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Geoscientific Model Development Discussions

Interactive comment on "Testing the Reliability of Interpretable Neural Networks in Geoscience Using the Madden-Julian Oscillation" *by* Benjamin A. Toms et al.

Anonymous Referee #1

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The authors apply a neural network to project the phase of the real time multivariate MJO index from gridded data. They present the network with fields of data and the corresponding phase numbers in the index to train the network to predict the phase from the data. They compare results against those achieved by comparison against a similar linear regression model. The result is well presented, and, were it not for an important weakness, I would recommend publication. The normal pathway to detecting the phase from the data is to simply project the data onto the EOF patterns associated with the leading two eigenmodes in the combined data matrix of zonal wind and OLR anomalies, then to label the phases as segments of the phase space generated by PC1 and PC2. The network evidently can replicate the results of the projection

approach well, but the comparison against the linear regression approach is unfair. Although the authors used a full grid of data for their demonstration, I used PC1 and PC2 (together with a column of ones) to predict the phase numbers using linear regression as a demonstration of concept. The fundamental weakness of linear regression emerges immediately. It is that phase number goes from 1 to 8, and phases 1 and 8 are proximate to each other (that is, phase is a cyclic variable). That is, in terms of the comparison between neighboring phases, phases 8 and 1 are just as proximate to each other as phases 4 and 5, in the phase space, but they are as far apart as any two phases can be, in terms of the phase number. Thus following the linear regression approach, phases 4 and 5 will be predicted well by linear regression, but the lowest & highest phases will have large errors because the regression approach cannot yield a linear model that disaggregates signal that projects well onto phases 8 and 1 both. Thus much of the advantage of the neutral network may be in being able to address a signal that is *defined* as nonlinear from the start. If, in contrast, the authors had applied both the NN and the regression model to predict the OLR anomaly at a given grid point or region (a relationship that could have a large linear component), it is not so clear that the neural network would do better. The authors result in comparison against linear regression seems to arise simply because they defined a nonlinear frame for comparison, which is, phase number. It is trivially obvious that the linear regression cannot replicate that point. I think the authors could quickly verify that linear regression does well during phases 4-5, but poorly in 7,8, 1,2. These errors near phases 1 and 8 will dominate the difference between the linear regression and neural network. The problem, then, is that the authors chose a context in which linear regression cannot work. Yet there are many other contexts in which there might be a fair comparison. For example, using the NN and linear regression to predict OLR anomalies in a given region based on the PCs.

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