

A backward Monte Carlo radiative transfer model for Titan’s PCM

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Titan’s atmosphere has been extensively studied and modeled over the years. Global Climate Models (GCMs) successfully reproduce the main features of Titan’s atmosphere, including the detached haze layer and the polar clouds [Lebonnois et al., 2012, Lora et al., 2015, de Batz de Trenquelléon et al., 2025a,c,b]. However, those models rely on simple plane-parallel radiative-transfer algorithms which fail to capture the effects of heterogeneity and sphericity, important for the extended atmosphere of Titan.

To address this limitation, we are coupling **htrdr-planets** [<https://www.meso-star.com/projects/htrdr/htrdr.html> He et al., 2026], a 3D backward Monte Carlo radiative transfer model, able to account for sphericity and heterogeneity effects, with the Titan LMDZ Planetary Climate Model (PCM) [de Batz de Trenquelléon et al., 2025a,c,b]. **htrdr-planets** incorporates recent developments in computing science [Galtier et al., 2013, Villefranque et al., 2019], and is able to calculate the radiative budget within each PCM cell with very little approximations and relatively low computational cost.

Preliminary comparisons between the original 2-stream plane-parallel model used in the Titan LMDZ PCM and **htrdr-planets**, indicates that important differences are expected at high altitudes and latitudes, and should affect the stratospheric circulation and the thermal structure of the atmosphere.

In this presentation, we present these comparisons and we explore the first results of the coupling.

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