

1 **2 Response to Reviewer #2's comments**

2 Review of MS No.: esd-2023-1

3 Causal interactions between ENSO and the North Tropical Atlantic

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5 The authors study causal interactions between the North Tropical Atlantic mode (NTA) and the El
6 Niño–Southern Oscillation (ENSO), accounting for possible compounding effects of the Indian
7 Ocean Dipole (IOD) and the Indian Ocean Basin mode (IOB), using a form of Granger causality
8 (GC) analysis. This is an interesting topic potentially bringing important results.

9 Reading the paper, a number of technical questions emerged.

10 Sampling: The authors use monthly data, however they evaluate seasonal indices, leading to
11 yearly data, i.e. they obtained the results using 65 samples. Questions:

12 2.1 1. Model order- they mention two criteria, but do not specify which was finally used and
13 which order of models was applied. Considering 65 samples, any order higher than 1 or 2
14 can be problematic, considering 4 variables in the models.

15 **Response:** We should note that the model order and the number of ‘variables’ are independent
16 variables. The order is related to the number of ‘samples’ as you mentioned. Please see the
17 supporting information for additional information (Lines 39-46).

18 2.2 2. The results are asymmetric, which might be interpretable as ENSO being more important
19 climate mode. On the other hand, by data construction, the effect of ENSO on NTA was
20 evaluated using a time delay of 3 months, while the other direction has inherent time lag 9
21 months. Can this play any role? Would not be analysis using monthly data and different
22 time lags interesting?

23 **Response:** We only focus on the peaking seasons of each climate mode. We are not interested in
24 analyzing monthly data because of the different peaking seasons of each climate mode. For
25 example, analyzing the relationship between ENSO in the decaying months (e.g., June) and NTA
26 in the peaking months (e.g., April) is generally not of interest. The time lags indeed play important

27 roles and that is the point we want to test. In fact, despite long time lag, NTA impacts can still be
28 observed in reanalysis data and some models (Figures 7 and 8).

29 2.3 3. The results in Fig. 3 and other maps - are they obtained in the same way using yearly data,
30 just ENSO effect was evaluated on any grid-point separately? Is p-value mapped?

31 **Response:** Yes, they are the same approach.

32 The question 3 leads to:

33 2.4 4. If many tests are presented, is any correction to multiple testing considered? This can be
34 very critical esp. in Fig. 7, where a few significant spots could appear by chance. Not to
35 speak about very weak criteria taking as significant also values of p 0.1 -0.3. Good to remind
36 that typical conservative approach relies on $p < 0.05$. I would conclude that no effect of NTA
37 on ENSO was detected, and very few models were able to reproduce the effect of ENSO on
38 NTA, observed in the reanalysis data. Btw. in Fig. 2 the results for the reanalysis data is not
39 visible because of small p-value? This should be mentioned in the caption and the value
40 should be written.

41 **Response:** We followed the approach suggested in previous work to discuss the degree of
42 uncertainty (Lines 50-57, supporting information). Fundamentally, the results of causal impact or
43 no causal impact are equally important and both results should be reported.

44 2.5 5. Another remark to significance levels - if they are obtained from an analytic expression,
45 there are always some data requirements. I propose to add some computational statistics such
46 as surrogate data or bootstrap, to avoid false significance.

47 **Response:** Please see the response in section 2.4. In our opinion, the study is well designed.

48 2.6 6. Multiplicity correction applies also for sliding window results, e.g. Fig. 9e.

49 **Response:** Please see the response in section 2.4.

50 2.7 7. What would be the results without accounting for IOD and IOB?

51 **Response:** We aim to provide information close to real-world teleconnections. Hence, accounting
52 the impacts of IOD and IOB are necessary. For this reason, we have not tried to produce analyses
53 excluding these two modes.

54 2.8 8. If p-values is mapped in Figs. 3 and similar, I would not talk about the causal effect.

55 p-value gives the reliability of inference (of causality in this case) which is not generally
56 equivalent to (physical) causal effect of the cause on the effect variable.

57 **Response:** Please see the response in section 2.4. The results shown in Figures 3, 5 and 7 support
58 the causal effects (i.e., the modulation of atmospheric circulation related to ENSO and NTA).