3.2 Sites E-G: (MCR-Lab, University of Basel)

Micrometeorological measurements were carried out at six sites which were located on the westward slope of the Riviera valley and formed the upper part (between 800 and 2000 m) of the valley transect (see Tab. 3.2-I and Fig. 2.3). The main measurement period was during August and September 1999. An overview on data availability for all stations is given in Fig. 3.2-1.

Tab. 3.2-I: Coordinates and heights of sites E-G (see also map in Fig. 2.3).

Site name		height a.s.l. (m)	coordinates	
Roasco	E1	1060	46°16'00"N	9°02'14"E
Monte Nuovo	E2	1030	46°16'14"N	9°02'11"E
Alpe Domàs	F1	1750	46°16'12"N	9°03'19"E
Alpe di Gagèrn	F2	2110	46°16'22"N	9°03'39"E
Alpe di Motto	F3	1860	46°16'19"N	9°03'11"E
Censo	G	870	46°16'27"N	9°01'54"E

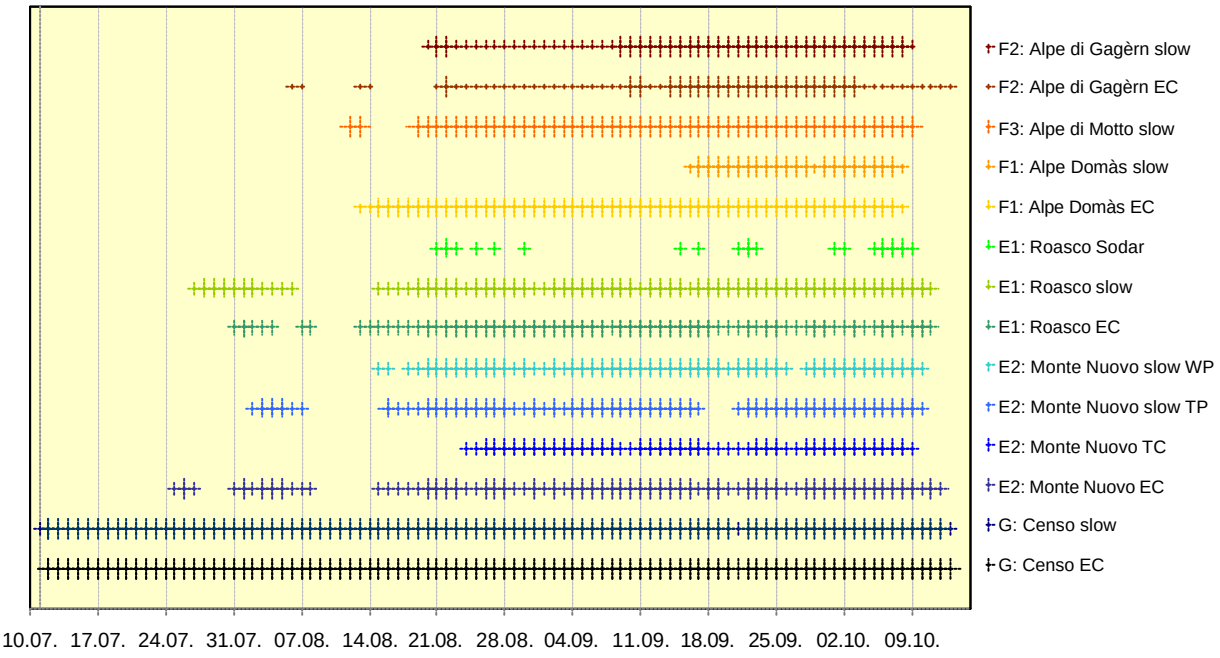

Fig. 3.2-1: Overview on data availability at stations E to G. Large markers: whole day available. Small markers: Only part of the day available. EC = eddy covariance, "slow" means measurement of temperature, humidity, wind speed and components of net radiation. Different set-ups at different stations. WP = wind profile, TP = temperature profile, TC = thermocouple profile. Stations are grouped according to height.

