

**Geoscientific Model Development**  
**Review: EGU sphere-2024-2682**

**Title: Implementation and validation of a supermodelling  
framework into CESM version 2.1.5**

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## **Overview and major comments**

The present paper describes the implementation of a *supermodel* framework in which the two conventional climate models CAM5 and CAM6 are interacting, or *synchronized*, during their simulation through the regular exchange of nudging terms for some of their state variables. Through an appropriate tuning of the computation of these nudging terms, and because of the higher dimensionality of the supermodel benefiting from the advantages of each of its components, one might expect some compensation of the component model errors and an improved representation of the climate dynamical system. The present paper is a preliminary step towards such an assessment, providing a significant step in developing such kind of supermodels, sufficiently efficient to be used for climate studies.

The paper is well structured and written (though quite a few typos remain and deserve a more careful reading of the whole text). The objective are clearly stated, and the results clearly demonstrate an efficient supermodel (about 3-4 years of simulated years per days) and a rather appropriate synchronisation of the model variables, as indicated in particular by a high-frequency variability commensurate with the conventional models. I have a few general comments and a longer list of minor comments that follow. The general comments should not be understood as a major revision, as I consider the present paper as a technical contribution to the *Geoscientific Model Development* Journal. These comments are meant to widen a bit the analysis and whenever possible enhance the physical interpretation of the results and discuss their implications, possibly in light of previous works (which I am not familiar with).

## **General comments**

1. The synchronisation is convincing for U, V and T, except over the tropics. Can you formulate hypotheses why this happens? Is it con-

sistent with previous studies? To what extent is it an issue for the supermodelling strategy? Do you see ways to improve this synchronisation? For variables that are not part of the nudging strategy, the synchronisation is rather weak. To what extent is it also an issue for the supermodelling strategy?

2. Have you analysed the supermodel behaviour for other fields than wind and precipitation? What about radiative fluxes or surface turbulent fluxes? Do you keep a reasonable energy budget in the supermodels? If not, this should clearly prevent you to apply the approach for the coupled system, shouldn't it?
3. With respect to natural variability, you focus on the PNA and NAO types of variability. Have you analysed other modes of variability, like the MJO or convectively-coupled equatorial waves? To what extent is their simulated behaviour over the tropics consistent with the reduced high-frequency variability over the tropics?

## Minor comments

1. p2, l28: the NMME and CMIP acronyms need to be defined.
2. p3, l60: typo: one of the two 'to be' needs to be removed.
3. p3, l80: what does 'reference' stand for here? Did you forget to add a reference here?
4. p3, l81: I guess it is 'component models' rather than 'components model'.
5. p4, l123-124: do you mean that sea surface temperatures are constant over each day in CAM (there is thus a small jump at the end of each day)?
6. p5, l127: why using a bilinear interpolation and not a conservative one? At least for precipitation, a conservative interpolation sounds more appropriate. Besides, what is the resolution of ERA5 and GPCP datasets?
7. p5, l151-154: I feel this technical development requires a bit more explanation to more fully understand how you overcome this challenge of submitting jobs through a single PBS/SLURM scheduler.
8. Section 2.4: I am a bit confused about how the nudging is performed. Do you average the instantaneous state of the atmosphere over the two model, and then use it for nudging over the 6 following hours (thus the

fields toward which the model is nudged are constant over the 6-hour window)? Besides, which nudging timescale to you use?

9. p6, l167-168: while being an important effort toward open science, this sentence does not seem to be at the right place in these technical description.
10. p7, l171-172: this would be interesting to have the elapsed (integrated also) time also for CAM5 and CAM6, to document the overloading of the model synchronisation.
11. p7, l177: can you elaborate a bit more on this difficulty when adding specific humidity in the nudged state variables?
12. p8, l195: I guess your refer to Figure 3.
13. p8, l196: 'Fig.' is missing before '3'.
14. p8, l199-200: without any more detailed analysis, I would argue that the whole atmospheric physics might be at play (most of it is strongly different between CAM5 and CAM6). Besides because the U, V and T forcing in the tropics is in general weaker than in the extratropics, this is rather expected that the model are more sensitive to their own physics, isn't it?
15. p8, l202: missing ending bracket.
16. p8, l202-203: The link between the two parts of the sentence remains unclear, and not obviously consistent with what you write l199-200.
17. p8, l207-208: the link is interesting, but probably hard to fully understand for most readers. A bit more explanation would be welcome.
18. p8, l218: missing closing bracket.
19. p10, l222: do you mean increasing or reducing the relaxation timescale?
20. p12, l251: do you mean the correlation between the PNA pattern of SUMO5 and that of SUMO6?
21. p12, l255: do you have an interpretation or an hypothesis for such a different result between PNA and NAO? Has it been seen in previous studies?
22. p13, l258: I guess it should be 'here', not 'her'.
23. p13, l267-268: My understanding is that Figure 4S is showing the differences between the non-interacting ensemble and the supermodel ensemble. It does not seem to correspond to what you are referring to here.

24. p16, l289: I would remove the 'in' before CESM.
25. p17, Code and data availability: a recap about the CAM versions and the place where to find the code would be welcome in this section.