UNIVERSITY OF BAYREUTH

Department of Micrometeorology

COPS experiment
Convective and orographically induced precipitation study
01 June 2007 – 31 August 2007
Documentation

Stefan Metzger, Thomas Foken

**With contributions by Rafael Eigenmann,
Wolfgang Kurtz, Andrei Serafimovich, Lukas Siebicke, Johannes Olesch,
Katharina Staudt and Johannes Lüers**

Arbeitsergebnisse
Nr. 34
Bayreuth, September 2007

Arbeitsergebnisse, Universität Bayreuth, Abt. Mikrometeorologie, Print, ISSN 1614-8916
Arbeitsergebnisse, Universität Bayreuth, Abt. Mikrometeorologie, Internet, ISSN 1614-8924
http://www.bayceer.uni-bayreuth.de/mm/

Eigenverlag: Universität Bayreuth, Abt. Mikrometeorologie
Vervielfältigung: Druckerei der Universität Bayreuth
Herausgeber: Prof. Dr. Thomas Foken

Universität Bayreuth, Abteilung Mikrometeorologie
D-95440 Bayreuth

Die Verantwortung über den Inhalt liegt beim Autor.

Contents

1 Description of the experiment

Goal of the COPS experiment is to improve the Quantitative Precipitation Forecast (QPF) which has been stagnated during the last 16 years due to a lack of comprehensive, high-quality data sets usable for model validation as well as for data assimilation, thus leading to improved initial fields in numerical models. An Intensive Observations Period (IOP) is the backbone for the Priority Program SPP 1167 of the German Research Foundation (DFG) by producing the demanded data sets of unachieved accuracy and resolution (see Figure 1-1). The University of Bayreuth contributes with four energy balance stations (surface in-situ), a Sodar-Rass instrument and a 9m Mast, who's measuring arrangement is summarized below. An overview over the whole COPS-region gives Figure 1-2

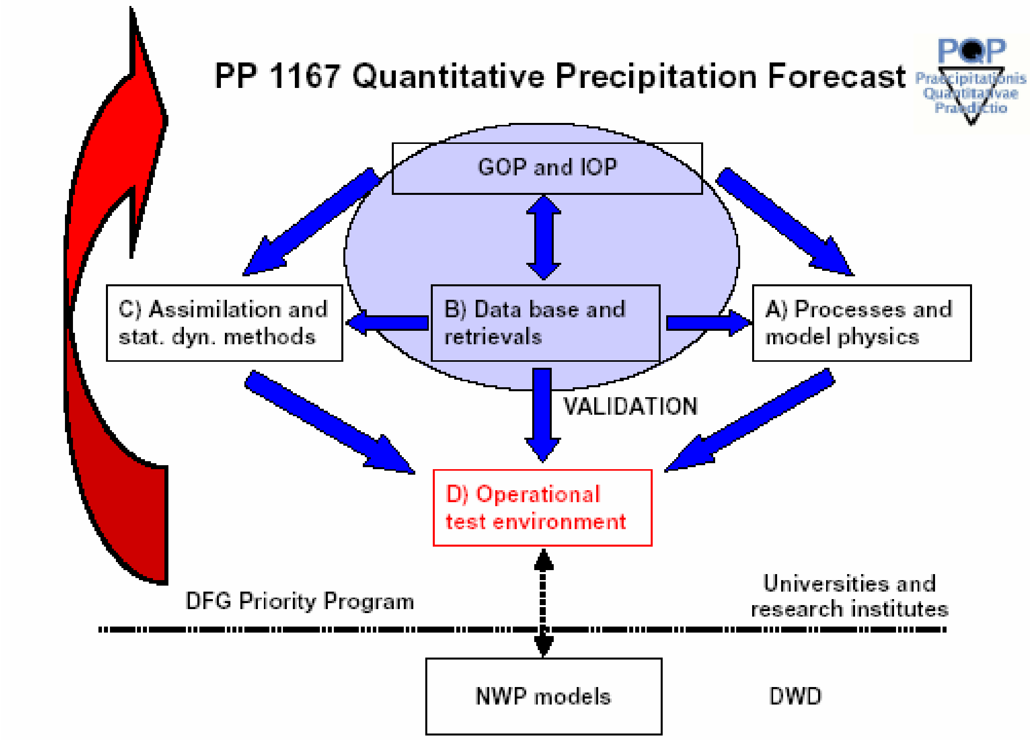


Figure 1-1: Structure of Priority Program 1167 Quantitative Precipitation Forecast -Praecipitationis Quantitativae Praedictio (PQP). GOP: General Observation Period, IOP: Intensive Observations Period : COPS.

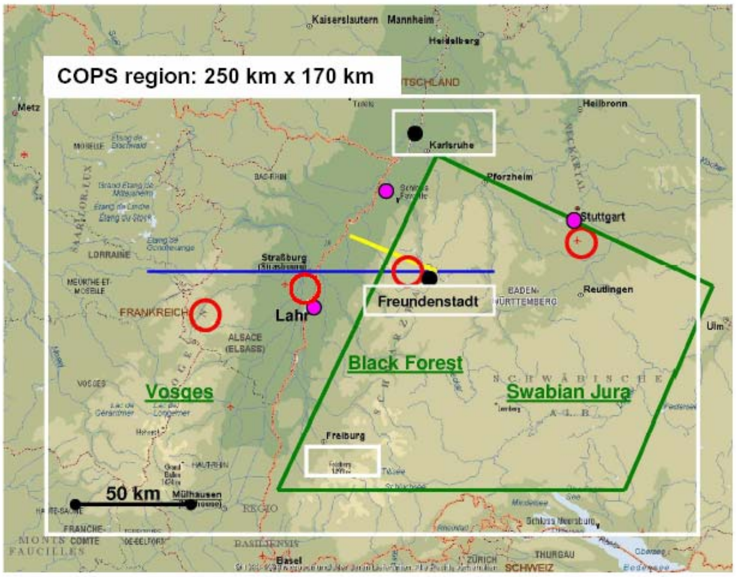


Figure 1-2: The most pronounced orographic feature in the COPS (= IOP) region is the Rhine valley between the Vosges and the Black Forest mountains. The red circles indicate the proposed supersites for the COPS field campaign. The thunderstorm climatology is valid for the green box including Black Forest and Swabian Jura.

Figure 1-3 shows a detailed segment of the region in the Kinzig valley with the measuring sites of the University of Bayreuth highlighted.

Figure 1-3: measuring sites of the University of Bayreuth; red pin: Fußbach I +II, green pin: Fischerbach, blue pin: Hagenbuch.

2 Experimental setup

Table 2-1: Coordinates of the measurements based on Ellipsoid WGS-84. Top: As obtained with the Garmin Emap GPS in UTM projection, accuracy 5-10m. Bottom: Longitude and latitude coordinates converted from UTM on http://pages.globetrotter.net/roule/utmgoogle.htm. Altitude information read off Google Earth.

UTM Zone 32U		
Measurement	**Easting [m]**	**Northing [m]**
BT01 EC	427608	5357758
BT01 Profile	427612	5357670
BT01 Radiation & soil	427598	5357675
BT0102 MBR / Scin send	427513	5357545
BT0102 Sodar Rass / Scin rec	427530	5357620
BT03	435628	5348076
BT04	440996	5347931

Google Earth Interface			
Measurement	**Latitude N [dms]**	**Longitude E [dms]**	**Altitude [m]**
BT01 EC	48° 22' 7.82"	8° 1' 21.17"	178
BT01 Profile	48° 22' 4.97"	8° 1' 21.42"	179
BT01 Radiation & soil	48° 22' 5.13"	8° 1' 20.73"	179
BT0102 MBR / Scin send	48° 22' 0.88"	8° 1' 16.68"	180
BT0102 Sodar Rass / Scin rec	48° 22' 3.32"	8° 1' 17.46"	180
BT03	48° 16' 57.4"	8° 7' 56.28"	226
BT04	48° 16' 54.59"	8° 12' 16.81"	245

Table 2-2: Radio module channel allocation for the data transmission of the turbulence systems.

	Campbell CR23X / Metek MBR		**Mini ITX**	
Measurement	Reception adress (S252)	Transmission adress (S256)	Reception adress (S252)	Transmission adress (S256)
BT01 EC	4	3	3	4
BT02 MBR	8	7	7	8
BT03 EC	6	5	5	6
BT04 EC	2	1	1	2

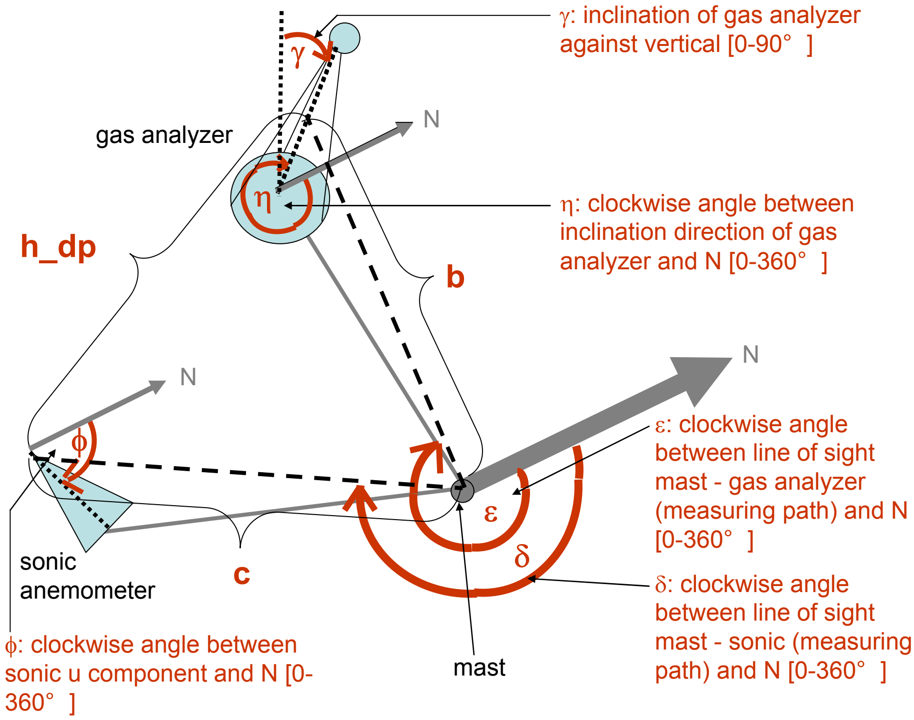


Figure 2-1: Conventions for the Eddy Covariance setup.

2.1 Fußbach I (BT01ETGS) and Fußbach II (BT02ETG)

Figure 2-2: Position of the stations Fußbach I +II.

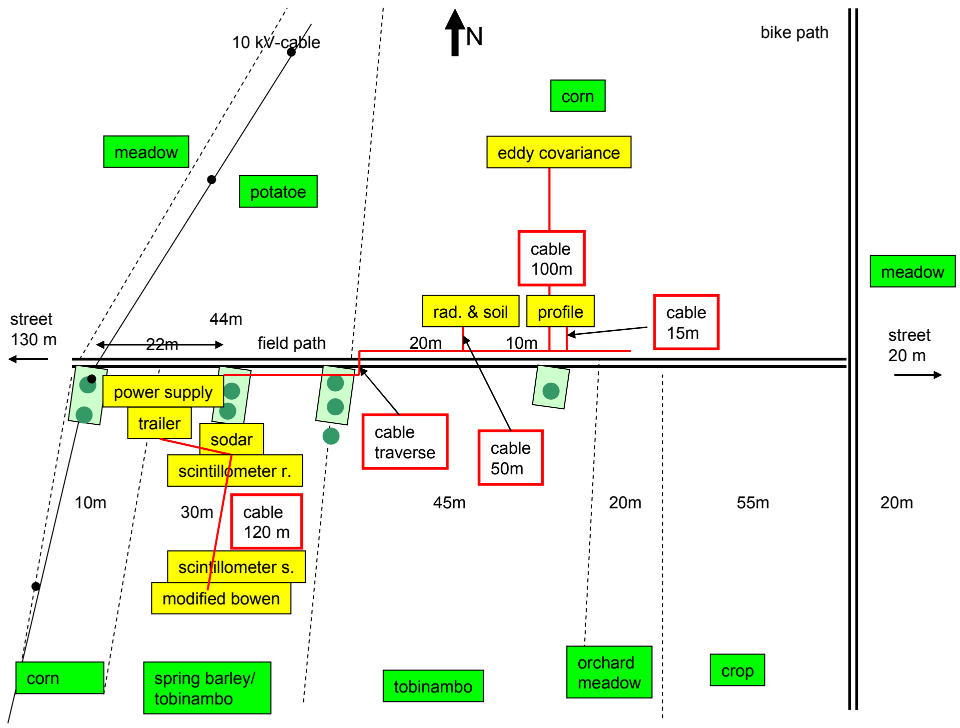


Figure 2-3: installation plan of the station Fußbach I +II.

2.1.1 Fußbach I (BT01ETGS)

Table 2-3: measurement and canopy heights, zpd: zero plane displacement for measurement heights 0.5m, 1m, 2m adjusted on the spot by means of a carriage.

date	height EC [cm]	height radiation[cm]	profile zpd [cm]	canopy height [cm]
2007-06-04			10	15
2007-06-06				29
2007-06-10	257	196	32	48
2007-06-26				120
2007-06-28	340	365	80	120
2007-07-02			100	150
2007-07-09	384		120	180
2007-07-16			160 (max.)	240
2007-07-18	425			
2007-07-23				275
2007-07-30		413		290
2007-08-06				290
2007-08-13				290
2007-08-20				290
2007-08-27				290

2.1.1.1 Turbulence measurement complex

Table 2-4: Turbulence measurement complex, mh := measurement height agl, v_dp := vertical displacement, h_dp := horizontal displacement, others see Figure 2-1.

parameter	instrument	serial	signal in	calibration factor	conversion in logger	signal out	mh / v_dp / h_dp [cm]	orientation	logger
Wind vector and sonic temperatur	CSAT3	0205-1 (Box), 0205-2 (Sensor)	runtime binary encoded	-	calculation in logger	wind vector [ms^{-1}]	see Table above / - / -	c=82cm δ=91° ϕ=88°	CR23X SN:1113
Humidity	LI7500	75B-1200	voltage	0-1500 mmol m^{-3} (0-5V)	linear interpolation according to calibration	[mmol m^{-3}]	see Table above / 0 / 29	b=64cm ε=73° γ=35° η=342°	CR23X SN:1113
CO2	LI7500	75B-1200	voltage	10-30 mmol m^{-3} (0-5V)	linear interpolation according to calibration	[mmol m^{-3}]	see Table above / 0 / 29	b=64cm ε=73° γ=35° η=342°	CR23X SN:1113

The Campbell logging program CSAT3_36.DLD (21.03.2003 15:01) has been utilized, the EC measurement output is resolved in 20Hz.

Table 2-5: configuration of CR23X, SN 1113

instrument	cable color	factor	connection
LICOR	brown	CO2-voltage	SE 7
LICOR	blue	H2O-voltage	SE 8
LICOR	black		ground
LICOR	white		ground
LICOR	red/black	External Power	G
LICOR	red/white	External Power	12 V
CSAT3	clear	Power out	12V
CSAT3	black	Power out	G
CSAT3	red		not connected
CSAT3	SDM Cable:		
CSAT3	black	between Power out and Control I/O	G
CSAT3	green	Control I/O	C1
CSAT3	white	Control I/O	C2
CSAT3	brown	Control I/O	C3
Power cable	grey	External Power	G
Power cable	red	External Power	12 V

2.1.1.2 Radiation and soil heat flux measurement complex

Table 2-6: Radiation measurement complex.

parameter	instrument	serial	calibration factor	conversion in logger	height/depth [cm]	orientation [°]	logger	channel
s_CM24_GLB	CM24	020955	0.1117 mV mW^{-1} cm²	10^6	see Table above	175	QLC V29218 external QLI2	CH08
s_CM24_REF	CM24	020956	0.1107 mV mW^{-1} cm²	10^6	see Table above	175	QLC V29218 external QLI2	CH09
s_PIR_GEG	PIR	32006F3	C=3.75 µV W^{-1} m^2	10^6	see Table above	175 until 2007-06-28, therafter 355	QLC V29218	CH02
			K1=-0.016				external QLI2	
			K2=0.9997					
			K3=3.056					
s_PIR_AUS	PIR	32007F3	C=3.94 µV W^{-1} m^2	10^6	see Table above	175 until 2007-06-28, therafter 355	QLC V29218	CH03
			k1=0.016				external QLI2	
			k2=1.0006					
			k3=2.842					
Body up	PIR	32007F3	see Table below	10^3	see Table above	-	external QLI2	CH04+
Body down	PIR	32007F3	see Table below	10^3	see Table above	-	external QLI2	CH04-
Dom N	PIR	32007F3	see Table below	10^3	see Table above	-	external QLI2	CH05-
Dom SE	PIR	32007F3	see Table below	10^3	see Table above	-	external QLI2	CH05+
Dom SW	PIR	32007F3	see Table below	10^3	see Table above	-	external QLI2	CH06+
s_NR_Lite	NR Lite	980165	see Figure below	10^6	see Table above	175	QLC V29218 internal QLI	CH09
s_NR_Lite	NR Lite	000643	see Figure below	10^6	see Table above	175	QLC V29218 internal QLI	CH09

Table 2-7: Calibration formulas for PIR and CM24:

