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The Cryosphere Discussions

Interactive comment on "Sensitivity of the surface energy budget to drifting snow as simulated by MAR in coastal Adelie Land, Antarctica" *by* Louis Le Toumelin et al.

Anonymous Referee #2

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This is an interesting study on the impact of drifting and blowing snow on boundary layer meteorology, surface radiation and energy balance in Terre Adélie, a region on the slopes of the East Antarctic ice sheet. A 9-yr time series (2010-18) of observations at a site near the coast is used to validate the regional climate model MAR. Methodology, presentation and discussion of results as well as the conclusions are sound. One of the main findings is that sublimation of drifting-snow particles leads at the surface to a reduction in sensible and latent heat exchange, which is compensated by an increase in net radiative forcing. While the net impact on total surface energy budget, and therefore surface temperature, is minimal, structure of the lower atmosphere is modified, which needs to be resolved in climate models to understand impact of warming on air-surface

interactions and boundary layer meteorology.

I have only minor comments, and recommend publication after they have been addressed.

1. It would be useful to get more detail on how sublimation rates are computed in MAR and how reliable they are. What are the model assumptions (snow particle size distribution and shape). Another model parameterisation of bulk sublimation rates from blowing snow by Déry and Yau (1999) uses the mean snow particle diameter. Is this the case in MAR and is particle diameter a sensitive parameter? If yes, future studies would gain by deploying next to an electro-acoustic sensor also an optical particle counter, to measure particle diameter as well as snow mass flux more accurately.

What are the uncertainties of calculated sublimation rates and how do calculations compare to existing observations in Antarctica (e.g. hourly blowing snow sublimation rates at Halley range 0.1-1 mm we/day (King et al., 1996))?

2. The limitations of the current evaluation method needs to be expanded (Section 4.4), in order to guide future observations, which parameters should be measured to better constrain the model. Comment also on model uncertainties in vertical profiles (e.g. T, RH, wind speed, sublimation rate) and drift layer height, and how they would impact on the main conclusions.

SPECIFIC COMMENTS

L142 Please provide detail on the model parameters for snow particles (size, shape) used in MAR.

L145 '... the drifting-snow scheme simulates erosion at every grid cell in which the modelled wind shear exceeds a threshold value depending on the local surface snow density.' What is this threshold value? How is it parameterised? Does snow particle size play a role? Please expand.

L231 'snow particle ratio'; do you mean here snow particle mixing ratio (mass of sus-

pended snow particles to that of dry air)? Please clarify.

L243/Fig.3 Expand explanation - I assume the vertical maxima in SWnet (Fig.3d) reflect the diurnal cycle, and a small reduction is seen <100m on 3 Oct compared to 2 Oct, but the impact of drift snow on LWnet is only noticeable below 50m (Fig.3c). Why is that? And is it consistent with estimated drift snow layer heights during that time?

L278 'Drifting snow modifies the seasonal values of incoming radiative fluxes by enhancing LWD and decreasing SWD (Fig. 4 (e) and (g)). ' - the latter does not seems to be supported by Fig.4g, both model scenarios plot on top of each other, please clarify.

Fig.3b What is the averaging period simulated sublimation rate refers to? Per 30min or per hour? Are these values consistent with observations existing elsewhere in Antarctica?

TECHNICAL COMMENTS

Fig.3l Place legend outside the figure panel.

Fig.5a,c The grey shaded area to illustrate RMSE is missing.

REFERENCES

Déry, S. J. and Yau, M.: A Bulk Blowing Snow Model, Bound.-Lay. Meteorol., 93, 237–251, doi:10.1023/A:1002065615856,1999.

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