Venus as a natural laboratory to infer observational prospects of close-in-orbit rocky exoplanets with a 3D model

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In recent years, several Earth-sized exoplanets have been detected in short-period orbits of a few Earth days, around low-mass stars (Gillon et al. 2017). Despite their small size compared to gas giants, their close-in orbits combined with the small radius of the host stars compared to our Sun's make these worlds the best targets for atmospheric characterisation among rocky exoplanets. These planets have stellar irradiation levels that can be several times that of the Earth, suggesting that a Venus-like climate is more likely (Kane et al. 2018). Thus, the atmosphere of our neighbouring planet Venus presents a relevant case to address observational prospects. The James Webb Space Telescope will make progress toward the atmosphere and climate characterisation of nearby rocky exoplanets, with the support of upcoming ground-based observatories and space telescopes, such as the ESA/Ariel mission, scheduled for launch in 2029. The interpretation of the observables produced by these missions (e.g. reflectance, thermal emission and transmission spectra) will need support from modelling studies of exoplanetary atmospheres. In particular, 3D Global Climate Models (GCMs) are critical for interpreting the observable signal's modulations, as they provide synthetic top-of-the-atmosphere fluxes that can be disk-integrated as a function of the orbital phase. The spatial and temporal variability of these fluxes reflect the atmospheric variability of the simulated temperature and wind fields and provide insight over the large-scale circulation. In this work, we use a 3D model, the Generic Planetary Climate model (PCM), developed at the Laboratoire de Météorologie Dynamique for exoplanet and paleoclimate studies (Forget et al. 2014, Turbet et al. 2016, Wordsworth et al. 2011, Leconte et al 2013) to model highly irradiated rocky exoplanets orbiting an M-dwarf star. We assume a CO2-dominated (e.g., 99.96 %) Venus-like atmosphere, with 92-bar surface pressure and H2SO4 prescribed global cloud layer, as a possible framework for the atmospheric conditions of TRAPPIST-1 c (Gillon et al. 2017, Luger et al. 2017) and Speculoos 2c (Delrez et al. 2022). Synchronous rotation, zero eccentricity and obliquity are also assumed. We will show results of those simulations in terms of temperature and wind fields (Quirino et al. in preparation) with the goal of providing predicted emission phase curves and transmission spectra of the atmosphere of those potential Venus analogues. Their potential detection and characterization by JWST and future instrumentations will be discussed. References: Gillon et al. 2017. Nature. 542, Kane et al. 2018. ApJ. 869., Forget & Leconte, 2014. Phil. Trans R. Soc. A372., Turbet et al. 2016. A&A. 596. A112., Wordsworth et al. 2011. ApJL. 733. L48., Leconte et al. 2013, Nature, 504, 286, Luger et al. 2017, Nature Astronomy, 1, 1 , Delrez et al. 2022, A&A