Earth Syst. Sci. Data Discuss.,
https://doi.org/10.5194/essd-2018-155-RC2, 2019


Open Access Earth System Science Data Discussions



# *Interactive comment on* "Glaciers and Climate of the Upper Susitna Basin, Alaska" *by* Andrew Bliss et al.

**Anonymous Referee #2**

Received and published: 2 July 2019

General Comments:

This study presents, validates and interprets a comprehensive and impressive data set, which covers a range of parameters in the variable environments of the Susitna Basin, Alaska. The data set includes meteorological, glaciological and soil parameters. The data set is unique, as many of the measurements were done in complex terrain where measurements generally are sparse. It is effortful and requires extensive planning to acquire meaningful data in this terrain. Problems in the data are addressed and generally, implications that arise with these problems are described in detail. Overall, the manuscript is well structured and provides a good overview of the data. The data set itself could be extremely valuable for model validation or comparison with future field studies. However, the manuscript is not always coherent and suffers from redundant



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information (e.g. section 3.3, section 5.2, figure 9), which distracts the reader from following the key points and weakens the focus of the paper (see specific comments). The introduction does not adequately motivate the manuscript, as it does not really make clear why the data set is important and what the purpose of the data set is (see specific comments). In addition, some of the presented data appear isolated and need to be put into context better (e.g. section 4.4., how do continuous mass balance measurements compare to stake measurements nearby?) Therefore, I suggest a number of minor revisions to focus the main messages of the manuscript and to emphasize the uniqueness of the data set.

Specific Comments:

Introduction: Mentioning climate change in the beginning of the introduction is not convincing, since you only acquire three years of data. Either remove the link to climate change, or emphasize that the data set is meant to be used for comparison with future studies (as you do in the conclusions). P2, l9-10: using changes in river flow on dam operations as a motivation here seems misplaced, since you mention in the beginning that the dam was not built. In addition, river flow is not covered in this study. Please rephrase or remove. You could motivate each of the data types (meteorological/climatological, glaciological, snow, soil) individually, as you do later in the manuscript. E.g., p4,l23-26 motivates meteorological/climatological measurements, p25,4-5 motivates soil measurements and should be placed in the introduction

- p1, l6: since only the years 1981-83 were investigated, please do not write 1980s here but refer specifically to the years 1981-83

- p2, l5: state precise number instead of “more than 120 glaciers”

- p3, l5: please add reference here

- p3, l10-p4,l3: detailed description of surge history seems unnecessary here, please shorten





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- p6, l4: what does the number 3 in brackets mean?

- p6, l26: first time abbreviation “DGGS” is mentioned, please provide full name

- p7, figure 4: please provide figure in higher resolution

- p8, l13: delete sentence “Data are not available from 18 January 2014 to 22 April 2014 when the station was buried in snow.” since this was mentioned before.

- p9, table 2 caption: delete “18 January 2014 to 22 April 2014.” from caption, since it was mentioned before

- p11, figure 5: please provide higher resolution figure

- p12, figure 6: figure is not mentioned in text, please add reference to figure in text. Also, please provide figure in higher resolution

- p13, l8: reference to figure 4: is this right or do you mean figure 7?

- p13, l11: rather say “very close to 1.0”

- p13, l12/13: “The lack of a consistent pattern in these comparisons prevented us from adjusting the HOBO temperature data to match the Campbell data.” This is confusing since you mention an average offset the sentence before. Can you clarify this?

- p.14, l1/2: What is your confidence that no double tips are missed or that normal tips are identified as double tips?

- p15, figure 7: how do you explain very high RH offset of some HOBO-sensor at higher RH, especially in 2013?

- p14, l11: “Precipitation amounts did not correlate significantly with elevation, slope, aspect, or location.” How do you define “location”? What drives the variations in precipitation amounts?

- p14, l15-17: katabatic wind flow: Can you back this with references or add a more thorough analysis based on your data, e.g. wind direction analyses? Or is this just an

assumption you make?

- p15, figure 7: colour codes are missing

- p16, figure 9: what is the purpose of figure 9? There is no in-depth analysis provided in the text and patterns are trivial (yearly temperature cycle, lower temperatures with higher elevation). In addition, it figure again suffers from relatively low resolution. Please either remove figure or provide more detailed analysis

- p16, section 3.3: this section does not provide a thorough analysis and is not useful for the manuscript since it is not based on your data. Either please remove or transform; rather than a trend analysis, the section could provide an assessment whether the years 2013-2014 were exceptional (in terms of temperature) or normal.

