

Ann. Geophys. Discuss., referee comment RC1
<https://doi.org/10.5194/angeo-2021-54-RC1>, 2021
© Author(s) 2021. This work is distributed under
the Creative Commons Attribution 4.0 License.

Comment on angeo-2021-54

Anonymous Referee #1

Referee comment on "Echo state network model for analyzing solar-wind effects on the AU and AL indices" by Shin'ya Nakano and Ryuho Kataoka, Ann. Geophys. Discuss., <https://doi.org/10.5194/angeo-2021-54-RC1>, 2021

General Comments

This paper reports on the results of a recurrent neural network having the ability to predict auroral AU and AL indices. This neural network is then used to examine some of the properties of the relationships between the solar wind and interplanetary magnetic field and these indices.

I agree very much with the statements that "the learned relationships between solar-wind inputs and auroral electrojets are of interest from the scientific perspective as well" and "it is meaningful to analyze the input-output relationships of the trained models." So this demonstration of a technique for looking at the solar wind-magnetosphere-ionosphere coupling problem, using a "synthetic solar wind" with the "black box" neural network has value.

This work may have potential after additional work and resubmission

Specific Comments

Lines 102-103: "We can then identify properties of the auroral electrojets by analyzing the synthetic indices obtained from various artificial inputs"

This can be very useful, but it is surprising how it was done in practice. The construction of the "synthetic solar wind" was done by fixing one of the input parameters to zero or other fixed level in order to determine the effects on the output. While that process produces some useful results, I expected something like use of a step function for velocity or IMF values. For example, using a steady value of one parameter such as B_z for a period of time, such as a few hours, then stepping up to another value, and repeating. The

results should show how the AU/AL indices respond to that parameter.

Line 94 and elsewhere: "ESN meets a satisfactorily high accuracy". I think the accuracy is overstated, as the model output seems to miss the amplitudes of a lot of AU/AL variations.

Table 1 and elsewhere in the text: It would be helpful to include correlations, as another measure of model performance.

The paper needs to have more details in the Discussion or Summary regarding the relationship of the results with the dynamic pressure ($nV^2/2$). There is no mention of pressure, although it appears in several previous publications, such as Newell et al. [2007 and 2008], as related to the effects of the density. Interestingly, the results in Figure 9 seem to follow a V^2 curve.

I think that two of the references cited by Newell et al. [2008] had indicated that sudden increases in dynamic pressure only produced on temporary response, in the magnetosphere [Boudouridis et al, 2005, Ober et al., 2007]. For example, the polar cap electric potential may increase for a while, then go back down to near the pre-impulse level. This temporary behavior complicates any search for a consistent relationship between the solar wind density and ionospheric response.

Technical Corrections

In Figure 1, the graph showing the three IMF components is not clear. These should be put into three separate rows.

Lines 98-99: This sentence is not clear.

Figure 3 needs to be taller in order to help show the differences between some of the lines.

Title and line 100:

I don't agree with the use of the word "sounding," and a different terminology would be preferred as the title sounds a little pretentious. In my opinion, this use doesn't agree with any of the multiple, dictionary meanings of the word "sound" or "sounding." Whether or not a change is made is entirely up to the discretion of the authors.

The web link for WDC for Geomagnetism, Kyoto isn't working, due to the line break. A different Latex package for URL references might work, or try putting the link all on one line without a break. This is a common problem encountered with URLs in Latex.