

# ***Interactive comment on “The Canadian Earth System Model version 5 (CanESM5.0.3)” by Neil C. Swart et al.***

## **Anonymous Referee #1**

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The paper describes the Earth-system model CanESM5, which has performed simulations in support of CMIP6. The paper itself is very well written with very few grammatical or typographical errors.

I was particularly impressed with the detailed discussion of how the model is managed with regard to the structure of the various git repositories. The improvements to model throughput are also impressive, going from 4.5 to 16 simulated years per day from the various changes described.

The model itself represents some quantities well and others not so well, as might be expected in any ESM. Given the model has a relatively coarse resolution and does not represent all processes the behaviour is not unreasonable.

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I will structure my comments with some more major ones first followed by a small number of minor errors. I believe that with some small changes to the manuscript the paper would be ready for publication.

## Major Comments

In the Introduction the authors briefly discuss CanESM5 within the modelling system of CCCma, which includes CanRCM, CMAM, and CanSIPS. It might be helpful to describe how these are connected - are they all entirely separate, or do they share components/models?

Figure 1 - I find this figure a little frustrating. While it is clear in naming the different component models that make up CanESM5, it does not describe how they are connected or each model's complexity. A reader must consult Appendix A, which is somewhat technical and is still not complete for all linkages as this only discusses what goes through the coupler. As it is this figure doesn't really show the "evolution of components" as it does not describe how complex each component model is in either CanESM2 or CanESM5, although it does show the changes to model version numbers or the change of model used.

What I felt was missing in section 2 was a description of just how complex the atmosphere model CanAM5 is. The description is very brief and readers are directed to Cole et al. (2019), which although will also be in the same special issue as this paper, is currently still in preparation. Also, this paper describing CanESM5 should stand enough on its own such that important details regarding component models should be presented here. I suggest that the authors expand section 2.1 enough to briefly cover the complexity of the atmosphere model and what processes (or not) are represented. There is also no mention of atmospheric chemistry or the complexity of the aerosol scheme.

The authors should ensure that each component model is described in sufficient detail to understand what processes it can simulate and how these models interact together

in the ESM. As this is an Earth-system model, I am interested in seeing just how the component models interact. The tables in Appendix A only cover what goes through the coupler, so methane emissions that are discussed on lines 125-130 aren't mentioned for instance - are there any others? Here what do the methane emissions do, is there a simple methane oxidation scheme, does it produce water vapour etc.?

At line 422 the authors mention "five realisations of CanESM2", and then later discuss a 50 member large ensemble of CanESM2. Is it just that only 5 members were submitted to CMIP5? These are first mentioned on line 844. Is there a reference or more detail that can be provided?

### Minor Comments

Out of interest, why does the numbering system go from CanESM2 to CanESM5?

line 33 - I believe that "earth" should be capitalised in this context.

line 149 - I'm not sure why "converted into ice" is in quotes here. Is there a reason for this?

Section 2.3 - the way numbers and units are represented here are slightly different from other sections. The  $\times$  symbol is rather large (compare to line 236), and units are given as  $m^2/s$  rather than  $m^2s^{-1}$  as is done elsewhere in the manuscript.

line 280 - why are "bilinear" and "conservative" in quotes? I don't think this is necessary here.

Section 5.4 - two different ways of doing a  $\pm$  symbol are used (lines 621 and 642). Given the differences in Section 2.3 (mention above) I suggest that the authors double-check how numbers and symbols are presented for consistency.

Table B1 (versioning) - should this be "CanESM.vX.Y.Z"?

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