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CO_2 storage and release in the deep Southern Ocean on millennial to centennial timescales

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The carbon content of the deep Southern Ocean is widely thought to control atmospheric CO_2 on glacial-interglacial timescales, but few direct tests of this hypothesis exist. Here we present new deep sea coral boron isotope data that reflect the pH – and thus CO_2 chemistry – of the deep Southern Ocean over the last 40,000 years. At sites most influenced by deep Southern waters we find a close relationship between ocean pH and atmospheric CO_2: during intervals of low CO_2 ocean pH is low, reflecting enhanced ocean carbon storage; during intervals of rising CO_2 ocean pH rises, reflecting loss of carbon from the ocean to the atmosphere. In contrast at shallower sites we find extremely rapid (centennial-scale) pH decrease during abrupt CO_2 rise, reflecting the transfer of carbon from the deep to the upper ocean and atmosphere. These data thus confirm the importance of the deep Southern Ocean in ice age CO_2 change, and demonstrate that deep ocean CO_2 release can occur as a dynamic feedback to abrupt climate change on centennial timescales.