

# ***Interactive comment on “Subglacial lakes and hydrology across the Ellsworth Subglacial Highlands, West Antarctica” by Felipe Napoleoni et al.***

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This article makes the contribution of expanding the inventory of subglacial lakes, specifically in West Antarctica, and discusses the basic characteristics of these lakes. Through the use of radar echo sounding observations that were collected in 2004/2005 bed echoes that could be characterized as a reflection off of an ice/water interface were identified. These reflections were further classified in four categories that relate to the confidence that the echo is from an ice/water interface. The analysis used established approaches for the identification and classification of subglacial water bodies, namely bright, low variance reflections that have flat hydraulic potential.

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Overall I found this to be a fine article. I believe the methodology needs clarification in a multiple locations. There are many specific instances that I note within the line comments below. In particular the specularly methodology has left me scratching my head (see line comments 81,122 below). Also, I don't think specularly is being measured/observed, but instead consistency of bed echo is being used as a proxy, in combination with other observables (relative and absolute brightness), to infer specularly. I think that distinction should be clear in the methodology.

I am unmoved by the lake volume estimates. This attempt is highly unconstrained to the point of being untrustworthy. I understand the desire for volume balances beneath the ice sheet and that others have made similar assumptions within the literature, but a volume range from 8 to 125 km<sup>3</sup> with fully contrived shorelines isn't a rigorous or defensible result.

The ice catchment boundaries made it to the abstract, so it must be considered an important detail, but the boundaries (ice verse subglacial hydrology nor old subglacial hydrology verse updated subglacial hydrology) are never directly compared. A figure should be modified to allow the reader to understand this reported observation. The change in 'known' subglacial hydrology catchment beneath Thwaites Glacier may be an important contribution, but the reader has no opportunity to assess this finding and to evaluate the implications to an important region of West Antarctica. Including these boundaries would support the conclusions of the authors and, if truly significant, increase the impact of this article.

When I read though an article I note places where I get confused. Certainly, not every reader would share my confusion, but perhaps some readers would. There are many suggestions below that ask for clarity and specificity. There are also comments that relate to the broader points outlined above.

Line 7) 'region': Not sure a region has been defined yet. 60% increase for Ellsworth Highlands or West Antarctica? While it certainly becomes evident later, the abstract

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should stand alone.

23) 'most likely': Hypothesized, maybe?

27)'many that': should it be 'that many' or 'many'?

27,36) 'highly': What is the threshold between dynamic and highly dynamic?

36) Maybe high dynamism \*is\* the filling and draining, not highly dynamic \*and\* fills and drains?

39-40) This is at the edge of my grammatical confidence, but are these semi-colons correct?

47) 'Not fully understood': Is anything? Perhaps; "many hypothesis remain untested" or something else

48) 'fastest changing': In what regard? Certainly if we choose differing metrics we could identify different glaciers that are fastest changing. Maybe generalize this statement. If PIG and THW are the fastest changing then e.g. should be i.e.

52) 'ice basal water': perhaps just 'basal water'?

52-53) 'edge of the continent': This might not be accurate as the ice sheet grounding zone is not coincident with the continental margin.

56) First time PIG is used and acronym is not defined.

62) 'subset of this data-set': Which subset? Just the data over ESH? Why was this done? The justification for this work talks about the importance of analyzing existing data sets? Why wasn't the entire data set analyzed / why restrict it?

65) How parenthetical abbreviations with parenthetical references are formatted varies. For example: Line 65 they are within the same parenthetical. Line 39-40 they are in independent parenthetical. Should this be consistent throughout, or maybe rewrite to not require the combination of parentheticals?

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66-69) Maybe explicitly enumerate the list, e.g. i) ii), for clarity

73-75) I think the sentence would read more clearly if the final clause was moved closer to the beginning of the sentence, maybe 'Following previously published methods, these reflections were then...'

78) Point 2 is that the lake surface is has a flat hydraulic potential, right? Should it use those terms? The hydraulic potential water surface should not be inclined in a lake context. I wonder if 'potential', means a candidate site and not a potential energy surface, if so, that is leading to my confusion. Also it's unclear what 11 times opposite means. Perhaps it's, 11 times the magnitude in the opposite direction?

