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# *Interactive comment on* "The Met Office HadGEM3-ES Chemistry-Climate Model: Evaluation of stratospheric dynamics and its impact on ozone" *by* Steven C. Hardiman et al.

**Anonymous Referee #1**

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General Comments This work evaluates the stratospheric dynamics and impact on ozone of the Met Office HadGEM3-ES chemistry-climate model. The authors have done an excellent job of describing the new version (compared to the previous CCM-Val2 version designated as UMUKCA-METO). They have examined 14 dynamical metrics and graded the model in the manner of Waugh and Erying 2008. Overall I fine this study appropriate for GMD and recommend it for publication. I some specific comments below that would improve the current draft.

Specific Comments

Since it is not stated, I assume that the REFC1 and REFC2 simulations only use one ensemble member, correct? This will limit what you can say about variability. For



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example, your comments on Page 8, lines 6-8.

Page 3, line 27 In most (if not all publication), the Chemistry-Climate Model Initiative is designated as CCMI, not CCM-I.

Page 4, line 5. The authors state the horizontal winds and temperature are nudged. Question, many groups that use a specified dynamics approach also nudge surface pressure. I am assuming you don't do this because you only nudge over the 2.5km-51km range, therefore not nudging the surface region? Could you give a few more detail on why you made this choice?

Also, how do you transition to the free running version above 51km?

Page 6 discussion of Figure1. One very minor suggestion would be to add column numbers at the top of Figure 1 since you are specifically identifying columns in the text. It will make it a bit easier for the reader to quickly follow the discussion.

Page 6, lines 26-30, and Figure1 (QBO nudging). I am also surprised that the SD version grade in Figure1 is only 0.8. Your explanation makes sense; however, I have one clarifying question. The reanalysis implicitly has a representation of the tropical zonal winds (QBO) based on observation. Therefore, when you run in SD are you also nudging the model explicitly with a relaxation to Singapore winds (similar to what is done in a REFC1 simulation)? This could cause issues if the nudging is essentially done twice.

Page 8, lines 29-30. Please give a brief summary of the PSC approach (i.e., do you represent NAT, water-ice, and supercooled ternary solution (STS) PSCs?).

Discussion of Figure 3 (lat/time T at 50hPa), Figure 6a (Oct polar cap avg PSC area, 50hPa?), and Figure 12d (SH column ozone). I can understand that the free running model may not give good ozone depletion, but why doesn't the SD version? In SD you have temperatures and vortex area that are well represented. So why is the total column ozone $\sim$50DU higher than observations? Doesn't this say something about

the PSC/heterogeneous chemistry parameterization in the model? Or does this have something to do with the advection routine being too diffusive?

Page 10 and the discussion of Figure 8b. (SD version) You state that the "tape-recorder signal appears more coherent far higher in the stratosphere in the nudged simulations. However, Figure 8(e) shows that this is not due to the amplitude of the annual cycle harmonic." I'm a bit confused by this statement, since, the "dry phase" of the tape recorder seems to represent the SWOOSH data well at the entry level and the propagation upward. This does not seem to be the case for the "wet phase". Does this say something about the robustness of the models' microphysical parameterization of ice (i.e., too much dehydration)?

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