

## ***Interactive comment on “Simultaneous solution for mass trends on the West Antarctic Ice Sheet” by N. Schön et al.***

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### Summary

This paper presents an assessment of ice mass losses from West Antarctica based on two of the three available satellite geodetic techniques – satellite altimetry and satellite gravimetry, but not satellite mass budget – and also global positioning system observations of rock uplift. These observations are combined using a statistical approach to arrive at separate estimates of ice, rock, and snow mass change. The data are restricted to a 6-year period, and lead to an estimated West Antarctic Ice Sheet mass loss of  $76 \pm 15$  Gt/yr between 2003 and 2009. This value differs by  $9 \pm 26$  Gt/yr from the estimated loss ( $67 \pm 21$  Gt/yr) derived in a recent assessment (Shepherd et al., 2012) over a similar period (2003 to 2008) using all three satellite geodetic techniques.

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### Points for discussion

In attempting to establish a motive for their study, the authors have unfortunately misrepresented the status quo in assessments of ice sheet mass imbalance. For example, near to line 5 (p2997) the authors state that rates of mass balance for West Antarctica “still differ significantly”, with reference to two recent studies - Shepherd et al. and Gunter et al. It's a shame that the authors picked these two studies to illustrate their point, because the first (Shepherd et al.) presents an ensemble of many independent results that explains in some detail the limitations of estimates based on few results, whereas the second (Gunter et al) is an assessment based on few results. It's also incorrect to state that these two studies present estimates of ice mass loss that differ significantly. For example, Shepherd et al. estimate Antarctic ice sheet mass loss to be  $72 \pm 43$  Gt/yr over the period 2003 to 2008, and Gunter et al. estimate it to be  $100 \pm 44$  Gt/yr over the period 2003 to 2009. The difference between these values,  $28 \pm 62$  Gt/yr, is not significant.

I suggest the authors could replace

“While there is a general consensus that West Antarctica has experienced ice loss over the past two decades, the range of mass-balance estimates still differ significantly (compare, e.g, Shepherd et al., 2012, with Gunter et al., 2014).”

With

“There is a general consensus that West Antarctica has experienced ice loss over the past two decades, and the range of mass-balance estimates are in close agreement (compare, e.g, Shepherd et al., 2012, with Gunter et al., 2014).”

P2997 Line 6- The authors state that Shepherd et al. (2012) “make use of satellite altimetry”. However, it seems that the authors may have overlooked that Shepherd et al. in fact make use of four satellite techniques - satellite laser and radar altimetry, satellite gravimetry, and satellite mass budget assessments, plus a wide range of ancillary data

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including satellite GPS observations and regional climate models.

P2997 Line 11 – It is worth noting that uncertainties associated with the partial spatial and temporal sampling of satellite missions is a main source of error in estimates of mass imbalance

P2997 Line 20 – I am not sure readers will be familiar with the concept of an “ice discharge map”; perhaps you could explain that uncertainties in ice discharge arise from errors in ice thickness and in ice speed.

P2997 Line 22 – I don’t think that most readers will consider van den berg 2006 to be a recent estimate? Also, it’s not entirely clear, but it seems that King et al 2012 is introduced as another estimates of Antarctic ice sheet mass imbalance, but this seems a little odd following the earlier discussion.

P2997 Line 24 – The authors again use the phrase “recent studies”. I am not sure what it means – within 2, 5, 10, 20 years? The phrase is used often in the paper to mean ostensibly different things. I suggest reviewing the context throughout to make sure you are consistent.

Page 2998 Line 1 -The authors state that “we eliminate the dependency of the solution on solid-Earth and climate Models”, but I don’t think that this is the case. The altimetry solutions will, for example, be dependent on surface mass balance fluctuations in a way that the authors’ model does not admit, as the effects of electromagnetic interaction with the snowpack are not considered. So it is too strong to say that the effects are eliminated - an attempt is made to eliminate them.

P3000 line 6 – the authors state that “Compared to laser altimetry, radar altimetry is less suited for measurements over ice”. I don’t think this is a correct statement. Firstly, the spatial and temporal sampling of the sensor will by a major factor in its capability of detecting changes in ice volume, and this cannot be overlooked. Secondly, laser altimetry is sensitive to fluctuations in the true surface that tend to be dominated by short

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period fluctuations in accumulation, whereas radar altimetry is sensitive to fluctuations in the firn layer which is less affected by short period fluctuations in accumulation. If one is interested in measuring ice, as the authors state, then a sensor that is sensitive to snow is less suitable than one that is less so.

P3005 line 20 – The authors appear to be suggesting that a “simple average .. of corrected data sources” is not statistically sound. I am not sure what to think of this statement, because I don’t really know what the term “sound” means (at least in a scientific context). Nevertheless, I suspect that most readers will consider an average to be a statistically sound calculation, so perhaps a change of wording is required here.

P3011 line 5 – I don’t think that the numbers  $-97 \pm 20$ ,  $-105 \pm 22$ , and  $-76 \pm 15$  can be considered different, when they agree to within 0.5 sigma. So I suggest a rewording here when the new results are presented. Also, where does the figure of  $-97 \pm 20$  Gt/yr attributed to Shepherd et al come from? My reading of the Shepherd et al. puts their estimate of West Antarctic Ice Sheet mass imbalance at  $-67 \pm 21$  Gt/yr over the IceSat period (Table S2).

P3011 line 7- Again, Shepherd et al is not an altimetry-based estimate- it includes observations from 4 satellite techniques – more, in fact, than the present study!

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Interactive comment on The Cryosphere Discuss., 8, 2995, 2014.

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