Reviewer 2

In this study, the authors try to use the Bayes network method to construct a graph model, which is inspired from the structural relationship of a dynamic model named GREB. They find the graph model outperforms the GREB model. The methodology is sound and the results are interesting. However, this manuscript is not clear enough in terms of methods and results. Thus substantial revision is needed.

(1) The sensible heat expression (Qsense) in lines 65/72 and Equation (1 and 2) is inconsistent.

Response 1

We unified the representation of *Qsense* as F_{sense} in the revised version of the article.

(2) Why the equations 3 and 4 can be derived from equations 1 and 2 need more explanations. What is the kinetic and thermodynamic basis for equations 1 and 2 that can be expressed using five variables (C, W, S, V, O)? For example, ocean temperature (O) is only controlled by radiation (S), and is independent of V. This may facilitate the construction of a graph network, but it is physically unreasonable. Please provide the physical basis for constructing the relationship (the directed edges).

Response 2

We have added further derivation details in the paper and modified the abbreviations of the variables from C, W, S, V, O to CLD, q_{air}, F_{solar}, $\vec{u}$, T_{ocean} in the tendency equation, which makes the abstraction process more intuitive.

The nodes are selected considering not only the tendency equation but also the efficiency of the calculation, so the unselected nodes do not mean that they are unimportant in the physical, but the positive objects are discarded in the case of little impact on the accuracy of the results in order to improve the efficiency of the calculation and make it reach the starting point of GREB " a fast tool for the conceptual understanding and development of hypotheses for climate change studies"

(3) Line 151. What are the standards for data selection?

Response 3

We chose these data because they are needed in the simulations of the two cases chosen.

(4) The descriptions in Figures 2 and 3 are too sketchy. What are the units of the colors? What is the label of z-axis?

Response 4

Fig.2,3 shows the climate state of the quarterly average of surface temperature and temperature of

the atmosphere from 1995-2014, which is simulated by bayes network. z-axis labeled has been revised to “years” 1995 to 2014. This figure represent the climate state in which they are located. In the case of surface temperature, for example, in the case of 5 state classification, the figure 1 represents a temperature less than 242.73 K, the figure 2 represents a temperature between 242.73 K and 264.91 K; and in the case of 7 state classification, the figure 1 represents a temperature less than 236.92 K in the case of category 7, the figure 2 represents a temperature between 236.92 K and 252.70 K. All classification intervals can be seen in Appendix B.
We chose states rather than specific values to represent these climate variables, the main starting point being to improve the speed of the calculations so that they meet the original intention of the GREB model to be " a fast tool for the conceptual understanding and development of hypotheses for climate change studies"

(5) Please give more details about the natural break method.

Response 5

We have added a section in the methods section to give more details about the natural break method and why choose state as evaluation objects.

(6) Captions about the figures 5 and 6 maybe wrong. I guess the subplots (e) and (f) are related to the GREB results rather than IMPM.

Response 6

We have corrected the notes on Figures 5 and 6.

(7) The title is somewhat misleading. In fact, the authors refer to GREB equations to guide the construction of a graph model. After that, a completely new statistical model was evaluated using NCEP data. However, this statistical model is not used to optimize the GREB model in turn. In general, improving physical models using statistical models is achieved by optimizing uncertain empirical parameters. Therefore, it seems that the IMPM has nothing to do with the GREB improvement. The authors should reconsider whether the current title is accurate.

Response7

In response to this comment, we have added experiments to the paper. we introduced a coarse-fine structure to improve the GREB model based on Bayes network. The improved model uses the GREB model as the basis of the global simulation framework and uses the Bayes network (improved model in the original manuscript) to do local optimization. The concept of coarse-fine model provides a joint modeling approach of dynamical-statistical hybrid model that is different from the traditional use of statistical model to optimize the empirical parameters of the dynamical model.

Response 8

In addition to the above targeted revisions, we added experiments to further reflect the improvement of the method on the GREB model (a coarse- fine structure improved model with the GREB model as the global framework and Bayes networks as the local optimization was constructed, the main framework is shown below), and the language of the article was also embellished to make it more consistent with the expression of the climate field and to enrich the details in the paper.

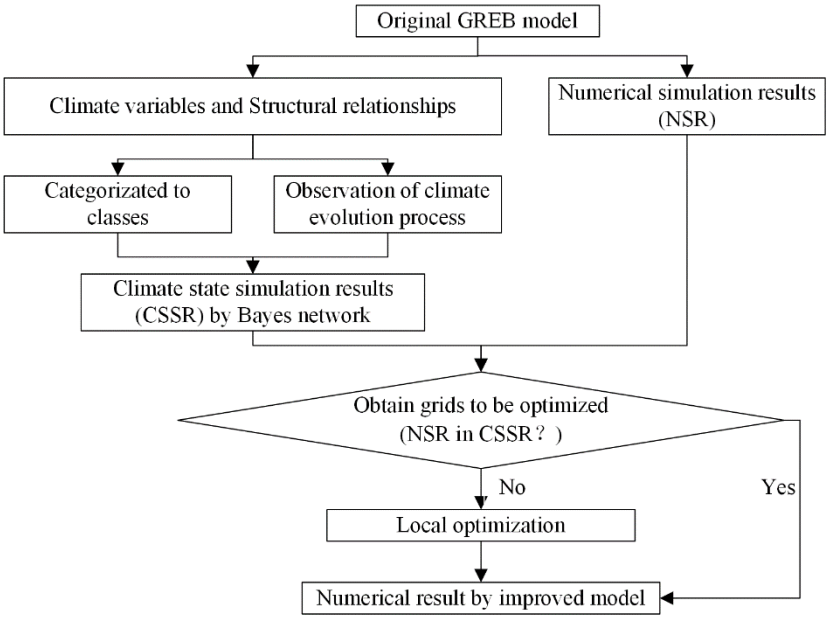

Fig. 1 Overall framework of the improved method