

Interactive comment on “Centennial-scale shifts in the position of the Southern Hemisphere westerly wind belt over the past millennium” by B. G. Koffman et al.

Anonymous Referee #2

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Koffman and co-authors present a dust particle dataset from the West Antarctic Ice Sheet Divide ice core over the past 2400 yrs. Measured dust size changes are compared with zonal wind strength between 1979 and 2002 in an attempt to calibrate the dust record in terms of wind strength. The dust size is interpreted as reflecting Southern Hemisphere westerly wind strength and is subsequently compared with published datasets from the mid-latitude and tropical Pacific.

The paper reads well and the datasets appear to have been obtained in a rigorous manner. However, I have several major comments below which should be addressed before the manuscript is published in its final form. In general I feel that more effort should be made to understand what the measured dust parameters actually represent

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before fitting the data with existing hypotheses about SWW shifts.

Major points:

The authors argue convincingly that the relatively coarse size of the dust particles at WAIS suggests that dust sources are local, and are thought to be in Marie Byrd Land; P3140). Yet, in terms of the link between wind strength and CPP, there is little correlation between dust size and wind strength in the Marie Byrd Land region (Fig. 6). The authors should explain why this is the case. There is an arrow in their schematic (Fig. 9) suggesting the authors must have reason to think that winds were stronger in this region during periods of coarser CPP. One reason for that lack of correlation may be that the main winds in this region (and the arrow on the schematic) are onshore i.e. they are meridional as well as zonal. Therefore, the authors could also analyse the correlation with meridional winds in this region. Until a mechanism linking CPP and SWW in the Marie Byrd Land region is shown, the interpretation of CPP remains speculative.

The timing of the increase in CPP seems not to fit so well with the northern hemisphere climate anomalies, the MCA and LIA. The maximum in CPP is at 1300 and seems to span between about 1200 and 1450, hence covering the boundary between both MCA and LIA periods. The authors should still compare their record to the northern hemisphere climate anomalies such as the MCA and LIA, but I do not think that the CPP peak at about 1300 CE should necessarily be attributed to the MCA as is stated in the abstract and conclusions. Similarly, the timing appears to be later than climate changes in other records that are shown in Fig. 8. If the control on all of the other records is simple shifts of the SWW as the authors argue in section 4.4, the mismatches in timing should be better justified than the explanation that is presently given (P3149, L8-9).

The link between SWW speed and dust emission/transport to the WAIS Divide site is an important aspect of the story but it is only briefly mentioned in the discussion (P3114

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L20-26). The mechanisms by which increased cyclogenesis causes an increased CPP should be explained more clearly here, in terms of this region and the WAIS dust record and should be included in the abstract. Also, if cyclones are important, the authors could test this by analysis of temperature indicators as suggested by Lubin et al 2008.

In the introduction there is a lengthy description of the SWW and their importance for global climate. However, considering that the manuscript aims to reconstruct changes in dust sources and dust transport pathways, very little information is presented on known Antarctic dust sources and on the mechanisms by which this dust is transported towards the ice core site. The introduction should be modified to focus more on Antarctic dust sources and transport pathways and less on the significance of the SWW.

In the discussion there is a great deal of comparison with other records from South America. However, there is little comparison with downcore changes in dust from other high-resolution ice core records. I suggest to reduce the discussion of SWW records from South America but to add some plots and comparison with published ice core records (for e.g. those that are mentioned: Ruth et al, 2004; McConnell et al, 2007; Mosley-Thompson et al, 1990 or the cores using nssCa). This might help to assess the regional nature of dust deposition.

Land-use changes are mentioned several times as a cause of the increase in dust flux over the last 150 yrs in the WAIS record and in other records (McDonnell, et al 2007). The authors should address how land use might also be compromising the calibration of CPP and wind speed (between 1979 and 2002).

Minor points:

Abstract, L4: mention the timescale under investigation

P 3129, L27: 'regional temperature' – which regions?

P3130 L1: replace glacial with glacier

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P3135 L10: mention Fig. 2e

P3137, L3: 1680 to 1730 – this is labeled as 1670-1730 in the figure.

P3138, L10: why is 700 Pa shown rather than 850 Pa? Please justify

P3139, L23: 6-7000 km, should read 6000-7000 km

P3140 L30-P3141 L4: Distal sources are suddenly mentioned. How much dust are they thought to contribute compared to local dust?

P3142 L18: refer to the correct figures (Fig. 2d and e) here and check that figures are always referred to throughout the manuscript. Check a to e is labeled on the figure.

P3142 L19-25: The explanation here should be more detailed and specific to the WAIS core. Which glacier, which desertification and which dust source region are meant?

P3143, L28: Yes, it seems counterintuitive to me - I would have thought stronger winds would result in emission of coarser particles. Perhaps the reasons for this can be better explained here.

P3143 L8-9: Availability from a local source could also be caused by increased local wind strength in the region of the local dust source

P3144 L19-25: CPP and PSD are both mentioned. Are the authors referring to two different parameters here or do they use them interchangeably in the sense that CPP is a measure of PSD? Either way, I think it's better to stick to one or the other in the text.

P3146, L28: Fig 8c should be Fig. 8d

Figures: Figure 1 The colour of the symbols should be more distinct. Some symbols in S. America are hard to see. Consider making the WAIS symbol different from all the rest. Make sure that every region/place name that is described in the text is labeled on the figure (eg Marie Byrd Land, Victoria Land etc).

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