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Interactive comment on "Patterns of extreme weather associated with observed and proxy River Ammer flood records" *by* Norel Rimbu et al.

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Response to Reviewer #1

We thank the reviewer for her/his critical but constructive comments. The fact that the main point of criticism is that the material presented in the manuscript contains a rather limited gain of knowledge related to flood variability showed us that this point needs to be better presented.

I agree that a more extensive discussion of synoptic scale phenomena related to flood variability, as described in recent papers (e.g. Grams et al. 2014, Messmer et al. 2015, Hofstätter et al. 2017), should be presented in our manuscript. However, these papers analyze synoptic scale processes related to observed extreme precipitation and flood

variability during the last decades. In this manuscript we investigate the role of synoptic scale phenomena not only to observed flood variability, but also to frequency of flood layer variability at interannual to millennial time scales. Our manuscript focuses on the role of atmospheric blocking circulation in explaining extreme weather and climate patterns associated with river Ammer floods as well as on the possible role of blocking circulation to explain flood-solar forcing relationship as described in previous papers (Czymzik et al. 2010, 2013, 2016).

In a previous paper (Rimbu et al. 2016) we investigate the large-scale atmospheric circulation anomaly patterns associated with river Ammer floods. In the present manuscript we focus on extreme weather variables (i.e. daily maximum temperatures and daily precipitation totals) as well as on extreme climate indices (i.e. TX90p and r10mm) anomalies associated with river Ammer floods. Therefore, we investigate changes in the tails of the distribution functions of weather variables during periods characterized by a high frequency of floods. Changes in the tails of the distribution functions of weather variables are related to changes in the corresponding means in a complex way (e.g. Zhang et al. 2011). For example, TX90p and temperature anomaly patterns associated with floods could be different each other. Therefore, searching for a direct link between flood frequency and extreme climate indices during the observational period could improve the interpretation of paleoflood records in terms of extreme climate variability during the past.

Although the linkage between the solar forcing and river Ammer floods is discussed in previous papers (Czymzik 2010, 2013 and 2016), here we focus on synoptic scale process behind this relationship. We argue that the increase in blocking frequency in northeastern Europe during low solar activity increases the probability of wave breaking and associated extreme precipitation synoptic scale processes leading to increased flood frequency. The role of northeastern European blocking in generating extreme precipitation and floods over western Europe during the last decades is well known (e.g. Barton et al. 2016 and reference therein). However, we investigate this linkage using two-dimensional blocking indices covering more than one hundred years (based on 20CR v2 since 1871), which makes this relationship relevant for flood variability on longer time scales. Detailed significant tests reveal that this relationship, i.e. the low solar activity is related to increased blocking frequency over northeastern Europe, is robust.

I think that the analysis presented in our manuscript gives new information related to flood-climate relationships. We emphasize the essential role of atmospheric blocking over northeastern Europe in increasing simultaneously the probability of floods over western Europe and extremely high temperatures over northeastern Europe during summer. The modulation of blocking frequency by solar forcing explains, from synoptic scale perspective, the solar forcing-river Ammer flood frequency linkage as discussed in previous papers. Climate model simulations are needed to better understand the physical mechanisms that control flood variability and its relationships with extreme weather and climate at multidecadal to millennial time scales.

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