

## ***Interactive comment on “Rivers in the sky, flooding on the ground” by Monica Ionita et al.***

**Monica Ionita et al.**

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R: We thank the reviewer for the suggestions/comments/feedback that helped us improve our manuscript and for tacking time to read and review our paper.

The paper provides an interesting and unique contribution showing atmospheric rivers as drivers of high flows in the lower Rhine catchment. It thus enriches our understanding of hydrometeorological flooding drivers at the catchment level for this global region. By utilizing a long and comprehensive meteorological record, the authors show how indeed ARs have led to important damages in the region. It also provides interesting insights these events are preceded up to 7 days by intense moisture transport from the tropical North Atlantic basin typically precede ARs. The comments I have are minor which concern mainly methodological clarifications as well as suggestions to provide more insights of the repercussions of their findings. If a new version of

C1

the manuscript successfully address these issues I would recommend the article for publication. Please find here below my specific observations:

Line 78: “i) analyze from a hydrological point of view” This sounds rather broad and ambitious; this line should be refined to specify what ‘hydrological’ actually means in the context of this publication

R: We will modify the text following the reviewer’s suggestion.

Line 81: “iii) link the flood peaks with 80 the occurrence of AR”. It does not look very scientifically sound to try to find a link between these two aspects. This suggest that the objective is already anticipating the results. This objective should be changed to something along the lines of ‘explore how the occurrence of ARs explains flood peaks’ or similar

R: Thank you for this comment. We will change the paragraph according to reviewer’s suggestion.

95-102: This paragraph should be enriched with references. It sounds as if data has been already processed and the authors are already presenting their results

R: We will modify the text following the reviewer’s suggestion. More references will be added.

Line 98: “winter or spring floods, which are triggered by warm air intrusions with corresponding snow melt in flatlands and low mountain ranges and summer floods, which are fed by large-scale 100 heavy rain or long-lasting repeated precipitation episodes (in connection with late snowmelt / glacier runoff in the Alps)” Please improve the fluidity of this sentence or try to split it two. At present it is not very clear

R: The paragraph will be modified and improved in the revised version of the manuscript.

Line 112: This paragraph would be enriched by a short 1-2 sentence conclusion about

C2

the general hydrological trends of these tributaries.

R: We will add the required information in the revised version of the manuscript.

Line 114: How is this station representative for the catchment? What about the impact of upstream water infrastructure (dams, reservoirs, levees, and others which may mitigate floods)? Wouldn't readings at this specific part of the catchment give a misleading interpretation if the catchment is heavily intervened? Is hydraulic and infrastructure intervention indeed important here?. I think that this is very relevant when you compare events of 1925 vs the 1990s. I suppose that a number of hydraulic interventions have been made in the river in a period of ~60 years. Probably these interventions and the fact that you are just looking at river gauge readings are leading us to underestimate the connection between ARs and flood peaks. Even if the role of hydraulic infrastructure is not deemed as relevant in this part of the catchment, it would be useful to clarify these aspects throughout the text.

R: In the revised version of the manuscript we will add a paragraph regarding the importance of Köln gauging station as well as the influence of river training on the flood magnification in the Lower Rhine. Although Rhine River has been intensively modified, most of the river training was done in the upper Rhine, especially on the Swiss side of the river. There are numerous studies showing that the modification on the catchment area have a relatively small influence on the flood peak in the Lower Rhine. All this information will be added in the data and methods part in the revised manuscript.

Line 144: reference? What is the general proportion of floods happening during winter vs summer? Are winter ones more or less frequent (generally speaking although these trends, naturally, are not constant)?

R: We will add a table with the occurrence rate of annual maxima over the period 1817 – 2019. The annual maxima, @Köln gauging station occurs mainly during the winter months. This information will be added also in the revised version of the manuscript.

### C3

Line 214 and in general throughout the text: The manuscript would be highly enriched if somehow these monetary losses are translated to current USD/EUR values; not asking the authors to perform a complex econometric calculation but it would be useful to put these economic losses in perspective. For example, the 1925 event seemed to have caused losses of 100 Million DM vs 50 Million DM in 1993 vs 500M in 1995. How do they compare each other nowadays in current USD/EUR?. Similarly, the text would be enriched if the authors provide a table (or figure) comparing the impacts that these events have had on human lives, displaced people, monetary losses, infrastructure damages (even a qualitative description), and others. This would provide a useful information to understand the truly impacts of ARs in this key global catchment.

R: We agree with this comment and we will try to change the currency of monetary losses in Euro. We can make mostly just a rough approximation, because we do not have data regarding the inflation rate for 1925/26 for example.

Line 333, Conclusions:

o In general I think that either here or in previous sections there should be a short discussion describing the general trends of ARs-caused high flows over these 2-century time period. With the data you already have, it would be very useful to have a perspective on whether ARs-caused floods in the Rhine have been more recurrent? Or more intense? Both? None? While I understand that a full and comprehensive trend type of analyses might be out of the scope of this study, the manuscript will be highly enriched if even few sentences are added exploring this issue.

R: We fully agree with this comment and we will try to improve the conclusion part in the revised version of the manuscript taking into account the aforementioned suggestion.

The conclusions should also highlight the socio-economic impacts that these events have caused.

R: This information will be added to the conclusion part in the revised version of the

### C4

manuscript.

Please also note the supplement to this comment:

<https://www.hydrol-earth-syst-sci-discuss.net/hess-2020-149/hess-2020-149-AC1-supplement.pdf>

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2020-149>, 2020.