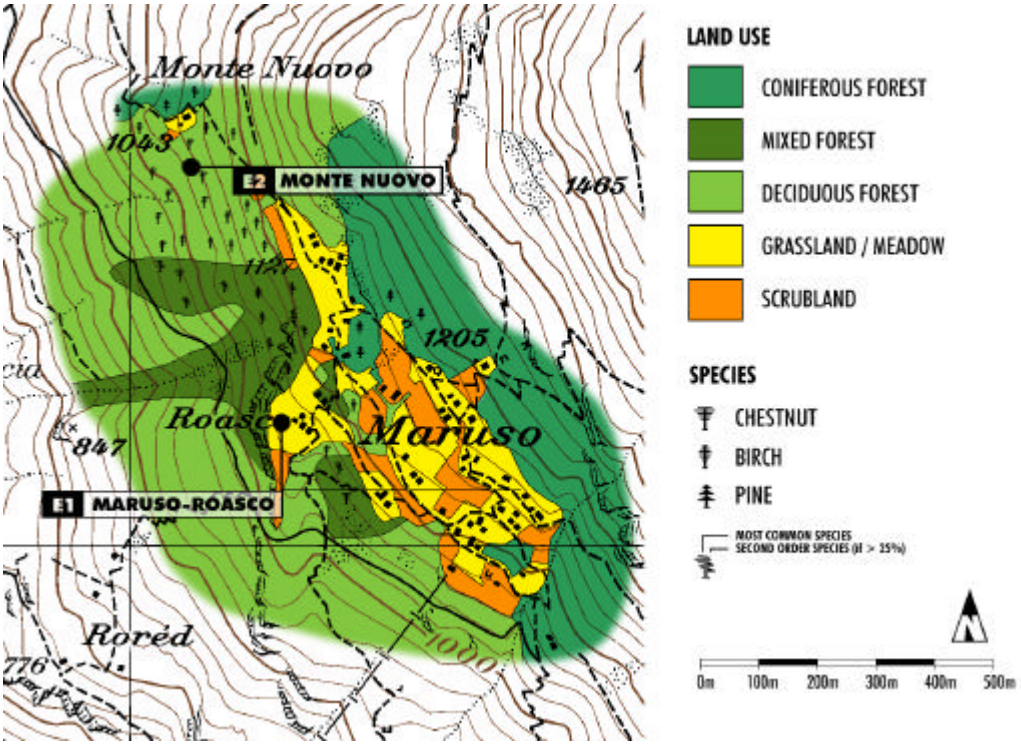

Fig. 3.2-2: Map of surrounding at stations *Monte Nuovo* and *Roasco*. Base Map: Carta Nazionale della Svizzera 1314 1:25'000, 1998, © Bundesamt für Landestopographie 2000 (JD002102).

E1: Maruso-Roasco

Roasco is a little spot SW of the small village *Maruso*, and lies 1060 m above sea level. The village is inhabited during summer months only; and nowadays it is mainly used for recreation.

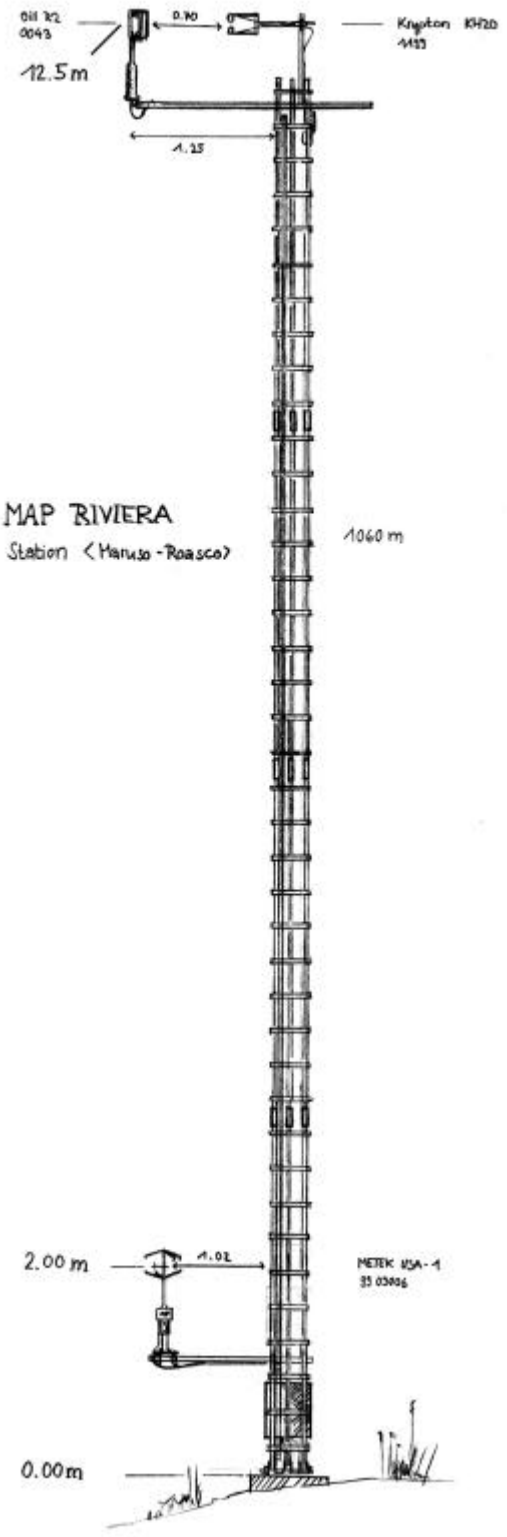

Fig. 3.2-3: Top: view on measuring site and the set-up of the radiation measurements. Bottom right and left: view of the EC mast that was mounted in *Roasco*. Right: Sketch of the tower at *Roasco*.

A 12 m mast was mounted close to an approximately 5m high rock wall on a grass field in the western part of *Roasco*. Two sonic anemometer-thermometers were fixed to the mast. A Metek USA1 was installed 1.5 m above ground at a 1m boom directed southward. On top a Gill R2 was mounted at a 1.2 m boom together with a Krypton hygrometer. Raw data were stored via serial ports on a PC. Details of instrumentation can be found in Tab. 3.2-II and in Fig. 3.2-3. From Fig. 3.2-2 it is obvious, that the mast is in a rather heterogeneous surrounding. Inclination and vegetation varied: westward, downhill, the forest bordered on a rock wall. Eastward, uphill, the slope was only 15° and after about 50 m of grassland the slope (now 35°) was covered with forest again. The radiation measurements were located 30 m ENE from the tower. All components of the radiation balance were measured slope-parallel as well as horizontal. A SODAR was installed 30 m south of the mast in an enclosure of 2 m height (see section 4.6).

