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Interactive comment on "Rapidly-changing subglacial hydrology pathways at a tidewater glacier revealed through simultaneous observations of water pressure, supraglacial lakes, meltwater plumes and surface velocities" *by* Penelope How et al.

S. Sugiyama (Referee)

sugishin@lowtem.hokudai.ac.jp

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General comments:

This paper presents field and satellite observations of glacier hydrology and ice dynamics near the front of a calving glacier in Svalbard. The data include subglacial water pressure measured in a bottom reaching borehole, which is one of a few direct observations of subglacial conditions near the front of a calving glacier. The observa-

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tional data are compared with the results of glacier melt and run off modeling as well as subglacial hydraulic potential analysis. Based on the observations and analysis, the authors provides interpretations on hydrological conditions and their influence on the glacier dynamics during the summer 2014.

Glacier hydrology near the front of tidewater glaciers is drawing attention because it plays key roles in glacier dynamics and glacier discharge into the fjord. Despite its importance, processes related to subglacial hydrology are not well understood because in-situ observations are difficult. This study combined several different observations and numerical analysis to reveal the evolution of glacier hydrology over one summer melt season. This kind of integrated observational data set is available at only a few limited glaciers, thus presented data are valuable to improve our understanding of the hydrology of tidewater glaciers. Text is very well written and nicely organized, which clearly explains relatively complex methodology and observational results. I like the way of interpretation, first in chronological order in Section 6 and then discussion on selected important processes in Section 7. Plots and photographs are carefully prepared. Overall, I find the manuscript is already in a good standard and interesting to many of the journal readers.

The interpretation and discussion on the glacier hydrology are reasonable, but they are based on surficial observations and not much supported by direct evidences. I agree that they are likely scenarios, but other possibilities should be also mentioned. I listed such comments on the authors' interpretations followed by relatively minor comments and suggestions, which can be considered for revision.

Scientific issues:

5.5 Borehole pressure I understand the borehole pressure was recorded from September 2013. Why not showing all the data from the beginning of the observation? Water pressure over one year period provides insights into basal conditions as well as the connectivity of the borehole to the subglacial hydrological system. At least, overview

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of the pressure record over the entire period should be described in the text.

7.2 Upward-propagating supraglacial lake drainage I wonder if glacier dynamics can be the cause of the lake drainage. When the glacier accelerates near the front, a longitudinally stretching flow regime is enhanced. This causes crevasse opening and increases chance of lake drainage. Assuming that such acceleration initiates near the glacier front and propagates upglacier, the observed lake drainage can be explained by this process.

7.4 Subglacial drainage of Kronebreen Throughout the paper, the authors assume the borehole pressure represents the subglacial water pressure over the region. Nevertheless, the lack of short-term pressure variations gives me an impression that the borehole is not well connected to active subglacial drainage system. The pressure drops in September, but it is only 15 m out of 280 water depth. I agree that the authors' interpretation is one of likely scenarios, but it is worth mentioning that there is a possibility that the borehole pressure does not represent basal conditions in the region.

Specific comments:

page 1, title: I think "Rapidly changing subglacial hydrology pathways" is not supported by evidence and does not fit the presented results. For example, "a stable efficient drainage system effectively transported this water through the north region... (page 1, line 6–7)" contradicts to "rapidly changing pathways". What about something like "Subglacial hydrology at a tidewater glacier as revealed through ..."?

page 1, line 7: What is "this water"? "subglacial meltwater"?

page 2, line 3: "Borehole data is spatially limited" » "Borehole data provide only spatially limited information"?

page 2, line 11: "upper section of the glacier" » Not necessary because it is not clear where it is.

page 2, line 17: "spatial patterns" » It sounds odd because borehole data do not show

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spatial patterns, but useful to understand temporal variations.

page 3, line 16: "Subglacial transient pressure waves" » Not clear what are these waves. Please provide citations if this term is defined and used in previous studies.

page 4, line 3: "Most direct observations" » It sounds strange to say satellite imagery are the most direct observation.

page 4, line 8: Delete "a complete".

page 5, line 12: Why "Calving activity persists throughout the year"? Because of absence of sea ice?

page 5, line 31: "real-world" » Is this a common expression? "velocities, areas and distances in real space"?

page 6, line 2: "Digital Elevation Model" » "digital elevation model"

page 6, line 5: Trimble GeoXR "GPS" rover

page 6, line 6: post-processed "in a kinematic mode"?

page 6, line 15: from Site 3 on Colletthogda "(Fig. 1)".

page 7, line 1: "real-world extents" » surface area?

page 7, line 7: " Glacier" surface velocities were...

page 7, line 29: This was undertaken in order to isolate the hydrology of the glacier tongue (» isolate from what?) and better observe direct hydrological influence (» influence of what?) in the region of interest.

page 8, line 2: Can you explain more about the wireless pressure sensors (specification of the sensor and communication system)? Any citation for the borehole instrument used in this study?

page 8, line 3–4: Can you give uncertainties to the bed elevation and the ice thickness?

