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Detailed simulations of snow properties and accumulation across the Antarctic Ice Sheet

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Surface mass balance (SMB) represents a large uncertainty in characterizing Antarctic Ice Sheet (AIS) mass balance. Atmospheric reanalysis products, which are commonly used for AIS SMB studies, do not include small-scale snow redistribution processes even though these can be of the same order of magnitude as snow accumulation in many parts of the AIS. Therefore, a proper representation of these processes is critical to interpret local SMB and firn observations, such as from ICESat-2 repeat altimetry. In this study, we use a detailed, multi-layer snow model (SNOWPACK) forced by a global atmospheric reanalysis (MERRA-2). Firstly, we show that a new accumulation scheme, designed to better represent wind-driven snow compaction in SNOWPACK, substantially reduces simulated biases in near-surface snow density at 131 locations across the AIS. Next, we employ a distributed version of SNOWPACK to two regions on the AIS, and compare the simulation output to airborne radar and in-situ observations of SMB. Our results demonstrate that SNOWPACK can capture the timing of blowing snow events, snow erosion events, as well as observed kilometer-scale spatial SMB variability. This study illustrates the importance of using high-resolution SMB models when converting surface height (volume) observations to mass changes.