In a world dealing with a changing climate, there is a need for studies investigating environmental changes following anthropogenic influences, especially in understudied ecosystems with complex dynamics such as semi-arid savannas. This study uses an unique long term dataset collected in a large-scale nutrient addition experiment in a semi-arid savanna in Spain to look into the effect of altered nutrient levels on the relationships between NEE and it's key drivers, using robust methods as Singular Spectrum Analysis and Information Theory. The long term dataset is analyzed both as a whole and divided into phenological seasons, which results in a deeper understanding of the ecosystem as wel as interesting insights into the effects of the nutrient addition, underneath the water or energy limitation during different seasons. The methods are well explained and the important results are wel discussed, however some points require further clarification or discussion.

Specific comments:

Materials and Methods

1. Line 109: Authors could add a map of the region

2. Line 137: Is there more information on when N and P were applied to the plots in terms of seasons or years? Would you suspect that the results over the years, for example in Fig 6, could be in anyway linked to the timing of the application of N and P?

3. Line 154. How many soil sensors were installed per footprint? And were they installed in open field or under trees or both? There is mention in the discussion part that soil temperatures below oak trees are more important than those in open areas during the regreening in autumn (line 575) and that this also could be related to the variations in soil moisture between open and shaded pastures. Therefore it seems important to know where the sensors were located and if the authors were able to capture some of these variations in soil moisture that could underpin this statement.

4. The authors use only daytime measurements to calculate the aggregated daily means of NEE. Why is the nighttime data removed?

5. Line 228 – 230 "In the second step X is decomposed into its orthogonal components by determining eigenvalues and eigenvectors corresponding to principal components (singular value decomposition). Then the eigenvalues of the covariance matrix $X \cdot X$ are ranked."

   I don't know the SSA method very well, however this part is slightly confusing for me as I think it is the eigenvalues and eigenvectors of XX^T that are determined and then X is decomposed in matrices with rank 1 which are constructed using these eigenvalues and eigenvectors. For me the term "decomposed in its orthogonal components" sounds vague. Also maybe avoid the use of "ranked" as I think you mean ordered by decreasing magnitude here. Rank in terms of matrices can be confused with the terminology of rank of a matrix.

6. Line 239: Here is stated that the data is gap-filled using the igapfill – function, however in Line 205 – 206 you state that you only use measured values to avoid confounding with the other meteorological variables in later analyses. Is this gap filling necessary because the

SSA requires a full time series? Will you not introduce this confounding again by gap filling here, in the sense that even though you remove the gap filles values again after the SSA (mentioned in Line 299), the gap filling will have an influence on the SSA result? Or is this method of gap filling not based on the meteorological data?

7. Section 2.4.4: I think that there are some inconsistencies with equations here. Formula (4) has no double sum, iterating over both x and y. This double sum is however seen in equation (6). Equation (6) on the other hand has no logarithm included in the right hand side of the equation both in the numerator as in de denominator (as is present in equation (4)) . Also a maximum operator should be present as MI_{max} is the maximum iterated over different values of tau and in the denominator of equation (6) an "i" pops up. Maybe check that these formulas are indeed consistent and correct.

Results

8. Section 3.2.

   Line 351 – 354 states the common, most important predictors which are nicely highlighted and explained in the discussion, section 4.2

   Line 385 – 388 highlights that r and MI nicely agreed in the detection of the most important drivers, which explains why you continue only with the MI measurements.

   Line 355 – 384 describes the key controls for each plot, however I would suggest to make this shorter and more to the point. It reads difficult due to the many variable names and these separate results for each plot are nowhere discussed in the discussion section. The comparison between the towers in section 3.3 contributes more to the story of the paper than these separate observations, in my opinion.

   The section and graph are needed to support discussion section 4.2 but I feel like the separate observations could be either shortened or restructured.

9. Table 2: the authors might add the MI values in the table or in supplementary material of the five most important drivers for each phenological season. Would be interesting to see if for example the three first ones have a way higher MI value than the two last ones, or if the values are all close to each other.

Discussion.

10. Section 4.1
    Line 475: there is an increasing trend in the difference between annual NEE maximum and annual NEE minimum in the NPT plot. Is both the minimum value going down and the maximum value going up? Or is this increase in difference guided by mainly one of the two?

    Only NPT has a significant increase, however the explanation as why this could be the case, does not specifically mention only N+ P addition, so you would also expect this increase in the N plot. Is there an explanation why this is not the case? Or would you nuance the p-value and suggest that this increase might also be the case for N addition?

11. Line 530: here is stated that EF, which is a proxy for rain pulses, is an important driver but that SWC, VPD and RH are not important drivers following the MI analyses. This seems to be contradictory results as you mention both of them as proxies for rainfall. Points this towards the fact that in this study soil water related variables and rain pulses are not as important as previously found in other studies and that the link with EF as important driver is more based on its relation with LAI or radiation than with moisture related variables? However in line 544 is also stated that Radiation does not seems to have a major influence. How can this opposite results be interpreted?

12. Section 4.3: the authors could restructure the sections to follow the order of Table 2 and section 3.4. or restructure the table and the accompanying result section to follow the order from the discussion section.

Technical corrections:

Abstract

Line 15: Semi-arid ecosystems dominate the variability and trend of the terrestrial carbon sink.

Line 29 -30 : The increasing NEE variability might become even more pronounced with increasing N deposition and a changing climate in the future.

Introduction

Line 62: ~~human shaped~~ man-made savanna-like agroecosystem, ...

Line 72-73: Few studies so far have dealt ~~so far~~ with ...

Materials and Methods

Table 1: add in the caption that the soil heat flux and soil temperature in the shadow were calculated based on the shadow fraction ...
Also the height of the air pressure device is not present

Line 113: heterogeneous with values between 0.5 and 2.5 ....

Line 151: here CO2- flux is also in the list of additional atmospheric variables, maybe remove

Line 173: and collected red, blue, ...

Line 291: Positive and negative values of τ show an asynchronous interaction between X and Y, with a lag ...

This phrasing may sounds like it insinuates that it is the value of tau that is the interaction, however tau is merely the time lag. Maybe rephrase.

Results

Line 347-350: this sentence is difficult to understand and has a point which seems wrongly placed.

> “accounts for collinear relationships. and MIsync and …”

Line 411: remove the sentence about soil temperature here, soil temperature is again mentioned in a better way in Line 416

Line 455: “We observed that with N addition, NEE became less sensitive to certain variables during autumn (i.e., the regreening phase), the drydown phase, and winter over time (Fig.5).”

> In winter this is “more sensitive” and not “less sensitive” as there is increase as mentioned in line 459.

Figure 5: the caption states that NT vs CT is in the bottom figure and NPT vs CT in the top figure but it is the way around.