

# Technical comments on the data records from the Gletschermitte station, Vernagtferner, Oetztal Alps, for the period 1968 to 1987

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## 1) Abstract

From 1968 to 1987, the meteorological station ‘Gletschermitte’ was run in the Vernagtferner basin during the summer months. It was the first monitoring station, run by the Commission for Glaciology (since 2010 Commission for Geodesy and Glaciology) of the Bavarian Academy of Sciences in the Vernagtferner basin, but also the first to be closed due to staff reduction after the end of the ‘Sonderforschungsbereich 81, TP A1’ in 1987. It was mounted on a small rock in the western part of the glacier at an elevation of 3078 m a.s.l. The coordinates are 46.868939° (Lat.) and 10.802986° (Long.). The recorded quantities comprise wind velocity and direction, air temperature, humidity and precipitation. Over the major part of the period, the same instruments were used as at the Vernagtbach climate station, installed in 1974. Thus, wind direction and wind velocity was recorded with a so-called ‘Woelfle-Windwegschreiber’ from 1968 to 1986, air temperature and humidity of the air with the ‘BTW-Langzeit-Thermo-Hygrograph’ from 1977 to 1987. These data are available for an hourly time increment (resolution). From 1968 to 1975, air temperature (and partly also the humidity of the air) were recorded with a mechanically driven thermo-hygrograph with a weekly cycle, and in 1976, air temperature was recorded on a Schenk paper chart recorder. In addition, photographs of the eastern part of Vernagtferner were taken once a day in summer between 1981 and 1986, and a Belfort analogue weighing gauge was run from 1977 until 1987, with the recordings analysed for daily sums only.

## 2) Wind records

The complete data series was recorded on the so-called ‘Woelfle-Windwegschreiber’ (Wind Recorder according to Woelfle, e.g. [www.lambrecht.net](http://www.lambrecht.net)). This mechanical device is equipped with a 3-armed cup rotor for wind run and a wind vane for wind direction. The clockwork is manually wound up by a key and runs for 31 days. The ‘recording tool’ of the time series of wind direction and wind velocity is a special wax-paper. Hence no ink or auxiliary power is required and the device is almost maintenance-free. The evaluation of the data is done manually: (1) wind velocity is analysed with a calibrated straightedge, resulting in hourly averages; (2) wind direction is analysed according to the imprinted scaling of the chart. During this period, the direction scaling differed between (1) 0° and 320° and (2) 0° and 360°. For the time series given here, all direction data refer to the 360°-range, with the 320° values converted to this range. Both parameters are calibrated by the selling company; thus, the instrument has only to be adjusted to the north direction when mounted.



sensor, humidity with a hair hygrometer. Both records are written with red ink on paper charts. The device is battery powered, on a single paper chart three months can be recorded.

Two types of charts were provided from the manufacturer: (1) temperature scale of  $-20^{\circ}\text{C}$  ...  $+40^{\circ}\text{C}$ , (2)  $-35^{\circ}\text{C}$  ...  $+40^{\circ}\text{C}$ , both spread over 6 cm paper width. The scale for humidity was uniformly 0% ... 100% spread over 7.5 cm. The device was delivered with an air temperature calibration for the first temperature range, for the other one, the calibration had to be converted. In addition, a variable offset was applied to the temperature ranges to account for the actual conditions expected for the station. These offset had to be determined by the calibration procedure.

In the late 1980s, all the recording strips were digitized, using a 380x260 mm sized passive graphics tablet with a physical resolution of 0.5 mm. The implemented special software WDG1 (M. Weber, 1985) for MSDOS performs coordinate transformations and afterwards averaging by oversampling. The resulting un-calibrated data accord to the values of the charts original units. It was stored on floppy discs and was additionally listed on paper with a 30 min resolution. Discs and listings were kept safely over more than 25 Years.

Due to this double save-keeping the whole dataset could be recovered, calibrated and tested for quality. If available, offset (*Offs*) and spread (*Spread*) of the temperature calibration (eq. 1) were determined by comparison of the time corrected raw-data ( $T_{\text{record}}$ ) to repeated readings of maximum, minimum and actual temperature of standardized maximum/minimum thermometers within the weather hut.

$$T_{\text{calib}} = (T_{\text{record}} - \text{Offs}) \cdot \text{Spread} \quad (\text{eq.1})$$

But the resulting values are constant only for a few weeks. For the periods with missing references, some simulated temperature readings were calculated from the records of the climate station 'Vernagtbach' (<http://doi.pangaea.de/10.1594/PANGAEA.775113>), but only during situations with physically definable vertical gradient. As a result, the calibrated temperature series from 'Gletschermitte' and 'Vernagtbach' remain a useful empirical basis to investigate the spatial interpolation of temperature within the Vernagtferner basin.

