GENERAL COMMENTS

This paper and the release of the underlying glacier inventory are an important step in the completion of the world glacier inventory. The paper presents, for the first time, a reliable measurement of the glacierized area outside the Greenland ice sheet, based on established semi-automated glacier outline digitization from mainly orthorectified Landsat 7 scenes. The resulting outlines and areas of the ice masses are a baseline for ice extent peripheral to the Greenland ice sheet around the year 2000. Additionally, DEMs were used to extract ice divides and separate the ice masses into individual glacier units, and extract a range of topographic attributes. The paper presents the used datasets, the methods and the results in a clear way. The authors also attempted to classify levels of connectivity of the local glaciers to the ice sheet. Although this is commendable, I explain below that this aspect may need more extensive work before it is presented in such a prominent and conclusive way.

Overall, the paper is of good scientific quality and clear. The work is novel and of generally high standard. I have some major concerns with parts of this paper (e.g. error analysis, connectivity classification) and feel that some many other parts need minor improvement and strengthening. The language and writing style will need to be improved, and many of the figures need adjustments. More details of my suggestions for major changes, and minor corrections, are given below. I have tried to minimize repetition of Graham Cogley's referee comments. Overall, I feel this paper presents important results and a diverse set of glacier data, and that it is appropriate for publication in TC, once reviewers' comments are addressed.

MAJOR COMMENTS

TITLE: The title is misleading, as the inventory excludes the Greenland ice sheet and directly connected ice masses. Rename to e.g.: "The first complete glacier inventory of ice masses peripheral to the Greenland ice sheet."

LANGUAGE AND WRITING STYLE: The use of English is poor at times. The writing style is convoluted and contains errors, including erroneous direct translations from German. Avoid the use of acronyms and abbreviations if not necessary (in the abstract), be consistent in verb tense within a section, and use commonly accepted terminology (e.g. not 'entities' but 'glacier units', change 'glaciers and ice caps (GIC)' to 'ice masses' (Paul et al., 2009)). Some major errors are indicated in my comments below, but I also recommend the authors to spell-check (e.g. 2400-20: arround) and ask a colleague who is proficient in scholarly English to correct for 'sentence flow'. Some place names should be checked directly with GEUS (Anker Weidick or Michele Citterio) or Higgins (2010). Some of Weidick's (1995) spelling may no longer be official (see also http://www.oqaasileriffik.gl/en/resources/greenlandiccity_andsettlementnames).

QUANTIFICATION OF ERRORS: The ice mass outline error needs to be better quantified.

a) Ice margins are from summer images. Since the extent of calving margins has annual fluctuations of > 1 km for larger outlet glaciers, with a most retreated position in summer (Howat et al., 2010; Bevan et al., 2012), the glacierized area given in this paper thus a minimum extent. Mention this, and, if possible, estimate the seasonal fluctuation (even if just regionally).

b) A figure with digitized glacier margins overlain onto Landsat 7/Landsat TM of 1-2 land-terminating glaciers with/without dirty ice or moraine, 1-2 tidewater-terminating glaciers in a fjord with sea ice as well as a glacier margin with an adjacent ice shelf, will demonstrate the digitizing accuracy and problems better.

c) Though manual correction of seasonal snow was applied, there may be regions where this remains problematic (especially in ice divide regions, e.g. Fig 3). Say something more about this potential error.

d) Mosaicking errors: Landsat images were not mosaicked before digitization: were there no connection shift problems detected when the outlines were mosaicked?

e) Reprojecting: The magnitude of area errors in UTM depend on latitude. Mention a % range for the Greenland latitude range. However, reprojection also introduces errors, which should be given as a potential % error for the latitude range as well.

f) The cumulative error calculation needs to be clear (e.g. Jiskoot et al., 2012: p 37).

g) It would be helpful to add a table with the total glacierized area based on the UTM projection as well as the Greenland Lambert Azimuthal Equal Area projection, as well as areas of the largest glaciers (e.g. in Fig 1 plus 1-2 large glaciers in the far south and west) based on both projections. This is important for the comparison of areas given in other publications, which have sometimes used UTM projections. In the same table areas of the overlapping largest glaciers from other regional inventories can be listed (e.g. Weidick et al., 1992; Citterio et al., 2010; Palmer et al., 2010; Jiskoot et al., 2012), and a full discussion of accuracy and subjectivity of glacier delineation in complex glacier systems can be discussed.

