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A 1D radiative-convective model of H_2O-CO_2 atmospheres around young telluric planets: an update

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The study of the early phases of the evolution of terrestrial planets has recently known significant progress [1,2]. It appears that their cooling phase during the magma ocean stage is first dominated by a radiative cooling stage through its atmosphere. If the planet is able to reach radiative balance during this stage, then its further evolution is dominated by the escape flux, and no large scale condensation of water occurs (Hamano-type II planets). On the other hand, if the planet is far enough from the sun, then radiative equilibrium cannot be reached until the outgoing flux has fallen below the runaway greenhouse limit, implying the condensation of most atmospheric water vapor into a global water ocean, thus sheltering most water from atmospheric escape (Hamano-type I planet). In the solar system, Earth is clearly a type-I planet, whereas Venus was most likely a type-II planet from quite early on in its history [1,2].

In this presentation, we will deal with the atmospheric radiative model used by [2] and first described in [3]. After describing its recent improvements since [3] (pressure grid enabling an arbitrary total volatile amount, correction of the k-correlated radiative transfer in the thermal radiation, improvement of the numerical stability and integration scheme) and their consequences on the detectability of extrasolar type-I or type-II planets, we will deal with the possible improvements and extensions to such models, such as but not limited to: (1) adopting a 1D-spherical geometry suited for larger atmospheres around smaller planets, (2) improvement of the visible albedo parameterization based on recent 3D-modelling GCM [4].

[1] : K. Hamano et al., Nature (2013)
[2] : T. Lebrun et al. JGR (2013)
[3] : E. Marcq, JGR (2012)
[4] : J. Leconte et al. (2015)