The Cryosphere Discussions

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Interactive comment on "Event-driven deposition: a new paradigm for snow-cover modelling in Antarctica based on surface measurements" *by* C. D. Groot Zwaaftink et al.

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The authors address the difficult problem of surface snow compaction under windy and cold conditions. The observations collected at Dome C, routinely or within the framework of this study, are appropriate for the investigation of some of the compaction processes at work. The method which was developed for feeding SNOWPACK with snowfalls at higher densities than its basic version proves itself undoubtedly efficient for a long-term simulation of the surface snow layers density and temperature.

However, some aspects of this method would benefit from additional information: - a comparison with a simpler method for representing snow deposition according to the

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observed precipitation time series and at the minimal density of equation 1 (250 kg/m3) would help to assess the benefit of the wind dependency in equation 1. - quantitative statistics comparing the different simulations over the complete 3y period would be very helpful as well, i.e. RMS on surface and subsurface temperature, RMSe and correlation on the albedo during the summer period, correlation and RMSe on the detrended snow height, ... - as mentioned by the authors, a better surface density is a prerequisite condition for long term simulations of the Antarctic firn, since it significantly affects the energy and mass exchanges between the surface and the atmosphere. This aspect could be illustrated in the paper by comparing in the different versions the contribution of different terms controlling the state of the snowpack, i.e. sublimation/hoar, sensible heat fluxes, radiative fluxes, heat flux from the bottom layer, ...

The authors refer to a previous work with the snowpack model Crocus where the representation of near-surface snow compaction was modified to account both on the wind velocity during the snow fall and on the snow drift events occurring after the snowfall, if any (Brun et al., 1997, Vionnet at al., 2012). Indeed, this former method was already an event-driven way to simulate the snow surface density over the Antarctic Plateau. In this regard, the sentence on page 3579 spanning lines 14 and 15 Âń Compaction, however, does not necessarily happen at the time of deposition but can occur days or weeks later Âż is misleading since it gives the impression that Brun et al. (1997) only considered wind speed at the time of deposition. As mentioned in Brun et al. (1997) and described in details in Vionnet et al. (2012), this is not the case and the impact of wind after the time of deposition is explicitly taken into account and leads to quicker snow compaction close to the surface in the presence of wind, depending on the physical properties of snow. Compared to the method presented in the paper in discussion, the advantage of this former method was to allow the deposition of snow at the actual time of snowfall episodes, which is a necessary condition when the snowpack is simulated within a climate or a meteorological model. However, the method developed in Crocus has been evaluated in an Antarctic context only over South Pole. A comparison between both methods would be very valuable. Since SNOWPACK uses a description

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of snow grains very similar to Crocus, including very similar metamorphism laws, the implementation into SNOWPACK of the parameterization of compaction induced by blowing snow should be technically easy. An alternative could be to drive Crocus with the 3y forcing data sets and to compare the results with those in the paper in discussion. We are open to carry out such experiments using meteorological driving data provided by the authors if they are interested in doing so.

Finally, there are in the literature previous papers addressing the snow and meteorological conditions at Dome C or over the Plateau, as well as the performance of meteorological and climate models to represent them. Some of them are quite relevant for the paper in discussion and could be referenced, i.e: Gallée, H. and V. Gorodetskaya, 2008. Validation of a limited area model over Dome C, Antarctic Plateau, during winter, Climate Dyn.,34, 61–72. Gallée, H., G. Guyomarch and E. Brun, 2001. Impact of snow drift on the Antarctic ice sheet surface mass balance : possible sensitivity to snow-surface properties, Bound.-Layer Meteorol., 99, 1–19. Genthon, C., M.S. Town, D. Six, V. Favier, S. Argentini and A. Pellegrini, 2010. Meteorological atmospheric boundary layer measurements and ECMWF analyses during summer at Dome C, Antarctica, J. Geophys. Res., 115(D05104).

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