The calibration of the air humidity is a major task, as comparisons to measurements with an Assmann psychrometer were only performed during 4 hours on 10 August 1982. These comprise only a small range of values measured due to the weather conditions during the visits of the station. The evaluation results in a mean deviation of 22% between recorded and measured relative humidity.

In addition, the absolute range of the humidity measurements can be used for calibration. The correlation of the humidity time series of 'Gletschermitte' and 'Vernagtbach' shows a strong interrelationship between the fluctuations, similar to the strong correlation between the two surface temperature series. These characteristics are used to evaluate the physical quality of the measurements. Obviously the device at 'Gletschermitte' fails, if the humidity goes below a certain limit. Its absolute value may not be lower than the corresponding humidity measured at the station 'Vernagtbach', because there the air is warmer. The upper limit is determined by the conditions with saturation, which can be clearly detected in the humidity record.

Interruptions in the time series were caused by several reasons. When the paper chart got wet, the ink was smeared over the paper and made it therefore impossible to read the recorded da-

ta. Batteries ran low and stopped the rotation of the paper chart. The recording paper was scrunched up in the device, and snow was sometimes blown into the Stevenson screen.

In spite of all these problems, summer (and sometimes even winter) records of many years could be retrieved from the BTW paper chart devices with an estimated accuracy of 0.1 to 0.5 K for air temperature and 5% to 10% for relative humidity by diligent calibration and evaluation of the charts.

#### **4) Precipitation records**

On the station Gletschermitte, a Belfort analogue weighing gauge was run from 1977 to 1987. This device is discussed quite in detail in the 'Technical comments on the data records from the Vernagtbach station for the period 1970 to 2001 (doi:10.1594/PANGAEA.775113)'. Therefore, it has only to be mentioned here, that the records of this station were solely analysed on a daily basis, resulting in daily sums of precipitation, whereas the records of the Vernagtbach station could be provided to the Pangaea data base with a time step of one hour. The main reason for the larger time step lies in the more difficult temporal allocation of the 'Gletschermitte' records due to the less frequent visits on the higher station. No records are available for 1978 and 1982.

#### **5) Photographs**

In addition to the one on the Schwarzkögele (c.f. further details, paragraph 3.3 'Precipitation', doi:10.1594/PANGAEA.775113), a second 35 mm single lens reflex (SLR) camera was run at Station Gletschermitte during the summer months of the years 1981 until 1986. High resolution scans (4800DPI) of the original black and white negatives are available at the KEG.

These daily images of the eastern part of Vernagtferner were also used for the analysis of the precipitation type of those years. Besides, they show that the 'Gletschermitte climate station' at that time represented even more a 'real glacier station' than the 'Vernagtbach climate station' one km below the glacier tongue. This characteristic got lost continually with the shrinking of the Vernagtferner area since the 1990ies; in the meanwhile, one even does not have to cross the ice in order to reach the now considerable 'Nunatak', where the station was once mounted!

#### **6) Final remarks**

In spite of the difficult calibration of the records and the short periods of availability, we believe that it is worth while to publish these early data from the Vernagtferner region. They provide a view on selected climate parameters during a period with partly positive glacier mass balances and add to the knowledge of climate conditions in this high mountain region of the Alps.



*'Gletschermitte' station (1985) with Belfort precipitation gauge, the wind recorder according to Woelfle on top of the mast, the Stevenson screen containing the thermo-hydrograph and the minimum-maximum-thermometers. At the end of the horizontal beam the protective case with the camera is mounted. (Photo: M. Weber)*



*Panoramic view (1988) covering nearly 360° around the location of 'Gletschermitte' (Photo: M. Weber)*



*Surroundings of 'Gletschermitte' station, situated on an icefree rock isle in the western part of Vernagtferner in 1983 (Photo: O. Reinwarth)*



*Aerial oblique photograph from August 1987, the view is directed to the eastern lateral moraine, which is surmounted by the summits of Schwarzkögele and Plattekogel in the background. In the foreground the environment of 'Gletschermitte' is shown, which is embedded within the western parts of the Vernagtferner. (Photo: M. Weber)*



*Aerial photograph from 21 August 1987, which shows the rock island with the station 'Gletschermitte' (GM), located at the western end of the icefree rock barrier below the summit of Hochvernagtspitze (3535 m a.s.l.) (Photo: M. Weber)*