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The Cryosphere Discussions

Interactive comment on "What's in an elevation difference? Accuracy and corrections of satellite elevation data sets for quantification of glacier changes" *by* C. Nuth and A. Kääb

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General comments

This submission attempts to identify and address the errors and biases present in widely available digital elevation sources to improve the accuracy of calculated glacier surface elevation changes using remotely sensed data. It has the potential to make an extremely valuable contribution to the literature by establishing processing protocols for this important application. To this end, a three-step methodology is proposed and demonstrated on case studies in the New Zealand Southern Alps and central Spitzbergen. However, while the content is (in my view) very worthy of publication, I suggest the

following four modifications would improve the quality and impact of the submission.

Specific comments

1. Overall, it seems that there is so much in this paper it loses focus. The methodological sections (1-4) work really well, but the addition of the case studies in Sections 5 and 6 feels superfluous. The paper would benefit from integration of one of the case studies (probably New Zealand) into the methodological description so that there is some demonstration of the framework, without such verbose descriptions of essentially the same thing (but using different data) twice over. A more concise paper, that proposes the framework with reference to a single case study, would have much greater impact in my view.

2. The section on the GDEM (5.2) sits a little oddly within the manuscript – essentially it is too long for simply stating that the GDEM is of insufficient quality (for calculating surface elevation changes). I think it could be reduced to a few lines without detriment to the paper (or even included in Section 3.1 as an important point to note).

3. The section on elevation changes in New Zealand (5.4) is confusing. . . having explained that there is significant potential error in each difference pixel, particularly over short timescales, you then present data where the trend is lower than the expected uncertainty (mainly on the east side of the divide, although the same can be said for both Franz and Fox on the short timescales). I would suggest focussing on the six-year data, where more confidence can be placed in the results, and not spend time explaining and interpreting effectively meaningless results just to illustrate a point. This modification could easily be implemented in line with comment 1 above.

4. Also in Section 5.4 there is some interpretation of frontal dynamics on the Fox Glacier, where you jump from talking about ice thickness changes to frontal advance/recession. First, some of the data being compared are from different seasons (e.g. April 2001 (at the end of summer) and February 2002 (at the height of summer)). So you should, as a minimum, make some reference to the impact this may have.

Second, the thickness changes do not necessarily translate into frontal fluctuations in a given year. Third, I'm not sure a surge has ever been detected/suspected in New Zealand – I think you mean a small speed-up, which is very different to a surge. This section should be modified accordingly.

Technical corrections

Page 2014, Line 10: perhaps use 'demonstrated' rather than 'exemplified'

- Line 17: 'apparent' might be better than 'effective'

Page 2015, Line 9: should read '. . .flown in February 2000. . .'

- Line 28: typo – interferograms

Page 2016, Line 11: 'common' would be better than 'popular'

Page 2017, Line 15: should read 'the first objective of this study is to. . .'

- Line 16: should read 'without the need for specialised software and with. . .'

Page 2018, Line 18: Earth needs an apostrophe

- Line 20: apriori should be hyphenated

- Lines 22 and 23: Airborne and spaceborne are single words

Page 2019, Lines 1/2: check spellings of satellite names

Page 2022, Line 5: should read '(i.e. off-glacier)'

Page 2023, Line 7: remove otherwise stated (unless you do state it somewhere – I can't find where).

Page 2024, Line 2: should read 'is shifted to the second. Resulting elevation. . .'

Page 2027, Line 19: is 'perfect randomness' not an oxymoron somehow?

Page 2030, Line 11: 'we will assume an auto-correlation length of 1km' – for what?

This needs explaining.

- Line 24: remove 'nearly global'

Page 2032, Line 26: should be 'determine'

Page 2033, Line 27: should read 'significantly, although it is slightly smaller. . .'

Page 2034, Line 9: repercussions

Line 2035, Line 2: maybe use 'features' rather than 'striations'

Figure 6 caption: should be [a], [c] and [f] I think (last sentence)

Figure 6: the y-axis on [g] needs a label

Figure 7 caption: you refer here to the amplitude error of 1-2 metres – later it is 2-4 metres – which is it?

Page 2036, Line 15: 'implication', not 'implications'

Page 2037, Line 3: should read 'for the SRTM data and are extremely difficult. . .'

- Line 20: do you mean 'precision'? Or 'accuracy'? They have different meanings

- Line 24/25: why should the changes on the tongue not be significantly different to zero? This is an odd sentence that can be removed

Line 25: 'the estimated rate. . .'

- Line 27: change 'is' to 'are'

Page 2040, Line 20: use 'caution' rather than 'precaution'

Page 2042, Line 18: 'complementary'

- Line 20: 'through'

Page 2044, Line 12: use 'affect' or 'impact on' rather than 'infect'

- Line 16: replace ‘as in’ with ‘than’

Page 2046, Line 5: I guess you mean ‘increases’ rather than ‘decreases’

- Line 8: ‘amounted to 5-70%’

- Line 14: remove ‘by’

- Line 24: change ‘dangerous’ to ‘significant’

Page 2047: change ‘infected’ to ‘affected’

- Line 22: 1-4 m – be consistent with earlier in the paper

Page 2048, Line 9: what is a table processing software?

Interactive comment on The Cryosphere Discuss., 4, 2013, 2010.