Response to Review of "Description and basic evaluation of BNU-ESM version 1" ***by*** **D. Ji et al.**

We first thank the reviewer for his/her insightful comments, which helped us clarify and greatly improve the paper. Comments from the reviewer are in black, and our responses are in blue.

General comments:

This paper describes the configuration of Beijing Normal University Earth System Model. Authors also evaluate the performance to simulate the mean climate and climate variability using CMIP5 simulations of BNU-ESM. I think that the description and results from new earth system model are sufficiently interesting to merit publication. However, there are a number of issues that require attention as described below. Addressing these issues could make the paper more publishable. So I have recommended that this manuscript could be accepted after minor revision.

Minor comments:

(1) Although there is a model description, some explanation to enlighten about the basic philosophy and logic to choose components of BNU-ESM will be helpful to understand the goal of development of BNU-ESM (or main goal of this new development). I wonder why only some components are chosen differently from CCSM4.0 (or CESM). Please remark how to keep up this model under circumstances of constant upgrades of original modules (e.g. CAM, MOM, CICE).

The development of BNU-ESM was prompted by foundation of a new multidisciplinary research center committed to study global change and earth system science in Beijing Normal University. The components of BNU-ESM were chosen based on the specific expertise and experience available to the research center, and furthermore with an eye to how the research strengths of the center can improve and develop it. We discuss these future developments in response to referee 2 major comment, which were:

Future model development plan

Currently BNU-ESM is evolving in many respects. As global biogeochemical cycles are recognized as being evermore significant in mediating global climate change, improvements of BNU-ESM are underway in the terrestrial and marine biogeochemistry schemes. On terrestrial biogeochemistry, the LPJ-DyN based carbon-nitrogen interaction scheme (Xu and Prentice, 2008) will be evaluated and activated in future. A dynamic marine ecosystem scheme will replace the current iBGC module, the new marine ecosystem scheme has improved parameterizations of dissolved organic materials and detritus (Wang et al., 2008), a phytoplankton dynamic module that produces a variable of carbon to chlorophyll ratio (Wang et al., 2009a), and refined nitrogen regeneration pathways (Wang et al., 2009b). Additionally, a three-dimensional canopy radiative transfer model (Yuan et al., 2014) will replace the traditional one-dimensional two-stream approximation scheme in the land component to calculate more realistic terrestrial canopy radiation. The spatial resolution of the BNU-ESM will be increased to better simulate more realistic surface physical climate, especially for the atmospheric and land components. Currently a $0.9^{o}\times1.25^{o}$ resolution land and atmosphere components adapted from the finite-volume dynamic core in CAM is being tested. We also note that CAM5 has made significant progress, such as correcting well know cloud biases from CAM3.5 (Kay et al., 2012). Discussion of how to incorporate these developments from CAM5 into BNU-ESM is underway.

(2) To add a plot showing zonal mean OLR at TOA is recommended to show the global net energy balance. To add basic fields including vertical structure of zonal mean temperature, zonal wind, and specific humidity, cloud water/ice content is recommended.

Agree and thanks for this suggestion.

a) The global net energy balance was shown with TOA net radiation (see Figure R1 below) in our response to referee#1 specific comment 1. Global mean TOA net radiation flux over *piControl* period is 0.88 W/m^2, while global mean surface net radiation flux is 0.86 W/m^2. The global mean sea surface temperature over *piControl* period is 17.69 ^{o}C, and has a warming drift of 0.02 ^{o}C per century.

b) Evaluation on basic fields including vertical structure of zonal mean temperature, zonal wind, and specific humidity, cloud water/ice content was added in response to referee#1 minor comment 3 (see Figure R2 and R3 below).

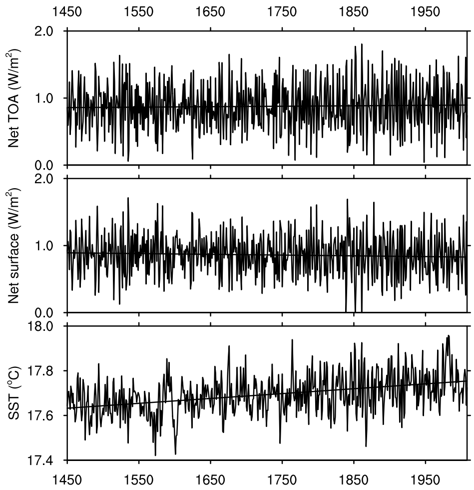

Figure R1. The global mean TOA and surface net radiation flux, global mean SST over the *piControl* simulation period. The black lines are linear regressions.

