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Interactive comment on "An automatic and effective parameter optimization method for model tuning" *by* T. Zhang et al.

Anonymous Referee #2

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Review comments of the manuscript entitled "An automatic and effective parameter optimization method for model tuning" by T. Zhang, L. Li, Y. Lin, W. Xue, F. Xie, H. Xu, and X. Huang

Recommendation: Rejection

General comments This study proposed a "three-step" parameter optimization procedure which can help tuning important parameters in general climate models with reduced computation load. This "three-step" procedure is an extension of downhill simplex method with a parameter sensitivity process to eliminate insensitive parameters and an initial value selection process to help improving optimization converging quality. Results show that by finding an optimal set of parameter values, the method is able to improve the climate simulation compared with default parameter values. At

the same time, the computation time required is reduced compared with traditional methods. However, there are great deficiencies in illustrating the methodology. Both the core procedure downhill simplex method and the extended parameter sensitivity process and initial value process are not clearly presented, making it very difficult for readers to follow and learn. Also, there is not enough meaningful comparisons between the results of new method and those of traditional methods for readers to judge whether it is a progressive method. A future version of this manuscript may potentially be acceptable. But that apparently requires a lot more work.

Specific comments 1. Page 3792, Line 9: "parameter sensitivity" should be more specified, such as the model's sensitivity to the parameters. "optimum initial value" should be specified for the parameter estimation process. 2. Page 3792, Line 10: What does the "step" refer to? Parameter optimization cycles? Model integration steps? Or method cycles? 3. Page 3794, Line 3: "high" should be "high-dimensional". 4. Page 3794, Line 19-20: ENKF and PF have the difficulty in looking for the representative samples: This problem needs to be explained more clearly and needs to be extended a little, and references should be introduced. 5. Page 3794, Line 25-26: "The above mentioned methods generally require long iterations for convergence." This is not necessary. It also depends on observation amounts and estimation frequencies. 6. Page 3795, Line 8-10: "Finally, the downhill simplex algorithm is used to solve the optimization problem because of its low computational cost and fast convergence for low dimension space." This dimension space corresponds to parameter space? Also, you have said that the parameter space in climate models are usually high-dimensional. Does it mean that this method is not suitable for climate model tunning? 7. Page 3795, Line 12. "This is result already." What does it mean here? 8. Page 3797, Line 13-14: "Previous studies have shown 5 years of this type of simulation is enough to capture some basic model characteristics." What are these basic model characteristics? Should be extended and necessary references should be included. 9. Page 3797, Line 17: "reference metrics". what is this metric like? It is a metric containing those climate variables? How is it formed? 10. Page 3797, Line 24: "evaluation metrics".

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What is the difference between the reference metric and evaluation metric? What is this evaluation metric like again? 11. Page 3797, Line 26: “metrics”. So this metric is the evaluation metric? 12. Page 3998, Line 2: “control simulation”. What is this control simulation here? With default parameter values? Please specify. 13. Page 3998, Line 10: “w is the weight due to the different grid area”. What is w like? Is it the same weight? 14. Page 3998, Line 13: “Global and local optimization method.” This section is supposed to tell the methodology of global and local optimization method. But the authors only listed typical examples and names of each kind without explaining the methodology. The whole section is rather too simplified that it is difficult to understand. 15. Page 3799, Line 14: “local downhill simplex method”. So the local downhill simplex method gives a optimal parameter value sets locally? Say, each region has an optimal set? And these parameter sets are assigned into next model integration cycle locally? Could you add some explanation about the specific methodology of downhill simplex method? And what is the difference between a local optimization and global optimization? If local, then local to where? spatially or in other space? If this "local" refers to spatial local concept, then why in Table 3 the optimization is one value set? Is it because it is local optimization to some specific region? Also without a clear explanation of the methodology of "local" and "global" method, there is no way for readers to understand the results and why global optimization gives better tuning results. And how do you judge "better" results. There is no direct comparison with a certain reference criterion here. 16. Page 3800, Line 6: “The Morris method”. At least a simple explanation about this "global" method should be provided. So it is a method of perturbing all parameters? After reading this paragraph, I still didn’t get how the sensitivity experiment is carried out. 17. Page 3800, Line 11-12: “n is the number of calibration parameters”. Is n different from N? If so, a consistent denotation should be used. What does it mean by trajectories? Sample simulations? 18. Page 3800, Line 14: “step size”. What do you mean by step size here? Number of integration steps? 19. Page 3800, Line 15: “The starting point of a trajectory is selected randomly”. What do you mean by trajectory? How do you provide initial condition? How is the

