Review of "Insights of warm cloud biases in CAM5 and CAM6 from the single-column modeling framework and ACE-ENA observations" by Wang et al.

In this study, model biases in aerosol and warm cloud simulations are examined in two versions of the NCAR CAM model using a single-column model framework (SCAM5 and SCAM6) for the ACE-ENA field campaign. The authors analyze differences between simulated cloud and aerosol properties and ACE-ENA observational data.

The paper is well organized and written, but lacks clarity and important information. My general comments reflect this issue.

Major comments:

1. SCAM5/6 configuration and ACE-ENA case setup:
    a. To enhance the comprehension and reproducibility of the study, it would be beneficial to include more comprehensive details on the configuration and setup of SCAM5/6 simulations. Specifically, but not exclusively, the manuscript could provide information on which parameterizations were employed, which large-scale forcings were included, the evolution of input thermodynamic profiles over time (stationary or not?), the number of vertical levels used, and the model time step. Additionally, it may be useful to explicitly mention that the moisture field evolves freely, assuming it does so based on L192.
    b. The retuned KK scheme is mentioned for the first time in section 4. To enhance the paper's clarity for all readers, including those who are not experts on cloud microphysics parameterizations, I suggest introducing the retuned KK scheme in the Methodology section (the mathematical description can stay in section 4) along with a brief description of the default cloud microphysics parameterizations of SCAM5 and 6.

2. I have a few related comments in section 3.1:
    a. Although the simulated median and mean temperature values agree well with the observations, the temperature PDF suggests that this is partially due to a "canceling effect" from the lower/higher bins relative to the middle ones., i.e., the simulated values over the temperature "extremes" (lower and higher bins) are larger than the observed ones, but in the middle bins, the observed values surpass the simulated ones (i.e., bins between 280 and 290 K). All to say that the temperature PDF doesn't fully support the sentence in L184–185.
    b. The authors conclude that the specific humidity bias of SCAM6 arises from the model moisture bias rather than the temperature bias (L190–191), partially because the temperature field is nudged towards the initial conditions (L133–134). While this is true, the nudging time-scale for the PBL is rather long (close to 10 days) which reduces the nudged impact on the PBL's evolution. In addition, the temperature PDF indicates a moderate bias in simulated temperature in the lowest bins, i.e., between 265 to 275 K. Hence, while not entirely disagreeing with

L190–191, the results in Figure 1 do not rule out the possibility that the temperature field also contributes to the RH bias.

c. The limits of the temperature plots are unnecessarily large. To improve the clarity of the temperature field, I suggest reducing the upper and lower limits to 260–300 K; this range is also consistent with the temperature PDF below.

Please comment on these and adjust section 3.1 and figure 1 accordingly.

Minor comments:

P4 L93–94: I can't find the reference to Wang et al. (2016) and Zhang et al. (2020) in the References list.

P4 L93–94: Please consider adding at least one more reference per reference set, and add "e.g.," before each reference set since there are too many available references to include all.

P4 L111–112: Please define explicitly the acronym MAM.

P6 L150: Please include the estimated median uncertainties also for N_c and *CLWC*.

P7 L167: The sentence "To make better… only selects the research flights with an "L" shape pattern center at the ARM-ENA site" may require additional context for readers who are not familiar with the flight sampling configuration used during ACE-ENA and its rationale. How does this pattern help improve comparisons between observations and simulations?

P10 L256: Could the authors provide more information on the physics used in the SCAM5 version in this study? In CAM6, CLUBB is responsible to diagnose the cloud macrophysical properties. To improve clarity, it would be helpful to include further information about the differences in the physics between the SCAM5 and SCAM6 versions used here; this ties in with my "Major comment 1". This should probably go in section 2.1.

P10 L264: Could you please confirm whether these in-situ profiles represent an average of data from the 17 flights? Also, could you clarify what the SCAM6 profiles correspond to? Are they averages of the 17-flight time-stamps, or do they represent something else?

P11 L308: In section 4, the results show that the retuned KK scheme improves cloud micro- and macrophysics in SCAM5, but "as expected" it doesn't lead to improvements in SCAM6 relative to the default MG2 (if I understood correctly). Thus, I was left at the end of section 4, questioning its purpose. I'm not suggesting removing it, but consider clarifying what this section adds to the paper.

P16 L423: The website link to where the data is stored is currently not working.

Figure 5: This is just a suggestion: Use the x-axis labels on only the bottom row or use the same labels on both rows. Currently, the bottom and upper rows have different x-axis labels even though they represent the same variable, which is a bit inconsistent.