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Five Years of Glaciological Monitoring of Venedigerkees, Hohe Tauern National Park, Austria

Bernd Seiser[1], Andrea Fischer[1], Hans Wiesenegger[2]

[1]Institute for Interdisciplinary Mountain Research (IGF), Austrian Academy of Sciences, Innsbruck
[2]Hydrological Service (HD), Federal Government of Salzburg

Abstract

Glacier mass balance is a sensitive indicator of climate change, and an important part of the hydrological regime of glacier covered basins. Changes in glacier mass result from ablation and accumulation and are directly related to prevailing atmospheric conditions. Since glacier mass balance governs glacier runoff, it is a valuable parameter for numerical runoff modelling and has various climatological and hydrological applications.

The spatial and temporal storage of water as snow and ice has a significant impact on the stream flow of Alpine head waters. Glacier mass balances are vital for gauging the extent of changes in ice, firn and snow in various mountain regions for specific glaciers. In our case study, we measure mass balance directly and record a separate winter and a summer balance. Direct glacier mass balance monitoring is an opportunity to see and measure changes directly on the object of interest in a cautious manner in protected areas. The direct mass balance measurements on Venedigerkees were initiated in 2011/12. The results show a high variability of the annual specific mass balances during the last 5 years. It is also apparent from the data that the glacier behaviour is mainly driven by the ablation in summer. Future investigations will tackle the mass balance and its reaction to current glacier disintegration.

Keywords

Mass balance, glacier, monitoring, runoff, Venedigerkees

Study site

The Venedigerkees is located in the Venediger range in the core zone of Hohe Tauern National Park, Austria. The upper part of Venedigerkees is north-exposed while the lower part, and especially the tongue, is exposed to the south-west. In 2012 Venedigerkees covered an area of 1.99 km².The elevation range of this typical valley glacier is from about 2480 m up to 3400 m, with Großvenediger the highest summit in the area at 3662 m.

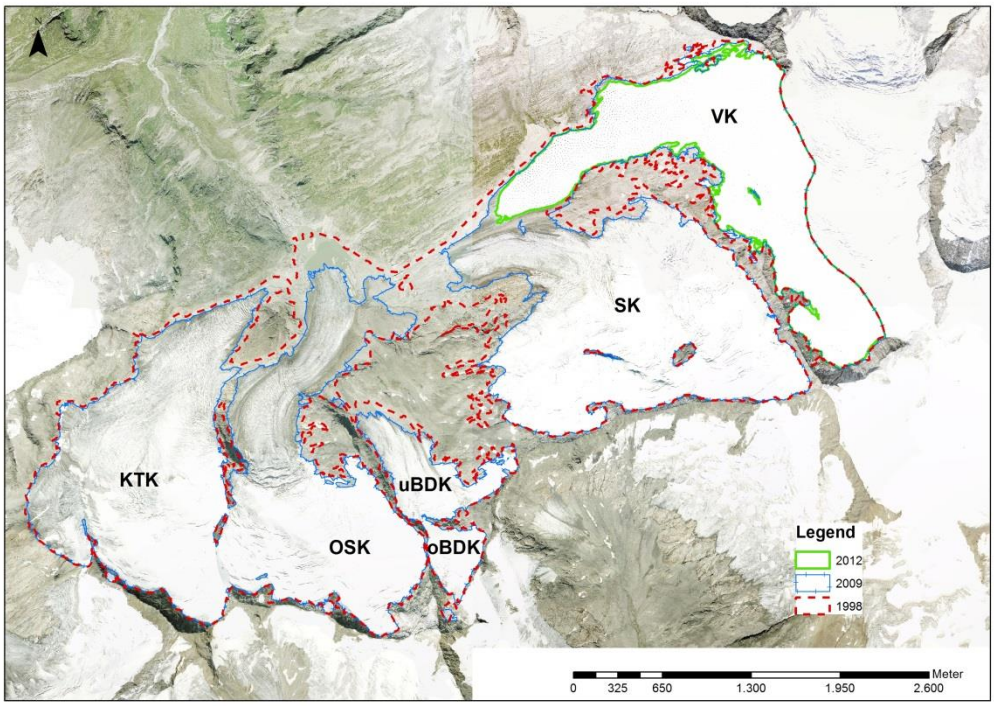

Figure 1: VK- Venedigerkees; SK- Sulzbacherkees;uBDK- unteres Bleidächerkees; oBDK- oberesBleidächerkees; OSK-Obersulzbachkees; KTK-Krimmlertörlkees;

Introduction

The time series started in 2011/12 without any data gaps. The direct mass balance (HOINKES 1970) is based on direct measurements in different areas on the glacier. The time frame for the measurements is the hydrological year, which runs from 1 October to 30 September. In this time period, ablation and accumulation were measured annually.

