Biomarkers on Earth-like planets around M dwarfs

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Coupled, 1-D photochemical-climate calculations have been performed for hypothetical Earth-like planets around M dwarf stars. Synthetic spectra of these planets were then generated at both visible/near-IR and thermal-IR wavelengths to determine which biomarker gases might be observable by a future, space-based telescope. The star sample

includes the active M dwarfs AD Leo and GJ 643 and three quiescent, model M stars with effective temperatures of 3650 K, 3400 K, and 3100 K.

An M-star planet with an O_2 concentration like Earth, would have a different atmospheric photochemistry as a consequence of the different spectral distribution of the star's radiation. A methane flux comparable to the present biological flux on Earth could produce a steady-state CH_4 concentration equal to ~200 times the terrestrial value on the active M-star planets. The same boundary condition will produce a methane runaway on the planets around the quiescent stars. N_2O and CH_3Cl are also more abundant on all the M-star planets than on Earth as a consequence of lower UV photolysis rates. Unlike the situation on Earth itself, both of these gases and methane could be present in sufficient concentrations to be detectable spectroscopically in either the thermal-IR or visible/near-IR by a future space-based telescope such as NASA's proposed *Terrestrial Planet Finder* Mission(s). O_2 and O_3 in our M star planet atmospheres show similar spectroscopic detectability to present-day Earth. The simultaneous detection of O_2 (or O_3) and a reduced gas like N_2O, CH_4, or CH_3Cl in a planet's atmosphere would provide strong evidence for life. Planets circling M stars may be good locations to search for such evidence.