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Interactive comment on "Standardized flux seasonality metrics: A companion dataset for FLUXNET annual product" *by* Linqing Yang and Asko Noormets

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Anonymous Referee #1

This paper extracted a series of standardized flux seasonality metrics through identifying key transition points and phase durations of carbon, water, and energy fluxes from the FLUXNET 2015 Dataset of about 200 sites and 1500 site-years of data. These metrics are useful to understand the ecosystem processes and their responses to climate change. However, the dataset presented in this paper was not enough exciting and attractive to readers, because these metrics were derived from existing FLUXNET dataset and some of metrics were widely reported and used, such as phenological

events from GPP and NEE. The other flaw is that the dataset is at site scale rather than at global scale. The work is lack of originality and effort to publish on the ESSD.

Response: Thank you for this perspective. It is true that phenological transition dates have been calculated for and analyzed based on both land- and space-based observations. However, to date there isn't a consistent terminology to describe the transitions, nor a comprehensive framework for deriving these metrics for different sites. Moreover, only the seasonality of GPP has been explored at any length, whereas the other biogeochemical fluxes have not been analyzed since the second author's book chapter over a decade ago. Since then, the FLUXNET database has grown exponentially, and has recently converged to globally harmonized data processing and sharing. The complementary dataset presented here is therefore timely and potentially valuable companion for this resource. We are also in communication with Ameriflux Data Team to have the workflow handed over and incorporated into their processing stream. Finally, this dataset can be used to validate other phenological products like land surface phenology products.

The major concerns are as below.

1. The meaningful of these metrics was not presented clearly in the Introduction section. Why the authors presented these metrics and how they are different with other existed metrics you mentioned in Line 35-50.

Reply: Thank you for the request to clarify. We have expanded this section, describing the relationship between ground based phenological observations, remote sensing seasonality metrics, and flux seasonality. What we report directly builds on the analyses of these earlier products, and we have cited the relevant publications. The novelty of the current study is in its universality of derivation of seasonality metrics for different fluxes, and quantifying aspects that previously have been addressed on a more ad-hoc basis (e.g. the change rate of fluxes during the spring and fall shoulder seasons). The framework is also open to incorporating other fitting models and strategies, as well as

applying the workflow to additional processes.

2. Line 79. How high-quality gap-filled data was defined. Which variable do you use to select the high-quality data. How many sites and site-years data were used after selecting by boundary conditions.

Reply: Thank you for this question. We have clarified in the paper that we used the variable-specific quality flags in the FLUXNET2015 data set. The flags indicate the fraction of daily coverage of observed and high-quality gapfilled records for the metric of selection. Specifically, we used FLUXNET2015 daily data product, which is integrated from half hourly data, and includes quality flags for all variables. The quality of individual 30-minute flux records is classified based on standard tests (originally based on Foken and Wichura 1996, reviewed by Mauder et al. 2008 and currently implemented in the harmonized data processing program ONEFlux (Pastorello et al. 2019), which is the data processing engine of the Ameriflux and ICOS workflows (Pastorello et al. 2020)), marking each record as: 0=measured, 1=good quality gapfilled, 2=medium quality gapfilled, 3=poor quality gapfilles. The quality of the daily aggregated values is expressed as a fraction of records with a quality flag value of 0 or 1. In this study, days with quality flag of 0.75 and higher were considered.

The final number of sites and site-years was as follows: for GPP: 169 sites and 1044 site-years; for RE: 173 sites and 1040 site-years; for LE: 134 sites and 834 site-years; for H: 128 sites and 800 site-years.

This information is summarized in the manuscript, lines 81-82: The final dataset included 169 sites and 1044 site-years for GPP, 173/1040 for RE, 134/834 for LE, and 128/800 for H.

3. The double-logistic model was used in this study. The method was useful for many of sites and land cover types. However, for some special site data, it may be not suitable and should be descripted more clearly. For example, how to define and extract these metrics for those sites with multi-peak seasonal dynamic, such as double-cropping

CRO, and SAV, Mediterranean and tropical ecosystems with complicated climate conditions.

Reply: Thank you for pointing this out. We have added a few sentences (lines 106-109) to explain how sites with non-standard flux seasonality were handled: Sites with non-standard flux seasonality, where the R2 of model fit was below 0.75, were filtered out during general model fit assessment. Most filtering related to poor quality gapfilling with obviously distorted seasonality, but 7 sites with multiple peaks during the same year were also excluded from the current study. Southern hemisphere sites were analyzed by shifting the calendar year cutoffs by 180 days. Future updates to this database are intended to include custom fits for sites with multiple peaks and phenological cycles across two different calendar years.

4. L315.The significant of these metrics should be strengthened. What are their usefulness and where they can be applied in. Please adding more details on the contribution of these metrics to discover the mechanism of carbon and water processes and their responses to climate and improve the calibration of the ecosystem models.

Reply: Thank you for this suggestion, but these aspects are covered in the Significance section of the manuscript. We mention several currently outstanding research themes that would benefit from the standardized flux seasonality dataset. Please see lines 322-339.

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