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Using radar layers to infer ice temperature and to interpret basal conditions across the West Antarctic Ice Sheet Divide

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Different local subglacial environments associated with sediments, volcanism, and faults introduce inherent heterogeneity to the dynamics of the West Antarctic Ice Sheet (WAIS). Complex spatial and temporal patterns of retreat of the marine-based WAIS ultimately affect the interior WAIS in the vicinity of the ice divide. The lack of major topographical structures of the bed directly beneath the current ice-flow-divide location indicates that the current divide has little local topographic control and since the divide is migrating today, it may have also migrated in the past. These geological and glaciological settings are a major challenge to accurately establish the depth-age time scale of the ice core and a regional framework to interpret environmental proxies from the ice core.

Our primary goal is to generate improved estimates of ice temperature and basal conditions. To do this we solve an inverse problem to infer histories of accumulation rate, ice thickness, ice-divide position, and ice temperature that are consistent with internal layers and the modern ice sheet. We assess the ability of the available data to record information about unknown thermal parameters, and the ability to infer this information by solving an inverse problem. Together with deciphering glacial history in this area, it is also an ultimate goal of this study to develop a model that is able to assist simultaneously with interpreting englacial radar reflectors and the returned radar power from within and beneath the ice sheet. Currently, these two aspects of radar observations are interpreted independently. However, bed returned power and its interpretation in terms of basal conditions depend on englacial attenuation, which is primarily a function of the ice temperature. Our modeling effort to infer a realistic modern temperature field will allow us to better assess the current bed condition at WAIS Divide, the geological and glaciological controls on the current ice sheet geometry, and ultimately the depth-age scale of the WAIS Divide core.