Tab 3.2-II: Overview on measurements and instrumentation at site E1, *Maruso-Roasco*.* = Measurements of ETHZ (Hydrology).

variable	height above tow. base (m)	instrument	serial number	sampling interv. (s)	averaging period (s)	output	calibration
u, v, w, t	2.0	Metek USA-1	9903006	0.1	raw data	(m s^{-1}),(K)	wind tunnel
water vapour density fluctuation	12.7	KH2O	1199	0.05	raw data	(g m^{-3})	manufacturer
u, v, w, t	12.7	Gill R2A	43	0.05	raw data	(m s^{-1}),(K)	wind tunnel
precipitation	1.5	Campbell ARG100	n/a	2	60	(mm)	manufacturer
pressure	-	Vaisala PTB100B	n/a	2	60	(hPa)	manufacturer
long-wave radiation (horizontal)	1.59	Eppley PIR	30323f3	2	60	(W m^{-2})	
long-wave radiation (horizontal)	0.95	Kipp & Zonen CG2	970042	2	60	(W m^{-2})	reference instruments
short-wave radiation (horizontal)	1.64	Kipp & Zonen CM21	910004	2	60	(W m^{-2})	
components of radiation balance (slope-parallel)	1.2	Kipp & Zonen CNR1	980080	2	60	(W m^{-2})	reference instruments
short-wave radiation (horizontal)	1.1	Kipp & Zonen CM11	903185	2	60	(W m^{-2})	reference instruments
soil temperature	-0.27 -0.12	Campbell CBT	6 2	2	60	(°C)	manufacturer
soil humidity*	-0.15 to -0.25	TDR	-	3600	3600	(Vol-%)	manufacturer
leaf humidity*	0.1		-	3600	3600	(%)	manufacturer

E2 Monte Nuovo (Birke)

The site of observation was located 100 m South of a little clearing called *Monte Nuovo* on a slope with a westward exposition and an inclination of ≈35°. A 22 m mast was mounted in a roughly 13 m high forest which mainly consisted of birch trees. Other species were chestnut, and few beech trees as well as hazel. The forest floor was covered with sparse understorey vegetation, mainly grass with heights up to 0.3 to 0.4 m.

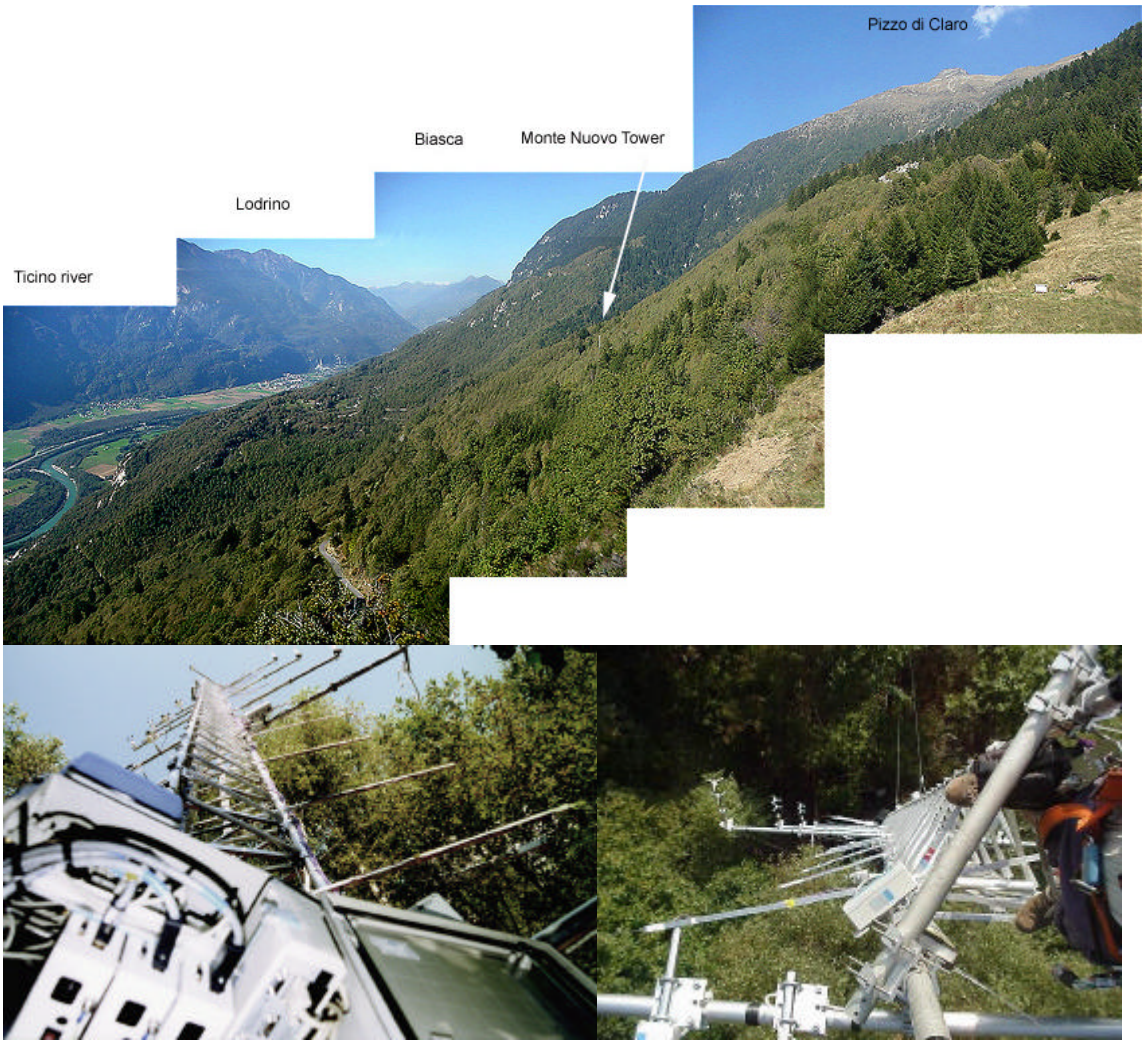

Fig. 3.2-4: Top: view on the slope with *Monte Nuovo* in the centre. Below left and right: bottom up and top down view of the tower at *Monte Nuovo*.

