EGUsphere, author comment AC1
https://doi.org/10.5194/egusphere-2022-921-AC1, 2022

Reply on RC1

Alessio Gentile et al.

Author comment on "Towards a conceptualization of the hydrological processes behind changes of young water fraction with elevation: a focus on mountainous alpine catchments" by Alessio Gentile et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-921-AC1, 2022

The work of Gentile et al. investigated the causes for young water fraction (F_{yw}) variations with elevation (F_{yw} is low at high altitudes) in Alpine catchments. The study areas are 27 catchments in Switzerland and Italy. The authors proposed new criteria for catchment classification into different hydro-climatic regimes. To gain insight into the reason for F_{yw} variations with elevation, this author used a new set of hydrological variables, namely the fractional snow cover area (F_{SCA}), the fraction of quaternary deposits (F_{qd}), and the fraction of baseflow (F_{bf}). In general, the idea of this paper about what drives F_{yw} variations with elevations is novel and of interest for understanding the functioning of catchments in Alpine regions as well as for understanding flow and transport in this region and potentially in other areas. However, the methodology and results do not fully support this idea. The text was not well written. Please find my main comments and line-by-line comments below.

Dear referee #1,
We would like to thank you for the overall positive assessment and the numerous detailed comments, which will contribute to our manuscript's improvement considerably.

Please find below a point-by-point response to your main comments. The responses to both your main and minor comments are reported in the Supplement.

We will incorporate all your constructive feedback once we receive the editor's response.

Sincerely,

The Authors

Main comments

• *Why did the authors need to propose a new criterion for catchment classification? The authors used two variables: (1) streamflow ratio between different months and (2) snow cover fraction for the proposed catchment classification, but later they adjusted the threshold of these two variables to have consistent results with Staudinger et al. (2017).*

Why didn't they just use the method of Staudinger et al. (2017)?

• We propose a new criterion for the regime classification because our dataset includes catchments outside the Swiss borders (i.e., the four Italian catchments) for which the Weingartner and Aschwanden (1992) and Staudinger et al. (2017) classification scheme cannot be strictly applied since they were designed for the Swiss hydro-climatic regimes. We "manually calibrate" the thresholds of F_{SCA} and Q_{June}/Q_{DJF} for classifying catchments in "rainfall-dominated", "hybrid" and "snow-dominated" as in the work of Staudinger et al. (2017). In this way, the classification scheme is "calibrated" on the Staudinger et al. (2017) catchments and we can apply it also outside the Swiss borders. According to the referees' comments, we will consider the possibility of modifying the classification scheme to make it more straightforward to link to previous classification (e.g., using streamflow and topographical data), but it will remain transferable to other regions.

• The objective is to investigate what drives F_{yw} variation with elevation. The authors proposed using a new set of hydrological variables, but what are the relations between these variables with elevation? For example, what are the relations between F_{SCA}, F_{qd}, F_{bf} with elevation? With F_{SCA}, I can infer from the text, but it was not explained in the text until the last sections (Section 5.2) of the manuscript. F_{SCA} cannot be directly related to elevation, instead, it needs to be related to the catchment classification then from catchment classification to mean elevation. However, in other areas, can we still relate F_{SCA} to elevation? With the other variables (F_{qd} and F_{bf}), it is unclear to me what are their relations to elevations. In addition, F_{qd} does not seems to be a good variable because there is no significant relation between F_{yw} and F_{qd}.

• Thank you for this comment: this is a good point. We will add, for each variable (F_{SCA}, F_{qd} and F_{bf}), a figure that shows the relation with mean catchments elevation. The three figures are reported in the Supplement, and we will include them in the revised manuscript.
a) The F_{SCA} increases with the mean catchment elevation in our data set, revealing a positive, statistically significant correlation. This suggests the increasing snow cover persistence at high altitudes.
b) F_{qd} decreases with the mean catchment elevation in our data set, revealing a negative, statistically significant correlation. This negative correlation reflects the fact that F_{qd} decreases when the mean slope increases (Arnoux et al., 2021) (mean slope increases with mean elevation for the catchments analyzed in this study, as shown in Fig. 4a of the manuscript). We have decided to use F_{qd} because Arnoux et al. (2021) demonstrated a strong positive correlation between F_{qd} and Winter Flow Index (WFI) highlighting the role of unconsolidated deposits in storing groundwater (in terms of age, old water). The missing information about the portion of fractured bedrocks, the thickness of quaternary deposits and the bedrock topography will demand future attention for a complete picture of the role of geology (potentially resulting in a statistically significant correlation with F_{yw}).
c) F_{bf} reveals an opposite behavior with respect to F_{yw}: it decreases until 1500 m and it increases at higher elevations.

• The manuscript needs to be restructured and revised. There is a lack of clarification in the text. More description of the study area characteristics is needed. Much of the information provided in Study Sites, and Material and Methods is not relevant (e.g., shape file, detailed source of data, etc.). Instead, citing the sources of the various data (both from individuals and organizations) can be moved to either the Authors' Contributions or Acknowledgements, or in the supporting information Sections or to a table rather than describe them within the text of the article, making it very difficult to read such detailed

information. If possible, I would also suggest the authors publish their data in an open repository.

- **Thank you for these suggestions. We will revise the "Study sites" and "Material and Methods" sections accordingly. We will move all the data sources in the "Data availability" section and remove irrelevant information. We will describe the study sites in a more concise manner using a Table and some descriptive figures: e.g., mean slope against mean elevation, mean annual precipitation and mean annual discharge against mean elevation, variations of mean monthly flow with elevation. These changes should make the text more fluent.**

Please also note the supplement to this comment:
https://egusphere.copernicus.org/preprints/2022/egusphere-2022-921/egusphere-2022-921-AC1-supplement.pdf