Review of

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Design and implementation of the infrastructure of HadGEM3: the next-generation Met Office climate modelling system
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General Comments

The paper provides a summary of the coupling architecture of model components in the HadGEM3 model and of the validation of globally conserved quantities dependent on all sub-models. Surprisingly, there is no explicit mention of the land model within the system. Yet this surely is an important component of an Earth System Model, if only for the importance of the carbon cycle as mentioned in the introduction. I think the nature of the land model within HadGEM3 should be discussed up front as many other modeling systems also consider the land model to be a separable component in the same way as NEMO and CICE here.

I understand that in some ways this article is meant to be a documentation of the development of HadGEM3 and as such contains a list of "development decisions" that would ordinarily be found in a technical note of the model. However, this makes it somewhat difficult to review as a science document. Some of the details listed appear to me to be very obvious and could easily be true of many of the decisions that were made for HadCM3 such as fluxes passed between components in many of the numerous included Tables and a too long description of what SCRIP does. Also I am not sure that the sometime superficial and speculative information about the computation system dependence of the formulation of HadGEM3 (i.e. IBM versus NEC) should be included as it distracts from the model formulation aspect of the article. Another concern is that the nature of the current usability or prime-time readiness of the model waivers throughout the paper, from it is a "very early stage model" to "it is being used for seasonal forecast". It therefore is difficult to assess how seriously I should take comments about the model performance, including all the figures shown. My sense is if the authors want to truly say that the model currently performs well compared to previous model versions and obs. they should include better figures that quantify the performance. If not then maybe there should not be any "climate performance" figures included beyond verifying that the coupling architecture conserves desired quantities (heat and water).

Specific Comments

*Abstract

Since there is no mention of how water and energy are routed from the atmosphere to ocean via land it is hard to evaluate the statements on heat and freshwater conservation.

1. Introduction

P1862L20: The pole problem is not a "new problem of going to high resolution" it is a problem at historically low resolution because the meridians converge and filtering is already required for lat-lon grids.

P1863L25: Again there is no mention of a land model in the system and how that is to be coupled through OASIS. Some readers may not know what "AMIP-style" means so an explanation about prescribing SSTs would be useful.

P1864L7: "In particular…" I am not sure what this means, is this referring to HadGEM3 or previous GEMs?

2. Coupling

Fig 1: Again I don't know what to think about this figure in the absence of information about the budgets in the land (e.g. river routing etc). If this already unchanged from a self contained formulation within the UM then it needs to be said explicitly.

P1865L10: Is freshwater formally conserved i.e. through changes in mass in the ocean that impact the equations of motion? I am pretty sure this is not the case and the conservations are via implied salt changes from freshwater extraction or addition processes.

P1865L29: Are aerosol fluxes across components dealt with given that aerosols are in the UM? i.e. flux of aerosols onto sea-ice causing darkening and flux of dust from the land to the atmosphere. This is important from an earth system perspective.

P1866L19: I am pretty sure that the north pole singularity has not been stretched as described in the text. Fig 1b indicates that singularity has been move to the middle of Canada and Siberia to avoid pole convergence problems.

P1866L29: Is surface sea-ice temperature really calculated in the atmosphere? That makes no sense as TS is mainly a function of the sea-ice column thermodynamic calculation. Do you really mean surface air temperature?

3. Fields exchanged

I am not sure all the appendices are required for all the mapped variables between components as this is these are well established variables and practices, unless this is meant to serve as model technical documentation.

P1870L8: "takes PLACE …"

4. Conservative Interpolation

4.1

Is anything specified here specific to HadGEM3 and not just standard SCRIP techniques as it seems references would suffice?

5. Model Results

5.1 – I am not sure this section is really required as it appears a very transitory result.

5.2

Fig 7f is wrong and looks like a copy of 7e. Also how long is the averaging period from the model.

P1878: Some of the descriptions of the model performance here appear to set the bar exceedingly low e.g., the storm tracks are in the right place. A more appropriate comparison, even at this early development phase, would be against HadGEM2 or maybe a HadGEM3 AMIP experiment where flux mapping issues between components shouldn't be a problem. A comparison against HadGEM1 is discussed but no figures are shown I think it would be good to include those figures.

Given that the paper primarily seeks to validate the coupling it would be more appropriate to show surface stress rather than u850mb.

P1879L10: This comment would also be more substantiated by showing surface stresses instead of u850mb.

5.3

P1879: Again I think the same applies here as to the atmospheric diagnostics. What are the changes compared to HadGEM1/2, given that there hints that they are pretty good in the text?

5.4

P1880L20: One could also argue that the SST bias would be improved if the sea-ice extent was better.