Conference Volume | 4th Symposium of the Hohe Tauern National Park for Research in Protected Areas September 17th to 19th, 2009, Castle of Kaprun | pages 295-298

Monitoring of glacier mass balance on Mullwitzkees Hohe Tauern

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Abstract

Since 2006, the Mullwitzkees, situated in the Venediger Massive within the core zone of the Hohe Tauern National Park, is subject to mass balance monitoring program. In contrast to other glaciers currently observed in monitoring programs, the glacier is located south of the main Alpine crest and also exposed to the south. The highest point of the glacier is Hoher Zaun (3450 m), the lowest part of the snout called Zettalunitzkees reaches down to an elevation of 2690 m. The mass balance of Mullwitzkees and the data of the Austrian glacier inventories allow gaining new insights in processes governing melt, hydrology and glacial recession for these types of glaciers. The monitoring network includes about 15 ablation stakes, several snow pits, a rain gauge and an automatic weather station. The mass balance of the glacier is measured using the direct glaciological method with fixed date. In the year 2006/07 the Mullwitzkees experienced a specific mass balance of -1447 mm. In the year 2007/08 the specific mass balance was -642 mm. In both years, therefore the mass loss was lower than the specific balance of the mass balance glaciers Hintereisferner (Ötztal) and Jamtalferner (Silvretta) although these are exposed to the north. The project is funded by the Hohe Tauern National Park and the Hydrological Service at the government of Tyrol.

Keywords

glacier, mass balance, Mullwitzkees, Venediger

Aims and duration of the project

The project aims at the measurement and interpretation of mass balance and climate data and the interpretation of the relationship of these measured parameters with respect to the current glacial recession and hydrology as well as for the development of future glacier scenarios for the both. The project is funded by the Hohe Tauern National Park and the Hydrological Service started in 2006 and is planned for five years at a first glance.

Area of study

The Mullwitzkees is situated in the Venediger Massive within the core zone of the Hohe Tauern National Park and is divided into the "innere" and "äußere" Mullwitzkees. Glacier fluctuations since the end of the Little Ice Age are summarised by Patzelt (1973). In the following only the "äußere" Mullwitzkees is regarded and therefore denoted as Mullwitzkees. The upper part of the glacier is exposed to the south and is confined by a ridge with the highest point Hohe Zaun at an elevation of 3450 m. The snout called Zettalunitzkees is exposed to the south-west and reaches down to an elevation of 2690 m. In 1998, Mullwitzkees (and Zettalunitzkees) covered an area of 3.24 km². The glacier area diminished to 3.08 km² in 2007. The glacier boundaries in Figure 1 and Figure 2 originate from the Austrian glacier inventory 1998. For 2007 the glacier boundaries were reduced on the basis of photos and inspections. Zettalunitzkees is also subject to measurements of glacier length by the glacier survey of the Austrian Alpine Club (e.g. Patzelt 2005, Patzelt, 2006). There are several glaciers along the alpine crest where mass balance measurements take place but the Mullwitzkees is the only one on the southern side of the main ridge of the Alps.

Method

To determine the mass balance of this glacier the direct glaciological method with fixed dates is used (HOINKES, 1970). Tough the mass gain and loss of the glacier within one year is detected. The year is divided into the accumulation period from the 1^{st} of October to 30^{th} of April were a mass gain of the glacier is expected and the ablation period from the 1^{st} of May to 30^{th} of September were the glacier experiences a mass loss.

Ablation is measured with ablation stakes in the ablation area. During the summer, the free ends of the stakes are measured several times. At the 30^{th} of April multiple snow pits are dug to measure the height and density of the accumulated snow cover and at the 30^{th} of September this work is repeated to determine the mass gain of the glacier within the hydrological year. The direct glaciological method is described in PATERSON (1994).

