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The effect of stratospheric mass-independent-fractionation on the triple isotope composition of atmospheric oxygen

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In 1999 Luz et al. suggested that mass-independent-fractionation (MIF) in the stratosphere which involves ozone formation and photolysis and CO_2 would result in MIF anomalous depletion of ^{17}O in atmospheric oxygen of about 0.12 permil. We have recently determined the triple isotope effects of the various respiratory mechanisms as well as of hydrology and leaf transpiration (e.g. Landais et al., 2007). These make it possible to calculate the $\delta^{17}O$ and $\delta^{18}O$ of air in the absence of stratospheric MIF. Comparison of these calculated values with high precision measurements of $\delta^{17}O$ and $\delta^{18}O$ of seawater (Barkan and Luz, 2005) substantiates the ^{17}O anomaly suggested by Luz et al. (1999). Further indication of the ^{17}O anomaly of atmospheric oxygen is clearly demonstrated by our numerous measurements of oxygen dissolved in the seasonal thermocline in the N. Atlantic near Bermuda. O_2 in the stably stratified water column is recycled by photosynthesis and respiration while exchange with the atmosphere is minimal. Over half a year when the water column is stratified the dissolved O_2 becomes enriched by about 0.15 permil in ^{17}O with respect to air O_2 of similar $\delta^{18}O$. Other groups working in the Equatorial and N. Pacific obtained similar results. In addition, we have recorded ^{17}O enrichment of the same magnitude by biological recycling in a Red Sea coral reef. All these results, from natural systems, clearly indicate that atmospheric O_2 is affected by stratospheric MIF. The MIF signature of atmospheric O_2 is removed by biological recycling by photosynthesis and respiration.

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Landais et al. (2007) Global Biogeochemical Cycles (in press)

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