Reviewer 2

We sincerely thank the reviewer for the careful, detailed, and constructive evaluation of our manuscript. We greatly appreciate the insightful comments and suggestions, which have been instrumental in improving the clarity, consistency, and scientific rigor of the study. We acknowledge that several aspects of the original manuscript, including the description of catchment selection, the treatment of hydroclimatic variables, and the interpretation of results, required further clarification and refinement.

In response, we have undertaken a comprehensive revision of the manuscript. The methodology has been clarified and strengthened, including a more explicit description of catchment selection criteria and the adoption of an event-based framework to ensure temporal consistency between hydroclimatic variables and peak streamflow. In addition, the Results and Discussion sections have been carefully revised to improve clarity, ensure consistent terminology, and avoid interpretations beyond the scope of the analysis. We have also addressed issues related to figure presentation, climate classification, and the treatment of anthropogenic influences.

Detailed responses to each comment are provided below. We are grateful for the reviewer's feedback, which has significantly contributed to improving the quality and robustness of the manuscript.

General comments

- Basin selection and Köppen-Geiger classification. It is unclear how the authors selected the catchments and why those, rather than other basins, were chosen or discarded. Similarly, the criteria for assuming that a basin with multiple Köppen-Geiger classifications is representative of that group are not specified. Is a basin with a fraction of its area classified as a particular climate group, representative of that group? The authors offer no argument to support that idea. Additionally, several streamflow gauges appear to measure water flowing in canals rather than in riverbeds (e.g., *Canal Vilama en Vilama*), and human interventions (e.g., dams, diversions) are poorly presented in the document. How do the authors address the presence of dams in the Copiapó River or the Elqui River basins? The presence of dams would directly affect the results, particularly high and low flows, as the authors highlight throughout the document (e.g., L400, 503, 605).

R. We thank the reviewer for these comments. We acknowledge that the manuscript did not clearly describe the rationale for catchment selection, the treatment of mixed climate classifications, or the influence of anthropogenic interventions.

The selection was designed to ensure the representation of contrasting hydroclimatic conditions across Chile, rather than to provide an exhaustive analysis of all available gauging stations. Catchments were selected based on (i) sufficient streamflow data availability to derive annual maximum series (with a minimum data coverage of 50% of the study period), (ii) availability of corresponding hydroclimatic variables, and (iii) representation of different Köppen–Geiger climate regimes.

Regarding climate classification, each catchment is assigned to a Köppen–Geiger class based on the dominant climate type within its area, defined as the class covering the largest fraction of the catchment. For catchments with mixed climate conditions, secondary and tertiary classes are also considered to represent transition zones, while maintaining a clear dominant classification for interpretation.

We also acknowledge that some stations correspond to artificial channels or are affected by strong anthropogenic regulation. Stations located in artificial channels (e.g., Canal Vilama) have been excluded because they do not reflect natural river flow conditions. Additionally, catchments strongly influenced by reservoirs have been excluded, including those affected by the Lautaro reservoir in the Copiapó basin and the Puclaro reservoir in the Elqui basin. These adjustments improve the consistency of the dataset in representing hydroclimatic variability.

Finally, we clarify that the objective of this study is to explore statistical associations between hydroclimatic variables and annual maximum streamflow across contrasting climatic settings, rather than to isolate strictly natural runoff processes.

The explanation regarding the selection of the catchments and the climatic classification that will be included in the "Materials and methods" section (section “2.1 Study area”) is provided below:

Catchment selection and climate classification

“Catchments were selected to represent contrasting hydroclimatic conditions across Chile, including differences associated with latitude, elevation, coastal influence, and precipitation regimes (winter- and summer-dominated). The objective was not to provide an exhaustive list of all available gauging stations, but rather to define a consistent, climatically representative subset suitable for comparative analysis of annual maximum streamflow.

The selection prioritized catchments with sufficient streamflow data availability to derive annual maximum series within the 2000–2021 period. Specifically, stations were required to have data coverage for at least 50% of the study period, ensuring a minimum number of annual maxima for robust analysis. In addition, all selected catchments include corresponding hydroclimatic variables (precipitation, temperature and soil moisture).

Each catchment was assigned to a Köppen–Geiger class based on the dominant climate type within its area. For catchments with mixed climate conditions, secondary and tertiary climate classes were also identified, allowing the inclusion of transition zones while preserving a clear dominant climatic signal."

- Runoff generation. The methodology proposed by the authors focuses on a series of annual maxima at the annual temporal scale for indices based on precipitation, soil moisture, and streamflow. However, more in-depth analysis is required before assuming that the (separately computed) annual maxima values are correlated. If the dates of the different annual maxima (e.g., cumulative 7-day precipitation and hourly streamflow) are not the same, why should the values be correlated? Additionally, some of the basins are strictly snow-driven, while others have a mixed hydrological regime. In such basins (e.g., snow-driven Río Elqui or Río Grande catchments), most precipitation falls in winter, while high flows occur in spring/summer due to snowmelt. How can the authors expect a correlation between the computed indices in such basins? The methodology does not address the seasonality of precipitation and streamflow and does not account for snow at all, which is very relevant for several of the basins the authors included in their analysis. Further, the combination of precipitation and antecedent soil moisture conditions can greatly impact peak flows during a storm. By treating these variables as "independent" (i.e., assuming that the maximum annual values of their suggested indices are comparable), the authors neglect relevant runoff-generation processes.

R. We thank the reviewer for this insightful comment. We agree that, as originally formulated, the use of separately computed annual maxima could lead to inconsistencies if the temporal alignment between variables is not considered.

To address this, the methodology has been revised to adopt an event-based framework. Specifically, for each catchment and year, the date of the annual maximum streamflow (Qmax) is identified, and the corresponding hydroclimatic conditions (precipitation, temperature, and soil moisture) are evaluated at that time, along with antecedent periods. This approach ensures that the analyzed variables are physically consistent and temporally aligned with the runoff-generating event, thereby avoiding comparisons of independent annual maxima occurring at different times.

Regarding the role of seasonality and snow-driven processes, we acknowledge that in some catchments, particularly in northern and high-elevation regions, streamflow peaks may be influenced by snow accumulation and subsequent melt, leading to a temporal decoupling between precipitation and discharge. Within the revised framework, temperature is included as a key variable to partially account for these thermodynamic controls, including potential snowmelt contributions.

At the same time, the objective of this study is not to explicitly model runoff generation processes, but to assess statistical associations between hydroclimatic conditions and observed peak flows across a wide range of climatic regimes. In this context, the event-based approach captures the effective hydroclimatic conditions at the time of peak discharge, regardless of whether these are driven primarily by rainfall, snowmelt, or a combination of both.

Additionally, no systematic differences in the strength or direction of the relationships were observed between catchments with different hydrological regimes, suggesting that the adopted framework provides a consistent basis for comparative analysis at the spatial and temporal scales considered.

These clarifications will be incorporated in the revised manuscript to better reflect the physical interpretation and limitations of the adopted methodology.

In Section 2.3.1 “Variable definition and derivation”, the revised explanation of the variables begins as follows:

“The selection of hydroclimatic variables was guided by their physical relevance to runoff generation processes and antecedent catchment conditions. Annual maximum streamflow (Q) was used as the primary response variable, representing extreme hydrological events. Precipitation (PP) was considered as the main atmospheric forcing driving runoff generation, while air temperature (T) was included to account for its influence on processes such as evapotranspiration and snowmelt. Soil moisture (SM) was incorporated as an indicator of antecedent wetness conditions, reflecting catchment storage and hydrological memory.

To ensure a physically consistent linkage between hydroclimatic conditions and streamflow extremes, an event-based framework was adopted. For each catchment and year, the date of the annual maximum streamflow was identified, and the corresponding hydroclimatic variables were evaluated at that time. In addition, antecedent conditions were characterized by using aggregated variables over preceding periods, including accumulated precipitation over 7 days (PP7) and smoothed soil moisture over 3- and 7-day windows (SM3 and SM7), which represent short-term catchment memory and storage conditions influencing peak generation.”

- Statements not supported by the results. There are many statements in the document that point to data or information that were never presented in the results (e.g., elevation, snow, presence of dams, etc.), for example (L514-515): "*This pattern suggests that warming amplifies evapotranspiration and reduces snow contributions, ultimately limiting water availability.*" Moreover, some of the statements are vague or too general (e.g., "*Correlations confirm that precipitation […] is the primary driver of streamflow and soil moisture*", L570) and can be inferred without conducting the study. This weakens the discussion and conclusions and jeopardizes the paper's novelty. Please see the details below.

R. We thank the reviewer for this important comment. We agree that several interpretative statements in the original manuscript extended beyond the scope of the analyses presented and, in some cases, were either insufficiently supported or overly general.

In the revised manuscript, we have carefully reviewed the Results and Discussion sections and removed or reformulated statements that were not directly supported by the data and methods. In particular, references to processes such as elevation effects, event-scale dynamics, snowmelt, evapotranspiration and frozen soil conditions have been either removed or rephrased to avoid unsupported causal interpretations.

Additionally, statements that were too general or self-evident (e.g., broadly asserting that precipitation is the primary driver of streamflow) have been refined to provide more specific, context-dependent interpretations grounded in observed spatial patterns and statistical relationships. This helps better highlight the study's contribution and avoid conclusions that do not add new insight.

Where appropriate, some interpretations have been retained but are now more clearly framed as hypotheses rather than conclusions. Overall, the revised manuscript ensures that all interpretations remain strictly consistent with the statistical analyses conducted (trend analysis and correlation-based relationships), without introducing processes that were not explicitly evaluated.

These revisions strengthen the scientific rigor of the manuscript and improve the clarity and relevance of the conclusions.

