NOTE: the line numbers in the revised manuscript have changed during the revision process.

RC1

Thank you for taking the time to share your feedback. We truly appreciate your valuable insights and will use them to guide our improvements. We have provided responses to each of your comments (highlighted in **bold and italics**). At this stage, the comments have not been incorporated into the manuscript, as per the editor's instructions to refrain from making revisions at this time.

Major comments:

- Lines 204 and 229: I recommend describing the performance of streamflow (Q) and evapotranspiration (ET) validation for the same watershed(s), as this would provide a more complete view of how the model represents the water balance. In addition, you could extend the validation analysis by describing how the model captures ET and Gross Primary Productivity (GPP) at sites where both variables are available

Response: Thank you for the helpful suggestion. In our case, the Q and ET validation datasets originate from different observation systems located in different areas: streamflow measurements are taken from gauging stations, while ET is derived from eddy-flux towers at the site level with a spatial scale at about 1 km^2. The watersheds and flux towers do not spatially overlap. Therefore, joint evaluation of Q and ET at the watershed level is not feasible with the currently available data due to scale and location mismatch.

However, ET and GPP are both observed at the same eddy-flux tower sites, and our analysis already reflects model performance where both variables are measured concurrently. This can be confirmed by comparing the site lists in Table S5 (ET) and Table 1 (GPP). We will clarify this in the revised manuscript.

Note: Added a statement in section 2.1 that, due to the lack of overlap between stream gauge and eddy flux tower, a joint evaluation was not possible.

- Could you provide a potential explanation for why the model tends to overestimate ET during winter? What are the implications for your results?

Response: Thank you for this comment. A likely explanation for the winter overestimation of ET is related to the way ET is parameterised in WaSSI. The model estimates actual ET as a function of potential ET (PET), precipitation, and leaf area index (LAI). During winter, LAI is low; however, precipitation is generally high in Germany, and the model formulation (see Equation 1) imposes a positive relationship between precipitation and actual ET. As a result, the model may

produce higher ET values than expected under cold-season conditions. Local corrections either the PET model (derived from the eastern U.S.) or the Equation 1 (derived from global flux data) might be needed to accurately simulate ET for winter in Germany.

Note: Added this model behaviour in the text section 3.1.2 ET Validation. In the discussion we already mentioned that the WaSSI model equations have limitation and we hope that covers why the ET is overestimated during winter.

- Since the analysis is focused on extreme dry–hot and wet–cold years, how does the model perform during drier years (e.g., MAP < 25th percentile) and wetter (e.g., MAP > 75th percentile) years?

Response: Thank you for this important question. The WaSSI model demonstrates strong overall validation results, indicating reliable performance for diverse environments. The model performance for dry-hot extremes (e.g., drought) has been studied in multiple studies. For example, Al-Qubati et al. (2023) showed that the WaSSI model performs well under drought conditions, effectively simulating water yield and ecosystem responses in dry years across different environmental settings. This provides confidence in the model's behaviour during years when MAP falls below the 25th percentile. In contrast, we are not aware of studies that explicitly evaluate WaSSI performance during anomalously wet years (e.g., MAP > 75th percentile). Although WaSSI performs well in general hydrological validation, its specific performance in wet years has not been systematically tested in the existing literature. As a result, our assessment of wet-year behaviour relies primarily on the validations presented in this study.

Note: Nothing to add in Manuscript for this review

- Figure 6: Are the simulated GPP and NEP variations (i.e., decreases and increases) consistent with observed changes from eddy covariance towers and satellite observations? This may provide a better indication of whether the model accurately captures the sensitivity of GPP and NEP to precipitation and temperature anomalies.

Response: Eddy-flux observations are available only at a limited number of point locations, and aggregating these sparse measurements to a national scale would introduce substantial uncertainty and would not provide a reliable basis for evaluation. Regarding satellite products, we have already incorporated them in our validation, which provides a reasonable model performance. For these reasons, we believe that the current validation framework sufficiently supports the model's ability to capture key ecosystem carbon dynamics. Lastly, a trend analysis was out of the scope of this study.

Note: Nothing to add in Manuscript for this review

- I recommend adding the model parameterisation to the supplementary material, as this would make the study easier to reproduce.

