Referee 2

Main points:

-Can you go into a little more detail concerning how you link the Aqua and Terra observations? Are you using trajectories to link each 1x1 degree box in Terra to their Aqua counterpart? What level winds are you using, and what assumptions are you making about these links?

The cloud field is advected (from Terra to Aqua, 10.30 to 13.30) using ERA5 reanalysis wind fields at 1000hPa. The advection is calculated on a 0.25° x 0.25° resolution grid as the movement of the cloud fields over 3h is expected to be less than 1°. Each grid box on the fine grid is treated as a 'parcel trajectory' and advected using the wind fields. The Aqua data are then sampled at the end points of these trajectories and then aggregated to a 1° x 1° grid.

The ERA5 wind field at 1000hPa is used as this level has been shown to accurately predict the locations of ship tracks, and hence suitable for advecting clouds over short time scales.

The above details have been added to the manuscript (L119).

-Data section: Are you doing any sort of filtration based on MODIS cloud cover or ERA5 meteorology? It is possible **that differing cloud morphologies** may have differing dominant processes, or that Nd and LWP anomalies could be associated with differing meteorology. It would be comforting to test for this, to see if these relationships persist when controlling for variables like cloud cover, EIS, SST, and humidity above the cloud.

We completely agree that the effect of cloud morphologies and large-scale meteorology can have confounding influences on the Nd-LWP relationship. Here, we are looking at simpler cases, and the effects of other variables such as EIS, SST and free tropospheric humidity are reserved for future studies. These can affect cloud top entrainment which could indirectly affect the results by introducing new FT aerosols. We have included a discussion of this in the conclusions now (L324). We decided to focus on the role of wind-driven processes as this will have a more prominent role in answering the question of the interplay between fine and coarse marine aerosols.

-LWP and Nd have strong variability with the MODIS sensor view angle. Have you looked at these relationships while controlling for this view angle? I recommend sub-setting the data into high/low sensor zenith angle bins and checking for consistency, as the zenith angle biases can be extremely strong.

We have already accounted for the MODIS sensor view angle by only considering pixels with sensor angles > 55° and solar zenith angle > 65° following Grosevnor et al 2018. The data and methods section have been updated to reflect this and other details on filtering applied to MODIS data (L113).

-Line 141 concerning regression to the mean: The patterns of increase/decrease seen in Figures 1a-b and 1d-e are almost certainly driven by regression to the mean, as stated. Anomalous initial values along trajectories have a strong tendency to regress to the mean as shown here:

Eastman, R., Wood, R., Bretherton, C.S., 2016. Time Scales of Clouds and Cloud-Controlling Variables in Subtropical Stratocumulus from a Lagrangian Perspective. https://doi.org/10.1175/JAS-D-16-0050.1

This figure shows this behavior clearly, with Low Nd and Low LWP adjusting positively as you move forward in time, and vice-versa for high values. That paper and others from that group explore how to deal with these tendencies, using a similar technique to the DoRs used here. It may be good to mention those papers to show how a similar technique has been successful in the past.

The following paragraph has been added to the methods section while introducing the DoR technique (L142):

If the clouds are advected across regions with a large gradient in meteorological properties, this would result in a large change in the cloud properties owing to how correlated the cloud is to a strong climatological change. Clouds with a high (low) initial value of LWP or Nd is likely to show a decrease (increase) in LWP or Nd, which is consistent with a 'regression to the mean' effect. This can happen as a statistical effect, where even when the cloud is remaining stationary, a positively biased first measurement (of re) is followed by a smaller second measurement. Since re is positively correlated with LWP and negatively correlated with Nd, this shows up as a highly negative dLWP and a large positive dNd. And an opposite effect for an initially negatively biased measurement of re. Previous studies (Eastman2016a, Eastman:2016b) have successfully accounted for this by looking at anomalous changes across Lagrangian trajectories by removing seasonal means for day and night separately. On the other hand, it was shown in a previous study (Gryspeerdt et al 2021) using dLWP and dNd calculated from MODIS Terra and Aqua that the 'flowfields' (the rate of change of Nd and LWP) do not look the same when dLWP and dNd are binned by the final LWP and Nd. If this was indeed a regression to the mean effect, the flowfields should have looked the same when calculated from either direction. As stated in Gryspeerdt et al 2021, while this does not completely rule out the impact of retrieval biases and the regression to the mean effect, it does rule out the possibility of the results being a statistical artefact caused by random biases.