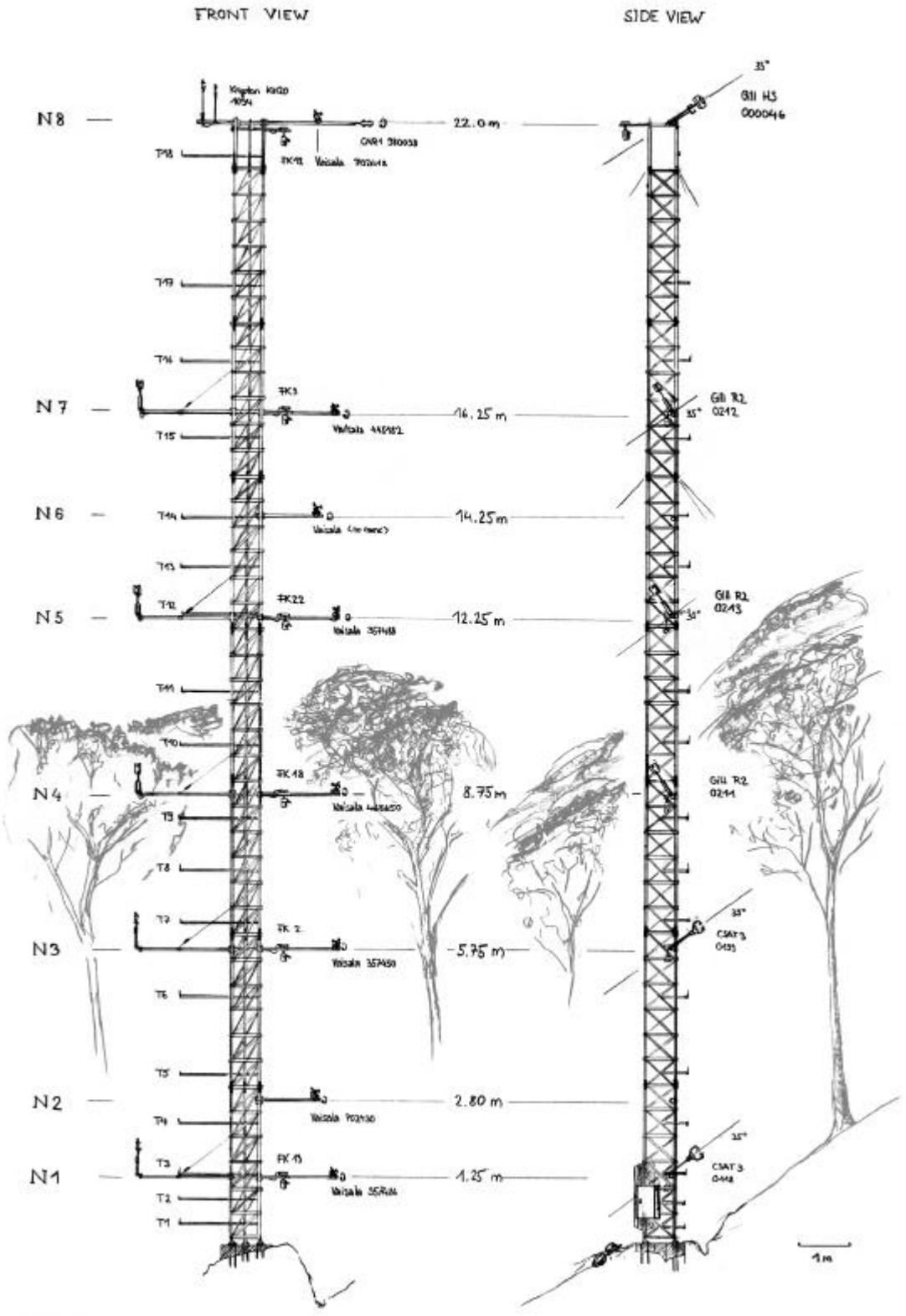

Fig. 3.2-5: Sketch of tower at *Monte Nuovo*. Down valley and side view.

The mast was in the middle of a relatively "homogeneous" part of the slope. Up- and downhill a kind of fetch was around 150 to 200 m. The same type of more or less homogeneous surface conditions, both in terms of tree height and species, were prevailing 100 m slope-parallel to the North and South. Figure 3.2-4 gives an idea of that "homogeneous" part of the slope.

The mast supported a profile of sonics, profile measurements of wind speed, temperature and humidity, and a high resolution profile of thermocouples. On top a net pyrradiometer was installed slope-parallel and measured the long- and short-wave components of net radiation. Details of the equipment are listed in Tab. 3.2-III and can be seen in Fig. 3.2-5.

Tab 3.2-III: Overview on measurements and instrumentation at station E2 *Monte Nuovo*.

variable	height above tow. base (m)	instrument	serial number	sampling interv. (s)	averaging period (s)	output	calibration
water vapor density fluctuation	22.68	Krypton KH_2O	1094	0.05	raw data	($g\ m^{-3}$)	manufacturer
u, v, w, t	22.68	Gill HS	000046	0.05	raw data	($m\ s^{-1}$),(K)	wind tunnel
u, v, w, t	16.82	Gill R2	0212	0.05	raw data	($m\ s^{-1}$),(K)	wind tunnel
u, v, w, t	12.82	Gill R2	0213	0.05	raw data	($m\ s^{-1}$),(K)	manufacturer
u, v, w, t	9.32	Gill R2	0211	0.05	raw data	($m\ s^{-1}$),(K)	manufacturer
u, v, w, t	6.34	CSAT	0199-2	0.05	raw data	($m\ s^{-1}$),(K)	wind tunnel
u, v, w, t	1.84	CSAT	0118-2	0.05	raw data	($m\ s^{-1}$),(K)	wind tunnel
components of radiation balance (slope-parallel)	22.00	Kipp & Zonen CNR1	098	4	60	($W\ m^{-2}$)	reference instruments
temperature humidity	22.0, 16.25, 12.25, 8.75, 5.75, 1.25	psychro-meter	FK12, FK09, FK22, FK18, FK??, FK13	4	60	(°C) (%)	water bath
wind speed	22.00, 16.25, 14.25, 12.25, 8.75, 5.75, 2.8, 1.25	Vaisala WAA15	P02418 445182 n.a. 357488 468650 357450 P02430 357486	1	60	($m\ s^{-1}$)	manufacturer
temperature fluctuations (18 levels)	21.27, 18.77, 17.27, 15.77, 14.27, 13.27, 12.27, 10.77, 9.77, 8.27, 7.27, 6.27, 4.77, 3.27, 2.27, 1.27, 0.77, 0.27	Thermo-couple	-	0.5 to 4	0.5 to 4	(°C)	no

