



Elevation gradients of temperature and humidity over a glacier surface at high altitude

Christina Schmid and Thomas Mölg

Friedrich-Alexander-University Erlangen-Nuremberg, Geography, Geography and Geosciences, Erlangen, Germany
(christina.schmid@fau.de)

Vertical meteorological gradients over glacier surfaces are important parameters for glacier mass balance models. However, there are relatively few measurements of these parameters especially at high altitude. Most models use gradients taken from the literature, which are not able to represent seasonal or characteristic climate variations.

There has been an extensive measurement program over the past 18 years on the summit of Kilimanjaro. At the moment four automatic weather stations, operated by the University of Massachusetts, Innsbruck and Erlangen, are located at Kilimanjaro measuring temperature, relative humidity, precipitation, wind velocity, and other selected variables. Automatic weather station 3 (AWS3) and automatic weather station 4 (AWS4), positioned on the Kersten Glacier at an altitude of above 5500 m a.s.l., have a vertical difference in height of 270 m. This set-up makes them suitable for evaluating the vertical gradients in temperature and relative humidity over the Kersten Glacier for the overlapping measurement period from 10/2009 to 09/2012.

Our results suggest that vertical gradients of relative humidity stay almost constant in the average annual cycle, but they fluctuate systematically in the mean diurnal cycle. This pattern can be explained through stronger wind speeds during the day and the associated vertical moisture transport. Temperature gradients show in general the expected theoretical decrease with height. Unexpectedly, the vertical gradients of the dry season are weaker than those of the wet season, which does not conform to the theoretical assumption of the wet and dry adiabatic lapse rate. Another surprising result concerns the mean diurnal cycle of the lapse rate, which shows the opposite pattern known from measurements on typical valley glaciers. Lapse rates on Kersten Glacier are the strongest during the night and morning hours, which demonstrates the weaker impact of katabatic winds at this high-elevation site where the influence of the free tropospheric flow is strong.