Results

In the year 2006/07 the Mullwitzkees experienced a mass loss of 4.46×10^6 m^3 w.e. (water equivalent) and a specific mass balance of -1447 mm. The AAR (accumulation area ratio) of 0.2 is low. Wind drift near the ridge causes the mass balance to be negative at high altitudes. Therefore the accumulation area is concentrated to mid-elevations of the glacier. The ELA (equilibrium line altitude) 2006/07 was 3160 m. In the year 2007/08 the mass loss devoted 1.98×10^6 m^3 w.e. and a specific mass balance of -642 mm, caused by high precipitation rates in winter, delaying the beginning of the ablation season. In Table 1 the characteristic numbers of the mass balance measurements on Mullwitzkees of both years are summarised and separated into terms of accumulation and ablation, as well as the AAR, the ELA and precipitation. The distribution of the mean specific mass balance on Mullwitzkees in centimeter water equivalent for the hydrological years 2006/07 and 2007/08 can be seen in Figure 1 and 2. The plot of specific mass balance (Figure 3) for HEF (Hintereisferner), KWF (Kesselwandfer), JAM (Jamtalferner), HSG (Hallstätter Gletscher) and MW (Mullwitzkees) shows that the mass balance tends to be less negative on Mullwitzkess compared to e.g. Hintereisferner, although it is exposed to the south. Further investigations are needed to prove these first results.

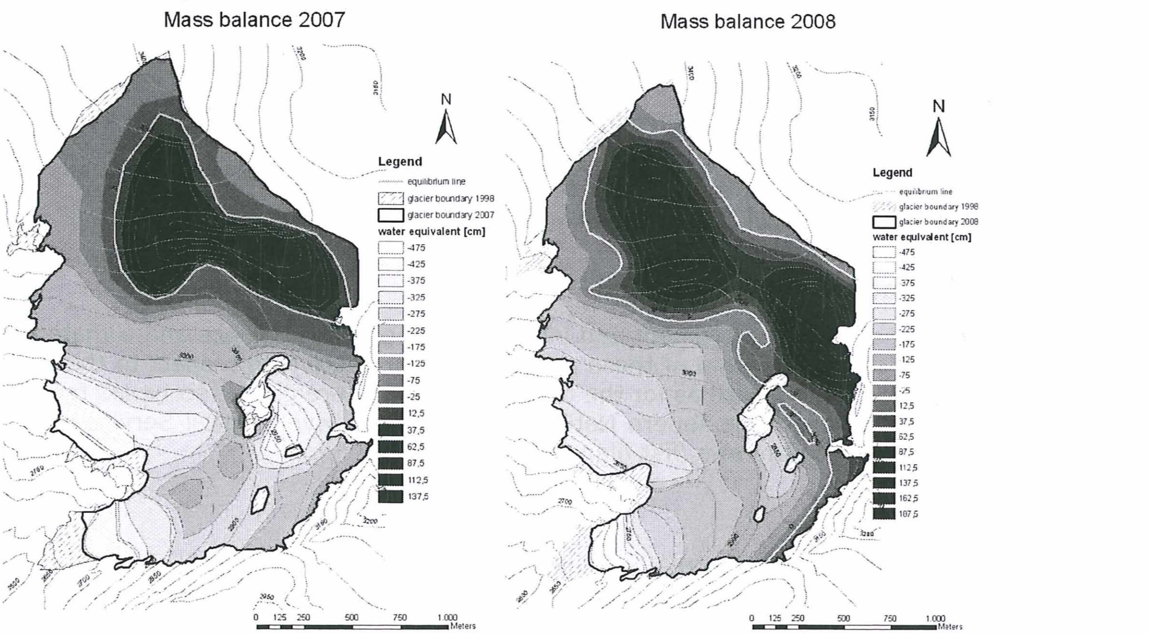

Figure 1 and 2: Distribution of the mean specific mass balance on Mullwitzkees in centimeter water equivalent for the hydrological years 2006/07 and 2007/08. The mass balance is colored gradually into 50 cm intervals within the ablation areas and into 25 cm intervals within the accumulation areas, the equilibrium line is plotted as a gray line.

