Dear Dr. Stenni,

Thank you for the opportunity to revise our manuscript, "Trends in South Pole Particle Concentrations Imply Holocene Westerly Wind Strengthening." The two reviews provided thoughtful guidance for revising the paper, and we gratefully acknowledge the reviewers' time and feedback. The following response to review addresses each of the reviewers' comments and/or questions.

Our responses are given below with reviewer comments in italics; author response in regular font, and revised text from the paper is provided in blue.

With Best Regards,
Aaron Chesler

Reviewer 1:

We thank Reviewer 1 for their thoughtful and insightful comments.

68. Which subset? What were the criteria for selection? Say something briefly also in the main text.

Line 80 - 81: While the entire Abakus measurements ranged from 1.1 – 12µm we only use 1.1 – 5.1µm due to limited number of particles in larger bin sizes. We add a new Figure 1e, highlighting size distribution variability over the over the Holocene, and the following sentence, "We analyze particles ranging from 1.1 – 5.1 µm and limit our temporal analysis from 11300 years BP to 250 years BP."

Text S1, p2. How are all the bins defined? You report "additional" bins by numbers … are they bin centers or lower/upper edges? How are those bins spaced?

Line S29 – 30: We currently state in the text that bins "ranged continuously in 0.1µm increments from endpoints (lower) 1.0 – 2.5 µm, followed by bins 2.7, 2.9, 3.2, 3.6, 4.0, and 4.5 µm with an upper limit of 5.1 µm. We add additional sentence to state that "Bin lower limit represents the upper extent of the of the previous bin size."

Text S1, p2. "The CFA system has an effective resolution of 3 mm with a dispersion signal of 1 cm". What are the implications?

Line S33 – 40: We add, "The implications of the CFA resolution and dispersion are negligible to the timeframe that we resample our average data to 50-year intervals. Current accumulation rates at the South Pole are ~8cm/year. While the CFA system can resolve particle concentrations to 3 mm intervals well below the accumulation rate, the coregistration of particles in the melter is a function of melt speed, ice density, and signal symmetry (Breton et al., 2012). Because we resample our data to 50 years intervals (mean depth interval of ~3.5 m), the dispersion of particles at 1 cm is negligible."

72. "we do not use metrics …" I suppose you refer only/specifically to the calculations of CPP, since your section 3.1 is called "Holocene dust flux". Please clarify.

Line 78 – 97: We rephrase the paragraph to say, "We measure microparticle concentration and size distributions using subset of data collected from a continuous flow analysis (CFA) Klotz Abakus laser dust sensor at Dartmouth College (Text S1; Breton et al., 2012; Winski et al., 2021; Osterberg et al., 2006). We analyze particles ranging from 1.1 – 5.1 µm and limit our temporal analysis from 11300 years BP to 250 years BP. To facilitate a comparison with other ice core records, we use a density of 2.6 g cm-3 (following Koffman et al., 2014) and a spherical shape to estimate flux, rather than the measured prolate particle shapes (Chesler et al., 2023). While we recognize that South Pole particle shape metrics (i.e., mass and flux) are unconstrained for the Holocene (i.e., Chesler et al., 2023) because of limited available data, we use South Pole flux as a comparison tool to assess similarities between other available microparticle Antarctic Holocene. We restrict particle metrics to number concentration and CPP because the particle shape assumption (i.e., particle flux and mass concentration), can artificially increase particle metric concentrations by 25 – 44%. We use particle number concentration measured between 1.1 – 5.1 µm and CPP (defined as number of particles mL-1 [3.2 – 5.1] /[1.1–5.1] µm diameter x 100) following other East Antarctic studies (i.e., Delmonte et al., 2020). We use a spherical particle shape assumption to facilitate comparison to other Antarctica ice core particle records that include a volume assumption (i.e., flux). While this produces higher-than-realistic particle flux values, it mitigates discrepancies from comparing dissimilar metrics, whereas in the past particle shape has been assumed to be spherical (Chesler et al., 2023; Simonsen et al., 2018; Potenza et al., 2016). Studies concerned with the absolute magnitude of dust flux at the South Pole should use prolate particle shapes to calculate flux (Chesler et al., 2023; data at USAP-DC, DOI: 10.15784/601553)."

74. You should probably specify "we use particle number concentration"

Line 91: Changed sentence to, "We use particle number concentration measured between 1.1 – 5.1 µm and CPP (defined as number of particles mL^{-1} [3.2 – 5.1] /[1.1–5.1] µm diameter x 100) …"

75. Remove "<" before "5.1"

Line 92: The "<" has been removed.

