



Differences in response of flow velocities of an adjacent Alpine blue ice- and rock glacier to climate warming

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The alpine blue ice glacier Kesselwandferner (KWF) and Hochebenkar rock-glacier(HEK) are located close to each other in the Ötztal Alps and both are subject to long term monitoring of flow velocities. Earlier work showed that the response of Hintereisferner to a climate signal differs significantly from that of Kesselwandferner. This study compares the pace and pattern of flow velocity changes of HEK and KWF, which both experience roughly the same climate forcing.

The rock-glacier in outer Hochebenkar has been the object of scientific investigation since the 1930s. Flow velocities have been measured regularly for over sixty years, resulting in a very long time series that has given, and continues to give, valuable insights into rock-glacier dynamics. The tongue-shaped talus rock-glacier extends from an altitude of about 2830 m down to 2360 m and faces north-west. Flow is determined by measuring the displacement of marked blocks along several profiles.

Flow velocities at HEK rock-glacier saw a decreasing trend from 1965 to the early 1970s. Velocities remained at low, fairly constant values of around 0.5 m/a until 1996, when they began to continuously increase at all profiles. This speeding-up of the rock-glacier continued until 2004, when values well over 2 m/a were reached. After 4 years of decreasing velocities, the rock-glacier is speeding up again since 2008 at all profiles. In 2011, velocities at the two profiles in the upper region of the rock-glacier again reached values close to those of the 2004 maximum. The rock-glacier flows over a terrain step at about 2580 m. A profile just above this steeper zone has shown strong acceleration since 2008 and exceeded the 2004 maximum by over 0.5 m/a in 2011.

Kesselwandferner (KWF) is a south-east facing glacier in the Ötztal Alps, about 12 km west of HEK. It extends from about 3500 m down to roughly 2700 m. Surface velocities have been regularly measured at KWF since 1965 along a longitudinal profile of stakes on the main flow line.

From 1965 to the late 1970s, flow velocities at KWF increased to rates of up to 90 m/a in the lower regions of the glacier. In the 1980s, velocities began to decrease rapidly. The glacier began retreating again at this time, after advancing from 1970 to 1985. Since 1990, KWF moves at rates of less than 10 m/a at all altitudes above 3100 m, with little year to year variation.

While year to year velocity variations at HEK appear to be strongly correlated with air temperature, KWF seems to have a slower response time to temperature changes. Under a trend of increasing temperatures, KWF has slowed down for over 20 years, while HEK seems to underlie a general trend of speeding up. This implies fundamental differences in flow regime at the HEK and KWF.