79) What's distinguishes between points 2 and 3? Appears to be describing the same characteristic in differing terms, flat hydraulic potential.

81) First time BRPr is used and it is not defined. If BPRr is a proxy for specularly, the term BPRr is not used in section 2.3. On line 121, BPRr appears to be absolute reflectivity.

82) '<3sigma BRPr': See line 122 comment

88) Is BRPe attenuation in ice or energy loss more generally? In this line, BRPe is defined by the methodology used to quantify it.

90,97) Is there an inconsistency in variables used for geometrical spreading ( $L_t$  and  $L_g$ )?  $L_t$  never appears in an equation. Also, with the placement of the parenthetical  $L_i$ , in line 90, it suggests it is defined differently than in line 97. Is  $L_i$  attenuation, system gains, or attenuation and system gains? I would look to make this nomenclature consistent and unambiguous. Also, the terms are repeatedly defined, maybe simplify to reduce repetition. An Oxford comma on line 90 could serve to reduce ambiguity. Check for consistency in the use of Oxford commas. Appears in some lists, for instance sentence that begins line 304 and not in others, for instance line 90.

99) Is an indent missing?

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102) 'height': Is that height of the antenna above the ice surface?

104) Is an indent missing?

104) 'section': What is a 'section'? How long/how many samples? This should be clear how calculated attenuation values vary within the survey and over what length scale. Understanding attenuation application could be significant to using BPR as an identifier for bright bed. On line 376, attenuation rate is reported as 'constant'. But here on 104, it seems to be calculated on a 'section' by 'section' basis. Which is it? Also, reporting the magnitude of attenuation rate will be of interest to the community.

111) 40 samples on either side or 20 samples are either side. What is a nominal sample spacing? If statistics are calculated for 40 meters of bed verses or hundreds of meters or kilometers it will influence significance/usability of the results.

Section 2.4) Which of the categories require hydrologic-potential flatness? Only 'definite' explicitly includes hydrologic-potential. Can a sloped hydraulic-potential surface be considered a lake with the other classifications?

122) '<3sigma BPRr': Maybe the threshold magnitude of specular proxy should be defined here. It is unclear to me. Partially as I am confused about the distinction between BRP and BRPr (see line 81 comment) and what <3sigma BRPr means. I understand that the analysis requires a low magnitude of standard deviation to be a definite lake, but that magnitude is not defined. Does the threshold vary between lakes, or is a universal threshold applied? Looking at Carter et al., 2007 those authors used 3 db standard deviation in bed echo strength as a threshold for a specular proxy. Should '<3sigma BRPr' be a 1sigma threshold of less than 3 db?

123) 'flat hydraulic surface': flat hydraulic potential surface

133) 'distinguish': What characteristics are not distinct? Should the clause be more specific?

Section 2.5) Lake shape assumptions seem poorly justified. Why should lakes have the

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same aspect ratio? The average of two lakes (SLE, SLC) does not reveal much about a distribution of lake sizes. How do aspect ratios of pater-noster lakes vary within a sub-aerial valley, does this lend credence to this assumption? Not all the candidate lakes are within a trough. Are the trough assumptions applied to all environmental settings? If so, how can that be justified? Perhaps making volume estimates from a single RES crossing exceeds the capacities of the data.

147) A mention of the tectonic environment (like the details discussed near line 235) in these sections would support the choice of a side slope lake depth assumption.

156) 'replaced them with Bedmap2': Bedmap2 is 1km grid product. Which bedmap2 value was chosen for inclusion in the new 2km grid DEM? What methodology was employed

158) 'downsampled': How?

162-163) Why include units for some variables?

167) equation 5, g is a different typeface.

171) These citations are specific to the middle of Whillans ice stream. The lakes in this article are in a different glaciological setting. How does hydrology in fine grained subglacial substrate in the middle of a fast flowing ice stream relate to the hydraulics in a fault bounded subglacial highland trough beneath an ice divide?