Text S1, p2. "We use a spherical particle shape assumption to facilitate comparison to other Antarctica ice core particle records that include a volume assumption (i.e., flux)". You could compare your "best" fluxes, i.e. assuming spheroids, with Coulter Counter based fluxes (and for calculating CPP). Those measurements are deemed accurate with respect to the actual volume of the particles, without the need of any assumption on their shape. Using spherical equivalent diameters to identify their sizes does not conflict with this notion. In fact, I think you should add in the main text a description of how you calculate dust mass flux, and move Figure S1 to the main text. The shape is not the only possible source of uncertainty, as there might be an unconstrained bias, in terms of a systematic underestimation of dust fluxes, due to the limited size range of the laser counter; the comparisons with coulter counter measurements in Chesler et *al. (2023) over the same size range do not allow a full evaluation this aspect. Also, you could compare different assumptions on particles shape (spheres and spheroids) to calculate mass-based FPP/CPP for the South Pole record and allow an easier comparison to previous published work using the same metric. At least this should be added as part of the supplement.*

We move Figure S1 into the main text of the paper, becoming the new Figure 2 and add a new Figure 1e to show particle size distribution from the Holocene. Due to sample volume limitations, we were unable to take Coulter Counter measurements during the Holocene, which is why Chesler et al., 2023 is limited temporally to the last glacial period (54 – 16 ka). Furthermore, publicly available Holocene FPP/CPP is limited to Talos Dome of which the size information is not comparable to the South Pole (Albani et al., 2012). At Talos Dome, the fine particle fraction ranges from 0.6 – 5.0 µm and the course particle fraction ranges from 5.0 – 10 µm. Furthermore, we limit our dust concentration to 1.1 – 5.1µm, because coarser particles (5.1 – 12µm) make up on average 4% of all dust concentrations (median dust concentration; 1Q = 1.67%; 3Q = 9.26%). Since particles <5.1µm make up over 90% of the data and the South Pole spherical particle flux is similar to other East Antarctic ice core records we limit the size range to similar values to facilitate comparison.

Line 89 – 97: We add, "We use a spherical particle shape assumption to facilitate comparison to other Antarctica ice core particle records that include a volume assumption (i.e., flux). While this produces higher-than-realistic particle flux values, it mitigates discrepancies from comparing dissimilar metrics, whereas in the past particle shape has been assumed to be spherical (Chesler et al., 2023; Simonsen et al., 2018; Potenza et al., 2016). Studies concerned with the absolute magnitude of dust flux at the South Pole should use prolate particle shapes to calculate flux (Chesler et al., 2023; data at USAP-DC, DOI: 10.15784/601553)."

78-80. Please provide a little more information on how you set up HYSPLIT runs, e.g. the starting vertical level of back trajectories, etc.

Line 118: We add, "We run the model at an altitude of 1000 m following Schwanck et al. (2017) and use the default vertical motion for the model." After the first sentence of the paragraph.

83. "pre-industrial (1850 – 2014 AD)": this not pre-industrial. The indicated period suggests that you used the output from historical CMIP6 experiments, rather than the pre-industrial equilibrium control experiments with 1850 CE boundary conditions. Please clarify, also by adding the experiments IDs, and add references for both periods referring to the CIMP6 and PMIP4 experimental setup (or synthesis of the main results) publications, e.g. for the mid-Holocene: Otto-Bliesner et al., 2017, https://doi.org/10.5194/gmd-10-3979-2017 (or Brierley et al., 2020, https://doi.org/10.5194/cp-16-1847-2020). In fact, you should also justify why you chose the historical rather than the (more logic option) piControl experiments.

Line 288 – 293: We rerun our model agreement analysis using the piControl model runs and add both citations to the figure caption. Figure 3 is now Figure 4. The figure caption now states, "Figure 4a – c: CMIP6-PMIP4 models agreement displaying difference between mid-Holocene and piControl precipitation (4a), wind speed(4b), and temperature (4c; Otto-Bliesner et al., 2017; Brierley et al., 2020). The color bar indicates the number of models that infer a positive or no/negative change in each variable between 6000 years BP and during the Pre-Industrial. Red regions indicate a stronger model consensus towards an increase and blue indicates a consensus towards a decrease in the respective variable. Values in the middle represent a lack of consensus. The black dotted line represents the average position of peak surface wind speed for both time periods.”. We replace instances “historical” with pre-Industrial or piControl.

84. Do you mean “We replace all positive values, …” with ones?

Line 123 – 124: To clarify, we amend the sentence to state, “We replace all positive values with a value of 1, which signifies an increase with time, and replace all negative values with a 0 and sum all model runs.”

Table 1. I believe it's NCAR - CESM2

Line 128: We replace the NCAR – CESM3 value with CESM2.

95-98. I would still prefer to read “number concentrations” for the sake of immediate clarity to the readers

Line 134: We add the ‘#’ symbol to the first sentence and add number concentration for immediate clarity. The sentences now read, “Total dust number concentrations (i.e., 1.1 – 5.1 µm # particles mL^{-1}) make up on average ~85 – 96% of all particles measured (median ± 1σ; Figure 1). The total dust number concentration and CPP abundance have opposing trends throughout the Holocene…”

97. “the timing of relative change within each metric is relatively similar”: I do not understand this sentence, please clarify.

