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Exploring Disequilibrium Chemistry in Exoplanet Atmospheres with a Grid of Pseudo-2D Photochemical Models

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Irradiated exoplanet atmospheres, with their hot day sides and eternally dark night sides, are intrinsically three-dimensional and highly dynamical. Vigourous atmospheric motions are expected to mix the atmosphere, reducing potential chemical variations with longitude. Day-side photochemistry, on the other hand, would enhance those variations. Both mixing and photochemistry drive the atmospheric chemistry out of equilibrium, and, as of yet, it is unclear to what degree both processes influence the composition of different exoplanet atmospheres.

We will present results from a grid of atmospheric disequilibrium chemistry models, incorporating vertical mixing, horizontal advection and photochemical reactions. Our grid spans a wide range of planetary temperatures (400 K – 2600 K), surface gravities, and rotation rates, so we will highlight the role that dynamical mixing and photochemistry play in each corner of the parameter space. We further focus on the compositional differences between the day- and night-side hemispheres that may arise, or be washed away, by disequilibrium chemistry processes. Finally, the influence of these processes on observations, such as transmission spectra, will be discussed. This work provides valuable constraints on the importance of disequilibrium chemistry, and the expected chemical diversity of exoplanets, with regards to upcoming space missions.