Changes in flux, size and composition of dust at Dome Fuji, Antarctica across Termination I

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Mineral dust plays an important role in the climate system by affecting radiation budget, cloud microphysics, and atmospheric CO_2 concentration. In addition, dust responds to climatic changes. Therefore dust in paleoclimate archives can serve as excellent proxies for the past climate and environment. Dust in Antarctic deep ice cores have provided invaluable information on the past climatic and environmental changes in the southern hemisphere. However, due to very low concentrations in Antarctic ice cores, accurate and high-resolution continuous data have been limited. In particular, the information on changes in size and composition has been sparse. Here we present the results of accurate and high-resolution continuous analyses of dust concentrations, sizes, and compositions.

To study the dust variability from the Last Glacial Maximum (LGM) to mid-Holocene, we have analyzed the Dome Fuji deep ice-core using a Continuous Flow Analysis (CFA) system developed at the National Institute of Polar Research. With the CFA system, we measured microparticles, seven elements (Na, Mg, Al, Si, K, Ca, Fe and S), stable isotopes of water, black carbon and methane for the depth interval between 200 and 640 m. For accurate measurements of microparticle concentrations using a laser particle counter (Abakus, Markus Klotz), we improved the software. In addition to the CFA measurements, we collected discrete samples continuously at a 50 cm interval, and analyzed concentrations and size distributions using a Coulter counter (Multisizer 4, Beckman Coulter).

Abakus and Coulter counter data agreed well, and both particle counters could detect small changes in concentrations even during the Holocene when concentrations were low. The dust flux at Dome Fuji around the LGM was higher than that at Dome C (EDC) and lower than that at EDML (Kohnen), which reflects their distances from the major dust sources in South America. Dust size changes from the LGM to the Holocene at inland sites in East Antarctica have been reported to show regional differences (Delmonte et al., 2004; Wegner et al., 2012; Delmonte et al., 2017). At Dome Fuji, the dust size increased from the LGM to the Holocene, which is similar to EDC and EDML, but opposite to Dome B. By 16ka BP, the dust flux at Dome Fuji had decreased to the Holocene level, as was previously reported at other Antarctic deep core sites. Around that time, the relationship between dust size and dust concentration changed. Before that time, the dust size was almost constant, independent of dust concentrations, while after that time, dust size increased with dust concentration. Furthermore, the element compositions changed at that time. These results suggest that dust sources and/or transport pathways changed around 16ka BP.

References

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