Reviewed research article

The subglacial topography of Drangajökull ice cap, NW-Iceland, deduced from dense RES-profiling

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Abstract — *Systematic mapping of the bedrock beneath the Icelandic ice caps began in 1980. We continue this effort by presenting a detailed bedrock digital elevation model (DEM) of Drangajökull ice cap in NW-Iceland, surveyed using radio echo sounding (RES) in March 2014. About 590 km of RES profiles, generally with 200–300 m spacing, were surveyed. This is to date the densest set of RES profiles measured on an Icelandic ice cap. We describe the processing of the radar profiles and construction of the bedrock DEM. We also analyse possible errors of surveyed glacier thickness along the profiles and discuss the accuracy of the final bedrock DEM. The bedrock DEM reveals topography with the same general character as other areas of NW-Iceland (Vestfirðir). The new bedrock DEM and a series of surface DEMs allow estimates of total ice cap volume and relative volume change since the mid-20th century. The bedrock data combined with the most accurate available surface DEM of Drangajökull, from July 2011, reveals a total ice cap volume of 15.4±0.4 km^3, of which ∼71% was stored on the west side of the ice cap. At that time the average thickness of Drangajökull was 107±3 m and the maximum observed thickness, found on Kaldalónsjökull outlet glacier, was 284±14 m. In 1946–2014, the total ice cap volume (in autumn) was reduced from ∼18 km^3 to ∼15 km^3. Approximately half of this volume was lost in 1994–2011. We describe and discuss several interesting phenomena revealed by the RES data and the derived bedrock DEM. The presented bedrock data also helps to explain curious surface features in the accumulation area of NE-Drangajökull.*

INTRODUCTION

Well constrained glacier geometry is fundamental for most glaciological studies. Digital elevation models (DEMs) of surface and subglacial topography are necessary prerequisites for glacier modelling (e.g. Gillet-Chaulet *et al.*, 2012; Aðalgeirsdóttir *et al.*, 2011) and subglacial hydrology studies (e.g. Björnsson, 1988, Flowers, 2015). Glacier thickness also provides a measure of freshwater storage in glaciers, relevant regarding use of glacier water for irrigation and electric power production (e.g. Radic and Hock, 2013) as well as to estimate the possible contribution of glacier melt to sea level rise (e.g. Vaughan *et al.*, 2013).

Various methods are available to accurately map the glacier surface, but glacier thickness and subglacial topography is typically constrained using radar, often referred to as radio echo sounding (RES). RES has been used to measure glacier thickness and map the bedrock of cold glaciers (ice temperature <0°C) since the 1960s (Bailey *et al.*, 1964; Robin *et al.*, 1969; Gudmandsen, 1969). In the 1970s sci-