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Department of Micrometeorology

Mesoscale Circulations and **E**nergy and Ga**S** Exchange **O**ver the **Ti**betan **P**lateau

Documentation of the Micrometeorological Experiment, Nam Tso, Tibet

25th of June – 08th of August 2009

Tobias Biermann, Wolfgang Babel, Johannes Olesch, Thomas Foken

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Universität Bayreuth, Abteilung Mikrometeorologie
D-95440 Bayreuth

Die Verantwortung über den Inhalt liegt beim Autor.

Contents

1. Description of the experiment

In the framework of the two projects, CEOP-AEGIS and TiP (SPP 1372), the Department of Micrometeorology of the University of Bayreuth set up an Eddy covariance measurement complex close to the Nam Tso Comprehensive Observation and Research Station of the Chinese Academy of Science (CAS), at Nam Tso, Tibet, China. The purpose of the experiment is to investigate the energy and matter exchange between the atmosphere and the underlying surface of the Tibetan Plateau, which is a basic requirement to understand Asian monsoon variability, effects of climate change and the role of the ecosystems under these conditions. Main aim of the experiment is the quality control of surface flux measurements and their upscaling to the grid scale of limited area models by footprint modeling. A second goal is the correct measurement of humidity in high altitudes. The acquired data will be used evaluate the output of the mesoscale ATHAM model, which is used to model atmospheric flow, clouds, precipitation and radiation of the area. The eddy-covariance measurements will also be used for ecological studies within TiP. The project is well connected with Chinese modeling efforts and German glacier and ecological projects within TiP. In the CEOP-AIGIS Project the data of radiation, turbulent fluxes and soil moisture, together with further stations operated by the CAS, will be used to improve data quality and footprint analysis for up-scaling on satellite grid elements.

1.2.TiP Project

The German Science Foundation (DFG) priority program 1372 TiP studies the Tibetan Plateau focusing on the three interlinked processes, plateau formation, climate evolution and human impact and Global Change. This study is motivated by the importance of the Tibetan Plateau on a global scale comparable to the importance of Antarctica and the Arctic. Its formation had a profound impact on the environmental evolution at regional and global scales and until today directly influences the habitat of billions of people. Moreover, the Tibetan Plateau, like the Polar Regions, proves to be particularly sensitive to anthropogenic Global Change. The different interactions and research areas of different subprojects are displayed in Figure 1-1. Within the project the key processes are analyzed with respect to their impact on ecosystems on three different time scales. The first being the Plateau formation, with the uplift dynamics and related climate change during the last millions to several tens of millions of years, he second being the Late Cenozoic climate evolution and environmental response during the last tens of thousands to hundreds of thousands of years with decadal to centennial resolution. And finally the phase of human impact and Global Change is analyzed focusing on the present stage, the past ~ 8000 years, and perspectives for the future, Figure 1-2.

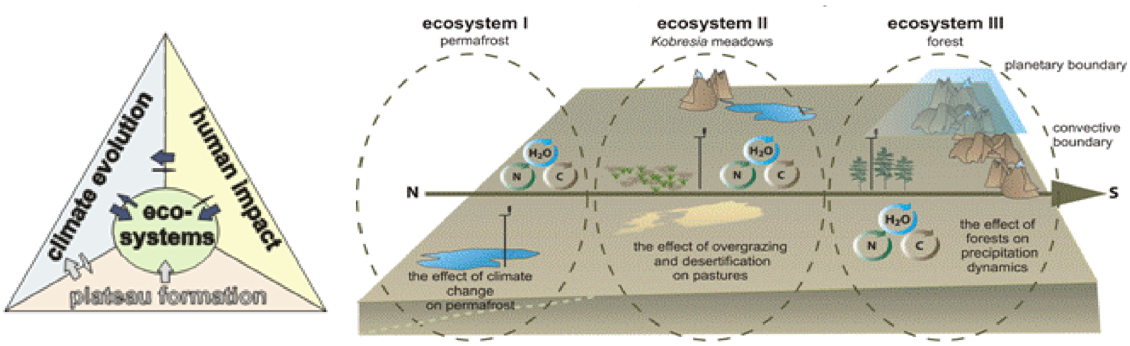

Figure 1-1: Scheme of the different research areas covered in the TiP Project.

