RESPONSE TO REVIEWER'S COMMENTS

We would like to thank the reviewer's valuable suggestions for our manuscript. The corrections and suggestions made by the reviewer improved our manuscript. The comments from the reviewer also provide us with future research directions.

Comments from Reviewer 1:

Comment 1: *The structure of the manuscript is not well organized and redundant. For example, the last two sentences of the introduction section (i.e., Section 1) mention about the experimental setup and the results. They should be in the dedicated sections for the "experimental setup" and "results." The first paragraph of Section 2 also repeats the same thing as that in Section 1.*

Response: Thanks for your suggestion. We have re-structured the manuscript. The current structure of the manuscript consists of Introduction, Related Work, Model, Data and experimental Setup, Results, Discussions and conclusions. The redundant sentences have also been deleted (Page 2, Line 59-62; Page 3, Line 64-66; Page 4, Line 116-121; Page 7, Line 160-165; Page 10, Line 233-236).

Comment 2: *Line 126, "STIC-Prediction generator reduces information loss...": This is not proven yet up to this line in the manuscript, nor supported by previous studies (indeed, no citation here). Therefore, this is just your working hypothesis at this moment. If you intend to prove that STIC-Prediction generator reduces information loss, it should be in the results section, not here. Besides, you need to define a metric for information loss. Otherwise, you cannot prove it quantitatively. I would recommend writing as follows: "STIC-Prediction generator is designed to reduce information loss and...". Other sentences in the same paragraph have the same problem. Please clearly separate introduction, experimental setup, result, and discussion.*

Response: Thanks for your advice. We have modified the sentences and added the Bias metric to measure information loss (Page 5, Line 130; Page 5, Line 136-140; Page 6, Line 151-154; Page 11, Line 260). The structure of the manuscript is now Introduction, Related Work, Model, Data and experimental Setup, Results, Discussions and conclusions.

Comment 3: *Line 153-157: This is the same as the previous comment. This is your working hypothesis until you present evidence for that.*

Response: Thanks for your advice. We have deleted the sentences because they are repeated in Page 2, Line 43, Page 5, Line 138, and Page 6, Line 151. You can find the deletion on Page 7, Line 160-165.

Comment 4: *Line 166, "By using hard_sigmoid as the activation function, the training speed is accelerated.": This is interesting, but not supported by evidence. You may accelerate the training near the origin, where the gradient is non-zero, while you will decelerate the training where the gradient gets exactly zero.*

Response: Thanks for your advice. The construction of hard_sigmoid allows gradients to flow easily when the unit is not saturated, while providing a crisp decision in the saturated regime. Therefore, it has lower computational cost and faster calculation speed. This is the reason why we chose hard_sigmoid. The sentences in the manuscript may have caused ambiguity, so we have modified them. We have also cited relevant references that mention this phenomenon (Page 8, Line 177).

Comment 5: *Page 8-10: In general, descriptions lack important information, such as the number of channels, padding, stride, batch size, etc. All these hyperparameters affect the model performance. Comparing different models without knowing setup of each model does not really make sense. At least, you should provide details of all the models you used in this paper. If it is too big, you can put them in the appendix or supporting information.*

Response: Thanks for your suggestion. We have provided the hyperparameters of ConvLSTM, ConvGRU, GA-ConvGRU, GAN-argcPredNet v1.0 and GAN-argcPredNet v2.0 in the supplement.

Comment 6: *Line 219-221: It is a little bit strange to conclude before showing results.*

Response: Thanks for your suggestion. We have deleted the sentences because they are repeated in Page 10, Line 238, Line 243 and Page12, Line 280. You can find the deletion on Page 10, Line 233-236.

Comment 7: *Section 4.1-4.3: They are the experimental setup. I would recommend to separate the experimental setup from the result section.*

Response: Thanks for your advice. We have separated the experimental setup from the result section (Section 4 and Section 5). The structure of the manuscript is now Introduction, Related Work, Model, Data and experimental Setup, Results, Discussions and conclusions.