Response: Thank you for this suggestion. The parameterisation of the WaSSI model for Germany followed the workflow described in Al-Qubati et al. (2023), where we tested multiple input datasets (e.g., ET formulations, snowmelt parameters, land-cover and soil datasets) and selected the combinations that yielded the best performance. In the current manuscript, we already provide the final parameter sets and input datasets used in the simulations

Note: Nothing to add in Manuscript for this review

- Line 277: I suggest conducting the analysis while accounting for the area of each land cover type. The high-water supply attributed to croplands may largely reflect their dominant extent in Germany. Similarly, the ecohydrological role of forests could be underestimated due to their smaller extent in the country. I encourage authors to present the results considering the mean and variability contribution of each land cover (mean ± SD m^3 ha^{-1} yr^{-1}). This approach would also allow you to discuss the potential implications of land-cover change (e.g., forest to cropland) on the provision of ecosystem services.

Response: Thank you for this insightful suggestion. For carbon sequestration, our results are already reported on a per-area basis (per m^2) for each land-cover type. For water supply, however, our current results are expressed as total values aggregated by land-cover type. We agree that presenting water-supply estimates by area would provide a clearer understanding of the contribution of each land cover.

Note: To address this point, we examined the relative contributions of forests and croplands in relation to their spatial extent. The total forest cover in Germany (including evergreen needleleaf forest, deciduous broadleaf forest, and mixed forest) is 30.5% (Table S2). Forests contribute approximately 30.2% of total water yield and 56.3% of total carbon sequestration in our results. This indicates that, despite their smaller areal extent compared to croplands, forests contribute disproportionately to carbon sequestration and comparably to water yield, and therefore their ecohydrological role is not underestimated in our analysis.

We chose to present contributions as percentages of national totals to provide a clear and straightforward comparison among land-cover types at the country scale. While we agree that presenting mean and variability (mean ± SD m^3 ha^{-1} yr^{-1}) would offer additional insight, this would require reprocessing the full model output at the watershed level across the time period, which is beyond the scope of the present study and not feasible within the available resources.

To improve transparency and support the interpretation, we have added the percentage cover of forests to the manuscript. This clarifies the relative efficiency and contribution of forests.

- Lines 264 and 289: The definition of drought and flood events typically incorporates not only precipitation anomalies but also temperature, along with other indicators such as soil moisture or vapour pressure deficit. Additionally, since both precipitation and temperature are inputs into the WaSSI model, I suggest that you characterize both precipitation and temperature anomalies, including temperature anomaly maps in your analysis (e.g., Figs. 8 and 9). In addition, while droughts often extend over large areas, flood-affected regions are more likely to be concentrated along river channels and flat terrains, whereas your analysis is at the country scale. Therefore, the terms 'hot-dry' and 'wet-cold' years may provide a clearer description of the extreme climate events.

Response: We will incorporate temperature anomalies into the analysis and add them in Figures 8 and 9. We also appreciate the point regarding terminology. We will adopt the terms 'hot–dry' and 'wet–cold' years to more accurately describe the climatic extremes analysed in this study. These changes will be reflected in the revised manuscript.

Note: We revised our plots and included temperature anomalies in Figs 8 and 9. Regarding the terminology, where sensible, we replaced the term "floods" with "extreme precipitation".

- Lines 314-396: You provide a lot of valuable insights in the discussion section. However, you should consider focusing more clearly on the three main results of the manuscript (i) model validation, including comparisons with previous studies; (ii) water yield and carbon sequestration associated with each land cover and the land cover change implications; and (iii) the response of these ecosystem services to extreme climatic conditions, including comparisons with previous studies and their implications under future climate projections in Germany.

Response: Thank you for this helpful suggestion. We agree that the discussion would benefit from a clearer emphasis on the three main components of the study. The current version already includes substantial discussion of the model validation and the responses of ecosystem services to extreme climatic conditions, and we will ensure that these sections are more explicitly linked to our key findings and to relevant previous studies.

Regarding the second point, we will expand the discussion on water yield and carbon sequestration associated with each land-cover type and clarify the implications of land-cover differences for ecosystem service provision. This

additional synthesis will improve the structure and focus of the discussion. These revisions will be incorporated in the updated manuscript.

