

Interactive comment on “Glaciological and geodetic mass balance of ten long-term glaciers in Norway” by L. M. Andreassen et al.

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Received and published: 9 January 2016

This is clear a well written paper about an important subject in glacier mass balance studies, the accuracy of glaciological or traditional mass balance measurements and calibration of such measurements with geodetic mass balance measurements over multi-year periods. Out of 21 periods over which geodetic measurements were available from the 10 studied glaciers, 9 cases showed deviations $>0.2 m_{we}/a$ and 5 had $>0.4 m_{we}/a$. These differences are quite large compared with typical year-to-year variations in annual mass balance or mean mass balances over 5-10 year or longer periods. The deviations are both positive and negative and, perhaps unexpectedly, they do not seem to be similar for different periods on the same glacier, except for Engabreen where the traditional mass balance measurements show a consistent positive bias

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$>0.4 m_{we}/a$. These results clearly indicate that traditional mass balance measurements need to be treated with great care and validated and calibrated with geodetic measurements in order to be reliable, a confirmation of the results of several previous studies in this field. Interestingly, the paper concludes, based on the analysis of Oerlemans (2013), that internal ablation, typically not taken into account in traditional mass balance measurements, is not negligible for some of the considered glaciers.

Comments:

I have only one minor comment other than the trivial suggestions for rewording and corrections of typos below. p. 6584, l. 20: Maybe Magnússon (2015) should also be referenced here regarding spatial statistics: <http://www.the-cryosphere-discuss.net/9/4733/2015/tcd-9-4733-2015.html>

Typos and suggestions for rewordings:

p. 6584, l. 5: "It also recommended" → "It recommended"

p. 6584, l. 6: "should be reanalysed in any case" → "should always be reanalysed"

p. 6584, l. 14: "orientation of the data set"? do you mean co-registration?

p. 6584, l. 21: "from the 1960s" → "in the 1960s"

p. 6585, l. 19-20: "The glaciers in southern Norway are located along a west-east transect, extending from a wet maritime climate where Ålfotbreen and Hansebreen are located to drier conditions in the interior where Gråsubreen is located" → "The glaciers in southern Norway are located along a west-east transect, extending from a wet maritime climate, where Ålfotbreen and Hansebreen are located, to drier conditions in the interior, where Gråsubreen is located"

p. 6585, l. 23: "elevation respectively" → "elevation, respectively"

p. 6586, l. 16: "Details on observation programme" → "Details on the observation programme"

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- p. 6586, l. 19: "in field" → "in the field"
- p. 6587, l. 1: "stake measurements" → "the stake measurements"
- p. 6587, l. 6: "To calculate winter" → "To calculate total winter"
- p. 6587, l. 10: "In the contour line method" → "In the contour line method,"
- p. 6587, l. 15: "In the profile method" → "In the profile method"
- p. 6584, l. 28: "The more thorough homogenizing process was applied" → "Thorough homogenizing was applied"
- p. 6588, l. 14: "Area-altitude" → "Area–altitude" (en dash)
- p. 6588, l. 16: "When a new map or DTM became available some time after the survey" → "When a new map or DTM became available some time after the survey,"
- p. 6588, l. 21-22: "on the results we obtained glacier wide balance values by recalculating the mass balance for the period of record" → "on the results, we recalculated glacier wide balance values for the period of record"
- p. 6588, l. 27-28: "and inhomogeneity is smoothed out." → "and on inhomogeneity is introduced"
- p. 6589, l. 14: "In the 1980s" → "In the 1980s,"
- p. 6589, l. 20: "have been" → "has been"
- p. 6589, l. 28: "with no outliers" → "of each other with no outliers"
- p. 6590, l. 9: "to a lake level varying" → "to a varying level"
- p. 6590, l. 16: "Nigardsbreen has been subject for annual glaciological mass balance measurements" → "Annual glaciological mass balance measurements have been carried out on Nigardsbreen"
- p. 6590, l. 18-10: "also the principal investigator responsible for the calculations have

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changed several times" → "and several principal investigators have been responsible for the calculations"

- p. 6590, l. 24: "geodetic mass balance" → "geodetic mass balances"
- p. 6590, l. 25: "1964-1984, 1984-2013 and 2009-2013"? only 1964-1984 and 1984-2013 appear in table 4, the periods 1984-2013 and 2009-2013 partly overlap
- p. 6592, l. 23: "For twelve of the years" → "For twelve of the years,"
- p. 6594, l. 4: "needs" → "need"
- p. 6594, l. 16: "were assumed to be less influential" → "were assumed to be insignificant"
- p. 6594, l. 23: "formulas 8 and 9" → "formulas (8) and (9)"
- p. 6595, l. 1: "dataset" → "data set"
- p. 6595, l. 3: "stations at the Meteorological Institute" → "stations of the Meteorological Institute"
- p. 6595, l. 10: "In the 1990s" → "In the 1990s,"
- p. 6595, l. 5: "In the following" → "In the following,"
- p. 6596, l. 3: "For surveys available as digitised contour maps" → "For surveys available as digitised contour maps,"
- p. 6597, l. 14: "exists" → "exist"
- p. 6597, l. 14: "In May 1987" → "In May 1987,"
- p. 6602, l. 1: "For Nigardsbreen" → "For Nigardsbreen,"
- p. 6602, l. 17: "For Ålfotbreen" → "For Ålfotbreen,"
- p. 6603, l. 9: "For Engabreen" → "For Engabreen,"

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- p. 6605, l. 14/16: "The annual correction factor" → "The annual correction" ?
- p. 6605, l. 26: "reduced the remarked positive cumulative balances measured at the"
→ "reduced the positive cumulative balances measured at some of the"
- p. 6606, l. 23: "remarked" → "distinctly"
- p. 6607, l. 16: "deficit" → "difference"
- p. 6607, l. 17: "Thus, carefulness must be used when interpreting" → "Thus, due care must be shown when interpreting"
- p. 6608, l. 14: "carried out" → "made"
- p. 6609, l. 7: "Hellstugubreen, Gråsubreen" → "Hellstugubreen and Gråsubreen"
- p. 6610, l. 1: "The interpolation methods on" → "The interpolation methods for"
- p. 6619, l. 4: "are accounted" → "are accounted for"
- p. 6619, l. 5: "both" → "the two"
- p. 6625, l. 1: "Glaciological vs. geodetic subtracted the calculated internal mass balance with error bars" → "Glaciological vs. geodetic mass balance, subtracting the calculated internal mass balance from the geodetic balance, with error bars"

Interactive comment on The Cryosphere Discuss., 9, 6581, 2015.