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Interactive comment on "Hydrologic Diversity in Glacier Bay Alaska: Spatial Patterns and Temporal Change" *by* Ryan L. Crumley et al.

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Review of Crumley et al. Hydrologic Diversity in Glacier Bay

Summary and general comments

This manuscript presents the results of high spatial-resolution hydrologic modeling of a dynamically deglacierizing environment, Glacier Bay in Alaska. The study furthers understanding of ecological parameters in Glacier Bay and freshwater runoff to the Gulf of Alaska by estimating changes in seasonal distribution of runoff between a historical and a future scenario and attributing changes to shifts between the runoff-producing processes of rainfall, snowmelt, and ice-melt. This topic is timely, relevant to current research questions in this field and in this geographic area, and suitable for this journal.

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The text is well written, the figures and tables are all appropriate and useful, and the details included in the Appendices are appreciated. This study relies heavily on methods developed for companion studies by several of the authors (especially Beamer et al., 2016 and 2017). Those robust studies are well-supported by references and descriptions in the text. Unfortunately, the present study suffers from the complete lack of available calibration data, which the authors overcome through (1) adoption of the model choices of the companion studies and (2) general comparisons to oceanographic salinity data. This is a creative solution and acceptable for the goals of the study but should be presented much earlier and more plainly in Section 3.4 Model Calibration. After reading author contributions, the disconnects in the presentation and significance of the oceanographic data seem more a matter of author coordination than flaws in the study and can be resolved without re-analysis.

Specific comments

Title: Can you find a term other than "hydrologic diversity" that better brings the topics of changes in runoff volume, seasonality, and drivers to mind? Hydrologic regime diversity...? Freshwater runoff ...? Not sure I have the perfect term, might take a phrase to say it.

Abstract, L 24-25: "a variety of changes" is vague. What is meant here?

P6, L15-17: The closest calibration point isn't always the most appropriate. Can you also say that the Mendenhall basin is the most similar?

P6, L17-18: These metrics are for the Beamer et al. (2016) study, correct? Since this "calibration" section oddly refers to the calibration of a prior study, I suggest phrasing this clearly so the skimming reader doesn't assume these metrics are for your study.

P8, L1: This sounds like a justification for a higher-than-expected result, but the wording isn't clear. Does the RCP8.5 scenario establish a minimum of 3 degrees change?

P10, L3: Is the 3.40 m/yr value actually for "runoff", not "precipitation" as stated? That

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would be more consistent with the value in the next line.

P12, 13-14: This statement about a non-stationary system is inconsistent with the presentation of Figure 10 on P10, L20-22, which notes little significant change with one basin as an exception. The trend for the excepted basin isn't very convincing ($p > 0.05$, short and discontinuous dataset, a bit noisy), making the comments on P12 seem overstated.

Appendix B: Interestingly, the forecast runoff hydrographs, which admirably show the relative contributions of runoff processes, produce a few seasonalities that aren't apparent for individual streams in my present work characterizing historical hydrographs. The composite GBNPP and North basins appear to have a snowmelt-dominated spring peak and a larger rainfall-dominated fall peak, a reversal of the typical relative magnitudes for a bimodal glacierized basin hydrograph. Can this be explained by an increase in spatial distribution of future rainfall-dominated areas within the composite basin or any other observations from the modeling?

Technical comments

Introduction: Trim and keep focused on the study by omitting details about GOA (especially in 1st and 2nd paragraph), minimizing drama (P2, L6-7), and considering moving setting information to the Study Area section if it's actually needed (the long discussion of tidal mixing and stratification and the Etherington et al. study made me think this was the study focus on first read). It's all interesting, but it's not until the penultimate paragraph (P3, L37-39) that the problem is hinted at and not until the final paragraph (P3, L13) that the actual work of the study is introduced, and the reader can finally start understanding the direction of the manuscript.

P2, L31 and P3, L3-4: The number of references to particular places within Glacier Bay suggests Figure 2 could be presented earlier.

Study Area, paragraphs 1 and 2: Clearly define study area (all watersheds within GB-

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NPP, which includes all the lands of GBNPP and some areas outside it?). The multiple nested, paired watersheds are a nice study design but are hard to keep track of. Suggest moving the parts of paragraph 2 that aren't obvious from the figure or table (P3, L29-30) into paragraph 1. Consider using a defining characteristics for the names or adding a column to Table 1 to associate basin names with a defining characteristic. It would be helpful to know "North" is the full Glacier Bay basin and that the choice of the three named basins allows comparison of basins having. . .(a range of elevation? a range of glacier characteristics?), for example.

P7, L23-24: This is one of the clearest statements of the goals/outcome of the study. Could use this earlier.

P9, L11-12: Delete information repeated from methods.

P9, L25-35: Many details of computations, and the discussion of the omission of routing, seem like methods. Consider moving to Section 3.1 or elsewhere in Methods.

P10 and 11, Section 5, first and second paragraphs: Most of the main points are made in the first paragraph; suggest combining the two and reducing detail. Consider moving computation of FLAs to methods.

P12, L5-6: Nice explanation of why CTD dataset was included, could use this earlier.

P11, L11-12 and L20: Check figure number. I assume you mean figure 11a and b, respectively.

References: References are used appropriately. I did not check to make sure all are used, or that all references cited are included. The recommended citation for USGS reports includes the report series title and report number. For Curran et al. (2003) that's Water-Resources Investigations Report (or WRIR, if preferred) 03-4188 and for Wiley and Curran (2003) it's Water-Resources Investigations Report 03-4114.

Fig. 1: Labeling Alaska and Canada (a) and Glacier Bay (b and c) would help reader comprehension.

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Fig. 2: Label Glacier Bay. The Alaska/Canada boundary is referenced in the text but not shown here.

Fig. 5 : Shading of forecast glaciers is distractingly similar to ocean. The title “Glacier Change” doesn’t match the legend items, which include two glacier positions and the GBNPP boundary.

Fig. 6: Suggest being consistent with the x-axis scale used for other monthly plots (use Jan-Dec, not Sept-Aug)

Fig. 7 caption, last sentence for (a): Check for typo in “the modeled for runoff climatology”

Tables 1 and 3, and Appendix A and B: Suggest some structure to convey basin/sub-basin relationship and the various pairings of nested basins (a line or spacing, for example). At a minimum, keep the same order in the Appendices as is used for the tables.

Appendices: These plots are useful results and would lend themselves well to being reduced in size. Consider rearranging to fit each Appendix on 1 page with a single legend for each and including in the text.

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