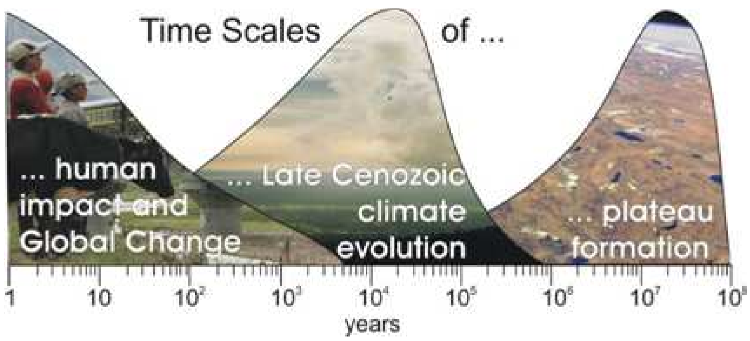

Figure 1-2: Time scales on which the importance of processes is analyzed within the TiP Project.

1.3. CEOP AEGIS

CEOP-AEGIS is a collaborative research project with a medium-scale focus and financed by the European Commission under FP7 topic ENV.2007.4.1.4.2 “Improving observing systems for water resource management”, and is coordinated by the Université Louis Pasteur, Strasbourg, France. It is motivated to support water resources management in South-East Asia. Currently only sparse observations are available lacking accuracy, spatial density and temporal frequency. Therefore an integrated use of satellite and ground observations is necessary to assist water resources management and to clarify the interactions between the land surface and the atmosphere over the Tibetan Plateau in the Asian monsoon system. CEOP-AEGIS aims at two goals, the first one being the construction of an observing system to monitor the plateau’s water yield by a combination of ground measurements and satellite based observations and secondly the monitoring of climate relevant parameters as snow cover, vegetation cover, surface wetness and surface fluxes in order to analyze land-atmosphere interactions influencing the Asian Monsoon System. The duration of this project is 48 months and it builds upon 10 years of experimental and modeling research on the Tibetan Plateau carried out by a consortium of 17 partners from 8 countries. On the long-term the observing system, once established, is very likely to remain in operation beyond project completion. The time-series of hydrological satellite data products will be the basis for an early warning system on droughts and on floods each.

2. Experimental setup

2.2.Measurement site

The measurement site is located at a small lake at the SE side of Nam Tso Lake, which is located at 4730 m a.s.l. and 150 km N of Lhasa, Figure 2-1. The small lake is in a distance of 280 m NW of the Nam Tso Station of the CAS, Figure 2-2. Its shore line stretches for about 1 km to each side of the site and in an angle of 232° against north. The coordinates of the site are N30°46.498’ E90°57.612’ and those of Nam Tso Station are N30° 46.44’ E90° 57.72’. Most of the measurement site has a gentle slope of 8° to the second terrace while the shore line drops in a step angle into the lake. The Eddy Covariance (EC) Station, which is equipped with a CSAT3, KH 20 and LICOR 7500, is set up next to the step drop, facing WSW, nearly parallel to the shoreline. Additionally to the EC Station with a soil complex, a CNR1 Net Radiometer is set up as well as a rain gauge. The soil complex contains temperature measurements in 7 depths, heat flux measurements at 20 cm depth and water content measurements with TDR Probes in 3 depths. In the lake a float is measuring water temperature at approximately 30 cm depth. On overview of the setup is given in Figure 2-3. The whole area, which also includes a site for a tent, is fenced with a one meter high netting wire. Distances between the different devices and obstacles can be seen in Figure 2-4, Figure 2-5 and Table 2-1. The location of the measurement site in context to Nam Tso Station is plotted in Figure 2-6.

