The Cryosphere Discuss., 9, C1778–C1783, 2015
www.the-cryosphere-discuss.net/9/C1778/2015/

The Cryosphere Discussions
Open Access

Interactive comment on "Estimating supraglacial lake depth in western Greenland using Landsat 8 and comparison with other multispectral methods" *by* A. Pope et al.

G.S. Hamilton (Referee)

gordon.hamilton@maine.edu

Received and published: 5 October 2015

This manuscript adds to the growing literature on remote sensing of surface water in Greenland by examining the performance of several different methods for extracting lake depths (and hence volumes) from optical satellite images, with a particular focus on Landsat-8 data. Existing methods fall into two broad categories: physically-based models or empirically-derived coefficients. Both methods, on their own, seem to produce sensible depth estimates but until now there has not been a rigorous comparison of their performance when applied to the same images. Moreover, many of the remotely-sensed depth estimates have not been well-validated with independent

observations. This paper addresses both these issues, and helps advance our understanding of how to quantify surface water on ice sheets from spaceborne observations. The material is definitely appropriate for the journal and the manuscript is reasonably well-written, so I recommend it be published pending some fairly minor changes.

The science is fundamentally sound and the interpretations are mostly valid. My major comment on the manuscript is that it is way too long and tends to lose focus in a few places. It works best as a thorough examination of the factors which produce the most realistic depth estimates. The glaciological results/discussion are interesting but they sit uneasily with the rest of the manuscript. My suggestion is to delete the description of results from P3271/L10 through P3272/L20 (by all means retain a 1-2 sentence summary), and the discussion between P3275/L17 through P3276/L17. This material would benefit from a more developed treatment in a separate paper.

I have a few additional comments that I hope are useful to the authors.

P3259 L3: delete sentence “Supraglacial lakes...”

P3259 L21: replace “glacial” with “ice sheet’s”

P3260 L4: material in the intro paragraph could be synthesized a bit better (e.g., don’t need two descriptions of positive feedback mechanisms

P3260 L10: Sneed and Hamilton (2007) is more appropriate than our 2011 paper

P3260 L17: why not say “WorldView series”, rather than just WV-2

P3261 L21: clarify if the spectral and bathymetric data are from the same lake; as written it’s not clear

P3262 L12: actually the requirement for having optically-deep water in the same image as supraglacial lakes is not absolute. See our discussion in Sneed and Hamilton (2011) in which we show that R_inf can be characterized for a particular sensor and then applied to other images lacking optically-deep water.

TCD
9, C1778–C1783, 2015

P3262 L18: “lake bed surfaces” is an odd term. Do you mean “lake bed” or “lake surface”?

P3262 L25: “The parameter g...”

P3263 L3: Delete “As the spatially closest...bottom albedo,”

P3263 L5: what “assumption”??

P3263 L6: delete “In an application of a form of” and replace with “We use spectral mixing analysis to...”

P3264 L15: my recollection of Legleiter is that the coefficients for supraglacial water might also vary depending on location.

P3264 L15: delete “based”

P3265 L4: delete “In situ concurrent and bathymetric”

P3266 L7: delete “is examined in 2013 as it as” and shorten to “is an area with...throughout summer 2013”

P3266 L7 (and elsewhere): write out all numbers smaller 11.

P3266 L7: “further” should be “farther” (distance)

P3266 L9 reorder sentence so “in 2014” at the very end.

P3266 L15: “based” should come after the material in parentheses.

P3267 L1: Using DEMs to validate remotely-sensed lake depths is not an entirely novel idea. See Georgiou et al. (2009; Ann. Glaciol.) for an earlier example from Greenland.

P3267 L2:not sure why there there is a subscript in the pixel size

P3267 L14: “lidar” should be “LiDAR” to be consistent with elsewhere in the paragraph.

P3267 L21: either cite the “preliminary studies” or delete.

TCD

9, C1778–C1783, 2015

P3267 L26: “as” should be “because”

P3268 L2: I think you mean “blunders” rather than “errors”

P3267 L6: “After these steps, > 250,000 pixels (30 m) from six days in 2013 and...”. Not clear if it is 250,000 pixels for each six-day period, or in total.

P3267 L10: “The results (Table 1)...are shown in Figure 2.”

P3267 L17: “success” is subjective term. How about “performance”?

P3267 L19: “RSME of 3.10 m” (and elsewhere where you quote paired RSME estimates)

P3267 L21: paragraph mixes sensors (OLI, ETM+) and spacecraft (Landsat 7) in a way that could confuse readers. Stick with a consistent descriptor.

P3269 L17: “Our analysis shows that supraglacial lake depth retrievals using Landsat-8 are as good as or better than Landsat-7 retrievals.”

P3269 L25: “day” should be lower case.

P3270 L4: “estimated” is better than “returned”

P3270 L5: delete “We investigate which method...”

P3270 L7: Is it really necessary to have a subsection (4.3) describing the DEM comparisons? Seems a bit odd to include it for the NW glaciers but not for the Jakobshavn area.

P3270 L17: no superlative needed, delete “very”

P3270 L22: not immediately clear why “ice flow” would lead to inconsistent depth estimates between images and DEMs. Delete or explain.

P3270 L23: “fairly” is a bit vague

P3271 L5: Tell readers over what surface area the reported water volume occurs.

TCD

9, C1778–C1783, 2015

P3271 L5: The sentence “A histogram...” seems a bit unnecessary. Shorten it to refer readers to Fig. 6a for the frequency distributions of lake depths.

P3271 L8: suggest rewriting to “...shallow lake pixels is consistent with the observed lakes having low surface slopes at their edges.”

P3272 L2: Delete the first paragraph.

P3273 L11: awkward introduction of a work in progress. Either discuss it in detail as part of this manuscript, or delete the mention of it.

P3273 L16: suggest rewriting to “...may, with better parameters, produce results consistent with the physically-based...”

P3273 L23: suggest shortening “g values” to simply “g”

P3274 L1: missing units (-0.1 +/- 1.7 m)

P3274 L24: “probably leading to significantly overestimated lake depths” seems a bit speculative. And how did you estimate the ∼30% difference?

P3275 L2: find a better word than “believed”

P3275 L5: paragraph starts to lose focus with the discussion of hydrofracturing. Suggest deleting this stuff and shortening the preceding summary of earlier work.

P3275 L12: We concluded the same thing in our 2007 paper (Sneed and Hamilton).

P3275 L13: delete “discussed in the previous paragraphs”

P3275 L14: what are the “updated lab-based g values”??

P3275 L17: Delete the next few paragraphs (as far as P3276 L17). They are too much of a digression and detract from the main message of the paper.

P3276 L29: We also showed that radiative transfer models (in our case, HYDROLIGHT) can be used to validate remotely-sensed lake depth estimates in Sneed and

TCD

9, C1778–C1783, 2015

Hamilton (2011).

P3277 L4: “varies” should be “variability”

P3277 L6: delete “on to”

P3277 L6: the sentence “However, because much...” runs on and is awkwardly constructed. Shorten and rewrite.

P3278 L24: delete “in the discussion”

Interactive comment on The Cryosphere Discuss., 9, 3257, 2015.