global Ocean Data Assimilation System analyses.

Resolution of model used to generate Control Analysis: T106L40 resolution for atmospheric model component, and 1°/3-1° horizontal resolution and 40 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 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, we have utilized high-level and near-surface atmospheric analysis and ocean analysis to force the air-sea-land-ice coupled model in a long-term integration, and the land initial conditions are produced during this process.

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 from a balance state produced by a long-term air-sea initialization integration. 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? I**f 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 air-sea initialization integration.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: T106 global Gaussian grid
List of model levels in appropriate coordinates: 40 vertical layers at 0.49, 1.05, 2.26, 4.71, 8.97, 15.11, 22.51, 30.20, 37.55, 43.86, 49.77, 56.47, 64.07, 72.69, 82.46, 93.53, 106.07, 120.26, 136.35, 154.60, 175.32, 198.84, 225.43, 255.11, 287.90, 324.04, 363.80, 407.43, 455.24, 507.51, 564.57, 626.73, 694.35, 767.78, 836.82, 889.28, 927.74, 956.07, 976.35, 992.56 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? non-local Atmospheric Boundary Layer (ABL) parameterization [Holtslag and Boville, 1993]
What kind of convective parameterization is used? Wu 2012 (Climate Dynamics)
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, atmospheric stability and convective mass fluxes.
What kind of land-surface scheme is used? Beijing Climate Center Atmospheric Vegetation Interactive Model version 1 (BCC-AVIM1), Wu et al., 2013 (J.G.R).
How is radiation parameterized? The radiation code originates from the CAM3 (Collins et al., 2004)
Other relevant details? The version 1.2 of the Beijing Climate Center Climate System Model (BCC_CSM1.2) is developed at the Beijing Climate Center (BCC), China Meteorological Administration (CMA). It is an updated version of BCC_CSM1.1 (Wu et al., 2013; 2014) and 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 2.1 (BCC_AGCM2.3), ocean component Modular Ocean Model version 4 (MOM4)-L40, land component BCC Atmosphere and Vegetation Interaction Model version 1.0 (BCC_AVIM1.0), 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 once per 2 hours. The exchange of atmospheric carbon with the land biosphere is calculated at each model time step (7.5 min).

7. Re-forecast Configuration

Number of years covered: 21 past years (from 1 Jan 1994 to 31 Dec 2014*)
Produced on the fly or fix re-forecasts? fix re-forecasts
Frequency: Once a day.
Ensemble size: 4 members
Initial conditions: NCEP R1 atmospheric initial conditions (2.5°×2.5° resolution) + BCC GODAS ocean initial conditions (1°/3-1° resolution)
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

- Originally the CMA re-forecast dataset covered the period 1st Jan 1994 to 30 April 2014. The date of the first real-timeforecast was 1st May 2014. However, in the S2S database, the real-time forecasts from 30 April to 31 December 2014 have been archived as re-forecasts (real-time forecasts and re-forecasts have the same ensemble size and configuration) so that the full year 2014 is now included in the re-forecast database to make calibration easier, and the real-time forecasts start on 1st January 2015.

8. References

- Liu X., Wu T., Yang S., et al., 2016: MJO prediction using the sub-seasonal to seasonal forecast model of Beijing Climate Center. Climate Dynamics, DOI: 10.1007/s00382-016-3264-7
- Wu T. et al., 2014: An overview of BCC climate system model development and application for climate change studies. J. Meteor. Res., 28(1), 34-56;
- Wu T. et al., 2013: Global carbon budgets simulated by the Beijing climate center climate system model for the last century. J Geophys Res Atmos, 118, 4326-4347
- Wu T., R. Yu, F. Zhang, Z. Wang, M. Dong, L. Wang, X.Jin, D. Chen, L. Li, 2010The Beijing Climate Center atmospheric general circulation model: description and its performance for the present-day climate, Climate Dynamics, 34, 123-147, DOI 10.1007/s00382-008-0487-2.
- Wu T., R. Yu, F. Zhang, 2008: A modified dynamic framework for atmospheric spectral model and its application, J. Atmos.Sci., 65, 2235-2253
- Wu T., 2012: A Mass-Flux Cumulus Parameterization Scheme for Large-scale Models: Description and Test with Observations, Clim. Dyn., 38: 725–744, DOI: 10.1007/ s00382-011-0995-3.
- Jie W., T. Wu, J. Wang, W. Li, T. Polivka, 2015: Using a Deterministic Time-Lagged Ensemble Forecast with a Probabilistic Threshold for Improving 6-15 Day Summer Precipitation Prediction in China, Atmospheric Research, 156: 142–159
- Liu X., T. Wu, S. Yang, W. Jie, S. Nie, Q. Li, Y. Cheng, X. Liang, 2015: Performance of the Seasonal Forecasting of the Asian Summer Monsoon by BCC_CSM1.1(m). Adv. Atmos. Sci.,doi: 10.1007/s00376-015-4194-8,in press.
- Liu X., T. Wu, S. Yang, Q. Li, Y. Cheng, X. Liang, Y. Fang, W. Jie, S. Nie. 2014. Relationships between interannual and intraseasonal variations of the Asian - western Pacific summer monsoon hindcasted by the BCC_CSM1.1(m). Adv. Atmos. Sci., 31, 1051–1064.
- Jie W., T. Wu, J. Wang, W. Li, X. Liu, 2014: Improvement of 6–15 day precipitation forecasts using a time-lagged ensemble method. Adv. Atmos. Sci., 31(2), 293–304, doi: 10.1007/s00376-013-3037-8.
- Huang A., Y. Zhang, Z. Wang, T. Wu, D. Huang, Y. Zhou, Y. Zhao, Y. Huang, X. Kuang, L. Zhang, Y. Fang, Y. Guo, 2013: Extended range simulations of the extreme snow storms over southern China in early 2008 with the BCC_AGCM2.1 model,J. Geophys. Res. Atmos., 118, 8253–8273, doi:10.1002/jgrd.50638.
  - Bonan G B, 2002: The Land Surface Climatology of the NCAR Land Surface Model Coupled to the NCAR Community Climate Model*[J]. Journal of Climate, 15(22):3123–3149.
  - Ji, J., 1995: A climate-vegetation interaction model: Simulating physical and biological processes at the surface. J Biogeogr, 22: 2063–2069
  - Ji, J., 1995: A climate-vegetation interaction model: Simulating physical and biological processes at the surface. J Biogeogr, 22: 2063–2069
  - Oleson, K.W., Y. Dai, and Coauthors, 2004: Technical description of the Community Land Model (CLM). NCAR Tech. Note TN-461+STR, 174 pp.
  - Wu, T., W. Li, J. Ji et al, 2013: Global carbon budgets simulated by the Beijing Climate Center climate system model for the last century. J Geophys Res Atmos 118:1–22

- Wu, T., L. Song, W. Li et al, 2014: An overview of BCC climate system model development and application for climate change studies. J Meteor Res 28:34–56