IS THERE A TIE BETWEEN ATMOSPHERIC CO_2 CONTENT AND OCEAN CIRCULATION?

(Abstract)

by

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The possibility that the CO_2 partial pressure of the surface waters of the ocean (and hence also of the atmosphere) is dependent on the rates of oceanic mixing is explored. The purpose of this exercise is to ascertain whether the abrupt rise in atmospheric CO_2 content at the end of the last glacial period could have been caused by a reorganization of deep-sea ventilation. We also have our eyes on the possibility that future warming of the planet induced by anthropogenic CO_2 will lead to a positive feedback (i.e. polar warming, reduced deep-sea ventilation rate, increase in the CO_2 partial pressure of surface ocean water). Our approach is to consider two end-member models for the distribution of CO_2 in the sea. One is thermodynamic, the other is biological. The surface-water CO_2 partial pressure difference between these end-member models is nearly a factor of two. We show that the situation for the real ocean probably lies roughly halfway between these extremes and explore how the ratio of deep-sea ventilation rate to air-sea CO_2-exchange rate might push the system closer to one extreme or the other. Our tentative conclusion is that decreases in the ventilation rate will push the ocean closer to the thermodynamic end member and hence raise the atmosphere's CO_2 partial pressure. Such a decrease in ventilation rate may have occurred at the end of glacial time. A further decrease may be induced during the next hundred or so years by the build-up of CO_2 in the atmosphere.

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A RECONSTRUCTION OF THE COASTAL ANTARCTIC CLIMATE AND SUMMER SEA-ICE POSITION AT 18 ka BP

(Abstract)

by

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The results of an investigation of the oxygen-isotope composition in present-day Antarctic snowfall (Bromwich and Weaver 1983) are assumed to apply at the last glacial maximum, and the resulting coastal climate is derived. Inputs are the observed change in $\delta^{18}O$ from ice cores (Lorius and others 1979), the extent of winter sea ice at 18 ka BP inferred from ocean sediment cores (Hays and others 1976), and the present-day connections between sea-ice extent and both temperature and $\delta^{18}O$ in coastal precipitation. The following variables are calculated: the annual, summer, and winter surface air temperatures, the summer and winter $\delta^{18}O$ values in precipitation, and the summer sea-ice extent, all for 18 ka BP.

Contrary to expectation, the derived 18 ka BP summer sea-ice extent and coastal air temperatures are approximately the same as at present. Accompanying the much larger winter sea-ice, the glacial July air temperature is found to be about 15°C cooler. Annual temperatures are about 7°C lower. The derived results imply a much more marked seasonality and a much larger cycle of sea-ice growth and decay.

Some observational evidence in support of these findings is available. The glacial summer sea-ice position is in general agreement with new ocean sediment interpretations (Burckle and others 1982) which suggest that the pack ice retreated close to the Antarctic continent in many years (personal communication from L H Burckle 1983). Perched deltas in Taylor Valley, which are ^{14}C-dated to 18 ka BP (Stuiver and others 1981), imply the presence of liquid water; in turn this may reflect relatively warm summer temperatures. Ice cores show a substantially larger "seasonal" variation in microparticle deposition onto the Antarctic ice sheet during the last glacial maximum (Thompson and Mosley-Thompson 1981).

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