

## Additional changes to the manuscript (tc-2014-78)

The manuscript is changed according to the response letter published at TCD the 18 of August, except from some changes of technical nature that clarified the text and improved the language (e.g. correction of grammar), and some changed or added references. Additional changes are listed in this document. Note that the line numbers refer to manuscript submitted on 9.9.2014.

### Text:

- Line 16: Removed “climatic aspects” to avoid confusion.
- Line 85-87: Moved a sentence from “4.4.2 Elevation” to “2 Study region” :
  - o “Since the beginning of the 2000s, all glaciers monitored by NVE have been in a state of retreat (Andreassen et al., 2005, Winkler et al., 2009).”
- Line 111-114: To improve readability a list of the advantages of using Landsat images was added under section “3.2 GI2000 and GI1990 – Landsat satellite imagery”:
  - o “The Landsat TM/ETM+ satellite images have multiple advantages compared to imagery from ASTER and SPOT due to: 1) the larger swath width of Landsat, 2) better availability of Landsat images, as other optical satellites were not operational during the time periods, and 3) Landsat has freely available georeferenced and orthorectified satellite scenes.”
- Line 150-155: Updated a sentence and reference under subsection “3.2.1 Band ratio accuracy and threshold sensitivity”:
  - o Old: “Similar results were found on a test site in the Swiss Alps, where outlines derived from Landsat TM imagery were compared with a SPOT satellite scene, which revealed an area difference of 2.3 % (Paul et al., 2002)”
    - Changed to: “Fischer et al. (2014) show that Landsat derived outlines (year 2003; medium spatial resolution (30 m)) compared to orthophotos (year 2003; high spatial resolution (50 cm)) for eastern Switzerland show similar results meaning there is comparable accuracy between the medium-resolution and high-resolution source data for glaciers > 1 km<sup>2</sup>. On the other hand, they found that glaciers <1 km<sup>2</sup>, the uncertainty of the outlines increased with decreasing glacier size.”
- Line 391-392: Corrected and updated sentence under subsection “4.2.1 Glacier length changes vs. in situ length changes”:
  - o Old: “Nine of the glaciers show good agreement between the length change methods, corresponding to +-1 to 2 pixels.”
    - Changed to: “Eight of the glaciers show good agreement (of +- 1 to 2 pixels) between the length change methods.”
- Line 416-417: Due to an imprecise sentence and reference, we corrected and updated a paragraph under section “4.3 Glacier change since the beginning of 1900s”:
  - o Old: “The glaciers response to the climate was not changes in the glacier dynamics, but rather by down-wasting (Paul et al., 2004).”
    - Changed to: “Strong thinning and retreat has been revealed for Langfjordjøkelen, one of the five ice caps, over the period 1966-2008 (Andreassen et al., 2012).

- Note! We took out the reference Paul et al., 2004, and refer now to Andreassen et al., 2012.
- Line 451-458: Clarified a paragraph in the section “4.4.2 Elevation”:
  - “These considerable changes are partly attributable to the glacier geometries: ice caps in Norway are relatively flat, and a high fraction of their surface remains close to the modern equilibrium line, which makes them highly sensitive to climatic change (e.g., Nesje et al., 2008), whereas the steep glaciers are less sensitive. If the equilibrium line rises on ice caps, large parts of the accumulation area is transferred to the ablation area, and the mass balance becomes strongly negative. For example the accumulation-area ratio (AAR) for Langfjordjøkelen, an ice cap in northernmost region, was 0% for many years during the 2000s, and the glacier is far from being adapted to the present climate conditions (Andreassen et al.,2012a).”
- Line 401-403: Clarified a sentence under “4.2.1 Glacier length changes vs. in situ length changes”:
  - Old: A limitation of using satellite images is the determination of glacier terminus in cast shadow, causing uncertainties in the derived length change (Paul et al., 2011).
    - Changed to: “The determination of glacier terminus in cast shadow is limited by the quality and resolution of the used satellite images, causing uncertainties in the derived length change (Paul et al., 2011).

## Tables:

- Updated table 4:
  - Corrected the column “Start” with correct years. They were not updated in the previous version.
  - “Na”-values (Not available) was inserted for the glacier Midtdalsbreen(2964) under “Maps/satellite(m)” values “FE” and “E1”.
  - Line 304-305: Under the section “3.7 Deriving centerlines”, we have changed a sentence so it makes more sense when compared with the table:
    - “Some of the in situ measurements began before or after the GIn50 first mapping year, but series were included if the gap was no larger than 5 years”.