Note: **In this revision we compared our results with studies in Germany that are mostly site level modeling studies, such as Zink et al. (2016) and Huang et al. (2010).**

We have highlighted the implications of dominance of each landcover on water yield and carbon sequestration. For example, most of the carbon sequestration by forests, so we emphasize the importance of forest management and increase forest resilience. We also point out the importance of wetlands that are minor in area but they can high GPP and NEP per unit area. Thus, protecting wetland are important. For water yield, over half of water yield of Germany is from cropland – suggesting that managing crop lands is important to improve nonpoint source pollution since water quality issues often arise from cropland drainage.

Climate extremes are a threat to ecosystem services. We suggest innovative approach is needed to confront these threats. For example, to protect existing forests, tree species that are resilient to drought should be given higher priority in reforestation efforts, and to transform less resilient pure forests (e.g., spruce) into mixed forests by introducing more resilient local tree species (e.g., oak). To mitigate floods, grey and green infrastructure (dams, reservoirs) and Natured based Solutions are needed.

Minor comments:

- Line 15: Please add the full name of the WaSSI model

Response: Thank you for highlighting these points. We will take care of it in the revised manuscript.

Note: Done

- Line 16: I suggest replacing “from 2001-2019” with “from 2001 to 2019”

Response: Thank you for highlighting these points. We will take care of it in the revised manuscript.

Note: Done

- Line 52: Add space

Response: Thank you for highlighting these points. We will address this in the revised manuscript.

Note: Done

- Lines 85-88: I suggest adding a paragraph in the introduction to describe the generality of the model, particularly its previous applications.

Response: We agree with this point. We will address this in the revised manuscript.

Note: In the introduction section, we have provided multiple studies where the WaSSI model is applied. These references are sufficient for readers to get a detailed understanding of the model. Furthermore, the generality of the model and other details are provided in the section "Methodology and Data". We believe it is sufficient for the reader. Are you suggesting moving information from one section to the introduction?

- Line 109: Please add the corresponding reference(s) to the eddy flux dataset.

Response: Sure, will be done in the revised manuscript

Note: Done

- Lines 115-116: Please specify if, at the monthly scale, the correlation between GPP and ET is linear or not.

Response: According to Sun et al. (2011), the relationship of monthly GPP with ET was estimated using linear regression procedures (SAS v9.1.3, Cary, NC). We will explicitly state this the revised manuscript.

Sun et al. (2011) : https://doi.org/10.1029/2010JG001573

Note: Done - text added in section 2.

- Line 119: I am particularly familiar with the WaSSI model, but I am curious if this includes any calibration process.

Response: Yes, a calibration process was conducted prior to applying the WaSSI model in Germany. Specifically, we evaluated the performance of multiple evapotranspiration (ET) formulations, tested alternative snowmelt parameter settings, and compared different land-cover and soil datasets. The combination of parameters and input datasets that produced the best model performance was then selected and independently validated.

Note: Nothing to add in Manuscript for this review

- Line 124: Is R^2 the coefficient of determination? Please specify.

Response: Yes, R^2 refers to the coefficient of determination. We will clarify this explicitly in the revised manuscript

Note: Done - text added in section 2.1

- Line 125: Which MODIS product? Add the corresponding reference.

Response: It is the MODIS ET product MOD16A2GF. This information is provided later in the section of the Dataset. We will insert the corresponding reference in the revised Manuscript.

Note: Done – We added corresponding references and highlighted that details are provided in the following section 2.3 "Validation Data"

- Line 126: Please clarify why you computed the monthly deviations and describe the interpolation process, as this is not clear in the methodology.

Response: We computed monthly deviations because WaSSI produces output at a monthly temporal resolution, and most of our validation was also performed at the monthly scale (with the exception of Tables S4, S5, and S6, which present annual values). Therefore, no temporal interpolation or downscaling was required. Monthly values were simply aggregated to annual totals when annual comparisons were needed. We will rephrase lines 124–127 in the revised manuscript to clarify this more clearly.

Note: Done – We added additional text in section 2.1

- Line 127: Which MODIS product? Add the corresponding reference to the MODIS and CGLS products.

