Response to Anonymous Referee #1

The study introduces a statistical forecast model of the July-October North Atlantic accumulated cyclone energy (ACE) wherein the causal effect network (CEN) approach is used to identify relevant precursors of the seasonal tropical cyclone (TC) activity in late and early spring of the same year. In the current version, I see the paper largely as a demonstration of the CEN method. There is not much value in other results. In the case of May forecasts, the robust precursors are well known. Results of the March forecasts are more interesting. However, it is not clear what physical mechanisms are at play, and whether the reported results will hold if a longer observational record is used.

> *We thank the reviewer for her/his useful comments. We agree that in the first version of the manuscript the discussion of the March precursors lacked some depth. As discussed below in more detail, we therefore added some analysis according to the reviewer`s suggestions.*

To improve the manuscript, I suggest the following:

a) Provide more discussion of the physical relevance of the March precursors.

> *In the new version of the manuscript, (see Fig. 10 and lines 268-282) we now hypothesize on the mechanism connecting the detected dipole precursor pattern in March to enhanced VWS in July-August. More precisely, we speculate that a high-pressure anomaly in the southern Indian Ocean and a low-pressure anomaly in the western South Pacific could weaken the trade winds in the western Pacific which is favorable for El Niño formation (which in turn is known to have an enhancing influence on VWS in the Atlantic).*
> *We test this hypothesis by constructing a causal effect network that shows the links between SSTs in the El Niño 3.4 region, trade winds in the western Pacific and the strength of the identified MSLP dipole. This analysis supports our hypothesis. Note, however, that more research is needed to confirm the robustness of this linkage, something we also clearly state in the paper.*

Incidentally, does the MSLP dipole pattern also exhibit a trend?

> *We use detrended time series to identify precursors and therefore do not expect the link between precursors and predictands to rely on such trends. The reviewer is right, however, that the skill in our final forecast model could depend on trends in the precursors and we thank him/her for pointing this out. We have, therefore, additionally analyzed the linear trends in three regions that have been identified as robust precursors in most training sets (see Figure S3).*
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> *For the two identified MSLP precursors, no significant trend is detected (p-values 0.16 for the western Pacific precursor and 0.67 for the Indian Ocean precursor). Also, the trend in the Atlantic SST precursor is insignificant (p-value=0.25). While we cannot rule out that (insignificant) trends maybe contribute to the prediction skill, we conclude that they cannot fully explain the relationships identified and are thus not primary responsible for our model skill.*
>
> *We added a discussion about the potential influence of trends in line 293-296.*

b) Build a forecasting model based on March reanalysis data using a longer observational record. At least JRA55 data is available since 1958. This would allow to assess the robustness of the presented results and perhaps provide more insight into the physical mechanisms.

We thank the reviewer for this suggestion. In the modified version of the manuscript, we now test the skill of a prediction model (that is trained over the period 1980-2018) to the earlier period of JRA55 (1958-1978). The skill of our model is reduced in the pre-1979 period which is mainly due to a systematic overestimation in hurricane activity.
We hypothesize that this overestimation could be explained by the influence of anthropogenic aerosols on hurricane activity that is not captured in our model. In the period 1950-1980 high aerosol emissions lead to tropical cyclone suppression in the Atlantic. Regulations in the late 1970s lead to fewer emissions weakening the tropical cyclone suppression (Dunstone et al. 2013)*. We also think that the quality of reanalysis products before the use of satellites before 1979 introduce systematic uncertainties which make it extremely difficult to further investigate the robustness of the our results (compare* Tennant 2004)*. We nevertheless included this sensitivity test into the SI (Fig. S8) and discuss it in line 308-319 of the manuscript.*

Minor Comments:

1. Line 30: I suggest replacing “regional” with “global and regional”.

We thank the reviewer for spotting this error in the manuscript and we now changed “regional” to “global”.

2. Line 65: What time period reanalyses data do you use?

We added the periods used for both datasets in the manuscript (line 67 and 69-70).

3. Line 90: Please clarify why for the seasonal forecasting case potentially existing common drivers do not represent a problem.

We agree with the reviewer that this part was not clear enough. We reformulated this paragraph and only explain the shortcomings of our application (line 89-95). We also discuss these shortcomings again in the discussion section (line 347-352).

4. Line 105: Maybe “for seasonal hurricane activity of the same year”?

We modified the manuscript accordingly.

5. Line 110: I suggest providing more background why SST and MSLP are used to find precursors of VWS.

We agree with the reviewer, that in the initial version of the manuscript an explanation was lacking. We added a sentence motivating the choice of these variables in line 115-117.

6. Line 230: “(Fig. 7c)” instead of “(Fig. 7b)”.

Done

7. Line 235: “(see Figs. 7b and d)” instead of “(see Fig. 7c and d)”.

Done

8. Line 290: Please clarify why it may be challenging to incorporate other favorable conditions into your framework.

We agree with the reviewer that this statement should be better explained. Although relative humidity is an important variable for the analysis of tropical cyclone formation it varies on shorter time scales and seasonal averages of relative humidity might not be insightful. SSTs and VWS are both to some extent modulated by ENSO and seasonal averages can therefore differ substantially. We added an explaining sentence in line 343-346.

References

Dunstone NJ, Smith DM, Booth BBB, et al (2013) Anthropogenic aerosol forcing of Atlantic tropical storms. Nat Geosci 6:534–539. doi: 10.1038/ngeo1854

Tennant W (2004) Considerations when using pre-1979 NCEP/NCAR reanalyses in the southern hemisphere. Geophys Res Lett 31:n/a-n/a. doi: 10.1029/2004GL019751