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Thermodynamic disequilibrium as a biomarker in Mars

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Disequilibrium should be a necessary condition in planetary body atmospheres hosting life, as a consequence of the chemical interchange between the atmosphere and the living organisms. In this study, we analyze the thermodynamics of Mars atmosphere considering more than 50 reactions (including those involving traditionally considered biomarkers such as H_2O or CH4), and estimating their entropy production and Gibbs free energy. Those complementary measurements provide information on the disequilibrium of the atmosphere in a measurable way.

Besides the atmosphere's thermodynamic state, the interaction between surface-atmosphere has been analyzed considering the abiotic analogs of those sources of energy for life on Earth (for example iron oxidation).

Using thermodynamic criteria we have studied the habitability under two different situations in Mars: the surface of the Gale crater (4.6S 137.2E),where the Mars Science Laboratory will land in August 2012, and a hypothetical cave near the equatorial zone. The study of the time-dependence of these thermodynamic quantities provides us with a complete tool to study the past and present habitability in Mars.