-In figure 2e-l there appears to be lots of noise on the left sides of the distributions. Is this signal believable? Larger bins or some sort of significance test may eliminate some of this distracting noise.

We agree that the region with Nd<30 (approximately) is very noisy. This is why we have restricted any conclusions from this figure for Nd>50. We currently comment only on *the role of the giant CCN only for Nd >100. Using larger bins has not made the region less noisy.*

-I'm not sure I follow the reasoning on line 166 starting with 'Consequently'. Can you elaborate on this and further tie this to the prior two sentences?

The entire paragraph has been rewritten and linked to the last sentence starting 'Consequently…'. (L168):

In addition to acting as a sink for the cloud Nd through the sedimentation of droplets, precipitation plays a key role in the scavenging of CCN (wet or below-cloud scavenging), which in turn can reduce Nd. The effects of precipitation are usually seen primarily in the (upper) left quadrant (LWP > 50gm^{-2}, Nd < 50cm^-3), i.e., for clouds with a high initial LWP and a low Nd. An overall positive change is seen in the dNd field in this region for both precipitating and non-precipitating clouds (red region in figures 1a,b, which is possibly a regression to the mean effect (discussed in the next paragraph). In addition to precipitation, other processes such as the primary production of CCN from sea spray, and entrainment of aerosols from the free troposphere (especially closer to the coast) can possibly act as significant sources of Nd for clouds with an initially low Nd.

However, precipitation rates as low as 1mm/d have been shown to be effective in reducing Nd by a factor of three over the SE Pacific {Wood2012}. The DoRs between precipitating and not-precipitating clouds (figure 1c) reveal that precipitation acts as a sink for the cloud Nd, with a reduction of Nd observed in more strongly precipitating cases. Precipitation results in a smaller overall net increase in dNd (i.e., the change in Nd over three hours) with figure 1a showing lighter reds and darker greens.

There is a smaller decrease (larger increase) in dNd for not-precipitating clouds in figure 1b (darker reds and lighter greens). Consequently, the corresponding DoR, ~(difference between figures 1a and b, i.e., a- b , is negative (figure 1c).

-Paragraph beginning on line 194: Can you add one additional paragraph explicitly stating how these numbers concerning the two pathways are determined. It wasn't clear on first reading how this really worked in relation to the figures.

More details have now been added in the section (L292). There was an error stating that figure 3 was being used, when it should have been figure 2.

-Are the figures in the appendix using the data from Eastman et al. (2019)? If so, rain rate estimates in that dataset are constructed from AMSR/E and AMSR/2, with CloudSat only used to tune the relationships. If that is the case, I would change the labels to read 'AMSR' rain rates instead of CloudSat.

Yes, the data is from Eastman et al 2019. The label has been changed to 'AMSR rain rates'.

Minor points:

-Nd and r_e are used somewhat interchangeably in the paper. Since the figures only deal in Nd, it may be easier to interpret the work if you keep the discussion limited to one variable, but also thoroughly explain the relationship between Nd and r_e in the data section.

We have tried to restrict re to section 3.2 as this is where it is most relevant. However, we have had to include re in a few other places as we felt it was important for the corresponding discussion.

-Why restrict the work to just the SE Atlantic? Could there be regional differences if compared to Pacific Sc decks? Or more robust results?

We have included a new section looking at regional differences. (Section 3.3)

-Line 192, 2 dashes: Instead of dashes, maybe label these two mechanisms as 'pathways' and reference Figure 3 here directly.

We have changed this according to the reviewer's suggestion (L283).

-Line 194: Contrary to which other results? This paper also shows that increased wind speed leads to decreased Nd and stronger rain rates:

Eastman, R., McCoy, I.L., Wood, R., 2022. Wind, Rain, and the Closed to Open Cell Transition in Subtropical Marine Stratocumulus. Journal of Geophysical Research: Atmospheres 127, e2022JD036795. https://doi.org/10.1029/2022JD036795

We have removed 'contrary' and included a reference to the above (and another) work.

(L290)