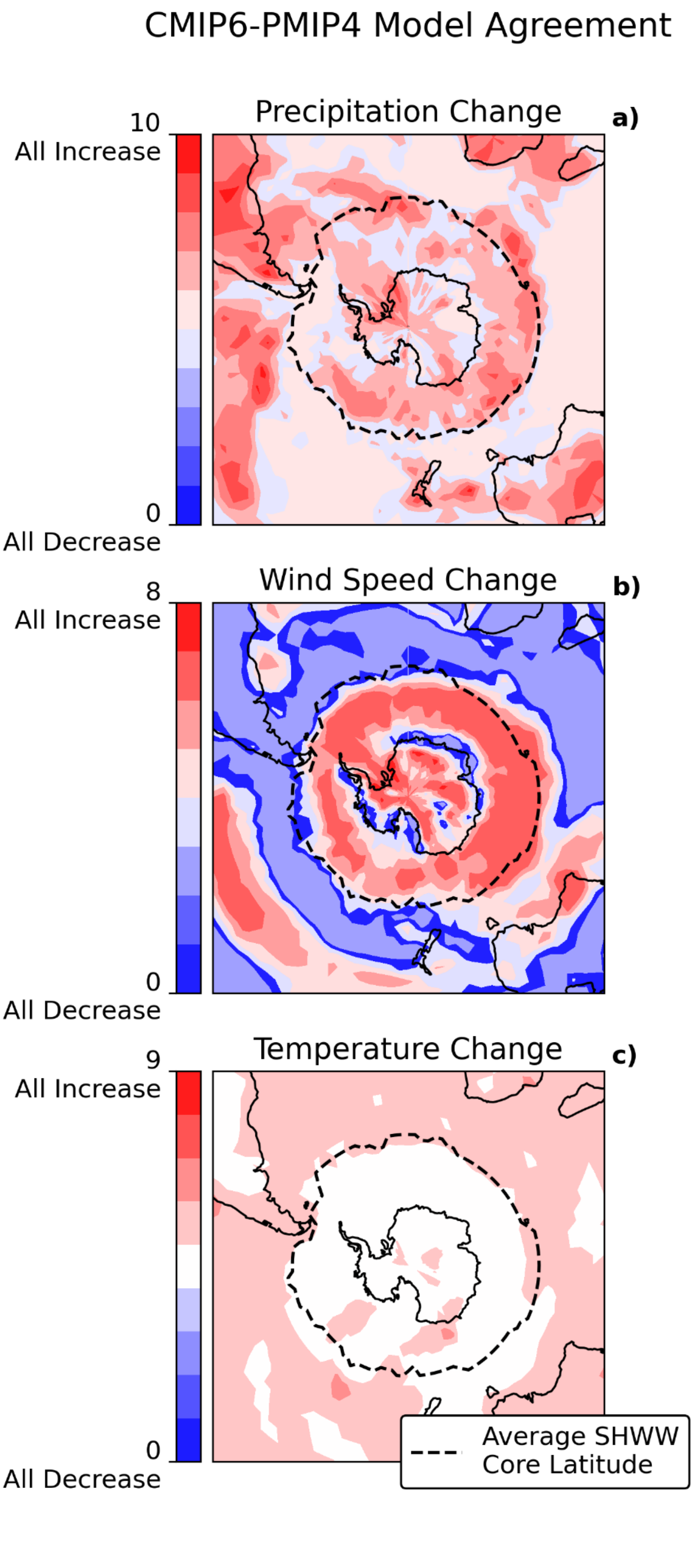
Line 135 – 137: We clarify the sentence so that it now reads, “The total dust number concentration and CPP abundance have opposing trends, yet the timing of change in both trends begins about ~7000 years BP. This inverse relationship is most apparent during the mid-Holocene (~7000 – 3000 years BP).”

97-98. What I see is a generalized inverse relationship between number concentrations and CPP along the entire record, which breaks between ~2,000 and ~4,500 Years BP, when the two records run almost parallel to each other. The phrasing of the description here should be more accurate. In addition, this feature should be discussed when positing a significant relationship between d18O and dust in the following section, i.e. at lines 112-114. Perhaps, you could use a running window approach for calculating correlations.

We ran a running Pearson correlation window (1000 – 2000 years) and find strong correlations ($r > 0.4$) exist between dust concentration and CPP but only before 9000 years BP and between ~4500 – 3000 years BP. There was no substantial relationship between South Pole $\delta^{18}O$ and dust concentration ($r > 0.4$ or $r < 0.4$) throughout our record.

Figure 3. "No increase" should read "All decrease", and a symmetrically diverging red-white-blue palette might be more effective at depicting the actual situation.

Line 287: Figure 4 (originally Figure 3) now has "All Decrease" instead of "No Increase" and we add a diverging color scheme so that the figure is more effective at depicting the model agreement (see below).



CMIP6-PMIP4 Model Agreement
Precipitation Change
a)
10
All Increase
0
All Decrease
Wind Speed Change
b)
8
All Increase
0
All Decrease
Temperature Change
c)
9
All Increase
0
All Decrease
Average SHWW
Core Latitude

156-160. Those two sentences are unclear. Please rephrase.

Line 224 – 228: We clarify the two sentences to say, "While we recognize that some air masses and dust particles can be sourced from the East Antarctic Plateau, this area would not be the primary source of reduced dust emission during the mid-Holocene since southern South America and Australia are the primary sources of dust during the Holocene and modern period (Wegner et al., 2012; Vecchio et al., 2024; Delmonte et al., 2020). Rather we suggest that the decrease in dust concentration was driven by reduced SHWW activity in the wind in the mid-latitudinal regions (Figure 4)."

