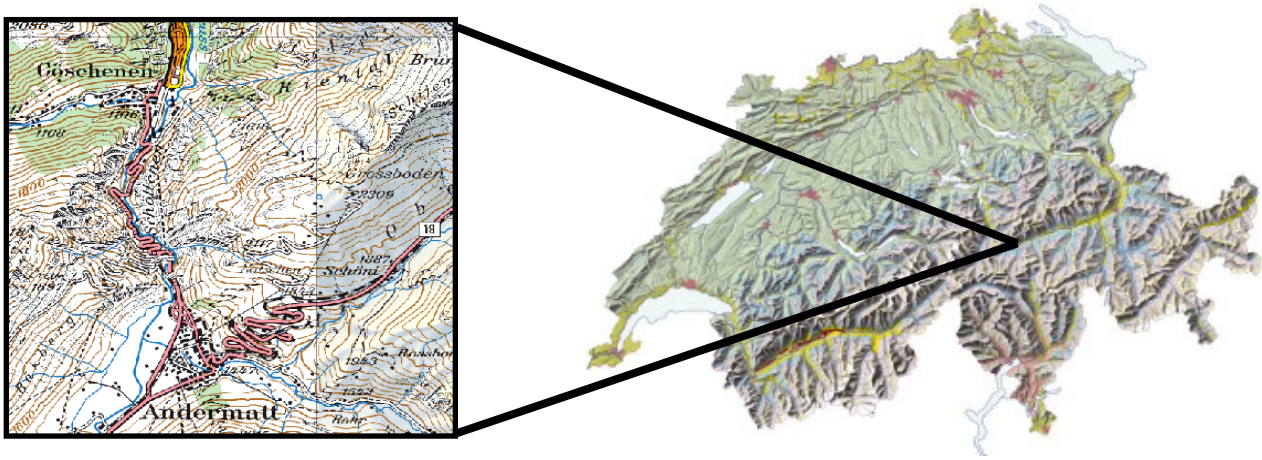
SITE

Name:	GUETSCH
Owner/operator	MeteoSwiss / Meteotest
Country	Switzerland
Geographical coordinates (°N, °E):	46.65 °N, 8.62 °E
Height (m a.s.l.):	2300
Weather station numbers LPNN/WMO:	6750

Orography



The Guetsch station is located in the middle of the Alps, in the Gotthard region above the village of Andermatt.

The first picture displays the general setup of the test facility, with the meteorological test station in the front, and the wind turbine facility in the background, at around 200 meters from the test station. Two 10 meters wind masts may be seen, the one at the back belonging to the official meteorological station of the Guetsch (METEK USA-1) which is located about 100 meters downward on the slope, while the second one at the front is connected to the test station (Rosemount Pitot tube). The second picture displays a close view of the 2 measurement bridges: the front one supporting the instruments which are to be tested while the second one at the back holds the standard reference meteorological instruments. The Data Acquisition systems are located in the enclosure which can be seen on the north side of the measurement bridges.

General and specific climatology over the measurement period

Table. Climatic monthly averages (30 years avg.) and monthly averages experienced during the test. T is air temperature, V is wind speed, GR is global radiation and N is the number of icing days (number of days with $T_{min} < 0$°C).

VALUE	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**March**	**April**
Clim T (°C)	2.1	-3.1	-5.5	-6.5	-6.9	-6.0	-3.7
Test T							
Clim Tmin (°C)	-0.5	-5.6	-8.1	-9.3	-9.5	-8.2	-5.7
Test Tmin							
Clim Tmax (°C)	6.0	0.1	-2.4	-3.8	-4.2	-3.3	-1.1
Test Tmax							
Clim Humidity	66.8	67.2	63.4	66.0	68.3	72.2	78.1
Test Humidity							
Clim V (m/s)	6.5	6.4	6.8	6.5	6.0	6.2	6.6
Test V (m/s)							
Clim GR (W/m^2)	112	78	61	74	119	180	229
Test GR (W/m^2)							
Clim N	14.7	26.3	29.5	30.8	27.9	30.3	28.1
Test N							

Meteorological test station

The meteorological station is presently equipped with 2 measurement bridges supporting the standard meteorological instruments and the instruments to be tested (back and front of the second picture displayed above). The infrastructure is designed to add easily two other similar bridges (e.g. in case of large scale measurement activities, e.g. international inter-comparisons) or to install other types of instruments near the ground (rain gauges, ceilometers, present weather sensors, etc…) or at higher elevation with dedicated supplementary masts.

