

I would like to thank all the reviewers for the comments on the paper and for recognising the potential of such a paper to the evidence base for long term variability of flooding. Below is a set of responses to the points identified.

Overarching comments

In developing this paper I attempted to provide a short review paper of existing published series which already include detailed accounts of the factors affecting the hydrology of each of the catchments and the different source materials, and provide five additional series which have yet to be published. The intention was to provide a summary paper which provided a 'rapid communication' of the first attempt at a British level to assess the different historical patterns of flooding that are starting to emerge from this dataset. In writing this paper the intention was to limit discussion of the factors affecting the individual catchments and focus on the 'big picture', whilst I appreciate that the consideration of the local factors affecting the hydrology of the individual systems is important and requires careful consideration, the focus of this short 'rapid communication' style paper was to explore some of the potential findings of such a dataset, rather than delve into the specific aspects the impact on each of the catchments, as such references to texts addressing these issues and where available the catchments considered in detail are provided. Following the reviewers comments a detailed depiction of the catchments and explanation for each of the different catchments has been included, the intention is not to provide a full detailed explanation of each catchment (beyond the scope of a single paper, this paper is now of a considerable size with brief catchment reviews), but a summary of the key points impacting on each system, so that this paper can be read independently of the separate detailed cited studies.

Reviewer one.

The paper does not directly reference the long series available for the Mediterranean, but I have added references to this work

I appreciate there are a number of anthropogenic influences that have affected river catchments over the course of this study. The intention is not to 'over simplify', but to avoid a detailed discussion of the different catchment modifications that could result in changes to the catchment hydrology, particularly as we are interested in only the largest events, events which tend to overwhelm the catchment irrespective of many of the human modifications. As documented above a summarised version of catchment specific conditions is provided for each system, this includes major landuse changes over the period and modifications which may have significantly modified the channel over the timescales involved.

Much of the deforestation of the UK was complete by c. AD 800-1000, before the start of this study, drainage of large areas and land improvements date back to pre-Roman times, with modifications of these systems throughout the intervening period. Within this study the points raised by the reviewer are all correct in relation to potential factors modifying local hydrology, but a number of authors have suggested that these modifications have a diminishing influence on extreme events, whilst they will certainly have an influence on lower frequency events, as this study is focussed on extreme flows it is likely that the influence of these land use modifications will be diminished.

As above, yes, most of these systems have structures built upon the adjacent lands, or crossing the rivers themselves, with modification of the channel, as explained in the paper this is one reason why greater confidence is given to the period 1750- as most of the catchment study locations present stable cross sections from this time. With greater uncertainty over the longer timeframe.

I agree that the preferential recording often reflects an impact to an individual or a community, this is addressed in the paper

The catchments in the UK that are used are predominantly rural with urban centres reflecting points at which records are carefully recorded, for one or multiple reasons often associated with religious, political or trade centres (e.g. York). The input of urban flooding during large flood events is minimal; these systems reflect large (UK relative) catchments. The recording of the events in terms of impact I agree varies through time with the development of flood defences, but during the magnitude of the floods discussed these are often overwhelmed, hence one of the reasons we use such a high threshold.

Even before the recent period (1750-present) the largest floods are still recorded, this period represent the timeframe within which most of the flood defences were constructed in UK cities. London is an exception and this is one of the reasons why I avoided using the city itself as a location, even given the wealth of materials present.

When considering the catchments focus is given to specific locations, I agree attempting to merge records over large catchments is fraught with problems hence why this study focuses on relatively stable channel sections in specific settlements. I accept and appreciate this oversight may have resulted in some misunderstanding an apologies for this omission, I have now cited the recent paper by Böhm, et al., 2015.

Each of the study sites selected was intentionally above the tidal limit and as such would not be influenced except during a potential tsunami event, none of which are noted to have affected the UK significantly during this period, the potential exception being the contested 1607 event on the lower Severn, this does not appear within the series.

The role of precipitation in its different states is discussed with different generating mechanisms responsible for flooding, in small steep catchments I agree catchment conditions can have an important influence, but in the systems discussed floods are generally either precipitation, snowmelt, or a combination in conjunction with frozen soils and persistent precipitation over a long timeframe. The role of groundwater in saturation can be important in relation to persistent precipitation and have added a section detailing the potential role of groundwater.

The reviewer is correct in stating a review of the historical societal position is not included, this is intentional as previously stated for the largest events human activities have an apparent limited impact (with the potential exception of large water retention structures), therefore the social aspects have limited significance for the most extreme events, other than through responses and management.

The idea behind transforming single point events to an averaged series, is that a set of single points (punctual) is not easily comparable to the potential drivers behind flood generation, as such to analyse the data in such a way over a long time-period then we need to explore the data in a more aggregated form.

I accept the comment concerning the contradictory statement, it should read positive forcing, so - “The flood-rich phase in different catchments around Britain (except Wales) during the late sixteenth and early seventeenth century corresponds to a phase of increased storminess in the North Atlantic (Lamb and Frydendahl, 1991) and increased solar activity (Muscheler et al., 2007), and is evidenced in flood accounts from catchments across southern and central Europe (e.g. Brazdil et al., 1999) suggesting a wider 25 flood-rich period, which relates to a particularly strong phase of positive solar forcing (Fig. 4).” This section has been further revised following the reanalysis.