178-179. Not surprisingly you see a spatially consistent warming in all model simulation: you are comparing, apparently, mid-Holocene simulations with the average of historical simulations, which include the response to increased greenhouse gases emissions up to the present-day. Data. You should acknowledge the HYSPLIT website, World Climate Research Programme's Working Group on Coupled Modelling, which is responsible for CMIP, the Earth System Grid Federation, as well as indicate the specific ESGF node and access date of your downloads for CMIP6/PMIP4 model output data.

Line 440 – 446: We changed our analysis so that we are using the piControl simulation, thereby removing the anthropogenic greenhouse gas forcing from our comparison and targeted the middle to late Holocene climate variability. We update our acknowledgements by adding in the following statements, which now read, "The authors gratefully acknowledge the NOAA Air Resources Laboratory (ARL) for the provision of the HYSPLIT transport and dispersion model and/or READY website (https://www.ready.noaa.gov) used in this publication. We acknowledge the World Climate Research Programme, which, through its Working Group on Coupled Modelling, coordinated and promoted CMIP6. We thank the climate modelling groups for producing and making available their model output, the Earth System Grid Federation (ESGF) for archiving the data and providing access, and the multiple funding agencies who support CMIP6 and ESGF. CMIP6 and PMIP4 model data was retrieved from the World Data Center for Climate (hosted by DKRZ) and Lawrence Livermore."

Reviewer 2:

We thank Reviewer 2 for their detailed and helpful comments.

Major Comments:

I think the fact that CPP rises because the fine fraction drops faster than the coarse fraction is an important result. This could easily be shown in an additional figure, or even within Figure 1 using a stacked plot instead of the current good looking but not so informative shaded areas. Within that context, I don't think the authors have made a strong case for a strengthening of the SHWW. If that were the case, one would expect increasing coarse particle concentrations. But this is not the case, CPP increases only because the coarse fraction decreases less than the fine fraction. Basing the conclusions on the CPP alone may therefore be deceptive. Similarly, a southward shift of the SHWW should increase the local (Antarctic) contribution. In line 180, the authors write "A southward shift in the core of the SHWW can simultaneously explain the *opposing trends in CPP and total particle concentration …", but do not proceed to explain this in actual words. I think the authors should take a good look at Lamy et al., 2010 Nature Geoscience, and rethink their interpretation of the data, looking more at the absolute concentration trends and less at the relative CPP. This paper potentially offers a framework that may better explain the trends apparent in the absolute data, and which is still consistent with the studies cited in lines 183-196.*

We refocus our argument on the total particle concentration and less so on coarse particle percentage. To do so, we add a new Supplementary Figure (Figure S2) to show the changes between Holocene temperature gradients in the Pacific based on the Osman et al. (2021) dataset. We add the following sentences to Section 4.2 to support our argument.

Line 257 – 268: "Furthermore, we also compare our dust number concentration results using Osman et al. (2021) surface air temperature record throughout the Holocene (11300 – 100 years ago) from the Western and Eastern Pacific Ocean 30 – 55°S similarly to Lamy et al. (2010) to assess temperature (wind) gradients (Figure S2). We find that average temperature gradients steepen, which we interpret to reflect a strengthening of the winds throughout the Holocene. Statistically, the dust concentration record has a significant anticorrelating relationship to both temperature gradients (p-value < 0.01) for both the western and eastern mid-latitudinal Pacific Ocean. However, the South Pole dust concentration has a stronger anticorrelating relationship to the western Pacific Ocean compared to the eastern Pacific Ocean ($r = -0.76$ and -0.65, respectively). We interpret this relationship to reflect changes in the Westerly Winds shifts and warm water circulation into the south Pacific gyre described in Denton et al. (2021). The small variations between the Western and Eastern Pacific further suggest asymmetrical wind changes, which support the conclusions of Lamy et al. (2010), Kaplan et al. (2016) with a cooling of coastal South American temperatures throughout the Holocene, and support increased upwelling in Pine Island Bay during the early Holocene Hillenbrand et al. (2017)."

Line S105 – 111: We also add a new Figure S2 shown below with the following caption to support our interpretations

