

## **Review**

Favier et al. carried out collections and a compilation for SMB data over the entire Antarctica. They conducted quality check for the data and filtered them to extract relatively reliable data. Features of the data set was examined. And then, the SMB data were used to test the representativeness of a climatic model to express SMB over locations of the SMB data. The comparison show agreement in some sense and disagreement in another sense. The authors argue necessity of new field measurements at low elevations, in the Antarctic Peninsula and in West Antarctica.

Compilation of SMB data is one of necessary tasks in our polar science community to study mass balance over Antarctica. After a paper of Vaughan et al. (1999), it has been only partially updated. In addition, present timing is that papers from IPY-related projects are appearing. Therefore, it is a good timing to carry out data collections and updated compilation. I thank the authors for their efforts to do it.

This paper has two main subjects/focuses within it. One of them is introduction of the update of the SMB data, descriptions as to how the authors conducted data collection, data compilation and quality check. The second part is a comparison between one of climate models to express the SMB and the observational SMB data set. These two subjects/focuses are related. To my view, the latter part is not very necessary discussion. It is rather a demonstration as to how the database should be handled to compare with a climate model and as to how quick comparison looks. Based on the comparison, we can claim that they are similar. But we cannot necessarily claim more about something essential. For a demonstration of the highly localized condition of the present SMB dataset, the comparison is not useful because a problem of data localization should be discussed essentially by examining currently available SMB data point in terms of geographical distribution. From this view point, I felt that a role/meaning of the comparison was presented with a bit tricky logic. For example, the model-based SMB and the average of the observational SMB tended to agree at elevations above ~2000 m in Fig. 7. But we cannot argue that present sites (shown in Fig. 1b) fairly represent SMB of the inland plateau on average, without any discussions on the geographical distribution of the data points. Agreement of the SMB values may be just accidental.

Nevertheless, I would like to encourage efforts of the authors collecting and compiling the data, considering the scientific merit to present the updated dataset.

The compilation of SMB is already big and complex task which has a large room to make it more complete and satisfactory in our polar community. The test of the climate models to express SMB is probably another big task which requires detailed discussions. Please consider a possibility that these two focuses are discussed in separated papers. By doing so, one of the two papers can provide more focus on description/construction of the database.

My comment above is because the description/discussions about the SMB data compilation seem still have some large rooms to be better. For example, one of my concerns is a condition that almost no use of GPR-based SMB data in the database. Nowadays, we can find subsurface radar (GPR) based SMB data published in papers. Examples from the IPY-related projects include, Norway-USA traverse (Anschütz et al., 2009, Anschütz et al., 2011 and Müller et al., 2010) and Japan-Sweden traverse (Fujita et al., 2011). GPR often provides very detailed spatial profile of SMB along traverse routes. Once isochrones are dated/calibrated with control points of reliable SMB data using pit work or firn core studies, it provide very rich information of SMB. At the timing of Vaughan et al. (1999), such radar data were still rare. However now, there are many papers that discussed GPR-based SMB data. At least, the methods and usefulness need to be discussed in the main part of the discussion and not in a short comment at the end of the paper. Hopefully, available such datasets should be included in the compilation of the SMB data in the near future.

The present paper highlighted that reliable SMB data are very limited and sparse both temporally and spatially in Antarctica. Reliable data are so limited as in Fig.1b, after more than ~50 years efforts of Antarctic research. This situation is partly because stake methods require revisits of stakes, which is a difficult task even for big campaigns like IPY. Firn coring and pit works are also tasks that cannot be easily performed at a lot of sites. In principle, we cannot increase number/distance of ground-based data so much. Considering such a condition, I hope to find some discussions to build future SMB data points network in Antarctica.

I understand that both authors of the V99 data and present authors made their big efforts of collection of the ground-based SMB data. However, I believe that collections of the SMB data by the authors can be significantly improved surveying both published and unpublished data. Future addition of the GPR-based SMB data is an example. Another example is more exploration of old archives. I note that large portion of the

data obtained by Japanese glaciologists, published in "JARE Data Reports" (<http://polaris.nipr.ac.jp/~library/DataReports/DRglac.html>) or folio series (Takahashi and Watanabe, 1997 and Takahashi et al., 1994) are not yet included in the database. It seems to me that the present authors performed their update of the data starting from the V99 dataset. Reassessment and critical views for data collection of the V99 data are also necessary because there is no guarantee that V99 dataset was complete.