- Overall document readability. In my opinion, the introduction of the document requires more work. It summarizes several previous studies, but it is unclear in terms of highlighting the novelty of the study or its relevance. Further, most of the figures correspond to maps, while the analysis is conducted at the catchment scale, without spatial heterogeneity. Thus, most of the figures could be combined for simplicity. Moreover, the authors refer to "*North*" (e.g., L400), "*central-southern regions*" (e.g., L41 or 336), or "*Patagonia*" (e.g.,

> L635) without specifying what particular areas they are referring to. Additionally, the authors used several names to identify different climate groups throughout the manuscript (e.g., "*Winter-rainfall regions (mediterranean, temperate, semi-arid)*", L499 vs. "*ET(w)–BSk(w)*", L410). This makes the manuscript very difficult to read.

R. We thank the reviewer for this comment. We agree that the original Introduction did not clearly articulate the conceptual framework linking hydroclimatic variables to streamflow responses, nor did it sufficiently clarify the study's scope and scientific motivation.

In the revised manuscript, the Introduction has been substantially rewritten to improve its structure and to clarify the study rationale. The revised version now explicitly:
(i) Presents the conceptual framework linking precipitation, temperature, and antecedent soil moisture with peak streamflow generation.
(ii) Clarifies that the study focuses on temporal trends in annual maximum streamflow and examines hydroclimatic conditions associated with peak flows.
(iii) Better articulates the scientific motivation and relevance of the three study objectives.

In addition, the objectives have been reformulated to avoid causal interpretations and to emphasize that the analysis focuses on statistical associations between peak streamflow and hydroclimatic conditions across contrasting climate regimes.

The revised introduction is included below and constitutes the new "1. Introduction" section in the manuscript.

Revised Introduction:

"Climate change is altering hydrological systems worldwide by modifying precipitation regimes, temperature patterns, and the frequency and magnitude of hydrological extremes (IPCC, 2023; Blöschl et al., 2019; Costa et al., 2023; Qiu et al., 2023; Sukanya and Joseph, 2023). In this context, understanding the occurrence of high streamflow events is essential for flood risk assessment, water resources management, and ecosystem functioning. Hydroclimatic conditions, including precipitation, temperature, and antecedent soil moisture, influence peak streamflow events. Understanding how these factors affect the occurrence and variability of peak flows is therefore essential for interpreting hydrological extremes across different climatic settings.

Peak streamflow events are typically generated by the interaction of multiple hydroclimatic factors, including precipitation intensity and accumulation, antecedent soil moisture conditions, and temperature dependent processes such as evapotranspiration or snowmelt. Previous studies have shown that precipitation is often the primary driver of high flows, while soil moisture can strongly modulate runoff responses by controlling catchment storage and infiltration capacity (Wasko and Nathan, 2019; Alam et al., 2024). Temperature also plays an important role in regulating hydrological processes through its influence on evapotranspiration, snow accumulation and melt dynamics, and the partitioning of precipitation between rainfall and snowfall. Because these variables interact in complex ways, multivariable approaches are increasingly used to analyze hydroclimatic variability and its relationship with streamflow extremes (Swain et al., 2024).

At the global scale, trends in streamflow extremes show substantial regional variability. For example, Do et al. (2017) reported decreasing annual maximum streamflows in parts of North America, Australia, and Europe, while increases were observed in eastern North America and some regions of South America and southern Africa. Similarly, Blöschl et al. (2019) showed that flood trends across Europe are strongly influenced by regional hydroclimatic drivers, particularly winter precipitation and soil moisture conditions. These studies highlight the importance of analyzing hydroclimatic influences on peak flows within regional climatic contexts, where different combinations of precipitation regimes, temperature patterns, and catchment storage processes may control runoff responses.

Chile provides an ideal natural laboratory for investigating such hydroclimatic variability. The country extends over approximately 38° of latitude and includes strong climatic gradients ranging from hyper-arid desert conditions in the Atacama Desert to humid temperate and cold climates in southern Patagonia. Annual precipitation varies from less than 1 mm in northern Chile to more than 3000 mm in southern regions, while elevation gradients associated with the Andes strongly influence hydrological processes. This diversity of climatic regimes produces a wide range of hydrological responses across Chilean catchments.

Recent studies have documented significant hydroclimatic changes in Chile. Boisier et al. (2018) reported multi-decadal declines in precipitation and streamflow across central-southern Chile, while Álvarez-Garretón et al. (2021) showed that the recent megadrought (2010–2020) amplified hydrological deficits through catchment storage and hydrological memory effects. Other studies have highlighted increasing temperatures, shifts in soil moisture regimes, and spatially heterogeneous changes in streamflow across the country (Oertel et al., 2020; Sangüesa et al., 2023). These findings suggest that hydroclimatic conditions influencing runoff generation may vary substantially across Chile’s diverse climate zones.

Despite these advances, important questions remain regarding how hydroclimatic variability relates to peak streamflow behavior across different climatic regimes. In particular, there is limited comparative analysis examining how hydroclimatic conditions associated with annual maximum streamflow events vary across Chile's contrasting climate zones. Understanding these associations is important for interpreting regional patterns of hydrological extremes and for improving the assessment of hydroclimatic influences on peak flows.

In this context, the present study analyses annual maximum streamflow records from 38 catchments distributed across a range of Köppen–Geiger climate regimes in Chile over the period 2000–2021. By combining hydrological observations with gridded precipitation, air temperature, and soil moisture datasets, the study examines the hydroclimatic conditions associated with peak streamflow across contrasting climatic settings.

Specifically, the objectives of this study are to:
(1) quantify temporal trends in annual maximum streamflow across Chilean catchments representing contrasting climate regimes;
(2) examine statistical associations between annual maximum streamflow and key hydroclimatic variables, including precipitation, air temperature, and soil moisture;
(3) assess how these hydroclimatic associations vary across different Köppen–Geiger climate zones.

By analyzing hydroclimatic conditions associated with peak streamflow across diverse climatic environments, this study contributes to improving the understanding of regional hydroclimatic variability and its association with extreme streamflow behavior. In addition, the comparative framework adopted here provides insights that are relevant for interpreting hydroclimatic controls on peak flows in other climatically heterogeneous regions."

We agree that the original maps (Figures 2–8), based on individual catchment polygons, were unnecessarily repetitive and did not fully exploit the dataset's spatial perspective. In response, we have redesigned the figures to present the results at the national scale using a unified map of Chile, where each catchment is represented by a single symbol indicating the trend direction and statistical significance. This new representation substantially improves clarity, reduces redundancy, and facilitates comparison across variables, as suggested by the reviewer. The revised figures have been incorporated into the manuscript as Figure 3 and Figure 4.

In section "3.1 Trend analysis", the new figures are the following two:

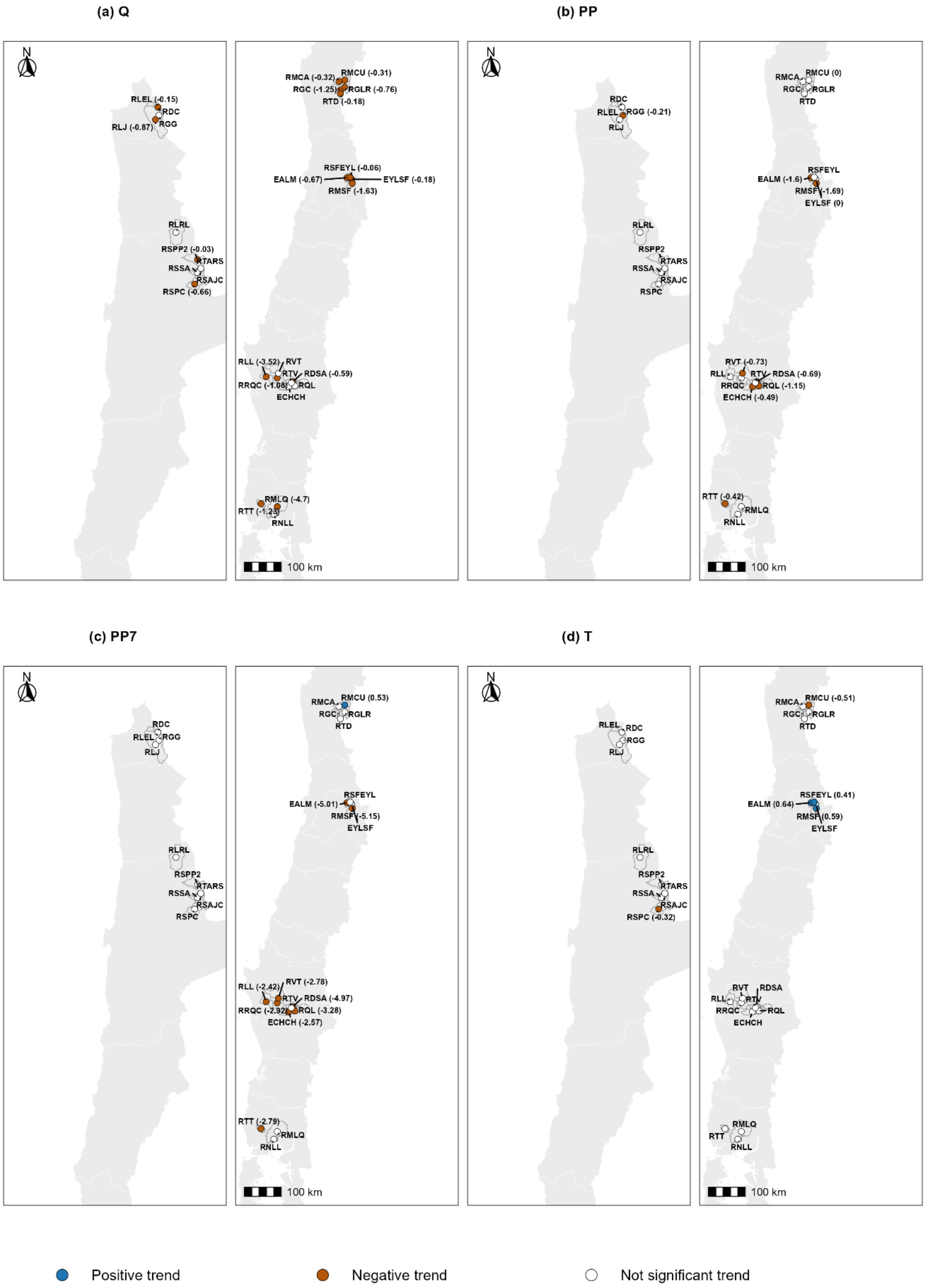

Figure 3. Trends in annual maximum streamflow and associated hydroclimatic variables (precipitation, 7-day accumulated precipitation and temperature) for the period 2000–2021. Values in parentheses next to the catchment labels indicate the Theil–Sen slope. The Theil–Sen slope is expressed in units per year: (a) Q in $m^3 s^{-1} yr^{-1}$, (b) PP in $mm\ yr^{-1}$, (c) PP7 in $mm\ yr^{-1}$, and (d) T in $°C\ yr^{-1}$.