Gerät	Eingangswert	Umrechnung im Logger	Umrechnung	Ausgangswert
Pyranometer oben	Spannung [V]	Spannung [µV] · 10^6	Loggerwert / 11,19 µV W^{-1} m^2	Strahlung [W m^{-2}]
Pyranometer unten	Spannung [V]	Spannung [µV] · 10^6	Loggerwert / 11,04 µV W^{-1} m^2	Strahlung [W m^{-2}]
Pyrgeometer oben	Spannung [V]	Spannung [µV] · 10^6	$E = \frac{U_{emf}}{C}(1 + k_1 \sigma T_B^3) + k_2 \sigma T_B^4 - k_3 \sigma (T_D^4 - T_B^4) - f \Delta T_{S-N}$ mit C= 3,75 k_2= 0,9997 k_1= -0,016 k_3= 3,056	Strahlung [W m^{-2}]
Pyrgeometer unten	Spannung [V]	Spannung [µV] · 10^6	$E = \frac{U_{emf}}{C}(1 + k_1 \sigma T_B^3) + k_2 \sigma T_B^4 - k_3 \sigma (T_D^4 - T_B^4) - f \Delta T_{S-N}$ mit C= 3,94 k_2= 1,0006 k_1= 0,016 k_3= 2,842	Strahlung [W m^{-2}]
Thermistoren	Spannung [mV]		$T = \left[1{,}0295 \cdot 10^{-3} + 2{,}391 \cdot 10^{-4} \cdot \ln \frac{R_X \cdot U_2}{U_1 - U_2} + 1{,}568 \cdot 10^{-7} \left(\ln \frac{R_X U_2}{U_1 - U_2}\right)^3\right]^{-1}$ mit U1= 0,5 V U2= Messwert [V] R_X in kΩ R_1= 14,948 Bodytemp. Oben R2= 14,988 Bodytemp. Unten R3= 14,994 Dometemp. N	Temperatur [K]
Bodenplatte G 425	Spannung	Wert / 15,6 µV W^{-1} m²		Wärmefluss [W m^{-2}]
Bodenplatte G 427	Spannung	Wert / 18,8 µV W^{-1} m²	$G(0{,}15) = \frac{\frac{SignalG\ 425}{c_{G\ 425}} + \frac{SignalG\ 427}{c_{G\ 427}}}{2}$	Wärmefluss [W m^{-2}]

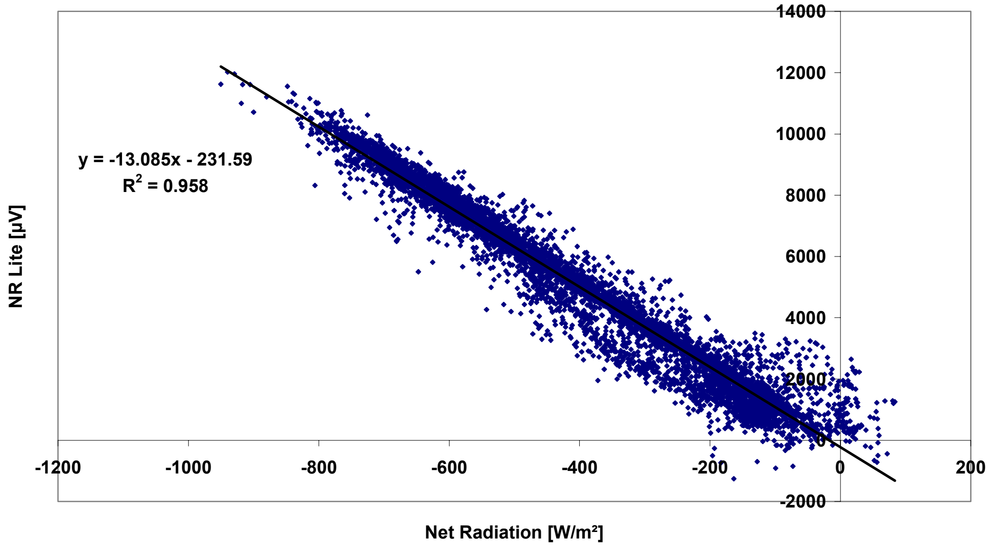


Figure 2-4: Calibration for NRLite #980165

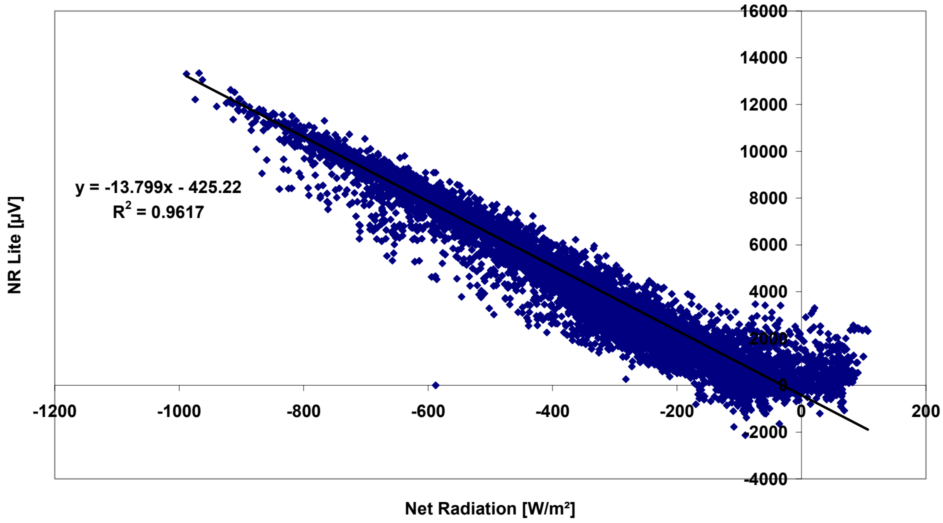


Figure 2-5: Calibration for NRLite #000643

Table 2-8: Soil heat flux measurement complex. HFP01SC was heated daily from 01:00 to 01:15 and 11:00 - 11:15.

parameter	**instrument**	**serial**	**calibration factor**	**conversion in logger**	**height/depth [cm]**	**orientation**	**logger**	**channel**
s_SoilTmp1	Pt100	0044		conversion to °C	-2	E	QLC V29218 internal QLI	CH02
s_SoilTmp2	Pt100	0043		conversion to °C	-5	E	QLC V29218 internal QLI	CH03
s_SoilTmp3	Pt100	0045		conversion to °C	-10	E	QLC V29218 internal QLI	CH04
s_SoilTmp4	Pt100	0041		conversion to °C	-20	E	QLC V29218 internal QLI	CH05
pressure	P6520	-	300 hPa/5V Offset 800 hPa	300 hPa/5V Offset 800 hPa	20	in Vaisala logger box	QLC V29218 external QLI2	CH07
s_TDR01	TDR-IMKO	11241	internal calibration	10^2	-5	O	QLC V29218 internal QLI	CH00
s_TDR02	TDR-IMKO	11225	internal calibration	10^2	-20	O	QLC V29218 internal QLI	CH01
s_HFP_CN3A	CN3A	G425	15.6 µV W^{-1} m^2	10^6	-10	N	QLC V29218 internal QLI	CH06
s_HFP_CN3B	CN3B	G427	18.8 µV W^{-1} m^2	10^6	-10	S	QLC V29218 internal QLI	CH07
s_HFP_HkFx	HFP01SC (heated)	0343	62.8 µV W^{-1} m^2	10^6	-10	N	QLC V29218 internal QLI	CH08

Table 2-9: Channel allocation for QLC V29218, internal QLI with logger program COBT01RA.qsp.

logger QLC V29218	typ	Variable Name	measurement	running	channel	E	H	L	C	Power
internal QLI	Sensor real	m_ws_C (wind speed 5. height)	cup anemometer #1057 / #4534		F1					
internal QLI	Sensor real	m_ws_D (wind speed 6. height)	cup anemometer #1061 / #4522		F2					
internal QLI	Sensor real	s_TDR01 (TDR probe depth 01)	Voltage single (+VE) #11241	5678	Ch 00		x white			
internal QLI	Sensor real	s_TDR02 (TDR probe depth 02)	Voltage single (+VE) #11225	35363738	Ch 01		x white			
internal QLI	Sensor real	s_SoilTmp1 (soiltemperature 1. depth)	PT100 4 wire, #0044	9101112	Ch 02	x black	x brown	x red	x orange	
internal QLI	Sensor real	s_SoilTmp2 (soiltemperature 2. depth)	PT100 4 wire, #0043	47484950	Ch 03	x black	x brown	x red	x orange	
internal QLI	Sensor real	s_SoilTmp3 (soiltemperature 3. depth)	PT100 4 wire, #0045	17181920	Ch 04	x black	x brown	x red	x orange	
internal QLI	Sensor real	s_SoilTmp4 (soiltemperature 4. depth)	PT100 4 wire, #0041	9101112	Ch 05					
internal QLI	Sensor real	s_HFP_CN3A (CN3 Heat Flux Plate)	Voltage diff (V) # G425	13141516	Ch 06		x white	x white-red		
internal QLI	Sensor real	s_HFP_CN3B (CN3 Heat Flux Plate)	Voltage diff (V) #G427	47484950	Ch 07		x white	x white-red		
internal QLI	Sensor real	s_HFP_HkFx (HFx Heat Flux Plate Hukseflux)	Voltage diff (V) #0343	5678	Ch 08		x white	x green		12V + Timer
internal QLI	Sensor real	s_NR_Lite (NR_Lite net radiation)	Voltage diff (V) #980165		Ch 09		x yellow	x brown		
internal QLI	Sensor real	s_NR_Lite (NR_Lite net radiation)	Voltage diff (V) #000643		Ch 09		x white	x green		
internal QLI			data transfer RS232	60	RxD					
internal QLI				61	TxD					
internal QLI				62	GND					

Table 2-10: Channel allocation for QLC V29218, external QLI 'Eppley circuit' with logger program COBT01RA.qsp.

logger QLC V29218	**typ**	**Variable Name**	**measurement**	**channel/ (number)**	**E**	**H**	**L**	**C**	**Power**
external QLI 2	Sensor real	m_ws_A (wind speed 3. height)	cup anemometer #1028/ #4524	F1		x yellow	x brown	x green	
external QLI 2	Sensor real	m_ws_B (wind speed 4. height)	cup anemometer #1055/ #4713	F2		x yellow	x brown	x green	
external QLI 2	Sensor real	Trvolt (Eppley power supply)	Voltage single (EVE) (-VE)	Ch 00			X yellow		
external QLI 2	Sensor real	s_PIR_GEG (long-wave incoming radiation)	Voltage diff (V)	Ch 02		X purple	X blue		
external QLI 2	Sensor real	s_PIR_AUS (long-wave outcoming radiation)	Voltage diff (V)	Ch 03		X pink	X grey		
external QLI 2	Sensor real	s_TR1_bdown (PIR dome thermistor 1 (body unten))	Voltage single (+V)	Ch 04		X grey-brown		x grey-pink	
external QLI 2	Sensor real	s_TR2_bup (PIR dome thermistor 2 (body oben))	Voltage single (−V)	Ch 04			X yellow-brown	x white-grey	
		Eppley-Schaltung		Ch 04		X brown	X white		
external QLI 2	Sensor real	s_TR3_dSE (PIR dome thermistor 3 (domeSE oben))	Voltage single (+V)	Ch 05		X green	X red-blue	x green-white	
external QLI 2	Sensor real	s_TR4_dN (PIR dome thermistor (dome N oben))	Voltage single (−V)	Ch 05		X yellow	x green		
external QLI 2		Eppley-Schaltung, Brücke auf 16/CH6C		Ch 05				X white-grey	
external QLI 2	Sensor real	s_TR5_dSW (PIR dome thermistor 5 (domeSW oben))	Voltage single (+V)	Ch 06		X white			
		Eppley-circuit		Ch 06		grey			
		bridge on 46, Ch5C		Ch 06		white-grey			
		bridge on 12, Ch4C		Ch 06		red			
external QLI 2		s_Press (pressure sensor Amonit)	Voltage single +VE	CH07		X white			DC+= brown DC-=green (12V)
external QLI 2	Sensor real	s_CM24_GLB (CM24 global radiation)	Voltage diff (V)	Ch 08		X red	X blue	X black & white	
external QLI 2	Sensor real	s_CM24_REF (CM24 reflected irradiance)	Voltage diff (V)	Ch 09		X red	X blue	X black & white	
		bridge to Eppley-circuit "+in"		-67	red-grey				
		bridge to QLC1, 63 SRD+		31	RD+1				
		bridge to QLC1, 64 SRD-		32	RD-1				
		bridge to QLC1, 67 DC+0		33	DC+1				
		bridge to QLC1, 68 DC-0		34	DC-1				

2.1.1.3 Profile mast

The cup anemometer and Frankenberger psychrometer heights in 0.5, 1.0, 2.0m were adjusted regularly with the carriage of the profile mast respectively to the zero plane displacement height in Table 2-3. Therefore the specifications for the lower three heights in Table 2-11 and Table 2-12 are in relation to the displacement height and correct at days where an adjustment was undertaken. Remaining heights are constant in time.

Table 2-11: Profile mast, Frankenberger psychrometers: Heights in 0.5, 1.0 and 2m height are adjusted to zero-plane displacement (see Table 2 4); other heights are fixed.

parameter	**instrument**	**serial**	**conversion in logger**	**height [cm]**	**installation / orientation**	**logger**	**channel**
		Cup/Sensor					
m_ws01	cup anemometer Climatronics F 460	1457/4719	(value/9.511 +0.3) / 2.237	50	E	QLC 347513 internal QLI	F1
m_ws02	cup anemometer Climatronics F 460	1456/4529	(value/9.511 +0.3) / 2.237	100	E	QLC 347513 internal QLI	F2
m_ws_A	cup anemometer Climatronics F 460	1028/4524	(value/9.511 +0.3) / 2.237	200	E	QLC V29218 external QLI2	F1
m_ws_B	cup anemometer Climatronics F 460	1055/4713	(value/9.511 +0.3) / 2.237	400	E	QLC V29218 external QLI2	F2
m_ws_C	cup anemometer Climatronics F 460	1057/4534	(value/9.511 +0.3) / 2.237	620	E	QLC V29218 internal QLI	F1
m_ws_D	cup anemometer Climatronics F 460	1061/4522	(value/9.511 +0.3) / 2.237	860	E	QLC V29218 internal QLI	F2

Table 2-12: Profile mast, Frankenberger psychrometers: Heights in 0.5, 1.0 and 2m height are adjusted to zero-plane displacement (see Table 2 4); other heights are fixed.

parameter	instrument	serial	conversion in logger	height [cm]	orientation	logger	channel
	Pt100 4 wire	body/ ventilator			W		
s_Psy01wet	0085	BT01?1/9038	conversion to °C	50	E, directing N	QLC 347513 internal QLI	CH 00
S_Psy01dry	0095	BT01?1/9038	conversion to °C	50	E, directing N	QLC 347513 internal QLI	CH 01
S_Psy02wet	0721	BT01?2/9068	conversion to °C	100	E, directing N	QLC 347513 internal QLI	CH 02
S_Psy02dry	0157	BT01?2/9068	conversion to °C	100	E, directing N	QLC 347513 internal QLI	CH 03
S_Psy03wet	0075	P3/9048	conversion to °C	200	E, directing N	QLC 347513 internal QLI	CH 04
S_Psy03dry	58006891311	P3/9048	conversion to °C	200	E, directing N	QLC 347513 internal QLI	CH 05
S_Psy04wet	0197	0124/7059	conversion to °C	405	E, directing N	QLC 347513 internal QLI	CH 06
S_Psy04dry	0045	0124/7059	conversion to °C	405	E, directing N	QLC 347513 internal QLI	CH 07
S_Psy05wet	0177	0134/0055	conversion to °C	857	E, directing N	QLC 347513 internal QLI	CH 08
S_Psy05dry	0167	0134/0055	conversion to °C	857	E, directing N	QLC 347513 internal QLI	CH 09

Table 2-13: Channel allocation for QLC 347513, internal QLI with logger program COBT01GR.qsp.

logger QLC 347513	typ	Variable Name	measurement	running number	channel	E	H	L	C	Power
internal QLI	Sensor real	m_ws01 (wind speed 1. height)	cup anemometer #1457 / #4719		F1					
internal QLI	Sensor real	m_ws02 (wind speed 2. height)	cup anemometer #1456 / #4529		F2					
internal QLI	Sensor real	s_Psy05dry (dry temperature 5. height)	PT100 4 wire, #0167	17181920	Ch 00	x yellow	x green	x brown	x white	
internal QLI	Sensor real	s_Psy05wet (moist temperature 5. height)	PT100 4 wire, #0177	43444546	Ch 01	x yellow	x green	x brown	x white	
internal QLI	Sensor real	s_Psy04dry (dry temperature 4. height)	PT100 4 wire, #0045	5678	Ch 02	x yellow	x green	x brown	x white	
internal QLI	Sensor real	s_Psy04wet (moist temperature 4. height)	PT100 4 wire, #0197	9101112	Ch 03	x yellow	x green	x brown	x white	
internal QLI	Sensor real	s_Psy03dry (dry temperature 3. height)	PT100 4 wire, #58006891311	35363738	Ch 04	x black	x yellow-green	x brown	x blue	
internal QLI	Sensor real	s_Psy03wet (moist temperature 3. height)	PT100 4 wire, #0075	35363738	Ch 05	x yellow	x green	x brown	x white	
internal QLI	Sensor real	s_Psy02dry (dry temperature 2. height)	PT100 4 wire, #0157	39404142	Ch 06	x yellow	x green	x brown	x white	
internal QLI	Sensor real	s_Psy02wet (moist temperature 2. height)	PT100 4 wire, #0721	1234	Ch 07	x yellow	x green	x brown	x white	
internal QLI	Sensor real	s_Psy01dry (dry temperature 1. height)	PT100 4 wire, #0095	13141516	Ch 08	x yellow	x green	x brown	x white	
internal QLI	Sensor real	s_Psy01wet (moist temperature 1. height)	PT100 4 wire, #0085	47484950	Ch 09	x yellow	x green	x brown	x white	
internal QLI			data transfer RS232	60	RxD					
internal QLI				61	TxD					
internal QLI				62	GND					

2.1.1.4 Sodar RASS

Sodar-RASS-measurements were performed with a DSDPA.90/64-Sodar and a DSDR3x7-1290MHz-RASS-extension from ‘METEK Meteorologische Messtechnik GmbH’. The Sodar consisted of a phase array with 64 loudspeakers, a screening and a PT100-sensor.

