Dear Editor,

We thank reviewers #1 and #2 for their time and consideration in reviewing our manuscript. We are pleased that anonymous reviewer #1 recognises the value of this work and recommends our manuscript should be published. Please find to follow our response to anonymous reviewer #2 comments. Reference lines mentioned in our response correspond to lines in our modified manuscript (version with "track changes" disabled).

Reviewer #2 comment 1:

"I am however still confused by the diatom assemblages preserved in the ice cores and how they relate to the ocean environments in comparison to the spatial correlation maps. In SHIC core, >60% of the diatoms are made by *Fragilariopsis cylindrus* (Tetzner et al., 2021). This species is linked to heavy sea ice conditions both in plankton and surface sediments, i.e. rather towards continental shelf and bay systems (Kang and Fryxell, 1992 ; Leventer et al., 1993 ; Burckle et al., 1987 ; Armand et al., 2005 ; Beans et al., 2008 ; Esper et al., 2010 ; Campagne et al., 2016). Additionally, *F.cylindrus* is very abundant in the Amundsen and Bellinghausen coastal regions due to the presence of coastal polynyas (Kellog and Kellog, 1987). So, if *F. cyclindrus* is responsible of the correlation with sea ice cover (fig 3), I wonder how/why the QHC is towards the winter sea ice edge where *F. cyclindrus* is probably not very abundant. I also wonder how *F. cyclindrus* can be wind blow from a region where it is not present at all, as the wind QHC is far north of the winter sea ice limit.

I agree that there is a statistically significant correlation between diatom abundances and winds, but the ecological preferences of the main diatom species transported to SHIC ice core would argue against a long distance transport. I wonder whether *F. cylindrus* (and other coastal diatoms) could be entrained by strong winds in the coastal region. The link between these winds and the SHWW needs to be discussed."

Response to comment 1:

We agree with Reviewer #2 that the diatom assemblage of SHIC is not derived by long-distant transport but is sourced more locally, from within the seasonal sea ice zone (SSIZ). A proximal SSIZ source of diatoms for SHIC is supported by the high diatom concentration and strong seasonal variability, reflecting the intense seasonal blooms that characterize the SSIZ (Tetzner et al., 2022). Additionally, the proximity of the summer sea ice edge (SIE) and coastal polynyas to the SHIC, provide the most likely source for the diatoms and account for the dominance of F. cylindrus.

Based on this evidence, we explicitly state that the coastal areas exhibiting high correlations along the Bryan coast and the Amundsen Sea coast (Figure 1 and Figure 3) are the most likely source regions for diatoms in the SHIC (as suggested in reviewer's #2 comment) (Manuscript lines 276-315).

To address this comment, we have amended the abstract and text throughout (Lines 283-315) in order to reiterate the proximal source of diatoms to the SHIC:

Example (Lines 292-295): "*Previous studies have identified recent reductions in the ice-covered days (sea ice concentration) during the austral summer (Stammerjohn et al., 2012) and the development of*

*coastal polynyas (Eltanin Polynya, Pine Island Polynya and Amundsen Sea Polynya) within the **coastal** regions identified as the SHIC diatom sources (Arrigo and van Dijken, 2003; Arrigo et al., 2012)*".

We have also added text to better explain the area(s) of high correlation in the northern Bellingshausen and Amundsen Seas (Lines 278-281), which likely reflect(s) the inter-connectedness of regional atmospheric circulation (ie. zonal and meridional winds, and sea ice cover/distribution), over the Amundsen & Bellingshausen Seas.

Reviewer #2 comment 2:

"Similarly, coastal diatoms (*Cyclotella* gp, *Achnanthes* gp and *Navicula* gp) amount 40% and >50% of the total diatom assemblages preserved in SKBL and JUR, respectively. I do not understand how they can be entrained from the open ocean where the QHC lies. I believe they are rather wind blown from the coastal regions (Amundsen/Bellinghausen or South America). Their link to the QHC in the core SHWW is therefore not clear at all and should better discussed. For example, I woudl suggest to assess whether the meriodional component of the Admunsea Low (potential regional entrainment force) is always in phase with the SHWW speed changes because, again, SHWW can't transport these coastal diatoms to the ice cores. Another test/approach would be to assess the relationship between the sole open ocean diatoms with wind speed"

Response to comment 2:

The main diatom assemblage of JUR and SKBL presents considerable amounts of *Cyclotella* gp, *Achnanthes* gp and *Navicula* gp. These diatom genera have a broad distribution and can be found across freshwater, brackish, and marine environments. Our results highlight a region of high correlation between the diatom abundance at JUR and SKBL and wind speed at the northern edge of the Amundsen Sea and within the core of the Southern Hemisphere Westerly Wind (SHWW) belt (~60S). Regional air mass back trajectory analyses show airmasses reaching high elevation ice core sites on the peninsula are at sea level only a considerable distance over the ocean and are higher in the atmosphere when they traverse the Antarctic Peninsula coast (Thomas and Bracegirdle, 2015; Allen et al., 2020). These results suggest that diatoms transported to JUR and SKBL are either removed from the sea surface within the SHWW belt or from lower latitudes and then entrained by air masses moving south. The back trajectory results show it is unlikely that air masses actively entraining particles from coastal sites in the Antarctic Peninsula would transport them to inland ice core sites in the Antarctic Peninsula (JUR and SKBL). Although we cannot totally rule out a local source for the *Cyclotella*, *Achnanthes* and *Navicula* groups recovered from JUR and SKBL, the available evidence suggests these diatoms are likely entrained in the SHWW and/or lower latitudes.

To address this comment we have modified the manuscript to emphasize that air masses reaching inland ice core sites only interact with the ocean surface away from the coast (Lines 324-326).