Response to Report #1:

We thank the reviewer for their attention to the revised manuscript and the thoughtful discussion. Our responses and line-by-line changes are below.

"It seems that the authors are putting far to much credulity in the linear regression relating the CFODD slopes to ERF_ACI, when the CNTRL simulation already almost perfectly matches the observation. I think this manuscript is borrowing way too heavily from the methodology used in the 'emergent constraints' world, where in many studies the control variable is very different between the simulation and the observation and it might make sense to use the linear regression to get a good estimate of ECS. If you really want to use this linear regression as quantitatively as you have you should prove that it is robust. For example, do several more experiments where you vary other model parameters and see how that changes your slope. I can almost guarantee that you can change it outside of the bounds of your existing uncertainty range.

My strong recommendation is to remove the repeated mentioning of reduced ERF_ACI by constraining the CFODD shape by such a precise number and instead just state the model is in agreement with observations and there is a strong sensitivity of ERF_ACI to this particular metric which provides a useful constraint on a highly uncertain process."

We agree that a different result and constrained value of $ERFaci_{SW}$ would be expected if we repeated the experiment for other model parameters that modulate droplet collection efficiency. This is stated on L419 and L529:

L419: As $ERFaci_{SW}$ is the result of many cloud processes, the updated CFODD analysis should be interpreted as a constraint on the component of $ERFaci_{SW}$ that is modulated by droplet collection efficiency due to autoconversion. In other words, the updated CFODD analysis shows the change in $ERFaci_{SW}$ one would expect if the bias in $ERFaci_{SW}$ due to a specific process representation affecting droplet collection efficiency were eliminated.

L529: While this study focuses on autoconversion, future studies should apply CFODD analysis to other microphysical processes that affect droplet collection efficiency (e.g., accretion, droplet breakup, evaporation) to generate additional ERFaci constraints.

In other words, we would expect a different result for another process. The CFODD analysis shows you what change in $ERFaci_{SW}$ you could expect if the bias in $ERFaci_{SW}$ due to a given process were reduced.

We also recognize that there are additional uncertainties in the linear regression approach to constraining ERFaci due to limitations of our study that are not represented in the 95% confidence interval, such as the limited number of experiments. We have modified the text as the reviewer suggested and have removed all statements referring to reducing $ERFaci_{SW}$ by a specific quantity.

Abstract: E3SMv2's CFODD slope (0.20 ± 0.04) is in agreement with observations (0.20 ± 0.03). The strong sensitivity of $ERFaci_{SW}$ to the CFODD slope provides a useful constraint on highly uncertain warm rain processes, whereby $ERFaci_{SW}$, constrained by MODIS-CloudSat, is estimated by calculating the intercept of the linear association between the $ERFaci_{SW}$ and the CFODD slopes, using the MODIS-CloudSat CFODD slope as a reference.

L400: The constrained value of $ERFaci_{SW\_SLWCs}$ is estimated at the intercept of the linear relationship with the observed MODIS-CloudSat CFODD slope (Fig. 4). We find that the $ERFaci_{SW\_SLWCs}$ predicted by the linear regression at the MODIS-CloudSat slope value (-0.066 W m^{-2} ± 0.06 W m^{-2}) approaches agreement with the $ERFaci_{SW\_SLWCs}$ value predicted by the E3SMv2 CNTL simulation (-0.077 W m^{-2}), particularly considering the additional uncertainties imposed by the limited number of sensitivity experiments that are not represented in the regression's 95% confidence interval. The agreement between the constrained and predicted value of $ERFaci_{SW\_SLWCs}$ indicates that the $ERFaci_{SW}$ due to autoconversion is well-represented in E3SMv2 according to CFODD analysis.

L521: In this study, we present an updated CFODD analysis, demonstrate how it can be applied to ESMs as a process-oriented constraint on ERFaci and find that E3SMv2's $ERFaci_{SW}$ agrees with the MODIS-CloudSat constrained value within uncertainty.

We have also updated L472 because important context was removed in the preceding paragraph on results due to the updates above:

L472: Considering that constrained $ERFaci_{SW}$ increases in magnitude with increasing R_e in Fig. S7,that the shortwave component of ERFaci is significantly larger than the longwave in CMIP6 models (Smith et al., 2020), and that E3SMv2's total ERFaci (-1.50 W m^{-2}) is relatively strong compared to the IPCC AR6 'very likely' range (-1.0 ± 0.7 W m^{-2}) (Forster et al., 2021), the underrepresentation of SLWCs with large R_e in E3SMv2 represents a compensating bias, without which the total ERFaci would be even stronger compared to IPCC AR6.