The authors would like to thank the referee for acknowledging the value of our study and providing valuable feedback on our manuscript. We addressed all of your comments. Our responses are provided in blue, and the revised parts of the manuscript are marked in red.

Reviewer #2: Anonymous Referee

The study describes a rich dataset of measurements of the specific surface area (SSA) of snow acquired during four traverses from the coast to the inland plateau of Antarctica and during a 13-day stay at Dome Fuji Station, on the plateau. The authors present the measurement locations, methods and auxiliary data in a reproducible way. The drivers of the variations of the SSA observed are then discussed. The article is clear, the results are well presented, and figures are effective. Overall, it nicely highlights the complexity of the surface processes impacting the snow optical and microstructural properties over the Antarctic ice sheet during summer.

However, some details about the measurement procedure should be cleared in the text. At line 193 the SSA is said to be measured "at 10 different surfaces, spaced 2 m apart along a transect perpendicular to the predominant wind direction". First, a more detailed scheme of the measurement area could help improve both understanding of the text and potential for satellite product validation.
Because of limited observation time during traverses, we simply set the 10 measurement surfaces by taking four steps forward between the surfaces, and the flat area in front of the toes was measured. I trained in advance to keep my stride length to a total of 2 m. While this scheme may not ensure accurate 2 m intervals, we believe that 10 surfaces were sufficiently randomly selected, not affecting our conclusions.

We will modify L193–194 in the original manuscript to "*At each observation site, we measured surface snow SSA at 10 different surfaces spaced roughly 2 m apart along a transect, by taking four steps forward and measuring the surface in front of the toes.*"

Second, why the choice of the transect perpendicular to the predominant wind direction? Is it related to the presence of wind-induced bedforms?
Yes. The predominant wind direction was determined by surface morphologies such as dunes and sastrugi, which typically extend parallel to the wind direction along our traverse route. To avoid measurement surfaces from being biased toward a specific bedform extending parallel to the wind direction, we positioned the transect perpendicular to it.

We will add "*The transect was positioned perpendicular to the predominant wind direction or the direction in which dunes and sastrugi extended, to prevent measurement surfaces from being biased toward a bedform.*" to L194 in the original text.

Third, how was the sampling carried out over rough surfaces (surfaces c. and d. in section 2.2.2), considering that erosion bedforms present different snow properties according to their exposition to the wind (Sommer et al. 2018)?

At such rough surfaces, five SSA measurements were performed within a flat area of ~ 0.05 m^2 (e.g., the side of sastrugi), which appears to have similar characteristics (e.g., density, grain size, and elapsed time after deposition). While a deposition and erosion surface may present SSA variation over several meter scales, as noted by Sommer et al. (2018), the variability of our five measurements within ~ 0.05 m^2 is small (3.5%). Investigating SSA variability within bedforms at several meter scales would be future work.

We will modify L194–195 in the original text to "*For each of the 10 surfaces, we conducted five measurements within a flat area of approximately 0.05 m^2 that appears to have similar snow properties, by shifting the measurement positions by approximately 0.1 m, and calculated their mean value.*"

Finally, it would be interesting to have more details about the measurement uncertainty and how it compares to the SSA variability observed along the transects.

The measurement uncertainty will be elaborated in L201–203; "*The relative SD of the five measurements at a surface, which represents the random error in a SSA measurement, is 3.5 ± 2.5 % (the average and SD for ~ 2150 surfaces). The absolute error in the HISSGraS measurements has been evaluated as 23.0% (Aoki et al., 2023). This value represents the relative root mean square error of HISSGraS data for 30 snow samples with SSA of 5–30 m^2 kg^{-1} collected in Hokkaido, Japan, compared to the reference SSA from the CH4 adsorption method (accuracy of 12%) (Legagneux et al., 2002)*".

The latter error (23.0%) of HISSGraS data includes a systematic error from SSA from the CH_4 absorption method and other error sources (e.g., the time difference between the two SSA measurements) (Aoki et al., 2023). In the relative comparison among measured SSA in this study, a random error of 3.5% (e.g., 0.7 m^2 kg^{-1} for 20 m^2 kg^{-1}) should be considered. This error is smaller than the SD for 10 surfaces along the transects (typically 1–5 m^2 kg^{-1} for a 10-surface mean of ~ 20 m^2 kg^{-1}), suggesting that the SSA variability observed along the transects is statistically significant. We will describe this in L317–319 in the original text; "*The appearance of various surface morphologies between 380–680 km, including fresh and aged deposition surfaces and glazed surface, results in the significant variability of SSA in the range. This variability is evident even within a 20 m transect at each observation site, with a SD of 10 surfaces (up to 20 m^2 kg^{-1}) exceeding the random error at a surface (3.5%).*".

Some minor comments:

Line 56 : clarify the difference between sublimation that decreases the snow SSA and that increases the snow SSA (line 58).

We will elaborate these two cases; *"It may decrease snow SSA by sublimating fine needles or branches of dendric crystals in freshly fallen snow with a high SSA, transforming them into rounded grains or* *causing them to disappear (Cabanes et al., 2002), and by eroding deposited snow, thereby exposing aged snow with a lower SSA (e.g., Lenaerts et al., 2017). Conversely, the wind may increase the SSA through the sublimation of snow grains into smaller particles and fragmentation of drifting snow crystals, creating new surfaces (Domine et al., 2009).”*

Line 60 : a brief description of snow bedforms that result from wind-induced redistribution could be introduced here, with the heterogeneous distribution.
We will modify the sentence to “*Strong winds further contribute to snow redistribution and heterogeneous deposition (Kameda et al., 2008; Picard et al., 2019), forming dunes or snowdrifts that elongate either parallel to or across the wind direction over several meters while exposing old snow at the surface in eroded areas (Filhol and Sturm, 2015; Sommer et al., 2018).*”

Figure 3 : a horizontal grid could improve the clarity of the figure, as most variations of the SSA in time are small
Thank you for the suggestion. We will add a horizontal grid to Figure 3.

Line 313 : the definition of erosion surfaces as “aged deposition surfaces” is confusing with respect to the definitions in section 2.2.2
Sorry for the confusion in our manuscript. We will revise it to “*Erosion surfaces ~~(aged deposition surfaces)~~ are predominantly observed in the coastal region ~~(inland plateau region)~~, aged deposition surfaces are observed in the inland plateau region, while …*”. Here, “*aged deposition surfaces*” in parenthesis did not define “*Erosion surfaces*”, but was the subject of “*(inland plateau region)*”.

Line 466 : the sentence “Also, the observed SSA … air temperatures.” is not clear, please rephrase
We will rephrase the sentence; *“SSA correlates non-linearly with air temperature, with large spatial variation in SSA observed in the lower temperature range (~ −35 to −15°C) and less variation observed in the higher temperature range (~ −15 to 0°C).”*