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Towards multi-decadal to multi-millennial ice core records from coastal west Greenland ice caps

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The Arctic region, and Greenland in particular, is undergoing dramatic change as characterized by atmospheric warming, decreasing sea ice, shifting ocean circulation patterns, and rapid ice sheet mass loss, but longer records are needed to put these changes into context. Ice core records from the Greenland ice sheet have yielded invaluable insight into past climate change both regionally and globally, and provided important constraints on past surface mass balance more directly, but these ice cores are most often from the interior ice sheet accumulation zone, at high altitude and hundreds of kilometers from the coast. Coastal ice caps, situated around the margins of Greenland, have the potential to provide novel high-resolution records of local and regional maritime climate and sea surface conditions, as well as contemporaneous glaciological changes (such as accumulation and surface melt history). But obtaining these records is extremely challenging. Most of these ice caps are unexplored, and thus their thickness, age, stratigraphy, and utility as sites of new and unique paleoclimate records is largely unknown. Access is severely limited due to their high altitude, steep relief, small surface area, and inclement weather. Furthermore, their relatively low elevation and marine moderated climate can contribute to significant surface melting and degradation of the ice stratigraphy. We recently targeted areas near the Disko Bay region of central west Greenland where maritime ice caps are prevalent but unsampled, as potential sites for new multi-decadal to multi-millennial ice core records. In 2014 & 2015 we identified two promising ice caps, one on Disko Island (1250 m. asl) and one on Nuussuaq Peninsula (1980 m. asl) based on airborne and ground-based geophysical observations and physical and glaciochemical stratigraphy from shallow firn cores. In spring 2015 we collected ice cores at both sites using the Badger-Eclipse electromechanical drill, transported by a medley of small fixed wing and helicopter aircraft, and working out of small tent camps. On Disko Island, despite high accumulation rates and ice thickness of $\sim$250 meters, drilling was halted twice due to the encounter of liquid water at depths ranging from 18-20 meters, limiting the depth of the final core to 21 m, providing a multi-decadal record (1980-2015.) On Nuussuaq Peninsula, we collected a 138 m ice core, almost to bedrock, representing a $\sim$2500 year record. The ice cores were subsequently analyzed using a continuous flow analysis system (CFA). Age-depth profiles and accumulation histories were determined by combining annual layer counting and an ice flow thinning model, both constrained by glaciochemical tie points to other well-dated Greenland ice core records (e.g. volcanic horizons and continuous heavy metal records). Here we will briefly provide an overview of the project and the new sites, and the novel dating methodology, and describe the latest stratigraphic, isotopic and glaciochemical results. We will also provide a particular focus on new regional climatological insight gained from our records during three climatically sensitive time periods: the late 20th & early 21st centuries; the Little Ice Age; and the Medieval Climate Anomaly.