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3D simulations of warm and hot Jupiter atmospheres: the role of 3D mixing in shaping CH_4-to-CO conversion pathways

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We present results from a set of cloud-free simulations of exoplanet atmospheres using a coupled three-dimensional (3D) hydrodynamics-radiation-chemistry model. We report in particular our investigation of the thermodynamic and chemical structure of the atmospheres of HAT-P-11b and WASP-17b and their comparison with the results for the atmospheres of HD 189733b and HD 209458b presented in Drummond et al. (2020). We found that the abundances of chemical species from simulations with interactive chemistry depart from their respective abundances computed at local chemical equilibrium, especially at higher latitudes. To understand this departure, we analysed the CH_4-to-CO conversion pathways within the Venot et al. (2019) reduced chemical network used in our model using a chemical network analysis. We found that at steady state nine CH_4-to-CO conversion pathways manifest in our 3D simulations with interactive chemistry, with different pathways dominating different parts of the atmosphere and their area of influence being determined by the vertical and horizontal advection and shifting between planets.