

Response to Editor:

> Comment:

L218: space missing before: The partitioning procedure

** Response:**

I have added the missing space before "The partitioning procedure". The correction is located at L218 and highlighted in yellow.

> Comment:

L320: extra space after cost J and before the dot: cost J .

** Response:**

I have removed the extra space after "cost J" and before the dot, so it now reads "the scalar cost J." The correction is located at L320 and highlighted in yellow.

> Comment:

The new paragraph starting L218 is too technical.

Can you rewrite/rephrase without mentioning the name of the functions.

For example:

The complete forward process that starts from δz and computes J is encapsulated in the closure function closure().

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The complete forward process that starts from δz and computes J is encapsulated in the closure function.

**** Response:****

Thank you for this comment. I have rewritten the paragraph to remove all function names. Specifically, "the closure function closure()" has been changed to "the closure function", and other code-style expressions such as `requires_grad=True` and `cost.backward()` have also been replaced with plain language.

I would also like to kindly note that this paragraph appears to start at L318 rather than L218 in the manuscript. I have made the revision accordingly at L318 and highlighted it in yellow.

Additional changes

In addition to the revisions requested by the reviewers, we have made the following changes to improve the manuscript:

Change 1. I have now set all mathematical variables in the equations to italic throughout the manuscript and highlighted these changes in yellow for your easy reference.

Change 2. Regarding the caption of Figure 2, I have revised it to:

"Figure 2. Simplified pseudo-code of the AD-based 3DVar minimization in PY3DVar. R_{inv} denotes the inverse of the observation error covariance R ." in L337-338.

The reason for this revision is that the figure is a piece of pseudo-code, in which variable names such as R_{inv} are naturally written in upright (roman) font, consistent

with the code itself. Therefore, I kept R_{inv} in upright font in the caption to match the figure, while the mathematical symbol R (the observation error covariance) is set in italic, following the standard notation for mathematical variables. I removed the explanation of the other symbols (δz , F , H , d) from the caption because they have already been defined in the main text, which also makes the caption more concise.

Change 3. In Figures 6–9, the panel labels (a)–(f) have been moved from text annotations inside the plots to subplot titles, and "PY3DVar" or "FT3DVar" has been added to each title to distinguish the two experiment sets. No other changes were made to these four figures.