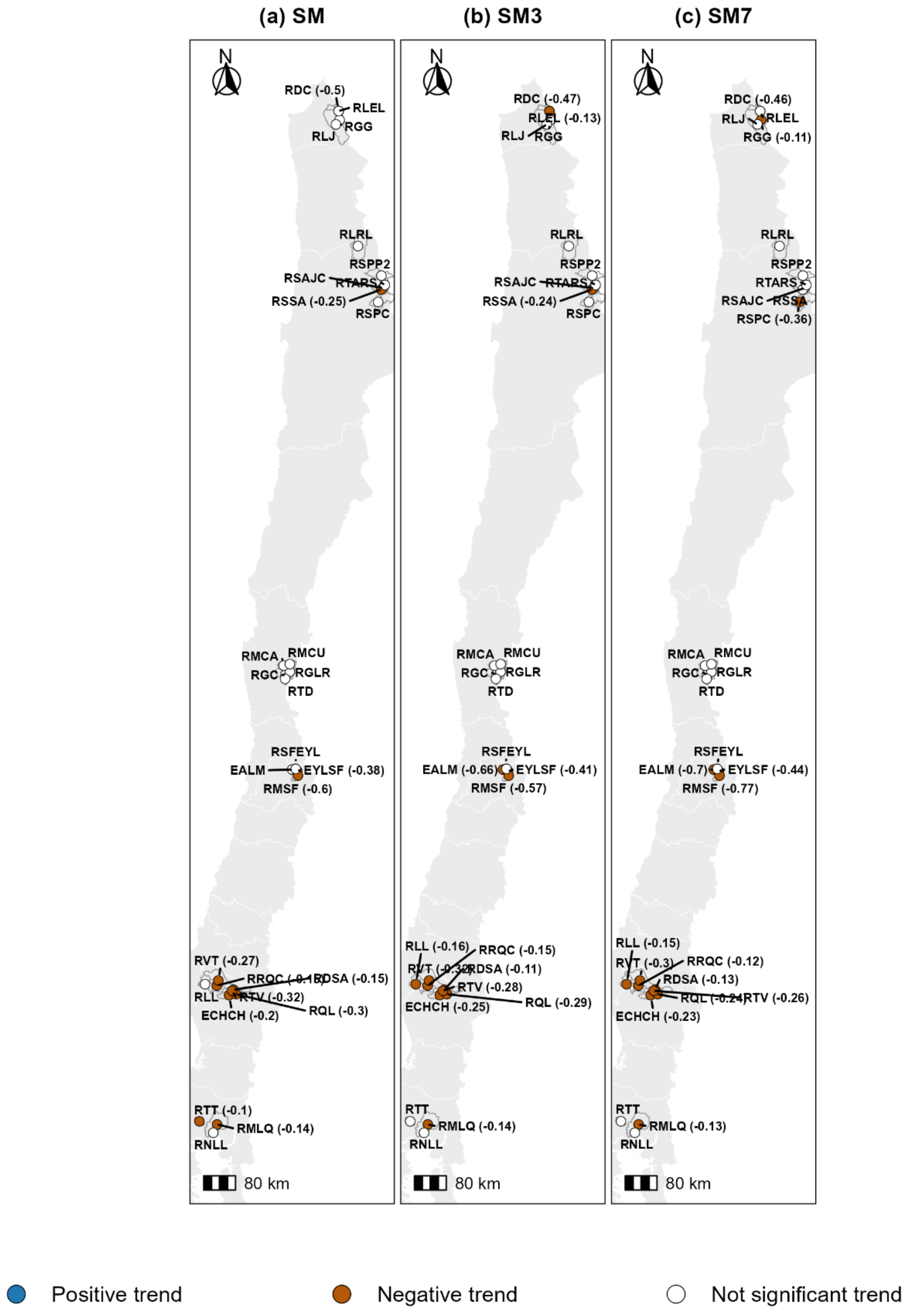

Figure 4. rends in soil moisture and its smoothed variants (3-day and 7-day moving averages) for the period 2000–2021. Values in parentheses next to the catchment labels indicate the Theil–Sen slope. The Theil–Sen slope is expressed in units per year: (a) SM in mm yr^{-1}, (b) SM3 in mm yr^{-1}, and (c) SM7 in mm yr^{-1}.

We agree that the clarity of the Results and Discussion sections can be improved by using more precise terminology and stronger linking between interpretations and supporting figures.

In the revised manuscript, we have addressed these issues in three main ways. First, variable naming has been standardized and clarified throughout the text. We now consistently distinguish between soil moisture variables (SM, SM3 and SM7) and precipitation variables (PP and PP7) and ambiguous expressions such as “annual maximum soil moisture” or “precipitation” have been replaced with the corresponding explicitly defined indices.

Second, references to climate zones have been made more explicit and consistent. Whenever broader terms such as “mediterranean”, “temperate”, or “summer-rainfall” climates are used, they are now clearly linked to the specific Köppen–Geiger classes defined in Table 1, ensuring that all interpretations can be unambiguously traced to the corresponding climate groups.

Third, we have revised the Results and Discussion sections to ensure that all interpretative statements are explicitly supported by references to the relevant figures or tables. This improves the traceability of the analysis and strengthens the scientific rigor of the manuscript.

These revisions substantially improve the readability and internal consistency of the manuscript, as well as the transparency of the interpretation of results.

In section “3. Results” there is a new introductory paragraph that clarifies the nomenclature of the variables:

“Hereafter, soil moisture variables are referred to as SM (3-hourly), SM3 (3-day moving average) and SM7 (7-day moving average) and precipitation variables as PP (daily maximum) and PP7 (7-day accumulated precipitation).”

The following excerpt illustrates how variable naming, climate zone references and figure linkage have been clarified in the revised manuscript:

“In mediterranean climates (**Csb** and ET(s)–Csb(h)–Csc), annual maximum streamflow (Q) exhibits predominantly negative trends (Fig. 2 (a)), with several catchments showing statistically significant declines. In contrast, in summer-rainfall climates (**ET(w)**, **ET(w)**–BSk(w) and BSk(w)–ET(w)), trends are generally weaker and mostly non-significant (Fig. 2). Similarly, precipitation indices, including daily maxima (PP) and 7-day accumulated precipitation (PP7), display consistent decreasing trends across winter-rainfall climates (Fig. 2 (b,c)), reinforcing the spatial coherence of hydroclimatic changes.”

Additionally, geographic references used throughout the manuscript have been clarified to avoid ambiguity. Terms such as “northern Chile”, “central-southern regions”, or “Patagonia” are now either explicitly defined or consistently linked to the corresponding climate zones and catchment groups analysed in the study.

- Length of period analyzed. The authors used a 20-year period for their analysis. Simultaneously, the authors state that the second half of that period is influenced by a megadrought (L43-44: “*Analysis of 106 Chilean catchments during the recent megadrought (2010-2020)*”, or L86: “*The last decade has been marked by an unprecedented megadrought*”), which greatly influences the presence/absence of trends. Using only 20 years can be considered particularly short for trend analysis. Instead of focusing just on hourly streamflow, the authors could also explore daily streamflow, which covers longer periods of time, to make their result more robust.

R. We acknowledge that the relatively short length of the study period represents a limitation for trend detection, particularly for annual maximum streamflow, which is inherently highly variable. As suggested, we have strengthened the manuscript to discuss this limitation more explicitly.

The selected period (2000–2021) corresponds to the maximum temporal overlap among all datasets used (streamflow, CR2MET precipitation and GLDAS soil moisture), ensuring methodological consistency across variables. Extending the analysis would require combining datasets with different characteristics, potentially affecting comparability.

We have also clarified in the Discussion section that the results should be interpreted as reflecting recent hydroclimatic tendencies rather than long-term trends. In particular, the study period captures a climatically relevant interval in Chile, including the recent megadrought, which provides meaningful context for interpreting changes in annual maximum streamflow.

In the section “2.2 Data sources”, the new paragraph, just below the title, is as follows:

“The study period (2000–2021) was defined based on the temporal overlap between streamflow observations, gridded precipitation data (CR2MET) and soil moisture data from GLDAS-Noah, ensuring consistency across all analyzed variables. While longer records are generally preferable for trend detection in extreme hydrological variables, the selected period reflects the maximum common temporal coverage of the datasets used.

It is acknowledged that the relatively short record length introduces uncertainty in trend detection, particularly for annual maxima, which are inherently variable. Therefore, the results should be interpreted as indicative of recent hydroclimatic tendencies rather than long-term trends."

In section "4. Discussion" at the end, there is now an explanation about the limitation of the study period:

"A limitation of this study is the relatively short record length (2000–2021), which may affect the robustness of trend detection, particularly for annual maxima that are inherently characterized by high interannual variability. Short time series can reduce the statistical power of trend tests and increase the sensitivity of results to individual extreme events.

However, the objective of this study is not to infer long-term historical trends, but rather to characterize recent hydroclimatic tendencies under current climate conditions. In this context, the selected period captures a climatically relevant interval that includes significant recent variability in Chile, including the megadrought (2010–2020), providing meaningful insight into contemporary streamflow behavior."

