Astrobiology News August 2015:
"Slushball" Earth?

I'd planned this month's news to be about the *Dawn* mission at asteroid/dwarf planet Ceres, but I'll postpone that article until we get further results. Instead, I'll share some recent research into the evolution of Earth's climate that's relevant to all denizens of our planet! Global climate models that predict where our planet is heading in the future can also be used to explore where it's been in the past. Such models indicate that the Earth has gone through several periods of runaway glaciation resulting in a "Snowball Earth", with global, or near global, ice cover. The principal evidence for these periods comes from geologic evidence of glaciers near the equator. Ice reflects about 55-80% of incoming sunlight (much more than either ocean water or land), sending that energy back into space rather than warming the planet, so more ice cover leads to lower temperatures which lead to more ice and even lower temperatures, possibly until the entire planet is frozen.

At least two of these Snowball Earth periods are associated with the Cryogenian period, which lasted from 850-635 million years ago. One big conundrum with the frozen Earth scenario during this period has been how the Earth managed to warm up. Once covered with ice, the positive feedback loop that leads to further cooling presents a problem for thawing the Earth. Also, there is no evidence for a mass extinction event during this period, nor is there geological evidence to support a great release of greenhouse gases into Earth's atmosphere due to volcanic activity that could warm the planet. However, there is evidence for an ongoing water cycle, rather than the dry atmosphere that would develop if the oceans were completely frozen over.

Columbia University geologist, Linda Sohl[1], and her colleagues have focused on modeling the Cryogenian period including important parameters in their models such as the brightness of the Sun (it was about 6% dimmer than it is today) and the arrangement of the continents into a single supercontinent near the equator. The goal of this research is to identify the factors most important in driving glaciation or halting it. They have found that ocean circulation seems to prevent a complete freeze, and their models predict about half of the oceans remain ice-free, resulting in more of a "Slushball" than "Snowball" effect. One of the most outstanding issues remaining in these studies may be the effect of topography; that is, altitude variations that could effect glaciation.

In addition to being critical to understanding Earth's evolutionary past, these computer models are important to discussions on the limits of habitability on planets orbiting other stars. A world of solid ice would not be very hospitable to life forms dependent upon liquid water! Might water-bearing planets like Earth carry

[1] See http://www.giss.nasa.gov/staff/lsohl.html

some “natural defense mechanism” against global freezing? If so, planetary environments containing liquid water may be more common than Astrobiologists have traditionally assumed. Check out www.astrobio.net to keep up with some of the latest Astrobiology research!

Until next month,

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