CONNECTIVITY: It is an admirable and novel to try and assign a level of connectivity to the Greenland ice sheet, but I have problems with way this is defined (especially CL1 and CL2). I feel it needs to be further explored and justified before releasing the dataset with that attribute, and before separating glacier areas (Table 1) on the basis of the connectivity levels and discussing regions (Fig 1 and e.g. 2409: 22-27). The now prominent result of the connectivity classification could be mentioned as a first step, but physically meaningful ways of connecting need to be explored, which may ultimately lead to a separate paper. My major concerns with the used connectivity classification are as follows:

a) The edge of the Greenland ice sheet is not an exactly known boundary (see also Cogley's comments).

b) For a connection between ice masses to be meaningful (at least for hydrological and glaciological modelling) it should be based on physical processes: these could include shared ice dynamics (e.g. confluence), shared accumulation (divergence), or a connected hydrological system (e.g. subglacial lakes). Physically, it also matters whether units are confluent or divergent, even though when either separate both configurations may change from fully-connected to unconnected. The connectivity levels used in this paper are based on line-connectivity, not on basin configuration or physical connectivity.

c) On the annotated Fig 3 (Supplement), I demonstrate that it is illogical to have glacier units connected to other units that have been assigned CL1 (or CL2) automatically adopt the same class. In the top blue circle the number of ice divides between the ice sheet outlet are written in each glacier. Most of these ice divides are not shared accumulation areas, but arêtes or cirque headwalls which may have seasonal snow. Glaciers marked with '0' are tributaries of the ice sheet outlet, and clearly must have a different connectivity than 1-10. Additionally, the southerly flowing 1-10 don't discharge into the same fjord as the ice sheet outlet. The lumped CL2 connectivity level has thus neither a glaciological nor a hydrological meaning. I would argue that glaciers marked 10 have at least the same level of unconnectedness to the ice sheet as the glaciers labelled CL0. In the lower circle I have indicated missing ice divides (and arrows for flow directions). Here, it is not clear to me why the yellow and red glaciers marked '1' have two different connectivity levels.

d) Geikie Plateau (for example) is a separate accumulation zone with radial flow into complicated outlet glacier systems, of which some are confluent with outlets from Watkins Bjerge accumulation area, but not with those of the Greenland ice sheet. Watkins Bjerge in the paper's connectivity should have a CL1, but Geikie Plateau and outlets CL2

COMPARISON OF DEMs (3.3): Stauning Alper, is probably one of the most inappropriate regions for the comparison of DEMS that are not exactly taken in the same years. Firstly, the region has a high percentage of surge-type glaciers (Jiskoot et al., 2003), which deplete rapidly during quiescence, and during a surge thin and thicken suddenly, and may change ice divide position. Secondly, the ASTER GDEM has been found inaccurate in high steep terrain (Frey and Paul, 2012), such as the Stauning Alper. This known inaccuracy should be mentioned and referenced. I suggest another region, devoid of surge-type glaciers, is used to demonstrate differences in DEMs.

DISCUSSION: In the minor comments I give suggestions for strengthening parts of the discussion that are too vague or incomplete.

MINOR COMMENTS

Abstract: State in a new sentence how many of the ice masses are ice caps. Delete CL0, CL1, CL2 here, as the explanations are sufficient.

Introduction: don't skip from what you have done to past inventories and back to your work: reorder into a more logical sequence.

2400-4: and FOR the past, potential and future.

2400-14: larger THAN

2400-16: Did you mean former instead of latter? Even for the former this is incorrect: Some estimates of local ice cover on Greenland are in the order of 70 000–100 000 km2, with extremes up to 163,200 km2 (Thomsen and Weidick, 1992; Yde, 2011). Many of the estimates were originally considered as mimimum estimates, as they were based on large-scale mapping

which excluded the smaller glacier units (Yde, 2011). Delete ‘according to all’, and adjust the percentage.

2400-17: smaller THAN

2400-20: around

2400-20-23: not sure what the authors are trying to say here about aspect because of the sentence structure. Not sure if this really belongs in the abstract. The median elevation is strongly dependent on the underlying topography, which generally increases with distance from the ocean.

2401-5 incorrect sentence after the comma, replace with ‘but inventory information is incomplete’.

2401-6: Delete ‘and differently used’

2401-8: database is one word

2401-15-23: Delete this section, as it contains methods, discussion and results and should be in the summary but not intro. If information given here is missing from the methods section include it there instead.

2401-25: Replace “Geikie glacier inventory (Jiskoot et al., 2012)” with ‘the Geikie Plateau and Scoresby Sund regions (Jiskoot et al., 2003; Jiskoot et al., 2012).’ The first paper is an inventory that covers both regions in 1995-1996 and is downloadable from GLIMS, but there were problems with the projection. The second paper is an updated inventory of the Geikie Plateau region only, based on 2000-2005 outlines, and will be uploaded to GLIMS soon.

