

**The Faint Young Sun Problem – how can early Earth and Mars be warmed?** F. Tian, Center for Earth System Science, Tsinghua University, Beijing, China (correspondence: tianfengco@tsinghua.edu.cn).

Based on current understanding of star evolution, the Sun was much fainter in the past than it is now. If the atmosphere of early Earth were the same as it is today, the Earth would have been frozen prior to ~2 billion years ago (2Ga). However, the lack of geological evidence for glaciation suggests that the Earth was at least as warm as it is today during the Archean (3.8~2.4 Ga) except for short periods of time.

There are three types of solutions to this faint young sun problem: 1) the Sun was different from other stars; 2) there was glaciations but we have not found the geological record yet; and 3) the Earth's atmosphere was much different from that of today and therefore could have provided much stronger greenhouse warming to the surface.

Similar to the early Earth, there is also a faint young sun problem on early Mars. There are many geomorphological and geochemical evidence that water once flowed on the planet's surface. However how long time it would have taken for liquid water environment to form these features is still open to debate. Nevertheless the intriguing perspective of life on our sister planet requires a warmer and wetter early Mars. How could such a climate have been maintained given the faint young Sun?

In the past two decades, more than 900 exoplanets have been discovered, and some of them are potentially habitable planets based on the traditional definition of the liquid water habitable zone. However, water is not the sole requirement of life as we know it. Could there be other considerations which would further constrain the habitability of exoplanets?

In this talk we will review the new progress related to the faint young sun problem of Earth/Mars and link it to the habitability of known exoplanets.