General statement

We would like to thank the editor for coordinating the review of our work and the peer-reviewers for their valuable comments on our study. In the following, we will address the referees' comments and present our plans and ideas for revising the manuscript. For clarity, our responses are highlighted in red.

Referee comment #1

In this manuscript, the authors claimed that they quantify uncertainty in nowcasting. However, I think the quality of this manuscript does not reach the level of a publishable work for a few key reasons:

The author misunderstood a few fundamental concepts in forecast post-processing. I have not seen the term 'analysis uncertainty' before, and it is very hard to know what it exactly refers to. If you are talking about uncertainties in weather forecasts, you should point that out, rather than using terms like: ' ensemble analysis ', 'analysis uncertainty', 'SIVA uncertainty', etc. In results, the authors tried to compare the ensemble spread with RMSE (e.g., line 203), giving me the impression that they do not really understand the basic statistics of weather forecasts.

Reply 1:

Thanks for the comments and we will give more explanations of the used terms in the manuscript. The term "analysis" as discussed in this work refers to "meteorological observations on a grid mesh", which refers to the representation or mapping of meteorological variables (such as temperature, pressure, wind speed, humidity, etc.) over a specific geographical area on a grid mesh with certain resolution (e.g. 1km×1km). Such analysis contains measurement errors and the errors produce by interpolation. We use the term "analysis uncertainty" to describe the uncertainty arising from such errors. This is crucial for gaining a more comprehensive understanding of the uncertainty in nowcasting. Hence, we propose an approach to estimate the uncertainty represented by those errors in the analysis: generating "ensemble analysis" by introducing appropriate perturbations. In the revision, we will ensure that these terms are explicitly defined and used in the proper context.

One of the most commonly used ensemble verification metrics to assess the reliability of ensemble forecasts is to compare the spread of the ensemble with the root-mean-square-error (RMSE) of the ensemble mean (Fortin et al., 2014). The ensemble spread quantifies the dispersion or variability among the ensemble members, while the RMSE measures the accuracy of the ensemble mean relative to the reference values. This comparison, which is a concept widely used in ensemble forecast verification, reflects whether the ensemble spread appropriately represents the uncertainty.

The revision will be traceable in the manuscript.

Reference:

Fortin, V., Abaza, M., Anctil, F., Turcotte, R.: Why should ensemble spread match the RMSE of the ensemble mean? J. Hydrometeorol., 15, 1708–1713. https://doi.org/10.1175/JHM-D-14-0008.1, 2014.

The manuscript has been carelessly prepared, making it extremely confusing and hard to understand. The whole manuscript reads like an automatic translation from a foreign language to English, using some software. Lots of grammatical errors and awkward expressions, making it hard to learn what they want to introduce. Please see examples in the detailed comments below.

Reply 2:

Thanks for the comment. We will carefully go through the whole paper and check the grammar issue. The revision will be traceable in the manuscript.

Results did not show much improvements, in the resultant ensemble forecasts relative to the original forecasts. I could not figure out the necessity of this work. In addition, many findings presented are based on speculation, rather than based on solid data analysis.

Reply 3:

Thanks for the comments. We understand the concern regarding the improvement in ensemble forecasts compared to the original forecasts. The primary objective of this work is not necessarily to show dramatic improvements in forecast scores, but rather to quantify the uncertainty in the analysis using a perturbation approach. We introduce Gaussian perturbations with zero mean into the deterministic analysis to simulate uncertainty. In this context, the scores (BIAS and RMSE) of the ensemble mean should ideally remain consistent with those of the deterministic reference.

Regarding the concern about the necessity of this work, we believe that quantifying uncertainty in the analysis has significant value. This is particularly important for improving the reliability and accuracy of nowcasts in practical applications and addressing the uncertainty in nowcasting. While the method may not lead to major score improvements in this initial evaluation, it provides a framework for understanding the uncertainty inherent in the analysis phase. The key novelty of this work lies in its approach to quantify uncertainty in the analysis and then estimating the uncertainty of nowcasting, rather than focusing solely on forecast score improvements.