To clarify collection conditions of the datasets, I suggest the authors to present a list (table) showing data sets included and excluded. Such a list is useful for future improvement of the datasets. An example of such a list for compilation of the ice thickness of Antarctica is seen in Table 1 of Lythe et al. (2001). Then, scientists in our community can see status of each data. For such a list, appearance in the paper or in supplementary information is much better than appearance in the web page of the project. Web page is always under risk to be easily modified or deleted.

### **Comments for detailed points**

P3668, L3 and L6

I doubt meaning to mention total number of SMB data. In any case, locations of the sites are highly localized. Even when we increase numbers of data, such a situation of localized condition will not change. For example, when radar-based SMB data are added to the database, large number of data appears in a limited area.

P3668, L4 and L8

Repetitive use of adjective "important" seems a bit too much decoration.

P3668, L7

Please clarify more than what. Grammar seems incorrect here.

P3669, L6

Some recent papers can be mentioned here on the recent change of SMB.

P3669, L19

Please cite papers for several IPY inland traverses that studied SMB

P3670, L6

Anschütz papers (2009, 2011) also mentioned a gap between the SMB of Arthern et al. (2006) and the observation of SMB using firn cores in the Norway-USA traverse.

P3670 L14-15

For "ERA Interim reanalysis" please provide reference paper(s) here.

P3670, L14-L18

It seems that the model/observation comparison is not a necessary condition to highlight the remaining gap. In Fig. 1b, the remaining gap is already apparent, without introducing any model. The expression/logic here seems tricky. Assessment for the geographical localization seems more important.

P3671, L7

Is Agosta 2012 paper (a) or (b)?

P3671, Sect. 2.2 1st Para

Among major IPY traverses, mention to Anschütz et al., 2011; Fujita et al., 2011 and Müller et al. (2010) are missing.

P3671, Sect. 2.2 1st Para

The authors should be careful to exclude Fujiwara and Endo (1971) work because age span is completely different from data of recent Syowa - Dome Fuji route since '90s. Besides, route trace is different between Fujiwara and Endo (1997) work and Motoyama et al. work. It seems to me that this replacing Motoyama works from the Syowa - South Pole traverse is a rough handling of earlier data. Both are valuable.

P3671, Sect. 2.2 1st Para

I suggest authors to provide a list of data set and/or reference papers as a table in the main paper or in supplementary information, to let readers (scientists in our community) what were included or excluded.

P3671, L20

I believe that some organization "the Chinese Antarctic research center" does not exist, both in the Ding paper or elsewhere.

P3671, L25 "Not to include" or "to exclude" is correct grammar.

P3672, L5-8 Surface slope and wind are also very important for SMB. Surface slope can be extracted from DEM.

P3673, L1-3 Is it also true for snow stake measurements?

P3673, L5-6 It seems better to tell readers that the data locations are limited within the past major inland traverses.

P3673, Section title of Sect. 2.3 It seems that the possessive case (our) should be avoided. It sounds like the database is more private than common contribution/efforts for the community. There are several more "our"s in the present manuscript.

Section 2.3 and Table 3

When volcanic markers are used to calculate SMB, SMB data quality should be as good

as using nuclear test markers. Handling of the volcanic markers (e.g., Pinatubo and Agung) is missing in the discussion and table. When locations of the control points are connected continuously by GPR, handling of the data should be as good as the data quality of the control points (A, B, or C) in terms of absolute value of SMB. In terms of relative spatial variations, quality of the GPR data should be excellent. Such views are missing here and necessary to be developed.

It seems to me that the authors' method of the rating (A~C) has somewhat subjective aspect. Scientifically, much more important is the estimation of error size. Even if the method is handled as B or C by the authors, some of data should be accurate and reliable depending on depositional conditions of each area. For example, at P3674 L27-28, I note that firn stratigraphy provides reasonable results in low accumulation site in polar plateau if wind is weak and snow surfaces are smooth. Please see Koerner (1971). Missing rate of some annual layer is rather small even at Plateau Station. In such cases, it seems that it is not always beneficial for our community to reduce number of old data. If we estimate properly possible errors, we can still use valuable data.

P3674 L16

Typo, "models were"

P3675 L12

Typo, "McMurdo Station"

P3675 L12-14

This sentence can be included in a short discussion how we can efficiently increase meaningful data of SMB in future field campaigns as a community effort.

