

## Reviewer #RC2

This paper investigated the relationships among catchment water availability, vapor pressure deficit, and gross primary productivity using causality analysis, circularity statistics, Principal Component Analysis, etc. The topic is novel and meaningful, the findings are interesting. Here are some concerns and suggestions:

*Thank you for your positive feedback on our manuscript. We appreciate your recognition of the novelty and significance of our work, as well as your interest in our findings. We are committed to addressing your concerns and suggestions in detail and believe they will enhance the quality of our paper. We look forward to incorporating your insights in our revision.*

**Comment:** Lines 95 to 99: How did you divide the catchments into six vegetation groups? Find the primary vegetation type based on the percentage of each vegetation type in the catchment? What are the criteria?

**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 the 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 classifications from NLCD and have 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:** Lines 218 to 224, what are the reasons causing the different lag time (e.g., 0, 1 month, 2 month) from the perspective of catchment characteristics?

**Response:** *Thank you for this insightful question. The different lag times between water availability and GPP, as well as between GPP and VPD, are influenced by catchment characteristics such as soil moisture dynamics, vegetation response, and hydrology. Faster water infiltration in well-drained soils results in shorter lags between water availability and GPP, whereas slower water release in clay-rich soils extends these lags. Dense or deep-rooted vegetation may delay the response to changes in water availability, leading to a longer lag between GPP and VPD as transpiration continues after peak GPP. Additionally, catchments with significant groundwater contributions or unique climate patterns may experience extended lags due to sustained water availability. We will include a discussion of these factors in the revised manuscript to clarify the observed variations in lag times.*

**Comment:** You used PCA and found that the first two principal components accounted for most of the variability of the size of the hysteresis loops across catchments. Did you also research on the importance of those selected variables used for PCA to see the dominant factors?

**Response:** *Thank you for the question. While we focused on using PCA to capture the main sources of variability in the size of the hysteresis loops, we did not conduct a separate analysis to evaluate the importance of the individual variables used in the PCA. However, this is an excellent suggestion, and we plan to explore the dominant factors in future work. We will also consider including a brief discussion of potential dominant variables in the revised manuscript to provide additional context.*

**Comment:** The last two paragraphs in the Discussion section seem more like results and conclusions. I suggest adding a discussion about whether any previous studies support or contradict your findings.

**Response:** *Thank you for your observation. We will revise the stated paragraphs and include a discussion on how our findings align with or differ from previous studies.*

**Comment:** Lines 119 – 120: The sentence has grammar error.

**Response:** *Thank you. This will be corrected in the revised manuscript*

**Comment:** For Figure 4, the title states that “The letters on the color bar represent months, with J for January, F for February, and so on.”, please double check it.

**Response:** *Thank you for pointing this out. Somehow this is shifted up from Figure 5. This will be corrected in the revised manuscript*