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Response to the Reviewer # 2

Dear Reviewer #2,

Thank you for prompt reviewing of this manuscript.

We hired Ms. Mary Golden (was chief editorial assistant of MWR) to help to improve the manuscript.

I changed the title a little bit from “Development of the Upgraded Tangent Linear and Adjoint of the Weather Research and Forecasting (WRF) Modeling System” to “Development of the Upgraded Tangent Linear and Adjoint of the Weather Research and Forecasting (WRF) Model” as this manuscript focus on WRF model, instead of the WRF modeling system, which includes WPS, REAL, WRF, WRFDA etc.

Best Regards,

Xin Zhang

Below is the point –by-point response:

*The paper describes some very significant improvements to the design of the WRF TL and adjoint codes, making use of the TAPENADE AD tool and the flexible WRF Registry infrastructure. The paper is generally well written, and should be published after minor changes.*

*Improvements to English grammer should be made. Most of my detailed comments below are grammer-related (my proposed text in* ***red****) with a few comments (in* ***blue****) to propose clarifications to help understanding.*

Authors: We hired a professional editor (Mary Golden, was chief editorial assistant of MWR) to improve the writing.

*Only a few figures, generally ok but Fig2b and 3b text could be increased in size – it is hard to read.*

Authors: We re-plotted Fig2b and 3b and the text size was increased.

***Detailed Comments:***

*‘During the past two decades, the use of the adjoint technique in meteorology and oceanography has been rapidly increasing.’*

Authors: We changed to “ the use of adjoint technique”, see line 24, page 2.

*‘The WRF model is designed to be an efficient massively parallel computing code to take advantage of advanced 33  high-performance computing systems.’*

Authors: We corrected, see line 33-34 page 2.

*‘WAMS has failed to follow the rapid development of WRF model and data assimilation system (WRFDA - Barker et al. 2012).’*

Authors: We added the reference of WRFDA paper, see line 54 page 3.

*‘makes WAMS inconvenient to be used with other systems. Furthermore, because WAMS uses disk input/output (I/O) for storing basic states and exchanging data, parallel efficiency is unsatisfactory on modern high performance computers ‘*

Authors: We made suggested changes; see line 58-62, page 3

*‘with the WAMS developed by Xiao et al. (2008) ‘*

Authors: We corrected. See line 65-66, page 3

*‘An innovative approach has been applied to develop the parallel code which dramatically reduces the’*

Authors: Editor suggests using “was” here and also changing “innovative” to “new”. See line 70, page 3

*‘Pascual (2004)) to re-develop the tangent linear and adjoint models of the WRF ARW core’*

Authors: Corrected. See line 84, page 4.

*‘condensation developed by Jimy Dudhia’*

Authors: Corrected. See line 100-101, page 4.

*‘(Vukicevic (1991);’*

Authors: Corrected. See line 105, page 5.

***I didn't understand this sentence****. Reword?: 'Due to the duality between MPI SEND and MPI RECV calls, in ADM, send message to where we receive in FWM and receive message from where we send previously. '*

Authors: After consulting with the editor, we changed this sentence to “Due to the duality between MPI SEND and MPI RECV calls, in transforming FWM to ADM, we replace MPI SEND calls with MPI RECV, and vice versa.”, see line 141-142, page 6. It is illustrated by figure 1.

*“*

*'In* ***the*** *FWM model, the variable U in* ***the*** *ghost region'* ***and subsequent 'ghost' references'***

Authors: Corrected. See line 145-149, page 6-7.

*‘In* ***the*** *WRF model, hundreds of thousands of lines of the code are automatically generated from a user-edited table, called* ***the*** *Registry ’*

Authors: Corrected. See line 150-151, page 7.

*‘The second entry ”HALO EM C” will be used in the model to refer to the communication operation being defined’. Also, explain what this example means i.e. what does \_C signify?*

Authors: Added “the”, see line 162, page 7.

“\_C” doesn’t mean anything, it just a suffix appended to halo entry name following the alphabetic sequence.

This example specifies that 4 points (one cell each in north, south, east, and west directions, respectively) of the stencil be used in updating the state arrays for fields u\_2 and v\_2 across the processors.

*‘During compilation, the WRF Registry ‘ and many following examples…*

Authors: Corrected. See line 166-167, page 7 and all the following .

*‘TLM has exactly the same exchange stencil’*

Authors: Corrected. See line 187, page 9.

*‘same communication latency and amount as in the first stage’*

Authors: Per editor’s suggestion, changed to “same communication overhead and amount as the first”. See line 212-213, page 11.

*‘It is worth mentioning that, with this approach, we completed the parallelization of the serial WRFPLUS model within a week by one person.’ Really? With no preparation? How long do you estimate this took with WAMS?*

Authors: We removed this sentence per editor’s suggestion.

With preparation (the registry is upgraded to be able to generate TLM and ADM of halo exchanges), we can complete in a week. Same estimation for the WAMS.

*‘grid points in the horizontal’*

Authors: Corrected. See line 221, page 11.

*‘that data is ready to be read. ‘*

Authors: Corrected. See line 258, page 12.

*‘and WRFDA fetches the data from the coupler instead of disk files.’*

Authors: Corrected. See line 267-268, page 13.

*‘introduced in a separate paper.’*

Authors: Corrected. See line 281, page 13.