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Geoscientific Model Development Discussions

Interactive comment on "Weather and climate forecasting with neural networks: using GCMs with different complexity as study-ground" *by* Sebastian Scher and Gabriele Messori

Anonymous Referee #3

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The authors build on a previous paper in which one of the authors applied a convolutional neural net with an encoder-decoder architecture to the problem of weather forecasting and climate simulation in a simplified atmospheric GCM. Here the approach is extended to a more comprehensive atmospheric GCM and to different horizontal resolutions in the GCMs. Inclusion of a seasonal cycle proves to be an important issue when trying to reproduce the climate with the neural net. The research question is exciting and the presentation and approach is generally good. However, changes are needed to properly describe the approach that has been taken and to quantify how well the neural net is doing.

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Discussion paper

Major comments

1. As far as I can tell, the same network as was applied to the simple GCM PUMA is applied to the more comprehensive GCM PLASIM. In particular, the variables used are horizontal winds, geopotential height and temperature. This is surprising since PLASIM presumably has a hydrological cycle, and specific humidity is presumably a prognostic variables. Therefore, the state of the atmosphere in PLASIM at a given time is not described with the 4 variables used. The choice to not include humidity in the network should be justified. Presumably a network with humidity included would do better (?)

2. It is difficult to assess how well the networks are doing in their forecasts in figure 3 because they are not compared to anything else. In the preceding work, comparison was made to 'persistence'. But a more informative choice would be to plot RMSE and ACC for a 'perfect model' forecast in which the same GCM is used to make the forecast with a small perturbation in the initial conditions (or alternatively in the tuned constants in the model physics). Comparing to a perfect model forecast would allow the reader to assess the skill of the neural net forecast - it can't be expected to do better than a perfect model prediction (given any error and the chaotic nature of the atmosphere). This was also help the paper have more impact since the neural net will ultimately have to compete with traditional NWP, albeit in terms of both accuracy and speed and not just accuracy.

3. Another possibility to consider for why the climate prediction with a seasonal cycle does not work well is that you are forecasting over a short time frame (1 day) in which diabatic effects that vary seasonally such as changes in insolation are not very important compared to the dynamical initial condition. Perhaps training using a longer forecast lead time (e.g. 5 days) would work better for the climate simulations with a seasonal cycle.

Minor comments

1. The neural net architecture is described as an autoencoder. My understanding of the nomenclature is that it is an encoder-decoder but not an autoencoder (since the output is not the same as the input).

2. A few more lines description is needed for each GCM in section 2.1. How is the dry dynamical core of PUMA forced? (e.g. is it a Held-Suarez setup?) What makes PLASIM an 'intermediate complexity' GCM? (e.g. how exactly does it differ from a standard GCM aside from the lack of a dynamical ocean).

3. Figure 2 is helpful but not fully described in the caption. In particular the caption should say what the numbers are - does None, 64,128,40 refers to ?, lat, lon, channels. What does 'None' refer to here?

4. Appendix A1: do you use all times t1 before and after t in the calculation?

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