Geophysical Research Abstracts
Vol. 19, EGU2017-10789, 2017
EGU General Assembly 2017

Rise in central west Greenland surface melt unprecedented over the last three centuries

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Greenland Ice Sheet surface melting has intensified and expanded over the last several decades and is now a leading component of ice sheet mass loss. Here, we constrain the multi-century temporal evolution of surface melt across central west Greenland by quantifying layers of refrozen melt within well-dated firn and ice cores collected in 2014 and 2015, as well as from a core collected in 2004. We find significant agreement among ice core, satellite, and regional climate model melt datasets over recent decades, confirming the fidelity of the ice core melt stratigraphy as a reliable record of past variability in the magnitude of surface melt. We also find a significant correlation between the melt records derived from our new 100-m GC-2015 core (2436 m.a.s.l.) and the older (2004) 150-m D5 core (2472 m.a.s.l.) located 50 km to the southeast. This agreement demonstrates the robustness of the ice core-derived melt histories and the potential for reconstructing regional melt evolution from a single site, despite local variability in melt percolation and refreeze processes. Our array of upper percolation zone cores reveals that although the overall frequency of melt at these sites has not increased, the intensification of melt over the last three decades is unprecedented within at least the last 365 years. Utilizing the regional climate model RACMO 2.3, we show that this melt intensification is a nonlinear response to warming summer air temperatures, thus underscoring the heightened sensitivity of this sector of Greenland to further climate warming. Finally, we examine spatial correlations between the ice core melt records and modeled melt fields across the ice sheet to assess the broader representation of each ice core record. This analysis reveals wide-ranging significant correlations, including to modeled meltwater runoff. As such, our ice core melt records may furthermore offer unique, observationally-constrained insights into past variability in ice sheet mass loss.