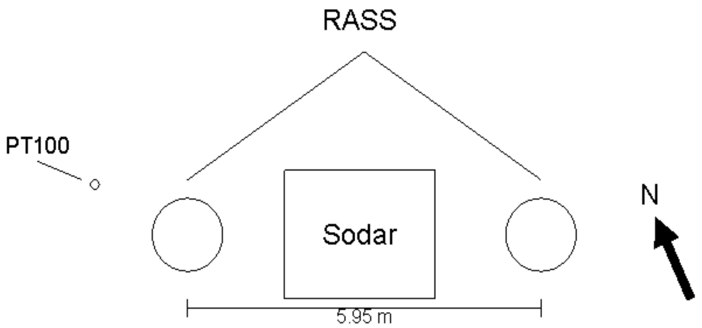


Figure 2-6: Alignment of Sodar-RASS-complex.

Table 2-14: Specifications for Sodar DSDPA.90/64.

Property	**Description/Value**
Operating range	
Wind velocity	0-35 m s^{-1}
Wind direction	0-360°
Standard deviation of radial components	0-3 m s^{-1}
Accuracy	
Wind velocity (0-5 m s^{-1})	± 0.5 m s^{-1}
Wind velocity (5-35 m s^{-1})	± 10%
Wind direction	± 5°
Radial components	± 0.1 m s^{-1}
Standard deviation of radial components	± 0.15 m s^{-1}
Range of measurements	
Minimum height	10 m
Height resolution	5–100 m
Availability	80% up to 200 m
Transmitted frequency	
Tunable	1.0-4.0 kHz

The RASS-extension consisted of 2 radar-antennas and had the following specifications:

Table 2-15: Specifications for 1290-MHz-RASS-extension DSDR3x7.

Property	Description/Value
Transmitter	
Operating frequency	1290 MHz
Transmitting power	20 W
Frequency stability	2×10^{-6}
Single side band phase-noise	-100 dBc/Hz
Modulation	Continuous wave
Receiver	
Detection	Phase synchronously with respect to transmit signal
Noise figure	1.5 dB
Bandwidth	$32\times(c_a/Dh)$ [Dh = height res.]
Noise bandwidth	(c_a/Dh)
Antennas	
Parabolic dish diameter	Æ 1.8 m

Table 2-16: Description of Sodar-RASS parameters I:

Index	Description
a	Number of antenna (1,2,3=Sodar, R=Rass)
c	Vector component (u,v,w)

Variable	Description	Unit
D	Wind direction	°
DAa	Availability of single spectra	%
DC	Class of Diffusion (internal scheme)	-
ERa	Code of plausibility (internal scheme)	-
Ga	Amplifying values	1
H	Measurement height	m
meta	see sheet 'meta'	
Pa	Peak power	dB
Ra	Reflectivity	dB
Sa	Standard deviation of radial wind velocity	m/s
SD	Standard deviation of wind inclination	°
SNa	Signal to noise ratio	dB
TMP	Temperature	°C
V	Wind velocity (polar coordinates)	m/s
VRa	Radial wind component	m/s
VVc	Vector wind component	m/s

Table 2-17: Description of Sodar-Rass parameters II and their occurrence during data processing.

			Original data array		Converted data matrix		
Variable	Description	Unit	Occurance	Description	Column	Occurance	Description
-	Date and time	DD.MM.YYYY hh:mm	1	-	1	1	-
AVE	Averaging period	s	1	-	2	1	-
MIN	Minimum measurement height	m	1	-	3	1	-
MAX	Maximum measurement height	m	1	-	4	1	-
NOI	Noise height (minimum level for ambient noise measurement)	m	1	-	5	1	-
STP	Step (width of a height step)	m	1	-	6	1	-
VOL	Volume (max = 4095)	-	6	1-5: Sodar; 6: Rass	7-11	5	1-5: Sodar
XMT	transmitter frequency	Hz	2	1: Sodar; 2: Rass	12-13	2	1: Sodar; 2: Rass
MIX	Frequency center	Hz	6	1-5: Sodar; 6: Rass	14-18	5	1-5: Sodar
SMP	Sampling frequency	Hz	2	1: Sodar; 2: Rass	19-20	2	1: Sodar; 2: Rass
AZI	Azimuth (horizontal alignment of sender array)	°	5	1-5: Sodar	21-25	5	1-5: Sodar
ZEN	Zenith (alignment of entire sender array against vertical)	°	5	1-5: Sodar	26-30	5	1-5: Sodar
TMP	Surface temperature	°C	1	-	31	1	-
FEC	Height of fixed echo elimination	m	1	-	32	1	-
DST	Distance between RASS transmitter and receiver	m	1	-	33	1	-
XTL	Crosstalk	V	1	-	34	1	-
SRV	Service Status	-	1	-	35	1	-

From 30.05.07 18:46 to 01.06.07 08:48 two frequency-tests were performed to optimize the emitting frequency to the local conditions.

Table 2-18: Frequency test 1 from 30.5. 18:46 to 31.05. 08:46.

XMT [Hz]	MIN [m]	MAX [m]	STP [m]	NOI [m]	AVE [s]	antennas
1598	30	980	20	1100	300	123r
1598	30	980	20	1100	300	123r
1715	30	980	20	1100	300	123r
1715	30	980	20	1100	300	123r
1803	30	980	20	1100	300	123r
1803	30	980	20	1100	300	123r

Table 2-19: Frequency test 2 from 31.05. 11:00 to 01.06. 08:48.

XMT [Hz]	MIN [m]	MAX [m]	STP [m]	NOI [m]	AVE [s]	antennas
1635	30	980	20	1100	360	123r
1635	30	980	20	1100	360	123r
1635	30	980	20	1100	360	123r
1715	30	980	20	1100	360	123r
1715	30	980	20	1100	360	123r
1715	30	980	20	1100	360	123r
1715	30	980	20	1100	360	123r
1758	30	980	20	1100	360	123r
1758	30	980	20	1100	360	123r
1758	30	980	20	1100	360	123r
1758	30	980	20	1100	360	123r

As a result, an emitting frequency of 1635 Hz was chosen for all Sodar-antennas. The parameter settings for the whole measurement campaign are summarized in the following. No use of blanks or special characters shall be used to denominate parameter sets. At best a short name in combination with a descriptive setting file is advised, otherwise problems with Sodar Ctrl Software can occur.

Table 2-20: Measurement parameters Sodar-RASS.

begin		end		XMT [Hz]	MIN [m]	MAX [m]	STP [m]	NOI [m]	AVE [s]	VOL
date	hour	date	hour							
01.06.07	08:48	01.06.07	09:15	1635	30	980	20	1100	360	4095
01.06.07	09:15	11.06.07	15:00	1635	30	980	20	1100	300	4095
11.06.07	15:20	06.07.07	08:40	1635	30	710	20	810	600	4095
06.07.07	09:50			1635	30	710	20	810	600	3800

Table 2-21: Antenna-orientation.

	zenit [°]	azimuth [°]
antenna 1	23 - 24	100
antenna 2	23 - 24	190
antenna 3	0	-

Remarks to the conversion routine: „Das Programm schreibt für jede Variable eine eigene csv-Datei. Die Endungen der jeweiligen Datei geben die Variable an. In diesem File steht in der ersten Spalte der Zeitstempel, dann in jeder Zeile die jeweiligen Messwerte für die Höhen. Die Höhenzuordnung kann mit dem entsprechenden File mit der Endung "_H" gemacht werden. Zusätzlich wird eine erste Fehlerkontrolle anhand der Fehlercodes durchgeführt. Für die Reflektivitätsdaten werden die Fehlercodes nicht beachtet, also alle Daten wie sie sind in die files geschrieben. Für alle anderen Sodar-Größen werden alle Messwerte, für die eine Fehlercode ungleich 00000 aufgezeichnet wurde, mit NaN ersetzt. Bei den RASS-Daten wird zusätzlich zu dem Fehlercode 00000 (= kein Fehler) noch der Fehlercode 04000 akzeptiert.“ Each converted file contains columns with values for one height class (but not 'COPS2007_mmdd_meta.csv'). For the height class of each column see 'COPS2007_mmdd_H.csv'. COPS2007_mmdd_meta.csv' contains operational data.

2.1.1.5 Scintillometer

The scintillometer sender is aligned at 10°, the receiver at 190°.

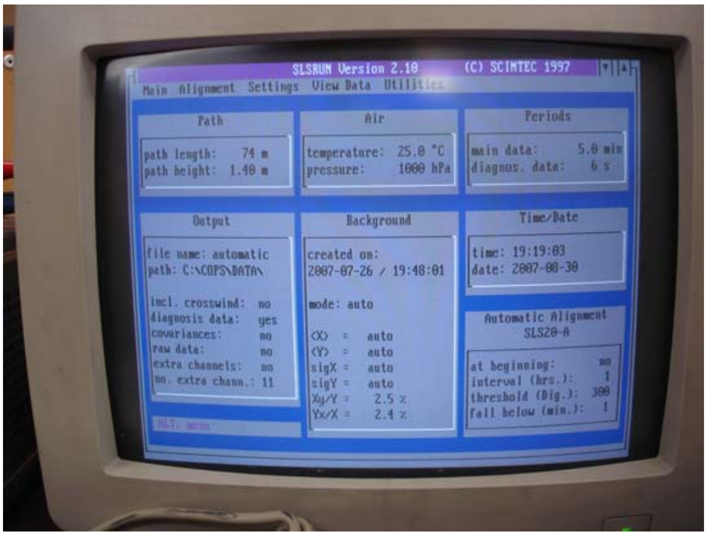


Figure 2-7: Scintillometer preferences.

For instrument specifications see master thesis: Laslopp, G.: Bestimmung turbulenter Flüsse über Gras auf der Basis von Laser-Scintillometer Messungen. Dipl.-Arb., Univ. Bayreuth, 2006.

2.1.2 Fußbach II (BT02T)

Durch einen Blitzschlag am 27.06.2007 ist der Strahlungs- und Bodenkomplex ab 27.06.2007 ausgefallen. Die ursprünglich als BT02ETG-Station geplante Messstelle musste auf BT02T zurückgestuft werden. Durch kräftigen Zwischenwuchs von Torinambo sind die Messdaten nur Anfang Juni und ab 27. Juli brauchbar.

2.1.2.1 Modified Bowen measurement complex

Table 2-22: measurement and canopy heights.

date	**lower measurement [cm]**	**upper measurement [cm]**	**canopy height [cm]**
2007-06-04	90	227	60
2007-06-26			140
2007-07-02			140
2007-07-09	116,5	227	140
2007-07-18			200
2007-07-23			200
2007-07-26	90	227	60
2007-07-27			30
2007-07-30			25
2007-08-06			10
2007-08-13			16
2007-08-20			20
2007-08-27			20

Table 2-23: Modified Bowen ratio measurement complex.

parameter	instrument	serial	signal out	height [cm]	installation / orientation	logger	channel
Wind vector	USA-1 FHN	99 05007	wind vector [mms^{-1}]	300,00	5°	Mini ITX with Tcopy logging program	x,y,z
Sonic temperature	USA-1 FHN	99 05007	[m°C]	300,00	5°		t
Moist temperature	PT100	0114/9149	[m°C]	227	W, directing N		a5
Dry temperature	PT100	0114/9139	[m°C]	227	W, directing N		a4
Moist temperature	PT100	0104/9129	[m°C]	see Table below	W, directing N		a7
Dry temperature	PT100	0104/9119	[m°C]	see Table below	W, directing N		a6

The fans are directed E. The logging program Tcopy has been utilized with the batch file start.bat (01.06.2007 15:41), the EC measurement output is resolved in 20Hz.

2.1.2.2 Soil heat measurement complex

Table 2-24: Soil heat measurement complex, demounted at 2007-06-28.

parameter	instrument	serial	calibration factor	conversion in logger	height / depth [cm]	orientation	logger	channel
s_NS	tip scale	OMC 212		0,1	100		QLC R44303 QLI internal	Count 1
s_Soiltmp1	Pt 100	0055		conversion to °C	-5		QLC R44303 QLI internal	Ch 00
s_Soiltmp2	Pt 100	0054		conversion to °C	-10		QLC R44303 QLI internal	Ch 01
s_Soiltmp3	Pt 100	0040		conversion to °C	-20		QLC R44303 QLI internal	Ch 02
Soil Heat flux	HP3	65658	243 µV $mW^{-1}cm^2$	10^6	-10		QLC R44303 QLI internal	Ch 05

Table 2-25: Channel allocation for QLC R44303, internal QLI with logging program COBT02SR.qsp, demounted and moved to BT03 at 2007-06-28.

logger QLC R44303	typ	Variable Name	measurement	running number	channel	E	H	L	C	Power
internal QLI	Sensor real	s_NS (precipitation Kippwaage), in R118	#OMO212		F 1	-	-	-	-	
internal QLI	Sensor real	s_SoilTmp1 (soiltemperature 1. depth)	PT100 4 wire, #0055		Ch 00	x black	x brown	x red	x orange	
internal QLI	Sensor real	s_SoilTmp2 (soiltemperature 2. depth)	PT100 4 wire, #0054		Ch 01	x black	x brown	x red	x orange	
internal QLI	Sensor real	s_SoilTmp3 (soiltemperature 3. depth)	PT100 4 wire, #0040		Ch 02	x black	x brown	x red	x orange	
internal QLI	Sensor real	s_HFP_HP3_A (Heat Flux Plate HP3-A)	Voltage diff (V) #65658		Ch 05		x brown	x blue		
internal QLI	Sensor real	s_TDR01 (TDR Sonde depth 01)	Voltage single (+VE) #14067		Ch 06		x white			
internal QLI	Sensor real	s_TDR02 (TDR Sonde depth 02)	Voltage single (+VE) #14072		Ch 07		x white			
internal QLI			data transfer RS232	60	RxD					
internal QLI				61	TxD					
internal QLI				62	GND					

2.2 Fischerbach (BT03ETG)

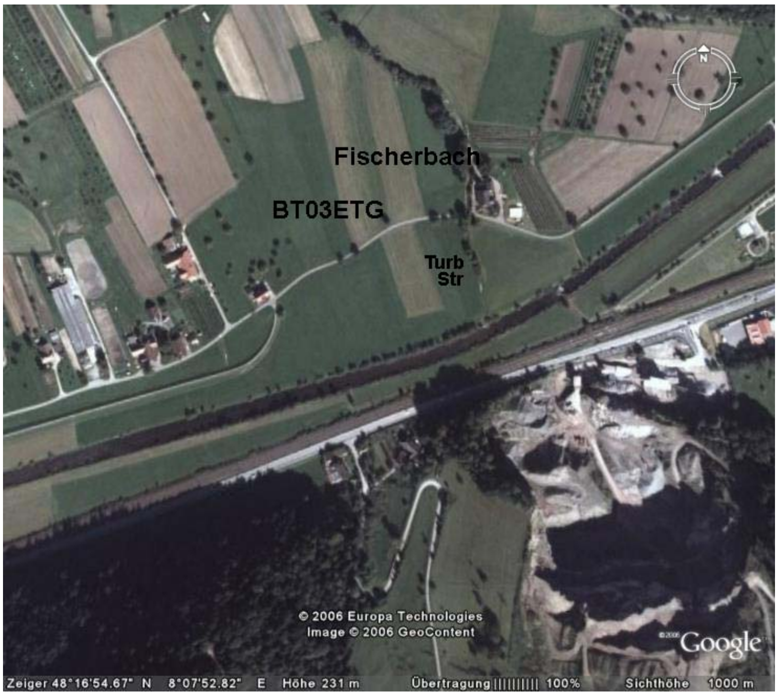


Figure 2-8: Position of the station Fischerbach:

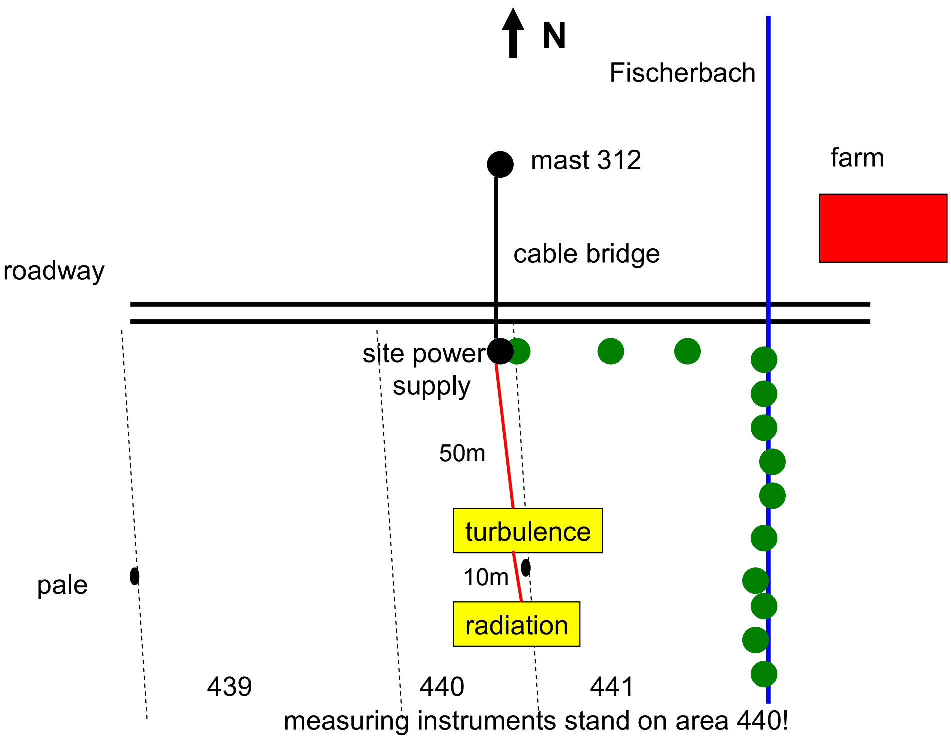


Figure 2-9: Installation plan of the station Fischerbach.

