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

Stefanini et al., 2025

Editor: Lei Geng

This paper deals with snow accumulation data provided by several stake farms distributed around Dome C. This is probably one of the sites located in the inner East Antarctic Ice Sheet which is most studied from this point of view. With many data available from ice cores, geophysical prospecting, and previous studies on stake farms. From this point of view the site is thus extremely important in the field of Inner Antarctica snow accumulation estimation.

The authors present new data returned from novel stake farms that have been monitored in the last years. The core of the study is the comparison between these new farms and previous ones, including a comparison with data derived from reanalyses and models.

Notable discrepancies are noted among the different farms which cannot be related to the well-known precipitation gradient that characterizes the Dome C area. Several hypotheses are made to explain such differences and in the end the explanation provided by the author is that several processes are responsible for the variability observed in the data. The existence of the cited gradient, the different size of the farms (with impacts on uncertainties and variability of annual data), the effect of buildings on snow accumulation/erosion.

In general the paper is well written, it is scientifically solid and the data are carefully analyzed and interpreted. I would probably suggest to deepen a little bit the part where reanalyses -derived data are described. Considering the peculiar features of the site, it is not clear how the authors calculated snow deposition, erosion, sublimation using reanalyses data. Please provide more information on this.

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

This sentence has been added at the end of Section 2.2: “SMB has been calculated as the sum of the snowfall and snow deposition minus snow sublimation”.

My second concern, which is the most notable one, is about the general “story” behind the manuscript. The current title is “Snow accumulation rates at Concordia Station, Antarctica, observed by stake farms”. Reading this title and the general structure of the paper, in particular the introduction, one can think that the key message of the present work is to provide new estimate for snow annual accumulation for an important site of inner East Antarctica. This is only partially true in my opinion. The main argument of this work is to discuss in details the parameters which can influence the estimation of snow accumulation using multiple stake farms distributed around a single site. This is now not clear, in particular if a reader only focuses on the title/abstract and introduction. I suggest to the author to change a bit these key elements of the manuscript, focusing more on the parameters which introduce variability in data gathered from stake farms. Adopting a title like “On the factors which influence the estimation of snow accumulation rates at a site in inner East Antarctica: lessons learned at Dome C”, would surely help the readers to understand what they will find in this nice and detailed manuscript. Of course changing the title and in general the “scientific narrative”, it would be needed to change also some other parts of the manuscript, in particular the introduction.

The title has been changed to “Challenges in Surface Mass Balance Estimation at Dome C: Stake Farm Comparisons, Measurement Uncertainties, and Station-Induced biases”. Moreover, this part has been added to the Introduction, after line 43:

"A large fraction (two thirds) of the annual accumulation at Dome C comes from clear-sky precipitation, such as diamond dust and vapor condensation, rather than conventional snowfall events (Stenni et al., 2016). While snowfall and diamond dust provide the baseline input, post-depositional processes exert the greatest influence on spatial and temporal variability. Inland accumulation is primarily driven by fluctuations in snowfall, which dominate interannual variability in SMB (Noël et al., 2023). However, the apparent uniformity of precipitation over tens to hundreds of kilometres is disrupted by wind and surface processes, which modulate local accumulation through redistribution across microtopographic features (Fujita et al., 2011). These effects are often amplified when high-precipitation episodes coincide with strong wind events, which also modulate local accumulation through redistribution across microtopographic features shaped by underlying bedrock (Fujita et al., 2011). Wind is consistently identified as the dominant control across the East Antarctic Plateau. Processes such as drifting snow, erosion, and redistribution create highly variable features including sastrugi, dunes, and megadunes, which contribute to substantial local heterogeneity (Frezzotti et al., 2005; Eisen et al., 2008). Sublimation—both surface and wind-driven—further reduces accumulation, and in particularly dry areas like Dome C, Dome Fuji, and Vostok, it may cancel out a significant fraction of snowfall (Eisen et al., 2008). Over the central plateau, katabatic winds actively shape the surface, driving strong spatial variability even where precipitation is minimal (Lazzara et al., 2012). At the South Pole, for instance, annual accumulation decreased significantly from 1983 to 2010, largely attributed to changes in wind and sublimation patterns rather than reductions in snowfall (Lazzara et al., 2012). Topographic effects are also critical: Dome sites generally exhibit lower spatial variability (3–9%) compared to regions with complex surface morphology, where variability may exceed 40% (Eisen et al., 2008). Small-scale features such as sastrugi, wind crusts, and megadunes introduce accumulation noise two to four times the mean, occasionally resulting in multi-year ablation (Frezzotti et al., 2005). On larger spatial scales, Dome Fuji records demonstrate how accumulation differences are strongly correlated with position relative to ice divides and prevailing wind directions, and are further modulated by elevation and distance from moisture sources (Oyabu et al., 2023). Overall, spatial variability at kilometre scales is an order of magnitude greater than temporal variability at decadal to secular scales (Frezzotti et al., 2005). This highlights why dome sites such as Dome C are often favoured for paleoclimate reconstructions: their relatively stable conditions reduce the noise introduced by local post-depositional processes, even though wind redistribution and sublimation remain significant factors (Frezzotti et al., 2005)."

Line 15-20: I don't think it is necessary to provide such detailed information about the stake farm position in the abstract. There is the materials section for this. I would just say that in this work you are going to compare results from the different available farms around Dome C, providing some basic data about the temporal interval which is considered here.

Indications of the stake farm positions have been removed from the abstract.

Line 35: "for understanding"?

Corrected.