

## ***Interactive comment on “A Radar Reflectivity Operator with Ice-Phase Hydrometeors for Variational Data Assimilation (RadZIceVarv1.0) and Its Evaluation with Real Radar Data” by Shizhang Wang and Zhiquan Liu***

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Received and published: 22 May 2019

This paper describes a radar reflectivity operator and its adjoint for variational data assimilation. The new operator is implemented in WRFDA and preliminary test is presented with a convective case occurred in the U.S.. The developmental procedures of the operator is well described and the results are well explained and analyzed. My recommendation is to publish on GMD after minor revision. Although I do not have any major concerns about the content of the paper, I do suggest that the authors pay good attention to improve the English writing. Below are some suggestions from me to

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help improve the readability of the paper, but I strongly suggest the authors to hire a professional editor to further improve the paper.

1. Title: The abbreviated algorithm name is not necessary in the title.
2. Abstract, lines 15-18: Change to “It is shown that the deficiencies in the analysis using this operator, caused by the poor quality. . . error covariance, can be partially resolved . . .”.
3. Page 1, lines 24-25: “. . .Xue et al., 2006) and they have demonstrated that assimilating these observations improves. . .”
4. Page 2, line 1: Change “limited in” to “limited to”.
5. Page 2, line 12: Add references for this statement.
6. Page 2, line 13: Change “and the conditions that” to “in which”.
7. Page 2, line 22: Change this sentence to “Reflectivity operators have been developed both for the variational method (. . .) and for the ensemble Kalman filter method. . .”.
8. Page 2, line 30: Suggested change: “Despite the difficulty, some efforts have been undertaken for reflectivity assimilation . . .”
9. Page 3, line 14: “To compute Eq. (2), the mixing ratios of . . . are required.”
10. Sections 2.1.2 and 2.1.3: There are so many parameters, such as those in Eqs. (11) and (16)-(20). Can you briefly explain the meanings of these parameters? Are they theoretically or empirically determined? What are their uncertainties?
11. Page 9, line 14: “. . .more substantially than that from dry snow. . .”
12. Page 9, line 24: “. . .from southern South Dakota to northern Nebraska, as shown in Fig.2. Note that there is also a weaker precipitation system near the north boundary of the domain. The top of the convective system of interest at this time, identified by reflectivity greater than 5 dBZ, reached 16 AGL”. In the next line, “a bow echo was observed. . .”. Line 3: delete “as shown in Fig. 2” here.
13. Page 10, line 25: Change “that of snow and graupel” to “those of snow and graupel”.
- Line 27: do you mean a broad vertical distribution?
14. Page 11, line 25: “More outer loops were necessary due to the inaccurate . . .”.
- Lines 26-28: do you mean a total of four experiments were performed by varying the number of iterations and the analysis time?
15. Page 11, line 30: “RadZIceVar is unable to create hydrometeor increments. . .”? 16. Page 12, line 2: “. . .constant, it is expected that. . .”. This should be a general expectation, so you do not have to refer to J08. Line 7: “nonzero” instead of “nonvanishing”. Line 9: “To examine the analysis

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performance...". Line 14: add "the" before "length scale". 17. Page 13, line 16: Why was such a small weighting 0.1 used? Did you tried any other weighting? 18. Page 13, line 17: The use of "reflectivity space" and "model space" are not appropriate in this context. Also in line 5 on page 15. Line 18: delete "the" before "both". Line 20: delete "relatively". 19. Page 16, line 7: Suggest to replace "Two deficiencies are observed in the 3DVar analysis" by "Two problems of RadZlceVar were found in our test".

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Interactive comment on Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2019-67>, 2019.