Table 1: Characteristic numbers of the mass balance and climate observations on Mullwitzkees for the hydrological years 2006/07 and 2007/08, separated into terms of accumulation and ablation, as well as the accumulation area ratio, the equilibrium line altitude and precipitation.

	2006/07	2007/08	
Sc (accumulation area)	0.639	1.22	km^2
Bc (total accumulation)	0.44	0.93	$10^6\ m^3$
bc (mean specific accumulation)	682	764	mm
Sa (ablation area)	2.444	1.864	km^2
Ba (total ablation)	-4.90	-2.91	$10^6\ m^3$
ba (mean specific ablation)	-2004	-1562	mm
S (glacier area)	3.083	3.084	km^2
B (total mass balance)	-4.46	-1.98	$10^6\ m^3$
b (mean specific mass balance)	-1447	-642	mm
AAR (accumulation area ratio)	0.207	0.396	
ELA (equilibrium line altitude)	3163	3115	m
P (precipitation)	1358	1553	mm

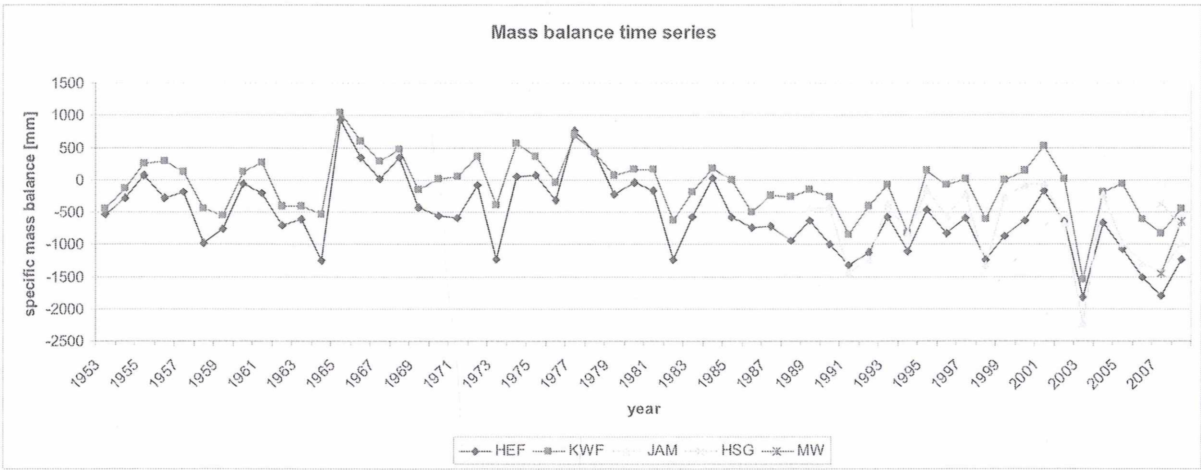

Figure 3: Time series (1953 – 2008) of the specific glacier mass balance in millimeter w.e. on HEF (Hintereisferner), KWF (Kesselwandferner), JAM (Jamtalferner), HSG (Hallstätter Gletscher) and MW (Mullwitzkees).

Discussion

Comparing the first two years of mass balance measurements on Mullwitzkees one of the most conspicuous results is the position of the accumulation area, which is displaced from the ridge to lower elevations due to wind drift during the winter. The ice thickness is decreasing at the highest elevations of this glacier (Span et. al., 2005, Fischer et. al., 2007). A relationship between the local climate and the appearance of this glacier can be found at the earliest after five years.

These investigations do not relate to the status of protection but the Mullwitzkees is a glacier located in a protected area. Nevertheless mass balance measurements are the coherency between glacier and climate and therefore it is important to observe the actual conditions, to answer questions which are anchored in the minds of the general public, especially with regard to protected areas, as for example the questions how long the glaciers of the Hohe Tauern National Park tend to exist in different climate scenarios described in the IPCC Report 2007.

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