Interactive comment on "Examining controls on peak annual streamflow and floods in the Fraser River Basin of British Columbia" *by* Charles L. Curry and Francis W. Zwiers

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We thank Dr. Jenicek for his perceptive review. In response to his major comments:

1) We are grateful for the Reviewer's comment on the Introduction, which highlighted two weaknesses in the submitted version: first, the larger context and motivation for the work were incompletely expressed; and second, the historical summary provided in Sec. 1.2 is something of a distraction for those readers not specifically interested in the FRB. For this reason, we have eliminated much of the material from the previous Sec. 1.2 and moved two shortened paragraphs to Sec. 4, where they fit well with the case studies examined there. A new Sec. 1.1 better explains the context and aims of

our work.

2) Section 2.3 and Table 2: As mentioned in the response to the minor comment of Reviewer 1, we have provided a clearer motivation for our use of the CRI in the last paragraph of Sec. 2.3 and in the paragraph describing the cross-correlations between CRI and streamflow in Sec. 3.3.3. The measure R_APF is similar to CRI, but weights each day's rainfall equally in the sum, while CRI weights each prior day's R by an additional factor of 0.9. Thus, as mentioned by the Reviewer, R_APF likely overestimates the influence of antecendent rainfall in the regression calculation compared with CRI. Since we found that R_APF was not a significant predictor of either observed or VIC-simulated APF, we might expect that CRI computed for the day of APF would be a similarly poor predictor of APF. An explicit check confirms this conclusion. Hence, it is something of a moot point whether R_APF or CRI(day of APF) should be included in the predictor set, as neither is significantly correlated with APF (and thus neither appears in the correlograms).

Despite these negative results for an interannual relationship between CRI and APF, we emphasize that intra-annual covariations between CRI and streamflow at various lags are detected, as summarized in Fig. 4.

3) p.8, lines 22-25: MLR does not require the "mutual independence" of predictors in the sense of the predictors being orthogonal, but it does require that the predictors are not multi-collinear. That is, if there are k predictors, the predictors should collectively span a k-dimensional vector space as opposed to a lower-dimensional vector space. Ascribing "explained variance" to individual predictors when predictors are not orthogonal is always challenging. One approach that is sometimes used is to orthogonalize the predictors, but this produces explanatory variables that are difficult to interpret, are not directly observed and in fact, cannot be determined uniquely (any fixed rotation or reflection of a given set of orthogonal vectors would produce another set of orthogonal vectors that spans the same vector space equally well). We therefore prefer to use the candidate predictors as observed, recognizing that they are not fully independent

and taking that into account in the interpretation of the MLR results. The extent to which the predictors are linearly dependent on each other can, in part, be assessed by calculating cross-correlations, which are discussed in Sec. 3.3.4 and illustrated in the correlograms Figs. 3b and 6.

4) Sections 3.3.5 and 3.5.5: The Reviewer correctly ascertained that the MLR models we obtain are not suitable for APF forecasting. Instead, the word "predictor" is used in a statistical sense; "predictor" is often used as a synonym for "independent variable" when regression models discussed. Rather, they constitute a useful summary of which variables have most influenced the APF over the historical period examined. The Reviewer (and also Reviewer 1) also asked about whether results from the MLR might be used to say something about projected future APFs. We have made some suggestions along these lines in the Conclusions.

5) Paper structure: In response to this criticism, and acknowledging similar comments from Reviewer 3, we have reorganized the content in the revised manuscript. Specifically, the descriptions of methods in the Results were moved to Section 2: Data and Methods.

Response to minor comments of Reviewer 2:

"...abstract sounds a bit vague...(some numbers, etc.).": We have added the univariate correlation coefficient value for each predictor mentioned in the Abstract, in order to provide a more detailed description of results.

"...aims of the paper are not explicitly defined in the introduction...": As mentioned in the response to point 1) above, a new Sec. 1.1 better explains the context and aims of our work.

Page 3, line 5; page 15 line 28: In fact, there is no standard in English usage requiring that "On the other hand," be preceded by "On the one hand". It is acceptable to use this phrase when it is clear what the contrasting situation is that is being referred to,

even if that contrasting situation or thought is implicit. Specifically, the former phrase need not precede a statement that is the converse of a previous statement, unlike, say, "On the contrary,...". See, e.g., http://dictionary.cambridge.org/grammar/british-grammar/comparing-and-contrasting/contrasts

Page 4, lines 11-13: In this sentence, we have replaced the word "trends" with "decadal trends" to clarify that the statement refers specifically to the results cited in paragraph 2 on page 3. The results cited earlier in this paragraph are relevant to the results we derive later in the paper for Fraser-Hope, and this connection is made explicit at the beginning of Sec. 3.2.

Page 6, line 4: The abbreviation is now defined.

Page 6, lines 8-10: The MSS locations are not uniformly distributed across the FRB. We have added a short description to the sentence.

Page 6, line 12: SST has now been defined where it was first used, near the beginning of the paragraph.

Page 6, line 18: Added the year to this reference.

Section 2.2: We have included a few sentences describing the snow and soil routines, as requested by the Reviewer, along with the appropriate references to the primary literature.

Page 7, line 8: We have clarified the reason why the frozen soil parameterization was not used.

Page 7, lines 10-17: In the second para on p. 7 it is now stated that the VIC simulation we analyzed was produced by colleagues for another purpose. For this reason, and since the calibration and validation procedures are thoroughly described in the papers referred to in the second para on p. 8, we feel that adding a description of the calibration and validation procedures here would be superfluous and detract from the flow of the paper.

Page 7, line 14: Islam and Dery (2017) used the Nash-Sutcliffe efficiency and temporal correlation coefficients as criteria for goodness-of-fit. However, we feel that it is unnecessary and possibly distracting to provide this level of detail in the text.

Page 11, lines 17-20: This CRI description was moved to Methods Sec. 2.3.

Page 13, lines 27-33: The few VIC grid cells with unrealistic SWE occur at or near high elevation locations in the FRB where glaciers are present in the real system. Thus, the deficiency lies not in the snow parameterization, but rather in the lack of a dynamic land-ice module that would permit the export of accumulated ice in one grid cell to its neighbours.

Page 14, lines 1-5: This paragraph was moved to Methods Sec. 2.2.

Page 15, lines 8-9: Yes, the results in Table 5 do suggest that large APFs in average SWE years are characterized by large dT/dt (1982, 1958, 2002). We have added a sentence to the first paragraph of Sec. 3.5.4 to emphasize this.

Page 15, lines 22 and 23: p-values inserted, thank you.

Page 18, line 6: We appreciate the Reviewer's suggestion, but beg to differ. We view the antecedent results in the paper as far more than a case study. Rather, they are a statistical summary of the APF-climate relationship in the FRB and its subbasins, which may apply to other nival watersheds as well. Consequently, we have left the title and organization of Sec. 4 unchanged.

Table 2: We agree, and replaced "Julian day" by "Calendar day"

Table 3: Changed "APDF" to "APF" in header

Figure 1: We intend to add a scale bar to this figure, and will change the colour scheme to a more conventional green-to-brown for elevation.

Figures 2, 3, 5, 8 and 9: Where possible, we have enlarged the size of all fonts to improve legibility.

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