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Intercomparison of General Circulation Models for Hot Extrasolar Planets

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Abstract

Carefully testing complex, general circulation models (GCMs) of extrasolar planet atmospheres is important for understanding the physical properties of the atmospheres, as well as for assessing the numerical accuracy of the models. Intercomparison of GCMs and benchmarking of dynamical cores and testbed models against standard "solutions" are common in Earth studies (e.g., [2, 1, 5, 4]) and are also becoming more common for studies of other Solar System planets. Limited tests have been carried out so far in models for hot extrasolar planets. Given that the conditions of many extrasolar planets are markedly different than the Earth, and much more exacting, it is useful to subject the models to tests which are more appropriate for the extrasolar conditions (e.g., [7]; see also [3] and [6]).

The focus of this study is to perform model comparisons in a uniform and equatable way as possible for a number of models, employing several types of numerical algorithms for spatial domain and flow viscosity. A range of tests have been performed, from simple to stringent. Here, we present results from tests which broadly fall under the following cases: 1) steady state jet, to assess convergence; 2) freely-evolving, unstable jet, to ascertain model behaviour over time in a "controlled" setting; and, 3) zonally-asymmetric (mode-1), diabatically heated flow starting from a resting state, to elucidate large-scale flow and temperature distributions observed in current simulations of tidally synchronized extrasolar planets. Both intracomparisons and intercomparisons of considered GCMs are presented.

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