Atmospheric Dynamics of the Transiting Planet HD209458b

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Showman and Guillot 2002 (A&A, 385, 166S) presented preliminary numerical simulations of the meteorology of HD209458b's atmosphere in the radiative region using the EPIC model of Dowling et al. 1998 (Icarus 132, 221). Their simulations reveal that the intense radiation of the star sustains a steady temperature difference between the day and night sides of the planet. In steady state, the models predict strong eastward equatorial jets. Day-night temperature variations and winds are potentially observable both in the infrared light curve of the planet, if it can be measured, and in the planetary albedo, which is likely to be variable across the planet's surface due to variations in upper atmospheric chemistry and cloud formation.

The magnitude of the day-night temperature difference depends on the radiative transfer of the upper atmosphere, the physics of the deep atmosphere at the interface with the planet's fully convective interior, and the effects of winds. We will present improved, higher resolution three-dimensional models of the general circulation of HD209458b. We will include in the new calculations a more realistic Newtonian cooling scheme than the one employed by Showman and Guillot (2002) to approximate the radiative transfer. We will include parameterizations of drag and vertical mixing near the lower boundary based on expectations of how the convective interior interacts with the atmosphere. We will thus generate models of the global, steady-state temperature structure and winds of HD209458b under a variety of assumptions and discuss the implications for future observations. A long-term goal is to couple these results with the one-dimensional cloud model of Cooper et al. 2003 (ApJ 586 n 2, 1380), which predicts the location of cloud formation in planetary atmospheres for the primary condensable species.