We would like to sincerely thank the reviewer for her/his support and comments on the manuscript. The comments have helped to improve the quality of our work and include some new information.
We provide here a detailed point-by-point answer (shown in blue), to the comments and suggestions.

Reviewer 2:

In their manuscript “Two-dimensional monitoring of air pollution in Madrid, Spain using a MAXDOAS-2D instrument”, the authors report on measurements in Madrid using a new MAX-DOAS instrument with both elevation and azimuth pointing capabilities. Examples of NO2 profile retrievals are discussed and some results of onion peelingretrievals presented. Finally, a comparison is performed between hourly mean values from the lowest MAX-DOAS profile level and data from the air quality network, showing good correlation. The manuscript is generally clear and well written but lacks detail in many places. It also does not provide reference to the many existing studies using similar instruments, performing similar retrievals, and addressing similar research questions.

My main problem with this manuscript is however the lack of novelty: In fact, I do not see anything new in this manuscript on instrument development, DOAS retrievals, profile retrievals, the onion peeling approach or the validation of the retrievals. The instrument is similar to many others operated (see Kreher et al., 2020), the DOAS retrieval is performed using the freely available software QDOAS, the profile retrieval is using the software BePro, the onion peeling follows the work by Ortega et al. And the validation is limited to a single figure showing measurements from a not further defined time period. I therefore unfortunately cannot recommend this manuscript for publication in Atmospheric Measurement Techniques.

The measurements of the 2d-MAX-DOAS instrument in Madrid certainly have the po-tential to provide interesting results on

pollution in the city, and how it depends on emissions and meteorology. Such a study would then however be more appropriate for ACP than for AMT.

I also have some more detailed comments, which the authors could take into consideration when using the existing draft as base for another manuscript providing novel results and data.

We thank the reviewer for her/his comments, which we address below. We however think that AMT is the appropriate journal for publication of our results. To further add information on the capabilities of MAXDOAS-2D to the study of air pollution in Madrid, we have performed, and included in the revised manuscript, analysis of HONO spatial distributions. We now include an example of a two-dimensional map of HONO at 6 UTC time for the same representative day we used for NO_2. To our knowledge, this is the first time in which a 2D instrument is used to retrieve the HONO spatial distribution. The DSCDs simulated and calculated are in good agreement, and the comparison has a slope of 1.12 and a correlation coefficient of 0.99. In addition, the MAXDOAS-2D measurement of HONO has added value for air pollution research in the city since it is not measured by the in-situ monitors of the Council of Madrid air quality network. Therefore, our MAXDOAS-2D could provide some useful information regarding the mesoscale distribution of HONO, its role in the atmospheric chemistry in Madrid and its interactions with other trace gases such as NO_2.

Line 120: I am not sure that profile retrievals “try to reconstruct the photon paths” – in my view, they mainly try to find a vertical distribution that is consistent with the retrieved DSCDs

Thank you. We have changed this description for the sake of clarity and we have added a better RTM summary (from line 160 to line 163).

Table 1 / Table 2: I am not sure what exactly is meant by “All spectra and the Ring cross sections were allowed to shift and stretch (order 1) in wavelength”. However, in my opinion, reference spectra should not be allowed to shift and stretch as they are measured at high precision. If the background spectrum (here: the zenith-sky measurement) is well calibrated using a Fraunhofer Atlas, the only spectrum that should be allowed to shift and stretch is the horizon measurement itself.

Thank you for this comment. We think we failed to provide a clear explanation in our original submission. We only let to shift the measured spectra (with the MAXDOAS-2D) and the Ring, not the spectral absorption cross sections of the trace gases. We decided to include a shift to the Ring cross section because it is based on the inelastic rotational Raman scattering, which slightly changes the wavelength of the scattered photon when the scattering occurs, so it should have a little shift to improve the analysis. We checked the values of the Ring shift and although low, it improved the analysis, so we think that we could let the Ring shift in wavelength. This is now clarified in Tables 1 and 2.

Line 239: Cloud clearance using AERONET data will work in the direction of the sun, but as far as I know, it does not guarantee 360◦ of cloud free measurements.

We have added more information regarding the role of cloud measurements in our study. We mention the AERONET data because we compared the AERONET data with our MATLAB code data and the results are similar. Now, we have added the MATLAB code filter that we programmed from scratch (it is explained from line 312 to line 332).

Figure 4 and discussion: I did not fully understand what was done here and why -surely, it does not make sense to use an atmosphere for the wrong surface height. I also fail to understand what the conclusions i) and ii) exactly imply, and how they follow from the

fact that the profile retrieval is able to compensate a wrong atmospheric pressure profile by wrong extinction coefficients when reproducing O4 measurements.

We would like to take the opportunity to clarify that we did not use a wrong surface height, in which case we agree it would not make sense. We have used a height grid of layers that start right at the surface (0 m height). What we did was to interpolate the US Standard pressure profile (that is assumed to be accurate for the sea level) to the mean height of Madrid above sea level. Using those two sets of atmospheric profiles as examples, we ended up having very similar simulated DSCDs of O_4 in both cases, hence it seems that small variations in the atmospheric profiles do not affect significantly the O_4 analysis, thus we concluded in i) that the main driver of the O_4 retrieval are the measured O_4 DSCDs, which gives confidence to the overall analysis. However, each set of atmospheric profiles gave rise to notable differences in the extinction coefficients (especially above the surface layer). Therefore, we concluded that variations in physical parameters such as the pressure profile can produce changes in the extinction coefficients, hence given the difficulty to obtain very accurate atmospheric profiles, we think that as of now we cannot reliable assign those extinction values as particulate matter extinction (i.e. to aerosols). We prefer to discuss uncertainties in the atmospheric profiles rather than true or false profiles. Nonetheless, as shown in Figure 5, the fact that the simulated DSCDs still reproduce with high accuracy the measured O_4 DSCDs means that the light paths derived will be essentially the same (regardless the chosen atmospheric profile), and hence will ultimately generate almost the same results for the trace gases profiles.

Figure 9: I think it does not make sense to present two pieces of radial information from the onion peeling approach in this smoothed fashion that suggest a higher information content than there really is.

We tried to specify within the text that we carried out the calculations with two radial values, we decided to show the contour because we thought it would be easier to grasp both NO_2 location and its temporal variation at a glance. However, we understand the reviewer's point that interpolating from just two radial values may be misleading. Hence we have modified the figure in our revised manuscript to present our results through an usual polar plot without interpolation (see lines 638-641 for the figure caption).