Response to reviewers comments

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Title: 'Improved constraints on ammonia emissions and deposition from co-assimilating NH_3 and NO_2 satellite observations over the Netherlands' by Wizenberg et al.

We would like to thank the reviewer for their additional helpful comments and suggestions for the manuscript. The reviewer comments are in blue, author responses are in black, and any additions to the text are underlined. The page and line numbers correspond to the version of the manuscript that is available on ACPD.

Responses to reviewer #1

Comment C1.1:

The reviewer noted that our previous response did not adequately address the request for uncertainty estimates on *R*, μ, and σ. The reviewer clarified that uncertainty estimates for these quantities can be obtained using standard analytical approaches, such as the standard error of the mean for μ, an analytical approximation for σ, and the Fisher transformation for *R*, and requested that these uncertainties be reported in the manuscript. The reviewer also requested that the manuscript state whether the optimized-minus-base changes in these statistics are statistically significant.

Reply:

We thank the reviewer for this detailed clarification. We agree that our previous response was not sufficiently clear, and we also agree that uncertainty estimates for the Pearson correlation coefficient (*R*), mean bias (μ), and spread of the model-observation differences (σ) should be reported in the manuscript to support the interpretation of statistical significance. In the revised manuscript, we have therefore added uncertainty estimates for all statistical quantities reported in the model-observation scatter-plot comparisons, including *R*, regression slope, μ, and σ.

Specifically, the uncertainty in *R* is now estimated using the Fisher transformation as suggested by the reviewer, the uncertainty in μ is estimated as the standard error of the mean model-observation difference, and the uncertainty in σ is estimated using the standard analytical approximation for the sample standard deviation. The uncertainty in the regression slope is estimated from the ordinary least-squares covariance matrix. We have added a description of these calculations to Sect. 3.5 and explicitly state that these estimates assume independent paired samples and approximate normality, and should therefore be interpreted as approximate, particularly for comparisons involving repeated monthly values across sites.

In addition to the uncertainty estimates for the individual statistics, we have added paired bootstrap confidence intervals for optimized-minus-base changes in the reported statistics. These bootstrap estimates are calculated using matched observation, base-model, and optimized-model triplets. Changes are described as statistically significant only when the 95% bootstrap confidence interval does not include zero.

To avoid overcrowding the scatter plots, we did not add all uncertainty intervals directly to the figure panels. Instead, the main surface NH_3 comparison statistics are now summarized in Table 2, while the full uncertainty estimates and bootstrap results are provided in Appendix Tables C1-C5. Appendix Table C1 provides uncertainty estimates for the surface NH_3 comparisons, Table C2 provides paired bootstrap confidence intervals for optimized-minus-base changes in the surface NH_3 comparisons, Tables C3 and C4 provide the corresponding uncertainty and bootstrap estimates for the wet-deposition comparisons, and Table C5 provides uncertainty estimates for the 2020 satellite-subset sensitivity experiments. For the satellite-subset experiments, we report per-run uncertainty estimates, but do not assess all pairwise differences because these experiments are intended as a sensitivity analysis rather than a formal pairwise model-selection test.

We have also revised the relevant Results and Conclusions text to distinguish statistically significant changes from changes that are positive but not statistically significant. For example, the LML comparison now states that the reduction in mean bias is statistically significant, while the increase in spatial correlation is positive but not statistically significant. The MAN comparison now states that the optimized simulation significantly improves the spatial correlation for the full MAN network, but also significantly increases the positive mean bias. The co-located MAN sensors at LML sites show statistically robust improvements in bias, slope, and spatial correlation. The wet-deposition section has also been revised to state which temporal and spatial changes are statistically significant.