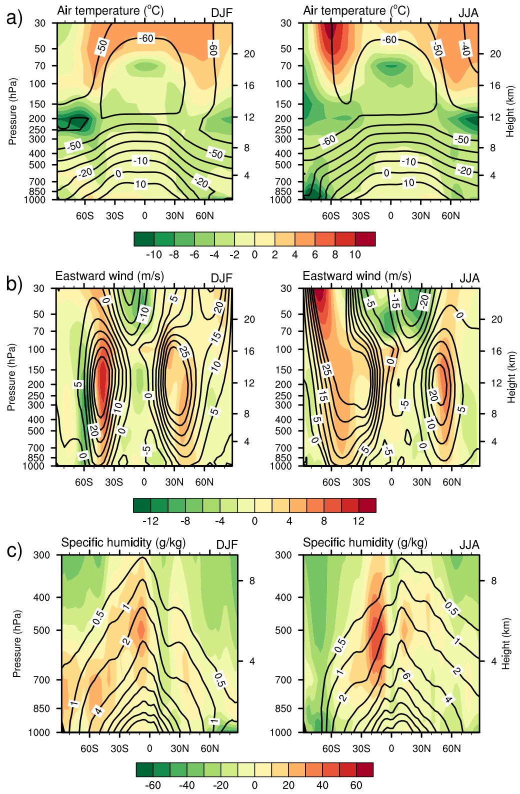

Figure R2. Zonally averaged air temperature (a), zonal wind (b) and specific humidity (c) climatology from BNU-ESM (black contours) and bias relative to the ERA-Interim climatology (color) for 1989-2005.

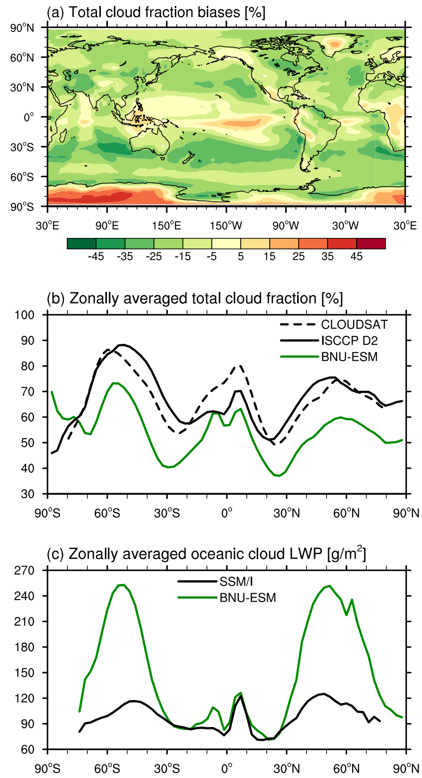

Figure R3. (a) Total cloud fraction bias relative to ISCCP D2 retrievals (Rossow and Schiffer, 1999; Rossow and Dueñas, 2004). (b) Zonally averaged total cloud fraction compared to ISCCP D2 retrievals and CLOUDSAT retrievals (L'Ecuyer et al., 2008.) (c) Zonally averaged total liquid water path (LWP) compared to SSM/I retrievals (Wentz, 2000, 2013) over oceans.

(3) Since this model simulate stronger interannual variability to the observed, to add a plot to show the amplitude of response of circulation fields to the interannual variability of SST anomalies is recommended. (e.g time series of SOI, regressed field of circulations by NINO3.4 or time series of leading EOF mode of SST).

Agree and done. We added time series of SOI to show the amplitude of response of circulation fields to the interannual variability of SST anomalies. And we will add following paragraph to ENSO section in the final revised paper:

The Southern Oscillation is the atmospheric component of El Niño. Figure R4 shows the Southern Oscillation Index (SOI) from BNU-ESM compared to observation. The observed SOI is calculated using station data from Darwin and Tahiti. For the model, areal averages of mean sea-level pressure over 125°E-135°E, 17°S-7°S and 155°W-145°W, 22°S-12°S (10°×10° areas centered close to the Darwin and Tahiti stations) are used. The interannual variability in the modeled SOI due to ENSO events is well reproduced and shows the expected negative correlation with Niño-3.4 SST anomalies (Fig. 10). The modeled regression coefficient between monthly deseasonalised SOI and Niño3.4 SST anomalies is -0.52 hPa/K while the observed is -1.52 hPa/K. Hence, the model underestimates the strength of the atmospheric response to ENSO.

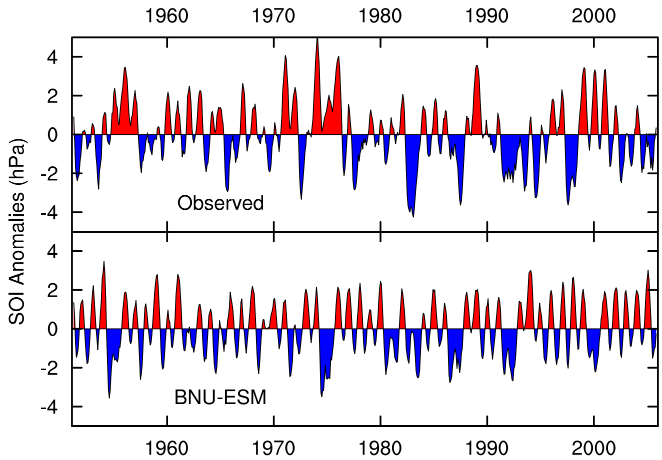

Figure R4. Time series of Southern Oscillation index (5 month running mean) from 1951 to 2005. The observed SOI is calculated using station data from Darwin and Tahiti. Absolute rather than normalized time series are used here.