Reply to referee #1

We thank the anonymous referee for the positive evaluation of the paper. We have made changes to the manuscript based on the recommendations of the referee. The comments below require additional explanations included in this response.

Lines 64-68: I personally think that saying a particular emission estimate is higher/lower than the MEGAN inventory is not very useful, since (as the authors also pointed out) BVOC emissions estimated from MEGAN can be very different depending on the input PFT data, meteorological data, year of simulation, and also model resolution. I would strongly recommend that the authors revise these statements to give numbers, which would also give the readers a feel of the uncertainty in top-down/bottom-up BVOC emission estimates over Europe.

This is a good suggestion, though it is important to note that the studies referred to in the text cover different domain sizes and some do not report total emission fluxes. Consequently, intercomparing these different studies is not straightforward. We have included the numbers where available and made additional comparisons in Sect. 5.2 when describing the top-down emission results.

Section 2 and lines 335-340: Because a strict cloud filtering was applied, the HCHO column dataset used for the inversion may have a 'clear-sky bias', i.e., it is biased high because it only sampled days when the cloud cover was very low. Did the authors consider this when doing the bias correction using the ground-based measurements and when performing the inversion? If so, how? Was the optimization only applied to simulated days/grids with no cloud cover? Did the final weekly emission inversion accounted for the effects of cloud cover?

When computing the bias correction, only clear-sky data are used for the comparison. This is because the FTIR technique inherently requires clear-sky conditions. This implies that the validity of the bias correction for cloudy conditions is unknown. In principle this is fine, since we apply a strict cloud filter (cloud fraction CF<0.2) to the TROPOMI HCHO data used in the inversion.

However, as the referee highlights, the strict cloud filter might introduce a clear-sky bias in the inversion. The model is sampled at the time of TROPOMI overpass on days with valid TROPOMI measurements, so in general will also be sampled on clear-sky conditions. However, emissions are updated over the full week, hence the emissions are modified during both clear-sky and cloudy conditions even though the inversion only considers clear-sky conditions.

In order to evaluate the impact of the strict cloud filter on the emission inversion, we have conducted a new sensitivity inversion (S11, see Table 3) without this additional cloud filter for the TROPOMI HCHO data. We maintain the standard requirement of QA value > 0.5, which only excludes scenes with >40% cloud cover. In other words, in this sensitivity run, the cloud filter threshold is adapted from 20% to 40%. Because of the change in observational data, we have recalculated the bias correction using unfiltered TROPOMI data and use these bias-corrected unfiltered TROPOMI HCHO data as constraints for the sensitivity run.

In general, we find that the absence of the strict cloud filter leads to slightly lower HCHO columns over land and slightly higher columns over oceans (that is, after applying the new bias correction). In southern

Europe, the change in the bias corrected columns is the smallest. In central Europe, and particularly France, Belgium, the Netherlands, and Germany, the column change is larger, i.e. the unfiltered columns are lower than the standard run by about 1 x 10^{15} molec. cm^{-2}. The sensitivity run consequently shows almost no changes in the emissions in southern Europe, and slightly lower biogenic and anthropogenic emissions at higher latitudes, with respect to the standard inversion. In comparison with the standard inversion results, the total change in emissions over the domain is very small. The total isoprene emissions of the S11 sensitivity run are only 0.04 Tg/yr lower than in the standard S0 run (on a total of 18.3 Tg/yr). The anthropogenic emissions are about 0.17 Tg/yr lower in the S11 run. To summarize, the application of the strict cloud filter has little impact on the inversion results. A brief discussion on this sensitivity run is added to the paper. Table 3 and the bar chart in Fig. 11 have also been adapted.