Firstly we would like to thank W.R Berghuijs for sharing his opinion on the manuscript and the response provided to Anonymous Referee # 1. His suggestions and opinion are aiding in clarifying various points of the manuscript, and have promoted discussion on the subject of recurrence and its relation to seasonality. We would like to respond as below to his comment.

As pointed out by W.R. Berghuijs the relation between the timing of peaks of P and PET is in fact a factor that influences recurrence. Figure A1 and A2 of this document show the relation of the peaks between P and PET with respect to the recurrence in Q and S respectively. Basins out of phase (difference in peaks longer than 3 months) between P and PET show generally high recurrence, especially in S. On the other hand, the basins in phase (shorter than 2 months) between P and PET, the recurrence tends to be smaller, but differs significantly depending on the basins.

Aridity can also be influential to the recurrence of variables. Figures A3 and A4 of this document show the relation between aridity and recurrence in Q and S respectively. In the tropical and subtropical region, humid basins have high recurrence in all variables as discussed in the discussion paper. In the temperate area there is no apparent relation between aridity and recurrence. In the subarctic region there is some relation indicating that the drier basins show lower recurrence especially in the case of storage.

In case of tropical basins aridity is the main factor defining recurrence. In this region the aridity of basins ranges through the entire spectrum, ranging from very humid to very dry. In very humid basins the runoff ratio and the storage change ratio is higher allowing for runoff and storage to follow the patterns in precipitation, in the cases analyzed they follow a recurrent pattern. These recurrent patterns in variables are independent of the seasonality for example in Amazon where precipitation and runoff are recurrent and have low seasonality.

In tropical and temperate areas with higher aridity index, all basins have low recurrence in runoff (classified as PES, PE, ES, or E), essentially due to the high sensitivity of runoff to precipitation under smaller runoff ratios. In the case of storage, its recurrence depends on the timing of the peaks between P and PET. If the peaks are in phase evapotranspiration will be taking moisture at the same time that precipitation is supplying leaving less volume to transfer to storage change making storage more sensitive to variations in precipitation. In the case where the timings are out of phase,

there will be higher variation in storage making it less sensitive to changes in precipitation making it more recurrent.

Subarctic basins are particular because of snow effect. Recurrence in storage and runoff is dependent on the amount of precipitation that falls as snow and it is rather independent on the pattern of recurrence in precipitation. This is because of the constant snow accumulation during winter and the melting during spring and its independence with the pattern in which precipitation falls. In this region also, the recurrence of the variables is different than the seasonality as it has been pointed out in the manuscript and the response to Anonymous Referee #1 between the Yenisei and Ob basins, and also in basins such as Ob where precipitation and runoff have a similar seasonality but their recurrence is different.

To our understanding, seasonality is calculated and identified from the regime curve or climatology, which will be the result of a long term average. In the case of recurrence, we are checking the year to year variability of the yearly pattern of a variable, and we are interested on the degree to which these patterns are similar in each of the four variables, and what makes the different combinations exists. Our choice of investigating the recurrence of hydrological variables is motivated by the importance of the repetitive patterns from a water management perspective, and the need to investigate how these patterns are created.

The points we discussed in this response to the short comment by W.R Berghuijs will be included as part of the discussion in the revision of the manuscript to enhance and clarify the aspects of recurrence and its link and difference with seasonality.

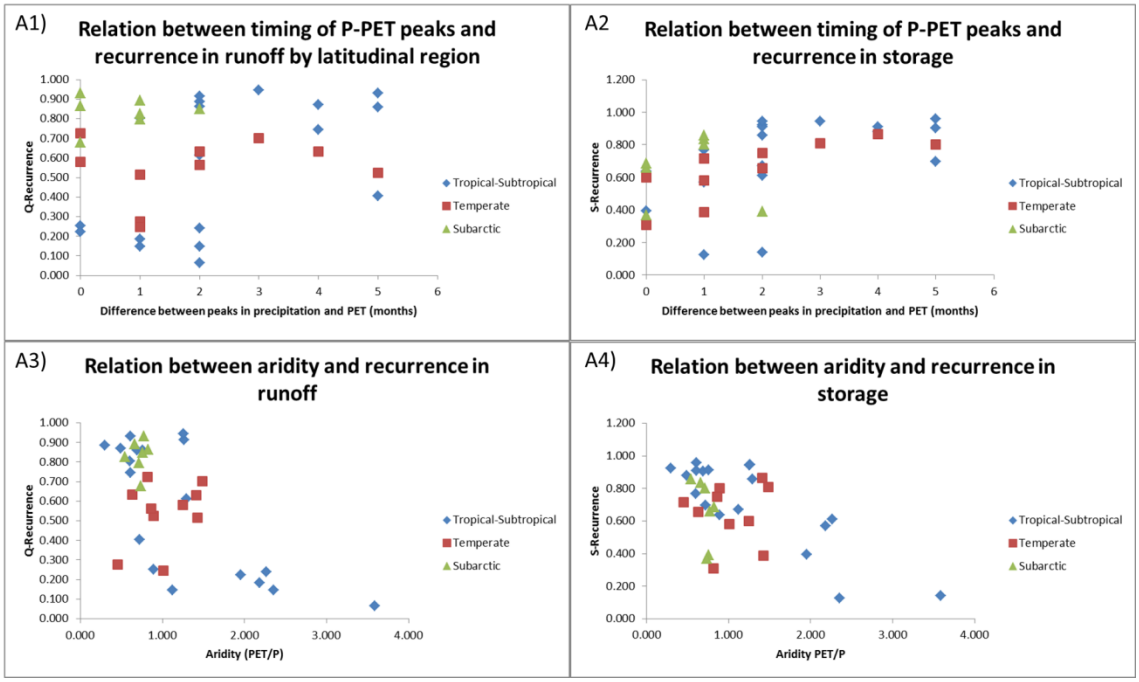

Figure A. Relation between timing of peaks in P and PET and recurrence and aridity and recurrence.