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Deglacial pulses of deep-ocean silicate reveal enhanced Southern Ocean upwelling

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Growing evidence suggests that the low atmospheric CO_2 concentration of the ice ages resulted from enhanced storage of CO_2 in the ocean interior, largely as a result of changes in the Southern Ocean. Early in the most recent deglaciation, a reduction in North Atlantic overturning circulation seems to have driven CO_2 release from the Southern Ocean, but the mechanism connecting the North Atlantic and the Southern Ocean remains unclear. Biogenic opal export in the low-latitude ocean relies on silicate from the underlying thermocline, the concentration of which is affected by the circulation of the ocean interior. Here we report a record of biogenic opal export from a coastal upwelling system off the Prydz Bay located in southern of the Antarctic Polar Front that shows pronounced opal maxima during each glacial termination over the past 620,000 years. These opal peaks are consistent with a strong deglacial reduction in the formation of silicate-poor glacial North Atlantic intermediate water (GNAIW).
The "density vacuum" due to the reduction in GNAIW has been proposed to drive the deglacial rise in atmospheric CO_2. The reduction in GNAIW led to upward silicate transport, it should also have allowed the downward mixing of warm, low-density surface water to reach into the deep ocean. The resulting decrease in the density of the deep Atlantic relative to the Southern Ocean surface promoted Antarctic overturning, which released CO_2 to the atmosphere. However, such a circulation change drived by GNAIW reduction would have been limited at the GNIAW circulation and the water mass beneath. The Antarctic overturning deglacial opal maxima reported here suggest an alternative mechanism for the deglacial CO_2 release.