- p18, figure 11: what purpose do the different colours serve? If none, please use black or dark grey

- p19, l12: Did you think about adding the line fit to the figure? This would allow the reader to clearly identify the equilibrium line altitude you derived

- p19, l1/2: Since you used only point measurements, it is also possible that the stake measurements do not fully represent the area that was covered by satellite. In addition, you mentioned earlier that most of the stakes were placed on the centreline of the glacier, which is typically higher than the margins (which are included in the satellite estimation?), potentially leading to higher estimation of the equilibrium line altitude

- p19, l7/8: “Glacier-wide mass balance estimates were then calculated by summing the distributed mass balance over the whole glacier.” Did you use hypsometry of each individual glacier? Or did you use hypsometry of the entire glacier area for the calculation of the individual glacier mass balances? If so, the numbers you get probably have very high uncertainties. Please clarify.

- p20, l2: “East Fork Glacier had a similar mass balance as Maclaren Glacier.” Why do you stress this here? Seems misplaced, please delete

- p20, l17: “To robustly validate model simulations of snow accumulation. . .”; please move to introduction, since this provides a motivation for your measurements and you are presenting results in this section

- p21, l2/3: “. . .at 2000 m measuring 2-3 times higher than at 1000 m.” looks more like 2-4 times higher (see year 2014)

- p21, l4: “A notable south-north decrease in total SWE and accumulation gradient indicates a strong orographic influence.” Please remove: sentence is redundant since you mention elevation dependence the sentence before. In addition, this is not always necessarily a north-south gradient

- p22, figure 14 caption: “In early August 2013, the sensor’s mounting pole began to tip over and give bad readings. On 1-2 September 2014, 18 cm of snow accumulation was recorded, consistent with observations during a site visit. The sensor pinged off falling snow, so some points in that window are labeled as bad data.” please remove or move to text

- p22, l16: “data became noisier as the surface transitioned from snow to ice.” can this be seen in figure 14?

- p22, l21/22: “This leads to an average melt rate of 0.016 m w.e. d$-1$ for the summer of 2013 and 0.012 m w.e. d$-1$ for 2014.” This information seems a bit isolated from the previous, interesting mass balance investigations. Can you provide a comparison here? How does this compare to nearby ablation stakes summer mass balances?

- p23, l7: “Snow water equivalent (SWE)”: abbreviation has been initialized before

- p23, l14: “. . .generally showed a strong elevation dependence.” dependence of what type? Maybe just write “increased with elevation“

- p23, l16/17: “At the Lower Windy Cr. site, about 40 mm of SWE (25%) was lost due to melt of the end-of-winter snowpack between 9 April and 22 April 2014 (Table 6)” Why is this stressed here? Please remove

- p24, section 5.2: This section does not add any value to the paper but is very distracting; please remove

- p25, l1: “characteristics we observed”; please specify these characteristics so the agreement between soil pits and STATSGO becomes clearer

- p25, l4/5: “Understanding the distribution of permafrost and seasonally-frozen ground across the basin is important for modeling of water moving across the landscape”; again, this provides a motivation for your measurements and you are presenting results in this section, so please move to introduction

- p27, l28/29: “Summer air temperatures in 2012-2014 were 1.1âŮęC warmer than 1981-1983. Annual temperatures were 0.5°C warmer in the recent period.” Why do you add this here? This is not based on your own measurements and thus not a significant outcome. Please consider removing.

- p28, l2: since only the years 2012-14 vs. 1981-83 were investigated, please do not generally say 2010s vs. 1980s since you have no information on the other years

Technical Corrections:

- p8, l12: move “On-Ice” to the end of this sentence

- p6, l33: please remove “instead of every minute”

- p16, l4: “most distinct“ instead of “least complicated”

- p18, l2: “refers to the period October. . .” instead of “refers to October. . .”

- p20, l11/12: “Therefore, lower annual balance in the latter period (-1.72±0.87 m w.e.) compared to the former period (0.04±0.25 m w.e.) were driven by the more negative summer balances.” should be “balances. . . were driven. . .” or “balance. . . was driven”

- p26, figure 17 caption: “soil” instead of “soils”; remove “,” after data

2019.