Geophysical Research Abstracts
Vol. 19, EGU2017-3635, 2017
EGU General Assembly 2017

Exoplanet modelling with the Met Office Unified Model

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This talk will present an overview of work being done to adapt the Unified Model, one of the most sophisticated weather and climate models of this planet, into a flexible planet simulator for use in the study of any exoplanet. We will focus on two current projects:

Clouds in hot Jupiter atmospheres - recent HST observations have revealed a continuum in atmospheric composition from cloudy to clear skies. The presence of clouds is inferred from a grey opacity in the near-IR that mutes key absorption features in the transmission spectra. Unlike the L-T Brown Dwarf sequence, this transition does not correlate well with equilibrium temperature, suggesting that a cloud formation scheme more comprehensive than simply considering the condensation temperature needed for homogenous cloud growth, is required. In our work, we conduct 3D simulations of cloud nucleation, growth, advection, evaporation and gravitational settling in the atmospheres of HD209458b and HD189733 using the kinetic and mixed-grain cloud formation code DIHRT, coupled to the Unified Model. We explore cloud composition, vertical structure and particle sizes, as well as highlighting the importance of the strong atmospheric dynamics seen in tidally locked hot Jupiters on the evolution and distribution of the cloud.

Climate of Proxima B - we present results of simulations of the climate of the newly discovered planet Proxima Centauri B, examining the responses of both an 'Earth-like' atmosphere and simplified nitrogen and trace carbon dioxide atmosphere to the radiation likely received. Overall, our results are in agreement with previous studies in suggesting Proxima Centauri B may well have surface temperatures conducive to the presence of liquid water. Moreover, we have expanded the parameter regime over which the planet may support liquid water to higher values of eccentricity and lower incident fluxes, guided by observational constraints. This increased parameter space arises because of the low sensitivity of the planet to changes in stellar flux, a consequence of the stellar spectrum and orbital configuration. Finally, we have produced high resolution planetary emission and reflectance spectra, and highlight signatures of gases vital to the evolution of life on Earth (oxygen, ozone and carbon dioxide).