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The Inner Boundary of the Habitable Zone for Earth-like Planets

B. Stracke (1), J. L. Grenfell (2), P. von Paris (1), B. Patzer (2), H. Rauer (1,2)

(1) Institut für Planetenforschung, Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Berlin, Germany (barbara.stracke@dlr.de), (2) Zentrum für Astronomie und Astrophysik, Technische Universität Berlin, Berlin, Germany

Liquid water is a commonly accepted, fundamental requirement for the development of life. Based on this condition the Habitable Zone (HZ) is commonly defined as the region of possible orbits around a star where liquid water exists on the surface of a terrestrial planet. The inner boundary of the HZ can be defined in different ways. The "water loss limit" occurs where an Earth-like planet loses its entire water content within the planet's lifetime. The "runaway greenhouse" limit marks the point where the greenhouse effect becomes unstable via water evaporation. We present here a thorough study of the inner boundaries of the HZ around solar-type stars. To investigate these inner boundaries a one-dimensional radiative-convective model of the atmosphere is applied to different planetary system scenarios. Our modelling approach involves the step-by-step increase of the incoming stellar flux and the subsequent calculation of resulting changes in the atmospheric composition and the radiative properties. To achieve this, the infrared radiative transfer scheme was improved to be suitable for such high temperature and pressure conditions. Modelling results are presented for the influence of various planetary and atmospheric conditions on the inner boundaries of the HZs around solar-type stars.