**ACP-2022-505 – Vertical structure of the lower-stratospheric bias in the ERA5 reanalysis and its relation to mixing processes**

By Krüger et al. (2022)

Reply to review #2

This is an excellent evaluation of ERA5 water vapor using a large airborne dataset from HALO. The techniques used to assess biases are varied and comprehensive and complement existing assessments for other reanalysis models. Overall, I find the manuscript to be in great shape and have only a handful of what I hope are helpful suggestions to the authors as they work to finalize the paper.

We are grateful to reviewer #2 for the positive review and the recognition of our study. Below, we answer each comment in blue font.

**SPECIFIC COMMENTS**

1. Lines 97-102: While these outlines have become unfortunately common, I find them to be absolutely unnecessary. Recommend removing

We decided that we want to keep the outline to give an overview about the structure of the paper.

2. The maximum in humidity bias in the lower stratosphere is highlighted throughout and first introduced in Figure 5. In considering this bias and the accompanying discussion, the thought occurred to me that temperature in that layer was not evaluated in great detail. Are their sufficient temperature profile data in the HALO measurements to also assess temperature biases in these environments? That seems to be incredibly important to understanding the context for such humidity biases. Perhaps this layer, commonly characterized by containing a strong tropopause inversion layer (of similar shape to the humidity bias even), is driven in part by a warm bias in the model? For these reasons, if possible, I would strongly suggest the authors evaluate temperature bias and add that here to provide further context on the likely nature of this bias (and its variability between environments).

Unfortunately, our data set lacks collocated temperature profile data, which made it necessary to rely on simulated tropopause altitude only (see also the second comment by reviewer#1). There are a few dropsondes available for some of the considered campaigns, however, these are not representative for the entire data set. For this reason, we focussed on the LS moist bias and its relation to mixing using the comprehensive and unique DIAL data set. Certainly, a consideration of temperature observations to investigate the relation of temperature and humidity biases in the UTLS is an interesting task (see discussion in the Sect.1). Please note that recently Bland et al. (2021) used radiosonde data during the NAWDEX campaign to quantify the LS moist and its relation to temperature biases. They show that the analysis temperature representation is fairly good, but radiative effects in relation to the LS moist bias cause a cold bias that is intensifying with increasing forecast lead time.

**Technical Edits:**

Line 19: delete "located" Corrected.

Line 193: delete "on" Updated.

Line 268: a word appears to be missing here. I think the authors meant to write "the systematic **nature** of the diagnosed" Updated. Included **"nature"** in the sentence.

Line 461: delete "the" Corrected.

Line 473: "This supported" should be "This is supported" Corrected.

Line 514: "profile" should be "profiles" Corrected.