**Reviewer # RC1**

The authors investigated the causal relationships between catchment water availability, vapor pressure deficit, and gross primary productivity across 341 catchments in the contiguous US. They employed various statistical methods, including circularity statistics, correlation analysis, and causality tests, to determine the complex interactions between catchment wetness, atmospheric dryness, and vegetation carbon uptake. I found this work interesting, as it enhances our understanding and predictive capabilities regarding ecosystem responses to climate change. I have few minor suggestions:

*We would like to express our sincere gratitude for your positive feedback regarding our manuscript. We are pleased that you found our work interesting and valuable for enhancing the understanding of ecosystem responses to climate change. Your insightful comments and suggestions are greatly appreciated, and we have carefully considered each one.*

Comment: What are the potential reasons for a strong positive causal link between the current and the preceding month's GPP?

Response*: We appreciate your insightful question. This relationship is indeed complex and multifaceted, stemming from several interconnected ecological and physiological factors. We provide a couple of examples: 1) Biological Inertia: vegetation exhibits a form of biological inertia, where its physiological state in one month significantly influences productivity in the following month. For instance, the continuity in the leaf area index reflects gradual changes in canopy structure, leading to a strong month-to-month correlation in photosynthetic capacity. Additionally, the development of the root system over time affects water and nutrient uptake in subsequent periods. 2) Soil Moisture Memory: Soil water content often has a memory effect that can span weeks to months, impacting plant water availability and, consequently, GPP.*

Comment: This is an interesting finding: "Vegetation response lagged behind changes in Wetness, and changes in VPD followed the vegetation response, resulting in a hysteresis phenomenon." Please comment if such hysteresis phenomena are likely to change in space and time.

Response: *Thank you for highlighting this important aspect of our findings. We address the potential changes in hysteresis phenomena in both spatial and temporal contexts. Spatial Changes: Across CONUS watersheds, we observed that the size and nature of the hysteresis phenomenon vary geographically. This variation is driven by differences in factors such as seasonal dynamics of hydrologic dryness and vegetation carbon uptake efficiency. We will revise the manuscript to provide greater clarity and detail on this spatial variability, ensuring that the geographical differences in hysteresis are more explicitly articulated. Temporal Changes: Our study utilized regime curves based on long-term monthly averages, which limits our ability to evaluate temporal changes in hysteresis within the study period. To assess temporal variability, it would be necessary to divide the study period into smaller segments and analyze them individually. We plan to address this task in future research, where we will explore temporal shifts in hysteresis patterns over shorter time scales. We appreciate your suggestion and will incorporate additional explanations in the revised manuscript to enhance the discussion of these spatial and temporal dynamics. This* *will help clarify the potential for hysteresis phenomena to change over space and time, providing a more comprehensive understanding of these processes.*

Comment: Cations for figures 3-5 seem to be swapped. Please correct.
Response: *Thank you for bringing this to our attention. We will review and correct the captions for Figures 3-5 in the revised manuscript.*

Comment: In Section 5, please develop your discussion in the context of prior similar studies and articulate your major contributions.
Response: *Thank you for your suggestion. We will revise Section 5 to better contextualize our findings within prior studies and clearly articulate our major contributions.*

Comment: In Section 5 or 6, please include one paragraph on the limitations of your study. It is often quite complex to study the non-linear relationship between selected variables.
Response: *Thank you for this valuable suggestion. We will provide more discussion on the limitations of our study is crucial for providing a balanced perspective on our findings.*

Comment: Can we use Soil moisture products (e.g., remote sensing products) instead of W minus (deltaS)?

Response: *Thank you for this insightful question. We chose to use W minus (deltaS) instead of soil moisture products for several important reasons. W minus (deltaS) represents the total water available to vegetation, including not only soil moisture but also deeper groundwater resources, which is crucial because many plants, especially those with deep root systems, can access water beyond the shallow soil layers typically measured by remote sensing products. Satellite-based soil moisture products generally capture moisture only in the top few centimeters of soil, leading to an incomplete picture of water availability for vegetation. By using W minus (deltaS), we aimed to move beyond the traditional reliance on surface soil moisture, which can be limiting in ecosystem studies, and provide a more integrated measure of water availability at the catchment scale that aligns better with our study's spatial focus. Additionally, W minus (deltaS) is more directly linked to the overall water balance of the catchment, offering a more holistic representation of water availability. While soil moisture products have their merits for surface-level analyses, our choice of W minus (deltaS) allows for a more comprehensive assessment of water dynamics relevant to vegetation across various depths and ecosystem types. We appreciate your question as it allows us to clarify this important methodological choice in our study.*

Comment: Please justify why you made 6 groups to represent 341 catchments.
Response: *Thank you for your question. The decision to group the 341 catchments into six categories was based on the dominant vegetation cover, which is defined as covering more than 50% of the watershed area. This information is sourced from the CAMELS dataset and aligns with the National Land Cover Database (NLCD) classifications. To streamline our analysis and facilitate meaningful comparisons, we consolidated similar vegetation classes into six broader categories. Evergreen Forest: This group combines Broadleaf and Needleleaf Evergreen Forests, reflecting their similar ecological functions and carbon uptake dynamics. Woody Savannah, Open*

*and Closed Shrublands: These classes were merged due to their comparable structural and functional characteristics to form Woody Savannah and Shrublands group. Cropland/Natural Vegetation Mosaic (NVM) and Cropland: These were grouped together to account for areas dominated by agricultural activities. The other three groups including Deciduous Broadleaf Forest (DBF), Grasslands (GL) and Mixed Forest are all original classification from NLCD and has not been merged with any other group. This categorization allowed us to efficiently analyze and interpret the data across the catchments, ensuring that each group represented a distinct ecological and hydrological regime. We will include this explanation in Section 2 of the manuscript to provide clarity on our methodological approach.*

Comment: How did you analyze various data sets when they have different spatial and temporal resolutions? For example, the GPP dataset features a spatial resolution of 30 meters and a temporal resolution of 16 days, while other data sets are of varying resolution. How it was handled in the analysis?

Response: *Thank you for your question. To address the challenge of integrating datasets with different spatial and temporal resolutions, we conducted our analysis monthly with the watershed as the spatial unit. For climate variables, we used the CAMELS dataset, which provides spatially averaged daily data for each watershed. This daily data was aggregated to a monthly scale to align with our analysis timeframe. Similarly, the daily streamflow data can be converted to daily runoff depth and then to monthly scale. For the GPP data, which is available at a 16-day temporal resolution, we first converted the values to a daily scale by assuming a uniform distribution of GPP over each 16-day period. We then aggregated these daily values to a monthly scale to ensure consistency with other datasets. Spatially, we clipped the GPP data, originally at a 30-meter resolution, to match the watershed polygons and calculated the spatial average of all 30-meter pixels within each polygon. This approach allowed us to derive a representative GPP value for each watershed, maintaining spatial consistency with other datasets. By standardizing both the temporal and spatial scales in this manner, we ensured that all datasets were compatible for integrated analysis. We will include this explanation in the methodology section of the manuscript to clarify our data processing approach.*