# THE MASS BALANCE OF A SMALL GLACIER IN NORTH-ICELAND

Kaisa Halkola[1], Haraldur Ólafsson[2] and Yngvar Gjessing[3]

[1]University of Helsinki, University of Svalbard and the Icelandic Meteorological Office
[2]Háskóli Íslands (University of Iceland), Veðurstofa Íslands (Icelandic Meteorological Office) and Rannsóknastofa í veðurfræði (Institute for Meteorological Research)
[3]University of Bergen and University of Svalbard
E-mail: *haraldur@vedur.is*

**Abstract**: The mass balance of a small glacier in North-Iceland is estimated during a 52 day period in the autumn of 2002. The accumulated snow is measured, precipitation is simulated and sublimation is calculated from weather observations. The estimations indicate that precipitation is an order of magnitude greater than net transport of snow and sublimation during periods of blowing snow.

***Keywords –*** *Kambsjökull, Iceland, mass balance, precipitation, MM5, sublimation, snowdrift, numerical simulation*

## 1. INTRODUCTION

In North-Iceland there are several small glaciers in a relatively warm climate. These glaciers are located in lowerings in the mountain ranges and in most cases they face towards north. Here we attempt to calculate the mass balance one of these glaciers, Kambsjökull during a period of 52 days in the autumn of 2002 (Fig. 1 and 2). The main motivation for this study is to estimate the relative magnitude of precipitation, sublimation and transport of snow by wind to the glacier. The mass balance can be expressed as

$$ACC = PRE + SND - SUB - RUN$$

Where ACC is the observed accumulation of snow on the glacier, PRE is accumulated precipitation, SND is net snowdrift onto the glacier, SUB is sublimation (and evaporation) from the snow surface or from blowing snow and RUN is runoff. The ACC is measured with snowsticks at various locations on the glacier, PRE is estimated with a numerical atmospheric simulation, SUB is calculated using weather observations from a nearby mountain and RUN is estimated to be zero.

## 2. OBSERVED SNOW ACCUMULATION

The accumulated snow on the glacier is observed by direct measurements of the snow density and snow-depth by snow-sticks (Fig. 3). The observed snow depth is 100-200 cm and the spatially averaged water equivalent of the snow is 800 mm. There is a mean increase in snow depth of about 10 cm for every 100 m elevation.

## 3. SIMULATED PRECIPITATION

There are no precipitation observations available in the mountains, and conventional raingauge observations would probably be of little value because of large errors in precipitation observations in sub-zero temperatures and strong winds. Therefore, precipitation is estimated from a numerical simulation with the model MM5 (Grell et al., 1995). The model is run with boundary values from the European Centre for Medium range Weather Forecasts (ECMWF) and nested down to a horizontal grid of 3 km. In the model output, there is a large precipitation gradient in the mountains and the maximum simulated value is about 1270 mm. The precipitation over Kambsjökull is estimated to be about 1000 mm.

## 4. SUBLIMATION

Evaporation is considered to be very little, but some sublimation must be expected in connection with blowing snow. For the calculations of sublimation, weather observations from an automatic weather station at the nearby Vaðlaheiði are used. The sublimation estimations are based on Pomeroy (1995) and they are given in Fig. 4. The total sublimation of the period is calculated to be about 120 mm.

## 5. DISCUSSION

With an accumulation of 800 mm, precipitation of 1000 mm and sublimation of 120 mm and no runoff, there is little room for very significant accumulation of snow transported from elsewhere. The uncertainties in the measurements of the snow accumulation are not large, but there is definitely an error margin of at least +/-30% when it comes to the precipitation simulation. It should however be mentioned that precipitation values have been simulated quite accurately in the Reykjanes mountains in SW-Iceland, with a similar setup of the MM5 model (Rögnvaldsson et al., 2004). The sublimation can be very sensitive to wind speed and it is therefore a source of error not having local wind observations. There is also uncertainty whether the snow is in the state of going into suspension or not.

