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Climatic implications of glacial evolution in the Tröllaskagi peninsula (northern Iceland) since the Little Ice Age maximum. The cases of the Gljúfurárjökull and Tungnahryggsjökull glaciers

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The Tröllaskagi peninsula is located in northern Iceland, between meridians 19º30'W and 18º10'W, jutting out into the North Atlantic to latitude 66º12'N and joining the central highlands to the south. About 150 glaciers located on the Tröllaskagi peninsula reached their Holocene maximum extent during the Little Ice Age (LIA) maximum at the end of the 19th century. The sudden warming at the turn of the 20th century triggered a continuous retreat from the LIA maximum positions, interrupted by a reversal trend during the mid-seventies and eighties in response to a brief period of climate cooling. The aim of this paper is to analyze the relationships between glacial and climatic evolution since the LIA maximum. For this reason, we selected three small debris-free glaciers: Gljúfurárjökull, and western and eastern Tungnahryggsjökull, at the headwalls of Skíðadalur and Kolbeinsdalur, as their absence of debris cover makes them sensitive to climatic fluctuations.

To achieve this purpose, we used ArcGIS to map the glacier extent during the LIA maximum and several dates over four georeferenced aerial photos (1946, 1985, 1994 and 2000), as well as a 2005 SPOT satellite image. Then, the Equilibrium-Line Altitude (ELA) was calculated by applying the Accumulation Area Ratio (AAR) and Area Altitude Balance Ratio (AABR) approaches. Climatological data series from the nearby weather stations were used in order to analyze climate development and to estimate precipitation at the ELA with different numerical models.

Our results show considerable changes of the three debris-free glaciers and demonstrates their sensitivity to climatic fluctuations. As a result of the abrupt climatic transition of the 20th century, the following warm 25-year period and the warming started in the late eighties, the three glaciers retreated by ca. 990-1330 m from the LIA maximum to 2005, supported by a 40-metre ELA rise and a reduction of their area and volume of 25% and 33% on average, respectively. The 1.5 ºC warming recorded at the city of Akureyri from late 19th century to 2005 does not agree with the 0.3 ºC value obtained from the ELA rise and lapse rate. On the contrary it demonstrates that other factors – for example, precipitation and wind – have been decisive in the evolution of the glaciers. All the models applied suggest a precipitation increase of ∼700 mm water equivalent at the mean ELA since the LIA maximum, and higher and lower values depending on warm and cold periods respectively. The overall increase in precipitation is compatible with the increase in the surface temperature of the North Atlantic and a possible negative-to-positive shift in North Atlantic Oscillation (NAO) mode. However, the link between winter accumulation and prevailing wind directions recorded at nearby weather stations remains unclear.

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