A rugged camera system (extra heating) is installed on one of the wind masts and allows for panorama views of the surrounding as well as zoomed pictures of the instruments providing valuable information on the icing rates. Pictures taken in specific directions are further used for monitoring the visibility by aiming at specific targets located at different distances. A complete picture set is taken every 10 minutes, but the camera is moved constantly to avoid ice accretions on the rotating parts.

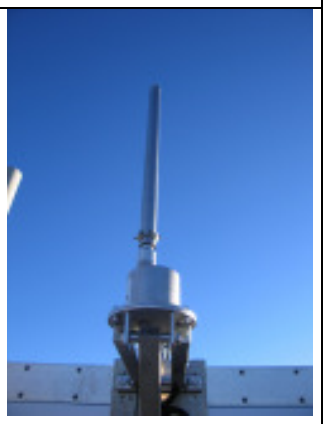
The enclosure for the data acquisition systems is located on the north side of the bridges.

Data from the camera and from the data acquisition system is transmitted through a dedicated fiber optic line to a nearby building located lower on the slope at about 200 meters distance.

Instruments

The manufacture and country, type, some characteristics and maximum heating power (MHP) of sensors operated at Guetsch are displayed in the following table.

Manufacture Country	Type	Principle of operation, Additional information	Picture
Metek, Germany	USA-1	• 3D Ultrasonic, time of flight. • The arms, the sensors and the vertical pole are heated. • The body unheated • The sensor also provides the (sonic) air temperature • Measuring range 0…60 m/s • Weight 0.7 kg • Operating temp. -30…+50 °C • MHP: 50 W	

Rosemount, USA	1774W	• 2D Pitot tube • Measures dynamic pressure of wind vs. atm. Pressure • Sensitive part (holes) are strongly heated • Measuring range 0..60 m/s • Operating temp. -30 …+50 ℃ • MHP: 360W	
Goodrich/ Rosemount, USA	0872J1	• Ice detector • Ultrasonic resonance • Duration of icing • MHP: 200 W,	
Goodrich, USA	0872E3	• Freezing Rain detector • MHP: 415 W • Designed to measure the intensity and duration of ice storms and differentiates rain from freezing rain as temperatures approach freezing.	
Combitech, Sweden		• Vertically mounted rod • The rod is a cylinder (pipe with a top cover) placed on top of a rod supported by a load cell for weighing. • The cylinder can freely rotate when ice builds up to obtain a cylindrical ice build up which is detected by the load cell as a vertical force. • The bearing for the rod is heated (via a thermostat) to secure the weighing function. • MHP:	

HoloOptics, Sweden	T26	• Patented digital optronic ice indicator • IR emitter • Photo detector • Probe changing its optical properties if covered with any kind of ice.	
Vaisala, Finland	Ceilometer CT25k	• Unique single-lens optical design • Measurement range up to 7.5 km (25,000 feet) • Reports up to three cloud layers simultaneously • Operates reliably in all weather • Approved by the FAA	
Meteolabor, Switzerland	THYGAN	• Ventilated temperature • Dew point temperature with chilled mirror • Computes relative humidity	

Data acquisition system of the meteorological station

The Data Acquisition System consists of 2 Automatic Data Acquisition Systems ADAS (Telvent/Almos, AMS220) similar to the standard stations of the SwissMetNet. The ADASs provide ports for the connections of all types of meteorological instruments (A/D conversion, serial inputs, etc.). For the test station, additional boards have been added in order to connect all the sensors which have to be tested under harsh conditions, either for future integration in SwissMetNet or for specific applications such as COST-727.

The first ADAS is used for reference measurements of the standard meteorological parameters:

- Wind (Rosemount Pitot tube 1774W)
- Pressure (Vaisala PTB220)
- Temperature & Humidity (Meteolabor THYGAN, Rotronic Hygroclip)
- Radiation shortwave (K&Z, CM21)

- Radiation longwave (K&Z, CG4)
- Cloud height and amount (Vaisala CT25K)
- Precipitation detector (Thies, xxxx)
- Precipitation amount (Lambrecht 1518H3)

All instruments are either ventilated or heated or both in order to yield the best possible quality of these meteorological reference instruments

The sampling frequency is 1 Hz for most of the instruments. The integration time is 10 minutes. The data are transferred immediately to the test server located at Payerne, Switzerland.

