The Drivers of early Archean Earth’ s Hydrology: Resolving the Faint Young Sun's Paradox

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Understanding how the early Archean Earth supported standing bodies of liquid surface water under the faint young Sun is one of the greatest challenges of modern science. Can this problem be resolved as a part of the puzzle of understanding of the origin of building blocks of life on early Earth? Here, we present a new concept of how these two pieces of the mystery of life can be reconciled if we reconstruct the eruptive history of space weather from the young Sun at the time when life started on Earth. Our three-dimensional (3D) magnetohydrodynamic model of the young Sun suggests that energetic protons can be accelerated in shock waves driven by frequent and powerful Coronal Mass Ejection events and Corotating Interacting Regions produced by the young Sun's wind. Accelerated protons at energies > 300 MeV penetrated into the nitrogen-rich weakly reducing atmosphere and initiated the reactive chemistry by breaking molecular nitrogen, carbon dioxide, and methane, producing nitrous oxide, the potent greenhouse gas, and hydrogen cyanide, an essential feedstock molecule of life. Our Global Climate Model, ROCKE-3D, suggests that at 4(1000) ppmv of nitrous oxide produced in a 1(0.5) bar atmospheres outputs the mean annualized Earth’ s temperature of +16(5.2)C, and thus may provide a resolution of the FYS paradox and explain the presence of early oceans.

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