Geologists theorize early Earth was kept warm by hydrogen-nitrogen collisions

January 4 2013, by Bob Yirka

Credit: NASA

(Phys.org)—Geologists Robin Wordsworth and Raymond Pierrehumbert of the University of Chicago, suggest in a paper published in the journal *Science* that early Earth was kept warm enough for life to develop by collisions between hydrogen and nitrogen molecules in the atmosphere. In a perspective piece in the same journal, fellow geologist James Kasting of Pennsylvania State University comments on the work Wordsworth and Pierrehumbert have been doing and suggests their theories seem plausible.

During the first two billion years of Earth's existence, something helped keep the planet warm enough for life to develop, but it wasn't heat from the sun. Scientists have put forth many theories to explain why the planet wasn't covered with ice despite receiving just 70 percent of the solar radiation it gets today. Most have centered on the idea that methane from hydrogen eating organisms likely served as a greenhouse gas, helping trap the small amount of heat that did come from the sun.

In this new research, Wordsworth and Pierrehumbert suggest an entirely different source – collisions between hydrogen and nitrogen molecules that resulted in the creation of "dimer" molecules that would wobble in response to being struck by infrared light from the sun. That wobbling, they say, would have allowed for heat capture providing the planet with a warm blanket.

For this theory to stand up, there would have had to have been more hydrogen gas in the atmosphere than there is today and the researchers point to new work by others that suggests that this might in fact have been the case – some calculations show that during Earth's formative years, its atmosphere might have been made up of 30 percent hydrogen. Wordsworth and Pierrehumbert suggest that if it was even as much as 10 percent, that would have been enough to cause the planet to heat by as much as 18 to 27 degrees Fahrenheit.

Because of their findings and theories, the researchers suggest that other planets may be experiencing similar warming effects and thus scientists searching for life outside of our solar system might consider revising the criteria they use for determining if a planet or other body is worthy of further research, particularly those known as super-Earth's – those considered to be of the right size, but more distant from their star than our planet is from the sun. If they have a lot of hydrogen, they might be worth a closer look.

More information: Hydrogen-Nitrogen Greenhouse Warming in Earth's Early Atmosphere, *Science* 4 January 2013: Vol. 339 no. 6115 pp. 64-67 DOI: 10.1126/science.1225759

ABSTRACT

Understanding how Earth has sustained surface liquid water throughout its history remains a key challenge, given that the Sun's luminosity was much lower in the past. Here we show that with an atmospheric composition consistent with the most recent constraints, the early Earth would have been significantly warmed by H_2-N_2 collision–induced absorption. With two to three times the present-day atmospheric mass of N_2 and a H_2 mixing ratio of 0.1, H_2-N_2 warming would be sufficient to raise global mean surface temperatures above 0°C under 75% of present-day solar flux, with CO_2 levels only 2 to 25 times the present-day values. Depending on their time of emergence and diversification, early methanogens may have caused global cooling via the conversion of H_2 and CO_2 to CH_4, with potentially observable consequences in the geological record.