The second ADAS is dedicated to special measurements and among others to the COST-727 instruments:

- Combitech IceMonitor
- Goodrich Rosemount ice detector
- Goodrich Rosemount freezing rain detector
- HoloOptics T26

The second ADAS works similar to the first unit. Both units are monitored on-line (high speed internet connection) from the National Competence Center located at Payerne. Dedicated plausibility tests are applied continuously on the data (Quality Control level 1)

The data are stored on the local system (memory capacity for 28 days) as well as on the test server. The bulletins are archived.

The bulletins are sent in parallel to a dedicated DataMart which store them for the last 3 months: these data are therefore available on line for daily Quality Control (Quality Control level 2) and dedicated, specific evaluations.

Wind turbine

An Enercon E-40 600kW wind turbine with a hub height of 50 m and an integrated blade heating system is installed approximately 150 m north-west of the met station. This wind turbine is monitored for its performance under icing conditions. The following parameters are available from the wind turbine:

Operational data

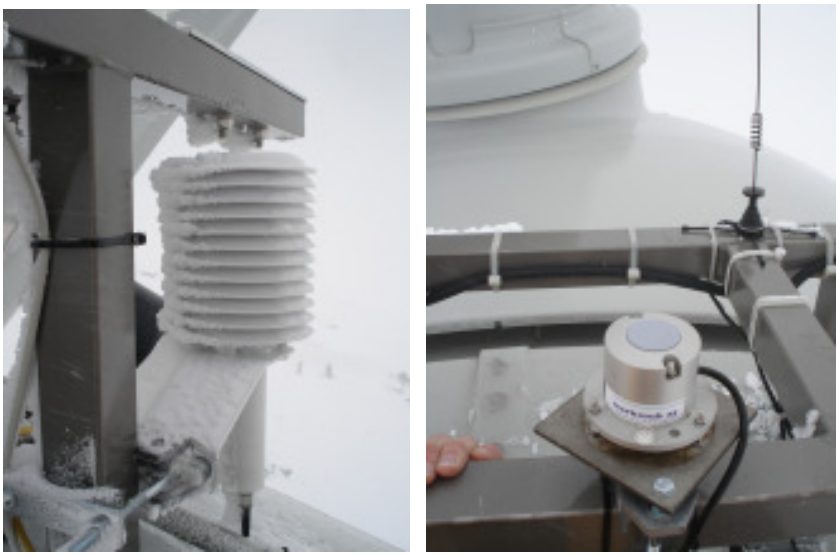
Data acquisition system: ENERCON Scada
Integration time: 10 minutes
Available Parameters:

- produced power
- wind speed at hub height (Thies 2D-Sonic Anemometer)
- position of nacelle
- ambient temperature at hub height (resolution only 1°C)
- air temperature inside the blades (resolution only 1°C)

Additional measurements at nacelle (50 m agl)

Data acquisition system: Campbell CR10X
Integration time: 10 minutes
Available Parameters:

- ambient temperature (Rotronic MP101A)
- relative humidity (Rotronic 101A)
- incoming longwave radiation (Kipp & Zonen CG3)



Left picture: Rotronic MP101A, right picture: Kipp & Zonen CG3

Camera observation

The Thies Ultrasonic anemometer as well as the rotor blades are constantly (every 30 minutes) monitored with Mobotix M12-Secure Webcams.

Left: image of Thies Ultrasonic anemometer on nacelle of the wind turbine. Right: image of rotor blade.

MEASURED DATA

Recorded values of parameters are associated with a date and time stamp.

Parameters:

	Unit	Resolution	Averaging	Remark
Wind speed	m/s	0.1 m/s	10’	
Wind direction	°	1°	10’	
Temperature	°C	0.1 °C	10’	
Dew point	°C	0.1 °C	10’	
Humidity	%	1%	10’	
Solar radiation	W/m^2	0.1 W/m^2	10’	
IR Radiation	W/m^2	0.1 W/m^2	10’	
Ice load	Kg	0.001 Kg	10’	
Ice detection	Seconds/10’	1’’	10’	
Cloud height	meter	m	10’	
Cloud amount	octa	1 octa	10’	