

Comments to “Efficient surrogate modeling methods for large-scale Earth system models based on machine learning techniques” submitted to *Geoscientific Model Development*.

**General Comments:**

The heavy model evaluation time is always the burden of simulation and prediction of complex earth system. This study developed a technique to build surrogate models for a large-scale Earth system model (ESM) with many output variables. This study uses singular value decomposition to reduce the output dimensions, and then use Bayesian optimization techniques to generate an accurate neural network surrogate model based on only 20 ESM simulation samples.

This research problem is of interest in ESM field. The manuscript is well organized and easy to read, the results and discussion are sufficient to support the conclusion. However, this paper may be improved after clearing following few questions, and a minor revision is recommended to this paper.

**Specific Comments:**

1. Line 367: For the 800 epochs to train NN model, are these epochs have the same 20 training data? and they are different at the choosing of the 6 validation data?
2. Personally, I want to see how complex is the ESM, it would be nice if the authors can present the response surfaces or contour maps of the ESM, such as the zero GPP zones;
3. Line 335, Please give a short description to the TPE method.
4. Line 555, May be some references are needed to support this statement “NNs, attribute to the layered architecture and the nonlinear activation function, usually show better performance compared to other surrogate approaches.”
5. The plots of Figure 6 is not clear, please revise it.