In addition, we acknowledge that including the recent megadrought (2010–2020) within the study period may influence the detected trends, particularly given the relatively short record length. This aspect has been explicitly considered in the interpretation of the results. Rather than representing long-term hydroclimatic changes, the identified trends are interpreted as reflecting recent conditions under a period of pronounced hydroclimatic variability. This context is now clearly stated in the revised Discussion section.

Regarding the use of longer streamflow records based on daily data, we acknowledge that this could allow extending the temporal coverage of the analysis. However, the objective of this study is to maintain a consistent multivariable framework integrating streamflow, precipitation, temperature, and soil moisture. The availability of soil moisture data from GLDAS-Noah constrains the analysis period to begin in 2000, and extending the streamflow record independently would prevent a consistent comparison across all hydroclimatic variables. For this reason, the study prioritizes temporal consistency across datasets over extending the analysis period using a single variable.

- Research questions. The authors posed three research questions that partially address Q1 by computing temporal trends – using the Man-Kendall test and the Sein-Theil slope– over a 20-year period (2001-2021). Q2 ("*identify dominant hydro-climatic controls on streamflow evolution …*"), although relevant, is not addressed and is poorly supported by the results,

> since the authors do not analyze high flow events, but just focus on annual (independent) maxima indices. Such methodology impedes the analysis of runoff generation and of how precipitation, antecedent soil moisture conditions, isotherm 0°c, etc., interact to generate runoff. This point is heightened by the lack of 1) analysis of the diversity of processes driving high flows in rainfall-driven, snow-driven, or mixed hydrological regimes (all present in the study basins), and 2) spatial heterogeneity within each catchment. Regarding Q3 ("*assess regional variations in climate-streamflow relationships…*"), the authors poorly discuss why some of the basins within the same area show mismatching trends (e.g., Figs. 2b, 2h, 3h, 3i, 4h, 5b, 5e, 5i), weakening the overall conclusions. Moreover, the authors do not show the spatial distribution of Köppen-Geiger climate groups for Chile and do not indicate which fraction of these areas is covered by the selected basins. Including such analysis would put the representativeness of the selected catchments into context and, subsequently, the robustness of the conclusions.

R. We thank the reviewer for this detailed and insightful comment. We acknowledge that the original formulation of the research questions did not fully align with the scope of the analyses, particularly in interpreting hydroclimatic controls on streamflow.

Regarding Q1, we confirm that the objective is appropriately addressed through the analysis of temporal trends in annual maximum streamflow using the Mann–Kendall test and Theil–Sen slope estimator.

For Q2, we agree that the original formulation ("identify dominant hydro-climatic controls on streamflow evolution") could be interpreted as implying a process-based or causal analysis, which is beyond the scope of this study. To address this, the objective has been reformulated as: "2- Explore statistical associations between annual maximum streamflow and hydroclimatic variables (precipitation, temperature and soil moisture)." This revised formulation better reflects the statistical nature of the analysis and avoids overinterpretation of the results.

In addition, the methodology has been revised to adopt an event-based framework. Specifically, for each catchment and year, the date of the annual maximum streamflow (Qmax) is identified, and the corresponding hydroclimatic conditions (precipitation, temperature, and soil moisture) are evaluated at that time, along with antecedent periods. This approach ensures temporal consistency between variables and provides a more physically meaningful basis for interpreting hydroclimatic conditions associated with peak flows, while remaining within the scope of a statistical analysis.

In the section “2.3.1 Variable definition and derivation,” the new explanation about the variables begins with this:

“The selection of hydroclimatic variables was guided by their physical relevance to runoff generation processes and antecedent catchment conditions. Annual maximum streamflow (Q) was used as the primary response variable, representing extreme hydrological events. Precipitation (PP) was considered the main atmospheric forcing driving runoff generation, while air temperature (T) was included to account for its influence on processes such as evapotranspiration and snowmelt. Soil moisture (SM) was incorporated as an indicator of antecedent wetness conditions, reflecting catchment storage and hydrological memory.

To ensure a physically consistent linkage between hydroclimatic conditions and streamflow extremes, an event-based framework was adopted. For each catchment and year, the date of the annual maximum streamflow was identified, and the corresponding hydroclimatic variables were evaluated at that time. In addition, antecedent conditions were characterized by using aggregated variables over preceding periods, including accumulated precipitation over 7 days (PP7) and smoothed soil moisture over 3- and 7-day windows (SM3 and SM7), which represent short-term catchment memory and storage conditions influencing peak generation.”

We acknowledge that the study does not explicitly model runoff generation processes or the diversity of mechanisms driving high flows (e.g., rainfall-driven, snow-driven, or mixed regimes), nor does it resolve sub-catchment spatial heterogeneity. These aspects are beyond the scope of the present analysis, which is conducted at the catchment scale and focuses on identifying consistent statistical relationships between hydroclimatic conditions and observed peak streamflow.

Regarding Q3, the objective has been reformulated as: “3- Assess how these hydroclimatic associations vary across contrasting Köppen–Geiger climate zones.” Within this framework, differences observed among catchments within the same climate zone are interpreted as reflecting local variability in catchment characteristics and hydroclimatic conditions, rather than inconsistencies in the analysis.

To address this point, a new paragraph has been added in section “4. Discussion” explicitly acknowledging intra-zone variability and clarifying that climate zones provide a regional framework for comparison, but do not imply uniform hydrological responses across all catchments. This addition avoids overgeneralization of regional patterns and strengthens the interpretation of the results:

“Within individual climate zones, some catchments exhibit differences in the direction or significance of trends. This intra-zone variability reflects the influence of local catchment characteristics and hydroclimatic conditions, which can modulate the response of streamflow to climatic forcing. Therefore, while climate zones provide a useful regional framework for comparison, they do not imply uniform hydrological behavior across all catchments. These differences highlight the importance of interpreting regional patterns alongside local variability, rather than assuming homogeneous responses within each climate group.”

Finally, to provide additional spatial context and address the representativeness of the selected catchments, a new figure has been incorporated showing the spatial distribution of Köppen–Geiger climate zones across Chile, together with the location of the analysed basins. This addition allows a clearer assessment of the dataset's climatic coverage and improves the interpretation of the results.

A new Figure 1 is added to section “2.1 Study area”:

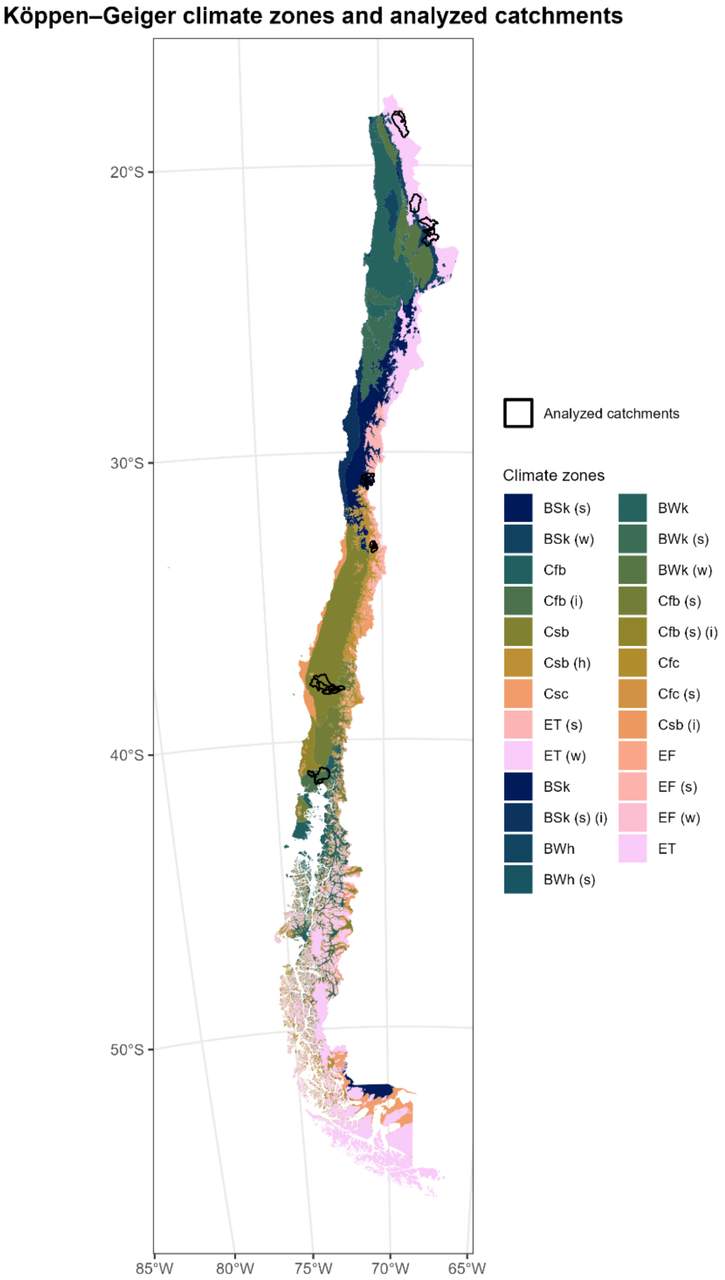

Figure 1. Climate zones and study catchments.

Specific comments

- L21-29: The authors use the present tense to highlight the current effects of climate change on water resources. I suggest using more up-to-date references to support their statements. Here are some suggestions that could be useful: (i) https://doi.org/10.1139/er-2021-0109, (ii) https://doi.org/10.1016/j.scitotenv.2022.159854, and (iii) https://doi.org/10.1016/B978-0-323-99714-0.00008-X.

