

This study contributes to the development of a new hydrological cycle model that is found able to improve precipitation, evaporation, and water vapor transport in idealized simulations. The development framework is reasonable as it incorporates additional parameters with physical mechanisms explained. A series of analyses are performed to illustrate the improvements, and model verifications shed lights on further applications. Therefore, I support to publish this work on *Geoscientific Model Development*. Comments and suggestions are summarized below to potentially improve the manuscript.

General Comments

Can the authors elaborate the difference between the GREB model and CMIP5 CGCMs? As atmospheric and oceanic circulations are not simulated in the GREB model, it is probable that the GREB simulations give rise to results lacking of dynamical contribution. Does this lacking component play some roles in affecting the performance in the new model?

Due to the fact that CMIP5 CGCMs have biases in simulating circulations (e.g., Yang et al., 2018, *Journal of Climate*), the differences, at least for circulations, between the GREB model and CMIP5 models could be traced to the differences between prescribed wind fields in ERA-Interim reanalysis product and simulated wind fields. In other words, different background wind states may be part of the reason generating the discrepancy. What if comparing results using the CMIP5 simulated mean fields to force the old/new GREB model? Do authors have insights toward this point?

If no daily weather systems are simulated, does that mean the temporal integration is performed in the time step of one month or more in the GREB model? I am confused because the model time step is 12hrs as mentioned in Page 3 Line 14. In addition, having no weather system simulated does not mean no internal variability generated in the model. I suggest authors rephrasing this paragraph or providing further explanation.

Specific Comments

Page 1 Line 8: Does “the hydrological cycle” refer to the hydrological model? Similar mixture appears throughout the abstract.

Page 1 Line 9: The authors should clarify the meaning of “zero order”. Does the “order” means numerical convergence rate in time or space?

Page 2 Line 6: Authors may consider mentioning the computational efficiency of idealized model here.

Page 2 Line 23: I suggest re-organizing the paragraphs that describe the GREB model. For example, the model layer configuration and resolution in Page 3 Line 10 can be introduced before the description of the NCEP climatological fields used in the original GREB model. This may make introduction of the GREB model framework smoother.

Page 2 Lines 25-26: Any specific reason generating topography from an atmospheric model? Why not using ETOPO dataset?

Page 2 Line 29: I suggest providing brief explanation for the reason of changing dataset here and directing further details to section 3.4. Also, the NCEP reanalysis datasets are used during 1950-2008, whereas the ERA-Interim reanalysis data during 1979-2015. Therefore, long-term mean climatology values may be different. What is the results using the NCEP data during 1979-2015?

Page 4 Line 3: How important is the diffusion term compared to advection? Could we ignore diffusion effect in large-scale circulation dynamics and/or thermodynamics?

Page 10 Line 6: ENSO events include both El Niño and La Niña. Is the analysis for La Niña shown in the manuscript? Figure 10 only shows analysis for El Niño composite, but not La Niña. How does response to La Niña look like?

Page 10 Line 9: Figure 10g shows the improvement in precipitation anomalies. It

could be informative also discussing extratropical precipitation response because ENSO-mid-latitude linkages were also well documented. In Figure 10g, no precipitation increases in the Southern U.S. region. Does that indicate ENSO teleconnection is still not resolved well in the new model?

Technical Corrections

Page 1 Line 15: It is better to mention the full name of “CMIP” in the abstract.

Page 1 Line 16: El Nino → El Niño (and through the manuscript)

Page 1 Line 17: Add the full name of “CGCM”.

Page 1 Line 25: What is “CGCMs” stands for? If it refers to “General Circulation Models” at the end of Line 24, it should be abbreviated as GCMs.

Page 1 Line 26: “(AR4)” only appears once here, there’s no need to provide abbreviation.

Page 3 Line 5: Figure 2c and 3c → Figures 2c and 3c. I found this kind of error appears through the manuscript (e.g., Page 4 Line 4 and Page 5 Line 23). Please check carefully and revise them consistently.

Page 3 Line 7: rcp85 → RCP8.5 (to be consistent to that in the caption of Figure 11, Page 27).

Page 4 Line 10: RHS: $(dq_{air}/dt)_{obs}$ minus simulated terms?

Page 7 Line 7: remove the parenthesis.

Page 9 Line 7: remove the parenthesis.

Page 17: what are the color shadings and streamlines in Figure 1d?