General Comments:

Reviewer comments are bolded, *our answers are italicized*, *any text in the manuscript that did not change is red*, and modified text is blue

We thank the reviewers and editor for their thorough examination of this manuscript, and we believe that we have now addressed your concerns. The primary major concerns of reviewer 1 centered on: 1) uncertainties in the retrieved cloud-properties in broken cloud regions, 2) problems with the nighttime cloud-property retrievals, and 3) our definition of the “after” period. Below we have addressed these concerns. Specifically, 1) we modified the main text to only include microphysical-properties on cloudy pixels that are connected to four other cloudy pixels (excluding corners) to limit biases due to broken clouds and found that our overall results and conclusions did not change, 2) we moved all discussion of the nighttime cloud-property results to an Appendix, and 3) we now explicitly state that the “after” period either means that open cells transition back to closed cells or start transitioning to Cu. See our detailed responses below.

Editor's Remarks:

The reviewer/editor comments are bolded, *my answers are unbolded and italicized*, and any unchanged text is red and changed text is blue

Dear Dr. Smalley,

I now have a second round of reviews. While Reviewer 2 feels the manuscript is ready for acceptance with only minor corrections, Reviewer 1 remains concerned that a few technical aspects of the analysis have problems that were pointed out in the first round of reviews but have not been satisfactorily addressed. I suspect you can address these quite readily and hope you will seriously consider the merits of the Reviewer's points for my consideration.

As an editorial comment, much of the discussion and conclusions of the paper are focused on the potential role (or lack of it) that aerosols play in POCs. Given that there has been significant discussion on this point, as you summarize in the body of the document, I would like to suggest that you highlight related conclusions in the abstract.

Regards,

Tim Garrett

Editor Comment:

We added the following sentence to the abstract (lines 14-16) that now addresses aerosols: *"Interestingly, there are no differences in reanalysis aerosol-optical depth between both sets of trajectories which may lead one to the interpretation that differences in aerosol concentrations are not influencing POC development or resulting in a large number that re-close. However, this largely depends on the reanalysis treatment of aerosol-cloud interactions and the product used in this study has no explicit handling of these important processes.*"

Reviewer 1:

The authors have addressed many of my comments on the original version of the manuscript to a large degree, but some key issues remain.

Please do a search for "CONTROL" in text and figure labeling and make sure all are changed to "CLOSED" for example, Table 2 annotation of "CONTROL" needs to be changed to "CLOSED".

We have changed "CONTROL" to "CLOSED" in the caption of Table 2.

a) Related to previous comment: Further detail is needed regarding the statistics of POCs that do not reclose in order to distinguish among several scenarios. In particular, the size of the subset of POCs that essentially run off the cloud deck needs to be quantified.

The number of POCs that do not reclose are given on lines 224-225: "Further breaking this down, 129 POCs never re-close, 12 POCs re-close, and 6 of the calculated trajectories leave their associated POC area prematurely." and in your following statement. Statistics regarding POCs that do not re-close are listed in Table 1 (added after the last revision) and are referenced in the main text (lines 238 and 252).

Since only 12 POC cases reclose out of 141, nearly all the "ends" are going off the edge of the cloud deck. To reduce the ambiguity of what "end" and "end time" of POC means in the text, suggest replacing "end" with "exit cloud deck" in text and esp. in caption for Table 1 and captions for Figures 5, 7 in the paper.

We feel the language is clear as stated in the text (abstract and section 3.1), Table 1, Figure 5, and Figure 7. For instance as stated on lines 243-245, "Why might POCs preferentially end (exit the StCu) during the day? We find that StCu area reaches a minimum around 12 local time (Figure s-1). As a result, we hypothesize that the tendency for POCs to exit the StCu during the day may simply be the result of a general

reduction in StCu extent during the daylit hours (Burleyson and Yuter, 2015), so that the StCu edge effectively moves towards the POC during sunlight.", the POCs that do not re-close are exiting the StCu deck. Therefore, to change "exit" to "end" in the text would be incorrect language. In the table and figure captions the POCs are referred to as ending because both the POCs that do and never re-close are grouped together.

b) Inadequate response to previous comment: B) Retrievals of cloud properties from areas of broken cloud have high uncertainties

Authors' response:

We agree that the uncertainties of cloud property retrievals inside POCs may be problematic, however the primary reason we include the nighttime results - i.e. we expect that if we see similar patterns in both the daytime and nighttime results, we suspect that the changes found in the different cloud properties are real and not due to uncertainty resulting from broken cloud. To clarify this, we added lines 161-164:

"Overall, uncertainties in microphysical retrievals inside POCs (Coakley et al. 2005) are unavoidable. However, the nighttime retrievals provide an independent comparison to the daytime retrievals that can lend confidence to the patterns, not magnitudes, in the daytime microphysical patterns and alleviate concerns about daytime retrievals due to broken cloud (Coakley et al. 2005)."