Response: It is the MODIS GPP product MOD17A2HGF. This information is provided later in the section of the Dataset. We will insert the corresponding references in the revised Manuscript.

Note: Done – We mentioned the product name in this section, and we have also inserted corresponding references

- Line 129: Please add the description of the extent of the included watersheds for Q validation

Response: Could you please clarify what you mean by 'extent'? A similar point was raised by Reviewer #1, and in the revised manuscript we will clarify that the chosen upstream stations were selected to ensure spatial coverage across Germany, representing the country's major climatic zones, land use, and land cover types. We also prioritised stations with long and continuous discharge records.

Note: Done - we added the above-mentioned details brieflz in section 2.1 and more details in section 2.3.1

- Line 160: What is meant by anthropogenic influence? Does this refer to dams, land cover change, or other factors?

Response: Yes, in this context, anthropogenic influence refers to human infrastructure or activities that modify the natural flow regime of rivers. This includes dams and reservoirs.

Note: Done – We added an example of Dams in section 2.3.1 to make it clearer.

- Line 191: I suggest presenting the results of the main figures first (e.g., Figure 2) and then supporting your analysis with supplementary Figures and tables.

Response: Sure, will be done in the revised manuscript

Note: Done – We moved the Figure 2 text at start of section 3.1.1

- Figure 2: Add the performance metrics in each panel. All you can order the panels following a criterion such as watershed area, natural/transformed land cover area, or annual precipitation

Response: We can add the performance metrics to each panel in Figure 2 and will include them in the revised version. However, reordering the panels based on watershed area, land-cover characteristics, or annual precipitation would require additional processing steps and resources that are beyond the scope of the current revision.

Note: Done – The font size had to be kept small otherwise we could not fit all the performance metrics

- Line 199: I am curious if the model exhibits any dependence on watershed area or dominant land cover types regarding its performance?

Response: In our analysis, we did not observe any clear dependence of model performance on watershed area or land cover within Germany

Note: Nothing to add in Manuscript for this review

- Line 205: I think this corresponds to the methods section.

Response: We will revise it in the manuscript

Note: Done - We moved it to section 2.1

- Figure 3: Please add performance metrics. Please clarify in the scatterplot labels and lines legend which correspond to observations and simulations.

Response: We will add the performance metrics to Figure 3 in the revised manuscript. As noted in the figure caption, the simulated values are labeled with the corresponding WS_ID.

Note: Done - We added the performance matrics and additional legends to highlight observed and simulated data.

- Line 224: I consider that this corresponds to the methods section

Response: We will revise it in the manuscript

Note: Done - We moved it to section 2.1

- Line 253: I notice that in the results section, you use past and present tenses. I suggest using the present tense.

Response: Thank you for highlighting. We will adjust this in revised manuscript.

Note: Done - We converted past tense to present in the results section where it made sense.

- Lines 267-269: You state that Q and NEP are more sensitive to changes in precipitation than ET and GPP. You should also consider how climatic conditions before wet or dry years affect the responses of water and carbon fluxes, as well as their responses after dry or wet years, to examine potential lag effects. In this context, it is not clear how groundwater buffers drought impacts based on the results presented in Fig. 8 (Lines 373–375).

Response: In WaSSI, water storage is simulated through soil moisture dynamics. When examining years with low precipitation, we observed that soil water carried over from previous wetter years can partially buffer hydrological responses, which may explain the reduced sensitivity in some watersheds. Q was sensitive to Precip because ET is relatively stable.

However, a detailed analysis of lag effects—such as how wet or dry conditions influence subsequent water and carbon fluxes—would require additional diagnostics and is beyond the scope of the current study.

Note: Nothing to add in Manuscript for this review

- Figure 6: Precipitation is not typically considered an ecosystem flux

Response: Thank you for highlighting. We will adjust this in revised manuscript.

Note: Done – Figure 6 caption revised

- Figures 8 and 9: I suggest presenting the anomalies as percentages or standardized anomalies to better account for spatial variability across Germany.

Response: Thank you for the suggestion. Presenting anomalies as percentages or standardized values would indeed help account for spatial variability. However,

implementing this transformation for all watersheds would require additional data processing beyond the resources available for the current revision. We appreciate the recommendation and will consider incorporating standardized anomaly analyses in future work.

