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Comment on acp-2021-1001

Anonymous Referee #1

Referee comment on "A Lagrangian analysis of pockets of open cells over the southeastern Pacific" by Kevin M. Smalley et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-1001-RC1, 2022

The paper demonstrates the value of high spatio-temporal resolution (10 min, 0.5 to 2 km) geostationary satellite data from GOES-16 for examining the lifecycle of Pockets of Open Cells (POCs) in the southeast Pacific. Most of the findings confirm previous work. Three areas need to be addressed: A) The new findings related to re-closing need more explanation. B) Retrievals of cloud properties from areas of broken cloud have high uncertainties, more relevant would be to emphasize comparisons of cloud properties in overcast conditions an hour or more *before* POCs form. C) Issue with “corresponding” POC and CONTROL tracks

General Comments

A) New findings related to re-closing need more explanation

The implication in the paper that marine stratocumulus boundary layer is well mixed all the time is not correct. There is a diurnal cycle in the degree of coupling between the ocean surface and cloud base with more coupled (well mixed) conditions overnight when negative buoyancy of parcels is stronge compared to more decoupled conditions during the day (see Burleyson et al. 2013, esp. Fig 3 and 4) including situations during the day where there is a stable layer within the subcloud layer (Wilbanks et al. 2015). The diurnal cycle in the degree of coupling of the boundary layer means that there is a much lower probability that a POC that is present during the day will close compared to a POC at night.

Based on Figure 7, most POC tracks end during the day.

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. Suggest add a table that addresses the number of tracked POCs and their median lifetimes, and median areas for the following categories:

POCS that form during the night and reclose

POCS that form during the day and reclose

The category of "not reclose" includes

POCs that form at night and reach edge of cloud deck during the following day

POCS that form at night and do not reclose the following night

POCS that form during the day and reach edge of cloud deck before the next evening

POCS that form during the day and do not reclose the following night

Additionally consider modifying Figure 5 to also indicate whether the end of POC track coincides with edge of the cloud deck.

B) Retrievals of cloud properties from areas of broken cloud have high uncertainties

Coakley et al. 2005 showed that retrievals of cloud properties from areas of broken cloud have high uncertainties. Hence, comparisons between POC (which is by definition broken cloud) and CONTROL for cloud optical depth, cloud top effective radius, liquid water path, and cloud droplet number concentrations are problematic. Suggest refocus presentation of results to emphasize comparisons of the distributions of cloud properties of overcast clouds an hour or more before POC formation with overcast conditions that do not form POCs. This information may already be in the paper but needs to be clarified and emphasized.

Since you have a Lagrangian track and run it up to 6 hours before POC development (Line 125), you can estimate the position of the air mass that forms the POC an hour or more prior to formation. Figure 13 shows "BEFORE" conditions but it is not clear in the paper what the increment of time before means other than to note it is before visible cloud transition. Is this 10 min before, 1 hour before, 2 hours before? Is it the median of the conditions 6 hours before? One might expect a larger LWP in overcast clouds that later form POCs since those clouds likely precipitate more but it is not obvious if other cloud characteristics would appreciably differ an hour or more before POC formation.

Also consider examining if there are any trends in cloud characteristics in the overcast clouds over the 6 hours prior to the POC opening up.

Related to Figure 13-16, please add information to indicate sample sizes for BEFORE, DURING and AFTER statistics. Since most POCS run off the cloud deck presumably "AFTER" is only for the subset of POCs that reclose? Are sample sizes for BEFORE and DURING the same?

C) Issue with "corresponding" POC and CONTROL tracks.

Calling the CONTROL track that is +/- 24 hours from the POC track but in the same start location the "corresponding CONTROL track" is a big stretch since the stratocumulus cloud deck itself is not steady state over 24 hour periods.

I do not find the line of reasoning Line 136 "to ensure that both the POC and CONTROL trajectories travel through similar meteorological regimes at the same time of day" very compelling given typically obvious changes in a southeast Pacific cloud deck and high pressure patterns in 24 hours. Suggest either justify this further or remove all materials related to "corresponding" tracks.

The CONTROL tracks are still relevant as a data set of conditions in overcast clouds. My objection is to the idea that a specific track within overcast cloud 24 hours before or after a POC corresponds directly to that specific POC (i.e. other than the fact that the POC occured all other key environmental conditions are equal).

Specific Comments:

1. Line 90-91, mentions that POCS formed in response to gravity waves are excluded. How is this done?

2. Section 2.4, Please clarify that AMSR-2 data used for the precipitation estimation is available only at most twice a day (swath width means revisit time is every 2 days) and thus provides the equivalent of a few minutes information along the median 10 hour POC duration. [https://www.ospo.noaa.gov/Products/atmosphere/gpds/about_amsr2.html]

3. Section 3.2, Please provide information that quantifies POC occurrence normalized by the area of the overall cloud deck in the study region. To what degree are fewer POCs occurring because there is less cloud deck area? This is an important constraint on understanding environmental controls on POC formation. Based on Figure 10, the area with cloud fraction > 80% is substantially larger for days with >= 7 POCs compared to those with 0 POCS. Related to this, it also would be helpful to add the time series of daily Sc cloud area to Figure 9.

4. Figure 11 caption, please clarify what is the data set used to compute Sc cloud area. Is this the 0.5 - 2 km pixels from the GOES-16 sensor.

5. Figure 12 caption discussed purple and green dots but the actual figure shows blue and red dots.