**Figure 1.** Location of the Kambsjökull glacier (red dot inside the frame)


**Figure 2.** Aerial view from the north. (photo: Oddur Sigurðsson)

## 6. CONCLUSION

An estimation of the main contributors to the mass balance of Kambsjökull glacier in N-Iceland during 52 days in the early winter 2002 indicate that transport of snow by the wind may not be very important for the net accumulation of snow where the glaciers of the region are located. There are however many and quite large uncertainties involved.

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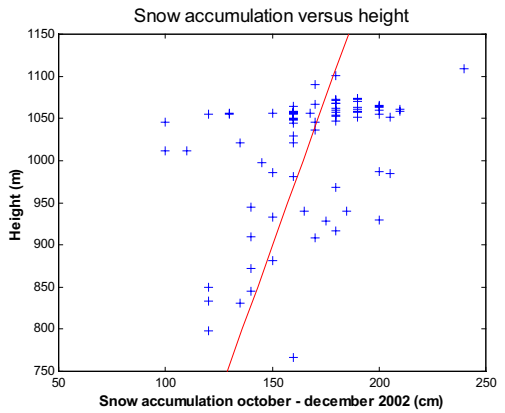


**Figure 3.** Observed snow accumulation on Kambsjökull from the middle of October to 7 December 2002.

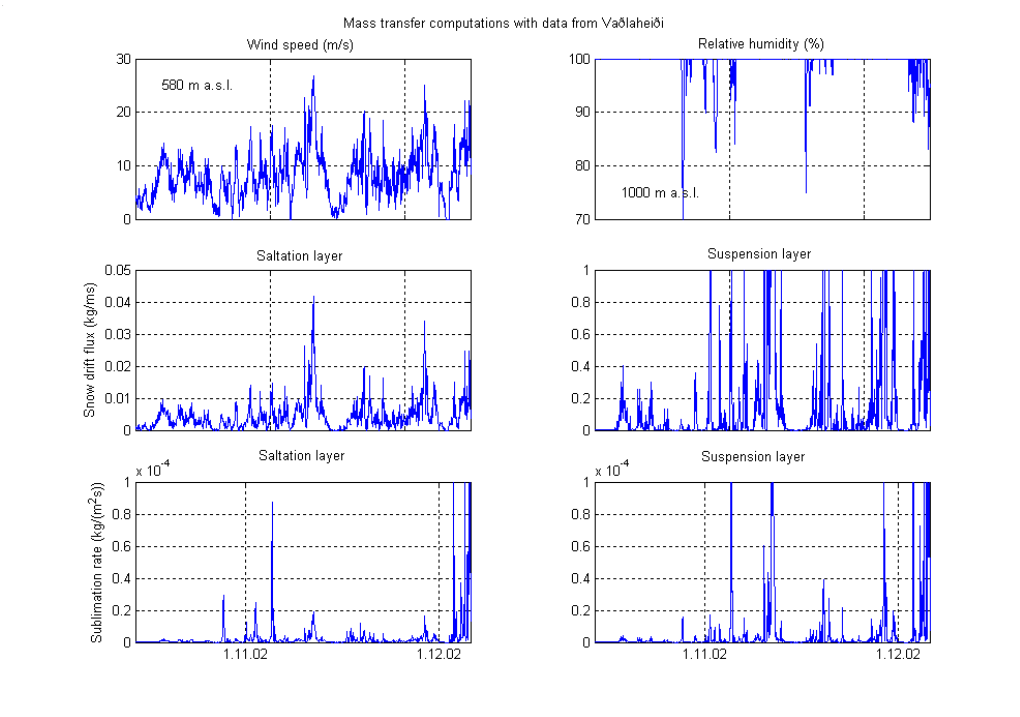


**Figure 4.** Calculations of mass fluxes and sublimation for the same period as in Fig. 3