Flow Dynamics of Byrd Glacier, East Antarctica

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Byrd Glacier is a fast-moving outlet glacier transecting the Transantarctic Mountains, funneling an estimated 20.6 Gt/yr of ice originating on the East Antarctic plateau into the Ross Ice Shelf through a fjord that is ~100 km long and ~20 km wide. The glacier has been the subject of glaciological investigations since the early 1960s, including a comprehensive assessment of balance of forces on the lower trunk by Whillans et al. (1989) using surface elevations and ice velocities derived from repeat photogrammetry in the late 1970s. That study, as well as subsequent more recent studies, was limited by lack of detailed information on the bed topography under the glacier. In 2011-2012 the Center for Remote Sensing of Ice Sheets (University of Kansas) conducted extensive airborne radar sounding for mapping the bed under Byrd Glacier, thereby allowing reevaluation of results from earlier studies and, in particular, to investigate the relation between "sticky spots" and basal relief. The present study aims to investigate flow dynamics and essentially represents an update of the study of Whillans et al. (1989).

Force-balance calculations reveal large variations in the along-flow component of driving stress that are muted by gradients in longitudinal stress such that basal drag is less variable spatially. The most pronounced sticky spot is located at the downstream end of a basal overdeepening, while smaller regions of high basal drag are co-located with a bed ridge transverse to the flow direction. On the large scale, gradients in longitudinal stress play a small role in balancing the driving stress, and flow resistance is partitioned between basal and lateral drags. Confirming earlier results, there is a significant component of driving stress in the across-flow direction resulting in non-zero basal drag in the direction perpendicular to ice flow. This is an unrealistic result and we propose that there are spatial variations in ice strength similar to those found on other glaciers.