General comments:

The authors used the Conditional Spectral Granger Causality framework to evaluate local biosphere – climate interactions at a global scale. This was done at three temporal scales (monthly, seasonaly and yearly) and using vegetation dynamics (based on LAI) retrieved from both satellite observations and earth system model data. Overall, I think it is a very interesting and innovative approach. Although the method has a few restrictions, such as the inability to account for off-site effects of vegetation on climate, these are well acknowledged in the discussion.

Thank you for your insightful comments and support of the manuscript.

Specific comments:

1. The authors could consider to change the title to multi-temporal scales instead of scales as the latter may also refer to spatial scale.

We acknowledge the possibility for confusion and will change the title accordingly.

2. Although not in the scope of this paper, could the approach be useful to evaluate how the interactions change over time?

Conditional Spectral Granger Causality can be used to address changes over time. Currently, the wavelet spectrum is averaged over all time steps, resulting in the loss of the time domain. However, by adapting the method to use the frequency-spectrum at each time step instead of averaging over time, Conditional Spectral Granger Causality in the time and frequency domain is possible. We are in the present working on adapting the algorithm to explicitly resolve different time scales, but as the reviewer states, exploring the time dimension lies out of the scope of the current manuscript.

3. There is likely an important anthropogenic effect on both vegetation and climate dynamics. Could this impact the obtained results?

Anthropogenic effects impacting climate on the long term, and resulting in multi-decadal trends, are not addressed in this study due to the limited data record. As the reviewer noticed, based on the three-decade record length we operate with, we can only resolve reliably those time-scales up to multi-annual. Likewise, short-term vegetation disturbances directly driven by human activities, such as deforestation, will reflect a low causal relation with climate variability, being the latter not the main driver of these changes. Moreover, since Granger causality assumes causal sufficiency, regions with unobservable causes (in this case those leading to e.g. deforestation) will be more poorly resolved by the framework. This will be explicitly mentioned in the revised version.

4. The interannual impact of climate on vegetation is also very patchy over Africa and North America in contrast to the modeled output (fig 2). Do the authors have an idea why this happens? Is it a methodological issue, data issue or are the drivers of long term trends more spatially heterogeneous (which is not catched by the models).

We thank the reviewer for this comment. We further explored these patterns after the referee's comment, and concluded that the frequency parameter of the used wavelet partly influences the results in this regard. This parameter provides a trade-off between spectral and temporal resolution. By increasing the time-resolution the conditional causality patterns at inter-annual scales can be improved. This improves the clarity in the figures, even if some heterogeneity still remains. Moreover, Reviewer #2 requested an ensemble based on multiple datasets of LAI and climate variables, which would help resolve issues related data errors. Both the exploration of the frequency parameter as well as the creation of the ensemble will be adopted in the revised version.

5. Did the authors try to run the analysis over the same time period for the remote sensing and model data (page 4, line 17)? Do the results substantially differ?

We thank the reviewer for this comment. We have already run the analysis over the same time period; we will include the results to the supplementary and discuss them in the main text.

6. The approach includes data outside the growing season to estimate the monthly interactions. Yet, variations in LAI might not be meaningful during this period. Could this potentially affect the results?

Yes, we agree with the reviewer. While we are currently working to resolve the time domain to the Conditional Spectral Granger Causality formulation (see above), which would allow us to tackle explicitly this issue in the future, our preliminary results indicate that the strength of the signal during the growing season strongly dominates average temporal patterns. We are also confident that the adoption of an ensemble approach will dampen the sensitivity to errors in the individual data sources.

7. What is the policy of the authors concerning sharing data/scripts? Are the authors planning to make these available via a repository/upon reasonable request/…?

We are open for sharing the scripts using GitHub after publication at https://github.com/lhwm. All used datasets are freely available.