F1 Alpe Domàs

At *Alpe Domàs* a station was put up in a avalanche track at 1750 m a.s.l.. Trees within the track had an average height of 8m and were rather sparse: The slope was exposed towards 216° with an inclination of 27.5°. The width of the track was ≈100 m and it was bordered by spruce forest.

Fig. 3.2-6: View uphill towards *Alpe Domàs*.

On top of the tower a sonic anemometer was mounted. Temperature fluctuations were measured with a thermocouple. One minute averages of first and second moments were stored on a Campbell 21X logger. At three heights wind speed, temperature and humidity were measured. The cup anemometers were fixed in 1 m distance from the mast. Furthermore the net radiation was measured with a pyrradiometer. Two heat flux plates were installed to get the soil heat flux and soil temperature were sampled with four thermistors. A view on the avalanche track is given in Fig. 3.2-6 and details of measurements and set-up can be found in Tab. 3.2-IV and Fig. 3.2-7.

Tab 3.2-IV: Measurements and instrumentation of station F1, *Alpe Domàs.*

variable	height above tow. base (m)	instrument	serial number	sampling interv. (s)	averaging period (s)	output	calibration
u, v, w, t	6.3	Gill Enhanced	009	0.2	60	(m s^{-1}),(K)	manufacturer
net radiation horizontal	2.0	Ph. Schenk Mod. 8111	8477	2	60	(W m^{-2})	reference
soil heat flux	-0.02	HFP	65638 65640	2	60	(W m^{-2})	manufacturer
soil temperature	-0.02, -0.05, -0.1, –0.15	Campbell CBT		2	60	(°C)	manufacturer
temperature humidity	2.0 3.0 5.0	Vaisala HMP35AC	424129 394832 394828	2	60	(°C) (%)	manufacturer
wind velocity	2.0 3.0 5.0	Vaisala WAA15	n/a 445200 357476	2	60	(m s^{-1})	manufacturer