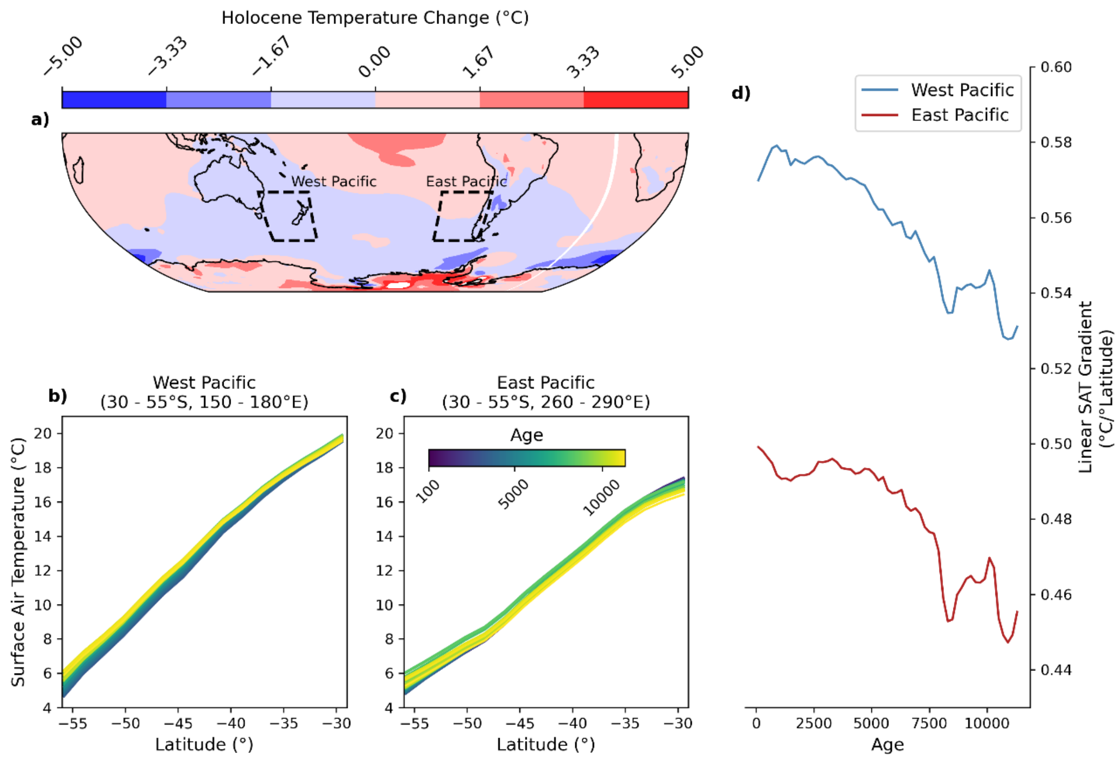


Figure S2 a – d: Surface air temperature data (11300 – 100 years ago) from Osman et al. (2021). S2a) highlights Southern Hemisphere average temperature change from the early Holocene (11300 – 7000 years ago) to pre-Industrial (300 – 100 years ago). S2b and c) are temperature gradients, colored by model age, from the eastern and western Pacific basin (highlighted in S2a). Slope values of linear regressions for each age (°C/°Latitude) are plotted in S2d.

The authors attribute the 3-5 um coarse fraction of their measured dust particles to local, and the 1-3 fine fraction to remote sources. However, recent research has shown that coarser particles can travel a very long way and should not be excluded from remote sources (see recent papers by (Jasper Kok and Yemi Adebiyi). That interpretation should therefore be revisited taking into account the recent development in coarse particle transport research.

We reframe the argument by including coarse particle concentration in our results (Section 3.2 and now Figure 1 and in our discussion section (Section 4.4). The coarse particle concentration is similar to the total particle concentration at a different order of magnitude with the small variations between the two trends creating an increase in CPP throughout the Holocene. We now place the coarse particle concentration within the context of interpretations from Adebiyi and Kok (2020) and Albani et al. (2012). We still interpret the CPP increase as an increase in the SHWW strength given the evidence of the CMIP6 - PMIP4 model agreement results, mid-latitudinal proxy evidence, and additional data from surface air temperature change from Osman et al. (2021). We now suggest that the coarse dust concentration change was driven by a combination of decreased mid-latitudinal sources and deflation of exposed Antarctic dust source regions.

Below we include the updated text from Section 3.2.

Section 3.2 Holocene trends in dust deposited at the South Pole

Line 196 – 201: "Coarse particle concentrations have a similar decrease compared to the fine particles, however, at an order of magnitude smaller (total dust concentration slope = ~ -20 # particles mL-1 kyr-1 compared to coarse particle decrease ~ -2 # particles mL-1 kyr-1. The total and coarse particle fractions have similar, albeit slightly different changes throughout the Holocene, whereas there is a ~ -40% difference between the Early Holocene and Late Holocene for total dust concentration and a ~ -35% difference between the Early Holocene and Late Holocene for coarse dust concentration. This 5% difference results in an increase in the CPP starting at ~7000 years BP."

Section 4.4 Antarctic ice sheet thinning and CPP increase

Line 325 – 356: We rephrase Section 4.4 to say, "Previous studies have linked CPP variability with changes in air mass advection and/or activation of local dust sources (Delmonte et al., 2020; Koffman et al., 2014; Albani et al., 2012; Wegner et al., 2012; Aarons et al., 2017; Gabrielli et al., 2010). We explore the changes in the SPC14 CPP within the context of the coarse particle concentration. The coarse particle concentration has a similar trend throughout the Holocene as the total particle concentration, suggesting predominantly similar dynamics between coarse and total particle concentration change. However, because the CPP increases throughout the Holocene there must be an additional forcing mechanism(s) acting upon the coarse particles.

