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New Implications for a Sun-Earth-Moon System

"It appears that the tides are, surprisingly, an intricate part of the story of climate change, as is the history of the lunar orbit." - Wunsch (2000)

Smil (2002) characterizes the biosphere as being energized by two sources: "by the Sun's radiation, and the Earth's heat" (95). Both of these energy sources have drastically influenced Earth's plate tectonics, which Smil holds responsible for "making possible the evolution of land plants and heterotrophs and humans (Taylor and McLennan 1995; Smil p 120). Furthermore, plate tectonics plays an essential role in water and mineral flows within the biospheric Earth cycle (Smil 2002).

Likewise, advancements in technology and recent research have shown that our Moon, too, is a power plant of biospherical energy. Wunsch and Munk (2000) concluded that about half the energy required to return deep waters to the surface was primarily driven by the dissipation of tidal energy. Although the Sun's gravity plays a minor role, the tidal energy is principally lunar. Figure 1 demonstrates M2-tide energy input into Earth's oceans from the Moon.

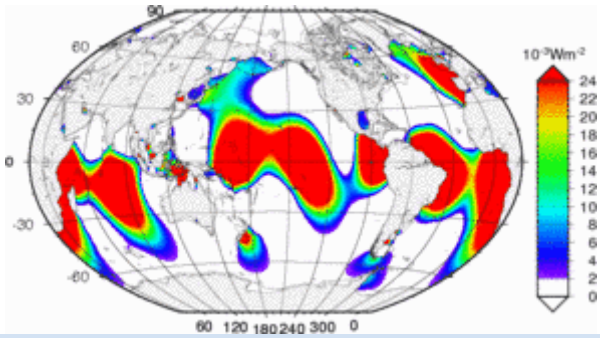

Fig.1: M2-tide energy input from the Moon (HAMTIDE)[1]

It is obvious that ocean tides and deep ocean currents play a significant role in the biosphere. The movement of Earth's oceans are one facet of the "rock cycle" (Turner Lecture 3). It is easy to imagine that the Moon's tidal energy amplifies rock weathering by slamming the Earth's oceans against her continents and stirring her beaches. Without volatility within the Earth's oceans, it would be more difficult for minerals to be broken down and coalesce into new rocks on the ocean floor. The relationship between tidal energy, the "rock cycle", and our atmosphere should not be ignored. Further research into the feedback systems between these forces, and implications for climate change, is needed.

[1] http://www.massentransporte.de/index.php?id=304

The Moon's proximity, gravity and orbit has affected the biosphere in other ways. Most notably, "the tidal friction results in a transfer of angular momentum from the Earth to the Moon, gradually slowing down the rate of Earth's rotation and withdrawing the Moon from Earth" (Shweiki 2000). The net affect has increased the length of a calendar day by about nine hours.

Shweiki continues to consider how the changing circadian rhythmicity may have affected the behavioral, physiological and biochemical evolution of prokaryotes and eukaryotes. The study goes as far as to consider the temporal conditions of intercellular communication and the formation of the cytoskeleton (548). Shweiki concludes that, "Endogenicity is currently in the heart of the circadian rhythms paradigm" (551). It is clear that without the Moon, Earth would be a vastly different place.

Taking a step back, astrophysicists have coined the term Sun-Earth-Moon System (Alladin 2005) to account for dynamics relating between the Sun-Moon system and even the affects of our planetary neighbors (Smulsky 2011). A hierarchy of magnitude of affect was described by Smulsky, "The greatest action on the Earth rotation is from the Moon, then from the Sun, and from Venus among the planet." He concludes that the culmination of these affects constitutes Earth's axis at an almost invariable average rate (134).

By adding the Moon to Smil's Sun-Earth system, we get a more complete idea of what forces have aided in the inhabitation of our planet. This new consideration solicits the mind to ask, "Are Planet-Moon relationships necessary for the conditions of a habitable planet?" We may never get our answer, but research has been conducted to predict the odds that a planet such as Earth would be impacted forcefully enough to create a comparable satellite.

Elser, et al. (2011) found that planets lying in the habitable zone, with a moon system such as our own, would not be rare, and that "giant impacts with the required energy and orbital parameters for producing a binary planetary system do occur with more than 1 in 12 terrestrial planets hosting a massive moon, with a low-end estimate of 1 in 45 and a high-end estimate of 1 in 4." Considering the simulations run by Elser, et al., we should not consider the Earth-Moon system to be unique to the universe. Rather, the system should appear quite often.

In conclusion, little is known about the relationship between Earth's biosphere, geosphere and the Moon. Paradoxically, it seems hard to frame geological and biospherical evolution of the Earth without its satellite. Gaining insight into how these cycles feedback my provide a more sound understanding of historical global climate change and help simulate climatic predictions.

Additional Discussion

The primitive Earth-Moon system is investigated during co-accreation by Morishima and Watanabe (2003). Despite crude data, Kagan's (1998) historical analysis concludes that "good results" are achieved when accounting for the changes in resonance properties of the ocean on geological timescales.

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