Earth Syst. Dynam. Discuss.,
https://doi.org/10.5194/esd-2019-66-RC2, 2020

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Interactive comment on "Statistical estimation of global surface temperature response to forcing under the assumption of temporal scaling" *by* Eirik Myrvoll-Nilsen et al.

Anonymous Referee #2

Received and published: 4 January 2020

This is an interesting and useful piece of work which is well worth publishing. While physically-based models are attractive in terms of interpretation of parameters and underlying mechanisms, if a model that is not so directly intepretable can be shown to perform as well or better, then as well as being functionally useful that's an additional challenge and avenue for improving our understanding. The parameter estimation method also looks like a powerful approach and demonstrating its use may be of benefit for many readers.

I am however a little bit underwhelmed by the comparison to the simple exponential model. At least one of the authors has already shown that this is far from adequate for

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modelling the transient behaviour over the 20th century! Thus, it's really too easy a target to beat. While the point about additional parameters is well made, adding a second deep ocean layer is surely not too demanding and such a model has markedly better performance. If the authors don't want to include additional uncertain parameters, those relating to the second layer could even be fixed at plausible values.

There is also a bit of a gap in the analysis that really needs to be filled. Unless I have missed something, there is no direct analysis of how well the model performs at predicting GCM behaviour. The analyses in Fig 4 and 5 fit the models to observed temperatures and compare projections to the models, observing that the simple exponential model tends to underpredict compared to the GCM-based AR5 projections. It would be more of a test to fit the models to each of the GCM hindcasts and see how well they manage to predict the respective GCM futures under a given scenario. While the scale-invariant model appears to match the projections better, the reason that the exponential model underestimates the projections may partly be that the GCMs overestimate the (transient) response to forcing. Though as mentioned above the relatively performance of the exponential model is not particularly noteworthy anyway.

I'd also like to see more discussion of the striking difference between the two panels in Fig 2. What is the underlying explanation for the different uncertainties, and are the estimated uncertainties in 2(a) reliable? Conversely, the uncertainties in Figs 4 and 5 appear the other way round, with the scaling response leading to much larger spread. Error bars on the TCR estimates on Fig 6 would also be helpful.

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