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Signature of recent ice flow acceleration in the radar attenuation and temperature structure of Thwaites Glacier, West Antarctica

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Englacial temperature structure exerts significant control on the rheology and flow of glaciers and ice sheets. It is however logistically prohibitive to directly measure at the glacier-catchment scale. As a result, numerical ice sheet models often make broad assumptions about englacial temperatures based on contemporary ice surface velocities. However, this assumption might break down in regions – like the Amundsen Sea Embayment – that have experienced recent acceleration since temperature and rheology do not respond instantaneously to changes in ice flow regime. To address this challenge, we present a new technique for estimating englacial attenuation rates using bed echoes from radar sounding data. We apply this technique to an airborne survey of Thwaites Glacier and compare the results to temperature and attenuation structures modeled using the numerical Ice Sheet System Model (ISSM) for three surface velocity scenarios. These include contemporary surface velocities, surface velocities from the early 1970s, and ice-sheet balance velocities. We find that the observed attenuation structure is much closer to those modeled with pre-acceleration surface velocities. This suggests that ice sheet models initialized with contemporary surface velocities are likely overestimating the temperature and underestimating the rheology of the fast-flowing trunk and grounding zone of Thwaites Glacier.