Relies to the comments of Anonymous Referee #1

Authors' replies are in blue color and revised sentences are in italics.

> This paper proposes a method to identify the main flood season(s) in all large rivers in the world, based on a distributed hydrological simulation over a few decades, forced by an atmospheric reanalysis product. The article is well written and the storyline follows a sound structure. Although the flood regime of most world rivers is already well known, the findings of this research can be useful for some hydrological applications, such as for ungauged river basins and also to provide a continuous and consistent spatial dataset with global coverage with such type of information. I assume that the validity of the findings is limited to a specific range of basin size, given the spatial resolution used in the modeling, and its use in detecting extreme discharge values. I think that this research is worth of being published, provided that the few comments below are adequately addressed.

We thank the anonymous reviewer for the positive comments and further critical comments that we believe have enhanced the overall quality of the manuscript.

> P.4600-4602: the authors first highlight the benefits of POT approaches (e.g., p.4600, line 24-26) and then don't seem to implement this technique for peak selection. The method based on P_AMF is more like a percentile approach, while in the POT one should select only the peak within the same event, hence it is different. See the recent works by Mallakpour and Villarini (2015) and by Alfieri et al. (2015) for recent applications of POT on observed river discharge and simulated gridded streamflow, respectively.

We apologize for the misunderstanding that we have not applied the POT method in perhaps the traditional sense. In fact we do use aspects of POT not simply for peak selection, but to define Peak Month (PM.) We initially introduce two sampling methods (Annual Maximum and POT) and subsequently argue that the idea of a threshold in the POT approach is more appropriate for defining a flood season in terms of a volume-based threshold technique. Thus POT, in terms of volume, is critical for our classification approach. Additionally, PAMF metric is used to evaluate the defined flood seasons. Thanks also for the references on POT. We have added those as appropriate into the manuscript. For clarification, we have changed P.4600 line 20 - P.4601 line 7 text to read as:

In contrast to the AM method, this characteristic of threshold can capture multiple large independent floods within a year, including the annual maximum flow, but may also miss the annual maximum flow in years in which streamflow is less than the pre-defined threshold (Cunderlik and Ouarda, 2009; Cunderlik et al., 2004a; Ouarda et al., 1993.) Thus, deciding the proper threshold level is important.

Therefore, to define the FS, and specifically the PM, both volume and magnitude aspects need to be considered (Javelle et al. 2003). To do this, we adopt a volume-based threshold technique. This technique is similar to a streamflow volume-based method in terms of capturing the Julian day by which a fixed percentage of the annual streamflow volume has occurred (Burn, 2008), however it also applies this fixed percentage across the entire streamflow record and records points where streamflow volume surpasses it, drawing from the prescribed threshold concept in the POT method. Here we select streamflow surpassing the top 5% of the flow duration curve

(FDC) across all years (1958-2000) as the threshold for considering a high streamflow level, as commonly adopted in threshold approaches (Burn, 2008; Mishra et al., 2011.)

> Indeed, methods based on fixed time windows are likely to be appropriate for river basins where floods occur with timing similar to that duration. In reality the flood duration vary a lot, and mostly depend on the size of the river basins. In small river basin the flood wave can be entirely contained in a single day, while for large rivers such as the Amazon or the Zambezi, there is a distinct single peak in each year, and the river discharge can be above flooding conditions for a month or more. The authors should consider this in defining the approach for peak selection and perhaps state the limitations/caveats of using the approach described. Other option would be to clarify that the focus of the article is more on detecting the season with on average higher river runoff, rather than looking at extremes causing floodplain inundation.

We agree with the reviewer's comments. Basically, the flood season defined in this study is designed as a fixed time window (3 months) to identify spatial and temporal patterns of dominant streamflow uniformly. To define PM and FS, we focus on the average timing of dominant streamflow, rather than flow duration – as suggested by the author. Thus, globally defined flood seasons are not necessarily representative of individual flood characteristic (e.g. flood duration), but rather the timing of dominant streamflow. For clarifying this, we have changed P.4600 line 1-5 to:

To identify spatial and temporal patterns of dominant streamflow uniformly, we design a fixed time window for representing flood seasons globally. Here we define major flood seasons as the 3-month period most likely to contain dominant streamflow and the annual maximum flow. The central month is referred to as the Peak Month (PM) and the full 3-month period is referred to as the Flood Season (FS.) Specifically, we define PM first, and then define FS as 1 month before and after the PM. This approach is performed for both observed (station) and simulated (model) streamflow to gauge performance.

> Sect. 3.3: As the authors write, there is a potential delay due to routing of the flood wave downstream and smoothing effect due to lakes and reservoirs. Anyway, I think that considering the start of the flood season is a more suitable parameter than the average PM, as the flood often originates upstream and then propagates downstream with a delay dependent on the travel time. Again, I bring up the example of the Amazon river (see, e.g., Rudorff et al., 2014) being the extreme case, where such approach of averaging would simply identify the peak month of a portion of the river basin located in its intermediate part (in terms of distance from the outlet location).

We agree with the reviewer's comments. In the case of large-scale river basins, long travel time and varying climate affects flood seasonality at different locations in the same basin. In section 3.3, we screened out stations having low PAMF values and defined the PM mode as a sub-basin's PM. The start of the PM with a high PAMF value would be a suitable approach to define the basin-scale PM (applicable for numerous management purposes), however, biased simulations or varying climate effects in parts of the basin may impact one or a few stations that could subsequently affect the entire basin's PM. The goal of section 3.3 is to define the sub-basin scale PM for comparing model outputs and observations; in this case considering the most frequent PM may be more robust overall as compared to the start of PM. In consideration of the review's comments, we have provided the following sentences after p.4604, line 4:

The sub-basin's PM is defined based on occurrence of PM rather than the PAMF value to diminish results being skewed by biased simulations or varying climate effects in small parts of the sub-basin. When there are an equal number of occurrences for different PMs, the average PAMF values are used to determine which PM is selected. In this case, the effect of stations downstream of reservoirs will be minimized given their typically low average PAMF values.

Figure 12: panels should refer to specific river sections rather than just river names

Thanks for the suggestion. We have now provided specific locations. The Figure caption has changed to:

Model-based streamflow climatology (left) and corresponding monthly PAMF (right.) Types and locations are: a) uni-modal streamflow – At Bom Lugar, Amazon river, Brazil, b) bimodal streamflow – At Saacow, Webi Shabeelie river, Somalia, c) constant streamflow – At Terapo Mission, Lakekamu river, Papua New Guinea and d) low-flow – At La Sortija, Quequen Salado river, Argentina.

References Alfieri, L., Burek, P., Feyen, L. and Forzieri, G.: Global warming increases the frequency of river floods in Europe, Hydrol. Earth Syst. Sci., 19(5), 2247–2260, doi:10.5194/hess-19-2247-2015, 2015.

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Rudorff, C. M., Melack, J. M. and Bates, P. D.: Flooding dynamics on the lower Amazon floodplain: 2. Seasonal and interannual hydrological variability, Water Resources Research, 50(1), 635–649, doi:10.1002/2013WR014714, 2014.