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Evidence for soft-bedded, marine-terminating outlet glaciers in East Antarctica

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Dronning Maud Land (DML), East Antarctica, has been considerd less dynamic than many other areas in Antarctica. Here, we present evidence that questions this view. We report results of a radar survey carried out on the West Ragnhild Glacier (WRG): the longest and widest glacier in DML. It reveals that the glacier bed is smooth and low ($\sim$600 m b.s.l.) in its seaward 65 km becoming even lower toward in a deep valley further upstream. The grounding line lies well below sea level, which characterizes WRG as a marine terminating glacier. Moreover, across-flow radar profiles of the basin show little topographic controls on the glacier-outlet position. In the seaward part of the glacier (< 65 km away of the grounding line), very low roughness occurs at the bed-ice interface in both direction (across and along). Our interpretation indicates that this flat basin is continuously covered with sediments. Analysis of the radar power returned from the bed shows that the bed is smoother and water richer within $\sim$40 km of the grounding line, so we conclude that most of the sediment basin is water-saturated and, therefore, acts as a soft bed and enhances the ice flow. We verified this hypothesis using a higher-order ice flow model. We modeled the ice deformation along the flow line and pointed out an increasing discrepancy between modeled and observed (by interferometry) surface velocities toward the grounding line. It shows that basal motion occurs only over the sediment basin, with magnitude increasing further downstream up to 75% of the total surface speed. These geographic settings make the glacier's grounding-line position unstable. As other outlet glaciers in DML have similar geographical settings, the inter-connected system of outlet glaciers and ice shelves in DML may be much more likely subject to a sudden change than previously thought.