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Geoscientific Model Development Discussions

Interactive comment on "Using the UM dynamical cores to reproduce idealised 3-D flows" *by* N. J. Mayne et al.

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Referee's Report for Mayne et al. (2013) by Kevin Heng

I. General

The manuscript of Mayne et al. presents a detailed study of the comparison between the finite-difference New Dynamics and ENDGame dynamical cores of the UK Met Office. Specifically, four versions of the dynamical core, incorporating or excluding the effects of a shallow-atmosphere approximation and constant gravity are implemented for the Held-Suarez test, a simplified model of Earth and a model of a tidally-locked Earth, as described in previous publications, as a prelude to the simulation of hot Jovian atmospheres. The manuscript focuses mostly on technical details, but is written in

a clear and concise manner and adopts a sober tone. An even and fair review of the literature is performed. The calculations are executed competently, at least from the viewpoint of an external reviewer or reader. There are no major flaws with the manuscript. It is anticipated that the work described within will be a useful addition to the general circulation model (GCM) literature as the field moves towards the accurate simulation of exoplanetary atmospheres.

II. Scores

Scientific significance: 2 Scientific quality: 1 Scientific reproducibility: 1 Presentation quality: 1

III. Specifics

1. In Section 1, the authors begin describing the "shallow-atmosphere" approximation. Judged on its own, this part of the text is somewhat vague. Perhaps it will be useful to already state that the shallow-atmosphere approximation simply involves replacing all of the 1/r terms, where "r" is the radial coordinate, with 1/R, where "R" is the bulk radius of the (exo)planet? I understand that this definition is already made in Table 1, but stating it earlier helps to avoid confusion between the shallow-atmosphere approximation, the adoption of a shallow atmospheric domain (e.g., in hot Jupiters, where one models 1 to 3 orders of magnitude in pressure rather than 6 to 8) and the shallow-water approximation (which is essentially two-dimensional).

2. In Section 1, the statement about the traditional approximation having "adverse effects" for the simulations of hot Jovian atmospheres is based on a conference proceeding by Cho & Polichtchouk (2011), which is not peer-reviewed. As such, the statement may be considered to be poorly substantiated. Given the higher quality of the text in general, it may be advisable to remove this sentence until either the Cho & Polichtchouk study is published in a peer-reviewed journal or the authors of the present study explore the implications of the traditional approximation for hot Jupiters in a future study.

3. In Section 2, it may be fair to mention the work of Y. Kaspi, who has adapted the MITgcm to model deep atmospheres and used it to study Jupiter.

4. In Section 2.2, it is not immediately clear how the authors have either solved or circumvented the pole problem. I strongly recommend that a schematic figure is added to aid the reader. The clarity of the text may also be improved in this regard.

5. In Section 3 and equation (6), is the CFL condition for the time step set solely by the atmospheric dynamics (rather than by radiative considerations)?

6. Generally, given the multiple references to polar filters used in the New Dynamics dynamical core, it may be useful to concisely summarise the basic idea behind these filters, somewhere within the text? It will allow a non-specialist reader to better judge why and how the polar filters are affecting the flow.

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