Effectively, this is using bad data to check for consistency with bad data. Reviewer 2 also expressed major concerns about the nighttime retrievals of cloud properties. In the authors' response to Reviewer 2 "Yes, LWP and N are derived at night, and, because of the differences in day and night retrievals of COD and re, we find the magnitude of LWP and N are smaller at night than during the day. However, we have not found any studies that have evaluated the validity of deriving LWP and N from nighttime retrievals."

Authors do not seem to understand that VIS/IR satellite retrieved cloud properties in areas of broken cloud (and especially in broken cloud at night) have such high uncertainties that they are effectively unusable for properties such cloud amounts, droplet effective radii, optical depths, cloud altitudes, cloud liquid water, and column droplet number concentrations.

Given the issues, suggest removing all material related to nighttime retrievals and limit all daytime retrievals to areas of high cloud fraction. This is an area where the satellite retrievals cannot stand in for in situ measurements from aircraft. The

paper's credibility is substantially weakened by inclusion of such problematic data.

- *Broken cloud issues*
  - *We agree with the reviewer that regions of broken clouds are problematic, and we should have done a better job addressing this. Ideally, we would address this by removing partially-filled pixels, unfortunately this data is not publicly available. Therefore, we now limit our cloud-microphysical analysis to cloudy pixels that are bordered by four other cloudy pixels (excluding corners). This does not completely remove biases in broken-cloud areas, but it does limit the impact of pixels likely containing cloud edges. After doing this, we found that although the magnitudes of our microphysical statistics changes slightly, the overall results and conclusions do not change (ex. Figure R.1). Lines 171-175 explain this: "Prior studies have also found biases in retrieved optical properties in broken clouds due to cloud-edge effects (Coakley et al., 2005; Vant-Hull et al., 2007; Platnick et al., 2017; Zhu et al., 2018) and 3D radiative transfer artifacts (Zhang et al., 2012; Liang et al., 2015). GOES-R does not flag partially-filled pixels similar to MODIS (e.g. Jensen et al., 2008), meaning these biases likely influence our results. Therefore, we only include microphysical properties (COD, re, LWP, and N) on cloudy pixels connected to four other cloudy pixels (excluding corners), similar to MODIS (Platnick et al., 2017), to limit these biases.", and all cloud-property figures (Figures 13, 14, S.2, and S.3) have been updated to account for this.*
- *Nighttime vs daytime*
  - *Yes, the nighttime retrieved cloud optical properties are problematic, and this is because the retrievals are limited to IR channels only. However, the nighttime retrievals used by GOES-R using only brightness temperatures are well established (i.e. Lin and Coakley 1993; Baum et al. 1994).*
  - *Given the inability of the GOES-R retrievals to capture the full range of COD at night and the reviewers concerns, we have modified both the methods (lines 160-167) to state that the main text focuses only on the daytime cloud-property results: "The day/night retrieval algorithms are fundamentally different. At night, COD is limited from 0 to 16 and r_e is limited to 2 μm – 78 μm, whereas, during the day, COD can be retrieved from 0.25 to 158 and r_e can be retrieved from 2 μm to 100 μm. The dynamic range is smaller at night because the emissivity of larger particles is similar at 11.2-μm and 12.3-μm, resulting in a smaller range of COD and r_e values that can be discerned (Lin and Coakley Jr. 1993). An effect of the limited range of nighttime optical depth retrievals is that a noticeable*

fraction of nighttime CODs are exactly 16. The diminished range of COD and r_e limits our analysis of cloud-property differences between the POC and CLOSED trajectories. Therefore, we focus only on the daytime cloud property results in the main text and use the nighttime results as a comparison dataset as discussed in Appendix A.".

