

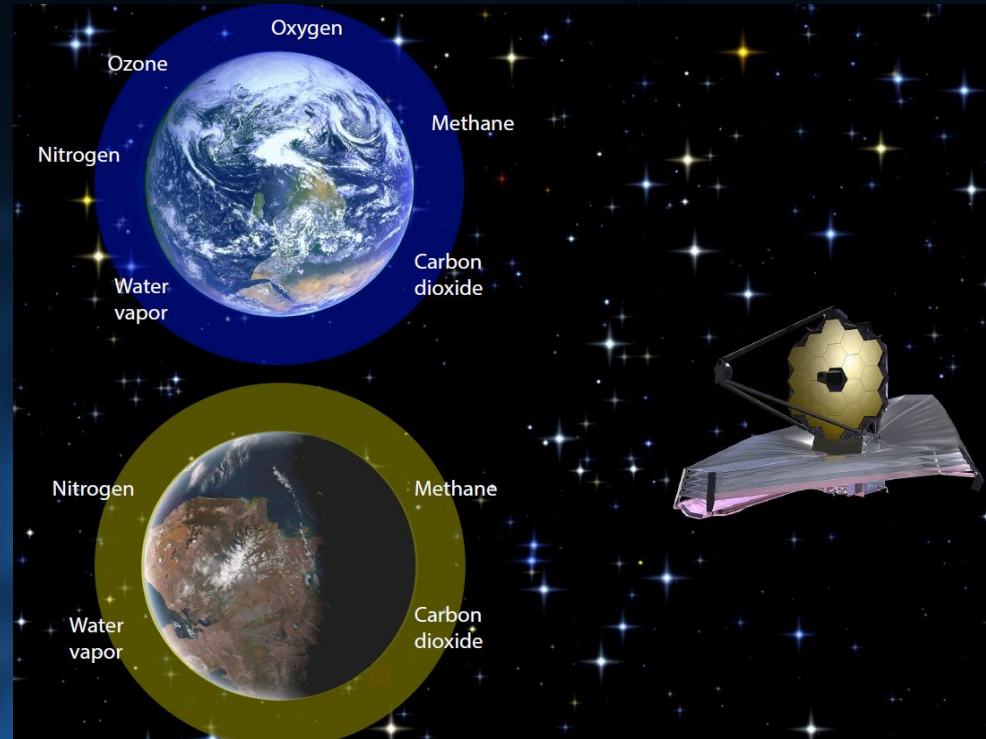
A New 'Atmospheric Disequilibrium' Could Help Detect Life On Other Planets

BACKGROUND: Disequilibria in planetary atmospheres has been proposed as a generalized method for detecting life on exoplanets through remote spectroscopy. Among solar system planets with substantial atmospheres, the modern Earth has the largest chemical disequilibrium due to the presence of life. However, how this disequilibrium changed over the billions of years of life and Earth, and during increasing oxygen levels, is largely unknown.

THE RESEARCH: This team calculated the disequilibrium of gases between the atmosphere and ocean during the *Precambrian period. They report that (i) the disequilibrium increased through time in step with the rise of oxygen; (ii) both the Proterozoic and Phanerozoic periods may have had remotely detectable biogenic disequilibria due to the coexistence of O_2 , N_2 , and liquid water; and (iii) abiogenic disequilibrium in the Archean period caused by the coexistence of N_2 , CH_4 , CO_2 , and liquid water, which, for an exoplanet twin, may be remotely detectable.

TAKE-HOME: On the basis of these results, the researchers identified a new combination of gases that would provide evidence of life on an exoplanet: methane and carbon dioxide found together, but only in the absence of carbon monoxide.

*Precambrian: ~4.6 billion years ago to the beginning of the Cambrian Period, about 541 million years ago



Future telescopes like the James Webb Space Telescope (image above, right) will observe the atmospheres of distant planets to seek evidence of life. Earth (top left) has several gases in its atmosphere that reveal the presence of life, primarily oxygen and ozone. The new study finds that for the early Earth (bottom left), the combination of abundant methane and carbon dioxide would provide an alternative sign of life. Source: NASA/Wikimedia Commons/Joshua Krissansen-Totton