

Response to Reviewers

In accordance with the color schemes policy of EGU publications, the original color scheme in the manuscript has been updated. The colors for ACE-ENA summer (originally red), ACE-ENA winter (originally blue), and SOCRATES (originally green) have been changed to pink, purple, and green, respectively. Only the colors have been altered; all the data remain original and intact. The updated figures were checked using the Coblis Color Blindness Simulator (<https://www.color-blindness.com/coblis-color-blindness-simulator/>) to ensure they allow readers with color vision deficiencies to interpret our findings correctly.

Response to Reviewer #1

Thanks for accepting our manuscript. In the response below, your comments are provided in black text and [our responses are provided in blue text](#).

I have a single edit for the authors:

Line 386: There is repeating text: “which is also confirmed in previous studies (J. Wang et al., 2022; Wang et al., 2023).”

[Thanks for catching it. The repeating text has been removed.](#)

Response to Reviewer #2

We appreciate your time and effort in thoroughly reviewing our manuscript in the second round. We are truly grateful for your constructive comments and patient suggestions on the typographical issues. We have revised the manuscript based on your comments, and we have carefully gone through the manuscript for grammar errors and clarity. In the response below, your comments are provided in black text and [our responses are provided in blue text](#).

SUMMARY

Thanks to the authors for their responses to my and my fellow reviewer's comments. The reframing of the physical process discussion to de-emphasize turbulence as the primary contributor to increased collision-coalescence in the ACE-ENA winter regime was particularly appreciated. I still question the use of 1 Hz velocity data for quantifying turbulence but given the more qualitative discussion of the role of turbulence, this is sufficient. I have a few comments on additions to the manuscript and numerous typographical/language notes, but overall these should require only minor revisions. On the latter topic of typographical comments, I understand the pressure to respond to reviews in a quick and timely fashion, but I encourage you to take a closer final editing pass before resubmitting future manuscripts. There are numerous errors in the added text that could easily have been avoided with one more close reading of the revised text. I can't speak for all reviewers, but this particular reviewer is always more agreeable/less cranky when a resubmitted paper is free (or at least, very close to free) of these minor and entirely avoidable errors, which are distracting and add significant time/effort to my review process.

[Thanks for thoroughly reviewing our revised manuscript; please find our point-to-point response below.](#)

MINOR COMMENTS

L148-149: re: "the enhanced large-scale subsidence would lead to a deeper stratocumulus-topped MBL" -- This is paradoxical - enhanced subsidence ostensibly compresses the boundary layer, so

how does it lead to a deeper cloud-topped MBL? Maybe you're getting at the fact that enhanced subsidence also tends to sharpen the inversion?

We have revised this statement to ‘...where the enhanced large-scale subsidence would lead to stronger and sharper temperature inversion above the stratocumulus-topped MBL...’

L184-185: re: “[the SOCRATES region] is under more consistent influence of mid-latitude cyclone systems than over the ACE-ENA region” – I’d say the dominant impact on winter weather at ACE-ENA is very much mid-latitude systems.

We have revised our statement of the SOCRATES and ACE-ENA winter IOP as follows:

‘The region of selected SOCRATES cloud cases crosses a larger latitudinal zone and is under more consistent influence of mid-latitude cyclone systems than the ACE-ENA during the summer IOP.’

‘The winter IOP was under the frequent impacts of the mid-latitude systems and prevalently featured precipitation-generated cold pools, where evaporative cooling alters the thermodynamical structure of the MBL, sustains and enhances turbulence mixing, hence contributes to dynamical perturbations that can influence the behavior of the MBL (Terai and Wood, 2013; Zuidema et al., 2017; Jenson et al., 2021; J. Wang et al., 2022; Smalley et al., 2024).’

Reference:

Smalley, M. A., Witte, M. K., Jeong, J.-H., and Chinita, M. J.: A climatology of cold pools distinct from background turbulence at the Eastern North Atlantic observations site, EGU sphere [preprint], <https://doi.org/10.5194/egusphere-2024-1098>, 2024.

L302: “the ratio of the coupled sub-cloud MBL thickness to the sub-cloud MBL thickness” – I think you mean “cloud thickness” instead of the 2nd “sub-cloud MBL thickness”?

L302: Why such a complicated expression for D_{cp} ? Assuming $H_c = z_c - z_b$ (which you haven't stated in the text up to this point) and inserting your definition of H_{cp} , I come up with $D_{cp} = 1 - ((z_t - z_{cp}) - (z_c - z_b))/z_b = 1 - (z_b - z_{cp})/z_b = 1 - 1 - z_{cp}/z_b = z_{cp} - z_b$.

Answer to these two comments:

Thanks for catching it. We have simplified the expression of D_{cp} to:

'Therefore, the degree of MBL decoupling (D_{cp}) can be quantified as the ratio of the coupled point height (z_{cp}) to the cloud base height (z_b), where $D_{cp} = z_{cp}/z_b$.'

And we have added the description of cloud thickness in the previous paragraph:

'The detailed selected cloud profiles, with their cloud base heights (z_t), cloud top heights (z_b) and cloud thicknesses ($H_c = z_t - z_b$) are listed in Table S1, along with the cloud profile macrophysics.'

L743: There are high-rate measurements available from both SOCRATES (25 Hz; <https://data.eol.ucar.edu/dataset/552.005>) and ACE-ENA (20 Hz; https://adc.arm.gov/discovery/#/results/id::6747_aimms_sfcmet_met-air_airborne_horizwind?measurementsView=true&showDetails=true), so it's misleading that you frame this as a lack of access. You don't need higher rate data than that to estimate turbulence properties, although aliasing is still an issue.

