

Authors response

The authors would like to thank referee #1 and #2 for their valuable comments. We have changed the manuscript accordingly. The changes made to the manuscript are marked in red (deleted text) or green (added or changed text/figures) in the attached word file.

On behalf of all authors,
Shelley van der Graaf

Response to anonymous Referee #1

Dear Referee #1,

We would like to thank you for taking the time to review our manuscript and your encouraging comments!

Kind regards,
Shelley van der Graaf

Response to anonymous Referee #2

Dear Referee #2,

Thank you for your valuable comments! We have written responses to your notes individually in blue in the text below. Thank you again for taking the time to review our manuscript.

Kind regards,
Shelley van der Graaf

Medium comments

Comment 1: The authors should explain how the temporal variability is calculated in the background runs and why improving it is important; it took a few readings to understand that it is not the hourly profile that is being changed.

Minor edits and comments

Line 18: column data can be interpreted as total column; maybe use profile instead here and throughout? **We have changed this to “the CrIS-NH₃ profile”**

Line 63: spatial and temporal distribution... **we changed this**

Line 73: Need to check if NH₃ products are being generated from IASI-NG

Line 74: CrIS has greater sensitivity to near-surface... **changed**

Line 76: These trace gas measurements have opened up... **changed**

Line 89: for the daily distribution ... **changed**

Line 91: Using a Local ... **changed**

Line 92: approach as a data-assimilation system, which enhances existing spatial patterns. (can the authors explain why?) **We removed this line here because it is explained later in the manuscript.**

Line 99: that can ... **changed**

Line 124: has greater sensitivity to NH₃ close to the surface due to its low spectral noise ... and its 1:30 pm observation time, which coincides with the time of day with highest thermal contrast. **We have added this to the text.**

Line 161: Gaussian curve to scale NH₃ surface concentrations (see section 2.3.3) from CrIS in each cell. **We changed this.**

Line 175: that are mainly dependent... **changed**

Line 186: to adjust the daily variability in the hourly profiles **changed**

Line 186: Explain what qlag=3 entails and why it was chosen (to increase the number of available points?) **This is correct, we decided to use the observations with a quality-flag of 3 or higher because the number of observations with quality flag 5 per grid cell was insufficient for a decent fit.**

Line 194: differs by region... **changed**

Line 195: and chemical conditions. We changed this

Line 196: The factor is derived from ... changed

Line 200: Colors in Figure S2 are not defined We have added a color bar to the figure.

Line 201: Explain a bit why it is important to avoid flattening the spring peak We elaborated more on this and added an explanation.

Line 232: What does linearization of $h(x)$ to x mean here? We describe this later in the next paragraph (2.4.4), we added a reference to this paragraph in the text.

Line 235: The $\sim N(0,R)$ is not familiar to all readers The error is taken from a normal distribution with mean 0 and standard deviation R , we added some lines to the text explaining this.

Line 241: Define G Matrix G is the gridding operator, used to “regrid” the model and satellite layers. We added some lines to the text explaining this.

Line 246: The connection between eq. 8 and eq. 9 is not well made The missing link between the two equations, $y^{\text{true}} = h(x^{\text{true}}) + v$, is added to the paragraph.

Line 264: Explain why $QF=5$ is being used here. As the data-assimilation system navigates between the model and observational uncertainty, we decided to use only observations with a low uncertainty ($QF=5$). Observations with a high uncertainty are far more likely to lead to small or no emission updates in the analysis runs, and therefore their impact is more limited.

Line 310: the time factors alone changed

Line 367: Similarly changed

The statistics in Figures 12 and 13 should be presented also in a table, with the most important results highlighted. Also need a table here showing the type of instruments in each location. We have added the requested table with a summary of the computed statistics to the manuscript (Table 2).

Line 625: In this study..... This is a good point.