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The role of ice rises in the stability of an ice sheet: a forward/inverse approach to interpret radar layers using ice-flow models

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Ice rises in coastal areas of the Antarctic play a crucial role in the dynamics of the advancing and retreating ice sheet. Most ice rises are islands of grounded ice within the ice shelf, although some of them are still connected to the continental ice sheet. They are characterized by a local ice flow pattern (e.g. Berkner Island) and exert a backpressure on the ice shelf, hence stabilizing the inland ice flow.

In 2008, the BELISSIMA expedition (Belgian Ice Sheet – Shelf Ice Measurements in Antarctica) carried out a number of radio-echo sounding and D-GPS surveys across an ice rise still connected to the main ice sheet in Dronning Maud Land, East Antarctica. The surveyed profiles run across the ice rise itself as well as in the saddle area, connecting the ice rise to the main grounded ice flow. The latter profiles have the advantage that lateral strain components can be neglected (non-convergent ice flow), which facilitates the use of 2D flowline models. Both bedrock elevation and internal layering were identified. Several inverse ice sheet models of different complexity (higher-order) were applied to investigate the nature of internal layer anomalies (such as basal melting and the presence of “Raymond” bumps), once major effects of surface accumulation and bedrock sensitivity were accounted for.

We used a 3D regional higher-order ice sheet model that accounts for grounding line migration to evaluate the effect of the presence of such an ice rise in that area on the dynamical behavior of the ice sheet in Dronning Maud Land and its sensitivity to changes in sea level and accumulation rate.