- *To indicate that we view the nighttime retrievals as less trustworthy but still complementary to the daytime retrievals, we have moved all discussion of nighttime cloud-properties to Appendix A.*

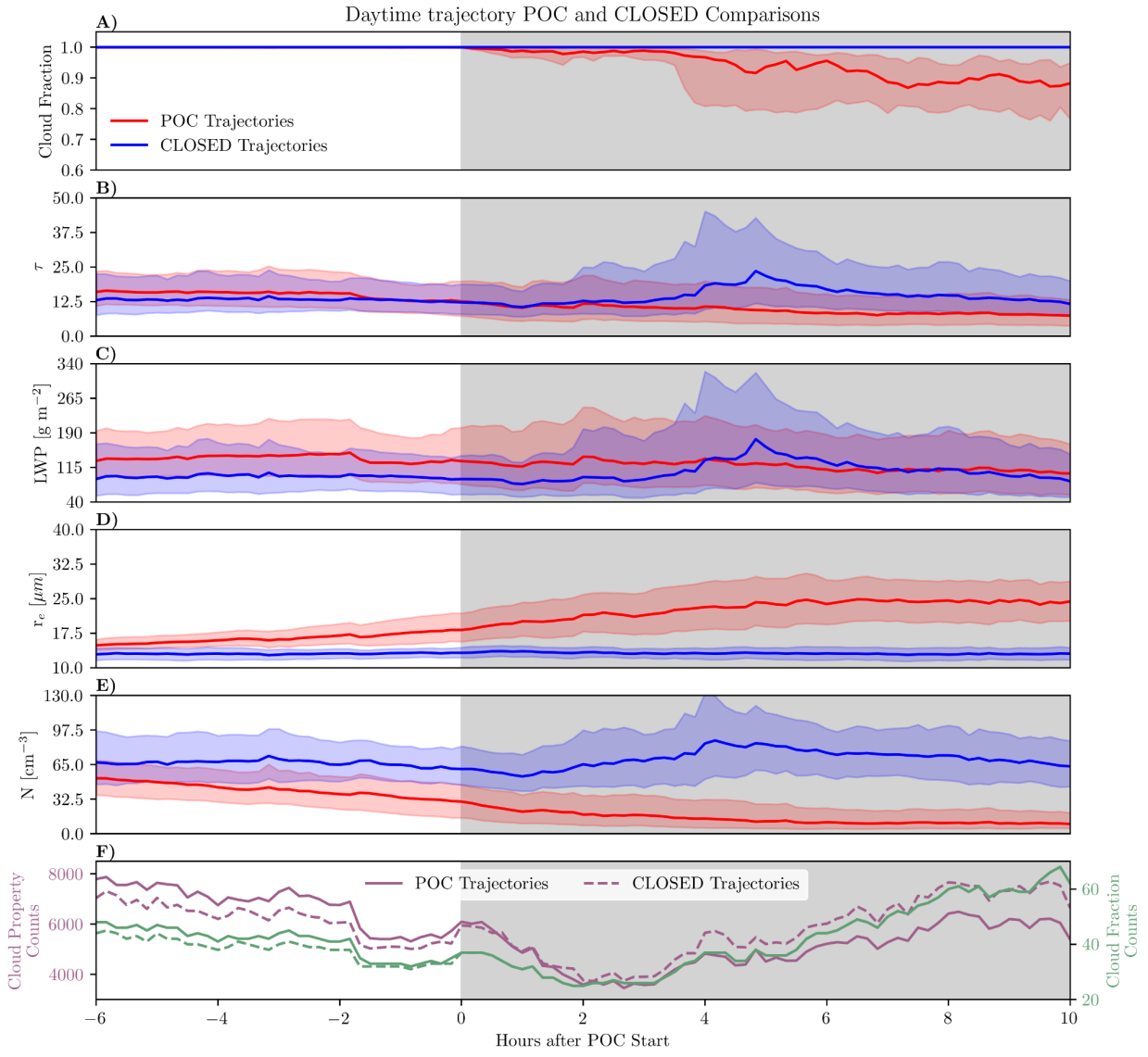

Figure R.1: The median changes in daytime cloud fraction (panel A), cloud optical depth (panel B), liquid water path (panel C), effective radius (panel D), and cloud drop number concentration (panel E) for the six hours before until ten hours after POC development are shown along all POC (red) and CLOSED (blue)

trajectories, where the red and blue fill represent changes in the interquartile range. The number of valid samples for both the GOES-16 microphysical properties (purple) and GOES-16 cloud fraction (green) are shown in panel F). Gray shading indicates the time after POC development.

c) Related to author's clarification of "before" and "after" periods:

Authors' response: Regarding the "before" period - it ends 10 minutes before the cloud transition, and the "after" period represents 10 minutes after POC end. Lines 129-130 have been modified to clarify this: "The trajectories are run forward and backward from 10-minutes before POC development up to 6 hours before POC development and 6 hours after POC dissipation."