R. We thank the reviewer for this suggestion. We agree that incorporating more recent references strengthens support for statements on current climate change impacts on hydrological systems. In the revised Introduction, additional recent references have been included in the first paragraph to better reflect the current state of knowledge. This new paragraph is included at the beginning of the new section "1. Introduction":

"Climate change is altering hydrological systems worldwide by modifying precipitation regimes, temperature patterns and the frequency and magnitude of hydrological extremes (IPCC, 2023; Blöschl et al., 2019; Costa et al., 2023; Qiu et al., 2023; Sukanya and Joseph, 2023). In this context, understanding the occurrence of high streamflow events is essential for flood risk assessment, water resources management and ecosystem functioning. Peak streamflow events are influenced by hydroclimatic conditions, including precipitation, temperature and antecedent soil moisture. Understanding how these factors influence the occurrence and variability of peak flows is therefore essential for interpreting hydrological extremes across different climatic settings."

- If I understand correctly, the authors aim to address relationships between streamflow, climate, and soil moisture. Although answering these questions could be useful in a climate change assessment, these topics do not necessarily involve climate change (as the first paragraph states; L21-29). In my opinion, the manuscript's introduction would greatly benefit from reducing its focus on climate change.

R. We thank the reviewer for this comment. We agree that the original Introduction placed excessive emphasis on climate change given the study's scope. In the revised manuscript, the Introduction has been adjusted to reduce this emphasis and to more clearly focus on hydroclimatic conditions and their relationship with peak streamflow, while retaining climate change as a broader contextual framework. This new paragraph is included at the beginning of the new section "1. Introduction":

"Climate change is altering hydrological systems worldwide by modifying precipitation regimes, temperature patterns and the frequency and magnitude of hydrological extremes (IPCC, 2023; Blöschl et al., 2019; Costa et al., 2023; Qiu et al., 2023; Sukanya and Joseph, 2023). In this context, understanding the occurrence of high streamflow events is essential for flood risk assessment, water resources management and ecosystem functioning. Peak streamflow events are influenced by hydroclimatic conditions, including precipitation, temperature and antecedent soil moisture. Understanding how these factors influence the occurrence and variability of peak flows is therefore essential for interpreting hydrological extremes across different climatic settings."

- L116-117: It is unclear to me what the criteria are to select (or discard) a Köppen-Geigger group. What do the authors mean by "*A climate zone was included in a study area if it covered at least 10% of the zone's surface* [What zones' surface?] *or 15% of a specific catchment*" (How were the catchments previously selected to apply such criteria?).

R. We thank the reviewer for this comment. We agree that the criteria for including Köppen–Geiger climate zones were not clearly explained in the original manuscript. In the revised version, the description of catchment and climate classification has been simplified and clarified.

Specifically, the previous criteria based on percentage thresholds of climate zone coverage (10% of the zone or 15% of the catchment) have been removed, as they introduced ambiguity. Instead, each catchment is now assigned to a Köppen–Geiger class based on its dominant climate type, with secondary classes identified where relevant.

Additionally, the selection of catchments is now explicitly described based on data availability and to represent contrasting hydroclimatic conditions across Chile.

The new explanation of catchment selection is below, and it will be part of the "Materials and methods" section in the Manuscript, particularly in the "2.1 Study area" section.

Catchment selection and climate classification

"Catchments were selected to represent contrasting hydroclimatic conditions across Chile, including differences associated with latitude, elevation, coastal influence and precipitation regimes (winter- and summer-dominated). The objective was not to provide an exhaustive representation of all available gauging stations, but rather to define a consistent and climatically representative subset suitable for comparative analysis of annual maximum streamflow.

The selection prioritized catchments with sufficient streamflow data availability to derive annual maximum series within the 2000–2021 period. Specifically, stations were required to have data coverage for at least 50% of the study period, ensuring a minimum number of annual maxima for robust analysis. In addition, all selected catchments include corresponding hydroclimatic variables (precipitation, temperature, and soil moisture).

Each catchment was assigned to a Köppen–Geiger class based on the dominant climate type within its area. For catchments with mixed climate conditions, secondary and tertiary climate classes were also identified, allowing the inclusion of transition zones while preserving a clear dominant climatic signal.

Stations located in artificial channels were excluded, as they do not represent natural river flow conditions. Additionally, catchments strongly affected by anthropogenic regulation were excluded to improve the consistency of the dataset in representing hydroclimatic variability."

- In my opinion, Figure 1 would greatly improve if the authors added the regions of Chile mentioned in the text, as well as a spatial distribution of the Köppen-Geiger classification. Also, the text in Fig. 1c, 1g, and 1k is difficult to read. Also, panels have different font sizes for numbering. If the coordinates for each panel are needed, I strongly suggest increasing the font size. Please also increase the font size of the distance scales.

R. We thank the reviewer for this comment. We agree that the original multi-panel figure could be improved in terms of readability. In the revised manuscript, the figure has been updated by increasing the font sizes of the coordinates, scale bars, and panel labels, and by ensuring more consistent formatting across panels. In addition, the spatial distribution of Köppen–Geiger climate zones across Chile and the location of the analyzed catchments are now presented separately in the new Figure 1, while the original detailed multi-panel figure is retained as Figure 2.

In section "2.1 Study area" a new Figure 1 is incorporated:

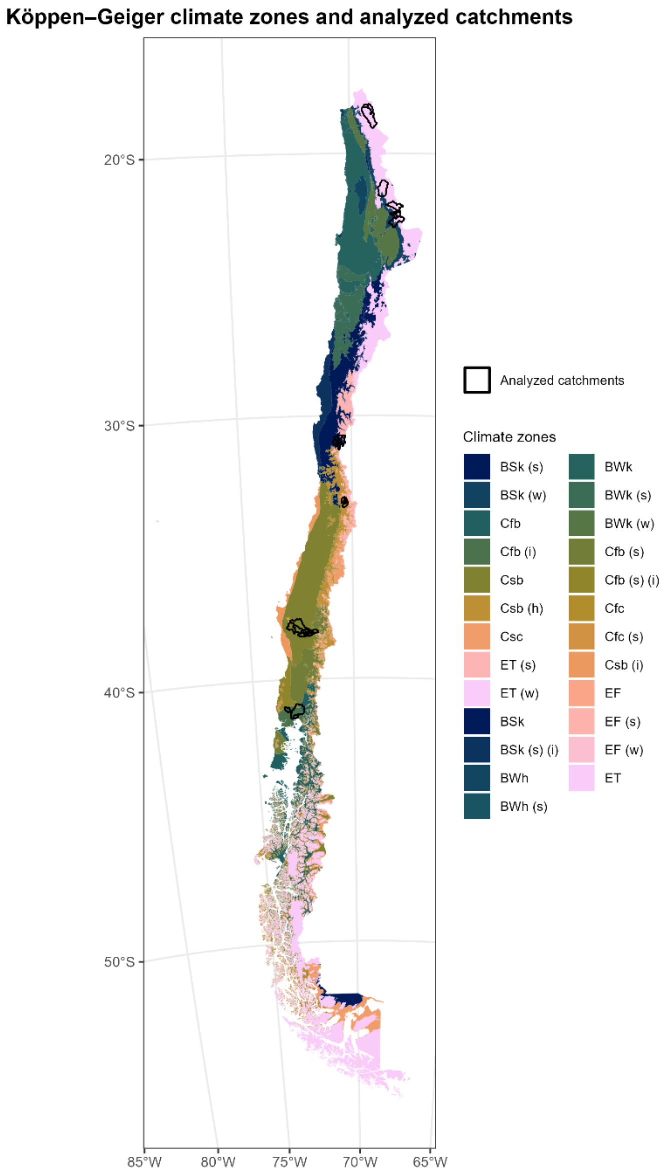

Figure 1. Köppen-Geiger climate zones and selected catchments.

And in section “2.1 Study area”, Figure 2 (previously Figure 1) is as follows:

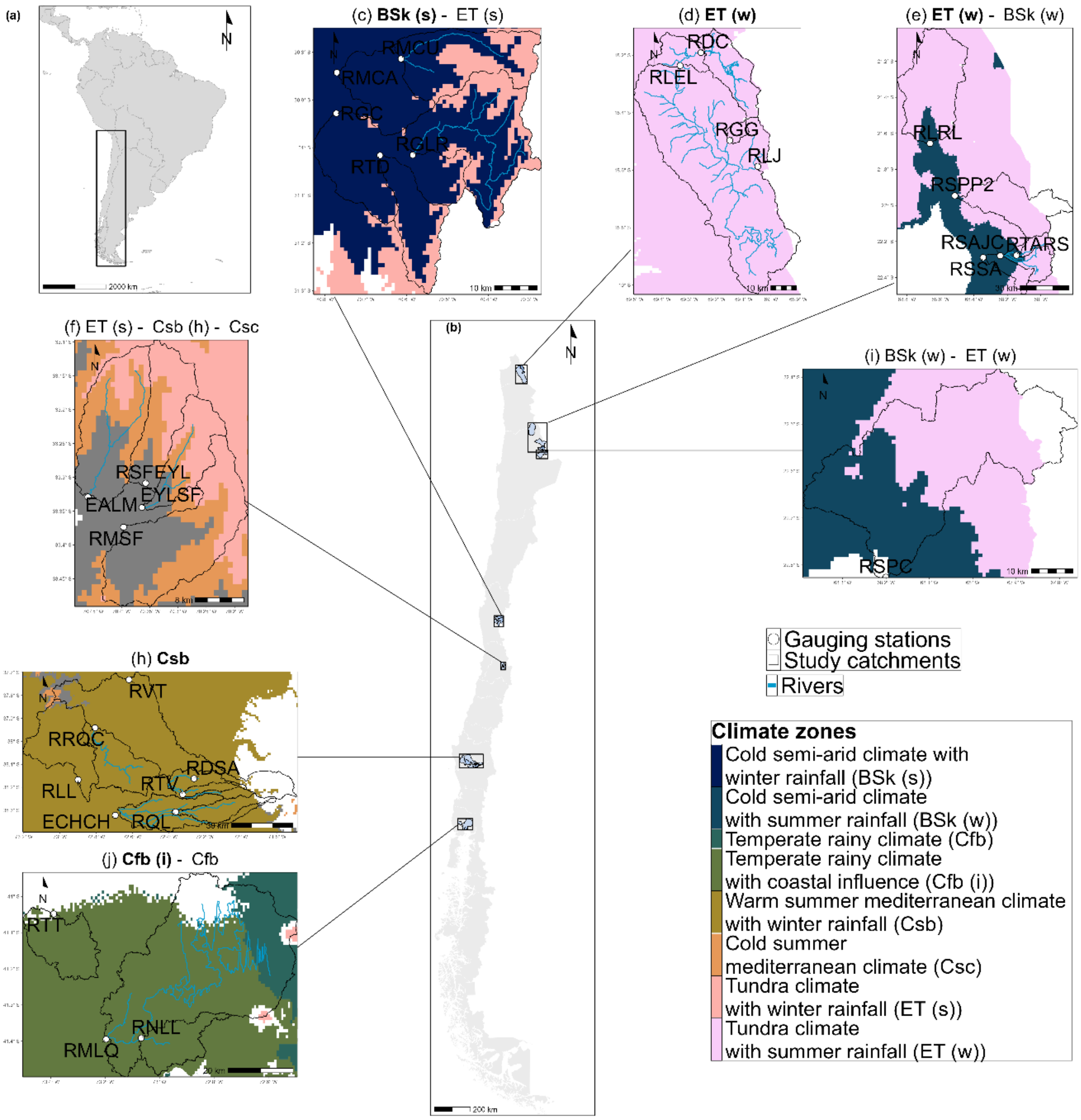

Figure 2. The study catchments are grouped by study zones and labelled according to the dominant climate zones, ordered from left to right by surface coverage percentage. Maps use Scientific Colour Maps (SCM v7). Sequential layers are shown with the Batlow palette; categorical overlays use neutral contrasts to preserve legibility (Crameri et al., 2020).

- The selection of some catchments is peculiar. Why would the authors choose streamflow stations measuring streamflow in canals (e.g., Canal Lauca en Sifón n°1, Canal Vilama en Vilama, Canal Tilomonte antes represa, Canal Mal Paso después de bocatoma)? Also, if the authors aim to study streamflow trends – particularly if they use hourly streamflow records (L182) –, how would they isolate the effects of dams in these basins: Río Copiapó en la ciudad de Copiapó, río Copiapó en La Puerta, and río Elqui en La Serena (e.g., L324, L504)?

R. We thank the reviewer for this important comment. We agree that streamflow records from artificial channels and basins strongly affected by anthropogenic regulation may not be representative of natural hydrological processes and could bias the interpretation of streamflow trends.

To address this issue, the selection of catchments has been revised. Stations located in artificial channels (e.g., Canal Lauca en Sifón N°1, Canal Vilama en Vilama, Canal Tilomonte antes represa and Canal Mal Paso después de bocatoma) have been excluded from the analysis. In addition, catchments with strong influence from reservoirs or flow regulation (e.g., Río Copiapó and Río Elqui basins) have also been removed to ensure that the dataset more consistently reflects natural hydroclimatic variability.

- What is the hydrological regime of the different basins? I think this would influence the climate attributes required to characterise high streamflow events.

R. We thank the reviewer for this insightful comment. We agree that the hydrological regime of the basins (e.g., rainfall-dominated, snow-influenced, or mixed) is an important factor influencing the relationship between hydroclimatic variables and peak streamflow.

The catchments analyzed in this study span a wide range of hydroclimatic conditions across Chile, including rainfall-dominated catchments as well as those where snow processes may contribute to streamflow generation. The hydrological behavior of the basins was examined during the interpretation of the results, allowing us to identify differences consistent with varying runoff-generation processes across regions.

Although the hydrological regime was not included as an explicit variable or classification in the methodological framework, the revised Discussion now explicitly acknowledges that differences in dominant runoff-generation processes, including the relative contributions of rainfall and snowmelt, may influence the observed relationships among variables.

The new paragraph in section "4. Discussion" is as follows:

"The analyzed catchments span a wide range of hydroclimatic conditions across Chile, including rainfall-dominated systems as well as basins where snow processes may contribute to streamflow generation. The interpretation of the results indicates that differences in the strength of the relationships between hydroclimatic variables and peak streamflow are consistent with variations in dominant runoff-generation processes across regions. For example, in rainfall-dominated catchments, stronger associations with precipitation are expected, whereas in basins with snow influence or greater spatial heterogeneity, these relationships may be weaker or more diffuse due to storage and delayed release processes."

- When gap-filling streamflow, how were the donor catchments selected? Is the pool of donor catchments the same as in Table 1? Also, how did the authors evaluate the performance of each "*infilled record*"(L253-254)? Did they conduct a cross-validation? How many of the annual maximums correspond to gap-filled values?

R. We thank the reviewer for this important comment. Missing streamflow data were reconstructed using regression relationships between neighboring stations within the same climatic zone, selected based on the best statistical fit during overlapping periods. The donor stations were primarily drawn from the same pool as the analysis, although additional nearby stations were used when necessary.

The performance of the infilling procedure was evaluated using the coefficient of determination (R^2), the Nash–Sutcliffe Efficiency (NSE) and the Percentage of Bias (PBIAS), based on validation using overlapping periods and synthetic gaps.

To assess the influence of reconstructed data on the results, the proportion of annual maximum streamflow values associated with gap-filled records was quantified. After excluding stations located in artificial channels or clearly affected by flow regulation, 103 out of 638 annual maxima (16.1%) corresponded to infilled values. This clarification has been incorporated into the revised manuscript.

The explanation for this is now found in section "2.3.1 Variable definition and derivation", just above equations 11 and 12. This explanation is presented below.

"Original streamflow records contained gaps due to natural and operational factors. To ensure temporal consistency, missing data were reconstructed using regression relationships between neighbouring stations (Eqs. 11 and 12). This procedure allowed the generation of continuous hourly streamflow series over the study period, including periods with limited or no original observations. Annual maximum streamflow values were then derived from these reconstructed series.

Missing streamflow data were reconstructed using regression relationships between neighbouring stations (Eqs. 11 and 12). Such approaches are commonly used in hydrology for streamflow record extension and regionalisation, where empirical relationships between gauged sites are employed to estimate missing observations (Hirsch, 1982; Vogel and Stedinger, 1985; Razavi and Coulibaly, 2013). Logarithmic regression models were adopted to represent power-law relationships between streamflow series, which are widely observed in hydrological processes and often provide improved performance compared to linear formulations. This approach allows capturing non-linear scaling between stations while maintaining a simple and robust empirical framework."

And in the section "4. Discussion" now is a new paragraph that clarify the proportion of annual maximum streamflow values derived from gap-filled data:

"The proportion of annual maximum streamflow values associated with gap-filled data was quantified to assess the potential influence of reconstructed observations on the analysis. After excluding stations located in artificial channels or clearly affected by flow regulation, 103 out of 638 annual maxima (16.1 %) corresponded to infilled values. This indicates that most annual maxima used in the analysis were derived from observed records, although reconstructed data still represent a non-negligible fraction of the dataset."

- In my opinion, without clarifying the hydrological regime of the basins (e.g., rainfall-driven, snowfall-driven, mixed, etc.), it is very difficult to determine whether the Spearman Correlation between the annual maximum variables makes sense or whether the climate descriptors are sufficient to characterise the catchments. For example, in L286, the authors state: "*Conversely, in snow-dominated or arid regions, temperature and snowmelt dynamics often exert stronger control on streamflow variability (Viviroli et al., 2011; Zhai & Tao, 2017).*" Which of the climate attributes suggested by the authors would represent the effect of snow (e.g., L331 or L345)?

R. We thank the reviewer for this important comment. We agree that the original manuscript included interpretations related to hydrological processes (e.g., snowmelt contributions, snow-dominated regimes and the upward shift of the 0 °C isotherm) that were not explicitly evaluated in the analysis.

In the revised manuscript, these statements have been removed or reformulated to ensure that all interpretations remain strictly consistent with the variables and methods used. In particular, references to snow-dominated processes and elevation-related mechanisms have been eliminated, as the study does not explicitly include variables that directly represent snow dynamics.

The analysis has been reframed to focus on statistical associations between annual maximum streamflow and hydroclimatic variables (precipitation, temperature and soil moisture), evaluated under an event-based framework. Within this context, temperature is retained as a general hydroclimatic descriptor, but without attributing specific physical mechanisms (such as snowmelt or isotherm shifts) that are not directly resolved by the data.

These changes ensure that the interpretation of results is consistent with the scope and limitations of the study.

- Also, in several basins (particularly in northern and central continental Chile), the wet season occurs in winter, while maximum streamflow occurs in spring and summer due to snowmelt. In such basins, why would the maximum rates of daily precipitation be correlated with the annual maximum hourly streamflow values (e.g., L365-366)?

R. We thank the reviewer for this important comment. We agree that, under the original formulation based on independently computed annual maxima, temporal mismatches between precipitation and streamflow could lead to physically inconsistent interpretations, particularly in basins where peak flows are influenced by delayed processes such as snow accumulation and melt.

To address this, the methodology has been revised to adopt an event-based framework. Specifically, for each catchment and year, the date of the annual maximum streamflow (Qmax) is identified and hydroclimatic variables are evaluated at that time and over antecedent periods. This ensures that the analyzed variables are temporally aligned with the runoff-generating event, avoiding inconsistencies associated with comparing independent annual maxima.

Within this revised framework, the interpretation of precipitation is no longer based on annual maximum values, but on its contribution to the conditions leading to peak discharge. This allows capturing both direct rainfall-driven events and cases where precipitation contributes indirectly through antecedent conditions or delayed processes.

In addition, statements referring to snowmelt-dominated behaviour and its influence on the lack of correlation with precipitation extremes have been removed or reformulated to avoid unsupported process-based interpretations. These changes ensure a more physically consistent interpretation of hydroclimatic controls on peak streamflow.