The increase in SPC14 CPP begins ~8000 – 6000 yr B.P. (Figure 1 and 4a) coinciding with the timing of glacial retreat and dust source exposure in lower-elevation regions of Antarctica between ~7500 – 6000 y B.P. (Figure 4h; Jones et al., 2020; Jones et al., 2015; Stutz et al., 2021; Stone et al., 2003; Hein et al., 2016; Kawamata et al., 2020). For consistency, we recalibrate ^{10}Be surface exposure ages using production rates from Putnam et al. (2010) and (Kaplan et al., 2011; Supplementary S1). Newly exposed source areas in the Weddell Sea sector are plausible origins of dust in SPC14 given prevailing low-level wind patterns (Lazzara et al., 2012; Winski et al., 2021; Clem et al., 2020). However, because the South Pole has multiple air sources, either moving into the East Antarctic plateau via in the Weddell Sea (Winski et al., 2021; Clem et al., 2020; Lazzara et al., 2012) or across West Antarctica (Nicolas and Bromwich, 2011), we interpret the changes in coarse particles to reflect broader scale Antarctic changes rather than to indicate activation of a specific local source (Figure 2).

Holocene icesheet thinning, leading to exposure of Antarctic dust sources, is primarily related to 1) ocean warming (Jones et al., 2020; Stutz et al., 2021), 2) change in glacial flow patterns (Hein et al., 2016), and/or 3) reduced buttressing (Stutz et al., 2021). Strengthening and/or southward latitudinal shifts in the SHWW have been shown to increase surface upwelling of relatively warmer circumpolar deep water (CDW) and increase air mass incursions driven by cyclogenesis into the Antarctic plateau (Hillenbrand et al., 2017; Carrasco et al., 2003). It seems likely that contracting, southward shifting, and accelerating SHWW, leading to warming ocean and atmosphere, is linked to the mid-Holocene glacial retreat (i.e., Albani et al., 2012; Koffman et al., 2014) and would increase Antarctic dust sources and the increase in CPP observed in SPC14, however, the coarse dust concentration has a slight decrease and a strong running correlation until ~4000 years BP, suggesting a similar dust source and/or dynamics, which could indicate either 1) deflation of local Antarctic dust sources, similar to Holocene dynamics at Talos Dome (i.e., Albani et al., 2012) or 2) transport from mid-latitudinal sources (Adebiyi and Kok, 2020). As further evidence, the timing of decreasing surface elevation around Antarctica corresponds to increases in SPC14 CPP as a southward shift in the Atlantic ITCZ, representing warming of the Southern Hemisphere relative to the Northern Hemisphere and the Lago Guanaco which was interpreted to reflect latitudinal migrations in the SHWW (Figure 4a, c, and e; Haug et al., 2001; Moreno et al., 2010; respectively). We suggest the CPP increase is primarily related to changes in remote dust contributions in the mid-latitudinal regions and also secondarily related to Antarctic dust source deflation."

Minor Comments:

Abstract: Not sure if the guidelines for CP abstracts have changed recently, but if allowed, it would be good to add 1-2 sentences after the first sentence about the state-of-the-art of SHWW changes through the Holocene. Also, I recommend against elevating the 20 particles /mL /kyr average number to the abstract. This will be picked up by many people and used as is. The real behavior shown in Figure 1 and discussed by the authors is significantly different than this average value.

Line 35 – 44: We remove the average linear regression values in the abstract and add the following sentence, so the abstract now reads, "The Southern Hemisphere Westerly Winds (SHWW) play an important role in global climate and Antarctic ice sheet dynamics; however, high-resolution proxy reconstructions are sparse. Conflicting evidence suggests SHWW latitudinal change weakening and/or strengthening throughout the Holocene. Dust microparticles preserved in Antarctic ice cores provide valuable paleo-perspectives on SHWW behavior. We present South Pole Ice Core (SPC14) dust records spanning the Holocene. Dust concentrations (1.1 – 5.1 µm) decrease through the Holocene, while the coarse particle percentage (CPP) increase due a relatively larger decrease in finer (1.1 – 3.2 µm) dust. Dust trends, CMIP6-PMIP4 model results, and SH proxy records are consistent with an increase in wind speed south of the SHWW core (>~51°S) across the mid-Holocene. The decrease in dust concentration may reflect weakening winds coupled with precipitation and/or vegetation changes over mid-latitude dust source regions, while the CPP increase may indicate strengthening of the SHWW south of the core. Our findings suggest that following a stable early Holocene, the SHWW began contracting towards Antarctica ~7 – 6 ka."

Lines 68-70: Please indicate the time resolution of the resulting dataset.

Line 81 – 83: We add the following statement to the following sentence, "Uncertainty during the Holocene is ± 18 years while between 1800 – 3100 years BP the uncertainty increases to ± 25 years (Winski et al., 2019). There while the CFA can produce sub-annual resolution, we resample the data using the median value to 50-year intervals."

Lines 72-76: This first sentence doesn't make much sense (particle shape does not cover the Holocene?). And the second sentence doesn't follow from the first one (therefore,…). Please clarify these two sentences. Also, the choice of 2-3 um for the FPP or CPP cutoff in the Delmonte papers is based on the size-distributions shown in Fig. 3 of Delmonte et al., 2002 (Climate Dynamics). To justify the same cutoff (and generally, for good measure), it would be good to show the size distribution from this core as well.

