Snow accumulation rates at Concordia Station, Antarctica, observed by stake farms

Stefanini et al., 2025

Editor: Lei Geng

Dear Claudio, congratulations with this manuscript, it is brilliant!

Thanks to devote time to the review of our manuscript and for the helpful suggestions.

I have a couple of comments, see below:

Section 2.1, Italian stake farms: as I can see from the text, the size of the farms is something like 60 by 70 m. If so, the farms are comparable in size with the largest snow dunes traveling across the snow surface. This fact can add the noise to the inter-annual ITA SMB time-series, which may explain a larger inter-annual variability at ITA farms (Fig. 5).

Morphology certainly affects observations, and its effects should emerge if the disturbance were regular. However, no statistically significant difference was found between the two axes of the stake cross, either in terms of mean values or variability. Moreover, a preliminary analysis of surface elevation fluctuations from the REMA dataset suggests the presence of 200–400 m wide undulations, which appear to have remained stationary over the past 15 years.

Then, the distance between stakes at these farms is 10 m which is close to the distance of noise correlation. It means that the observation at a single stake is not independent from the adjacent stakes, and the effective number of datapoints is < 13.

I tried to apply the same procedure described in Section 3.1 of your 2023 article on Vostok. We calculated the mean correlation coefficient between the time series of annual build-up measured from 2011 to 2023 at adjacent stakes (i.e., 10 m apart) and at stakes separated by 20 m or more. The difference between the two correlation coefficients is not statistically significant at the 95% confidence level. Furthermore, the same analysis was applied to the French stake farms, specifically comparing the annual build-up in 2017–2023 at FRA and FRAb for adjacent stakes. The difference in correlation coefficients between pairs of stakes separated by 2 m (i.e., a stake from the old network and the corresponding one from the new network) and those separated by 40 m is also not statistically significant. These results suggest that stakes can be positioned even closer together than the spacing used in the ITA network so far.

Taking this into account, and also considering the information in Section 4.3 (the farms are too close to the Station?), is it better not to use the ITA data in further analyses?

Striking a balance between the significance of the collected observations and logistical constraints is essential. The current stake field is accessible year-round and, to maintain this accessibility, it must remain within 1 km of the Station. A second stake field is under consideration, possibly located northwest of the Station, in an area less affected by buildings and with the potential for a higher number of stakes. However, even the FRA and FRAb stake farms are not without issues, as the influence of nearby buildings is still noticeable there.

Also a few small ones:

Line 46 - “SMB is a small difference between large fluxes». I am not sure what you mean here exactly. SMB is (in a first approximation) a difference between precipitation and sublimation, the latter being relatively small fraction (like 10-20 %) of the first. It is the total Antarctic ice sheet mass balance which is a small difference of two huge fluxes, total snow accumulation (SMB integrated over the area) and ice ablation on the AIS’s edges.

Absolutely right, the sentence was referred to the total mass balance, not SMB, that phrase has been removed.

Lines 54-56 – here you describe how we make a correction for snow compaction at Vostok, but this paragraph is about defining the density of an annual layer in order to calculate SMB in water equivalent. For this we measure the mean density in the upper 20 cm of snow thickness in a number of random points across the stake farm.

The lines have been changed as suggested.

Line 72 – I cannot find Vandecrux et al., 2024 in the reference list.

The reference has been added to the list.

Line 109 – as I can see in Figure 1b, the length of each farm's profile is about 1 km, 25 stakes in each profile. It means an average distance between stakes is 40 m, not 25 m.

It was a misprint, 40 m is correct.

Lines 175-176 — it is better to say that each snow layer within this thickness is compressed under the weight of the overlying snow.

Corrected as suggested.

Tables 2 and 4 – there are negative values in the lower limits of the confidence intervals of the compaction corrections which is not possible physically. Probably it's better to set forcibly the lower limits to zero?

Thank you for the advice. We decided to adopt a different solution; since the compaction corrections are positive values, we used a gamma distribution instead of a Gaussian one. The new estimates are nearly the same with respect to the previous ones, but they are now strictly positive.