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Sulfate-climate coupling over the past 300,000 years in inland Antarctica

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Sulfate aerosols, particularly micrometer-sized particles of sulfate salt and sulfate-adhered dust, can act as cloud condensation nuclei, leading to increased solar scattering that cools Earth's climate. Evidence for such a coupling may lie in the sulfate record from polar ice cores, but previous analyses of melted ice-core samples have provided only sulfate ion concentrations, which may be due to sulfuric acid. Here we present profiles of sulfate salt and sulfate-adhered dust fluxes over the past 300,000 years from the Dome Fuji ice core in inland Antarctica. Our results show a nearly constant flux of sulfate-adhered dust through glacial and interglacial periods despite the large increases in total dust flux during glacial maxima. The sulfate salt flux, however, correlates inversely with temperature, suggesting a climatic coupling between particulate sulfur and temperature. For example, the total sulfate salt flux during the Last Glacial Maximum averages 5.78mgm^{-2} yr^{-1}, which is almost twice the Holocene value. Although it is based on a modern analogue with considerable uncertainties when applied to the ice-core record, this analysis indicates that the glacial-to-interglacial decrease in sulfate would lessen the aerosol indirect effects on cloud lifetime and albedo, leading to an Antarctic warming of 0.1 to 5 kelvin.

Keywords: sulphate aerosols, cloud condensation nuclei, polar ice core, ice sublimation method