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The impact of mass loss from the Greenland Ice sheet (GrIS) on the 20th Century sea level rise (SLR) has long been subject to immense discussions. While globally distributed tide gauges suggest SLR of 15-20 cm computing the input constituents is of great concern - in particular for modeling sea level projections into the 21st Century. Estimates of the GrIS contribution to SLR have been derived using a number of different approaches, e.g. surface mass balance (SMB) calculations combined with estimates of ice discharge founded in correlating SMB anomalies and calving rates. Here, we show a novel geometric approach to determine the post-Little Ice Age (LIA) mass loss of the southern GrIS.

We present mass balance estimates of the GrIS south of 71N since retreat commence from the maximum extent of the LIA to 2010. The mass loss estimates are derived for three intervals, LIAmax (1900) - 1981/85 (1), 1981/85 - 2002 (2), and 2002 - 2010 (3).

We use high quality aerial stereo photogrammetric imagery recorded in 1981 and 1985 to map morphological features such as trim lines (boundary between freshly eroded and non-eroded bedrock) and end moraines marking the ice extent of the LIA, which thereby enables us to obtain vertical difference associated with former ice extent. We combine these with contemporary ice surface differences derived using NASA's Airborne Topographic Mapper (ATM) from 2002-2010, NASA's Ice, Cloud, and land Elevation Satellite (ICESat) from 2003-2009, and NASA's Land, Vegetation, and Ice Sensor (LVIS) from 2010, to estimate mass loss throughout the 20th and early 21st Century.

Using our novel approach we find mass loss rates for the above periods (1) to (3) of 53 Gt/yr, 46 Gt/yr, and 109 Gt/yr, respectively. In southeast GrIS we find substantial and extensive mass loss reaching the ice divide while in southwestern GrIS mass loss is less and mainly associated with marine outlet glaciers. Furthermore, post-LIA mass loss is found to be highly variable, even within relative close proximity to other outlet glaciers and within comparable terminal environments.