Response to Referee #2

We thank the reviewer for their comments, and respond to each below.

Reviewer Comment (RC): The paper describes the adaptation of a stratosphere/troposphere separation algorithm to the upcoming geostationary satellite instrument TEMPO. It is well written, logically structured and convincing in its conclusions. The paper should be published on AMT after dealing with the following issues:

Author Response (AR): We thank the reviewer very much for their positive and constructive remarks.

RC: Gridding approach: The authors perform a gridding as very first step (page 5, line 29). This is not optimal, as satellite pixels with potentially very different conditions (i.e. a low total column over a clouded pixel next to a high total column over a power plant stack without clouds, both within the same 0.1◦ grid box) are just averaged, with consequences hard to foresee due to the many nonlinearities involved. I would like to encourage the authors to rethink this approach and go for a different order, i.e. applying the filter on Strop,prior and the masking of pixels high ratio of strat vs trop AMF on individual satellite pixels rather than averaged 0.1◦ grid pixels.

AC: We agree with the reviewer that averaging pixels before running the algorithm may introduce unknown effects, and we thank the reviewer for the opportunity to clarify our strategy. Indeed, the TEMPO algorithm should be performed on the individual TEMPO pixels. Nonetheless, testing our algorithm on the individual OMI pixels would not necessarily capture issues that will be unique to the TEMPO viewing geometry. For this reason, and given the absence of real TEMPO data, we have treated the individual gridded satellite pixels as a proxy for individual TEMPO pixels, and focus in this manuscript on the performance of the algorithm with respect to the limited field of regard.

We recommend that the operational algorithm be performed on the individual TEMPO pixels once they are available. We thank the reviewer for bringing up this point, and have included the following text and clarifications in our manuscript:

Page 6, line 27:

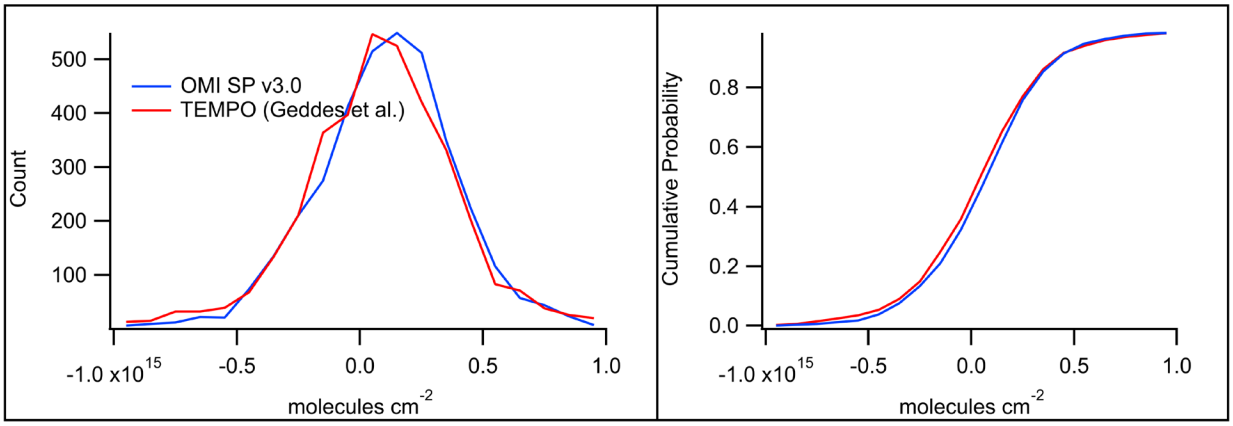
"Although we begin our implementation with the OMI observations gridded to 0.1 x 0.1, the TEMPO algorithm would be performed on individual TEMPO pixels. In other words, here we are treating our gridded OMI observations as TEMPO pixels."

RC: Tropospheric columns: Please provide some information on the frequency distribution of tropospheric columns over remote regions. Do negative columns occur? How large and how variable is the tropospheric column at the edges of the TEMPO domain?

AR: The reviewer asks a good question regarding potential negative tropospheric columns, and a related question about the columns at the TEMPO edges. While it is relatively difficult to identify "remote"

regions within this field of regard, we will treat the pixels immediately adjacent to the western TEMPO edge as “remote” for this investigation.

Figure R1 shows the histogram of the tropospheric NO2 columns that result from our TEMPO algorithm for the pixels directly adjacent to the western TEMPO edge (10 pixels deep) on July 15, 2007. We also show the cumulative probability distribution for the tropospheric NO2 columns along this region. For comparison, we include the tropospheric NO2 columns for the identical pixel locations from the OMI v3.0 standard product retrieval.



As you can see, our algorithm indeed results in negative tropospheric columns. The distribution is consistent with the independent SPv3 standard product retrieval for the same pixels. In both algorithms, about 37% of the pixels along this region are negative, as we would expect for a noisy signal close to zero. The mean tropospheric NO2 column along this western edge in our TEMPO algorithm is 0.71 x 10^{14} +/- 3.63 x 10^{14} molecules cm^{-2}, consistent with the mean tropospheric column in the same pixels from the standard OMI product is 0.98 +/- 3.38 x 10^{14} molecules cm^{-2}.

In summary, to answer the reviewer’s questions: we find negative tropospheric columns in our algorithm, and these are consistent with the distribution from the independent standard product retrieval from NASA. These distributions also answer the reviewer’s question about the magnitude and variability of the tropospheric column along the edge: we calculate a mean of 0.71 x 10^{14} molecules cm^{-2}, with a standard deviation of 3.63 x 10^{14} molecules cm^{-2}.

In response to the reviewer’s question, we have added the following material to our manuscript:

Page 14, line 11:

“We further evaluate the performance of our algorithm by comparing the NO_2 tropospheric column distribution along the western-most edge (1˚ deep) of the TEMPO field of regard with the NO_2 tropospheric column distribution resulting from the independent NASA SPv3 standard product. In this relatively remote region of the field of regard, we find a similar mean and standard deviation in column density (0.71 x 10^{14} +/- 3.63 x 10^{14} molecules cm^{-2} in our TEMPO algorithm and 0.98 +/- 3.38 x 10^{14} molecules cm^{-1} in the NASA SPv3). The fraction of negative columns that are observed in our algorithm is consistent with the fraction of negative columns that occurs at the same location from the standard product (~37%).”

RC: After introducing LEO on page 1, line 19, please use it (e.g. page 2, line 9; page 3, line 1).

AR: We have made the appropriate changes to the manuscript by replacing “low earth orbit” with “LEO” where applicable.

RC: Please comment which STS algorithm is foreseen for operational processing of TEMPO

AR: We thank the reviewer for providing the opportunity to clarify processing strategy. In response to this comment, we have added the following text to our manuscript:

Page 18, Line 9:

“Given these results, our recommendation for TEMPO is to use a climatological estimate (e.g. a 30-day mean) of stratospheric NO2 for context outside of the TEMPO field of regard during near-real-time retrieval if LEO observations are unavailable. This climatological estimate can be constructed based on satellite-derived observations in LEO from the preceding year and corrected for the time of day based on model results or other independent observations. We would then propose a later re-processing of the data that incorporates the daily LEO observations when available from the correct observation day.”