Note: Nothing to add in Manuscript for this review

- Line 288: What are the implications of crop irrigation on water yield and carbon sequestration response to dry/wet years?

Response: The current WaSSI setup does not include crop irrigation, so irrigation effects are not represented in our simulations. However, irrigated lands may have higher LAI which was used in WaSSI model for characterizing land surface conditions and ET rates. In general, we expect that irrigation would increase local water yield due to deep groundwater withdrawal and higher carbon sequestration because of higher ET and productivity.

Note: Done - Since WaSSI does not include crop effects therefore we did not mention its impact in the Manuscript.

- Lines 411-413: I think this sentence does not correspond to the conclusions section.

Response: Thank you for highlighting this we will move it to the discussion section in the revised manuscript.

Note: Done – We removed it from conclusion, the future steps are already written in the discussion section

Technical corrections:

- Line 52: Add space.

Response: We will revise it in the manuscript

Note: Done

- Line 108: I guess the correct reference is “Fan et al. (2016)”

Response: We will double check and revise it in the manuscript

Note: After double-checking, the correct reference is Fang et al. (2015). The link to the paper is https://onlinelibrary.wiley.com/doi/10.1002/eco.1629

- Line 139: Add a space in “of 2018” and “100 m”. This typo is found throughout the document.

Response: We will revise it in the manuscript

Note: Done

- Please check whether the figure colors are suitable for color-blind readers.

Response: We will double check

Note: Done - The colors seem suitable for most types of color blindness.

RC2

Thank you for taking the time to share your feedback. We truly appreciate your valuable insights and will use them to guide our improvements. We have provided responses to each of your comments (highlighted in **bold and italics**). At this stage, the comments have not been incorporated into the manuscript, as per the editor's instructions to refrain from making revisions at this time.

General comments

- While reading the manuscript, I had the impression that the term "flood" is sometimes used to refer to a "high precipitation event" (e.g., line 372) or an "extremely wet year" (e.g., line 297). However, the term "flood" typically refers to the inundation resulting from an excess of water that causes normally dry areas to be submerged. It does not simply indicate heavy rainfall events or periods of above-average precipitation. I would therefore suggest reviewing the manuscript to ensure that the term "flood" is used correctly and, where necessary, replacing it with more precise terms or expressions.

Response: Thank you for highlighting this. We will change the term "flood" accordingly in the revised manuscript.

Note: Done – We reviewed the manuscript and corrected the use of the term "flood".

- I think it would be important to consistently include references to the datasets used in the text. I would therefore suggest checking this aspect throughout the manuscript—for example, at line 164 (FLUXNET2015) and line 177 (MOD17A2HGF).

Response: Thank you for highlighting this. We will include this change in the revised manuscript.

Note: Done

- Referring to Figure 4c, I found it a bit difficult to understand how, in some areas, actual evapotranspiration could exceed potential evapotranspiration. For readers who are not experts on the topic, the intuitive expectation would be that actual evapotranspiration is less than or equal to potential evapotranspiration. It might be worthwhile to explain and comment on this difference between the two variables, as this could help readers better follow the results.

Response: We agree with this comment and will further clarify this in the revised manuscript.

Note: Done – We added a brief explanation on PET and this should help clarify the concept behind energy or water limitations. We also added names of the states to help readers understand the ET dynamics better.

- I believe that certain essential details are missing in the description of the procedures, particularly in some steps that are crucial for understanding the methodology. Specifically, the following aspects would benefit from further elaboration:
    - Lines 145-146: a more detailed explanation of what the quality checks consisted of could improve the clarity of both the procedure and the results.

Response: The LAI data is provided by Copernicus, which applies a very detailed and complex Quality Check on the dataset. We can further elaborate on this process and share the source as in-text citation for readers.

Note: Done – we added a brief text on invalid LAI status

    - Lines 158-160: for transparency and clarity, it could be helpful to provide further details about why those specific stations were selected, why not more were included, and how the choice of different stations might affect the results. \

Response: We appreciate the opportunity to clarify our station selection criteria. In addition to minimising anthropogenic influences, the chosen upstream stations were selected to ensure spatial coverage across Germany, representing the country's major climatic zones, land use, and land cover types. We also prioritised stations with long and continuous discharge records. We will add this explanation to the manuscript. We believe this additional information will help readers better understand the rationale behind the station selection and the robustness of our validation results.

