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Atmospheric nitrogen at the time when life evolved on Earth

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The amount of nitrogen present in the atmosphere at the time when life evolved on Earth is central for understanding the production of prebiotic molecules and hence, is a fundamental quantity to constrain. However, estimates of atmospheric molecular nitrogen partial surface pressures (pN_2) during the Archean widely vary in the literature. In this study, we apply a model combining newly-gained insights into atmospheric escape, magma ocean duration and outgassing evolution to derive pN_2 during the Hadean and Archean. Results suggest <420 millibar surface molecular nitrogen (N_2) at the time when life originated, which is much lower compared to previous works, hence could impact the production rate of prebiotic molecules such as hydrogen cyanide. Our revised values provide new input for atmospheric chamber experiments simulating prebiotic chemistry on the early Earth. Our results assuming negligible nitrogen escape rates are in agreement with research based on solidified gas bubbles and the oxidation of iron in micrometeorites at 2.7 Gigayear ago suggesting that the atmospheric pressure was probably less than half the present-day value. Furthermore, our results contradict previous studies that assume N_2 partial surface pressures during the Archean higher than today and suggest that if the N_2 partial pressure were low in the Archean it would likely be low in the Hadean as well. Additionally, our results imply a biogenic nitrogen fixation rate from 9 to 14 Teragram N_2 per year which is consistent with modern marine biofixation rates, hence indicate an oceanic origin of this fixation process.