P3675 L15-26

It seems that the authors cannot necessarily justify their discussions here because the data is highly localized. Locations for lower rank data is also highly localized. I observe that the authors removed a lot of data from Lambert Glacier drainage basin, where the area is basically dry because the basin area is surrounded by large scale ice divides (ridges). In West Antarctica, locations of the remaining data are mainly on the Ross Ice Shelf side sites. Then, it is plausible that SMB data with particular local features were removed from the dataset and it can be one of major reasons why average SMB of the remaining data increased.

Fig. 3 and Fig. 4a

The authors analyzed that data in terms of elevation for the entire Antarctica.

To see highly localized distribution of the available data, I strongly feel that what we need is more detailed analysis on the data. For example, extending Fig. 3, variation of SMB should be analyzed in terms of continentality (distance from the coast), location of sites relative to major and minor ice divides, surface slope and so on. In addition, it would be much better that such analysis is done from one drainage basin to another. I feel that present analyses in Fig. 3 and Fig. 4a are just preliminary and very brief. It is related to future strategy to fill the data gaps. We should find the most effective and efficient ways to fill the area currently uncovered by ground-based observations both spatially and temporally. If we do not have such a view, I am afraid that data density will not be improved or only localized addition of data occur in future. For example, the authors argue short of data at elevation range 200-1000 m. We cannot increase data density without consideration for various glaciological conditions. Near the coast, feature of the ice surface topography is very different in Adelie Land (more gentle slope from the coast to Dome C) and in Dronning Maud Land (a kind of wall of the mountains near the coast).

Fig. 4d

Please comment to readers in the paper major cause of the stairs-like distribution of the histogram. A step near 1960 is due to IGY. What is the cause near 1990? Are there impact of using volcanic horizons of Pinatubo eruption or Agung eruption as time markers? Starting of some major project?

P3676 L15-18

The authors emphasized high quality of the SMB data based on volcanic markers and nuclear tests markers. The authors say that such points are isolated. But why didn't the authors see usefulness of the GPR connecting such high quality points? Because this paper is attempting to lead compilation of the SMB data, important views should be comprehensively covered.

P3676 L19 - P3677 L2

The authors did not mention that the stake methods can never cover wide area of Antarctica. The method require revisits of inland sites. Data quality is good. But our community cannot rely only on this method to increase data density for continental scale.

P3677 L3-L4

An adjective "reliable" was repeated so many times in the paper and too much here. Again, "our" should be avoided. "the" is sufficient. A form of a sentence is not nice as a section title.

P3677 L7

"real world data" seems a strange expression to me in a scientific paper. "observational data" is sufficient.

P3677 L12

Meaning is unclear to me. "secular climate variations"

P3677 L17

Meaning of rescaling is unclear. Does it mean temporal rescaling or spatial rescaling? Please explain.

P3677 L20

I did not understand the meaning "their spatial distribution is correct for model validation". Data points are highly localized. Does it make sense to say it is correct or incorrect?

P3677 L23 - P3678 L11

The authors removed the data if the elevation data provided by data contributor and the elevation from the DEM is more than 200 m. Satellite-borne radar/laser based DEM is information that emerged only recently. Before, accurate elevation measurements were particularly difficult in the field. If positioning (latitude and longitude) is reliable, the authors should not reject easily SMB data with a reason of inaccurate elevation data. If one can still trust positioning, we just trust the most reliable elevation data, either DEM or field data (GPS in nowadays, barometers or other methods in the past).

P3678 L16-18

Seventy percent ... Please provide reference paper?

P3680 L5-L6

I did not understand one of purposes " to correctly validate models by checking whether



any areas are insufficiently documented in the database".

Readability of some terms

The following terms are long and not easy to read until we read them until the end of each term. In addition, several are confusing. All these appeared in the paper.

GLACIOCLIM-SAMBA project

GLACIOCLIM observatory

GLACIOCLIM SAMBA observatory

GLACIOCLIM-SAMBA (just as area name at P3682 L15)

GLACIOCLIM-SAMBA network

GLACIOCLIM-SAMBA observation transect

GLACIOCLIM-SAMBA dataset

GLACIOCLIM-LGGE database

GLACIOCLIM-SAMBA website

SAMBA-LGGE SMB database

SAMBA-LGGE database

Please make them simpler and more readable. I felt that there were too much emphasis of "our" project, observatory, network etc. After their first appearance in the paper, abbreviation of GS is sufficient.

## References

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