177) 'tends': Does it ever not?

218) 'very close' is greater than 20 km? What does 'very close' mean?

220) '17': 17 is the total number of 'small lakes' or the number of small lakes near the divide? Maybe if it said (17 of x) or (x of 17) whichever is correct. Would that be clearer if the numeric values of this section were not parenthetical but part of the sentence, e.g. 'Seventeen of the small lakes. . .',?

221) 'these': Which lakes are 'these'? only the 3 largest?

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228) 'mean': What do we learn from the mean? Would the mode be more descriptive?

241) Where is the ET? Geographical names should be locatable with labels on figures. Particularly with a reference to figure 9 which does not have any locatable basal topographic features.

246) All the others have a count, why use percentage here? Is it better to be consistent?

246-253) Seems like some of this is repetitious. Velocity description occurs on line 228, lowland description occurs on line 238. Length appears on line 227.

262) Percentage or count? consistency?

269) '(Figure 7c and 7d)': These panels do not show catchment boundaries, so it is not possible to detect how the subglacial hydrology catchments and ice catchments differ and how that might be an important insight.

275) Is an indent missing?

277) 'channelization': Is channelization an assumption? How is the geometry of the system known? Perhaps 'routing' is a better word?

289) How deep is 'deep'? 290) What is the evidence of melting over the lake? Perhaps present as a hypothesis?

293) What is a 'variable' distribution? Can a more specific statement be used?

301) How is the shape of these lakes known? They are assumed to be circular or elliptical. How can these shapes be compared to the shapes in the Wright and Siegert inventory? In Wright and Siegert inventory a single length value is reported except for 8 lakes which have an additional width value. How is any meaningful shape comparison accomplished with these data?

306-308) It is ambiguous if this statement is an inclusive list (all are necessary) or are

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three independent criteria. I might rewrite to have the distinction be explicit.

330) 'trough': Capitalize?

334) 'cascade-type system': This term is used a few times (line 352,418) without a clear definition of what characterizes this system or what other systems might exist. I presume 'cascade' refers to a temporal correlation between respective draining and filling events? My understanding only becomes a possibility after reference to Thwaites lakes from Smith et al. as cascade. Maybe clearer terminology is needed?

349) Is an indent missing? Section 4.5) Much of this section appears to be methodology to me. Consider moving the text.

370) No space after 'energy.'

376) 'focused'/'single portions': Isn't BRP calculated everywhere? What does 'single portions' mean? Is it a length of flight line, or a certain number of samples? If so, that should be explicitly stated with the magnitude (e.g. # samples) of data used.

396) 'elevation': should it be 'altitude'?

398) 'appropriate': What is 'appropriate'? Denser (more closely spaced) survey lines are needed?

406) '124' and '7.7': Different magnitudes than reported on line 257

408) "dim": Dim in quotes here, but not elsewhere. Which way should it be?

FIGURES Figure 1) Colorbar: 3000 is white. But back ground is white as are the masks for ice shelves. Maybe change the end member color or background.

Figure 1) Colorbar: Mapping of elevation order with negative elevations closer to top of page is counter to more intuitive mappings of high elevation above lower elevation.

Figure 1) Figure 1 should include all the places referenced in the text. Should all abbreviations used in the figure be defined in the caption? This might assist the reader

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in establishing geographic spatial relationships.

Figure 1) Adding the flight lines to Figure 1 would aid in establishing the geographical extent of the aerial survey. Figure 4 is the only depiction of the survey extent and is plotted over only bed elevation with a minimum of geographic place names. I think having the flight lines on an image with more geographic and physical detail will help orient the reader.

Figure 6) 'a&b' and 'c&d',: maybe include reference to Figure 7.

Figure 8) Caption 'regional distribution in Antarctica': What does that mean? Is this the ice thickness distribution for the BBAS survey, all of Antarctica?

Figure 9) Why group a histogram of surface velocities with a map of hydrology routing? Figure 9b, should be in Figure 8.

SUPPLEMENT Table 2) The use of both BRP (in caption) and BRPr (table header) without a clear definition of difference.

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