Mass balance is measured by determining the amount of accumulated snow, and later measuring the amount of snow and ice removed by melting and sublimation. Mass balance is reported in snow water equivalent (SWE). This represents the average thickness gained (positive balance) or lost (negative balance) from the glacier during that particular year.

The mass change of the whole glacier area within a hydrological year is calculated by extrapolation of point measurements to the total glacier area. Ablation stakes are used to measure mass loss directly. We currently use 15 ablation stakes, which are drilled 8 to 10 m deep into the ice.

For monitoring mass gain, volume and density of the accumulated snow is measured in three snow pits. These snow pits have to be in the same place every year and have to be representative for particular surroundings. The snow pits have to be as deep as last year's glacier surface was. The density of the measured snow weight lets us know the snow water equivalent (SWE) for each snow pit.

The results from these two kinds of measurements, plus additional probings, are used to create maps of SWE isolines. The calculated difference of annual net mass balance and winter mass balance is the summer balance.
To get the exact date of the ablation maximum und the ablation patterns, we also use three automatic cameras, which take three pictures per day. These cameras show most parts of the glacier, with a particular focus on detecting the snowline at the date of the maximum ablation.

Results

The mean annual specific glacier mass balance during the past 5 years was -747 mm w.e. (water equivalent), but shows great variance, from -1567 mm w.e. to -152 mm w.e.. A comparison of the annual summer and winter mass balances suggests that the annual mass balances of this glacier mainly depend on the ablation season (Tab. 1). This means that the state of Venedigerkees is mainly driven by summer temperatures and summer snowfall events at the glacier. Snow accumulation during the accumulation season can be seen as the basis for the annual result, as it affects the length of the ablation season.

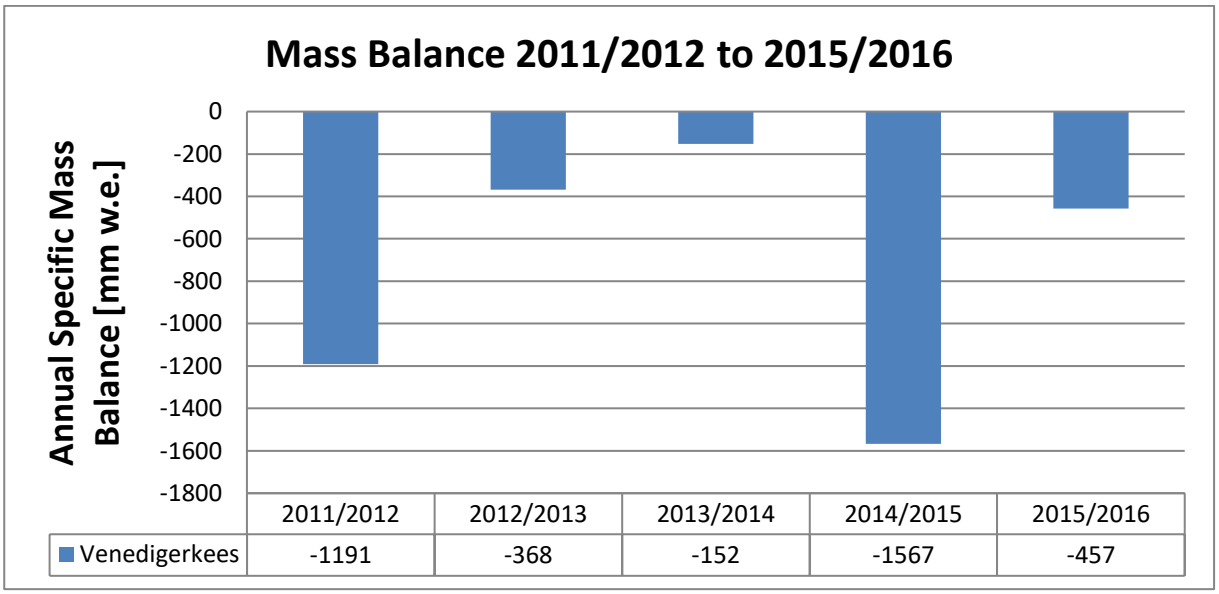

Figure 2: Annual specific mass balances for the last five years.

	b [mm]	bw [mm]	bs [mm]	ELA [m.a.s.l]
2011/2012	-1191	1323	-2515	3086
2012/2013	-368	1310	-1678	2929
2013/2014	-152	1317	-1469	2810
2014/2015	-1567	1297	-2864	3110
2015/2016	-457	1116	-1573	2946

Table 1: Key results of Venedigerkees mass balance measurements. ELA Equilibrium Line Altitude

Acknowledgements

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References

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Contact

Bernd Seiser
bernd.seiser@oeaw.ac.at
Austrian Academy of Sciences
Institute for Interdisciplinary Mountain Research (IGF)
Innsbruck
Austria