Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., referee comment RC2
https://doi.org/10.5194/gmd-2021-256-RC2, 2021

Comment on gmd-2021-256

Anonymous Referee #2

Referee comment on "Prediction error growth in a more realistic atmospheric toy model with three spatiotemporal scales" by Hynek Bednář and Holger Kantz, Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-256-RC2, 2021

Review comments:

This well-written paper studies the error growth with a simplified toy model that extends Lorenz' simplified system to three spatiotemporal levels. Given the critical importance of the scale-dependent nature of atmospheric predictability, this manuscript could provide some insights in our understanding of numerical weather prediction. The comparison with ECMWF data surely adds value to the study.

A major part of the study is to fit the error growth in the model with two function forms. The reviewer feels like clarifications and more analysis need to be made to justify the conclusions mentioned in the paper. Therefore, a major revision is suggested here before this paper could be published.

Specific Comments:

In the abstract, the authors wrote "there is an intrinsic limit of predictability after 22 days", this conclusion is made by fitting the modified power law function to the ECWMF data. If the function form in Zhang et al 2019 is used, then the predictability limit becomes 15 days as mentioned in the text. The difference between these two estimated limits is sort of large. In the context of the ECMWF operational forecast system, the reviewer did not find any advantage of using the modified power law function rather than the function form in Zhang et al. Is there any reason for the reader to believe that this 22-day limit is more accurate than the 15-day limit?

Scale-dependence is the key for understanding atmospheric predictability. The authors proposed this three-scale toy model. Could it be possible to verify this three-scale model with the ECMWF data? E.g., to connect X1 with snoptical errors, X2 with meso-scale error and X3 with turbulent motions. If such filters are applied to the ECMWF data and verify the errors of different scales with the toy model, then the results would be much more convincing.

Once the parameter of the three-scale toy model is set, then its error growth behavior is also determined, Is the results shown here sensitive to the value of the parameters in the equation(e.g. F, b, c, I) ?

Line 14-15: a theoretical justification of function form in Zhang et al. is recently provided by Sun and Zhang 2020 (https://doi.org/10.1175/JAS-D-19-0271.1).

Line 180: perfect model assumption is used, right?

Line 214: what does this "initial transient behavior" look like? Is the error decreasing with time? What would happen if the initial error is further reduced towards 0?

A bracket is missing in Equation. (20)

Line 365: the extended quadratic model Eq. (21) is more accurate than the extended exponential growth? How to reconcile this with the three-scale toy model results?

Line 415-425 : The authors seem to hint that the extended power-law form is better compared to the extended quadratic form here. This is true for the toy-model. But it is not supported by the ECMWF, right?