

Review of “The Fully Coupled Regionally Refined Model of E3SM Version 2: Overview of the Atmosphere, Land, and River” by Tang et al., submitted to *Geoscientific Model Development*

Recommendation: Minor revision

General comments:

Many numerical studies have demonstrated the importance of fine resolution in modelling the climate system, but at the current time, fine resolution and long-term integrations are competing requirements for climate simulations due to limited computational resources. With these demands and limitations, the variable-resolution approach is an attractive method to conduct high-resolution simulations within a global lower-resolution model. In this study, the authors overview the E3SM version 2 with the regionally refined technique, and presented the evaluation of climate simulations. Results show that the regionally refined technique can provide improved simulations over regional scales. This manuscript would be suitable for publication after revision.

In section 4, model results are validated at the global scale in terms of global air temperature increase and climate sensitivities. Precipitation simulation skill is an important aspect. I suggest the authors to add a figure to show the comparison of global annual mean precipitation.

Besides, I found that although the variable-resolution method indeed improves many aspects in modeling the regional climate, but the systematic biases in the lower-resolution model are not reduced. The authors may give more explain about this point in the manuscript.

Minor comments:

Table 2. Need to indicate the meaning of the numbers in the brackets.

Figure 8. Need to indicate the observational minimum-maximum range in the legend.

Figure 11. In the ERA5 reanalysis, I think there are also uncertainties in the precipitation. Could you please add an observational benchmark?