Note: Done – We added further explanation in section 2.1 and section 2.3.1.

Lines 164-165: a short explanation of how corrections and gap filling were carried out could be useful.

Response: Thank you for the helpful suggestion. The gap filling and corrections in FLUXNET2015 are conducted using standardised procedures described in Pastorello et al. (2020). We will add a brief note to the manuscript to clarify this point explicitly.

Note: Done – We added a sentence highlighting that the standardised procedure was used for gap filling to ensure temporal continuity and consistent flux measurements section 2.3.2.

- Results and Discussion Section lack some important steps and information. These missing elements are essential to fully grasp the reasoning that supports the results and to properly assess their applicability in different contexts:
    - In the Discussion section, I did not find any direct reference to Figure 6. It might be useful to elaborate on and comment on this figure, since it is the only one showing the temporal evolution of the variables considered.

Response: There is a detailed explanation on temporal evolution of the variable from line 264 – 273 with a direct reference to Figure 6 on line 357 section 3.2.3.

Note: Nothing to add in Manuscript for this review

- I think that from the presentation of the results, it is not clear how "buffers developed from the previous year can play a significant role in mitigating this effect", particularly when discussing the sensitivity of ecosystem services to extreme events (lines 318–319). I believe it would be important to elaborate on this point in the Results section and, if possible, refer to the corresponding figures in the Discussion chapter.

Response: Thank you for highlighting this, we will further elaborate on it in the revised manuscript.

Note: Done

- Line 320: it may be useful to further clarify why the model can be applied to the whole Central Europe. As it is currently written, it is not entirely clear how the procedures and conclusions could also be applied to areas beyond the specific study region (i.e., Germany).

Response: We find this comment very interesting and will add further clarification in the revised manuscript.

Note: Done – we added some more details on section 4 para 2.

Specific comments

- I am not very familiar with the WaSSI model, and I found it challenging to fully understand what it is and how it works. While some information is provided, it appears scattered across different parts of the manuscript. I think that an initial, more comprehensive presentation of the model—beyond what is already included—would be very helpful to better frame the analyses and to facilitate the interpretation of the results. This could include its main aim, the study areas considered, the way it operates, and other relevant details.

Response: Thank you for sharing this perspective. We will elaborate further on WaSSI model in the revised manuscript using your suggestions.

Note: Done – After going through all of the review points, we feel that the model description and validation is reasonably well explained. Further information on the Model is readily available on United State Forest Services portal (https://research.fs.usda.gov/srs/products/dataandtools/water-supply-stress-index-wassi).

- In the abstract, a lot of results are described and explained. I think it might be helpful to more clearly highlight the main novelties and contributions introduced by this work.

Response: The results shared in the abstract respond to the research questions we have for this study. They highlight the quantification of stocks and flow of ecosystem services in Germany. Nevertheless, we will further emphasize on the main novelty of this study, which is that a relatively simple modelling approach is adequate to analyse carbon and water response to climatic variability.

Note: All the main novelty is already mentioned in the abstract.

- Please consider adding a section describing the study area (climate, land use, etc.)

Response: Sure, we will add this section in the revised manuscript.

Note: Done

- Line 15: you may consider briefly clarifying what is meant by “ecosystem services” for readers less familiar with the concept.

Response: Sure, we will add some examples of ecosystem services in the revised manuscript.

Note: Done

- It would improve readability if acronyms were defined when they first appear in the text. For example, “MODIS” and “CGLS” (lines 125 and 127) are introduced without prior definition.

Response: We agree with you, thank you for flagging the acronyms we missed to define.

Note: Done – We went through the manuscript again and made sure acronyms were defined when they appear in the text first.

- Line 141: providing a short explanation of why exactly 10 classes were chosen, and whether you considered different numbers, might help clarify the procedure.

Response: Sure, this is valuable comment. The selection of 10 classes was based on the availability of water-use efficiency (WUE) parameters and their correspondence to the major biomes represented in the dataset. These 10 classes encompass all dominant ecosystem types across the study. We will add this explanation in the revised manuscript.

