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Icelandic glaciers; the recent mass balance and evolution through 20th and 21st century

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Glaciers in Iceland are rapidly losing mass in response to warming climate, as most glaciers of the world. We present observations and modelling of a number of glaciers in Iceland. In situ mass balance records from Vatnajökull ice cap (∼7700 km2, ∼3000 km3), Langjökull ice cap (∼840 km2, ∼190 km3) and Hofsjökull ice cap (∼810 km2, ∼190 km3) are available since the glaciological years 1991–92, 1996–97 and 1987–88, respectively. Shorter records of accumulation and ablation are available from Mýrdalsjökull and Drangajökull and geodetic mass balance has been obtained for ∼20 smaller glaciers. Geodetic mass balance records further back in time have been deduced from reconstructed surface maps based on glacial geomorphological evidence (such as LIA lateral moraines), published maps, historical aerial photographs, declassified spy satellite images, modern satellite stereo imagery and airborne lidar. These records yield a consistent story of slow retreat from 1890 to 1920, high rates of mass loss 1930 to 1950, period of close to equilibrium or slight mass increase 1960–1990, and finally a similar rate of mass loss from 1995 and through the first decade of the 21st century as in the 1930s and 1940s. A more detailed examination of shorter periods for 14 of the smaller glaciers shows that they are subject to somewhat different climate forcing and that higher decadal mass-balance variability is found on glaciers located at the south and west coast, in contrast to glaciers located inland, and in north and northwest Iceland. Since 1995, Hofsjökull, Langjökull and Vatnajökull have had a persistently negative mass balance, except that positive mass balance was observed in 2014–15 and near zero mass balance in 2017–18. In 2017–18, Vatnajökull had a positive mass balance on the west side, but negative on the east, reflecting a wet summer and a limited number of days with sunshine in west Iceland. Model simulations forced with different scenarios for future climate indicate that glacier mass loss will continue in the future. The smaller two of the main ice caps, Hofsjökull and Langjökull, respond more rapidly to climate warming than Vatnajökull. They will likely experience peak water runoff in the latter half of this century, while Vatnajökull is projected to have increasing runoff beyond 2100.