Deep-sea oxygen depletion and ocean carbon sequestration during the last ice age

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Ocean carbon storage during the Pleistocene ice ages was greater than during interglacial periods, lowering atmospheric CO_2 concentrations by 80 to 100 ppm. Leading hypotheses to explain lower ice-age CO_2 invoke a greater efficiency of the ocean's biological pump, in which case carbon storage in the deep sea would have been accompanied by a corresponding reduction in dissolved oxygen. We exploit the sensitivity of organic matter preservation in marine sediments to bottom water oxygen concentration to constrain the level of dissolved oxygen in the deep central equatorial Pacific Ocean during the last glacial period (18,000 – 28,000 years BP) to have been within the range of 20 - 50 μmol/kg, much less than modern value of ca. 168 μmol/kg. We further demonstrate that reduced oxygen levels characterized the water column below a depth of ~1000 m. Converting the ice-age oxygen level to an equivalent concentration of respiratory CO_2, and extrapolating globally, we estimate that deep-sea CO_2 storage during the last ice age exceeded modern values by as much as 850 PgC, sufficient to balance the loss of carbon from the atmosphere (ca. 200 PgC) and from the terrestrial biosphere (ca. 300 - 600 PgC). In addition, recognizing the enhanced preservation of organic matter in ice-age sediments of the deep Pacific Ocean helps reconcile previously unexplained inconsistencies among different geochemical and micropaleontological proxy records used to assess past changes in biological productivity of the ocean.