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Comment on amt-2021-362

Anonymous Referee #2

Referee comment on "LED-based solar simulator to study photochemistry over a wide temperature range in the large simulation chamber AIDA" by Magdalena Vallon et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-362-RC2, 2021

This manuscript describes the design of the illumination system developed for the AIDA chamber and provides results from a series of characterization and research experiments. The manuscript is clearly written, though it will require editing prior to publication. In addition to being helpful for any researchers involved in AIDA experiments or using data from AIDA, the novel integration of banks of LEDs to produce spectra similar to the solar spectrum would be of interest to a broad group of readers. The decision to use LEDs rather than more commonly used sources for solar simulation such as xenon arc lamps obviously made the system considerably more complex, but offers advantages of less heat generation and the ability to alter the spectrum for specific applications such as studying the wavelength dependence of photolysis reactions. Though I feel the manuscript should be published, there are some points that need to be clarified and several minor corrections that should be made.

One general recommendation is that the authors consider shortening the manuscript by removing either the section on photolysis of 2,3-pentanedione or photolysis of dissolved organic components. Both experimental datasets are interesting, but the manuscript is quite long and, for me, it was hard to maintain interest by the time I got to that last section. It also seems that either of those results could stand on their own in a separate manuscript.

The major issue I have with the manuscript is that, while there is a lengthy discussion of the light intensity gradient, there is not regarding the impact it will have on the different types of planned or possible experiments. On line 92 there is mention of use of a fan to rapidly mix the contents of the chamber, but then it is never mentioned again in the manuscript? Was it on for some or all of the experiments that are described? If not, what is the mixing time scale in the chamber? And even if it was on for some or all of the experiments presented in the manuscript, I am pretty certain that it would be undesirable for any experiments with cloud particles and so there should still be discussion of the mixing efficiency and time scale. In general, there is obviously a tradeoff between losses when the fan is on and, I assume, significant heterogeneity in time-averaged actinic flux for packets of air moving through the chamber. Or maybe there is enough natural convection that this isn't an issue. Either way, it needs to be discussed and, to the extent possible, discussed quantitatively. For which potential uses will the time scale of important reactions be comparable to or shorter than that of mixing in the chamber? Also, there needs to be some discussion of where the tubes to the gas and particle analyzers connect into the chamber as that could influence results for experiments such as the NOx/O3 system shown in Figure 4.

Minor comments:

Line 199: The discussion at this point is focused on the light intensity gradient. Unless I am missing something, absorption of light along the walls of the flange collar (and therefore before entering AIDA) will not contribute to the top-to-bottom gradient.

Line 201: Stating just the wavelength of maximum reflectivity of aluminum is not especially useful without some discussion of the extent of fall-off on either side of the maximum.

Figure 2: I realize that the figure is already busy, but it really needs a curve showing the ratio of the intensity in AIDA to that outside (or two to show the winter and summer ratios).

Figure 3: The relevance of the temperature-dependent shift for the shortest UV depends a lot on the type of experiment conducted. The authors should add some discussion of impacts for any photochemistry experiments for which photolysis of ozone is a significant source of OH. Related to this, the authors should explain if there is anything that can be done to recover the <320 nm UV for the highest temperature with the current LED bank or possibly with additions to it.

Line 352: I assume that CO yield is in % and not a fraction like the other two.

Line 468: I assume there should be a "decreasing" in front of temperature.