Thanks for the suggestion. We have revised the following statement to further clarify:

'Though currently beyond the scope of this study, utilizing the high-rate measurements of velocities available from SOCRATES (at 25Hz) and ACE-ENA (at 20Hz) to explore those mechanisms further will be of interest to future investigations.'

Table S2: Add units for all variables. I also recommend replacing “nan” with “—” but this is not a requirement.

The units are added in Tables S1 & S2, and all ‘nan’ are replaced by ‘-’ in Table S2.

TYPOGRAPHICAL/LANGUAGE COMMENT

L145: “both summer and winter IOPs of ACE-ENA ~~are~~ featured ~~with~~ anomalously stronger high-pressure” – remove “are,” “with” and “er” from “stronger”; add “ly” to anomalous

This sentence is revised to:

‘...both summer and winter IOPs of ACE-ENA featured anomalously strong high-pressure systems...’

L151: “while the winter IOP is prevalently featured ~~with prevalent~~ precipitation-generated...” – remove “is” and “with prevalent”; add “prevalently” before “featured”

This sentence is revised to:

‘The winter IOP was under the frequent impacts of the mid-latitude systems and prevalently featured precipitation-generated cold pools...’

L155: “In ~~Over the~~ recent years, many observational studies, based on ~~the~~ ACE-ENA data have...” – remove “Over the” and commas from this phrase; add “In” to start of sentence

This sentence is revised to:

‘In recent years, many observational studies based on ACE-ENA data have focused on the seasonal contrasts of the aerosol distributions and sources...’

L181-182: “anomalously strong” instead of “anomaly-stronger”

Change is made accordingly.

L190: what do you mean by “the functioning physical processes?” Your usage of “functioning” doesn’t make sense to me. Do you mean the “dominant” or “first order” processes? Or are you instead aiming to compile a comprehensive list of every process operating within these clouds?

We have changed it to ‘...the dominant physical processes...’

L272-274: Sentence starting “In this regard...” is a sentence fragment. Please restructure.

We have restructured this sentence to:

‘The cases selected for this study feature both coupled and decoupled MBL conditions, particularly during ACE-ENA summer, which is characterized by anomalously low MBL heights and substantial MBL decoupling.’

L274: “the decoupling conditions” → “decoupled conditions”

Change is made accordingly.

L278: “in order to ensure the aerosols and CCN...” – I don’t think “ensure” is the right word. I’d go for something like “to quantify the degree to which aerosols and CCN...”

We have revised this sentence to:

‘Therefore, we adapt and modify the metric in Jones et al. (2011) to calculate the sub-cloud coupled layer, in order to quantify the degree to which aerosols and CCN measured sub-cloud are in a well-mixed state and can represent the actual interaction (or contact) with the cloud layer.’

L329: “which is described in the last section” – add “the”

The word 'the' is added.

L344: “subside down” – the word “subside” implies downward motion; this is redundant

The word 'down' is removed.

L345-346: “are in the reconciliation of getting the close-to-cloud...” – I’m not sure what you mean by “are in the reconciliation of”

We have revised this sentence to:

‘Therefore, the 200 m criterion used in this study captures the close-to-cloud aerosol plumes and provides enough sample size for statistical analysis.’

L360: “and transport southeast” → “and be transported southeast”

Corrected.

L364: new sentence starting with “While...” should be combined with previous sentence.

L365: “a thousand” – add units after number

Answer to these two comments:

We have revised the sentence to ‘For individual cases, the above cloud aerosols vary from a couple hundred to over a thousand particles per cubic centimeter’

L382: superscript “-3” – I didn’t exhaustively catalog this issue, please double check unit superscripts throughout

We have corrected all the superscripts throughout the manuscript.

L394: “double of the above-cloud...”

Corrected.

L477-479: remove duplicated phrase “which is also confirmed in...”

The duplicated phrase is removed.

L586: “between the cloud top value and the upper-middle cloud...” – add “and”

Added.

L600: seems like “slowly” would be more appropriate than “not rapidly”

We have revised the sentence to ‘which occurs when dry and warm air mixes unevenly and slowly with the cloud air, hence partially evaporating the cloud droplets’, as suggested.

L604: what do you mean by “constant variation” – the nature of the variability is constant across cases? Please clarify.

This statement is changed to ‘The near-cloud top r_c profiles ($z_i > 0.8$) for the ACE-ENA cases exhibit fewer increases compared to the SOCRATES’

L642: “which can be attributed...” – add “d” to end of “attribute”

Added.

L683: Correct reference “Altas et al., 2020” => “Atlas et al., 2020”

Corrected.

L698: Correct reference “Wittle et al., 2019” => “Witte et al., 2019”

Corrected.

L880: “featured ~~with~~ enhanced...” – remove “with”; add “d” to “feature”

Corrected.

L881: “more larger” – remove “r” from “larger”

‘r’ is removed.

L896: Rcb equation – still not happy with this. I would prefer you explicitly write out "1.73x10-6" as it is not clear whether you are saying "natural base e to -10 power" or if you are referring to engineering notation, in which case the -10 would not be superscript and the “e” would be capitalized.

We have corrected the equations to the formatting using -10 power in the manuscript and on Figure 7. For instance:

‘Note that the relationship for SOCRATES in this study reveals a similar R_{CB} dependence on N_c but a smaller dependence on the cloud thickness than the study by Kang et al. (2024), who concluded a relationship of $R_{CB} = 1.41 \times 10^{-9} H_c^{3.1} N_a^{-0.8} \dots$ ’

L900: remove “where is”

Removed.

L1064: remove comma between “evolution” and “during”

Removed.