Geoscientific
Model Development
Discussions

Interactive comment on "Challenges and design choices for global weather and climate models based on machine learning" *by* Peter D. Dueben and Peter Bauer

Anonymous Referee #1

General comments

Overall, this is a nice piece of pilot work and a stimulating discussion about the potential for machine learning to change how we make numerical weather forecasts, and in particular the potential for an 'equation-free' approach that doesn't even use discretized equations of fluid motion. In particular, it highlights the important of an intelligent human design for such an approach to be competitive.

It is interesting (but reassuring given the structure of the underlying equations of atmospheric motion) that a 'local' approach works better for both problems considered than a 'global' approach. The machine learning global forecast approach uses limited inputs

(Z500 and optionally T2m, at 6 degree lat/lon resolution) but performs comparably to a version of the current ECMWF operational model with similar resolution (TL21), though not nearly as well as the full-resolution operational model. If you used a polar filter to remove high zonal wavenumbers in the NN-predicted Z500 near the poles, could you avoid the ad hoc approach of fixing Z500 at polar gridpoints to maintain the stability of your NN? Specific comments

Page 2 Line 7: There is some relevant new literature on machine learning used for atmospheric physical parameterization, e. g.: Schneider et al. (2017). Earth system modeling 2.0: A blueprint for models that learn from observations and targeted high-resolution simulations. GRL, 44, 12,396–12,417. https://doi.org/10.1002/2017GL076101 Brenowitz N.D., and C.S. Bretherton, 2018: Prognostic validation of a neural network unified physics parameterization, Geophys. Res. Lett., 45, https://doi.org/10.1029/2018GL078510.

The Schneider et al. paper is particularly relevant to the discussion here, as it uses a similar Lorenz 1995-type toy problem .

Page 2 Line 9: Add comma before 'or'

Page 2 Line 14: Remove comma after 'possible'.

Page 3 Line 30: Should be 'degrees of freedom'