We also acknowledge this comment about the speculative nature of some findings. We would like to clarify that all the results presented in this work are based on solid data analysis. For example, the Gaussian perturbations are generated based on the statistical errors in the analysis. We carefully assessed the consistency between the BIAS and RMSE of the ensemble mean and the ensemble spread to ensure that the perturbations do not introduce additional biases, while maintaining an accurate representation of uncertainty.

Detailed comments:

1. Line 21, what is the trend of NWP? You should spell out the full name of NWP, when using it for the first time.

Thanks for the comments and sorry for the confusion. We will explain more about this term in the manuscript.

2. Line 37, what does ‘the analysis’ refer to?

Thanks for the question and sorry for the confusion. The analysis here means "meteorological observations on a grid mesh". We will rephrase the sentence i.e. "As a result, … by those errors in analysis is one of the major challenges …."

3. Line 42, the 'impact' on what?

We will rephrase the sentence i.e. "Most studies focus on addressing the uncertainty in nowcasting, while only a few have explored the impact of analysis errors on the uncertainty in nowcasting."

4. Line 43, what is the analysis error

Sorry for the confusion. As described in Reply 1, the analysis is the representation of current atmosphere, calculated by calibrating the first guess using surface observations. We will rephrase the sentence i.e. "… the uncertainty represented by the errors in analysis could have a positive impact …."

5. Line 52, error produced by interpolation?

Sorry for the confusion. We will revise it i.e. "… into other errors in analysis, such as errors produced by interpolation."

6. Line 56, a very awkward way of introducing NWP

Thanks for the comments. We will rephrase the sentence i.e. "The first guess used in INCA is the numerical weather prediction (NWP) provided by the Austrian operational version of the Aire Limitée Adaptation dynamique Développement InterNational (ALADIN) limited-area model described by Wang et al. (2006)."

7. Line 69, to as?

Thanks for the hint. We will revise it, i.e. "The NWP output of China Meteorological Administration Mesoscale model (CMA-MESO) provides a deterministic first guess for SIVA to describes the spatial characteristic (Shen et al., 2020)."

8. Line 74, analyses are

Thanks for the hint. We will revise it.

9. Line 77, for which months?

Sorry for the unclear statement. The periods of our study are August 2020 and February 2021, which are referred to as summer and winter, respectively, in the following text. We will add more details about the dataset description in Section2 of the manuscript.

10. Line 84, how can you calculate analysis

Sorry for the confusion. We will rephrase this description i.e. “The analysis starts with a first guess, which is an NWP short-range forecast output of CMA-MESO. This first guess is then calibrated based on its errors relative to the observations, which are the ground true values provided by automatic weather stations. Topographic parameters are used to map the height of CMA-MESO model levels to the truth altitude of the station location.”

11. Line 110, ‘Selected…..’ this is not a complete sentence

Thanks for the hint, we will revise the sentence i.e. “To assess the effectiveness of ensemble analysis in representing uncertainty, 151 stations were randomly selected as the test set, while the remaining 1519 stations were used for the SIVA computation to generate the ensemble.”

12. Line 115, no north arrow, no scale bar, no location information of the study area

Thanks for the comments. We will add north arrow, scale bar and location information in figure1.

13. Line 131， no clear what is ‘valley, floor and surface’

Thanks for the hint. We will rephrase it i.e. “…. it implicates the downward (upward) shift that constrains model height to the true altitude of the station location.”

14. Line 154, no indentation

Thanks for pointing it out. We will revise it.

15. Line 166, there is no red line in the above figure

Thanks for the hint. We will revise it in this figure.

16. Line 172, why capitalize the word Analysis

Thanks for pointing it out. We will revise it i.e. “Verification of ensemble analysis.”

17. Line 183, which summer month and which winter month?

Thanks for the question and sorry for the confusion. We will rephrase it i.e. “…for summer (August 2020) and winter (February 2021).”