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Interactive comment on "Blowing Snow Sublimation and Transport over Antarctica from 11 Years of CALIPSO Observations" *by* Stephen P. Palm et al.

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General comments This paper presents very interesting and unprecedented continent-wide statistics of blowing snow over Antarctica from long-term satellite observations. These include estimations of blowing snow sublimation, a significant but poorly known component of the Antarctic surface mass balance. Such works are essential for evaluation of atmospheric models from which the total surface mass budget of the ice sheet can be estimated. However, there are some important missing aspects and information in the study that I would like to report here. Of particular concern is the method from which sublimation estimates are computed. One possibly very significant source of error is an underestimation of atmospheric moisture by MERRA-2: the method does

not take into account the fact that moisture from blowing snow sublimation is retained while air flows further through blowing snow regions, strongly reducing (or cutting if saturation is reached) any further sublimation of blowing snow downstream. MERRA-2 does not account for blowing snow sublimation, thus the method constantly resets air moisture to values for which blowing snow sublimation has never occurred, and very likely overestimates total sublimation.

Specific comments Observational studies on blowing snow in Antarctica are very scarce, to the extent that continuous measurements extending beyond a few weeks or months barely exist. However, considerable efforts have been made in the recent years on that specific topic, that you might have missed in your bibliography. An observation campaign dedicated to blowing snow has been run in January 2010 by the Laboratoire de Glaciologie et Géophysique de l'Environnement (LGGE, France) in coastal Adélie Land. Some of the collected data have been presented, for instance, in Trouvilliez et al. (2014), Barral et al. (2014) and Amory et al. (2016, 2017), and used for evaluation of preliminary modelling results (Gallée et al. 2013, Amory et al. 2015). Ground measurements on the ice sheet have been performed using second-generation acoustic FlowCapt™ sensors. While these sensors have been shown to slightly underestimate the blowing snow flux compared to optical snow particle counters SPC-S7 in the French Alps, they remain excellent detectors of blowing snow occurrences (Trouvilliez et al. 2015). To date, up to 7 years (2010-2016) of continuous ground measurements of blowing snow frequency in coastal Adélie Land are available (for comparison with CALIPSO data). The dataset also includes (discontinuous) measurements of snow particle size performed since 2013 at 50-m height above the ground with a SPC at Dumont d'Urville station (see Palerme 2014). I'm part of the research team that has produced (and still does) these observations and I'm open to discuss it with the authors if they wish.

P8, L222: Figure 2 shows an increase in particle density with height for the first 100 meters above the surface. This is surprising since the density of blowing snow particles is supposed to decrease as distance from the ground (i.e., from the particle source) increases (see for instance the strong decrease within the first 10 meters above the ground in Fig. 4 of Mann et al. 2000). Have you an idea of what can cause this feature?

P17, L431: In addition, clouds may be associated with precipitation which contributes moistening the dry surface air layer (Grazioli et al. 2017; http://www.the-cryosphere-discuss.net/tc-2017-18/) and thus correspondingly reduces blowing snow sublimation.

P17, L449 and onwards: Although this aspect is already partly discussed in the paper, estimating blowing snow sublimation by using MERRA-2 re-analysis fields of moisture could be misleading because i) re-analysed moisture near the surface could be underestimated and ii) no retro-action of sublimation on moisture is accounted for. Systematic dry biases in atmospheric models and meteorological (re-) analyses that do not account for blowing snow have been discussed in Barral et al. (2014). Using a 3-year dataset of ground measurements at a coastal location in Adélie Land, they showed (their Figure 6) for 3 modelling products that the moisture error in the near-surface layer for the continental grid point closest to the measurement location is much larger than 5% (as considered in the error analysis in Section 4), and that the 3 models fail to represent the observed increase of atmospheric moisture with wind speed. For instance, the moisture error almost averages 100% for the ECMWF operational analysis for wind speeds exceeding 12 m/s. It is likely that most meteorological and climate models ignoring blowing snow are affected by similar dry biases, at least over windy peripheral areas of East Antarctica where blowing snow is highly active. In addition, in the blowing snow layer the air quickly saturates as part of the blowing snow sublimates. This limits the total amount of blowing snow that can be sublimated and thus negatively feeds back on blowing snow sublimation. Following the method presented in the paper, forcing the blowing snow parameterization with an atmospheric model that ignore blowing snow and its sublimation neglects this negative feedback. In other words, this makes the atmosphere acting as an infinite sink for water vapor. Then,

even though the method presented relies on satellite observations, using raw moisture fields from such models to compute blowing snow sublimation very likely leads to significant overestimation. This appears to be a major limitation to the quantitative aspect of this work. Together with the arguments claimed in the discussion part, this certainly accounts for the large differences with previous model-derived estimates of Déry and Yau (2002) and Lenaerts et al. (2012). The overestimation of blowing snow sublimation compared to RACMO2 also seems questionable since the model has been shown to overestimate considerably the blowing snow flux and the resulting horizontal snow mass transport (see Lenaerts et al. 2014, their Figures 6b and 7c – pay attention to the difference between the left and right scales), suggesting an overestimation of the modelled sublimation.

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