Line 89 – 94: We add, "We use a spherical particle shape assumption to facilitate comparison to other Antarctica ice core particle records that include a volume assumption (i.e., flux) using particles that range between 1.1 – 5.1 µm due to the particle number concentration distribution (Figure 1e). We use particle number concentration measured between 1.1 – 5.1 µm and CPP (defined as number of particles mL^{-1} [3.2 – 5.1] /[1.1–5.1] µm diameter x 100) following other East Antarctic studies due to the similarity of the South Pole particle flux to other East Antarctic core records (Figure 1e; i.e., Delmonte et al., 2020)."

Line 83: 1850 – 2014 AD is the historical simulation, not PI. Did you compare to PI or to historical?

As we have received a similar comment from Reviewer 1, we reran the models with the piControl to more accurately represent change from the mid-Holocene to the pre-Industrial period. All text has been appropriately corrected to reflect the change in model runs. The updated runs have been included in the new Figure 4 (originally Figure 3).

Line 84-85: That method is very confusing and badly described. What were the positive values replaced with? Positive differences mean that pi values are higher than MH, not a change in time. If all negative values are replaced by zero then how can you assess if there is an increase/decrease in a variable? Please clarify.

Line 123 – 126: We clarify by changing the sentence to, "We replace all positive values with a value of 1, which signifies an increase with time, and replace all negative values with a 0 and sum all model runs. Our method allows us to assess if the models agree to an increase/decrease in each climate variable rather than assessing the magnitude of change between each model.

Table 1: Add length of simulation used for pi and mh.

Line 128: Length of simulation has been added to Table 1 along with experimental IDs (Reviewer 1). We include the updated version of the table below.

Model	Institute	Time Resolution	Grid Size		Model Run Time		Variables
			Latitude (°)	Longitude (°)	mid-Holocene	piControl	
ACCESS-ESM 1-5 or CM2	Commonwealth Scientific and Industrial Research Organization, Australia	Amon	1.25	1.88	501 - 800	101 - 0600	pr, sfcWind, tas
AWI-ESM-1-1-LR	Alfred Wegner Institute, Germany	Amon	1.85	1.88	3106 - 3205	1850 - 1954	pr, sfcWind, tas
FGOALS-f3-L	Chinese Academy of Sciences, China	Amon	1	1.25	720 - 1219	600 - 1160	pr, sfcWind, tas
GISS-E2-1-G	Goddard Institute for Space Studies, USA	Amon	2	2.5	2900 - 3199	4150 - 5000	pr, sfcWind, tas
INM-CM4-8	Institute for Numerical Mathematics, Russian Academy of Science, Russia	Amon	1.5	2	1880 - 2079	1850 - 2380	pr, sfcWind, tas
IPSL-CM6A-LR	L'Institut Pierre-Simon Laplace, France	Amon	1.27	2.5	1850 - 2399	1850 - 2349	pr, sfcWind, tas
MPI-ESM1-2-LR	Max Planck Institute for Meteorology, Germany	Amon	1.85	1.88	1001 - 1500	1850 - 2849	sfcWind
MRI-ESM2-0	Meteorlogical Research Institute, Japan	Amon	1.11	1.13	1951 -2150	1850-2550	pr, sfcWind, tas
NCAR - CESM2	National Center for Atmospheric Research, USA	Amon	0.94	1.25	0 - 700	1 - 1200	pr, sfcWind, tas
NUIST - NESM3	Nanjing University of Information Science and Technology, China	Amon	1.875	1.875	1798 - 1897	500 - 0999	pr, tas
NorESM2-LM	Norwegian Climate Centre	Amon	1.875	2.5	2101 - 2200	1600 - 2100	pr, tas

Line 95: Here would be a good place for a size-distribution graph. In particular to indicate how much of the dust is finer than 1.1 um (even if it's not actively measured in the Klotz device) and how much is coarser than 5.1 um. Incidentally, naming the 1-5 um fraction "fine" dust is a bit confusing when the authors name the 3-5 um fraction "coarse". Below, the authors use mostly the word "dust" (like dust flux), so it would probably be best to just define here that dust means the 1.1-5.1 fraction for the rest of the document.

Line 142: We have added a new Figure 1e that displays particle size distributions. For clarity we remove the use of "fine" to describe dust concentration and replace any instance of fine particle number concentration to total particle number concentration. Dust particles that are ≤ 1.0 µm make up on average (median) 0.05% of the total dust number particle concentration throughout the record. The new figure can be seen below.

