

## Mass loss of the southern half of the Greenland Ice Sheet since the Little Ice Age Maximum

Kristian K. Kjeldsen<sup>1\*</sup>, Kurt H. Kjær<sup>1</sup>, Anders A. Bjørk<sup>1</sup>, Shfaqat A. Khan<sup>2</sup>, Niels J. Korsgaard<sup>1</sup>, Svend Funder<sup>1</sup>, Nicolaj K. Larsen<sup>3</sup>, Bo Vinther<sup>4</sup>, Camilla S. Andresen<sup>5</sup>, Antony J. Long<sup>6</sup>, Sarah A. Woodroffe<sup>6</sup>, Eric Steen Hansen<sup>1</sup>, Bent V. Odgaard<sup>3</sup>, Jesper Olsen<sup>7</sup>, Jonathan L. Bamber<sup>8</sup>, Michiel van den Broeke<sup>9</sup> and Eske Willerslev<sup>1</sup>

<sup>1</sup>Centre for GeoGenetics, Natural History Museum, University of Copenhagen, Copenhagen, Denmark.

<sup>2</sup>DTU Space - National Space Institute, Technical University of Denmark, Department of Geodesy, Kgs. Lyngby, Denmark.

<sup>3</sup>Department of Geoscience, Aarhus University, Aarhus, Denmark.

<sup>4</sup>Niels Bohr Institute, Centre for Ice and Climate, University of Copenhagen, Copenhagen, Denmark.

<sup>5</sup>Geological Survey of Denmark and Greenland, Department of Marine Geology and Glaciology, Copenhagen, Denmark.

<sup>6</sup>Department of Geography, University of Durham, Durham, United Kingdom.

<sup>7</sup>Department of Physics and Astronomy, Aarhus University, Aarhus, Denmark.

<sup>8</sup>Bristol Glaciology Centre, University of Bristol, Bristol, United Kingdom.

<sup>9</sup>Institute for Marine and Atmospheric Research, Utrecht University, Utrecht, The Netherlands.

\*Corresponding author, e-mail: [kkjeldsen@snm.ku.dk](mailto:kkjeldsen@snm.ku.dk)

While the contributors to the current sea level rise are well-established, large uncertainties remains for the 20<sup>th</sup> century global sea level rise (GSLR) budget, including the role of the Greenland Ice Sheet (GrIS), thus hampering future projection of GSLR. Here, we address the problem by targeting the most climatically sensitive parts of the GrIS over centennial timescales and produce an estimate of the ice mass loss since the Little Ice Age (LIA) maximum. Surprisingly, the advance of glaciers during the LIA began as early as 1200 A.D. and even though it culminated between 1500 and 1600 A.D., the ice remained close to the maximum position until the early 20<sup>th</sup> century. We estimate a total mass loss of  $6108 \pm 1627$  Gt for southern GrIS between 1900 and 2010, equal to a rate of  $56 \pm 15$  Gt/yr. However, since 2002 the mass loss rate has doubled to  $109 \pm 9$  Gt/yr, and thereby result in a net mass loss during 1900 to 2010 equivalent to a  $17.0 \pm 4.4$  mm GSLR. Hence, presented results will aid in closing the 20<sup>th</sup> century sea-level budget. Importantly, most of the past ice mass changes occurred in the same areas, mainly at major marine terminating outlet glaciers, which has recently experienced the most significant mass changes along the southeast coast. This suggests that past and present thinning patterns may serve as analogues for future ice sheet surface.