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Biological oxygen productivity from triple oxygen isotope measurements from the Vostok ice core over four climatic cycles

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The oxygen isotope signature of atmospheric O_2 is linked to the isotopic signature of seawater (H_2O) through photosynthesis and respiration. Fractionation during these processes is mass dependent, affecting $\delta^{17}O$ about half as much as $\delta^{18}O$. An "anomalous" fractionation process, which changes $\delta^{17}O$ and $\delta^{18}O$ of O_2 about equally, takes place during isotope exchange between O_2 and CO_2 in the stratosphere. The relative rates of biologic O_2 production and stratospheric processing determine the relationship between $\delta^{17}O$ and $\delta^{18}O$ of O_2 in the atmosphere. Variations of this relationship thus allow us to estimate changes in the rate of mass dependent O_2 production by photosynthesis versus the rate of O_2-CO_2 exchange in the stratosphere with about equal fractionations of $\delta^{17}O$ and $\delta^{18}O$.
We reconstruct total oxygen productivity for the last four glacial-interglacial cycles from the Vostok ice core. Preliminary model calculations translate the triple isotope data into total oxygen productivity. Generally productivity parallels the atmospheric CO_2 concentration in the past. For the previous interglacials (MIS 5,7,9) we find productivities comparable to the present interglacial. During glacials total productivity was reduced to about 80% of present.