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Interactive comment on "Reconstructing coupled time series in climate systems by machine learning" *by* Yu Huang et al.

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In this paper, the authors studied the variable reconstruction problem with several machine learning methods, and test with simulations on several artificial climate models (Lorenz 63 and Lorenz 96) as well as real-world climate data. The authors innovatively use the convergent cross mapping (CCM) to estimate the nonlinear coupling relation between different variables and explain the reason why the variable reconstruction has direction dependence.

This paper is in general well written with sufficient simulations that support its conclusions. However, two main issues need to be addressed.

1. In Sec. 2.2, the authors introduce the reservoir computing method (Lu et al., 2017)

for the variable reconstruction problem. However, I find this introduction very confusing. It seems that different constructions of reservoir computers for different tasks (for reservoir observer or for predicting future of time seriers) are introduced as different layers for a single reservoir. (lines 144-150). It is also confusing why one would need the so-called prediction reservoir as a layer for this reservoir observer task. (lines 175-178) Does this closed-loop reservoir really being used in the simulation in this paper? If so, why is it necessary? A reservoir observer does not need to feedback its own output to its input, as it is simply trying to estimate variable b(t) based on the measured a(t), rather than predicting the future of both a(t) and b(t).

2. The authors in Sec. 3.2.1-3.2.2 discuss the nonlinear coupling relation, which is essentially the nonlinear observability in the control theory, as being pointed out in (Lu et al., 2017). This direction dependence can be explained by the nonlinear observability. For example, in the Lorenz 63 model, due to the symmetry of that ODE system, both (x(t), y(t), z(t)) and (-x(t),-y(t), z(t)) are solutions on the same chaotic attractor. Thus, one can not construct any nonlinear state-observer that estimates the value of x or y given the time series of variable z. However, a state observer can estimate z(t) given either x(t) or y(t). It was also shown that xˆ2(t) and yˆ2(t) can be estimated given z(t) as it is nonlinearly observable. The authors employ CCM to quantify the "nonlinear coupling relation" and show that it is better than a linear coupling relation. It is the reviewer's opinion that a brief discussion of the relation between the CCM and the nonlinear observability should be given. Is CCM essentially the same as nonlinear-observability? If not, what is the difference?

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