Figure 14-16, utilize POC characteristics "After" POC end which for 129 of the 141 POCs means the POC went off the edge of the cloud deck. Please clarify how one can obtain *any cloud characteristics* in the hours after a POC has moved off the edge of the cloud deck?

We modified our definition of the "before", "during", and "after" periods after the previous round of revisions, however it still appears to be inadequate. Specific to the "after" period, we note that a POC leaving the StCu deck does not imply that cloud fraction goes to zero; rather, it indicates that a transition to the Cu regime has begun. To clarify this, we modified lines 148-151 in the methods to "Specifically, we define the "before" time as the time prior to the comparison trajectory reaching the location where the POC forms, and we define the "after" time as the time after the comparison trajectory reaches the location where the POC dissipates (for the group of POCs that re-close, open cells transition back to closed cells, and for the group that never re-closes, open cells start transitioning to Cu).", *and lines 323-325 in the results to "The overall differences between the POC and CLOSED trajectories do not change much in the transition from the during to after periods, likely because most POCs never re-close before transitioning from a StCu to a Cu cloud regime."*

New Comment: Please clarify: Lines 465-473: While evidence that most POCS do not reclose before moving off of the edge of the cloud deck is in the paper, for finding in paper that POCs "tend to accelerate the StCu to Cu transition and not to reclose...", *evidence specially related to accelerating is not presented, nor is the definition of acceleration made clear in this context*

Accelerate in this context refers to the prior cited work (lines 650-655) discussing the potential role of precipitation in the StCu to Cu transition. We agree that a term like "accelerate" should be quantified so we modified lines 421-422 to "Our finding that POCs catalyze the StCu – cumulus transition and prevent POCs from re-closing

suggesting that the ability of aerosol to enhance cloud albedo is highly dependent on the current state of the cloud field."

Mention is made of Yamaguchi et al. (2017) LES paper but that is not evidence from *this study*.

This Yamaguchi paper is referenced several times in that section. However, we assume that you are referring to lines 412-414: "Furthermore, as the open-cells within POCs continue to organize and precipitation intensity increases, the StCu deck transitions to a precipitating shallow cumulus field (Yamaguchi et al. 2017).". Considering that we do not have any evidence of this organization occurring, we removed the preceding sentence "Considering most POCs identified in this study never re-close, our results suggest that the development of POCs driven by organizing precipitation can mediate the timing of the stratocumulus to cumulus transition." from the manuscript, and modified the concluding sentence of this paragraph (lines 414-416): "These results suggest a process possibly explaining why most POC cases we observe never re-close, but more observational studies tracking POCs over a longer timeframe and across more regions are needed to draw more general conclusions."

Reviewer 2:

The authors have addressed my original comments and concerns, and I appreciate the additional analysis that examined the growth rate of POCs (Sect 3.2) and how cloud properties evolve over the course of the POC lifetime (Fig 13) .

I only have technical comments and two minor suggestions below to consider before publication.

L207 – citation needs to be outside of parentheses.

On line 213, "(Romps, 2017)" is now "Romps (2017)".

Fig9 and Fig 11a: The information in the two plots appear to be almost identical. For this reason, I wonder if one (Fig. 9) might be removed.

We agree that these two plots are redundant, but we think both are necessary. Specifically, we chose to keep both because we wanted to show both plots with different temporal resolutions (daily and 10-minute) to make two separate points (one demonstrating how/why we separated days with many and no POCs and the correlation between the number of POCs every 10 minutes and StCu area).

L382 – typo with 104 km2

This has been corrected to "10^4 km^2" (line 381).

L419-422 – Perhaps it is worth mentioning again the result in Section 3.1 that noted that while modeling studies have examined what aerosol increases are necessary to close POCs, you find no evidence for such processes occurring in your analysis.

We do not think that a statement regarding the ability of aerosols to potentially close POCs is appropriate here, because MERRA-2 aerosols are not fully interactive with rain, and we cannot test this with our data.

L426-427 – This sentence needs to be fixed: the same phrase is repeated.

Lines 426-428 have been modified to "This study demonstrates, most importantly, that the improved spatio-temporal resolution of the current generation of geostationary sensors and the associated data product suite provides an important tool in evaluating the temporal dimension of POCs for future studies.".