Table 2-26: Canopy height.

date	**canopy height [cm]**
2007-06-25	80
2007-07-05	60
2007-07-10	60
2007-07-18	15
2007-07-24	25
2007-07-31	42
2007-08-04	50
2007-08-07	15
2007-08-14	25
2007-08-23	80
2007-08-25	10
2007-08-28	15

2.2.1 Turbulence measurement complex

Table 2-27: Turbulence measurement complex, mh := measurement height agl, v_dp := vertical displacement, h_dp := horizontal displacement, others see Figure 2-1.

parameter	**instrument**	**serial**	**signal in**	**calibration factor**	**conversion in logger**	**signal out**	**mh / v_dp / h_dp**	**orientation**	**logger**
Wind vector and sonic temperatur	CSAT3	0322-1 (Box), 0322-2 (Sensor)	runtime binary encoded	-	calculation in logger	wind vector [ms^{-1}]	249 / - / -	c=70cm δ=334° ϕ=339°	CR23X SN: 1361
Humidity	KH 20	1462 (up to 05.07.)	voltage	Vo= 10.61 ln (mV), kw=0.2036 ln (mV) m^3 g^{-1} cm^{-1}, x=1.2 cm	-	voltage	up to 02.07: 247 / -2 / 22.5 from 02.07: 237 / -12 / 25.5	up to 02.07: b=52cm ε=352° γ=0° η= - ; thereafter: b=53.5cm ε=353° γ=90° η= -	CR23X SN: 1361
Humidity	KH 20	1342 (from 05.07.)	voltage	Vo= 10.61 ln (mV), kw=0.2057 ln (mV) m^3 g^{-1} cm^{-1}, x=1.2 cm	-	voltage	237 / -12 / 25.5	b=53.5cm ε=353° γ=90° η= -	CR23X SN: 1361

The Campbell logging program CSAT3_37.DLD (13.09.2005 07:49) has been utilized, the EC measurement output is resolved in 20Hz. Measurements with KH20 #1342 must be recalibrated because of small lens distance.

Table 2-28: configuration of CR23X, SN 1361

instrument	cable color	factor	connection
KRYPTON	red	Power out	12V
KRYPTON	black	Power out	G
KRYPTON	white	Signal	SE5
KRYPTON	black	Signal	SE6
KRYPTON	clear	Signal	ground
CSAT3	clear	Power out	12V
CSAT3	black	Power out	G
CSAT3	SDM Cable		
CSAT3	black	between Power out and Control I/O	G
CSAT3	green	Control I/O	C1
CSAT3	white	Control I/O	C2
CSAT3	brown	Control I/O	C3
power cable	grey	External Power	G
power cable	grey/red	External Power	12 V

2.2.2 Radiation and soil heat flux measurement complex

Table 2-29: CNR1 connector (male), top view, black rectangles indicate pivots. Because of lightning, two different setups do exist.

	■		■		■		■		■		■	
< 07-06-27	Ch03 C	Ch03 H	Ch03 L	Ch03 E	Ch07 H	Ch07 L	Ch06 H	Ch06 L	Ch05 H	Ch05 L	Ch04 H	Ch04 L
> 07-06-27	Ch00 C	Ch00 H	Ch00 L	Ch00 E	Ch03 H	Ch03 L	Ch05 H	Ch05 L	Ch09 H	Ch09 L	Ch08 H	Ch08 L
Wire	blue	red	green	yellow	brown	green	grey	yellow	white	black	red	blue
Variable	s_CNR_T				s_CNR_Aus		s_CNR_Geg		s_CNR_Ref		s_CNR_Glb	
Cable	4 wire CNR1 cable				8 wire CNR1 cable							

Table 2-30: radiation and soil heat flux measurement complex until 2007-06-27 (because of lightning, two different setups do exist).

parameter	instrument	serial	calibration factor	conversion in logger	height/depth [cm]	orientation	logger	channel
s_CNR1_T	CNR1	990197		conversion to °C	200	-	QLC 506208 external QLI2	CH03
s_CNR1_Glb	CNR1	990197	10.82 µV W^{-1} m²	10^6	200	161°	QLC 506208 external QLI2	CH04
s_CNR1_Ref	CNR1	990197	10.82 µV W^{-1} m²	10^6	200	161°	QLC 506208 external QLI2	CH05
s_CNR1_Geg	CNR1	990197	10.82 µV W^{-1} m²	10^6	200	161°	QLC 506208 external QLI2	CH06
s_CNR1_Aus	CNR1	990197	10.82 µV W^{-1} m²	10^6	200	161°	QLC 506208 external QLI2	CH07
s_SoilTmp1 (demounted: 2007-06-27)	Pt100	0048		conversion to °C	-2	E	QLC 506208 internal QLI	Ch 00
s_SoilTmp2	Pt100	0056		conversion to °C	-5	E	QLC 506208 internal QLI	Ch 01
s_SoilTmp3 (demounted: 2007-06-27)	Pt100	0053		conversion to °C	-10	E	QLC 506208 internal QLI	Ch 02
s_SoilTmp4	Pt100	0050		conversion to °C	-20	E	QLC 506208 internal QLI	Ch 03
s_HFP_HP3_B	HP3	69813	227 µV mW^1cm^2	10^6	-10	S	QLC 506208 internal QLI	Ch 04
s_HFP_HkFx	HFP01 (non heated)	00070	68.1 µV $W^{-1}m^2$	10^6	-10	N	QLC 506208 internal QLI	Ch 05
s_TDR01	TDR-IMKO	14071	internal calibration	10^2	-5	E	QLC 506208 internal QLI	Ch 06
s_TDR02	TDR-IMKO	14073	internal calibration	10^2	-20	E	QLC 506208 internal QLI	Ch 07

Table 2-31: Channel allocation for QLC 506208, internal QLI with logger program COBT03SR.qsp until 2007-06-27 (because of lightning, two different setups do exist).

Logger QLC 506208	Typ	Variable Name	measurement	running number	channel	E	H	L	C	Power
internal QLI	Sensor real	s_SoilTmp1 (soiltemperature 1. depth)	PT100 4 wire, #0048		Ch 00	x black	x brown	x red	x orange	
internal QLI	Sensor real	s_SoilTmp2 (soiltemperature 2. depth)	PT100 4 wire, #0056		Ch 01	x black	x brown	x red	x orange	
internal QLI	Sensor real	s_SoilTmp3 (soiltemperature 3. depth)	PT100 4 wire, #0053		Ch 02	x black	x brown	x red	x orange	
internal QLI	Sensor real	s_SoilTmp4 (soiltemperature 4. depth)	PT100 4 wire, #0050		Ch 03	x black	x brown	x red	x orange	
internal QLI	Sensor real	s_HFP_HP3_B (Heat flux plate HP3 B)	Voltage diff (V) #69813		Ch 04		x blue	x black		
internal QLI	Sensor real	s_HFP_HkFx (HFx Heat Flux Plate Hukseflux)	Voltage diff (V) #00070 double!		Ch 05		x white	x green		
internal QLI	Sensor real	s_TDR01 (TDR probe depth 01)	Voltage single (+VE) #14071		Ch 06		x white			
internal QLI	Sensor real	s_TDR02 (TDR probe depth 02)	Voltage single (+VE) #14073		Ch 07		x white		ground	
internal QLI			data transfer RS232	60	RxD					
internal QLI				61	TxD					
internal QLI				62	GND					

Table 2-32: Channel allocation for QLC 506208, external QLI with logger program COBT03SR.qsp until 2007-06-27 (because of lightning, two different setups do exist).

Logger QLC 506208	Typ	Variable Name	Messung	running number	channel	E	H	L	C	Power
external QLI 2					Ch 00					
external QLI 2					Ch 01					
external QLI 2					Ch 02					
external QLI 2	Sensor real	s_CNR_T (CNR1 instrument temperature)	PT100 4 wire, #990197		Ch 03	x yellow	x red	x green	x blue	
external QLI 2	Sensor real	s_CNR_Glb (CNR1 global radiation)	Voltage diff (V) #990197		Ch 04		x red	x blue		
external QLI 2	Sensor real	s_CNR_Ref (CNR1 reflected irradiance)	Voltage diff (V) #990197		Ch 05		x white	x black		
external QLI 2	Sensor real	s_CNR_Geg (CNR1 long-wave incoming radiation)	Voltage diff (V) #990197		Ch 06		x grey	x yellow		
external QLI 2	Sensor real	s_CNR_Aus (CNR1 long-wave outcoming radiation)	Voltage diff (V) #990197		Ch 07		x brown	x green		
external QLI 2					Ch 08					
external QLI 2					Ch 09					
external QLI 2			data transfer RS232	60	RxD					
external QLI 2				61	TxD					
external QLI 2				62	GND					

Table 2-33: radiation and soil heat flux measurement complex after 2007-06-27 (because of lightning, two different setups do exist).

parameter	instrument	serial	calibration factor	conversion in logger	height/depth [cm]	orientation	logger	channel
s_CNR1_T	CNR1	990197		conversion to °C	200	-	QLC R44303 QLI internal	CH00
s_CNR1_Glb	CNR1	990197	10.82 μV W^{-1} m^2	10^6	200	161°	QLC R44303 QLI internal	CH08
s_CNR1_Ref	CNR1	990197	10.82 μV W^{-1} m^2	10^6	200	161°	QLC R44303 QLI internal	CH09
s_CNR1_Geg	CNR1	990197	10.82 μV W^{-1} m^2	10^6	200	161°	QLC R44303 QLI internal	CH05
s_CNR1_Aus	CNR1	990197	10.82 μV W^{-1} m^2	10^6	200	161°	QLC R44303 QLI internal	CH03
s_SoilTmp2	Pt100	0056		conversion to °C	-5	E	QLC R44303 QLI internal	Ch 01
s_SoilTmp4	Pt100	0050		conversion to °C	-20	E	QLC R44303 QLI internal	Ch 02
s_HFP_HP3_B	HP3	69813	227 μV $mW^1 cm^2$	10^6	-10	S	QLC R44303 QLI internal	Ch 04
s_TDR01	TDR-IMKO	14071	internal calibration	10^2	-5	E	QLC R44303 QLI internal	Ch 06
s_TDR02	TDR-IMKO	14073	internal calibration	10^2	-20	E	QLC R44303 QLI internal	Ch 07

Table 2-34: Channel allocation for QLC R44303, internal QLI with logger program COBT03_b.qsp after 2007-06-27 (because of lightning, two different setups do exist).

Logger QLC R44303	Typ	Variable Name	measurement	running number	channel	E	H	L	C	Power
internal QLI	Sensor real	s_CNR_T (CNR1 instrument temperature)	PT100 4 wire, #990197		Ch 00	x yellow	x red	x green	x blue	
internal QLI	Sensor real	s_SoilTmp2 (soiltemperature 2. depth)	PT100 4 wire, #0056		Ch 01	x black	x brown	x red	x orange	
internal QLI	Sensor real	s_SoilTmp4 (soiltemperature 4. depth)	PT100 4 wire, #0050		Ch 02	x black	x brown	x red	x orange	
internal QLI	Sensor real	s_CNR_Aus (CNR1 long-wave outcoming radiation)	Voltage diff (V) #990197		Ch 03		x brown	x green		
internal QLI	Sensor real	s_HFP_HP3_B (Heat flux plate HP3 B)	Voltage diff (V) #69813		Ch 04		x blue	x black		
internal QLI	Sensor real	s_CNR_Geg (CNR1 long-wave incoming radiation)	Voltage diff (V) #990197		Ch 05		x grey	x yellow		
internal QLI	Sensor real	s_TDR01 (TDR probe depth 01)	Voltage single (+VE) #14071		Ch 06		x white			
internal QLI	Sensor real	s_TDR02 (TDR probe depth 02)	Voltage single (+VE) #14073		Ch 07		x white		ground	
internal QLI	Sensor real	s_CNR_Glb (CNR1 global radiation)	Voltage diff (V) #990197		Ch 08		x red	x blue		
internal QLI	Sensor real	s_CNR_Ref (CNR1 reflected irradiance)	Voltage diff (V) #990197		Ch 09		x white	x black		
internal QLI			data transfer RS232	60	RxD					
internal QLI				61	TxD					
internal QLI				62	GND					

2.3 Hagenbuch (BT04ETG)

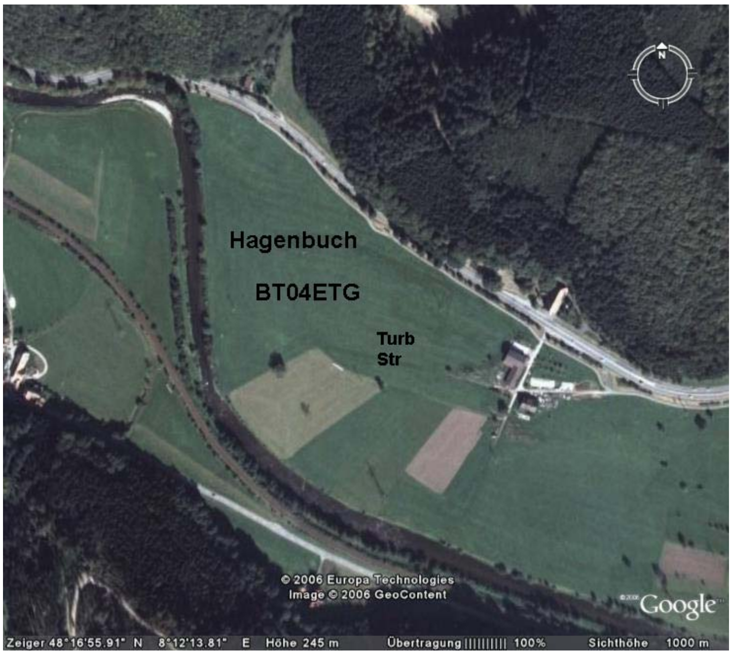


Figure 2-10: Position of the station Hagenbuch.

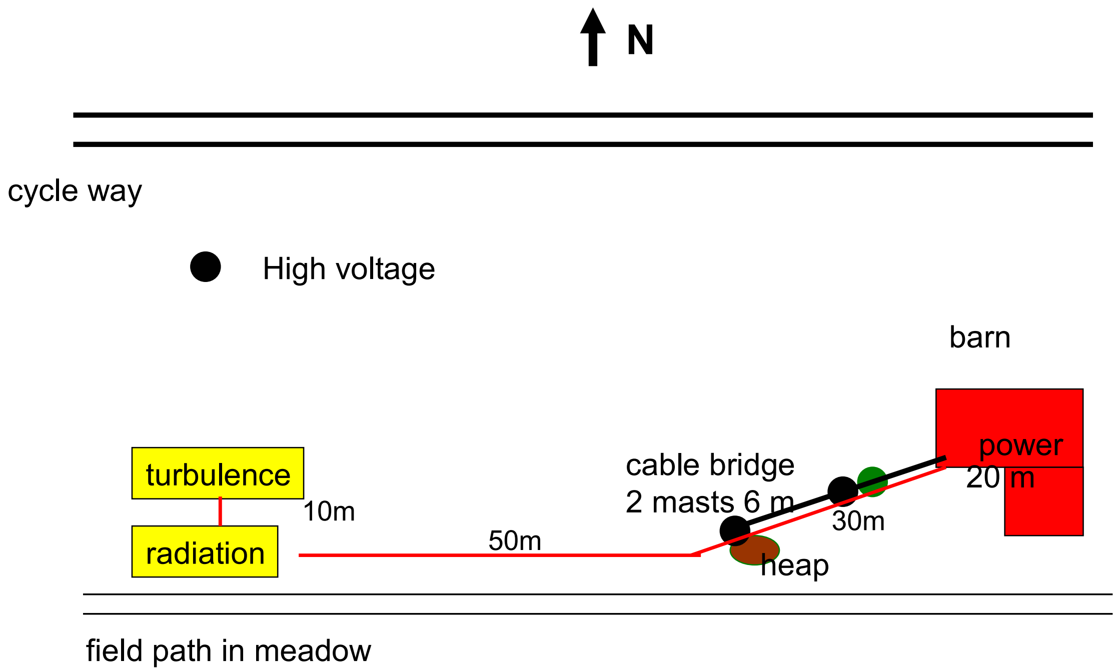


Figure 2-11: Installation plan of the station Hagenbuch.

Table 2-35: Canopy height.

date	canopy height [cm]
2007-06-25	115
2007-07-05	120
2007-07-10	120
2007-07-24	26
2007-07-31	46
2007-08-07	50
2007-08-14	55
2007-08-23	80
2007-08-25	10
2007-08-28	15

2.3.1 Turbulence measurement complex

Table 2-36: Turbulence measurement complex, mh := measurement height agl, v_dp := vertical displacement, h_dp := horizontal displacement, others see Figure 2-1.

parameter	instrument	serial	signal in	calibration factor	conversion in logger	signal out	mh / v_dp / h_dp [cm]	orientation	logger
Wind vector and sonic temperatur	CSAT3	0235-1 (Box), 0235-2 (Sensor)	runtime binary encoded	-	calculation in logger	wind vector [ms^{-1}]	250 / - / -	c=81cm δ=11° ϕ=7°	CR23X SN: 1047
Humidity	LI7500	75H-0220	voltage	0-1500 mmol m^{-3} (0-5V)	linear interpolation according to calibration	[mmol m^{-3}]	245 / - 5 / 30	b=72cm ε=32.5° γ=37° η=18°	CR23X SN: 1047
CO2	LI7500	75H-0220	voltage	10-30 mmol m^{-3} (0-5V)	linear interpolation according to calibration	[mmol m^{-3}]	245 / - 5 / 30	b=72cm ε=32.5° γ=37° η=18°	CR23X SN: 1047

The Campbell logging program CSAT3_36.DLD (21.03.2003 15:01) has been utilized, the EC measurement output is resolved in 20Hz.

Table 2-37: configuration of CR23X, SN 1047

instrument	cable color	factor	connection
LICOR	brown	CO2-voltage	SE 7
LICOR	blue	H2O-voltage	SE 8
LICOR	black		ground
LICOR	white		ground
LICOR	red/black	Power in	G
LICOR	red/white	Power in	12 V
CSAT3	clear	Power out	12V
CSAT3	black	Power out	G
CSAT3	red		not connected
CSAT3	SDM Cable:		
CSAT3	black	between Power out and Control I/O	G
CSAT3	green	Control I/O	C1
CSAT3	white	Control I/O	C2
CSAT3	brown	Control I/O	C3
Power cable	grey	External Power	G
Power cable	grey/red	Power in	12 V

2.3.2 Radiation and soil heat flux measurement complex

Table 2-38: CNR1 connector (male), top view, black rectangles indicate pivots.

