Millennial-scale latitudinal shifts of southern westerly winds during the last glacial

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The southern westerly winds (SWW) interact with the Antarctic Circumpolar Current (ACC) and strongly impact the global climate and Antarctic ice-sheet dynamics across glacial-interglacial cycles (Lamy et al., 2019). Greenland and Antarctic ice-core records reveal large fluctuations of global climate and eolian dust input on both orbital and millennial time-scales. Abrupt millennial-scale strength and latitudinal shifts of SWW have been also hypothesized to occur during the last glacial, based on the stalagmite record in New Zealand (Whittaker et al 2011) and deuterium-excess record of Antarctica (Buizert et al., 2018). To better assess the possibility of latitudinal shifts of SWW during the last glacial, we examined compositional changes of marine sediment cores (MR16-09, PC2), obtained from coastal southern Chile (46S, 76W, 2793 m). The study site locates near the boundary of the present-day South Pacific summer and winter westerly jet path; hence the site is sensitive to the past southern westerlies shifts and accompanying latitudinal precipitation changes. Age model of the core is established based on nineteen ^{14}C dates. We measured high-resolution (year-scale) elemental composition using XRF core scanner (ITRAX) and low-resolution mineral composition and grain size distribution. Using method of Katsuta et al. (2019), water content-corrected μ-XRF intensities of wet sediment cores were converted elemental concentrations (dry weight %).
The obtained elemental and mineral compositions show periodic (multi-millennial-scale) increase in potassium (K) and illite contents, whereas decrease in titanium (Ti) and calcium (Ca) contents. Comparison with Antarctic temperature records (WAIS Divide Project Members, 2015) suggests a marked correspondence between the increase in K and illite content and Antarctic cold interval. In addition, decrease in Ti content of MR16-09 PC2 seem to coincide with increase in Ti content in sediment core of ODP site 1233 (41S, 74W) (Kaiser & Lamy, 2010). Increased Ti content of ODP site 1233 (ca. 400 km north from MR16-09 PC2) is interpreted as increased terrigenous input from high Andean hinterland (Cenozoic volcanic rock) due to the extent of Patagonian ice-sheet during Antarctic cold interval (Kaiser & Lamy, 2010). In this case, decreased Ti content in our core suggests that hinterland was fully covered by Patagonian ice-sheet during cold interval. On the other hand, increased K and illite content are thought to be originated from coastal range, through the fluvial discharges by enhanced rainfall (Stuut et al., 2007). Thus, increase in K contents likely reflects the increased precipitation due to the equatorward shift of SWW around the core site during Antarctic cold intervals. On the other hand, decrease in K contents likely reflects decreased precipitation due to the poleward shift of the SWW during Antarctic warm interval (AIM). It is also noteworthy that the shrinking of sea ice and the strengthening of the ACC (Lamy et al., 2015) seem to coincide with the poleward shift of SWW during the Antarctica warm interval. These lines of evidence suggest that equatorward/poleward shifts of SWW and weakening/strengthening of ACC likely occurred simultaneously in response to the Antarctic colder/warmer episodes during the last glacial.

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