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Improving high-resolution basal temperature estimates of the Antarctic ice sheet

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The flow of ice sheets is greatly influenced by their thermal regime. Reliable estimates of basal temperatures in ice sheets are therefore fundamental in evaluating the spatial pattern of glacier dynamics. Accurate ice temperatures are also indispensable to determine the attenuation of radar signals in the ice so as to determine the basal reflector properties from radio-echo sounding surveys. Furthermore, a better knowledge on the distribution of cold basal ice in the central parts of the ice sheet is essential for delineating zones where the oldest ice can be found.

Although reliable observations of ice sheet surface elevation, ice thickness, ice flux, mass balance and surface temperature are becoming available, major unknowns to derive the temperature field in an ice sheet remain the treatment of the three-dimensional velocity components with respect to horizontal and vertical advection rates, and the geothermal heat flux estimation. Here we analyse different approaches to the velocity/temperature field determination and compare results with measurements from boreholes. Several datasets on geothermal heat flux were used. The method was further improved by adding a priori information on the spatial distribution of subglacial lakes, delimiting zones where basal melting should occur. In those areas (e.g. subglacial Lake Vostok), the 3D velocity field was determined using a higher-order ice sheet model in which the basal friction was set to zero to account for the ice/water interface.