- Before comparing the annual correlation between the annual maximum time series (L278-280), I wonder whether the variables correspond to the same events each year. For example, does $Qmax_{annual}$ occur on the same day as $Ppmax_{annual}$ or $PP7max_{annual}$? If that is not the case (for different basin-year combinations), what processes would explain such behaviour? This could be key to understanding and explaining trends in annual maximum hourly streamflow and to verifying whether the selected climate attributes are representative of the processes generating runoff.

R. We thank the reviewer for this important comment. We agree that, in the original formulation based on independently computed annual maxima, it was not ensured that the variables corresponded to the same hydrological events. As correctly pointed out, temporal mismatches between Qmaxannual and precipitation or soil moisture maxima could lead to inconsistent interpretations.

To address this limitation, the methodology has been revised to adopt an event-based framework. For each catchment and year, the date of the annual maximum streamflow (Qmax) is identified and the corresponding hydroclimatic variables are evaluated at that time and over antecedent periods. This approach ensures that all variables are temporally aligned with the runoff-generating event.

As a result, the analysis no longer compares independent annual maxima across variables but instead examines hydroclimatic conditions associated with the same peak flow event. This provides a more physically consistent basis for interpreting statistical associations between streamflow and hydroclimatic variables.

Accordingly, the text has been revised to reflect this change in methodology and to avoid implying that independent annual maxima are directly comparable across variables.

In this context, the new explanation about the selected variables is in the section "2.3.1 Variable definition and derivation":

"The selection of hydroclimatic variables was guided by their physical relevance to runoff generation processes and antecedent catchment conditions. Annual maximum streamflow (Q) was used as the primary response variable, representing extreme hydrological events. Precipitation (PP) was considered as the main atmospheric forcing driving runoff generation, while air temperature (T) was included to account for its influence on processes such as evapotranspiration and snowmelt. Soil moisture (SM) was incorporated as an indicator of antecedent wetness conditions, reflecting catchment storage and hydrological memory.

To ensure a physically consistent linkage between hydroclimatic conditions and streamflow extremes, an event-based framework was adopted. For each catchment and year, the date of the annual maximum streamflow was identified and the corresponding hydroclimatic variables were evaluated at that time. In addition, antecedent conditions were characterized by using aggregated variables over preceding periods, including accumulated precipitation over 7 days (PP7) and smoothed soil moisture over 3- and 7-day windows (SM3 and SM7), which represent short-term catchment memory and storage conditions influencing peak generation."

- The patterns found in Figs. 2b, 2c, and 2h are interesting. Is there an explanation for the mismatches in the trends of annual maximum hourly streamflow in these three regions?

R. We thank the reviewer for this observation. The coexistence of significant and non-significant trends within the same climate zones reflects the heterogeneity of hydroclimatic responses at the catchment scale.

Although catchments are grouped within the same Köppen–Geiger climate classification, they may differ in terms of area, elevation and local hydroclimatic conditions, which can influence the magnitude and detectability of trends in annual maximum streamflow. In some cases, trends may be present but not statistically significant due to variability in the time series or limited record length.

Therefore, the observed mismatches do not necessarily indicate contradictory behaviour, but rather differences in the strength and statistical significance of the trends across individual catchments within the same climatic setting.

- L339: When the authors mention "*Annual maximum precipitation*", are they referring to PP_{max} or $PP7_{max}$?

R. Annual maximum precipitation is PP_{max}. To avoid this confusion, variable naming has been standardized and clarified throughout the text. We now consistently distinguish between soil moisture variables (SM, SM3 and SM7) and precipitation variables (PP and PP7) and ambiguous expressions such as "annual maximum soil moisture" or "precipitation" have been replaced with the corresponding explicitly defined indices.

- L371: How do the authors conclude that trends in $Tmax_{annual}$ (Fig. 5) are also trends in "*both regional warming and the elevation-driven upward shift of the 0 °C isotherm*" (L371)? Or do they refer explicitly to the days associated with the annual maximum temperature? Also, how did the authors identify the summer events (L376)? Did they analyze more than just the annual maxima (e.g., seasonal maxima)?

R. We thank the reviewer for this comment. We agree that the reference to the elevation-driven upward shift of the 0 °C isotherm represents an interpretation that is not directly supported by the data analyzed in this study. This statement has been removed from the revised manuscript.

Temperature trends are now described more conservatively as reflecting changes in annual maximum temperature, without attributing them to specific physical mechanisms that were not explicitly evaluated.

Regarding the reference to “summer events”, we clarify that the analysis is based exclusively on annual maximum values and no explicit seasonal analysis was performed. The term “summer-rainfall regions” refers to the climatic classification of these zones, rather than to a specific identification of seasonal events within the time series. The text has been revised to avoid this ambiguity.

- L396-397: I wonder how the authors lead to this conclusion when analysing the trend of annual maximum soil moisture: “*These results suggest that in drier summer-rainfall regions, irregular rainfall events may counterbalance drying tendencies when soil moisture is measured at a three-hour resolution*”. Did they quantify other events than just the annual maxima?

R. We thank the reviewer for this comment. We agree that the original statement may overinterpret the results by implying a direct causal relationship that was not explicitly evaluated.

The analysis is based on annual maximum soil moisture values and no event-based or sub-annual analysis was conducted. Therefore, we have revised the text to adopt a more cautious interpretation.

The statement has been reformulated to indicate that the observed patterns may be associated with the variability of rainfall in summer-rainfall regions, rather than concluding that specific events counterbalance drying tendencies. This clarification avoids implying causation while still providing a possible interpretation consistent with the observed behaviour.

The new statement is:

“These results may reflect the high variability of rainfall in summer-rainfall regions, where intermittent precipitation inputs could influence soil moisture conditions despite overall drying tendencies.”

- Table 2 shows results for “*Q trend*”, “*PP trend*”, and “*T trend*”. However, such a acronyms haven’t been defined so far. Do they correspond to the annual maximum values?

R. Yes, all the values in that table are referred to maximum values. The new “Table 2” will clarify that in the tittle: “**Table 2.** Summary of maximum trend directions and significance across climatic zones. Positive trends are shown in blue, negative trends in red and non-significant trends are uncoloured.”

- The authors use the Köppen-Geiger classification and a climate classification (e.g., L499, 501). In my opinion, the manuscript would benefit from using a single clustering approach for simplicity.

R. We thank the reviewer for this comment. We clarify that the Köppen–Geiger classification is consistently used as the primary framework for grouping catchments throughout the analysis.

The terms “winter-rainfall”, “summer-rainfall” and “tundra regions” are used as descriptive labels to summarize shared hydroclimatic characteristics across multiple Köppen–Geiger classes, rather than representing an alternative classification scheme.

To improve clarity and avoid potential confusion, the text has been revised to explicitly link these descriptive terms to the corresponding Köppen–Geiger climate classes.

The following excerpt illustrates how variable naming, climate zone references and figure linkage have been clarified in the revised manuscript:

“In mediterranean climates (**Csb** and ET(s)–Csb(h)–Csc), annual maximum streamflow (Q) exhibits predominantly negative trends (Fig. 2 (a)), with several catchments showing statistically significant declines. In contrast, in summer-rainfall climates (**ET(w)**, **ET(w)**–BSk(w) and BSk(w)–ET(w)), trends are generally weaker and mostly non-significant (Fig. 2). Similarly, precipitation indices, including daily maxima (PP) and 7-day accumulated precipitation (PP7), display consistent decreasing trends across winter-rainfall climates (Fig. 2 (b,c)), reinforcing the spatial coherence of hydroclimatic changes.”

- Figure 12 displays acronyms that haven’t been previously defined (e.g., Q_T, PP_T).

R. That is true. Now, The title of the figure clarifies the meaning of this nomenclature: “**Figure 12.** Synthetic heatmap of average correlations across climatic zones. In the Y axis are the correlations between two maximum variables ”

- How do the authors reach this statement (L524-525): “*The streamflow trends reveal a clear and consistent decrease across Mediterranean, temperate, and winter-rainfall climates, indicating a strong sensitivity to winter precipitation, as also observed in Europe (Blöschl et al., 2019).*”?

R. We thank the reviewer for this comment. We agree that the original statement may be too strong in its formulation.

The interpretation was based on the predominance of negative streamflow trends observed across catchments located in mediterranean, temperate and winter-rainfall climate zones. However, we acknowledge that this pattern is not uniformly consistent across all catchments and that the analysis does not explicitly quantify sensitivity to winter precipitation.

The statement has been revised to provide a more cautious interpretation, describing the observed pattern without implying a direct or uniform causal relationship. The comparison with previous studies (e.g., Blöschl et al., 2019) has also been retained in a more contextual manner:

"Streamflow trends show a general tendency towards decreasing values across mediterranean (**Csb** and ET(s)–Csb(h)–Csc), temperate (**Cfb(i)**–Cfb) and winter-rainfall (**BSk(s)**–ET(s), **Csb** and ET(s)–Csb(h)–Csc) climate zones. This pattern is consistent with previous findings highlighting the importance of winter precipitation in these regions (Blöschl et al., 2019), although variability exists among individual catchments."

- L534-535: The authors state: "*These findings confirm the critical role of winter precipitation in sustaining streamflow, contrasting with the weaker or non-significant changes found in tundra and summer-rainfall climates.*" What "streamflow" are the authors referring to? Floods? Low flows? In summer/winter?

R. We thank the reviewer for this comment. We clarify that the analysis refers specifically to annual maximum streamflow (Qmax), rather than to general streamflow conditions or seasonal flows.

To avoid ambiguity, the text has been revised to explicitly refer to annual maximum streamflow. In addition, the statement has been reformulated to adopt a more cautious interpretation, avoiding strong causal language:

"These findings suggest that winter precipitation plays an important role in shaping annual maximum streamflow (Q) in mediterranean (**Csb** and ET(s)–Csb(h)–Csc) and temperate (**Cfb(i)**–Cfb) regions, in contrast to the weaker or non-significant changes observed in tundra and summer-rainfall climates."