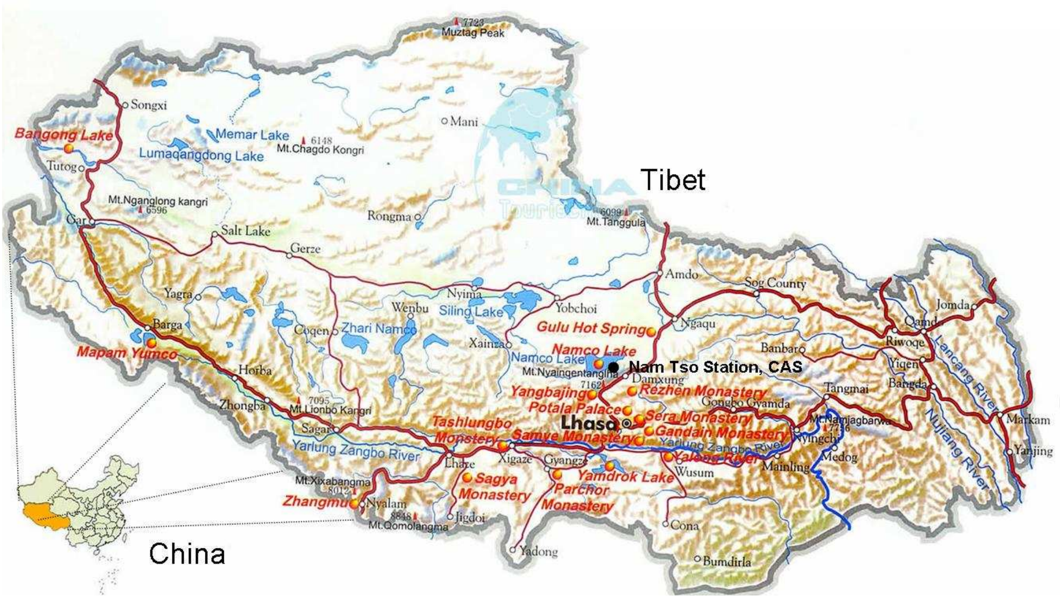

Figure 2-1: Map of the Autonomous Region Tibet and the PR China. The Black dot marking the Nam Tso Station, CAS. (modified from www.chinatouristmaps.com)

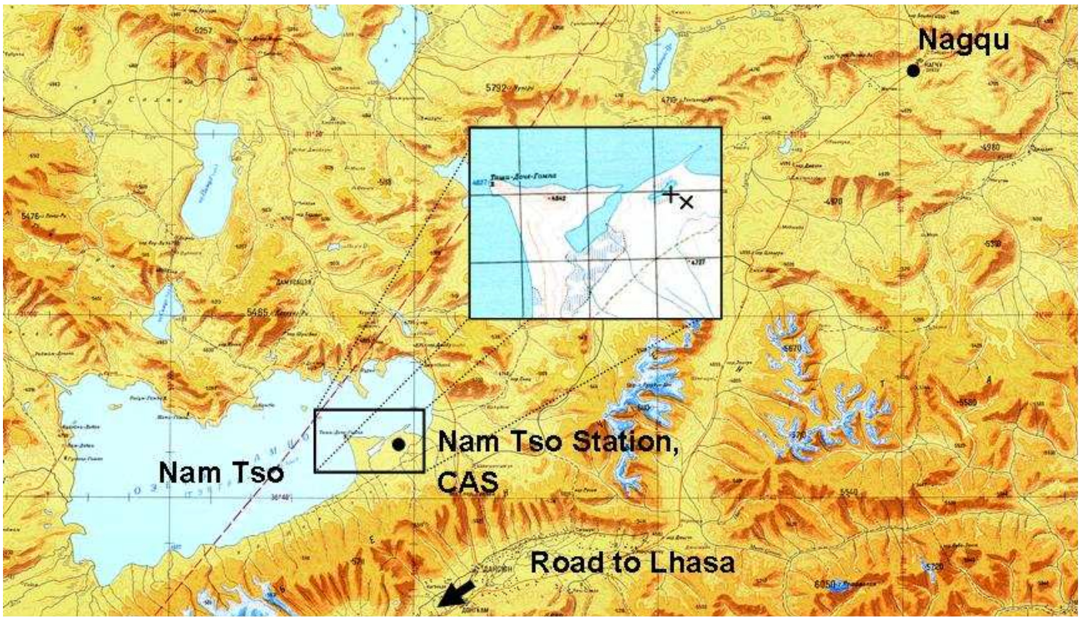

Figure 2-2: Location of the experimental site inside Tibet. The **+** marks the location of the EC Station and the **X** the location of the Nam Tso Station from CAS (modified from http://en.poehali.org/maps).