Channel	Ch03 C	Ch03 H	Ch03 L	Ch03 E	Ch07 H	Ch07 L	Ch06 H	Ch06 L	Ch05 H	Ch05 L	Ch04 H	Ch04 L
Wire	blue	red	green	yellow	brown	green	grey	yellow	white	black	red	blue
Variable	s_CNR_T				s_CNR_Aus		s_CNR_Geg		s_CNR_Ref		s_CNR_Glb	
Cable	4 wire CNR1 cable				8 wire CNR1 cable							

Table 2-39: radiation and soil heat flux measurement complex. HFP01SC was heated daily from 01:00 to 01:15 and 11:00 - 11:15.

parameter	**instrument**	**serial**	**calibration factor**	**conversion in logger**	**height/depth [cm]**	**orientation**	**logger**	**channel**
s_Soiltemp1	PT 100 wire	0046		conversion to °C	-20	W	internal QLI	CH 0
s_Soiltemp2	PT 100 wire	0052		conversion to °C	-10	W	internal QLI	CH 1
s_Soiltemp3	PT 100 wire	0051		conversion to °C	-5	W	internal QLI	CH 2
s_Soiltemp4	PT 100 wire	0047		conversion to °C	-2	W	internal QLI	CH 3
s_HFP_HkFx	HFP01SC (heated)	0070	59.0 µV W^{-1} m²	10^6	-10	N	internal QLI	CH 4
s_HFP_HF_3A	Heat Flux Plate HP 3A	G422	18.8 µV W^{-1} m²	10^6	-10	E	internal QLI	CH 5
s_HFP_HF_3B	Heat Flux Plate HP 3A	G428	15.3 µV W^{-1} m²	10^6	-10	W	internal QLI	CH 6
s_TDR_01	TDR-IMKO	14074	internal calibration	10^2	-5	S	internal QLI	CH 8
s_TDR_02	TDR-IMKO	11223	internal calibration	10^2	-20	W	internal QLI	CH 9
s_CNR_T	PT 100	970059		conversion to °C	192	-	external QLI 2	CH 3
s_CNR_Gib	CNR 1	970059	9.90 µV W^{-1} m²	10^6	192	185°	internal QLI	CH 4
s_CNR_Ref	CNR 1	970059	9.86 µV W^{-1} m²	10^6	192	185°	internal QLI	CH 5
s_CNR_Geg	CNR 1	970059	9.12 µV W^{-1} m²	10^6	192	185°	internal QLI	CH 6
s_CNR_Aus	CNR 1	970059	9.33 µV W^{-1} m²	10^6	192	185°	internal QLI	Ch 7

Table 2-40: Channel allocation for QLC 506209, internal QLI with logger program COBT04SR.qsp.

Logger QLC 506209	typ	Variable Name	Messung	running number	channel	E	H	L	C	Power
internal QLI	Sensor real	s_SoilTmp1 (soiltemperature 1. depth)	PT100 4 wire, #0046		Ch 00	x black	x brown	x red	x orange	
internal QLI	Sensor real	s_SoilTmp2 (soiltemperature 2. depth)	PT100 4 wire, #0052		Ch 01	x black	x brown	x red	x orange	
internal QLI	Sensor real	s_SoilTmp3 (soiltemperature 3. depth)	PT100 4 wire, #0051		Ch 02	x black	x brown	x red	x orange	
internal QLI	Sensor real	s_SoilTmp4 (soiltemperature 4. depth)	PT100 4 wire, #0047		Ch 03	x black	x brown	x red	x orange	
internal QLI	Sensor real	s_HFP_HkFx (HFx Heat Flux Plate Hukseflux)	Voltage diff (V) #00070 (double!)		Ch 04		x white	x green		12 V + timer
internal QLI	Sensor real	s_HFP_HP3_A (Heat flux plate HP3 A)	Voltage diff (V) #6422		Ch 05		x white	x white/red		
internal QLI	Sensor real	s_HFP_HP3_B (Heat flux plate HP3 B)	Voltage diff (V) #6428		Ch 06		x white	x white/red		
internal QLI	Sensor real	s_TDR01 (TDR probe depth 01)	Voltage single (+VE) #14074		Ch 08		x white			
internal QLI	Sensor real	s_TDR02 (TDR probe depth 02)	Voltage single (+VE) #11223		Ch 09		x white		ground	
internal QLI			data transfer RS232	60	RxD					
internal QLI				61	TxD					
internal QLI				62	GND					

Table 2-41: Channel allocation for QLC 506209, external QLI with logger program COBT04SR.qsp.

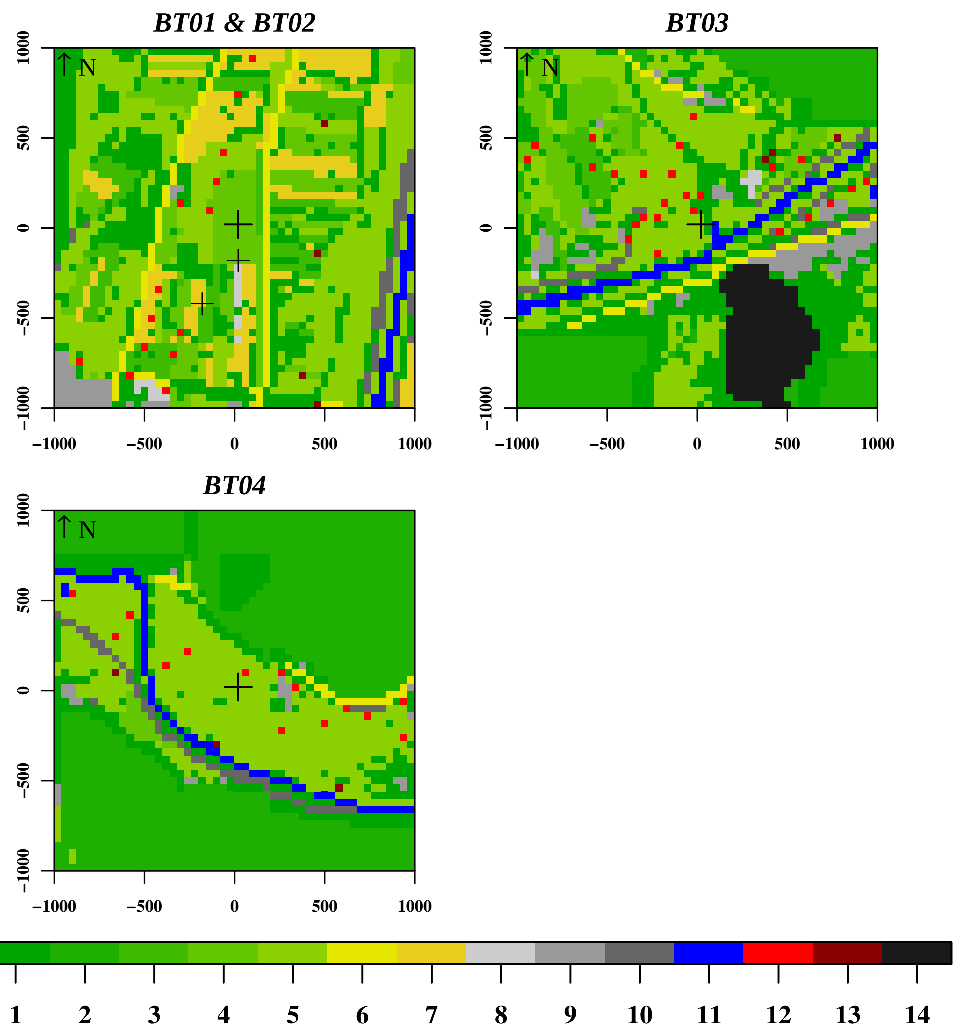
Logger QLC 506209	typ	Variable Name	Messung	running number	channel	E	H	L	C	Power
external QLI 2					Ch 00					
external QLI 2					Ch 01					
external QLI 2					Ch 02					
external QLI 2	Sensor real	s_CNR_T (CNR1 instrument temperature)	PT100 4 wire, #970059		Ch 03	x yellow	x red	x green	x blue	
external QLI 2	Sensor real	s_CNR_Glb (CNR1 global radiation)	Voltage diff (V) #970059		Ch 04		x red	x blue		
external QLI 2	Sensor real	s_CNR_Ref (CNR1 reflected irradiance)	Voltage diff (V) #970059		Ch 05		x white	x black		
external QLI 2	Sensor real	s_CNR_Geg (CNR1 long-wave incoming radiation)	Voltage diff (V) #970059		Ch 06		x grey	x yellow		
external QLI 2	Sensor real	s_CNR_Aus (CNR1 long-wave outcoming radiation)	Voltage diff (V) #970059		Ch 07		x brown	x green		
external QLI 2					Ch 08					
external QLI 2					Ch 09					
external QLI 2			data transfer RS232	60	RxD					
external QLI 2				61	TxD					
external QLI 2				62	GND					

3 Surface parameters

3.1 Land use

A land use survey has been carried out for the footprint analysis. Based on Google Earth screenshots, 1km^2 surrounding of each site has been classified by its land use. The classification itself was carried out with a Garmin Emap GPS in UTM projection, accuracy 5-10m, with a resolution of 20m. The land use matrices for footprint analysis as well as canopy height parameterizations are available on the DVD ‘COPS_meta’ at ‘COPS_meta\3_Surface_parameters\ 2_Landuse_matrix.xls’. As well, additional SRTM (elevation) and Landsat data can be found in the subfolder ‘0_Satellite_data’.

3.1.1 Land use maps



Legend see next page.

Figure 3-1: Land use map for the measurement sites under investigation. The positions of the EC measurements are indicated by the central cross-hairs. X- and Y- axis indicate the distance from the measurement [m]. For the map BT01 & BT02 additional crosshairs indicate the profile measurement (S) and the MBR measurement (SW). Land use classes for the measurement period are distinguished according to the color bar: 1:= deciduous tree, 2:= conifer, 3:= topinambur, 4:= corn, 5:= meadow, 6:= acre / fallow, 7:= garden, 8:= slope, 9:= street, 10:= building, 11:= stream, 12:= power pole small, 13:= power pole large, 14:= stone pit.

3.1.2 Vegetation

For canopy heights see experimental setup.

The vegetation at BT01 is maize. A vertical mass profile has been arisen and is available at 'COPS_meta\3_Surface_parameters\ 4_Corn_mass_profile.xls'.

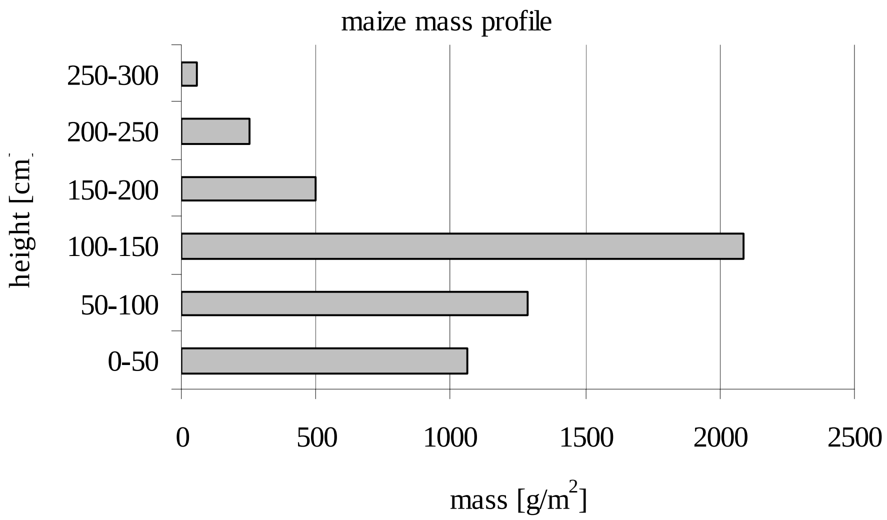


Figure 3-2: Maize mass profile at BT01, 22.08.2007.

The vegetation at BT02 is Barley / Topinambo until 2007-07-24, fallow and successively meadow thereafter.

Table 3-1: Excerpt of characteristic vegetation composition at BT03 and BT04.

BT03		**BT04**	
genus	**species**	**genus**	**species**
Achilléa	millefolium	Achilléa	millefolium
Galium		Dactylis	glomerata
Geranium		Geranium	
Plantago	lanceolata	Heracleum	sphondylium
Poa	spec	Plantago	lanceolata
Ranunculus	acrís	Plantago	major
Rúmex	acetosa	Poa	spec
Taraxacum		Ranunculus	acrís
Trifolium	repens	Ranunculus	repens
Trifolium	pratense	Rúmex	
		Taraxacum	officinalis
		Trifolium	repens
		Trifolium	pratense

3.2 Soil properties

3.2.1 Soil moisture

As a reference to the continual measuring of the soil moisture with TDR- probes, soil samples were taken with 100 cm^3 cylinders.

Table 3-2: BT01 soil moisture measurements with 100cm^3 cylinder.

depth [cm]	number	moist weight [g]	dry weight [g]	cylinder [g]	vol. water content [%]	grav. water content [%]	bulk density [g/cm^3]
sampling 1: 2007-06-26							
0 - 5	M10	249,72	233,89	118,39	15,83	13,71	1,16
0 - 5	M17	258,06	230,89	117,77	27,17	24,02	1,13
0 - 5	M15	238,98	216,47	118,96	22,51	23,08	0,98
5 - 10	M2	244,23	221,49	118,3	22,74	22,04	1,03
5 - 10	M12	238,64	215,73	118,02	22,91	23,45	0,98
5 - 10	M32	255,49	232,55	117,66	22,94	19,97	1,15
10 - 15	M14	260,31	233,16	118,55	27,15	23,69	1,15
10 - 15	M6	264,34	237,03	118,11	27,31	22,97	1,19
10 - 15	M13	275,15	250,32	118,76	24,83	18,87	1,32
15 - 20	M7	255,38	231,77	117,9	23,61	20,73	1,14
15 - 20	M16	253,2	227,75	118,89	25,45	23,38	1,09
15 - 20	M18	254,73	228,96	118,71	25,77	23,37	1,10
sampling 2: 2007-07-23							
0 - 5	M10	253,62	234,85	118,39	18,77	16,12	1,16
0 - 5	M17	252,56	232,98	117,77	19,58	17,00	1,15
0 - 5	M15	266,08	247,55	118,96	18,53	14,41	1,29
5 - 10	M2	252,55	232,92	118,30	19,63	17,13	1,15
5 - 10	M12	247,16	230,50	118,02	16,66	14,81	1,12
5 - 10	M32	249,16	231,25	117,66	17,91	15,77	1,14
10 - 15	M14	255,49	234,97	118,55	20,52	17,63	1,16
10 - 15	M6	241,26	221,37	118,11	19,89	19,26	1,03
10 - 15	M13	238,33	218,94	118,76	19,39	19,36	1,00
15 - 20	M7	259,01	238,31	117,90	20,70	17,19	1,20
15 - 20	M16	248,51	225,33	118,89	23,18	21,78	1,06
15 - 20	M18	244,96	221,02	118,71	23,94	23,40	1,02
sampling 3: 2007-08-13							
1 - 1	M10	295,79	263,91	118,39	31,88	21,91	1,46
1 - 2	M17	290,69	260,42	117,77	30,27	21,22	1,43
1 - 3	M15	294,03	267,67	118,96	26,36	17,73	1,49
2 - 1	M2	264,67	239,43	118,30	25,24	20,84	1,21
2 - 2	M12	257,24	234,11	118,02	23,13	19,92	1,16
2 - 3	M32	267,66	241,55	117,66	26,11	21,08	1,24
3 - 1	M14	255,65	226,63	118,55	29,02	26,85	1,08
3 - 2	M6	281,03	249,10	118,11	31,93	24,38	1,31
3 - 3	M13	250,56	225,13	118,76	25,43	23,91	1,06
4 - 1	M7	258,65	235,01	117,90	23,64	20,19	1,17
4 - 2	M16	262,15	236,82	118,89	25,33	21,48	1,18
4 - 3	M18	259,17	231,25	118,71	27,92	24,81	1,13

Table 3-3: BT02 soil moisture measurements with 100cm^3 cylinder.

depth [cm]	number	moist weight [g]	dry weight [g]	cylinder [g]	vol. water content [%]	grav. water content [%]	bulk density [g/cm^3]
sampling 1: 2007-06-26							
0 - 5	M34	270,52	237,35	118,3	33,17	27,86	1,19
0 - 5	M28	269	237,48	118,6	31,52	26,51	1,19
0 - 5	M36	269,27	237,33	119,11	31,94	27,02	1,18
5 - 10	M22	298,27	261,45	118,68	36,82	25,79	1,43
5 - 10	M41	269	237,81	118,75	31,19	26,20	1,19
5 - 10	M43	267,43	238,03	118,27	29,4	24,55	1,20
10 - 15	M31	279,98	243,25	119,54	36,73	29,69	1,24
10 - 15	M27	277,88	238,62	118,28	39,26	32,62	1,20
10 - 15	M50	257,3	225,48	118	31,82	29,61	1,07
15 - 20	M42	263,05	232,66	118,73	30,39	26,67	1,14
15 - 20	M39	271	237,93	118,2	33,07	27,62	1,20
15 - 20	M49	271,52	238,02	119,21	33,5	28,20	1,19
sampling 2: 2007-07-23							
0 - 5	M34	248,77	225,32	118,30	23,45	21,91	1,07
0 - 5	M28	241,67	220,23	118,60	21,44	21,10	1,02
0 - 5	M36	241,14	215,69	119,11	25,45	26,35	0,97
5 - 10	M22	216,98	197,47	118,68	19,51	24,76	0,79
5 - 10	M41	231,32	209,35	118,75	21,97	24,25	0,91
5 - 10	M43	245,82	219,48	118,27	26,34	26,03	1,01
10 - 15	M31	249,73	224,11	119,54	25,62	24,50	1,05
10 - 15	M27	236,08	212,18	118,28	23,90	25,45	0,94
10 - 15	M50	251,95	226,95	118,00	25,00	22,95	1,09
15 - 20	M42	247,41	222,00	118,73	25,41	24,61	1,03
15 - 20	M39	269,17	239,48	118,20	29,69	24,48	1,21
15 - 20	M49	257,74	228,34	119,21	29,40	26,94	1,09
sampling3: 2007-08-13							
1 - 1	M34	259,85	226,52	118,30	33,33	30,80	1,08
1 - 2	M28	279,59	247,39	118,60	32,20	25,00	1,29
1 - 3	M36	262,27	235,84	119,11	26,43	22,64	1,17
2 - 1	M22	263,99	235,35	118,68	28,64	24,55	1,17
2 - 2	M41	261,65	230,12	118,75	31,53	28,31	1,11
2 - 3	M43	253,51	226,43	118,27	27,08	25,04	1,08
3 - 1	M31	280,57	243,34	119,54	37,23	30,07	1,24
3 - 2	M27	271,15	235,01	118,28	36,14	30,96	1,17
3 - 3	M50	262,96	230,24	118,00	32,72	29,15	1,12
4 - 1	M42	272,20	237,53	118,73	34,67	29,18	1,19
4 - 2	M39	265,32	230,52	118,20	34,80	30,98	1,12
4 - 3	M49	289,14	251,27	119,21	37,87	28,68	1,32