Note: Done

- Line 145: including the number of removed pixels could be an informative detail.

Response: Thank you for this thoughtful suggestion. Unfortunately, estimating this information would require additional data processing and computational resources beyond the scope of this study. However, all quality-control and masking procedures were applied following the provided guidelines and best-practices.

Note: Nothing to add in Manuscript for this review

- Lines 165-169: this section might be difficult to follow for readers less familiar with the topic. Expanding the explanation with more details could make it clearer.

Response: Thank you for highlighting this, we will adjust it in the revised manuscript and briefly add more details. However, the eddy flux dataset is indeed a complex topic and a detailed description would be out of scope for this study.

Note: Done.

- In Section 3.1, I think it would be very helpful to include a comparison between the performance metrics obtained for the different variables (discharge, ET, GPP) in this study and those reported in the literature from other studies applying the same or similar models (if available). Providing

this context could help to better clarify the results and support the applicability of the WaSSI model to new study areas.

Response: Thank you for this suggestion. We agree that comparing our model performance with results from other studies could provide useful context. However, similar large-scale applications of model for estimation of discharge, ET, and GPP over the entire Elbe basin are very limited, directly comparable studies are difficult to find. Please feel free to share any studies that you feel would be meaningful. Additionally, we aim to keep Section 3.1 focused on presenting the results of this study, while broader contextual comparisons are more suitable for the Discussion section. We will therefore consider including a brief comparative discussion there to highlight the relative performance of our results within the context of available literature.

Note: Already done in the Discussion section

- Figure 2: adding a legend to indicate the meaning of the two colours could improve the clarity of the plots.

Response: Thank you for the suggestion. A legend indicating the meaning of the two colours is already included in the first subplot (Station ID: Bentfeld) and applies to all stations shown in Figure 2.

Note: Nothing to add in Manuscript for this review

- Figure 4: you may consider including in the figure the names of the regions mentioned in the text, or finding a way to highlight them. This would make the reading and the analysis of the figure much easier.

Response: Sure. We will take care of it in the revised manuscript.

Note: Done

- Lines 316-319: referring explicitly to the relevant tables/figures in the text could make the discussion clearer.

Response: Thank you for the suggestion. We will take care of it in the revised manuscript.

Note: Done

- Lines 324-327 and 333-336: a more detailed explanation of the influence of the different factors could add clarity.

Response: We appreciate the reviewer's interest in a more detailed explanation. We will add further details where possible to better explain the underlying processes in the revised manuscript

Note: After reviewing it again, we feel the explanations are sufficient for the scope of this study.

- Line 339: explaining why results are weaker for the Lackenberg Forest station, or what the reasons can be, could improve transparency.

Response: Thank you for the suggestion. We will take care of it in the revised manuscript.

Note: The potential reasons for discrepancies are explained in the same paragraph.

- Line 340 and 341: the meaning of the terms “complex” and “complicated” in this context is not entirely clear; considering alternative synonyms or more specific wording may help.

Response: Thank you for highlighting this, we will adjust it in the revised manuscript.

Note: Done

Technical comments

- I warmly suggest to check that the figures are accessible also for readers with colour-vision deficiencies. Alternative colour scales might improve clarity.

Response: Thank you for highlighting these points. We will take care of it in the revised manuscript.

Note: The colors seem suitable for most types of color blindness.

- Figure S1: you might consider modifying the colour scale (as noted above) and/or using different marker shapes for each category to increase readability.

Response: Thank you for highlighting these points. We will take care of it in the revised manuscript.

Note: Even, in a monochromatic color scheme we still successfully observe the main conclusion from the scatter plot regarding the relationship between the parameters.

- Please double-check punctuation when separating sentences across the manuscript. In some cases, a full stop is missing (e.g., line 36, between “interconnected reasons” and “two of them”), while in others a full stop is used where a comma or similar punctuation might be more appropriate (e.g., line 53, before the sentence starting with “Which negatively affects”).

In my opinion, this would strongly improve the readability of the manuscript.

Response: Thank you for highlighting these points. We will take care of it in the revised manuscript.

Note: Done – we went through the manuscript again.