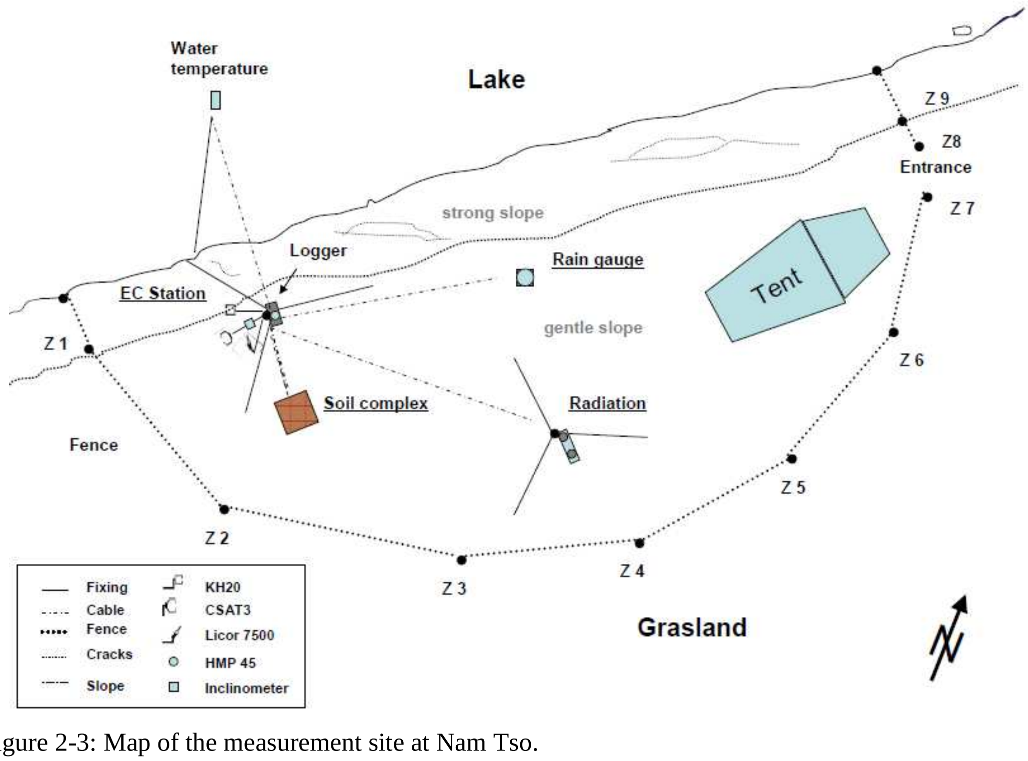

Figure 2-3: Map of the measurement site at Nam Tso.