2402-5: Kargel et al. (2012) not 2011

2402-11: They range up to 1000000 km2 (Thomsen and Weidick, 2012)
.
2402-12-14: poor phrasing after the comma: direct translation from German.

2403-6: Gunnbjørn Fjeld (correct spelling: Higgins, 2011).

2403-8: Weidick (1995): not et al: see references. Correct this throughout the paper.

2403-9: Sector division: If I compare your Fig 1 with Weidick (1995) Fig 1 I don’t see a further section in the south. His sections are just labeled southeast, southwest and southern west. Be more specific if you did anything different. What is the basis of your sector division lines: do you exactly follow Weidick’s major divisions? With the present knowledge of flow directions and slopes I suggest using ice divides on the basis of Rignot and Mouginot (2012) Fig 1F. Here you can see it does not make much sense to label a section South, as the flow direction is clearly southeast or northwest (see your Fig 7). Why do you have SE, S, SW, W, NW, etc in your table A4, but don’t indicate these divides in Fig 1?

2404-3: Replace the sentence with" ...., for instance in the Stauning Alper and Geikie Plateau regions (Jiskoot et al., 2003 and 2012; Weidick, 1988) and the Disko–Nuussuaq region (Yde and Knudsen, 2005).
If you want to keep to Weidick's spelling it is Disko–Nûgssuaq. Remove Jiskoot et al. (2001) from the reference list and replace with Jiskoot et al. (2003).

2404-12: These TM scenes cover a long period: at least indicate on the footprint map which areas were in need of this filling of data gaps.

2404-22: Hans Tausen Iskape: in Fig 1 this is called: Hans Tausen ice cap. Be consistent. Weidick (1995) spells it as Iskappe.

2404-23-24: What does 'partly not consider' mean? Also, you exclude glaciers smaller than 0.05 km2 so this should not be a problem.

2404-26: 'stick to the' is non-scholarly language.

2405-1-2: sentence needs a reference.

2405-7: ASTER GDEMII: give a range of years of ASTER images on which the was based and a reference (or website).
2405-9-10: This sentence needs to be at the end of the Introduction, or near the beginning of the Study Region.

2405-13: ….INTO three steps. There are 3 major steps and then within those sections more steps. This is confusing. Use different terms for the two levels.

2406-13: This is an important step, but is not the second (but the third within overall step a: very confusing), and these are in fact two steps. Mosaicking and Reprojecting.

2406-23: GREATER than 30 %

2406-25: 'for clean ice': what was the accuracy for snow, dirty ice, etc? The margins of land-based glaciers are often not clean. Also, what is the precision of calving margins? Did you have problems with fast-ice or pack-ice? How were ice shelves removed (2404-22) and what is the estimated error?

2407-6: remove 'that are explained in the following.' This phrasing is unnecessary when the explanation follows directly.

2408-1-16: Two other methods are through (visual) glaciological interpretation of surface flow (Racoviteanu et al., 2009), or through ice flow direction from gravitational driving stress (for which you need a surface and bed DEM, smoothed (Bevan et al., 2012). Both can be more accurate than just relying on the surface slope from DEMs. Did the authors assign an uncertainty to their ice divides (e.g. Paul et al., 2009)?

2408-16: Delete 'and can be discussed' (is implicit in 'subjective').

2410-11: Wrong calculation: Jiskoot et al (2012) state that the entire glacierized area is 41 591 km^2 of which 90% is tidewater terminating = 37432 km^2. Minus Kong Christian IV (11 079km2) is 26 352 km^2. This is quite close to the 24 494km^2 (+/- 750 km^2), given the error margins in both

inventories. This is actually quite encouraging, given the two different projections (we used UTM) and the complexity of drainage basins in this region!

2411-7: peak elevation?

2411-7-26: The discussion of the cause of the elevation differences belong in the discussion section. The authors should give data on measured MAAT and accumulation rates (from papers using model output in combination with meteorological stations: Weidick (1995, p C19) and papers by Box and/or van den Broeke will be useful): both factors influence the glaciation level and equilibrium line. This discussion should be expanded and improved.

2412-17: doms should be domes

2412-26: Also compare the assumed area of the Greenland ice sheet with the range of estimates given in Kargel et al. (2012: TC)

2413- 5-15: A range of 70 000–100 000 km2 is given by Thomsen and Weidick (1992) and (Yde, 2011), so this discussion will need adjustment.

2413-17-25: this discussion is too vague.

