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Thermal regime at the base of the West-Antarctic Ice Stream Tributaries - is the Holocene decay of the West Antarctic Ice Sheet coming to an end?

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The possible instability of the West-Antarctic Ice Sheet (WAIS) and its effects on global sea level was in the focus of Antarctic research for more then three decades, since Mercer (1968) proposed that the ice sheet collapsed during previous interglacials. Subsequent collection of field and remotely-sensed data has revealed, among other things, a complex structure in the WAIS drainage system and enabled us to better elucidate the basal processes that permit fast ice-stream motion under low driving stresses (e.g. Kamb, 2001). With high basal water pressures and a layer of weak, highly porous water saturated sediments playing a key role in facilitating the fast motion of ice in West-Antarctica, the spatial and temporal availability of basal water has to be incorporated into models simulating the present and future WAIS behavior.

Borehole observations in the interior of the WAIS (Robin, 1983) and in the Siple Coast ice streams (Engelhardt and Kamb, 1987) revealed a wet ice sheet bed and the ice at the base of the ice sheet being at its pressure melting. However the recent discovery of a up to 25 m thick basal ice layer at Ice Stream C indicates that basal melting either does not persist along the entire ice stream tributaries or did not persisted in the past. Lacking direct observations from the ice stream tributaries we are currently using finite-difference and analytical models to assess their basal energy balance; heat conduction away from the bed, geothermal flux and shear heating. Taking into account the uncertainty in the estimation of the geothermal flux (50 to 80 mW/m^2), the results of our calculations can be summarized as followed

1) the basal ice layer formed in the central part of the northern Ice Stream C tributary;
2) post Last Glacial Maximum (LGM) conditions favor basal freezing in spite of higher surface temperatures;
3) the presence of a12-25-m-thick basal ice layer request that either 2a) flow in the ice stream tributaries had stopped in the past and the temperature at the bed was below the pressure

melting point or 2b) that basal resistance in the tributaries is with 1 to 10 kPa similar small to the basal resistance in the ice streams.

Our calculations indicate that the presence of the basal ice layer at UpC has important implications for the models of WAIS stability. In both cases, 2a and 2b, the results are sensitive to small perturbations in the basal energy balance, which can lead to either increased lubrication, favoring a possible collapse of the WAIS or to increased basal resistance in favor of a possible stabilization of the WAIS. Although our model does not give a straight answer on whether the Holocene decay of the WAIS is coming to an end or not, it indicates that significant basal freezing has been and/or is currently occurring, basal freeze-on may increase basal resistance and eventually contributing to a stabilization of the WAIS. We therefore formulate the testable hypothesis that over large areas in the ice stream tributaries the basal energy balance is negative and freezing occurs increasing basal resistance. Further research and the acquisition of field data is necessary to decrease uncertainties in the basal energy balance, to test the hypothesis and so to increase the chance to successfully predict the future behavior of the WAIS.

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