Comment 8: *Equation 15: This is somewhat strange. Usually, radar reflectivity is converted to rain rate with the equation as follows (e.g., https://glossary.ametsoc.org/wiki/Z-r_relation):*
$Z = a * R^b$.
Then, the radar reflectivity is expressed in decibel (dBZ, https://glossary.ametsoc.org/wiki/Dbz):
$dBZ = 10 * log10(Z)$.
Although Eq 15 is the same as that in Shi et al. (2017), your definition uses log, not log10. If that is the case, your rain rate may be wrong. Please check your code and reprocess data if necessary.

Despite the wrong definition, the values in Table 1 seem correct. In addition, the citation just before this equation (Watters et al. 2021) seems misplaced. I do not understand why this is cited here.

Response: Thanks for pointing it. The calculation in the code is based on log_{10}. We have modified the formula and revised the issues in the manuscript writing (Page 11, Line 248; Page 11, Line 250).

Comment 9: *Line 261, "From Fig. 7, 8, 9, 10, and 11": Although you placed 5 figures with 4 panels each in the manuscript, you just describe them in a single line. This is not acceptable. Please add meaningful descriptions and discussion for them, or please consider reducing the figures.*

Response: Thanks for your advice. We have added descriptions and discussions of the figures, and simplified the original figures (Page 12, Line 289-300; Section 6.1).

Comment 10: *Figures 7-11, 13-17: These figures have 4-5 lines each, but they are not clear, and they are drawn with similar colors (many of them are in blueish colors). Please improve their quality. However, before improving them, please consider summarizing them more concisely.*

Response: Thanks for your advice. We have summarized them more concisely and changed the colors, symbols, and styles of lines to make the figures clearer. In the ablation study, we have replaced the figure with the table to present the data more specifically (Page 13, Line 299; Page 15, Line 324).

Comment 11: *Figure 12: You highlighted an intense rain area near the center of the domain, which is predicted well by the proposed method. Meanwhile, the rain area on the bottom right corner over-intensifies in the proposed method. The rain area near the top right in the domain goes out of the domain, which is different from the ground truth. In other methods, this rain area is located at the right place. I would say that the proposed method has pros and cons. Please discuss the results more carefully. Not just saying that you make a great system, but a more scientific consideration is needed. I imagine that the over-intensification near the bottom right may be related to the use of attention mechanism.*

Response: Thanks for your suggestion. We have pointed out this issue in the manuscript and discussed it carefully (Page 13, Line 305; Page 16, Line 347-353).

Comment 12: *Line 20, "intensification of echo feature sequence": It is not clear what you intensified. If you always increase the extracted features by CNN, I do not think you can make a good prediction. I guess you meant the attention mechanism, but this sentence did not make sense.*

Response: Thanks for your suggestion. We have modified the sentence (Page 1, Line 20).

Comment 13: *Line 45, "Existing deep learning models, ...": It is impossible to prove non-existence, so I would recommend adding "to the knowledge of authors."*

Response: Thanks for your advice. We have modified the sentence (Page 2, Line 46).

Comment 14: *Line 77, "these traditional methods fail to utilize": Most of the traditional methods are semi-process-based, so they do not intend to utilize historical data directly. Therefore, it is not fair to use the phrase "fail to."*

Response: Thanks for pointing it. We have modified the expression (Page 3, Line 81).

Comment 15: *Line 130, "where H, W and C denote": "T" and "l" are missing.*

Response: Thanks for pointing it. We have fixed it (Page 5, Line 135).

Comment 16: *Equation 9: \sigma before \phi_21 (there are two) must be \gamma.*

Response: Thanks for pointing it. We have modified the equation (Page 9, Line 213).

Comment 17: *Table 4, the values for 5 mm/h, FAR: CS-GAN and GAN-argcPredNetv2.0 show the same number within significant digits. Therefore, both should be presented with bold.*

Response: Thanks for advice. We retrained and retested the data to extend the prediction time to 1 h. As a result, the numbers in the table have changed, but we carefully checked them this time (Page 15, Line 324).

Comment 18: *Line 339, "However, there are further improvements on the basis of current accuracy.": I could not understand the sentence. Please consider rephrasing.*

Response: Thanks for pointing it. We have modified the expression (Page 17, Line 374).

Comment 19: *"hardware conditions": What does this mean?*

Response: Thanks for question. We mean that high-resolution prediction requires high hardware requirements, such as graphics cards with larger memory. We have modified the expression (Page 17, Line 376).