- What results support this statement (L539-542)? "*Global warming intensifies these effects, especially in drier catchments. While Vicuña et al. (2013) proposed that extreme heat might increase the contributing runoff area, the* *results here indicate that enhanced evapotranspiration instead reduces streamflow availability.*" Also, I think the authors are misinterpreting Vicuña et al. (2013), since Vicuña et al. analyzed temperature on rainy days, while the authors don't.

R. We thank the reviewer for this comment. We agree that the original statement overinterprets the results by attributing specific physical mechanisms that were not explicitly evaluated in the analysis.

In particular, the reference to enhanced evapotranspiration reducing streamflow availability is not directly supported by the variables considered in this study. In addition, we acknowledge that the interpretation of Vicuña et al. was not fully consistent with the context of that study.

Accordingly, this statement has been removed (or substantially revised) in the manuscript to ensure that all interpretations remain strictly consistent with the results presented.

- What results support this statement: "*In contrast, summer-rainfall climates display mostly stable or positive soil moisture trends, especially in semi-arid basins where convective summer storms sustain short-term replenishment despite high temperatures.*"?

R. We thank the reviewer for this comment. We agree that this statement overinterprets the results by attributing specific hydrological processes that were not explicitly analyzed in the study.

In particular, the reference to convective summer storms and their role in sustaining soil moisture is not directly supported by the variables or methods used. Accordingly, this statement has been removed from the revised manuscript to ensure that all interpretations remain consistent with the scope of the analysis.

- In my opinion, this statement is too vague (L571-572): "*Correlations confirm that precipitation – especially multi-day accumulation – is the primary driver of streamflow and soil moisture, reinforcing findings from Europe (Blöschl et al., 2019).*" Such a statement can be assumed without conducting this study. Also, the authors haven't explored the temporal mismatch between the annual maximum hourly streamflow and the maximum cumulative precipitation.

R. We thank the reviewer for this comment. We agree that the original statement was too general and could be interpreted as implying a causal relationship that is not supported by the analysis.

The results are based on statistical associations and do not aim to establish precipitation as a universal driver of streamflow, but rather to characterize relationships observed within the study dataset. Accordingly, the statement has been revised to adopt a more specific and cautious formulation.

In addition, as noted by the reviewer, the potential temporal mismatch between independently computed annual maxima represents a limitation in the original methodology. This has been addressed by adopting an event-based framework, in which hydroclimatic variables are evaluated at the time of annual maximum streamflow, ensuring temporal consistency in the analysis.

The new statement is:

“Correlations indicate that precipitation, particularly multi-day accumulation, is strongly associated with annual maximum streamflow and soil moisture within the study catchments, consistent with previous findings (Blöschl et al., 2019).”

- L591-593: In this case, I think correlation is not causation, and more in-depth analysis is required (e.g., event-to-event) to demonstrate such causation. Also, the small number of basins analyzed does not support such a generic statement.

R. We thank the reviewer for this important comment. We agree that the original statement may imply causal relationships that are not supported by the correlation-based analysis conducted in this study.

The objective of the analysis is to identify statistical associations between hydroclimatic variables and annual maximum streamflow, rather than to establish causal mechanisms. Accordingly, the text has been revised to avoid causal language such as “control”, “driven by”, or “effects” and to adopt a more cautious interpretation based on observed associations.

In addition, we acknowledge that the results are based on a limited number of catchments and should not be interpreted as universally applicable. The revised text now explicitly refers to patterns observed within the study dataset, avoiding overgeneralization.

The new paragraph is:

“In summary, accumulated precipitation shows a strong association with annual maximum streamflow in mediterranean (**Csb** and ET(s)–Csb(h)–Csc), temperate (**Cfb(i)**–Cfb) and winter-rainfall (**BSk(s)**–ET(s), **Csb** and ET(s)–Csb(h)–Csc) climates. Soil moisture is also associated with variations in streamflow, suggesting a potential role in modulating runoff responses, while temperature exhibits contrasting relationships across climate zones. Altogether, these patterns are consistent with a general tendency towards decreasing streamflow in winter-rainfall (**BSk(s)**–ET(s), **Csb** and ET(s)–Csb(h)–Csc) regions, in conjunction with concurrent changes in precipitation and temperature observed in these catchments. These results reflect statistical associations identified within the study dataset and should be interpreted within the limitations of the analysis.”

- L630-635: What results support this statement?

R. We thank the reviewer for this comment. We agree that parts of the original statement included interpretations that are not directly supported by the results presented.

While the reported trends in streamflow, precipitation and soil moisture are based on quantitative analysis, the attribution of these patterns to specific processes such as anthropogenic climate change, snowmelt dynamics, evapotranspiration, or large-scale atmospheric drivers was not explicitly evaluated in this study.

Accordingly, the text has been revised to retain the quantitative description of the observed trends, while removing or reformulating process-based interpretations to ensure consistency with the scope of the analysis.

The new statement is:

“These reductions in streamflow are accompanied by parallel decreases in precipitation (median slope: -1.53 mm/year) and soil moisture (median slope: -0.11 mm/year), suggesting a coherent drying tendency across winter-rainfall (**BSk(s)**–ET(s), **Csb** and ET(s)–Csb(h)–Csc) regions. By contrast, summer-rainfall (**ET(w)**, **ET(w)**–BSk(w) and BSk(w)–ET(w)) and tundra ((**ET(w)**, **ET(w)**–BSk(w), BSk(w)–ET(w) and **BSk(s)**–ET(s)) climate zones show more heterogeneous patterns, with mixed streamflow trends and stronger warming signals compared to other regions.”

- L635-636: None of the results support this conclusion.

R. This conclusion is not supported, so it is eliminated.

Technical suggestions

- L24-27: The statement reads very similarly to the previous one in L21-22. Maybe rephrase to avoid repeating the idea?

R. Ok. The new introduction avoids repeating this idea.

- L30-31: I wonder if the authors could expand the list of citations for such a statement.

R. Ok. The new introduction will consider a bigger list of citations.

- L32: "*… in the Atacama*" region? Desert?

R. Ok. In this case is Atacama Desert.

- L33-34: I think it would improve the manuscript if the authors could explain what they mean by "*however, recent studies have yielded diverse and sometimes contrasting results*." What in particular are they referring to?

R. In this case, the focus is on the heterogeneity of the results.

- L49: I think the paragraph works well without: "*For many years, global studies primarily focused on streamflow, temperature, and precipitation*."

R. Ok. Considered.

- L64: This sentence ("*Other studies emphasise the dominance of climatic drivers over oceanic signals in shaping hydrological regimes."*) reads strangely. The authors have primarily mentioned climate-related drivers in the previous two paragraphs (L49-57 and L59-64).

R. Right, L64 is not the best sentence.

- L84: I think the sentence would benefit if the authors clarified the spatial extent of the mega-drought.

R. Ok. It is considered the whole country.

- L86-89: I think this idea is repeated. It can also be found in L44-45.

R. That is right. Considered.

- I wonder if the authors would consider reordering the order of the paragraphs. For example, paragraph 1 (L21-29) describes general climate change impacts; it then moves on to continental Chile (paragraphs 2 and 3, L30-47), then to worldwide impacts (L49-79), and finally returns to the effects on Chile.

R. The introduction is completely rewritten (See answers to reviewer 1)

- L108: “68°W”

R. Ok.

- L120: What do the authors mean by “*ET(w)*”? I think such a term has not been previously defined. Similar comment for other acronyms (e.g., BSk(s), BSk(w), etc.).

R. Yes, the acronyms are now explained in “Table 1”. It is added.

- In Table 1, I believe there is a typo. Shouldn’t it be "*Río Copiapó*“ instead of “*Río Copiaó*”?

R. That is right. It is amended.

- I think the information provided in L216-217 is the same as the data provided in L196-198.

R. Ok. Considered.

- L306: I wonder if “sensitive” is more accurate than “susceptible in this context. Also, in L307, the authors state: “*with higher elevation modulating the magnitude of these declines.*” Is this related to orographic precipitation enhancement, precipitation partition into rain and snow, or something else?

R. Yes. There is some consideration that will be eliminated. Furthermore, the words are now carefully selected.

- When explaining the results in Fig. 2, the authors use the panel titles rather than the numbering (a, b, c, …). I think the text would benefit from using the numbering instead of the climatic zones. For example, in L312, the authors state “*in … Cfb(i)-Cfb, …*”, but this region corresponds to the last panel in Figure 2, so interpreting the figure and the text is difficult. This comment also applies to Fig. 3.

R. Ok. Considered.

- How did the authors find this conclusion (L318): “*likely reflecting oceanic influence and differences in catchment size.*”?

R. This conclusion is now not considered because it is related to a reservoir-controlled catchment.

- 2, 3, 4, 5, and 6 would benefit from mentioning the units of the Theil-Sen slope.

R. Ok, they are slopes, units are mentioned.

- L443-444: I think the sentence would benefit if the authors explained what they mean by "*northern zones*".

R. Ok. The new map will help to understand it better. But it will be clarified, nonetheless.

- In the title of Table 2, I wonder whether "*uncoloured*" could be changed to "in black".

R. Ok. Changed.

- 9 would benefit from increasing the font size of the axis text. Also, are all correlation statistically significant? Not showing which correlations are statistically significant makes it difficult to draw conclusions.

R. Ok. They are all significant correlations. This is clarified in the new phrase "The correlation analysis provides insight into the significant relationships among streamflow and hydroclimatic conditions evaluated at the date of annual maximum streamflow." It was also modified the size of the axis test.

- I wonder if Figures 9-11 can be combined into a single figure with a message that's easier to read. The way it is currently presented looks repetitive, and the message is unclear. This level of detail could be in the Supplements (note that very similar plots are also shown there).

R. The figures are changed to make them more readable.

- Code availability: I strongly suggest that the scripts be made freely available when the paper is published. For transparency, the study should be reproducible.

R. Ok. No problem to make all information available.