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Modelling dry snow densification without an abrupt transition

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This paper presents an empirical model for the densification of dry snow which provides for a smooth transition between Stage 1 and Stage 2 densification and leads to an analytical expression for density as a function of depth. The model introduces two new parameters with a simple physical basis: the transition density, rhoT, and a scaling factor, M, which controls the extent of the transition zone. Two further parameters are the densification rates, k1 and k2, away from the transition zone. These can be fixed at values suggested by previous workers (eg Herron and Langway) or allowed to vary. Calibration using strain rate data from Pine Island Glacier basin (Antarctica) produces best parameter values of rhoT = 580 kg m-3 and M = 7 using Herron and Langway densification rates. This paper extends the model calibration using snow density profiles from other areas, to test the hypothesis that transition density varies with climatic conditions. The SUMup data base, compiled by the NASA Surface mass balance and snow on sea ice Working Group, provides an easily- accessible source of suitable snow density profile data.