Dear Editor,

We thank you for your time in reviewing our re-revised manuscript and your positive feedback on it. Please find below our reply to your comment (italic) and the changes we implemented in the manuscript to address it (underlined). We further attach a revised version of the manuscript. Finally, we would like to thank you and the Editorial Team for your collaboration throughout the whole peer review process.

Best regards,

Giulia Bruno and co-authors

1-Clarification on P_{DJF} and Summer Low Flows (Referee #1, Question 4):

Authors response: "We argued that increases in winter precipitation (P_{DJF}) might have indirectly contributed to decreases in summer low flows in the eastern cluster via feedbacks with evapotranspiration (E). Specifically, increases in P_{DJF} might have supported increases in storage (S) recharge in winter and thus in S levels at the beginning of the growing season. In turn, increases in S levels at the beginning of the growing season potentially contributed to increased vegetation growth and therefore E, by further contributing to reduced summer low flows."

The conceptual linkage between increased precipitation, higher soil moisture or groundwater storage, enhanced vegetation, increased evapotranspiration is well-documented in ecohydrology and hydrological literature. However, in your response, the term storage (S) is ambiguous. Please clarify whether you are referring to soil moisture storage or groundwater storage. While I agree that increased vegetation growth can lead to higher evapotranspiration and a subsequent reduction in soil moisture, this mechanism does not directly apply to groundwater storage. On the contrary, an increase in winter precipitation that enhances groundwater recharge would typically support higher summer low flows, not lower. This appears to contradict the mechanism you propose. Additionally, I encourage you to address the directionality of this relationship. If a decrease in winter precipitation (P_{DJF}) will also lead to a reduction in summer low flows, how do you reconcile that with the claim that an increase in P_{DJF} also results in reduced summer low flows? If both increasing and decreasing P_{DJF} will lead to the same outcome (reduced summer low flows), a clearer justification or an alternative explanation is needed to resolve this apparent inconsistency.

We understand that two pieces of clarification are required: (i) whether we referred to soil moisture or groundwater storage in the previous reply, and (ii) on the directionality of the link between winter precipitation (P_{DJF}) and summer low flows.

Regarding the first point, we would like to highlight that we do not rely on soil moisture or groundwater data, due to their unavailability across all the study catchments. For the trend attribution, we approximated sub-surface storage conditions at the beginning of summer with precipitation in the preceding seasons. This approach does not allow us to disentangle the

contribution of the two storages (soil moisture and groundwater) and therefore, we used the overall term 'storage' (*S*) in our previous reply and in the manuscript. To avoid confusion, we added this point at L53–55 when we first introduce the term 'storage' and its abbreviation.

Long-term decreases in summer low flows in small catchments may originate from long-term increases in catchment actual evapotranspiration (*E*), decreases in precipitation (*P*) during the summer season, and decreases in water storage in the catchments (*S*, mainly in the soil and groundwater in catchments with little influence of snow, Montanari et al., 2023).

Regarding the second point on the link between P_{DJF} and summer low flows, we argue that increases in P_{DJF} may lead to increases in soil moisture which may on the one hand translate into increased groundwater storage and summer low flows. On the other hand, increases in P_{DJF} and soil moisture storage may also lead to increased vegetation growth and *E* during the growing season. If the latter process dominates, increases in P_{DJF} could result in decreases in soil moisture storage and groundwater recharge during the growing season, which may ultimately support decreases in summer low flows, as the negative correlation between trends in P_{DJF} and in summer low flows in the eastern cluster may suggest, even though we acknowledge that this relationship may also be spurious. To make our line of reasoning clearer, we expanded L355–359 as follows.

From a mechanistic point of view, increases in winter storage recharge may also promote increases in vegetation growth and *E*, and thus decreases in soil moisture storage and groundwater recharge during the growing season and ultimately in summer low flows. We speculate here that the negative correlation between trends in P_{DJF} and in summer low flows in the eastern cluster may suggest this chain of processes (Fig. 7), even though we acknowledge that this relationship may be spurious.