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Interactive comment on “A decade of supraglacial lake volume estimates across a land-terminating margin of the Greenland Ice Sheet” by A. A. W. Fitzpatrick et al.

Anonymous Referee #2

Received and published: 1 June 2013

Overview:

This paper provides a thorough study of supraglacial lake dynamics over an 11-yr period in the Russell Glacier region, and compares MODIS-derived lake area/volume to ice sheet surface melt and proglacial river discharge. The authors find that the timing and duration of lake drainages varies interannually, with drainage events contributing to downstream proglacial discharge anomalies. A correlation exists between higher temperatures and lake formation at higher elevations, yet the paper also shows that the 2003 and 2010 high-melt years translated to larger lakes in the lower elevations instead. This paper is well written and presents important and timely insight to supraglacial lake dynamics, and I believe that with mostly minor revisions it will be a

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valuable addition to The Cryosphere.

Comments:

1) The paper refers to catchment-wide hydrology, but should include more details about the catchment itself, how it is delineated, and how ancillary datasets are processed with respect to this catchment. In particular, the study area section can be expanded on with these details. How is the catchment delineated? The lakes in Figure 1 seem to encompass a bounding box study area rather than a specific catchment. The lake volumes are compared with Watson River discharge, but the uncertainty in how much of the surface lake drainage can be expected to be captured by that gauging station should be mentioned. Describe how surface melt is derived from the transect of weather stations, and how representative it is of total melt from the catchment. Essentially, address the different scales of the different datasets and how they are being reconciled for comparison. It would also be helpful to include in Figure 1 locations of Lakes F and Z, the Watson River gauging station, and the six ice sheet weather stations.

2) I suggest including an overarching paragraph at the beginning of the methods section to describe the broad goals and structure of the section. Similarly, make sure to include introductory sentences to paragraphs that state the main idea. For example, the last paragraph on page 1387 needs an introductory sentence.

3) Clouds seem to be a very large uncertainty for the time series of lake volumes. Are cloudy days completely thrown out for the time series? Or is the lake extraction maximized by pulling out data wherever possible, regardless if other areas in the same image are cloudy? Does the 4-day window for rapidly draining lakes include uncertainties (such as those shown in Figure 5) due to cloud cover?

Minor comments:

- 1) Page 1384, Line 6: Specify 2002 to 2012.
- 2) Page 1384, Line 7: Specify MODIS satellite images.

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- 3) Page 1384, Lines 9-12: Consider rewording this sentence, the second half is a bit unclear. Is the point to say that while modeling studies commonly show a threshold, the existence has yet to be shown in observations?
- 4) Page 1384, Line 13: Consider using “years” instead of “yr”.
- 5) Page 1386, Line 22 and Equation 1: While NDWI has multiple definitions, it is typically used with a NIR band and a visible band for land surfaces. I suggest noting this NDWI as a modified version for supraglacial surfaces. Yang and Smith (2012) use a similar modified ratio for supraglacial streams: Yang K and Smith LC (2012). Supraglacial streams on the Greenland Ice Sheet delineated from combined spectral-shape information in high resolution satellite imagery. IEEE Geoscience and Remote Sensing Letters, PP(99), 1–5.
- 6) Page 1386, Line 24: Is band 4 (green) used at all? And the range of bands 3 and 4 should be 0.46 to 0.57 μm . Also band 1 should be identified as the red band at some point in this paragraph.
- 7) Page 1386, Lines 25-26: Bands 1 and 2 both occur at 250 and 500m resolutions. Do you mean that the sharpening uses the ratio of band 1 at 250m to band 1 at 500m? Is band 2 used at all?
- 8) Page 1387, Line 6: Indicate the spectral range of band 6.
- 9) Page 1387, Line 20: How dense were the depth sounder measurements for the undrained Lake Z, maybe the surveyed transect/locations can be overlaid onto Figure 2? Just curious as to the accuracy of the interpolated bathymetry.
- 10) Page 1389, Lines 14-15: Could the depths from Lakes A and B also be used for a volume estimation/comparison?
- 11) Page 1390, Line 12: Figure 7 is referenced before Figure 4.
- 12) Page 1390, Line 24: Figure 6 is referenced before Figure 5, which only comes in

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at the very end of the results section.

13) Page 1391, Line 1: Does the 4-day window for rapidly draining lakes include uncertainties (such as those shown in Figure 5) due to cloud cover?

14) Page 1391, Lines 15-17: The Cappelan et al. reference is a bit confusing, are these extents taken from that paper? The rest of the data in this paragraph reference Figure 9a, which seems to line up with these extents.

15) Page 1392, Line 2: Briefly explain the energy balance model that produces the surface melt data (could be explained in methods).

16) Page 1392, Line 22: Specify 2002 to 2012.

17) Page 1393, Lines 13-14: Suggested wording: “Lake size varies with elevation, with smaller lakes forming at low (< 1000m a.s.l.) and high elevations (> 1600m a.s.l.), and largest lakes forming in between.”

18) Page 1394, Line 12: Figure 4, which contains the melt time series, should also be cited.

19) Page 1394, Lines 16-19: What governs the assumption that all the lakes in this area drain into the Watson River? More support for the delineation of the RGC would be helpful.

20) Page 1395, Line 16: Consider using “years” instead of “yr”.

21) Page 1395, Line 20: Consider using “drain twice” instead of “double drain”.

22) Page 1395, Line 21-22: Remove “the” before dates.

23) Page 1397, Line 9: Remove “on” in the phrase “. . . surface to bed coupling will likely impact inland ice sheet. . .”

24) Fig. 4: There is a lot of detail here that is lost due to the small vertical size, can this be enlarged to fit a whole page? Figure 5 could also benefit from a much larger size,

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particularly for the lake drainage elevation crosses.

25) Fig. 7: The y-axis label for figure 7c should have an upper case “L”.

26) Fig. 11: Include the latitude/longitude for the three locations, and that could be used to distinguish between a), b), and c) in the figure caption (rather than stating June 2012 twice).

Interactive comment on The Cryosphere Discuss., 7, 1383, 2013.

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