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Effects of eccentricity on habitability of planets

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Since the first discovery of an extrasolar planet [Mayor and Queloz 1995], about 150 extrasolar planets have been reported. Some of these extrasolar planets, though which are considered to be giant planets, have very high eccentricites that are not found in our solar system planets. Such 'eccentric' giant planets may harbor giant satellite around them. In addition, even eccentric terrestrial planets may exist. When we consider the habitability extrasolar satellites or planets, it is important to take the effect of eccentricity into account on their climate.

The effect of eccentricity on planetary climate is not a simple one. Mean annual solar radiation does not depend on eccentricity. However, the climate is not a linear function of insolation because of various feedbacks, such as ice albedo feedback or water-vapor greenhouse feedback. Therefore, temporal variation of insolation caused by eccentricity can affect the mean annual temperature. Thus, the annual mean climates are expected to be dependent on eccentricity. We considered hypothetical Earth-like plants orbiting a Sun-like star with various eccentricity and performed numerical simulation by taking into account the ice albedo feedback and limiting flux for the onset of the runaway greenhouse state. We show the result of simulation and discuss the effects of eccentricity on habitability.

Our results indicate that the hibitable zone migrates outward at large eccentricity and the width of the zone tends to increase with eccentricity. In addition, even at very high eccentricity, as high as 0.8, seazonal variation of temperature can be relatively small inspite of order of magnitude variation in insolation. This is caused by temporal runaway greenhouse. Thus, against intuition, the runaway greenhouse may help the habitability of planet.