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Nonlinear Processes
in Geophysics
Discussions

Interactive comment on "CNOP based on ACPW for Identifying Sensitive Regions of Typhoon Target Observations with WRF Model" *by* Bin Mu et al.

Bin Mu et al.

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List of Responses Responds to the Anonymous Referee #3's comments: Special thanks for your good comments which are very useful for us to improve the paper. 1. Response to comment: Although the idea put forward in the paper is good the writing really needs attention. Besides, I find that the notation related to the equations is not proper. I was caught between major revision and reject/resubmit. But it seems that the paper needs major rewriting and also need to be checked by a native speaker. Response: As Reviewer3 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: Starting with the line 10, pg3, – a perturbation of a quantity φ is conventionally noted $\delta\varphi$ (like φˆ'), where δ is understood to be an operator. The notation $\zeta\varphi$_0 is misleading. In addition, $\delta\varphi$_0 of φ_0 not Φ_0. Also requring âĂŰφ_0 âĂŰˆ2$\leq\zeta$? ζ is an operator in the text and now it is like a number? Response: As Reviewer3 mentioned, we have explained the formulas of CNOP in more detail. "where ζ is a constrained radius of an initial perturbation φ_0 We use $\zeta\varphi$_0 to represent the constrained initial perturbation. Φ_0 is an initial basic state and also a background field of a nonlinear numerical model. $\zeta\varphi$_0 is a type initial perturbation, which can be insert into the initial basic state Φ_0 P is a local numerical projection operator with setting 1 inside of the verification region and 0 outside, which is an operation of matrix multiplication. And the verification region is a key area considered by researchers, which is represented in Fig. 1. M denotes a nonlinear numerical model. " 3. Response to comment: The costfunction J is introduced in top of pg 3, but only explained and detailed 2 pages later? Response: As Reviewer3 mentioned, we have explained why we introduce the detail of J in the section 3. "J denotes the objective function of solving CNOP, and the detail of its computation is described in Section 3. Because, the detail of calculating J would be different as the experimental design is different." 4. Response to comment: P: projection operator – what kind of projection, and on which space? Response: As Reviewer3 mentioned, we have explained P in more detail. "P is a local numerical projection operator with setting 1 inside of the verification region and 0 outside, which isan operation of matrix multiplication." 5. Response to comment: Φ_t (should be φ_t for consistency) is not an operator – it is the state of the system at l18: CNOP is an optimization algorithm and not a cost-function Response: As Reviewer3 mentioned, we have modified the description of Φ_t." Φ_t is the state of nonlinear evolution of M from the initial time t_0 to the predicted time t." And we have explained the formula of CNOP "Combined with the formula (2), the formula (1) means that the CNOP is the initial perturbation having largest nonlinear development, i.e. J(ãĂŰ$\zeta\varphi$ãĂŮ_0ˆ*), when it is inserted into Φ_0 and M evolves from the initial time t_0 to the predicted time t with the modified initial state (Φ_0+$\zeta\varphi$_0)."

In this paper, CNOP is not an optimization algorithm neither a cost-function. 6. Response to comment: l23: environment idealized ??? Forecast income ??? Time consumption: CPU time. Response: As Reviewer3 mentioned, we have modified the unsuitable words, such as income and running time. “environment idealized” is a type of assumption. “All experiments are based on two assumptions that: a. When adding target observations in the identified sensitive areas, the environment around is idealized, and the improvements of observations added are reducing original errors to 0.75, 0.5 and 0.25 times. b. CNOPs achieved by us can be seen as the optimal initial perturbations. Once we reduce them in the sensitive regions, the benefits earned will be the best. As mentioned in the subsection 4.1, the sensitive region is determined according to the first 1.2% of total vertical dry energy, as shown in Figures 5 and 6, which are the shadow zones in the figures.” “Time consumption” is the time of ACPW solving CNOP. 7. Response to comment: Above all, it is not clear what is the main difference with Zhang et al. (2108), and what is the advantage of the new algorithm. Any concrete results ? Response: In this paper, we rewrite the ACPW and applied it to solve CNOP in the WRF-ARW for identifying sensitive areas of typhoon target observations. ACPW was proposed by us in 2018, the main difference between this paper and Zhang et al. (2018) is the different nonlinear model. 8. Response to comment: The authors use PCs to reduce the problem dimension. It is not clear how the PCs are obtained: PCs of what, and what is the sample size used to get these PCs? Are the authors using the 24-hr data with 6-hr sampling? Response: “Eight group of control parameters and the experimental results are list in Table 6. For the experimental analysis, the number of principal components (PCs), which are selected dimensions of the feature space from the dimension reduction of Principal Component Analysis (PCA), has little effect on the time consumption, but has great influence on the adaptive value of objective function. The samples of PCA are from the difference of the different forecast states in the forecast time. In the WRF-ARW model, we get 551 samples and reduce the dimension from 2.5*105 to 30-60 with PCA.” 9. Response to comment: Not clear how is the sensitive region determined as CNOP only identifies

initial perturbations. Are the authors computing the costfunction for different regions then compare them? Response: “As we use the total vertical dry energy to identify the sensitive regions of typhoons, the distribution of the vertical dry energy is presented in Figure 5 and Figure 6. And the figures show the area with the first 1.2% energy. ” “The experiments of this section include two parts: the forecasting benefits obtained by reducing CNOP to W $\times$ CNOP in the whole domain, i.e. the CNOP values of all grid points are reduced; the forecasting benefits from CNOP to W $\times$ CNOP is reduced only in the sensitive regions, i.e. the CNOP values of the sensitive grid points are reduced to 0.75 $\times$ CNOP, 0.5 $\times$ CNOP and 0.25 $\times$ CNOP. ” “In order to investigate the validity of CNOP in identifying sensitive regions, we compare the 24-hour simulated typhoon track by adding CNOP or W $\times$ CNOP to the initial states. Similar to the benefits, there are two ways to modify the CNOP value: one is to reduce the CNOP value to 0.75, 0.5 and 0.25 times in the whole domain; the other is to reduce the CNOP value to 0.5 times only in the sensitive regions of TTOs. ”

Please also note the supplement to this comment:
https://www.nonlin-processes-geophys-discuss.net/npg-2019-24/npg-2019-24-AC3-supplement.zip

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