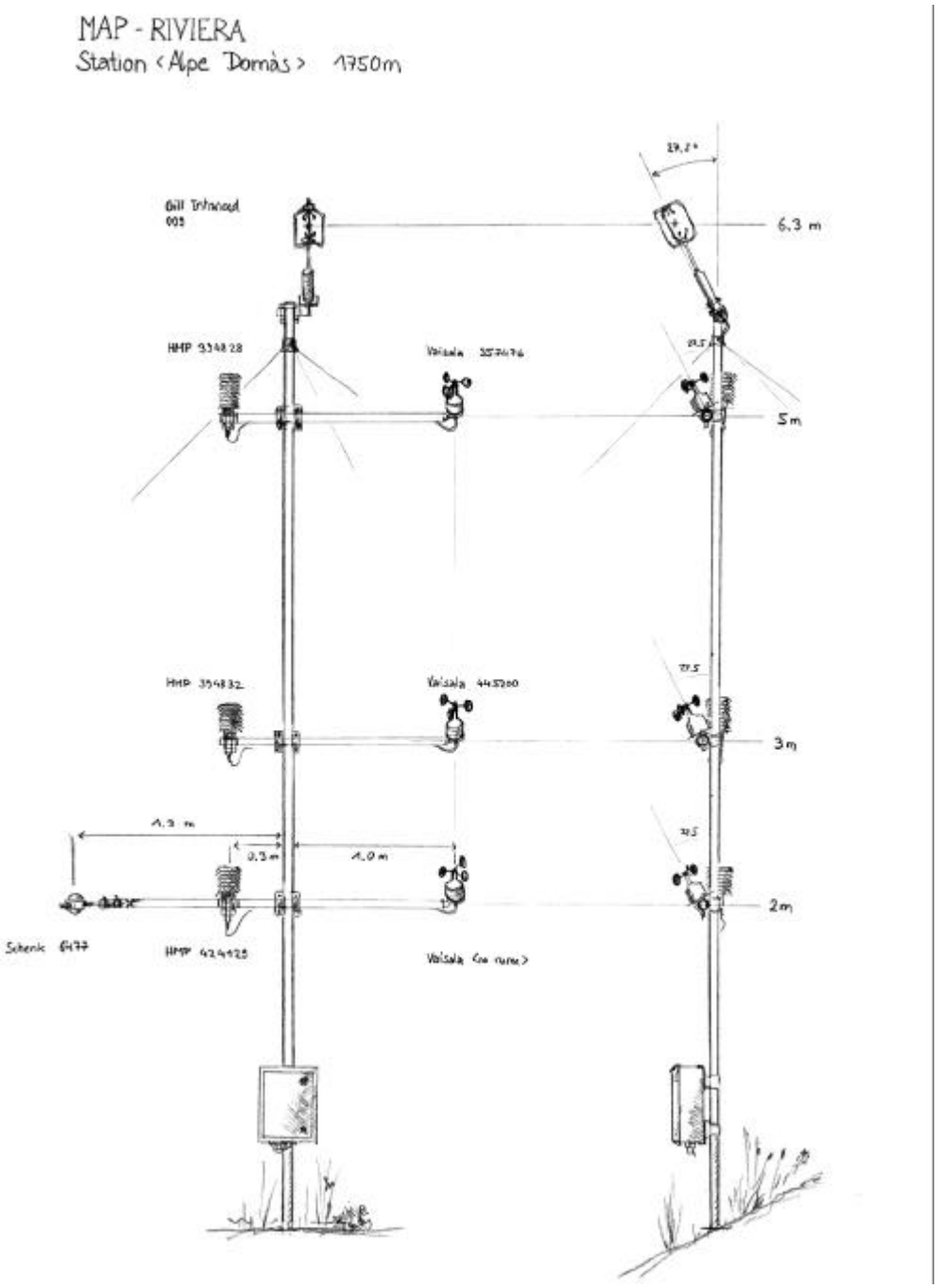

Fig. 3.2-7: Sketch of tower at *Alpe Domàs*. Down valley and side view.

F2 Alpe di Gagèrn (Krete)

The measurement tower was situated South of *Alpe di Gagèrn* 2110 m a.s.l.. This topmost site lay roughly 75 m below the crest on a slightly terraced part of the slope. The latter had an inclination of 40° on average and was exposed towards 240°. The tree line lay 300 m below the measuring site. The alpine vegetation was dominated by scrubs and alpine herbs. The plant cover was interspersed with rocks.

The instruments were mounted on a 11 m high tower. Two ultrasonic anemometer-thermometers measured the components of the wind vector as well as the temperature fluctuations at two heights. The sonics were mounted perpendicular to the slope. The upper sonic was mounted directly onto the mast whereas the lower one was fixed on a 2m boom in westward direction. From August 8, until September 9, raw data (20.83 Hz) were stored synchronously on a PC. From September 9 until October 10, 1 min averages of first and second moments were sampled using a Campbell 21X logger. Net radiation was measured at 2 m height. One set-up measured all components of net radiation parallel to the slope,

Fig. 3.2-8: Top: view South from Pizzo di Claro towards *Alpe di Gagèrn*. Bottom left: view on site F2 *Alpe di Gagèrn*. Bottom right: boom carrying radiation instruments.

another set-up measured horizontally exposed global and reflected global radiation. At three heights temperature and humidity measurements were carried out. Soil heat flux was measured directly with three heat flux plates and the soil temperature was sampled in four different depths. Additionally pressure and precipitation were measured. A view on the site is given in Fig. 3.2-8 and details of measurements and set-up can be found in Tab. 3.2-V and in Fig. 3.2-9.

Tab 3.2-V: Overview on measurements and instrumentation at station F2 *Alpe di Gagèrn*.

variable	height above tow. base (m)	instrument	serial number	sampling interv. (s)	averaging period (s)	output	calibration
u, v, w, t	3.10/1.90	Gill R2	0208	0.05/0.2	0.05/60	(m s^{-1}),(K)	manufacturer
u, v, w, t	-/11.00	Gill R2	0160	0.05/0.2	0.05/60	(m s^{-1}),(K)	wind tunnel
precipitation	1.50/1.50	RIMCO	206185	4	60	(mm)	manufacturer
pressure	1.00/1.00	Vaisala PTP101	T2430015	4	60	(hPa)	manufacturer
shortwave radiation horizontal	2.10/1.90	Kipp & Zonen CM21	950239	4	60	(W m^{-2})	
components of radiation balance (slope-parallel)	2.15/1.90	Kipp & Zonen CNR1	142	4	60	(W m^{-2})	reference
shortwave radiation horizontal	1.93/2.00	Kipp & Zonen CM11	902804	4	60	(W m^{-2})	
soil heat flux	-0.04 -0.04 -0.06	HFP	G0057 HP365628 G0050	4	60	(W m^{-2})	manufacturer
soil temperature	-0.03 -0.05 -0.10		CBT2 CBT8 CBT10	4	60	(°C)	manufacturer
temperature humidity	0.7/ 0.6 2.2/2.0 -/10.6	Vaisala HMP35A	476730 424125 424142	4	60	(°C) (%)	manufacturer