Table 3-4: BT03 soil moisture measurements with 100cm^3 cylinder.

depth [cm]	number	moist weight [g]	dry weight [g]	cylinder [g]	vol. water content [%]	grav. water content [%]	bulk density [g/cm^3]
sampling 1: 2007-06-27							
0 - 5	M44	267,81	230,43	119,03	37,38	33,55	1,11
0 - 5	M21	260,09	223,79	118,85	36,3	34,59	1,05
0 - 5	M9	276,48	235,97	118,89	40,51	34,60	1,17
5 - 10	M5	268,24	236	119,1	32,24	27,58	1,17
5 - 10	M46	266,75	235,31	118,41	31,44	26,89	1,17
5 - 10	M11	267,67	235,74	118,48	31,93	27,23	1,17
10 - 15	M4	275,41	243,66	119,28	31,75	25,53	1,24
10 - 15	M3	279,36	247,31	119,4	32,05	25,06	1,28
10 - 15	M19	267,75	236,72	119,46	31,03	26,46	1,17
15 - 20	M1	270,87	242,45	117,35	28,42	22,72	1,25
15 - 20	M8	283,67	253,64	117,95	30,03	22,13	1,36
15 - 20	M33	264,1	236,36	117,67	27,74	23,37	1,19
sampling 2: 2007-07-24							
0 - 5	M44	261,25	227,34	119,03	33,91	31,31	1,08
0 - 5	M21	269,05	238,43	118,85	30,62	25,61	1,20
0 - 5	M9	281,42	249,00	118,89	32,42	24,92	1,30
5 - 10	M5	254,91	229,75	119,10	25,16	22,74	1,11
5 - 10	M46	266,79	237,72	118,41	29,07	24,37	1,19
5 - 10	M11	267,98	241,21	118,48	26,77	21,81	1,23
10 - 15	M4	263,64	240,56	119,28	23,08	19,03	1,21
10 - 15	M3	262,95	240,26	119,40	22,69	18,77	1,21
10 - 15	M19	264,96	242,71	119,46	22,25	18,05	1,23
15 - 20	M1	281,18	257,10	117,35	24,08	17,23	1,40
15 - 20	M8	278,70	255,22	117,95	23,48	17,10	1,37
15 - 20	M33	260,54	240,34	117,67	20,20	16,47	1,23
sampling3: 2007-08-14							
1 - 1	M44	282,82	243,36	119,03	39,46	31,74	1,24
1 - 2	M21	263,95	227,81	118,85	36,14	33,17	1,09
1 - 3	M9	267,73	231,54	118,89	36,19	32,13	1,13
2 - 1	M5	279,28	243,72	119,10	35,56	28,53	1,25
2 - 2	39308	271,51	239,43	118,41	32,08	26,51	1,21
2 - 3	M11	266,97	234,15	118,48	32,82	28,37	1,16
3 - 1	M4	275,31	243,82	119,28	31,49	25,29	1,25
3 - 2	M3	283,69	250,62	119,40	33,07	25,20	1,31
3 - 3	M19	286,86	253,27	119,46	33,59	25,10	1,34
4 - 1	M1	277,82	247,50	117,35	30,32	23,30	1,30
4 - 2	M8	273,39	243,44	117,95	29,95	23,87	1,25
4 - 3	M33	268,09	240,89	117,67	27,20	22,07	1,23

Table 3-5: BT04 soil moisture measurements with 100cm^3 cylinder.

depth [cm]	**number**	**moist weight [g]**	**dry weight [g]**	**cylinder [g]**	**vol. water content [%]**	**grav. water content [%]**	**bulk density [g/cm^3]**
sampling 1: 2007-06-27							
0 - 5	M26	279,65	248,23	118,43	31,42	24,21	1,30
0 - 5	M45	271,48	240,13	118,47	31,35	25,77	1,22
0 - 5	M40	279,55	245,53	118,45	34,02	26,77	1,27
5 - 10	M29	243,8	237,04	119	6,76	5,73	1,18
5 - 10	M24	259,19	252,56	117,79	6,63	4,92	1,35
5 - 10	M20	249,31	243,34	118,39	5,97	4,78	1,25
sampling 2: 2007-07-24							
0 - 5	M26	253,37	212,14	118,43	41,23	44,00	0,94
0 - 5	m45	266,98	222,42	118,47	44,56	42,87	1,04
0 - 5	M40	263,86	219,53	118,45	44,33	43,86	1,01
5 - 10	M29	258,31	225,68	119	32,63	30,59	1,07
5 - 10	M24	241,5	211,81	117,79	29,69	31,58	0,94
5 - 10	M20	243,95	217,26	118,39	26,69	27,00	0,99
10 - 15	M37	274,26	242,81	118	31,45	25,20	1,25
10 - 15	M28	260,08	231,12	118,1	28,96	25,62	1,13
10 - 15	M23	270,8	239,83	118,71	30,97	25,57	1,21
15 - 20	M30	256,19	230,01	118,57	26,18	23,49	1,11
15 - 20	M47	247,54	223,9	118,08	23,64	22,34	1,06
15 - 20	M48	264,18	236,17	117,3	28,01	23,56	1,19
sampling3: 2007-08-14							
1 - 1	M26	265,57	226,12	118,43	39,45	36,63	1,08
1 - 2	m45	273,72	232,81	118,47	40,91	35,78	1,14
1 - 3	M40	262,85	225,52	118,45	37,33	34,87	1,07
2 - 1	M29	267,97	236,85	119,00	31,12	26,41	1,18
2 - 2	M24	272,57	243,99	117,79	28,58	33,73	1,26
2 - 3	M20	286,56	254,89	118,39	31,67	0,46	1,37
3 - 1	M37	255,52	229,68	118,00	25,84	36,14	1,12
3 - 2	M28	270,04	244,14	118,10	25,90	20,55	1,26
3 - 3	M23	282,37	250,70	118,71	31,67	23,99	1,32
4 - 1	M30	269,71	240,87	118,57	28,84	23,58	1,22
4 - 2	M47	276,22	244,49	118,08	31,73	25,10	1,26
4 - 3	M48	272,54	242,4	117,3	30,14	24,09	1,251

3.2.2 Soil profiles

Table 3-6: BT01 soil profile.

profile_nr	depth [cm]	signature	description	color	comments
1	0 - 30	Sl3	mean loamy sand	grey-brown	
	30 - 50	Sl2	weak loamy sand	reddish	
	50+				probably stones
2	0 - 30	Sl3	mean loamy sand	grey-brown	
	30 - 59	Sl2	weak loamy sand	reddish	
	59+				probably stones
3	0 - 25	Sl3	mean loamy sand	grey-brown	
	25 - 47	Sl2	weak loamy sand	reddish	
	47+				probably stones

Table 3-7: BT02 soil profile.

profile_nr	depth [cm]	signature	description	color	comments
1	0 - 30	Sl3	mean loamy sand	grey-brown	
	30 - 56	Sl3	mean loamy sand	reddish grey-brown	
	56 - 90	Sl2	weak loamy sand	reddish	
2	0 - 30	Sl3	mean loamy sand	grey-brown	
	30 - 100	Sl2	weak loamy sand	reddish	
3	0 - 20	Sl3	mean loamy sand	grey-brown	
	20 - 48	Sl3	mean loamy sand	reddish grey-brown	
	48 - 100	Sl2	weak loamy sand	reddish	

Table 3-8: BT03 soil profile.

profile_nr	depth [cm]	signature	description	color	comments
1	0 - 52	Sl2	weak loamy sand	brown	
	52 - 72	Sl2	weak loamy sand	reddish brown	
	72+				probably stones
2	0 - 57	Sl2	weak loamy sand	brown	
	57 - 71	Sl3	mean loamy sand	reddish brown	
	71+				probably stones
3	0 - 45	Sl2	weak loamy sand	brown	
	45 - 61	Sl2	weak loamy sand	reddish brown	
	61+				probably stones

Table 3-9: BT04 soil profile.

profile_nr	depth [cm]	signature	description	color	comments
1	0 - 44	St2	weak clayey sand	brown	
	44 - 62	Slu	silty-loamy sand	reddish brown	
2	0 - 50	St2	weak clayey sand	brown	
	50+	St2	weak clayey sand	reddish brown	
3	0 - 56	Sl4	strong loamy sans	brown	
	56+	Sl2	weak loamy sand	reddish brown	

4 Available data (days with convection events in the morning)

Table 4-1: List of IOP days with convection events in the morning for the station Fußbach 1: event time, data quality, wind rotation and Sodar-Rass availability are also specified. Events denoted with * only show a z/L value near < -1. (remark: replace ? by <)

date	IOP	event time (decline of z/L) [UTC]	data quality (flag system) during event	wind rotation from SW to N	Scenario (according to http://www.cops2007.de/)	Sodar-Rass availability
2007-06-05	1a	6:00 - 8:00	? 7	+	high pressure convection	complete data failure
2007-06-08	1d	6:45 - 9:45	? 5	+	high pressure/ forced convection	complete data failure
2007-06-14	3a	7:30 - 8:45 and 9:15 - 10:30	? 3 and ? 7	-	weakly forced diurnal convection	+
2007-06-19	4a	7:00 - 8:15	? 3	+	high pressure convection	+
2007-07-01	5a	7:30 - 9:30	? 7	intermittent	forced convection	complete data failure
2007-07-02	5b	8:00 - 9:00	? 7	intermittent	forced convection	data failure before 14:00
2007-07-15	8b	* 7:00 - 9:00	? 7	+	high pressure convection	+
2007-07-23	10	6:45 - 7:45	? 6	+	forced convection	data failure before 10:30
2007-07-25	11a	7:00 - 8:45	? 3	+	high pressure convection	+
2007-08-03	13b	7:00 - 8:15 and 9:00 - 10:00	? 5 and ? 3	+	forced convection	+
2007-08-06	14a	8:00 - 9:00	? 3	+	no information	data failure before 10:30
2007-08-13	15b	* 6:45 - 8:00	? 3	+	high pressure/weakly forced convection	+
2007-08-21	17a	6:15 - 7:15	? 5	+	weakly-forced convection	+
2007-08-25	18b	8:45 - 9:45	? 3	+	high pressure convection	+
2007-08-26	18b	* 8:15 - 9:45	? 3	+	high pressure convection	+

Table 4-22: List of interesting no-IOP days with free convection in the morning (remark: replace ? by <)

date	IOP	event time (z/L < -1) [UTC]	data quality (flag system) during event	wind rotation from SW to N	Scenario (according to http://www.cops2007.de/)	Sodar-Rass availability
2007-06-13	no	7:00 - 8:45 and 9:15 - 10:15	? 3 and ? 5	+	no information	+
2007-07-16	no	7:45 - 9:30	? 7	+	no information	+

5 Weather reports

The following weather report consists of daily excerpts from the regional COPS weather summaries on the official COPS Operation Centre Website (http://www.cops2007.de/). No summary is given for down days, the weather reports at 'COPS_meta\4_Reports\COPS weather summary\' have been used until 2007-08-17, thereafter the operation plans of the day at 'COPS_meta\4_Reports\COPS ops plan of the day\' have been taken since no further weather reports have been downloaded:

02 June 2007
Today, the COPS area will be affected by the latter mentioned small-scale, westward moving vorticity maximum (vort max) which is responsible for some mid/high level cloudiness and which may aid in convective initiation later in the day. Convective debris associated with this feature is in the process of substantial weakening, per latest radar trends, and should thus not affect the COPS area. This vort max will accelerate westward as it phases with a short-wave trough which pivots around the Mediterranean cut-off cyclone, altogether resulting in subsidence over the COPS region, and possibly in dissolving of the clouds. Surface flow will be northeasterly and rather weak; Where breaks in the clouds occur, thermodynamic profiles will become marginally unstable, with mixed-layer CAPEs expected to be in the 100 - 300 J/kg range. Shear profiles will be quite weak as well, so that the threat for organized storms is also very low.

04 June 2007
The COPS area remains under the influence of moderately moist, weakly unstable and weakly capped air. Large-scale forcing for ascent is missing, so any convective evolution will likely be tied to orography, and maybe to mesoscale boundaries, which have not been analyzed at the moment, however. Today's 00Z ascents from Stuttgart and Nancy revealed an inversion near 650 hPa, which may be obstructive to the development of deep moist convection. Current thinking is that the majority of the cumuli will spread beneath this stable layer, with only few parcels being able to penetrate the inversion. Though weak buoyancy will likely be present above the inversion, it is possible that sustained updrafts will not be able to develop. Most likely mode should be short-lived cells, though an isolated, poorly organized, small multicellular storm could develop.

06 June 2007
Today's convection appears to be mostly limited to the layer below around 600 hPa, where an inversion layer is located. Although it is possible that convective updrafts will locally break through the inversion layer later today, but this appears not very likely.

Possible reasons for failure of convective initiation include mixing effects created by the low level wind shear and increased upper-level cloudiness reducing surface heating. These are interesting questions to study.

07 June 2007
This morning's ascent from Stuttgart reveals that the mid-level inversion has vanished, an allover warming of the profiles, as well as substantial low-level moistening, resulting in about 800 J/kg MLCAPE. Given minimal capping, it seems likely that rather numerous thunderstorms will form, especially over the Black Forest and the Vosges mountains. However, the mesoscale models are still reluctant to initiate the convection, but this had been the case earlier this week when convection did develop afterwards. Storms may merge into clusters in the evening hours, which may well last into the night.

08 June 2007
Quite moist air is present over northern France, which is expected to be advected into the COPS area during the day. Initially, some dry advection may affect the northern COPS area, as long as the low-level winds have an easterly component. With the northward progression and strengthening of the surface low, resulting in a veering of the surface flow, the moist air should gradually spread across all of the COPS area until late evening. Though the vertical temperature lapse rates are not particularly strong, MLCAPE in excess of 1000 J/kg may develop until late in the day.
Given increasing DCVA-related ascent ahead of the upper low, widespread thunderstorms should form. Current thinking is that convection will again struggle to initiate over the northern Black Forest region, but may have better success over the southern Black Forest and the southern Vosges, given stronger low-level moisture and the closer proximity to the region of large-scale forcing for ascent. At the same time, extensive convective activity will develop over eastern France and slowly advance eastward, reaching the COPS area late in the night or early Saturday morning. Evolution of one or more weakly organized MCSs may ensue, though these will likely reach the COPS domain after having undergone substantial weakening. In fact, models do not produce much precipitation, and the forecast of the strength of this system remains challenging.

11 June 2007
Water vapor imagery clearly reveals a small upper low which is residing over southern Germany and should make slow eastward progress while gradually weakening. Some CAPE is expected to be in place according to both the GFS and ECMWF models that are simulating convective precipitation during the day. Interestingly, the available mesoscale models again do not initiate deep convection during the afternoon, though this has proven

to be no reliable information based on last week's experience. During the next hours, convection should become more widespread, and possibly merge into small clusters towards the evening hours. Given weak forcing for upward motion, convective activity should gradually diminish after sunset.

12 June 2007
The low-level stratiform clouds should continue to mix out during the next few hours and convective development should become more widespread. Latest soundings indicate a weak inversion near 600 hPa, which may obstruct part of the convection and result in stratiform cloudiness beneath the inversion. Still, scattered thunderstorms should form which may again conglomerate into small clusters in the afternoon. Storms may persist through much of the evening/night.

13 June 2007
Thermodynamic profiles suggest that weak instability will evolve during the day, so that a few isolated thunderstorms may form again in the afternoon hours. Given a lack of large- and mesoscale forcing for ascent, convection should diminish with the loss of daytime heating in the evening hours.

14 June 2007
The 00 UTC ascents from Stuttgart and Nancy already revealed surface-based CAPE (in addition to elevated CAPE, which has been released by the early-morning mid-level convection), and given sustained lapse-rate advection as well as low-level warming, CAPE should undergo some increase during the day. The GFS as well as the water-vapor imagery suggest that there are several sub-synoptic-scale perturbations crossing the region today, being superposed on weak large-scale ridging. It is thus somewhat uncertain when the convection will initiate. Current thinking is that isolated convection will form over the southern Vosges/Black Forest in the afternoon hours, and increase in coverage towards the evening. Storms will likely evolve into multicells, which may be capable of some hail, especially over the Vosges mountains in the evening, when/where low-level shear should be maximized.

15 June 2007
Latest observational data suggest that there are currently two main rainbands to affect the COPS area, one being located a few hundred km east of the cold front (which has crossed the operations center around 7:30 CEST). Along the front, which is currently located over eastern France, weak showers are revealed by the radar. Between these two features, no precipitation is occurring, but extensive low-level cloudiness is present. However, there are some chances of convective development over the COPS domain today: The most

likely scenario is that insolation will help in creating larger cloud gaps between the two rain bands. If this occurs, initiation may occur, possibly over the eastern COPS area where daytime heating will have lasted longest before the front passes. Given strong shear profiles, the storms will have fair chances of rapidly evolving into well-organized multicells or supercells, capable of severe wind gusts and large hail. However, this scenario is conditional upon the development of large cloud-free zones ahead of the cold front. The water vapor imagery shows a dry intrusion just west of the surface front. Should this feature overspread the front, reduced cloudiness would result, enhancing the chances for convective initiation also directly along the front. The latest GFS run (00 UTC) advertises the development of an MCS over the COPS region between 12 UTC and 15 UTC, which moves out of the area in the late afternoon.

