

List of Responses

Responds to the Anonymous Referee #1's comments:

Special thanks for your good comments which are very useful for us to improve the paper.

1. Response to comment: this paper proposed something interesting, however, the paper is not clear in current version, and its language also requires improvement. In summary, there are several comments that may help to improve the quality of this manuscript. 1) The english requires improvement, some sentences look like just the direct translation of Chinese, it is preferred to let a native speaker check the whole language style of the manuscript.

Response: As Reviewer1 suggested that we have tried our best to improve the presentation of this paper, and correct the syntax and spelling errors.

2. Response to comment: In the proposed work, the authors only use CMA trace data for verification, which is considered not solid and strong. I suggest the authors to use more trace data for analysis and comparison, such as trace data provided by JMA and USA.

Response: Thanks the advice of Reviewer1, but the CMA trace data is enough for the experimental design of this paper. Because the current experiments are under the ideal conditions. As your suggestion, we will use trace data provided by JMA and USA to do the further research about real environment.

3. Response to comment: The authors should explain the reason why these two typhoons are considered for analysis in this work, why they are representative? In fact, for further verification, more typhoon cases should be considered.

Response: For this paper, the experiments of two typhoons can be compared with our previous researches of MM5 model, and that can be used to prove the portability and effectiveness of ACPW method.

4. Response to comment: In the conclusion, the similarity of ADJ-CNOP and ACPW-CNOP of two typhoons are not very large. Or in other words, the similarity calculation is just cross-correlation.

Response: In this paper, the purpose of solving CNOP is to identify sensitive areas of typhoon target observations. The similarity of the ADJ-CNOP and ACPW-CNOP is not the main indicator. The identified sensitive region and its influence on the forecast skills are the most important indicators. And in our paper, the influence of the different sensitive areas identified by the ADJ-CNOP and ACPW-CNOP is almost the same.

5. Response to comment: Some terms are not clear at all, for general readers, such as the first guess field, the speed up and some others, the author should explain those terms for better understanding.

Response: As Reviewer1 suggested that we have explained the first guess field, the speed up and other terms in the paper for better understanding.

“As the SPG2 needs to execute several times to find the best result, several different initial perturbations (also called first guess fields) are needed. In this paper, we use four first guess fields. And

when we use the four first guess fields, the time consumption of ADJ method is up to 929.24 minutes.”

“The time consumption of ADJ method divided by the time consumption of ACPW is the speedup of the ACPW.”

6. Response to comment: The author should explain the importance of adjoint model and explain whether it is true necessary during the algorithm realization.

Response: As Reviewer1 suggested that we introduced that why the adjoint model is necessary in the SPG2 algorithm and why we develop the algorithm of free adjoint model.

“As we all know that the SPG2 algorithm must use the adjoint model to obtain the gradient information for updating the search direction. But the adjoint model of WRF-ARW only has one gravity dragging boundary layer parameterization scheme for such study, which limits the simulation of typhoon. In addition, when the horizontal resolution is higher than 30km, the gradient information calculated by the adjoint model has errors and omissions, which results in falling into the local optimum or optimization failure.”

7. Response to comment: Why all the dry energy are adopted as objective function?

Response: As Reviewer1 suggested that we explained that the reason of adopting all the dry energy as objective function.

“Zhou and Zhang (2014) studied three sensitive area identification schemes and recommended the vertically integrated energy scheme.”