**Mineral dust sampling and particle size distribution (PSD).**

High algal biomass ice samples were collected in sterile sample bags and melted at ambient temperatures (5-10 °C). The thawed samples were filtered onto glass fiber filters (0.7 μm pore size), from which the solids were removed into a glass jar using a stainless steel spatula. In 50 mL centrifuge tubes, the samples were treated using 30% H2O2 (w/w) (Honeywell Fluka™) to remove the organic fraction. The samples (1-2 g) were sonicated (VWR ultrasonic cleaner) in 45 mL of the H2O2 treatment for 10 min to disaggregate the material. The samples were left in the H2O2 treatment for 48 h, after which they were centrifuged for 10 min at 4000 rpm (Eppendorf centrifuge 5810). The supernatant was removed, and the H2O2 solution was replaced. This process was repeated up to ten times until no more organic oxidation was observed. The remaining mineral fraction was washed three times in water (Sartorius arium® pro ultrapure water), with centrifugation after each wash.

A 5 mg of H2O2-treated sample was suspended in 10 mL of ultrapure water. The sample was sonicated to disaggregate the grains. The suspension was dispersed onto a 0.2 μm polycarbonate filter (Sartorius Track-Etch Membrane, 0.2 μm). Once dry, a section of each filter was adhered to a stainless steel SEM stub using an adhesive carbon tab. The sample was coated with 8 nm of Ir (Agar high resolution sputter coater). The PSD was determined using a Zeiss Ultra Plus field emission scanning electron microscope (FE-SEM) operated at 20 kV. Automated particle counting software was used to determine the PSD in an area of approximately 1 mm2.