

Author's response to Editor
for 'Four-dimensional variational data
assimilation with a sea-ice thickness emulator'

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EC: Editor Comment; [AR: Author Response](#)

EC: Thank you for revising your manuscript according to the report by reviewer 2. You have splendidly answered to the many editorial comments. Yet, you must have overlooked the following remark: 'The quality of the science needs to be matched with good presentation. Some minor comments are provided below, but I suggest that the authors focus on addressing the more important issues of readability and presentation first.' This means that the reviewer clearly appreciates the scientific content but was less convinced about the overall presentation. You should consider the major comments of the initial report of this reviewer, particularly with regard to the introduction (comment 1) and the more general editorial requests (comment 5).

[AR:](#) Thank you for pointing this out. We acknowledge that Reviewer 2 stressed the need to improve readability and presentation alongside the scientific content. In this revision, we have therefore paid particular attention to refining the introduction (Comment 1) and addressing the broader editorial requests (Comment 5). We have restructured and edited the text to improve clarity, flow, and overall readability, while preserving the scientific content

[AR:](#) L28: sea ice \mapsto sea-ice, since it is an adjective here

[AR:](#) L34-40: We moved the paragraph to L50-54 to improve the flow of the introduction, while keeping the topical sentence requested in the previous review in its original place.

- AR: L84: We added the term 'numerical' to clarify that we are specifically referring to the numerical model described in Boutin (2023).
- AR: L100: We added 'Additionally' to emphasize that we use extra forcings as inputs to the emulator.
- AR: L109: We added 'during training' to emphasize our new approach of enforcing SIT positivity within the training process itself, rather than relying solely on a post-processing step during inference.
- AR: L116: We specified that the lower physical bound in the normalized space corresponds to SIT_{\min} .
- AR: L119: We added 'thanks to retraining with Relu as the final activation function' to emphasize that using Relu as the network's final activation is equivalent to clipping
- AR: L130: We changed the sentence 'First, we pre-train the model f_{θ} , omitting the clipping in Eq. (2b) during training, with a first loss. As in Durand et al. (2024), we use $\lambda = 100$ ' to 'First, we pre-train the model f_{θ} using $\lambda = 100$, as in Durand et al. (2024).' Mentioning the omission of the clipping was quite confusing since we were speaking about f_{θ} here.
- AR: L132: We added 'thanks to the Relu activation function' to highlight the connection between clipping and using the Relu as the final activation.
- AR: L160: We removed the sentence 'Within the DAW of 16 days, with observations taken on each of the N_z grid points, and on every second day starting on day 2, the total number of observation times is $K = 8$.' as it pertained specifically to the twin experiment rather than the general description of 4D-Var. Moreover, these details are already correctly presented in the appropriate section
- AR: L280: in Fig.6 \mapsto in Fig.6. (the point was missing)
- AR: L293: We added 'here' at the end of 'Note that no multiplicative inflation scheme is used here.'
- AR: L294: We removed "the" to clarify the sentence: "...we use past forecast from neXtSIM-F..."
- AR: L314: We added "Let us note" at the beginning of the sentence "Let us note that the RMSE metric penalizes the high level of details of the

neXtSIM model more than the emulator that smooths gradually with time” to emphasize on the differences between this sentence and the former one.

AR: L329: We added ”Additionally” to the sentence ”Additionally, the IIEE_{SIT} serves as a reliable indicator of how accurately the MIZ is positioned.” to emphasize that we are now discussing a new metric.

AR: L335: We added ”In the twin experiment case, ” at the beginning of the sentence to stress on the fact that Fig3 corresponds to the twin experiment case (even though the argument of smoothing is valid in both cases - synthetic or real - observations).

AR: L384: We added ”Promisingly” at the beginning of the sentence to emphasize on future improvements of AI-enhanced observations.

AR: L423: We revised the conclusion to ensure that all sentences are written in the present tense.

AR: L443: We removed in both occurrences $(n + k\Delta t)$ for more clarity.

AR: L457: We changed the sentence ”The forecast skill of g_θ is compared to the one of f_θ , and the persistence, which consist to take the initial condition as the constant state of the system.” to ”The forecast skill of g_θ is compared to the one of f_θ , as well as to persistence, which consists of taking the initial condition as the constant state of the system.” for more clarity.

AR: L464: We added \bar{x} to indicate to which symbol corresponds the temporal mean.

AR: L484: We added some details ”The state \mathbf{w}_0 (projected onto the EOFs) is mapped back to the physical space”.

AR: L486: We changed the word ’DAW’ to ’cycles’ in ’The total computation across all cycles is presented in Alg.C2.’ for more clarity.

AR: FigB2: We added some details in the caption: ”..., in twin experiments and in the 4D-Var-EOF case.”

AR: L494: We refer to Fig C2 at the end of the sentence.