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The Cryosphere Discussions

Interactive comment on "Surface formation, preservation, and history of low-porosity crusts at the WAIS Divide site, West Antarctica" *by* John M. Fegyveresi et al.

Anonymous Referee #2

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Review of

Surface formation, preservation, and history of low-porosity crusts at the WAIS Divide site, West Antarctica.

By John M. Fegyveresi, Richard B. Alley, Atsuhiro Muto, Anaïs J. Orsi and Matthew K. Spencer

General

This is a comparatively comprehensive study of the formation of so-called surface crusts, involving daily observations of surface crust formation at the WAIS divide site in West Antarctica over five consecutive summers (2008/09 to 2012/13), including annual

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Discussion paper

shallow snow-pit studies, snow temperature profiles and data (including shortwave radiation measurements) from an automatic weather station (AWS). The main conclusion is that crusts form most commonly in the summer from the effects of a large daily temperature cycle. There also appears to be crust formation in winter, as yet for unknown reasons.

The paper provides useful and original data for model development and evaluation, and the topic is suitable for publication in TC. The paper is rather descriptive, but useful, as the authors state in line 275: “Our data provide strong constraints on models of many of the observed processes.” However, the value of the study and analysis would be greatly quantified if the AWS and snow temperature data were used to calculate the surface energy balance, see comments below. I recommend to do this, which will require major revisions.

Major comments

While explicit modelling of microphysical snow processes is beyond this MS’s scope, a more quantitative interpretation can be achieved relatively easily by using the AWS and snow temperature data to close the surface energy balance. This will greatly aid the discussion by quantifying the sign and magnitude of surface energy fluxes, including the transport of water vapour by sublimation/deposition, during episodes of crust formation. See e.g. Van As and others (2005; 2006).

l. 45: “often warmed the near-surface snow above the air temperature, contributing to mass transfer. . .” This suggests that temperature gradient is a sufficient condition for sublimation, but this requires a specific humidity gradient (a less stringent condition).

l. 118: Were relative humidity measurements corrected for low-temperature offsets (See Andersen and others, 1994)?

l. 152: “accumulation at the site is relatively evenly distributed through the year, justifying this approximation”; this may be true for the climatological precipitation, but is there quantitative support that this holds for individual years as well?

l. 201: “following the air 202 temperatures as expected“. Figure 10: Surface energy balance considerations dictate that the amplitude of the daily cycle in surface temperature exceeds that in air temperature, to allow for nocturnal cooling and daytime heating by sensible heat exchange. This appears not to be the case in these time series. Please comment.

Figure 13: please translate y-axis into average crusts per individual month, and include standard deviation as error bar. Mention ice core time interval in caption.

Minor/Textual comments

l. 38: “insolation sensors” refers to incoming shortwave radiation. Better: “shortwave radiation sensors”

l. 113: pyrogeometers -> pyrgeometers

l. 191: crust removal -> hoar removal (?)

l. 330: “warm and windy air masses” an air mass cannot be windy, please reformulate.

References

Anderson, P., 1994: A method for rescaling humidity sensors at temperatures well below freezing, J. Atmos. Oceanic. Technol. 11, 138801391.

Van As, D. andÂăM. R. van den Broeke, 2006: Structure and dynamics of the summertime atmospheric boundary layer over the Antarctic plateau, II: Heat, momentum and moisture budgets,ÂăJournal of Geophysical ResearchÂă111, D007103, doi:10.1029/2005JD006956.

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