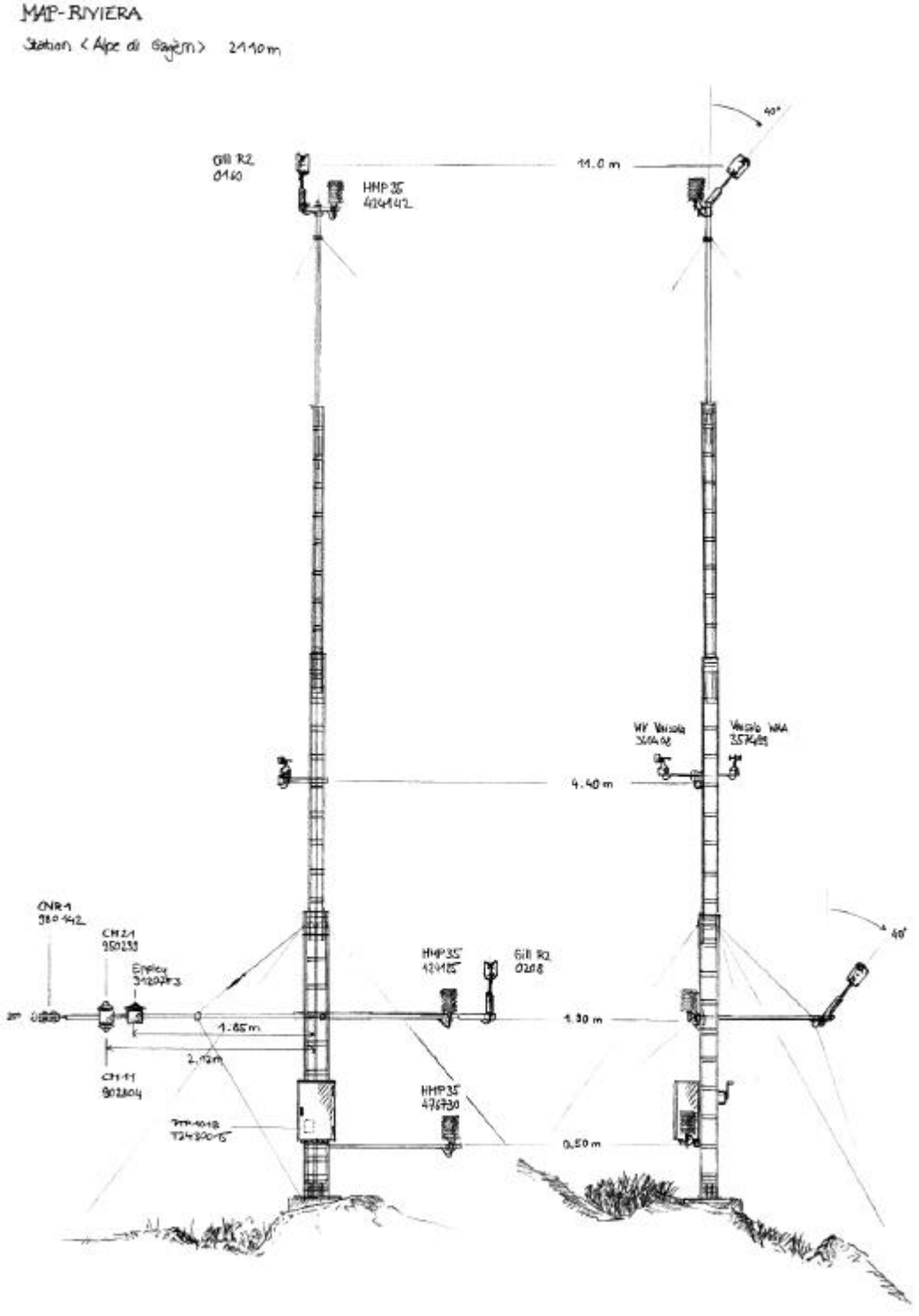

Fig. 3.2-9: Sketch of tower at *Alpe Gagèrn*. Down valley and side view.

3 Alpe di Motto

A small station was set up on *Alpe di Motto* at 1860 m a.s.l. to monitor wind velocity and wind direction wind vane. Net radiation was measured with a pyrradiometer. Details are listed in Tab. 3.2-VI and the set-up can be seen in Fig. 3.2-10.

The station was situated on a SW oriented ridge which lies between *Alpe Domàs* and the station *Alpe di Gagèrn*.

Tab 3.2-VI: Overview on measurements and instrumentation at station F3 *Alpe di Motto*.

variable	height above ground (m)	instrument and serial number	sampling rate/averaging period (s) and output	calibration
wind speed	2.2	Young MCR-035	3/60 (m s^{-1})	manufacturer
wind direction	2.2	Young MCR-035	3/60 (°)	manufacturer
net radiation	1.7	Ph. Schenk Mod. 8111	3/60 (W m^{-2})	reference

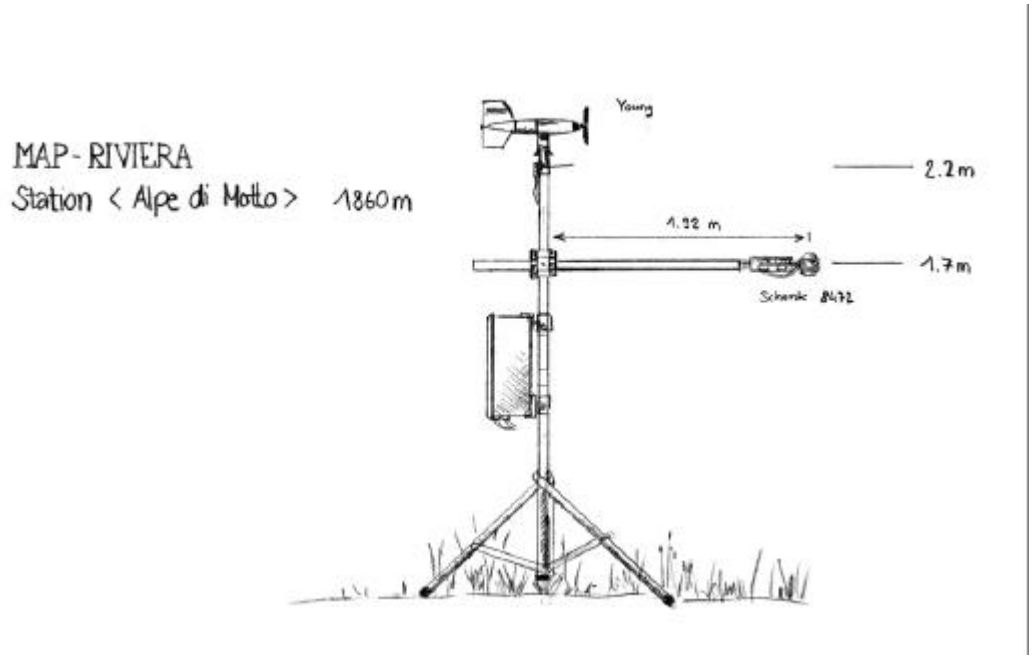

Fig. 3.2-10: Sketch of set-up at *Alpe di Motto*

G Censo (Kerbtal)

The station *Censo* was built on a bridge which crosses a river at a narrow point of the valley. The catchment area is about 4 km^2 and is covered with forest (mainly chestnut and birch). The valley cross-section at the bridge has a depth 12 to 15 m and its width is 15 to 17 m.