18 June 2007
synoptic controls over the COPS area will be weak. In the south, slight positive vorticity advection is expected, which is probably an important factor for the ECMWF model to produce some convective precipitation over the area, mainly in the evening. Other models, however, do not confirm this. A few showers or even thunderstorms are nevertheless expected this afternoon. Their coverage should slowly diminish this evening.

19 June 2007
Synoptic controls over the COPS area will initially be weak. However, the combination of increasing warm air advection and an approaching weak mid-/upper vorticity maximum during the evening hours should help to provide some upward vertical motion sufficient to initiate a few convective storms. These should be decoupled from the nocturnal boundary layer. As warm air advection moves eastward of the COPS area during the morning, any convection should do so too. It should however leave a rather moist and unstable lower troposphere in its wake that during the day will allow for renewed convective development, this time surface-based. The western extent of this unstable air will be formed by a cold front that is currently expected over the northwestern part of the COPS area. However, the exact position of the front varies from run to run and from model to model. A chance does exist that the front will be located further east and that most of the COPS area will experience too stable conditions for convective storm initiation. We do however not feel that this scenario is particularly likely.

20 June 2007
A quite unstable air-mass is present over the area east of a diffuse frontal zone over the western COPS area. The Burnhaupt sounding of 5 UTC displays a deep moist layer in the lowest kilometre of the troposphere. This should allow at least 1000 J/kg mixed-layer

CAPE to form in response to solar heating. Further north, the boundary layer is less moist and somewhat lower CAPE is expected. initation of storms is expected, firstly over the mountains.

21 June 2007

The moist and warm airmass is still present over the eastern COPS area. As the developping surface low will leave the COPS area into a northeasterly direction, cooler air will replace the unstable warm and moist air from the west. The models indicate a mesoscale area with mainly stratiform clouds and possible heavy precipitation. To the east op the COPS area near the frontal zone thunderstorms may increase the precipitation, some gusts up to 25 m/s are possible. Around noon this MCS will leave the southern parts of the COPS area, later on the northern parts, too. Some local showers are likely to follow until the evening.

22 June 2007

A vorticity maximum with stratiform clouds and embedded convection presently affects the COPS area but will leave slowly to the east. Some showers and local thunderstorms are likely to develop until evening.

25 June 2007

Currently, a prefrontal line of storms over northern Bavaria, Baden-Württemberg and Hesse. This activity is associated with rising motion in the warm advection regime. Visible satellite imagery shows an area of clearing behind this system ahead of a cold front stretching from the Saarland to central France. This should create the opportunity for some surface-based CAPE to form. A narrow convective line has already formed along the frontal boundary. It is expected to accelerate eastward through the COPS region during the early afternoon. Strong winds -in excess of 20 m/s winds at 850 hPa- suggest that strong wind gusts could occur. The strong shear additionally suggests that a few short-lived tornadoes are possible as well along the squall. Behind the squall, gusty winds will likely persevere and some rain is expected to set in later in the day.

27 June 2007

Current radar trend indicates that the mesoscale stratiform precipitation region that affected the COPS area this morning, will move off to the east while undergoing some weakening. During the afternoon hours, some rain showers will likely develop. The latest GFS simulates rather strong quasi-geostrophic forcing this evening, which could act to increase the depth/strength of the showers somewhat, though the evolution of stratiform precipitation may also occur with this feature, especially late in the evening/night.

28 June 2007

Some isolated showers, extending up to around 4000 m AGL will affect the COPS area today. Widespread cloudiness should persist until the late afternoon. On the approach of a shortwave ridge, descending motion and dissolution of clouds is expected during the evening.

29 June 2007

Mid-level cloudiness will likely prevail, with shallow cumulus convection underneath it, where the thickness of the mid-level clouds is sufficiently thin to allow the buildup of a convective boundary layer. However, with the approach of the above-mentioned trough over the North Sea, mid-level cloudiness is likely to increase in depth, which may also lead to rain in the COPS area, which may later attain convective character.

30 June 2007

Mid-level clouds over the northern half of the COPS area, that were responsible for some rain this morning, are expected to move eastward out of the region. Some high-level clouds, will however likely remain present throughout the day and coming night.

01 July 2007

Warm air advection and weak vorticity forcing has led to high level cloudiness already. From around noon mid-level clouds are also expected to form over the COPS area and might generate a little stratiform rain in the western parts. Although not very likely, an isolated shower or thunderstorm over the mountains may not be excluded towards the evening. In the first half of the night, a strong increase of convective activity is expected, bringing widespread showers and thunderstorms, moving in from eastern France and Switzerland. Thunderstorms may organize into MCS with some severe weather possible.

02 July 2007

Front associated cloudiness and rain will leave the COPS area around noon followed by cooler and unstable polar air mass. As the aforementioned long wave trough will cross the COPS area until the evening, vorticity forcing is present initiating widespread convective activity. Sunny spells and the given CAPE should make thunderstorms likely. Showers and storms will diminish during the night.

03 July 2007

Large scale forcing associated with several mid/upper-level troughs ahead of the eastward propagating frontal wave already provide mainly stratiform clouds and precipitation. The cold front is expected to cross the COPS area around midnight. Given windshear and instability, some severe weather is possible, including thunderstorms and storm force gusts.

04 July 2007
A large pool of cold polar air is present over the COPS area. A steep lapse rate provides some CAPE. During the entire Wednesday frequent showers and some thunderstorms are to be expected. Showers/storms might be strong in places and accompanied by storm force gusts and/or small hail. The showers/storms are seperated by short sunny intervals, being even shorter in mountainous areas. Convective activity will temporarily decrease during the night.

07 July 2007
The COPS-area lies at the northern edge of a surface frontal zone. Ahead of the ridge that starts to build up over France stabilisation is expected to increase until the night to Sunday. Apart from a single shower or two that could form in the very south of the COPS area, mostly shallow cumulus cloud should prevail; they partly may spread into stratocumulus and be accompanied with some altocumulus cloud patches in the midlevel.

08 July 2007
The COPS-area lies within a frontal zone, indicated by mid-level altocumus clouds and some cumulus clouds, that formed already.The increasing low-level southwesterly flow of warm and moist air and a passing upper-level short wave trough give the possibility of mainly stratiform rain in the afternoon with some embedded convection, even a local thunderstom cannot be excluded. The forementioned frontal wave is expected to cross the COPS area during the night from Sunday to Monday. Whereas at its northwestern edge in the colder air the rain is mainly non-convective, the COPS area should lie within warm and moist airmasses at first. Given horizontal temperature gradient, CAPE and wind shear, MCSs are likely to develop in the transition zone, with the possibility of embedded thunderstorms and some severe weather including heavy precipitation as well as hail and storm force gusts. As some models agree in the prediction of the tracks of the northeastward travelling MCSs, rain and thunderstorms are likely to be of less intensity within the COPS area. Although severe weather cannot be excluded throughout the COPS region.

09 July 2007
Still relatively warm and moist air is gradually being replaced by polar air during the course of the day. Mostly dry but cloudy conditions should prevail during the morning hours. Only little sunshine is to be expected throughout the day. Towards the afternoon/evening an approaching upper level short wave trough leads to large scale

ascent associated with mainly mid level cloudiness but also embedded showers and some thunderstorms. There remains some uncertainty in the amount of cloudiness, which is more pronounced in the latest GFS model run than in the LM forecast, the latter indicating more intense convective activity in southwestern Germany in the second half of the day.

10 July 2007

Central and northern parts of the COPS region remain within the moderately unstable, polar air mass in the centre of the trough. The main pool of upper level cold air remains over the COPS region today setting the stage for widespread shower activity, supported by slight increase of instability in conjunction with the diurnal cycle. Upper level forcing remains weak, so the convective activity can be characterized as mostly unorganized individual shower cells. The southern parts of the COPS region, being closer to an upper level vorticity maximum that moves across France to northern Italy, will experience some large scale ascent. Precipitation as well as cloudiness in these areas will partly be of stratiform character with embedded shower activity.

11 July 2007

A moist and slightly unstable polar air mass is still present over the COPS region. During the morning hours showers form mainly in the southern half of the COPS region, towards the evening rather in the northern part. Morning convective activity is mainly triggered by weakly divergent flow in the entrance region of a small branch of the jet extending across the Alps northwestward into the Alsace region. Afternoon convection is, on the one hand, tied to the diurnal cycle, on the other hand to some weak large scale forcing ahead of a surface trough, which is crossing Germany from the North Sea to the Southeast during the evening and the following night.

12 July 2007

The eastern part of the COPS area is still under the influence of the moist polar air mass in the early morning. However, slightly drier air, already stably stratified at mid levels, will arrive already during the morning and provide some short sunny spells. Towards noon the high level cloud shield of the approaching warm front will move in, getting denser during the afternoon and crossing the COPS region. Some light rain is possible in the evening.

13 July 2007

Anticyclonic conditions will dominate during the course of the day. The northern part of the COPS area is still under the influence of low level clouds, forming in the moist air. In the South, the air is already drier.

14 July 2007

Anticyclonic conditions will dominate during the course of the day. The air mass will be dry and warm. Generally, the sky is clear. Dry convection is developing at the end of the morning. Only few Cumulus (1 to 2 octas) are developing over the mountains without any precipitation. Some more unstable airmass moves from Aquitaine to the North-East but it doesn´t touch COPS area – in the worst, few instable Ac could be observed in the afternoon in North-West of COPS Area.

15 July 2007

Anticyclonic conditions and diurnal cycle manage again the weather. The air mass is drier and warmer than yesterday. Generally, the sky is clear. Dry convection is developing daytime and some shallow Cumulus develop over southern mountains.

16 July 2007

As the broad high-pressure ridge has shifted to the east, anticyclonic influence is still present over the COPS area. Due to the lack of mid/upper-level large scale forcings and the dry air, mainly shallow cumulus clouds are developping over the Vosges and the Black Forest. However, a shower/thunderstorm or two over the eastern slopes of the Black Forest cannot be excluded towards the late afternoon/evening.

17 July 2007

Today, the extended cloudiness that was present during the morning hours with small amounts of stratiform precipitation, diminishes towards the afternoon with some sunny intervals in between. As a weak upper-level short-wave trough approaches the COPS area, convective activity is likely to increase again towards the evening/night. Given CAPE and deep layer wind shear, there is a slight chance for thunderstorms organizing into a MCS or even supercells. However, the main convective activity will be found in the eastern and southern parts of the COPS area during the night.

18 July 2007

The frontal zone is pushed somewhat southeastwards towards the Alps, leading to more stable conditions in the COPS area in the course of the day. Stratiform cloud remnants and some rain from the morning is expected to dissolve and leave the COPS area from around noon. However, it might take some more time until the mountains get free of clouds. As largescale forcing remains weak, only one or two showers/thunderstorms may develop towards evening preferably in the south-eastern parts of the COPS area.

19 July 2007

Remnants of MCS-like systems, embedded in a still pretty strong southwesterly flow aloft and triggered by low level positive temperature advection and upper level vorticity maxima, are expected to leave COPS area from around noon. Some low level clouds in their wake should diminish during the afternoon hours giving the sun greater portions of the sky. Depending on timing and duration of the insolation there is a good chance for new showers and thunderstorms to form in the late afternoon/evening mainly over the mountains.

20 July 2007

A large MCS is already ongoing over central and eastern France. Over the COPS area, solar heating and upward vertical motion should be capable of creating around 2000 J/kg MLCAPE. The most widespread, mostly clustered storms will however be mainly tied to the strong forcing and will pass the COPS area to the northwest. The Vosges mountains may be affected by the aformentioned ongoing convective activity over France, whereas most isolated new development is likely over the Black Forest and further east over southern Germany during the latter half of the afternoon. Storms may become supercells and will have a large potential to produce large hail and strong downburst winds. The convection should move out of the COPS area as a cold front passes the Rhine Valley from the west at about 17 UTC.

21 July 2007

Over the COPS area, widespread clouds are expected during most of Saturday, although a few sunny spells may occur in the northwest. Some rain is expected during the entire day and night, especially over the eastern part of the COPS area that is partly convective in nature. A more or less intense mesoscale convective system is forecast to move northeastward over the eastern half of the COPS area during the evening.

22 July 2007

On Sunday the COPS area lies in the wake of a still intensifying surface low that developed over Bavaria/Austria yesterday evening and travels towards the Baltic Sea. No significant forcings are to be expected over southwestern Germany, even a ridging will be noticeable. Remnants of low/mid-level stratiform cloudiness have diminished in the morning hours, followed by some insolation and a quite surprising but short shower and thunderstorm activity on the western slopes of the Black Forest. In the afternoon, only more or less shallow cumulus clouds will be left. However, a shower or two cannot be excluded, a thunderstorm is unlikely.

23 July 2007

Today, the COPS area will be affected by a low pressure system that had developed on the eastern North Atlantic. It is travelling pretty fast towards the northeast with its center to be found over the Benelux on Tuesday morning. Ahead of the low, midlevel stratiform cloudiness has already arrived to the COPS area and will be present in the afternoon, too. However, only a few raindrops might fall at first. There is a little uncertainty concerning convection activity. If insolation will be significant enough, cumulus clouds may develop; given significant but not large amounts of CAPE even a thunderstorm may occur. This scenario is most likely in Bavaria, the COPS area probably will not see any thunderstorms before 15 UTC. The cold front is expected to cross the COPS area between 17 and 19 UTC. The passage can be accompanied by quite intense rain, some thunderstorms might be embedded with gusts up to 20 m/s.

24 July 2007

On Tuesday, the COPS area will be under the influence of an upper low system bringing cool, windy or even stormy conditions over the mountains with rain mostly of convective nature. A crossing upper-level short wave trough gives additional forcing, therefore convective activity often is of embedded character in the early afternoon, clouds prevail. Towards evening the sun might get a greater portion of the sky, showers are of more isolated pattern and decrease in frequency; however, a single thunderstorm or two cannot be excluded in the very south of COPS area.

25 July 2007

A high pressure ridge, initially found over France, propagates further to the east and leads to increasing and eventually strong mid-level subsidence on Wednesday. Some stratiform clouds at a morning low-level inversion have largely diminished already. Shallow cumulus clouds, are likely to form in the course of the day with tops probably not exceeding 700 hPa (3000 m) as a strong inversion will be present at that level. Showers or thunderstorms are not to be expected. Mid/upper-level winds weaken.

26 July 2007

At 06 UTC, the ridge axis has already moved out of the COPS area but still induces an inversion layer in the morning hours. As skies are nearly free of clouds, sun heating is pretty intense leading to a strong temperature rising. As low level atmosphere is much drier than yesterday, only few to scattered cumulus are to be expected with diurnal evolution. With the inversion layer vanishing around noon, one or another cumulus cloud might be able to grow up eventually leading to a very isolated shower. In response to CAPE charts and considering the help of a weak crossing vorticity maximum, the risk of a late afternoon/evening thunderstorm is rather weak but cannot be ruled out. Chances are best in the very south of the Black Forest and of the Vosges mountains. High clouds, tied to the forward edge of the disturbance will arrive, getting denser towards evening/night. Anyway, these cirrus clouds will not much disturb convection. Surface winds freshen in the course of the day but are not of significant strength, the winds aloft become stronger towards the evening from the southwest.

27 July 2007
In a rather strong mid/upper-level westerly flow only weak forcings are to be expected over the COPS area in the course of Friday. Two weak frontal zones linger around the COPS area but will not become very active. Some low-level clouds prevail early on, becoming scattered during the afternoon. Insolation leads to cumulus clouds (Cu hum, Cu med), partly embedded in stratiform layers. Chances for sunshine are best in the late afternoon/evening. Most of the area will stay dry, however, isolated weak showers are possible. A mean westerly wind of 25 kt is expected above 1000 m.

28 July 2007
In the strong westerly flow aloft, an embedded surface frontal wave currently moves eastward over Germany and is expected near the Polish border on Saturday afternoon. Low/mid level mostly stratiform clouds prevail throughout the day, becoming more convective with the approach of the cold front in the afternoon. There might be some gaps in the cloud cover, preferably in the lee of the Vosges mountains and the Black Forest . A few rain drops are possible at first, followed by scattered showers during the afternoon. As slightly unstable air is present, a thunderstorm or two may not be excluded to form over central Germany but are unlikely in the COPS area.

29 July 2007
In the strong westerly flow aloft, an embedded surface frontal wave currently moves eastward over Germany on Sunday. During afternoon hours large amounts of low/mid-level mainly stratiform clouds prevail, some stratiform rain is expected in places. While the cold front approaches, rain becomes of partly convective nature, although a thunderstorm seems not to be very likely. The cold front itself is expected to cross the COPS area at 16-18 UTC. While crossing a mid/upper-level short wave trough might give additional forcing enhancing precipitation acitivity. The passage could be quite pronounced with heavy rain, a possible thunderstorm and storm force gusts.

30 July 2007
In the wake of a frontal wave, the cold front of which has crossed COPS area yesterday in the late afternoon, a strong northwesterly flow has been established. Embedded mid/upper-level short wave troughs give some forcing, though being of less intensity in

southwestern Germany. Morning Sc over the Black Forest has evolved into Cu, accompanied by Cu elsewhere in the course of the day. As an inversion layer is present around 700 hPa, most Cu will not grow deeper. However, there is a chance for few Cu con, and – although unlikely – even one shower or two cannot be ruled out.

31 July 2007
Between a mid-/upper-level long wave trough that initially stretches from Scandinavia over the eastern parts of central Europe into the central Mediterranean Sea region and a high pressure ridge located over western Europe a north-westerly flow is present over central Europe advecting rather cool air of polar origin. As the ridge moves slowly towards the east, mid-level subsidence leads to an inversion at about 700 hPa. Therefore dry and fair weather conditions will prevail in the COPS area with only few shallow cumulus clouds that are likely to form in the course of the today.

01 August 2007
In the night to Thursday, the trough, that is followed by a cold front at the surface approaches the COPS area. As a result, the cloud cover, including embedded convective clouds will increase on the approach of an area of rain and convective storms that affects the COPS area in the 03-09 UTC time frame. Winds in the lower troposphere are expected to increase to about 15-20 m/s, so that the passage of the showers will likely be accompanied by relatively strong gusts, especially in the hills and mountains. In the wake of the storm system, cumulus and stratocumulus clouds will likely linger on and produce a few more light showers. This is especially the case during the late evening as a second trough approaches the COPS area from the west.

