EGUsphere, referee comment RC1
https://doi.org/10.5194/egusphere-2022-559-RC1, 2022

Comment on egusphere-2022-559

Anonymous Referee #1

Referee comment on "Emulating Aerosol Optics with Randomly Generated Neural Networks" by Andrew Geiss et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-559-RC1, 2022

This manuscript describes the development of neural networks to replace the aerosol optics in a climate model with a more detailed treatment, which is based on running the same types of codes with more detail to develop a parameterization which better represents more detailed modeling. In general the manuscript is well written and clear. There is a nice discussion of how the neural network is developed. However, my main critique is that the evaluation section (section 5) is pretty minimal. Just some error curves. What does it look like in the full model? You have demonstrated that the new parameterization represents the more detailed code better than the existing parameterization. Does it change the answers in the climate model it is designed for in any meaningful way, and does it cost anything more to run it. Also good to note in the conclusions what lessons you learn from this experience about building neural networks for parameterization replacement. This is probably suitable for publication with minor revisions, but with at least trying it in a climate model perhaps.

Detailed comments below.

Page 1, L10: Would be good to have more detail on what 'outperform' means specifically in another sentence or two.

Page 1, L15: Disingenuous. The direct effects of aerosols are not the largest uncertainty: only indirect effects on clouds.

Page 2, L29: Example of climate models generating training data (for replacing part of a parameterization: Gettelman et al 2021.

Gettelman, A., D. J. Gagne, C.-C. Chen, M. W. Christensen, Z. J. Lebo, H. Morrison, and

G. Gantos. “Machine Learning the Warm Rain Process.” Journal of Advances in Modeling Earth Systems 13, no. 2 (2021): e2020MS002268. https://doi.org/10.1029/2020MS002268.

Page 3, L63: clarify ‘these optical properties (absorption…etc’

Page 3, L77: what is the size range here? Please be explicit.

Page 3, L90: The CESM reference should probably be Danabasoglu, et al 2020.

Danabasoglu, G., J.-F. Lamarque, J. Bacmeister, D. A. Bailey, A. K. DuVivier, J. Edwards, L. K. Emmons, et al. “The Community Earth System Model Version 2 (CESM2).” Journal of Advances in Modeling Earth Systems 12, no. 2 (2020): e2019MS001916. https://doi.org/10.1029/2019MS001916.

Page 5, L148: how much error is there in the approximations? Can you quantify it?

Page 9, L251: why would a random network do better? Is there an explanation? Isn’t that a form of overfitting?

Page 10, L289: Please describe these terms a bit. ReLU, ELU, Leaky ReLU and Parametric ReLU

Page 10, L291: what is a transfer function? Above you call them activation functions. Please clarify.

Page 11, Figure 2: is the red dot the ‘optimum’ network?

Page 12, L350: can you make the evaluation a bit more quantitative in spots? It seems a bit ‘weak’ right now, especially compared to the rest of the paper.

Page 13, L360: What does the first column (Table:) of table 1 mean? Should it say something?

Page 13, L364: Can you explain the patters in Figure 5? What do they arise from?

Page 16, L402: Other lessons learned? It would be great to share in the paper.