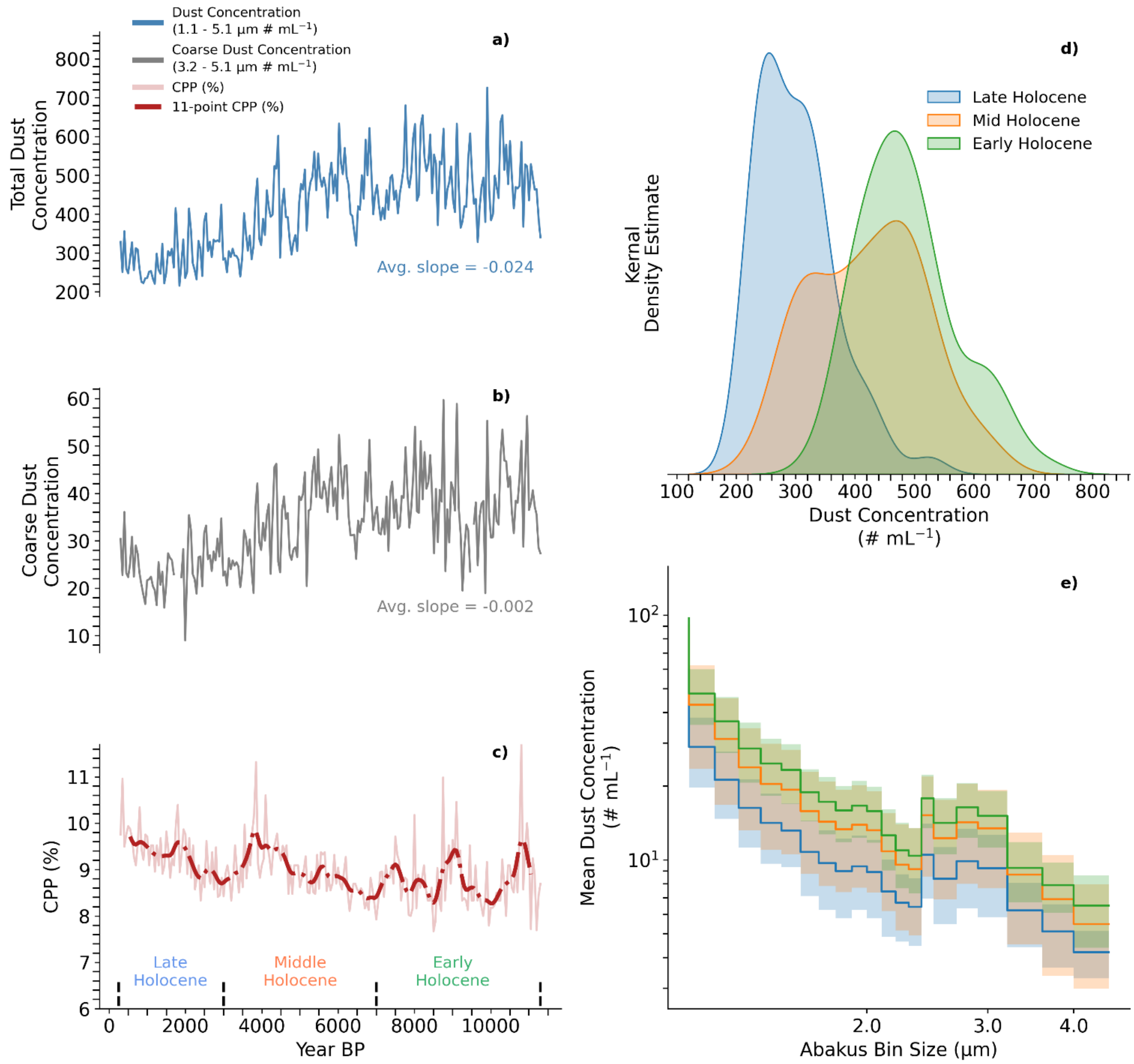


Figure 1a – e: 1a) 50-year median resampled SPC14 dust concentration (1.1 – 5.1 µm # particles mL-1; blue line), 1b) coarse particles (3.2 - 5.1 µm # particles mL-1; grey line), 1c) 50-year median resampled CPP (light red) and CPP 11-point rolling Gaussian mean (2σ; red dashed line), 1d) total dust # particles mL-1 concentration distributions, and 1e) total dust # particles mL-1 size distributions by time period. The figure is limited to 11,300 – 250 years BP to highlight Holocene variability recorded in the South Pole annually resolved record. Inset shows histograms of dust concentration from each of the three time periods highlighted in the record. Note the bimodal distribution during the mid-Holocene highlighting the transition from early to late Holocene. Average median absolute deviation (MAD) for the particle concentration is ~84 (Figure S1).

Lines 153-154: I don't understand these grids very well. Could you show them in Figure 2?

Line 239: We move Figure 2 to Figure 3. We use the term "grid" as a term to describe the sector of Antarctica since all directions could be described as "north" or "south". We replace the use of "grid" with the respective ocean sector (i.e., Atlantic, Pacific, or Indian) for clarity.

Line 159: Fluctuations are not advected. Please rephrase

Line 224 – 228: Per comments from Reviewer 1, we replaced these sentence (158 – 160) with the following statement, "While we recognize that some air masses and dust particles can be sourced from the East Antarctic Plateau, this area would not be the primary source of reduced dust emission during the mid-Holocene since southern South America and Australia are the primary sources of dust during the Holocene and modern period (Wegner et al., 2012; Vecchio et al., 2024; Delmonte et al., 2020). Rather we suggest that the decrease in dust concentration was driven by reduced SHWW activity in the wind in the mid-latitudinal regions (Figure 4)."

Figure 3: An aesthetic suggestion: If you copy-paste your data from 0 deg longitude to an additional column at 360 deg longitude, you avoid the white slice between 358 and 0 deg in the figure.

Line 288: We have removed the white slice in Figure 4 (originally Figure 3).

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