

## Space-Sun-Earth Interaction through time

Shigenori Maruyama<sup>1\*</sup>

<sup>1</sup>Tokyo Institute of Technology

[Purpose] The Earth's surface is open for the space, hence is suffered to GCR caused by supernova or explosive solar winds. By these reasons, surface environment and life must have been strongly influenced, and evolved associated with mass extinctions through geologic time. [Methods employed] We synthesize the relationships among surface environmental change, life history, solid Earth activity, geomagnetic intensity change, and system evolution to infer the Sun-Space-Earth interactions through time, by decoding Earth history.

[Result] (1) Relationship between Earth history and Sun-Space history. We list up the following mega-events on the Earth to be discussed herein, 1. Birth of the solar system, 2. Meteorite bombardment at 4.0Ga, to cause nearly complete surface melting, 3. 2.7Ga most active flood basalt to cover nearly whole Earth after 4.0Ga, and increased geomagnetic increase, 4. 2.3Ga snowball Earth followed by the birth of Eukaryotes, 5. Birth of first supercontinent at 1.8-1.9 Ga, 6. Snowball Earth at 0.77-0.52 and subsequent Cambrian explosion (birth of animals), 7. P/T boundary event of mass extinction, 8. K/T boundary by Dinosaurs extinction, and 9. Birth of human being. Among these, 4.0Ga bombardment, 2.3Ga snowball Earth and 0.77-0.52Ga snowball may have been strongly influenced by Sun-Space activities.

(2) Relationship between Space activity and evolution of life. Two examples of snowball Earth are examined to propose a new hypothesis. Two events at 2.3Ga and 0.8Ga were crucial for evolving life to shorten the evolution, by the increased speed of mutation (shuffling and duplication), presumably increased GCR because it coincides with starburst periods at 2.3Ga and 0.8Ga. When the Earth's surface has recovered to become warm after the snowball periods, life had suddenly evolved to bear Eukaryotes at 2.1Ga and large multi-cellular animals at 0.5Ga, respectively.

(3) What is the Space-Sun-Earth system?

Based on recently proposed model of the system to control surface climate change on the Earth, cloud formation seems to be strongly related to GCR, suggesting that starburst may be caused the snowball Earth. If so, the increased GCR must have strongly affected evolving life. When recovered the Earth's surface environment, life has evolved rapidly because of already coded in genome by GCR radiation. Therefore, not only the Earth's surface, but also even life must have been controlled by the space, and presumably Sun too.