2414-2: The continentality effect. That it is shown 'for the first time from the topographic glacier parameters in Greenland' is not entirely true as e.g. Jiskoot et al. (2003 and 2012) indicate differences in snowline along the coast and inland in East Greenland. See also Weidick (1995: C19-22). Many models also show this distribution, which should be brought into this discussion.

2414-18: 'values calculated here' is vague: do you mean the ice divides, hence glacier outlines and areas, or the elevation/aspect data or both?

2415-1: Straightforward is one word

2415-19-25: this may need to be adjusted: see earlier comments.

2415-27: 'might not yet be fully consistent': do you mean you still have to do some error checking?

2516-11: correct: ....largely due to differences in terrain topography, continentality and mass balance (precipitation rates and temperature).

2516-113-15: rather than 'hints' it confirms the effect of continentality on the precipitation rate.

FIGS:
For all figs that have satellite images as background give the type, scene, bands, and date, in the fig caption. Many figs are missing location, and scale, and some could use glacier names.

FIG 1: All the numbers for the largest glaciers are in the wrong location! See e.g. Weidick (1995), Jiskoot et al. (2012) or Rignot & Mouginot (2012) for correct locations. 'Blackicebank' is not a glacier: do you mean Sortebrae??
Geikie (spelling!) Plateau should be turned 90° counterclockwise, and not cover Gåseland with its letters 'Ge'. It is only the NE part inland of Blosseville Kyst, not the entire region (see Jiskoot et al., 2012: Fig 1, and Higgins, 2010)

FIG 2: Replace ‘Glacier outlines’ with glacierized area delineation (delineation of ice masses). Change ‘glacier entities’ to ‘glacier units’.

FIG 3: Give lat-lon and a scale bar, or a location box in FIG 1. Adding some glacier/peninsula/island names will also clarify the location. See referee Supplement figure and comments above, for concerns with the connectivity.

FIG 4: This fig does not really show the difference between the ice cap with topographic structure and without. Topographic structure may be missing at the scale of the used DEM, but this is not visible on the image. Superimpose DEM shading or contour lines to clarify. The lat-lon tick marks need to be in a larger font.

FIGA2: Why use triangle locations that are not at the tidewater margin? Instead, give two shades to the glacier outlines, with the darker indicating the TW terminating and lighter the land terminating glaciers (e.g. Jiskoot et al., 2012: Fig 1). The glaciers area drained by TW margins can then be easily assessed visually.

REFERENCE LIST:
Weidick (1995) is the sole author: Williams and Ferrigno are editors. See below for the correct reference.

ADDITIONAL REFERENCES:
Bevan, S. L., Luckman, A. J., Murray, T., 2012. Glacier dynamics over the last quarter of a century at Helheim, Kangerdlugssuaq and 14 other major Greenland outlet glaciers, The Cryosphere, 6, 923-937.

Frey, H, Paul, F., 2012. On the suitability of the SRTMDEM and ASTER GDEM for the compilation of to-pographic parameters in glacier inventories, International Journal of Applied Earth Observation and Geoinforma-tion, doi:10.1016/j.jag.2011.09.020,

Higgins, A.K., 2010. Exploration history and place names of northern East Greenland. Geological Survey of Denmark and Greenland Bulletin 21, 368 pp. http://www.geus.dk/publications/bull/nr21/index-uk.htm

Howat, I. M., Box, J. E., Ahn, Y., Herrington, A., McFadden, E. M., 2010. Seasonal variability in the dynamics of marine-terminating outlet glaciers in Greenland, J. Glaciol., 56, 601–613.

Jiskoot, H., Luckman, A., Murray, T. 2003. Surge potential and drainage basin characteristics in East Greenland. Annals of Glaciology, 36: 142-148. (use this paper instead of Jiskoot et al., 2001)

Palmer, S. J., A. Shepherd, A. Sundal, E. Rinner, P. Nienow, 2010. InSAR observations of ice elevation and velocity fluctuations at the Flade Isblink ice cap, eastern North Greenland, J. Geophys. Res., 115, F04037, doi:10.1029/2010JF001686.

Rignot, E. and J. Mouginot, 2012. Ice flow in Greenland for the International Polar Year 2008–2009, Geophys. Res. Lett., 39, L11501, doi:10.1029/2012GL051634

Weidick, A., 1995. Greenland. In: Williams, R.S. Jr. & Ferrigno, J.G. (eds): Satellite image atlas of glaciers of the world. U.S. Geological Survey Professional Paper 1386-C, 141 pp.

Yde, J., 2011. Greenland glaciers outside the ice sheet. *In*: Encyclopedia of Snow, Ice and Glaciers (eds. V. P. Singh, P. Singh, U. K. Haritashya), Encyclopedia of Earth Sciences Series, Springer. 1200 pp.