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Modeling firn height variability to infer ice-sheet mass change from NASA's ICESat missions

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Using the Community Firn Model, we have developed a newly calibrated firn densification model for use over both the Greenland and Antarctic Ice Sheets with the specific purpose of assessing mass change from surface elevation change. Density profiles from more than 200 locations over both ice sheets were used for calibration, and NASA's Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2) provided the atmospheric forcing for model runs. While most atmospheric reanalyses like MERRA-2 have relatively coarse spatial resolution, we leveraged a 15-year (2000–2014) high-resolution MERRA-2 'replay' over Greenland and Antarctica to form a full 39-year record (1980–present) of skin temperature and net snow accumulation at five-daily and 12.5 km resolution. Rather than run the model at such fine spatiotemporal resolution, we effectively coarsened model spatial and/or temporal resolution where length scales are quite large (e.g., the East Antarctic plateau), while maintaining the fine-scale resolution in regions of heightened small-scale variability (e.g., the Antarctic Peninsula). Here, we present details into the model calibration, development of the atmospheric forcing, and finally modeled firn height change over the Antarctic Ice Sheet over the period of overlap between NASA's ICESat (2003–2009) and ICESat-2 (launched September 2019) spaceborne laser altimeter missions.