Glacier Changes in Iceland From ∼1890 to 2019

Guðfinna Aðalgeirsdóttir¹, Eyjólfur Magnússon¹, Finnur Pálsson¹, Thorsteinn Thorsteinsson², Joaquín Belart¹,³,⁴, Tómas Jóhannesson³, Hrafnhildur Hannesdóttir⁵, Oddur Sigurðsson⁵, Andri Gunnarsson⁶, Bergur Einarsson⁶, Etienne Berthier⁴, Louise Schmidt⁶, Hannes Haraldsson⁵, and Helgi Björnsson¹

¹University of Iceland, Institute of Earth Sciences, Reykjavík, Iceland (gua@hi.is)  
²Icelandic Meteorological Office, Reykjavík, Iceland  
³National Land Survey of Iceland, Akranes, Iceland  
⁴Laboratoire d’Études en Géophysique et Océanographie Spatiales, Université de Toulouse, CNRS, Toulouse, France  
⁵National Power Company, Háleitisbratu 68, 103, Reykjavík, Iceland  
⁶Department of Geosciences, University of Oslo, Oslo, Norway

The volume of glaciers in Iceland (∼3,400 km³ in 2019) corresponds to about 9 mm of potential global sea level rise. In this study, observations from 98.7% of glacier covered areas in Iceland (in 2019) are used to construct a record of mass change of Icelandic glaciers since the end of the 19th century i.e. the end of the Little Ice Age (LIA) in Iceland. Glaciological (in situ) mass-balance measurements have been conducted on Vatnajökull, Langjökull, and Hofsjökull since the glaciological years 1991/92, 1996/97, and 1987/88, respectively. The combined record shows a total mass change of −540 ± 130 Gt (−4.2 ± 1.0 Gt a⁻¹ on average) during the study period (1890/91 to 2018/19). This mass loss corresponds to 1.50 ± 0.36 mm sea level equivalent or 16 ± 4% of mass stored in Icelandic glaciers around 1890. Almost half of the total mass change occurred in 1994/95 to 2018/19, or −240 ± 20 Gt (−9.6 ± 0.8 Gt a⁻¹ on average), with most rapid loss in 1994/95 to 2009/10 (mass change rate −11.6 ± 0.8 Gt a⁻¹). During the relatively warm period 1930/31–1949/50, mass loss rates were probably close to those observed since 1994, and in the colder period 1980/81–1993/94, the glaciers gained mass at a rate of 1.5 ± 1.0 Gt a⁻¹. For other periods of this study, the glaciers were either close to equilibrium or experienced mild loss rates. Comparison of our results with WGMS time series (Zemp et al., 2019) shows that the interannual variability is generally well captured by both data sets, but some details are not; for example, the large ice melt due to the Gjálp eruption in October 1996 and the non-surface mass balance are not included by WGMS data set. Our time seris is within the large uncertainty range of the GRACE record (Wouters et al., 2019) that has some years (e.g., 2006/07 and 2010/11) with more negative mass change, and others (e.g., 2005/06, 2011/12, and 2013/14) with less negative mass change than our estimates.