Constraining Oxygen False Positives in Terrestrial Planetary Atmospheres. C. E. Harman[1,2,3*], J. C. Schottelkotte[4], and J. F. Kasting[1,2,3], [1]Pennsylvania State University Department of Geosciences, University Park, PA, [2]Penn State Astrobiology Research Center, [3]NASA Astrobiology Virtual Planetary Laboratory, [4]Pennsylvania State University Department of Astronomy, University Park, PA ([*]C. E. Harman, Deike Building, University Park, PA, 16803; ceharmanjr@psu.edu).

Introduction: Oxygen (O_2) and ozone (O_3) in the present Earth's atmosphere are byproducts of oxygenic photosynthesis coupled with organic carbon burial. On Earth, no known abiotic surface process would be able to generate such an atmosphere, and by extension, lifeless exoplanets are expected to be devoid of O_2. As a result, molecular oxygen and ozone are often seen as unambiguous signposts for life. Recently, however, a number of authors have demonstrated the abiotic generation of molecular oxygen in a planetary atmosphere, either under oxidizing conditions [1], or around an M star [2]. Attempts to reproduce these 'false positives' have met with mixed success [3], but if a terrestrial planet could build up abiotic oxygen to sufficient levels (e.g., above the biotic levels of oxygen suggested for the Proterozoic Earth [4], which is also above the detection threshold for a proposed next-generation TPF-style space telescope [5]), the results would remove oxygen (and consequently ozone) from an already short list of easily detectable biosignatures.

Results: We explore oxygen false positives with our 1-D photochemical model, updated from Segura et al. [5]. If water vapor photolysis longward of ~200 nm is neglected, substantial amounts of CO and O_2 can build up in the lower part of the atmosphere of a planet orbiting a solar-type star, similar to the levels seen by [1]. Differences in chemical reaction networks may also play a role in exaggerating oxygen production and preservation from CO_2 photolysis. For M stars, the ratio of far-UV to near-UV (FUV/NUV) dramatically impacts the photochemical steady state of the atmosphere, allowing substantial amounts of CO and O_2 to accumulate. The ultimate fate of CO and O_2 produced in such atmospheres is strongly dependent on the imposed lower boundary conditions, with low deposition velocities corresponding to higher mixing ratios in the lower atmosphere. Such low deposition velocities are incongruous with our assumptions about a terrestrial planet, however, and realistic choices for the deposition velocities draw oxygen down below the detection threshold for a next-generation TPF-style space telescope, as well as below the biotic oxygen levels seen following the first rise of oxygen on Earth. Ultimately, the largely unconstrained aqueous chemistry of CO and O_2 in a terrestrial planet's ocean will control the deposition velocities, which is the subject of ongoing work.

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