Response to the reviewers

The authors thank the reviewers for their time and effort in providing critical evaluation of our work. In the following, we address their comments point by point.

Reviewer 1

The authors of this paper applied machine learning to provide temporally downscaled data and outputs of the temperature-humidity index (THI) for the cattle sector. The manuscript has undergone significant modification since the first round of review, and the authors have responded thoroughly to the suggestions made. I have two main suggestions to make that I believe would lead to a publishable article.

Firstly, the authors could provide more detail on the THI. It is difficult to interpret the variations and errors presented and discussed throughout the paper without greater context. The authors refer to specific THI thresholds but do not describe them nor their methods' impact on them, potentially missing a way of demonstrating the added value of temporally downscaling the THI.

⇒ We have expanded the Introduction section (lines 43-50) to provide specific THI thresholds which have been shown in the literature to correspond to detrimental physiological responses in dairy cattle.

Secondly, the authors could provide a plot relating mean absolute error to altitude. The dataset has spatially dependent errors, attributed by the authors primarily to altitude: "This discrepancy likely originates from the unique microclimates and larger diurnal variations often observed at higher altitudes". It would therefore be sensible to plot MAE against altitude to explore this attribution. This could be included as another panel in Figure 6.

⇒ We have expanded Figure 6 to include a KDE plot of the MAE against the elevation, as obtained from the evaluation set. We have also included a linear regression fit to this data, which clearly indicates a positive relationship between MAE and altitude. We have also expanded our discussion to include the new panel in Figure 6 in the main body of the manuscript.

I also have two minor suggestions. The first is to avoid using the blue-to-neutral-to-red colourmap for data that doesn't centre around zero. The second is to expand Figure C1 to include the entire globe, rather than just Antarctica, as it would be interesting to explore the seasonal variation of MAE across the entire globe.

⇒ We have changed the colormap of Figures 6 and B3 to avoid using a diverging colormap on plots that don't center around 0. We have also expanded Figure C1 to include the whole globe instead of only Antarctica and expanded the text in Appendix C accordingly.

Reviewer 2

In this revision, most of my major concerns have been addressed. However, for response 4, the section number seems to be incorrect, as Section 2.4.1 is not present in the manuscript. Additionally, the structure of the XGBoost regressor model is still incomplete. Providing more details on hyperparameter tuning (e.g., gamma, subsample, colsample_bytree), feature interactions, and other model-specific adjustments would be beneficial.

⇒ We thank the reviewer for spotting this mistake and apologise for the wrong reference, we were referring to Section 2.5.1 (Implementation Details). Furthermore, we have further expanded the section to include all the details of the XGBoost model used in the study (lines 207-216).