Anonymous Reviewer 2:

I would like to thank the reviewer for making the comments on the paper and for recognising the potential of such a paper to the evidence base for long term variability of flooding in the UK, providing an opportunity to move beyond the relatively short gauge series available. Below are comments directly addressing the concerns of anonymous reviewer 2.

Agree. I accept the reviewers comment and reference to the UK will be removed particularly in the short title and replaced with Britain.

Agree. The reviewer is correct it is the 90th percentile of the annual maximum series.

Agree. Clarification on the series construction for the Thames (Kingston/Teddington) will be added to the paper.

Accept. Whilst the intention of the paper was to provide limited catchment modification information a summary description for each of the different sites has been added explaining how catchment modification is accounted for.

The concept of flood seasonality is an interesting one and will be addressed in a separate paper

Agree. The inclusion of a discussion section addressing the northern England flood rich phases will be added to the amended paper. This is a good suggestion and am grateful to the reviewer for it.

Agree. The recent phase of flooding and its relation to the study is very interesting, unfortunately the acquisition, since the initial review the dataset has been updated through to December 2014, direct discussion is made to the December 2015 flood events, though not all sites have data for 2015, so at present is not included within the study. The use of unprecedented rather than exceptional would be preferential I agree, and will be amended.

Agree. I will expand the discussion section further to explore the implications of solar forcing further, though there is limited literature out there examining solar forcing and flooding explicitly, there is some potential for future implications as identified by the reviewer.

Comments to Reviewer #3

The reviewer is thanked for their considered comments on the paper and recognising the value and potential contribution of this paper to the broader literature on historical flooding and signals within these series. Below are a series of comments on the specific points raised by the reviewer

The reviewer raises concerns that 'too little is done to appraise quality, reliability and potential of the data... particularly pre-1750'. As stated in the paper the absence of records does not necessarily indicate an absence of floods, simply that they were not recorded, or that the data has been lost. The cited papers provide a detailed discussion of a number of the issues raised by the reviewer, as stated in comment to reviewer #1, the intention of the initial paper was to provide a 'rapid communication' style paper to permit a review of the datasets and the patterns/trends that they identify rather than focus on the series themselves in great detail, as this is provided for most of the series within the cited papers. Several of these points are now discussed in further detail in the specific sections addressing the locations and particular factors important to them.

As stated in the paper greater confidence is placed in the data post-1750, whilst I accept and appreciate the concerns with the pre-1750 data, if accepting of the limitations, then this can be of value in better understanding some the broader trends, but as stated this needs to be treated with caution. Whilst a number of the published studies focus on flood frequency analysis, they focus on the value of adding historical information into flood frequency analysis, as such a detailed and extensive chronology was constructed in each case, with large amounts of data not included as 'confidence' in an estimated flow was low, not that no event was recorded. A number of accounts detail floods, with over 3000 accounts held for the rivers discussed, but very few provide sufficient detail to permit the estimation of flow, the exclusion of the early accounts on the Tweed reflects a lack in confidence in estimated flows by the author, locally based individuals may feel that estimates could be provided with some degree of confidence, not that these accounts have been missed, as the reviewer states, confidence in accounts is vitally important. I hope that some of these points are now also clearer in the revised extended version of the paper.

Concerning the climatic drivers, I agree that seasonality is an interesting aspect, but this paper has been considerably extended and feel that the discussion of seasonality across the different sites warrants a separate discussion but I agree it is worthy of a more detailed discussion of the analysis.

An improved and more detailed explanation of the statistical analysis will be included, this is also requested for reviewer #4, I appreciate that upon reflection this can be improved and both reviewer's comments are appreciated. It is worth noting that this has not previous been attempted.

I agree with the reviewer that the changes to the channel form, cross section, landuse are all important issues and have been detailed in considerable depth within the cited specific case study analyses, these have now also been discussed more fully in the expanded sections; but sites do exist where comparison can be drawn as a result of long series, stable cross sections etc, but one must be careful in site selection and not just dismissive of complete systems. I strongly disagree with the reviewer in stating that the case studies do not provide this detail, as in these case studies detail these points and are explicitly and in great detail discussed, as to the value of the site used for analysis as it fulfils the criterion the reviewer states. I hope the expanded sections address the reviewers concerns, whilst recognising the constraints of bringing these series together within a single paper.

Comments to Reviewer #4

I would like to thank the reviewer for their insightful comments and hope to have address a number of the questions stated within the expanded revised version. Comments on specific points can be found below:

The abstract will be strengthened to reflect the greater discussion of the results

P10159 L9, The statement relates to Britain, with recognition given to other European studies within the cited papers

Methodology – this has been revised and I hope is now clarified in the revision and the reviewer's comments accepted and appreciated.

P10161 L9 (initial submitted version), each station.

As previously commented the analysis of indices and seasonality are interesting aspects, but will be covered in a separate paper, as this has already become a rather lengthy paper.