02 August 2007
The remnants of an MCS that has developed over France on Wednesday evening have moved to the northeast of the COPS area. In its wake, some sunshine is possible that may help to create some new instability. A surface trough that moves eastward over north-central France would then likely be the focal point of the convective activity. A problem that may prevent well-developed storms to form is the abundant low-level clouds currently west of the COPS area and lack of insolation preventing a fair amount of instability to form. Also, forcing may prove to be too weak. Nevertheless a few showers are expected during the afternoon.

03 August 2007
In the morning hours, mid-level and low-level clouds producing some scarce stratiform rain. With both diurnal evolution and the on-coming ridge, this cloud cover will turn into Cu clouds in the afternoon. In bright intervals, mediocris or even congestus Cu are likely.

A few light showers can be expected in the afternoon dying out in the evening. Thunderstorms are not likely as the convective storms should remain rather shallow.

06 August 2007
A diffuse frontal zone located from the Benelux countries over central France to Spain forms the western boundary of a plume of warm air. East of this zone, a convergence line has formed, partly in response to a vorticity maximum moving northeastward over France. Along the zone, surface-based convective storms are expected to form during Monday. Those storms will likely affect the COPS area late Monday afternoon and during the evening. Elevated convection and stratiform rain is expected near the cold front.

07 August 2007
A mesoscale convective system moves over the COPS area towards the northeast during the morning hours. Behind the MCS, a dry period will start that should last overnight and into Wednesday afternoon.

08 August 2007
Currently, the main 850 hPa front is aligned north/south, stretching right across the COPS area. With the eastward progression of the upper low, increasing DCVA-forced ascent will overspread the COPS area late in the day, which will aid in increasing frontogenetic forcing, resulting in strong mesoscale ascent, which will be associated with extensive stratiform precipitation in the late afternoon and evening hours, continuing through the night.

08 August 2007
Strong zonally-oriented baroclinic zone is currently stretching across the COPS area and will remain focus for ascent and mainly stratiform precipitation. It seems that the maximum of precipitation will be present north of the low-level frontal boundary, and it should not affect the COPS area. However, light rain will likely continue through most of the day.

11 August 2007
It appears that the sky will remain overcast during most of the day, with temporary, embedded rain showers. Models indicate that there will be some clearing, but not until late evening.

12 August 2007

The fog that is lingering over much of the COPS area should gradually disappear until 10 UTC, whereafter diabatic surface heating should allow for the build-up of a convective boundary layer. Towards early afternoon, first thunderstorms are expected, which should remain rather isolated until early evening, however. Thereafter, large-scale upward motion associated with a short-wave trough that grazes the COPS domain will affect the region, and showers/thunderstorms should become more widespread. The evolution into the night is somewhat uncertain. The loss of diurnal heating may be compensated for by large-scale ascent. Indeed, most meso- and large-scale models advertise precipitation throughout most of the night. Current thinking is that thunderstorms may continue until late evening (maybe as late as 00 UTC), but chance also exists that they will diminish earlier.

13 August 2007

The mesoscale details over the COPS region are somewhat complicated. The satellite loop reveals two cloud bands, one of which is associated with the storms that occurred during the past night. This cloud band appears to have been associated with a vorticity maximum which is currently entering western Germany. The upstream cloud band is correlated with a frontogenesis signal in the latest GFS analyses, which is tied to a weak cold front curving from central France into western Germany. Though the COPS region appears to remain in the weakly unstable pre-frontal air mass today, subsidence in the wake of the vorticity maximum moving into Germany should reduce the depth of the convective clouds after around midday/early afternoon. The mesoscale model suite indicates a complete ceasing of convecective precipitation, while the GFS maintains rain showers throughout the day. However, the previous GFS runs have not been too stable with respect to the precip amounts for Monday, so the (rather stable) mesoscale models are trusted more for today. Still, isolated thunderstorms or two could develop over the mountains in the late afternoon and evening hours, when large-scale vertical motion will become more upward again. This activity could even last into the night.

14 August 2007

Cirrus and Altoculumus clouds should persist, and gradually increase, during the day in response to warm advection. Chance of isolated showers and thunderstorms exists especially in the southeast of the COPS domain.

15 August 2007

The picture has not changed much compared to yesterday’s. The cold front should cross the Rhine Valley around 00 UTC. Ahead of this front, some CAPE is expected to develop, albeit not very much owing to weak mid-level lapse rates. However, it should be sufficient to maintain deep convection. Model consensus develops convection around 18 UTC or even a bit later. Current thinking is that thunderstorms will initiate around 18 UTC in the western COPS region and spread eastwards. Shear profiles remain favorable for rapid severe evolution, including a few supercells, main severe threats being damaging wind gusts along with some large hail. Strong low-level shear and ample low-level moisture should support low-level rotation of any supercell that forms, resulting in some threat for a brief tornado or two. However, given somewhat weak CAPE it is currently not expected that storms will grow into large MCSs. Along the main convergence line associated with the cold-frontal boundary, additional storms should form, which may be organized more linearly, given strong linear low-level forcing. Uncertainty exists about how well the storms will survive along the front through the night. However, the above-mentioned strong large- and mesoscale forcing for upward motion could sustain the convective system through the night. This system would pose mainly a threat for strong/severe wind gusts.

16 August 2007
Widespread stratiform cloudiness with some rain is expected to affect the COPS area during the morning and early afternoon, although gradually larger breaks are forecast during the day. Some shallow cumulus clouds will likely develop within the breaks.

17 August 2007
Isolated showers will develop over parts of the COPS area ahead and near the axis of an upper-level trough passing the area from the west. The convective clouds will likely reach up to an inversion at 4-5 km altitude where temperatures around -8 °C should be low enoug h to let them produce precipitation. The clouds may locally overshoot that level and become 7-8 km tall. After about 13 UTC shower coverage is expected to diminish from the west as subsidence sets in behind the trough.

20 August 2007
The major feature on the forecast maps is a trough that has its axis over the British Isles and western France. This trough is filled with relatively unstable air and should move eastward very slowly during the next days while evolving into a slack cut-off low over south-eastern France. At the surface, a low-pressure system should develop in the Gulf of Genua on Monday and later the low should "jump over" the Alps on Tuesday as cyclogenesis is expected over south-western Germany. On August 20, scattered cumulus

clouds are expected over the area. A few showers are still possible in the morning, but it should be dry during the remainder of the day.

21 August 2007

A surface low pressure system is expected to travel from northeastern Germany towards the southwest on Tuesday. Its huge rain area with some embedded thunderstorms will not affect the COPS area, however forces slightly more unstable air into southern Germany. Some CAPE may develop in the course of the day but will be greatest over Bavaria. Stratiform clouds are present at first but rain will cease. Even the sun gets some portions of the sky. During the afternoon hours/towards evening cumulus clouds are likely to form, too, and with the help of an upper-level short wave trough some showers of partly embedded character are expected to develop. Though most likely over southeastern Baden-Württemberg and western Bavaria a thunderstorm or two cannot be ruled out over the COPS region.

22 August 2007

On Wednesday, an upper-tropospheric trough over the western Mediterranean Sea –just off the Spanish east coast- is expected to move rapidly north-eastward. The upward vertical motion associated with it should affect the COPS area during the second half of the evening. Moist near-neutrally stratified air will remain over the eastern COPS area on Wednesday and Thursday, whereas the western part will deal with weakening stratiform precipitation. Competing low-level cold air advection and weak insolation will determine whether sufficient destabilization for isolated convective shower development will occur. Biggest chances are expected for the southern Black Forest and the Swabian Jura, but a few weak showers cannot be ruled out elsewhere, either.

23 August 2007

A large complex upper-level low filled with cold air is located over France, the Benelux, and western Germany. This system is expected to evolve into an elongated trough stretching from the Baltic Sea to Spain. On Friday, its axis will be located just to the northwest of the COPS domain. This should leave an unstable stratification allowing for diurnally-driven convective storms to develop on Friday and possibly on Saturday. Later on Saturday, weak subsidence is forecasted to warm the mid-troposphere so that the chance of convection should decrease. No deep convection is expected on Sunday. Sunday evening a cold front is expected to pass the COPS area from the north, with cool, dry air in its wake. Hence the convective storm potential is very low on Monday, too. Today, on Thursday, some scattered mid-level cloudiness is expected over the COPS area. The near-neutral environment forecast by the models and weakening low-level cold air advection indicate that isolated showers should be possible mainly during the afternoon.

24 August 2007
Today, the axis of an elongated trough stretching from the Baltic Sea to Spain is located just to the north-west of the COPS domain. This should leave a marginally unstable stratification allowing for diurnally-driven convective storms to develop very locally on Friday and Saturday. Later on Saturday, weak subsidence is forecasted to warm the midtroposphere so that the chance of convection should decrease. No deep convection is expected on Sunday. On Monday a cold front is expected to pass the COPS area from the north, with cool, dry air in its wake. Hence the convective storm potential is very low on Monday, too. On Tuesday we will likely experience a return of the frontal zone from the south. Today, Friday should be a quite friendly day with quite some sunshine. In response to solar heating, scattered cumulus clouds will develop during the morning. Over the mountains, a few isolated thunderstorms are expected to develop in the early afternoon.

25 August 2007
Today, on Saturday 25 August scattered convective clouds are expected to develop during the morning, especially over the mountains. There is a small chance that a few of them grow tall enough to produce some rain from the late morning onward. The balance between an increasing tendency for subsidence in the mid-troposphere and solar heating at the surface will determine whether precipitation will form. Small convective clouds and some high cirrus clouds are expected on Sunday. Otherwise, the day should be friendly and relatively sunny.

27 August 2007
The COPS region is situated on the southern periphery of a broad long-wave trough over Scandinavia. A cut-off low located to the west of the Iberian Peninsula is expected to move towards the east in the coming days. Increasing northward warm-air advection is expected ahead of that system. An inactive zonallyoriented front over central Germany is moving southward reaching the COPS region late on Monday. The front will likely be the focus for stratiform and embedded convective precipitation late Tuesday evening into Wednesday and Thursday. Today, Monday, a cold front is expected to move into the COPS area from the north and become quasistationary over the area. Little clouds and no rain are forecasted with this system.

28 August 2007
The COPS region is still situated on the southern periphery of a broad long-wave trough over Scandinavia. A cut-off low located to the west of the Iberian Peninsula is moving

eastward while evolving into a NE-SW oriented trough. Increasing northward warm-air advection is expected ahead of that system. An inactive zonally-oriented front has stalled near the southern COPS domain border. The front will likely be the focus for stratiform and embedded convective precipitation starting late on Tuesday and continuing into Wednesday and in the southeast into Thursday. In southern France and the Alps, the increased warm-air advection will likely cause the initiation of scattered storms within the warm air-mass on Tuesday. Stratiform and elevated convective precipitation is expected to commence in the range of the frontal zone later in the day and may also affect southern parts of the COPS domain.

29 August 2007
The COPS region is situated on the southern periphery of a broad long-wave trough over Scandinavia and ahead of a shortwave trough stretching from the southern North Sea to north-western Spain. Cyclogenesis is taking place over southern France. Ahead of that system, strong warm-air advection is expected. Today, Wednesday, scattered precipitation from elevated convection is expected over the southern and perhaps central parts of the COPS area. Some lightning is possible later with that activity. In addition to convective precipitation, some stratiform rain is expected as well. During the afternoon, the rain should retreat southward, leaving the central and northern COPS region under overcast skies with some mid- and especially high-level clouds.

6 DVD Archive

The documentation, raw data and preliminary results are arranged in five DVDs. The four DVDs "COPS_BT01", "COPS_BT02", "COPS_BT03", "COPS_BT04" contain the entire raw data, preliminary results and graphics for one measurement site each. To allow this handy storage, each one is archived in 7zip format. This packing software is freely available on the internet and also attached to the top level of each DVD. EC calculations have been carried out with preliminary information on the sensor alignment. The actual alignment was determined using a bearing compass during site disassembly. Due to avoidance of magnetic interaction, these values differ significantly from original measurements at the booms. Therefore preliminary EC results hold for data availability detection, but should not be used for footprint calculations. DVD "COPS_Meta" contains the documentation plus metadata, the folder structure as far as possible following this documentation, where necessary subdivided according to the site abbreviations BT01, BT02, BT03 and BT04:

- ⇨ 0_Documentation: Editable Word file of this documentation, data availability table, field protocol including short weather notice and packing list
- ⇨ 1_General_information: Information on the COPS proposal and entire experiment, logos etc.
- ⇨ 2_Setup: Site setup information subdivided in site- and instrument alignment, also containing utilized calibrations, logger programs, radio module setup and instrument specific software
- ⇨ 3_Surface_parameters: Contains the land use mapping procedure and results of the core cutter soil moisture- and soil mapping procedures
- ⇨ 4_Reports: Daily COPS reports as well as UBT COPS status Emails. However, at the time of writing COPS science director summary and COPS weather summary were only available until 2007-08-13 and 2007-08-17 respectively
- ⇨ 5_Preliminary_analysis_procedures: Software routines for Land use, Sodar Rass, Turbulence (contains preliminary parameter files) and Vaisala data processing
- ⇨ 6_Pictures: Additional graphic information on site alignment, land use and its succession; though Sodar Rass and Scintillometer are entirely documented within the main site BT01, because of locality pictures are included in folder BT02

In order to enable the quick access, tables in this documentation have been drawn in Excel and been copied her as Enhanced Metafile. The original tables are available on the DVD "COPS_Meta" accordingly. As well a paper file containing the hand written setup-, field- and soil moisture protocols, land use analysis and administrative documents is archived.

Volumes in the series ‚University of Bayreuth, Department of Micrometeorology, Arbeitsergebnisse’

Nr	Author(s)	Title	Year
01	Foken	Der Bayreuther Turbulenzknecht	01/1999
02	Foken	Methode zur Bestimmung der trockenen Deposition von Bor	02/1999
03	Liu	Error analysis of the modified Bowen ratio method	02/1999
04	Foken et al.	Nachfrostgefährdung des ÖBG	03/1999
05	Hierteis	Dokumentation des Experimentes Dlouhá Louka	03/1999
06	Mangold	Dokumentation des Experimentes am Standort Weidenbrunnen, Juli/August 1998	07/1999
07	Heinz et al.	Strukturanalyse der atmosphärischen Turbulenz mittels Wavelet-Verfahren zur Bestimmung von Austauschprozessen über dem antarktischen Schelfeis	07/1999
08	Foken	Comparison of the sonic anomometer Young Model 81000 during VOITEX-99	10/1999
09	Foken et al.	Lufthygienisch-bioklimatische Kennzeichnung des oberen Egertales, Zwischenbericht 1999	11/1999
10	Sodemann	Stationsdatenbank zum BStMLU-Projekt Lufthygienisch-bioklimatische Kennzeichnung des oberen Egertales	03/2000
11	Neuner	Dokumentation zur Erstellung der meteorologischen Eingabedaten für das Modell BEKLIMA	10/2000
12	Foken et al.	Dokumentation des Experimentes VOITEX-99	10/2000
13	Bruckmeier et al.	Documenation of the experiment EBEX-2000, July 20 to August 24, 2000	01/2001
14	Foken et al.	Lufthygienisch-bioklimatische Kennzeichnung des oberen Egertales	02/2001
15	Göckede	Die Verwendung des Footprint-Modells nach Schmid (1997) zur stabilitätsabhängigen Bestimmung der Rauhigkeitslänge	03/2001
16	Neuner	Berechnung der Evaporation im ÖBG (Universität Bayreuth) mit dem SVAT-Modell BEKLIMA	05/2001
17	Sodemann	Dokumentation der Software zur Bearbeitung der FINTUREX-Daten	08/2002
18	Göckede et al.	Dokumentation des Experiments STINHO-1	08/2002
19	Göckede et al.	Dokumentation des Experiments STINHO-2	12/2002
20	Göckede et al	Characterisation of a complex measuring site for flux measurements	12/2002
21	Liebethal	Strahlungsmessgerätevergleich während des Experiments STINHO-1	01/2003
22	Mauder et al.	Dokumentation des Experiments EVA_GRIPS	03/2003
23	Mauder et al.	Dokumentation des Experimentes LITFASS-2003, Dokumentation des Experimentes GRASATEM-2003	12/2003
24	Thomas et al.	Documentation of the WALDATEM-2003 Experiment	05/2004
25	Göckede et al.	Qualitätsbegutachtung komplexer mikrometeorologischer Messstationen im Rahmen des VERTIKO-Projekts	11/2004
26	Mauder & Foken	Documentation and instruction manual of the eddy covariance software package TK2	12/2004
27	Herold et al.	The OP-2 open path infrared gas analyser for $CO_2$and H_2O	01/2005
28	Ruppert	ATEM software for atmospheric turbulent exchange measurements using eddy covariance and relaxed eddy accumulation systems and Bayreuth whole-air REA system setup	04/2005
29	Foken (Ed.)	Klimatologische und mikrometeorologische Forschungen im Rahmen des Bayreuther Institutes für Terrestrische Ökosystemforschung (BITÖK), 1989-2004	06/2005
30	Siebeke & Serafimovich	Ultraschallanemometer-Überprüfung im Windkanal der TU Dresden 2007	04/2007

31	Lüers & Bareiss	The Arctic Turbulence Experiment 2006 PART 1: Technical documentation of the ARCTEX 2006 campaign, May, 2nd to May, 20th 2006	07/2007
32	Lüers & Bareiss	The Arctic Turbulence Experiment 2006 PART 2: Visualization of near surface measurements during the ARCTEX 2006 campaign, May, 2nd to May, 20th 2006	07/2007
33	Bareiss & Lüers	The Arctic Turbulence Experiment 2006 PART 3: Aerological measurements during the ARCTEX 2006 campaign, May, 2nd to May, 20th 2006	07/2007
34	Metzger & Foken et al.	COPS experiment, Convective and orographically induced precipitation study, 01 June 2007 – 31 August 2007, Documentation	09/2007