Climate of the Past Discussions

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Comment on cp-2021-88

Anonymous Referee #2

Referee comment on "Regional validation of the use of diatoms in ice cores from the Antarctic Peninsula as a Southern Hemisphere westerly wind proxy" by Dieter R. Tetzner et al., Clim. Past Discuss., https://doi.org/10.5194/cp-2021-88-RC2, 2021

The manuscript by Tetzner et al. is a follow up of several papers by the same team (Allen et al., 2020; Tetzner et al., 2021a) on the use of diatom abundance in ice cores as a potential proxy for changes in past wind strength. Although diatoms have been evidenced in ice cores since a long time, their use to record past wind strength is quite new and not very well evaluated. This study intents to fill this gap and validate this proxy regionally. I believe that this study is of broad interest and certainly deserves to be published if the following points are clarified.

Main issues

- It is mentioned lines 330-335 that established ice core wind proxies such as nssCa, ssNa and nssK present very patchy spatial correlations with annual wind strength across the southern mid-latitudes (figure 3). For this reason, these proxies are mentioned to be of limited interest in this region. However, it appears to be exactly the same for diatom abundances who similarly show very patchy spatial correlations with wind strength (SHIC) and very restricted zones of high correlation (JUR, especially, and SKBL, figure 3). Additionally, for JUR and SKBL, these quadrants of high correlations (QHCs) are outside the main 950 hPa circulation to the ice cores as evidence in Allen et al. (2020). Indeed, back trajectories showed very low density in the 50-60°S band west of 120°W (figure 6, Allen et al., 2020). So one may question how diatom can be sea-sprayed from the NAZ between 120-150°W and then transported to the ice core sites if the air masses reaching the core sites do not sweep the QHCs? Somehow, the correlation between the diatom abundance records and the QHCs might not be causal. One may imagine that changes in wind strength in the QHCs (zonal circulation) also increases the strength of the meridional circulation, which allows a greater diatom deposition in the coastal ice cores. However, nothing proves that there is a transfer of

diatoms from the zonal circulation to the meridional circulation (see after with the comment on the diatom assemblages preserved in the ice cores).

- The statistics are based on a small number of data in each ice core. At SKBL, which shows the strongest and largest spatial correlation between diatom abundance and wind strength, it is based on 19 samples. I wonder whether this is statistically significant, especially as the reader is not told how the degrees of freedom for the tests were determined, and what allowance was made for the autocorrelation in the relevant series. This statistical aspect should be presented much more rigorously. See, e.g., Bretherton et al., 1999, The effective number of spatial degrees of freedom of a time-varying field. Journal of Climate, 12, 1990-2009. In the same vein, I did not really get how the series were detrended. Only by substracting the first order linear trend? But many records do not show any trend. And sometimes mentioned trends are not evident. For example, one really needs the eye of the believer to see any trend in diatom abundance, nssCa, ssNa and MSA in core SKBL, despite what is written line 184.

- The diatom assemblages appear as important to deal with as the total diatom abundances. They are presented in Tetzner et al. (2021a), which commits the reader to uneasily shuffle between the two manuscripts. It is mentioned lines 237-239 that the QHC regions match with the production zones of the main diatom species preserved in the ice cores. I somehow disagree with that general statement. More specifically, in JUR only S. gracilis (30% of the total diatom assemblages) is produced in the open ocean NAZ. Fragilariopsis cyclindrus is produced within the seasonal sea ice zone, south of 60°S. Fragilariopsis pseudonana occurs in high abundances around the South Shetland Islands. The Cyclotella, Achanthes and Navicula groups (> 50% of the diatom assemblages) represent diatom thriving at the AAP and AS-BS coasts, maybe be at the South American coast. The same interpretations can be drawn for SKBL. This fits quite well with the back-trajectories presented in Allen et al. (2020) with highest density along the 80°W parallel. This suggests that wind strength might not be the only (main?) driver of diatom transport and deposition in coastal ice cores. The wind direction is also very (most?) important.

- Based on the spatial correlations, this new tool gives an idea of wind strength changes in very small regions of the SWW core. It however gives no information on important

aspects of the SWW system, i.e. whether changes in strength are associated to changes in the intensity or the position/expansion of the SWW core, or in the winds' direction that may sweep different regions as shown by the rich diatom assemblages (many coastal and few open ocean diatoms). In conclusion, I wonder whether this is possible to really deconvoluate between wind strength, wind direction and source areas as potential drivers of diatom abundances in ice cores. Not to speak about variable diatom production in different oceanic realms, potential depletion of benthic diatoms from wet rocks, ice, etc….

- Overall, I am very puzzled about the QHCs localisations in the middle of the Pacific sector of the Southern Ocean, which does not fit with the back-trajectories (Allen et al., 2020) and diatom assemblages preserved in the ice cores (Tetzner et al., 2021a). Some elaborations on these aspects would be welcome.

Minor issues

- Half of the references in the Introduction are auto-citations. For example, there are many other studies showing the recent warming in AAP based on instrumental data (lines 24-25). Similarly, there are other groups working with climate reanalyses.

- In Allen et al. (2020), fragments of large diatoms were included in the total diatom content. I could not find this information in Tetzner et al. (2021a) or in the present study. As such, I am unable to evaluate whether the total diatom abundance is robust or not, as one large diatom can form several fragments. And it is impossible to evaluate whether such fragmentation occurs in surface water, during depletion and transport or during precipitation at the ice core site.