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Caveat to marking the rise of oxygen on the Early Earth: photochemical responses in a hydrogen-rich atmosphere

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Earlier studies have implied that high UV on the ground (as implied by sediment data) on the Early Earth may suggest low atmospheric ozone hence low oxygen levels. Such reasoning is used to place constraints on the timing of the rise in oxygen on our planet, which has important repercussions for understanding the development of life on Earth. Our model study has revealed a potentially important caveat. We simulated an Early Earth atmosphere with high hydrogen levels (as suggested by Tian et al.(2005)) with coupled climate and photochemistry. The high hydrogen reacted with oxygen species to form hydrogen oxides which almost completely removed the ozone layer via photochemical catalytic cycles. Therefore, it is possible to envisage an atmosphere with quite high levels of oxygen (up to 10% of present day) but nevertheless virtually no ozone. This suggests, one should interpret with caution the sediment data in terms of dating the rise in atmospheric oxygen.