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parameter initial values chosen? Randomly? If the parameter initial values are chosen randomly, it is not convincing that the randomly given values would give accurate estimation of parameter sensitivity. And for sure it would take a very long time for parameter optimization to converge. And it is highly likely that the parameter would converge to a total wrong value. 20. Page 3800, Line 22: what is y? How to choose the integration time? Because after changing a parameter, the model would shortly respond in a linear manner and later exhibit nonlinear response? How to choose the integration time to compare y? Besides, how do you choose the parameter step size? Based on what? 21. Page 3800, Line 25: I didn't see any sensitivity results in Fig.1. It should be Fig. 2. 22. Page 3800, Line 25-27. The model's sensitivity to the parameters is somehow dependent on the perturbation magnitude. In terms of response time, model can be very sensitive to some parameters that the quickly displayed spread. However, to some parameters, the model's response is rather slow. In terms of sensitivity magnitude, the model could respond to the parameter, however, the magnitude of the spread could be small. In your study, it seems that only the magnitude is included as a criterion of sensitivity. And the parameter perturbation, step size, is not well explained here. 23. Page 3801, Line 1-10: This paragraph seems to be a old version of the next paragraph. 24. Page 3801, Line 24-25: Why is that? As I understand from your previous description, "local" here means the model's response to one single parameter. And this does not necessarily lead to a dependence on the initial value. 25. Page 3802, Line 4: what do you mean by a longer distance? What is the distance? Compared to what it is longer? 26. Page 3802, Line 5-6: "a smaller distance". I don't understand the distance here? Is it represented by any denotations in the Equations listed before? 27. Page 3802, section 4.3: After reading the whole section, I still cannot get how to get the inital value. 28. Page 3802, Line 22-23: "In Table 3, PSO gets the best solution." How do you get this conclusion? Can you provide any reference parameter value or error information so that we can tell which estimation is the best? 29. Page 3803, Line 2-3: I still didn't get how you judge whether this estimation is good or bad. 30. Page 3803, Line 21: "The change in

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terms of the RMSE factor". So how to calculate this change in RMSE? What RMSE quantity is shown in Flg.5? 31. Page 3803, Line 26-27: Maybe, but temperature obs is also included as a criterion in parameter optimization. It is possible that the compromising result will degrade the simulation of temperature, but it is still not very convincing...Have you checked the temperature's and other varibales' sensitivity to the parameters? If the sensitivity of temperature is much smaller than those of others, it may help support your arguement... 32. Page 3805, Line 14-15: There is no standard criterion for the readers to judge whether the estimation is good or bad. 33. Page 3805, Line 21-23: References should be included here. However, the surrogate-based optimization method seems to have no relation with this study at all, thus inappropriate to be formed as a comparison. 34. Page 3805, Line 25-27: Since you have said that the surrogate-based method cannot meet the requirement of climate systems, simply stating that future work focus on evaluate surrogate models seems not very relevant with this study, nor as an extension of this study. More justification is needed. 35. Figures: To justify that the three-step method is more effective and more efficient, more comparisons between this new method and the traditional method should be provided. Only comparing between EXP and CNTL is not enough.

Please also note the supplement to this comment:
http://www.geosci-model-dev-discuss.net/8/C1336/2015/gmdd-8-C1336-2015-supplement.pdf

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