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Chemical Processes affecting Ozone in Early Earth type Atmospheres

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Atmospheric ozone is believed to be a good biomarker because it may maintain quite a stable concentration over a range of oxygen levels. However, ozone is strongly affected by catalytic cycles involving NOx (=NO+NO2), ClOx (=Cl+ClO) and HOx (=OH+HO2) whose levels depend on parent species which are not well constrained in early-Earth type environments. In this work our goal is to gain a better understanding of how these cycles may affect ozone in such environments in order to reassess ozone's suitability as a biomarker. We do this by performing sensitivity studies varying NOx, ClOx and HOx using a coupled radiative-photochemical column model. Results support a previous box-model study of ours which asserted that the NOx-catalysed smog mechanism may have produced considerable ozone hence contributed to UV-shielding of the surface on the Early Earth. Varying ClOx and especially HOx within current uncertainties also has a significant effect upon ozone. Overall, our results suggest that ozone is generally a good biomarker but in terms of exoplanet search programs, scenarios with high oxygen yet low ozone levels are certainly possible due to efficient ozone loss via the catalytic cycles. Therefore, strategies which search for all biomarkers, not just ozone, are recommended.