

Interactive comment on “MODIS observed increase in duration and spatial extent of sediment plumes in Greenland fjords” by B. Hudson et al.

B. Hudson et al.

benjamin.hudson@colorado.edu

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Thanks for your thoughtful comments on this paper. All responses are italicized.

Comments: 1) Could the catchment delineations for the different rivers (or just for the three fjords) be included in Figure 1 (perhaps by using a larger scale inset map) or in a separate figure? It would help illustrate the statistics in Table 1 and inform the readers about the study region. Additionally, it would be useful to other researchers creating catchments in these regions.

We added a figure that now shows ice sheet catchments.

2) In both the introduction and discussion, distinguish studies on sediment dynamics in rivers and plume sediment dynamics in fjords. On Page 6103, Lines 26, the previous

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studies refer to river SSC, whereas the Chu reference and this paper's hypothesis refer to fjord plume SSC. Include a sentence to transition the discussion from river SSC to fjord plume SSC. In the last paragraph on Page 6116, also clearly state whether references and results refer to river or fjord plume SSC.

We combed through the manuscript and clarified river vs. fjord SSC wherever it was ambiguous.

3) I suggest reviewing the use of “truth” as the name of that dataset, and providing some clarification in dataset production. Perhaps define variables for the “truth” 13yr mean SSC dataset and the cloud-masked “truth” dataset. So is this “truth” dataset only spatially based on the 13yr mean cloud-free SSC (and is this the same as SSC_{msm}?), with temporal variability derived from a scene-generated intensity?

We have reviewed the use of truth, and changed it to simulated.

On Page 6111, Lines 3-4, is the range of y 1 to 300? How many scenes were there on average per day? Clarify Page 6111, Lines 5-7: the range of which parameter was selected by tuning the “truth” SSC values to the range of MODIS SSC?

This range was selected by matching simulated SSC values to the range found in the observed MODIS dataset.

4) The annual fjord ROI SSC metrics play a large part in the analysis, and they should be introduced more explicitly and all together in Section 3.4. The last paragraph in Section 3.3 (Page 6111, Line 8) introduces $P>t$ metrics indirectly as a means of exploring cloud bias, and they are explored more thoroughly in Section 3.4. I suggest reframing that paragraph as the first paragraph in Section 3.4 to introduce the variables $P>t$ and t as important metrics for analysis of interannual plume area. Perhaps include a more descriptive title for Section 3.4, such as “Plume extent and SSC metrics.” The variables can be defined earlier ($P>t$ was not explicitly defined as the percent of available fjord pixels above an SSC threshold until Section 3.4). Metrics can be referred to by their

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variables rather than using difference phrases for consistency (e.g., $P > t$ instead of “ROI metrics”, Page 6111, Line 24). It can also be stated more clearly that $P > t$ and SSC_{msm} are computed from the 13yr mean cloud-free MODIS SSC dataset (distinguishing this from the “truth” MODIS SSC dataset).

Sections 3.3 and 3.4 were reorganized and re-written to try to better introduce the $P > t$ metrics and improve the clarity of the paper. Section 3.4's head has also been changed to “Optimizing the quantification of plume characteristics”

5) Figures 6-8 and 10 are not referenced in the text.

These figures are now referenced in the text.

Minor comments: 1) Page 6103, Line 2: Include citation for “mass loss has accelerated since the 1990s”.

Reference added.

2) Page 6103, Line 7: Liquid runoff occurs at marine terminating glaciers too. Instead of separating mass loss into marine- vs. land-terminating glacier regions, perhaps separate it in terms of solid ice discharge vs. liquid runoff.

The relevant paragraph has been re-written to try to clarify this distinction.

3) Page 6103, Lines 25-27: Consider combining this reference with the Østrem (1975) reference (line 22) in a more general statement that a simple relationship is not always found between discharge and SSC. It makes the Fenn (1985) reference a nice cap to this discussion before transitioning to the limited but more positive results from Greenland.

These lines were re-written.

4) Page 6104, Lines 16-17: Specify for river study areas.

Clarified.

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5) Page 6104, Lines 18-19: Specify for fjord study areas.

Clarified.

6) Page 6104, Lines 19-22: Consider also including the broader goal of assessing how fjord SSC is related to proglacial runoff.

This goal was always implicit, but a sentence was added explicitly mentioning this.

7) Page 6104, Lines 24-25: Should start with “Three major fjords...” since the three fjords are named and the paper is structured around the fjords.

The order has been switched.

8) Page 6105, Line 4: Is the CRESIS Jakobshavn dataset basal or surface topography?

It is for basal topography. The relevant line has been re-written.

9) Page 6105, Line 1-6: State the spatial resolution of these three datasets.

Done.

10) Page 6106, Lines 4-5: Suggested wording: “. . .each 34 km in length,. . .”

Re-phrased.

11) Page 6107, Line 6: Would be helpful to see the different drainage catchments.

Now shown in Fig. 3

12) Page 6107, Lines 7-8: State the larger size too.

Added.

13) Page 6107, Lines 8-9: Which catchment do you use for the rest of the paper?

We use Naujat Kuat – Small throughout. This has also been clarified in the text.

14) Page 6108, Lines 6-8: Check sentence wording. Suggested wording: “Exelis ENVI

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4.8 software, including the MODIS Conversion Toolkit (<http://www.exelisvis.com>), was used for georeferencing, bow tie effect correction, and atmospheric correction (using dark object subtraction)."

We agree that software, as an active subject of the sentence may be confusing. It's been re-written to clarify that we used the software to do described work.

15) Page 6108, Line 12: Was it only a linear shift?

Yes, it was a linear shift; no warping of the image was needed.

16) Page 6109, Line 8: "We developed an SSC retrieval algorithm. . ."

Fixed.

17) Page 6110, Line 2: "...observations have provided. . ."

The satellite is still in operation, and is a general observation, so we leave this sentence in present tense.

18) Page 6110, Line 4: "...presence of clouds compromises. . ."

For the same reason we leave this sentence in present tense.

19) Page 6113, Lines 2 and 6: spell out "years".

Copernicus staff made this change. We defer to them.

20) Page 6116, Line 6: ". . .River plume, with a. . ."

fixed.

21) Page 6116, Line 10: "Both the Watson and Umiiviit have. . ."

fixed.

22) Page 6116, Line 12: ". . .while the Umiiviit metric was. . ."

fixed.

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23) Page 6116, Line 24: Remove comma.

fixed.

24) Page 6118, Line 3: ". . .MODIS record is complex. . ."

Since the analysis is done, and referring to a finite period in the past (between 2000 and 2012), we leave this sentence in the past tense.

25) Page 6118, Line 5-7: Perhaps comment on whether the fjord-aggregated mean plume SSC (since it does relate better to modeled runoff) can be used as a broad spatial proxy for runoff.

We this think this is still an open question so do not offer an opinion.

26) Figure 1: Include fjord names in the (a), (b), and (c) descriptions in the figure caption.

Fjord names added.

27) Figure 3 caption: Is the Scene Mean SSC the "truth dataset?"

Yes it is. Now clarified in the text.

28) Figure 4 caption: "masked with clouds" redundant" (b). State the day of year of this example image.

Fixed.

29) Figure 5: Can use "SSCmsm" or "melt-season mean SSC" instead of "Mean SSC" for consistency.

Changed.

Confusing caption wording, perhaps, "Percent deviation of annual plume metrics (SS-Cmsm and P>250) from "truth" dataset was used to constrain. . ."

Re-written.

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30) Figure 9: Larger font in figure labels.

Font was enlarged.

Interactive comment on The Cryosphere Discuss., 7, 6101, 2013.

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