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Firn depth correction along the grounding line of the Antarctic ice sheet

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The variable nature of the Antarctic firn layer complicates an accurate assessment of ice sheet mass balance in several ways. One problem concerns the calculation of the solid ice flux across the ice sheet grounding line: when no direct measurements are available, ice thickness is usually calculated from surface elevation and a floatation criterion, which equates the mass of the displaced seawater with the added weight of the combined ice/firn column, assuming hydrostacy. This requires a correction for the depth and density of the firn layer, also known as the firn depth correction. Here we calculate the firn depth correction in Antarctica from a regional atmospheric climate model in combination with a steady-state firn densification model. The modelled density agrees well with observations from firn cores, apart from a site at the origin of fast flowing West-Antarctic ice stream (Upstream B), where densification is anomalously rapid, probably due to horizontal compression. The spatial distribution of the firn depth correction over Antarctica shows large variations, especially in the grounding line zone where large climatic gradients exist. In places where the grounding line crosses ablation areas, the firn depth correction is zero. Along the remainder of the grounding line, it ranges from typically 13 m in dry coastal areas (e.g. Dronning Maud Land) to 19 m in wet coastal areas (e.g. West Antarctica).