The wind vector was monitored with a sonic anemometer which was mounted on top of the mast at a height of 5.25 m above the bridge and ≈18 m above the bottom of the valley. Additionally the temperature fluctuations were measured with a thermocouple (75 µm). First and second moments were stored as 1 min averages. Furthermore temperature, humidity and the scalar wind speed were measured at two heights above and below the bridge (3.05 and 2.10 m). The latter were sampled by a Campbell CR10, and the eddy covariance measurements by a Campbell 21X. Details are listed in Tab. 3.2-VII and the set-up can be seen in Fig. 3.2-11.

Tab 3.2-VII: Overview on measurements and instrumentation at station G, *Censo*.

variable	height above tow. base (m)	instrument	serial number	sampling interval (s)	averaging period (s)	output	calibration
u, v, w	5.25	Gill Enhanced	n/a	0.2	60	(m s^{-1})	manufacturer
t‘	5.25	thermo-couple	-	0.2	60	(K)	-
wind speed	3.05	Vaisala WAA15	357399	1	60	(m s^{-1})	manufacturer
wind speed	-2.1	Vaisala WAA15	436021	1	60	(m s^{-1})	manufacturer
temperature/humidity	3.05	Vaisala HMP35A	476728	1	60	(°C), (%)	manufacturer
temperature/humidity	-2.1	Vaisala HMP35A	476724	1	60	(°C), (%)	manufacturer

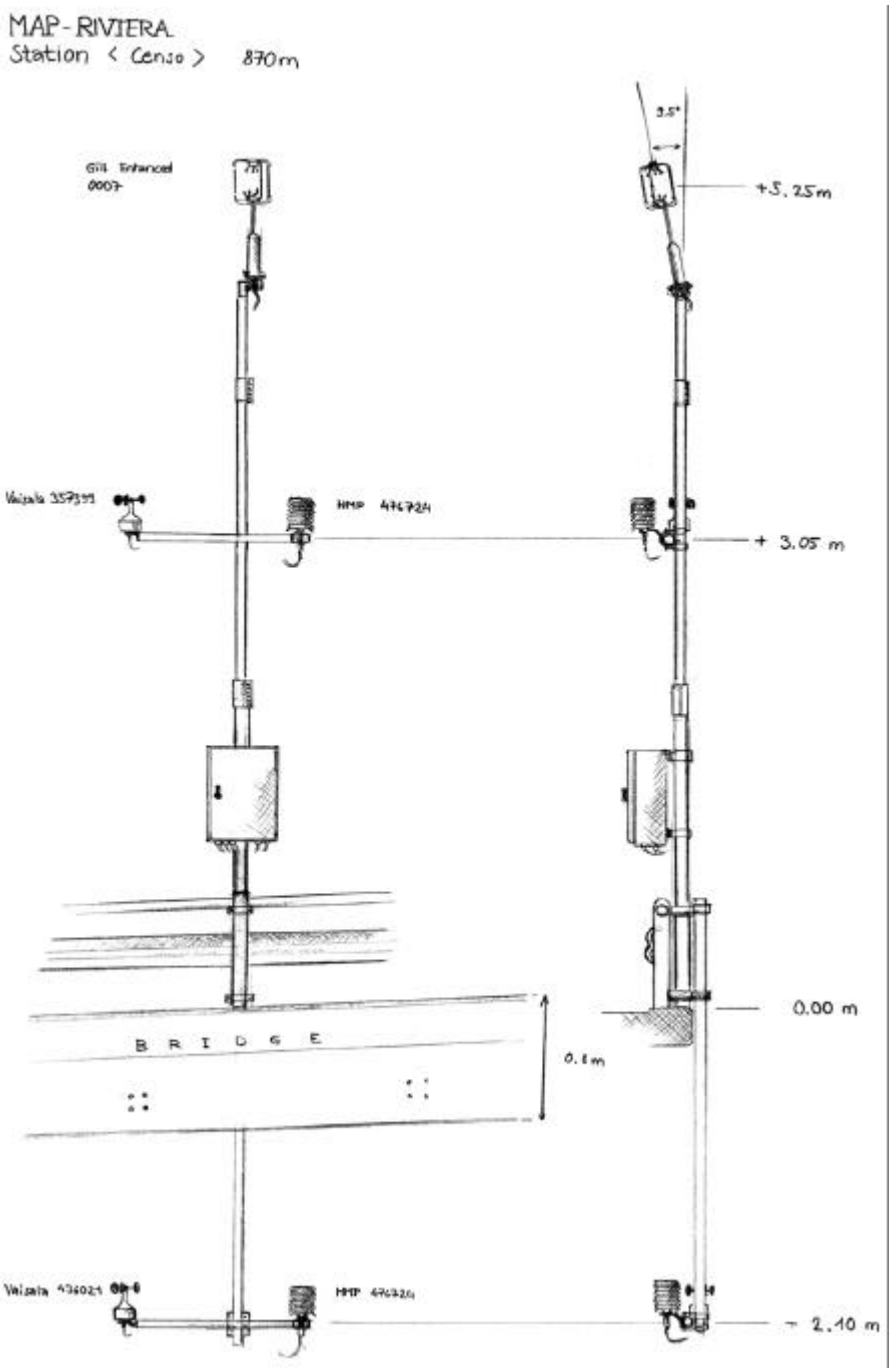

Fig: 3.2-11: Sketch of tower at *Censo*.