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page 8, line 9–10: "High temporal resolution of the GPS data did not add any further insights to this study." » Even if you did not find short-term variations, it gives very important information to this study. Please clarify what you measured by the GPS.

page 8, line 11: "Local bed pressure" » "Subglacial water pressure"?

page 8, line 31: "Digital Elevation Model" is not necessary because DEM is already defined.

page 8, line 31–32: Any citation for the radar measurement?

page 9, line 4: The subsection title is odd because lake level was not measured. "Supraglacial lake drainage" or "Supraglacial lake area"?

page 9: line 9–18: Please refer to each of the photographs in Figure 3. Please also refer Fig. 2E to explain the lake evolution.

Figure 2: The order of the subplots is not consistent with that in the text. Why not listing the plots starting from the lake measurements, then melt modeling, velocity, and borehole pressure?

Figure 2A: MPa is more common (MKS unit system) as a unit of pressure.

Figure 2B: Unit of rainfall should be mm/time (mm/d?). To avoid the overlapping of the line (melt) and bar (rainfall), I suggest to plot rainfall upside down, i.e. bar extending downward from the top axis.

Figure 2D: Can you provide uncertainty range in the plot and describe in the text?

Figure 2E: The variations of Lake 2 and 3 are very difficult to read. What about plot them for a more suitable scale taken on the right axis?

Figure 4: Plume 1–4 in the plots should be Plume N1, N2, N3 and S1.

page 13, line 6: "Upon intersecting" » "Upon reaching?"

page 14, line 4: 297 m is a little higher than I expect as the floatation level of the 320

m thick ice. What kind of ice density did you use?

page 16, line 11: "2477" » "2,477"?

Figure 6: The lakes and plumes on the map are difficult to find. Please indicate the texts (Supraglacial lake, Plume N1, etc.) directly on the map. Please indicate numbers on the bed contour lines on the map and provide the contour interval in the caption.

page 20, line 3: What is "This water"?

page 20, line 7: "Water is not being stored in the snowpack and firn layer." » It is not likely that meltwater penetrates through snowpack and drains without storage in snow. Is there a possibility that snow cover was not accurately modelled, and in reality bare ice was already exposed in June?

page 20, line 15–16: "sufficient pressure has accumulated to force a channel, or multiple channels, to open." » I wonder if high pressure can open subglacial channels. Enlargement/closure of a channel is the result of melting of the conduit wall and ice deformation due to isostatic pressure. This expression "pressure accumulates and force a channel open" appears again and again (page 21, line 21 and 33; page 24, line 23). Please make sure if this sentence accurately explains processes in your mind. Is it pressure or meltwater which accumulates at the bed?

page 21, line 10: Omit "episodes where there is"?

page 22, line 11: What kind of glaciers are you referring to by "other tidewater glaciers"? This question is because water depth is usually far below sea level at the fronts of tidewater glaciers. Kronebreen is not a special case, I think.

page 22, line 17: "efficient channels briefly form then collapse" » Why they collapse briefly? When water pressure is high (effective pressure is low), closure of channels should be slow.

page 22, line 24: It is not clear to me what "transient low-pressure wave". Do you

mean that subglacial water pressure drops as drainage efficiency increases, and it propagates upglacier as a channels system develops from the glacier front to upper reaches? Can you provide references for this process?

page 23, line 19: "as melwater continues to accumulate" » Something like "as surface meltwater gets access to the glacier bed"?

page 24, line 15: "A stable efficient drainage system can form here ...." » Ice speed is slower near the margins, but shear deformation is larger than the fast flowing central region. I wonder if this hypothesis is convincing enough to be here in conclusion.

page 24, line 20–21: disassociated from "modelled" runoff.

page 24, line 26: compared to "modelled" runoff

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