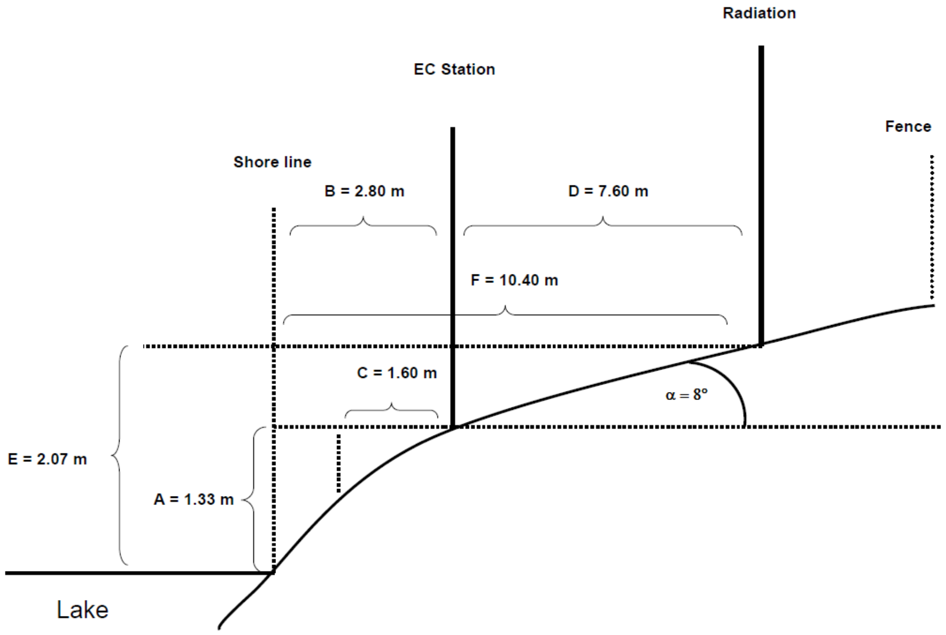

Figure 2-4: Elevation profile of the measurement site.

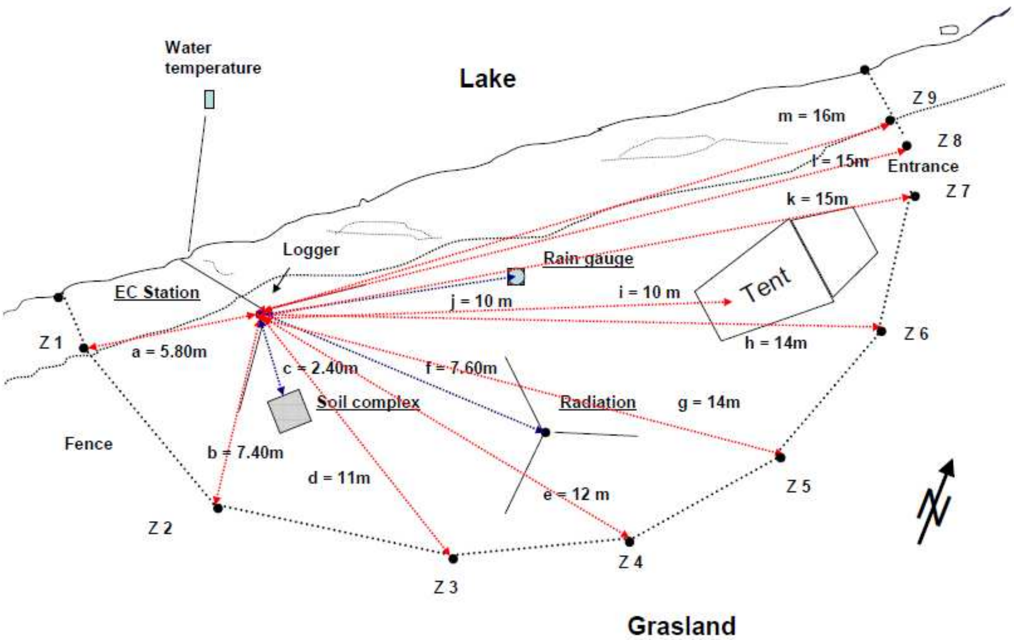

Figure 2-5: Overview of the distances in relation to the EC Station as described in Table 2-1.

Table 2-1: Distance on the measurement site, as shown in Figure 2-4 and Figure 2-5.

Obstacle	Label	Distance [m]	Angle against north [°]
EC Station – Fencepost 1 (Z1)	a	5.80	236
EC Station – Fencepost 2 (Z2)	b	7.40	160
EC Station – Soil complex	c	2.40	140
EC Station – Fencepost 3 (Z3)	d	11	146
EC Station – Fencepost 4 (Z4)	e	12	128
EC Station – Radiation	f, D	7,60	120
EC Station – Fencepost 5 (Z5)	g	14	110
EC Station – Fencepost 6 (Z6)	h	14	100
EC Station – Tent	i	11	75
EC Station rain gauge	j	5	72
EC Station – Fencepost 7 (Z7)	k	15	68
EC Station – Fencepost 8 (Z8)	l	15	60
EC Station – Fencepost 9 (Z9)	m	16	60
Water surface – Foot EC	A	1.33	-
EC Station – shore line	B	2.80	141
EC Station – step drop	C	1.60	-
Water surface – Radiation	E	2.07	-
Radiation – shore line	F	10.40	141

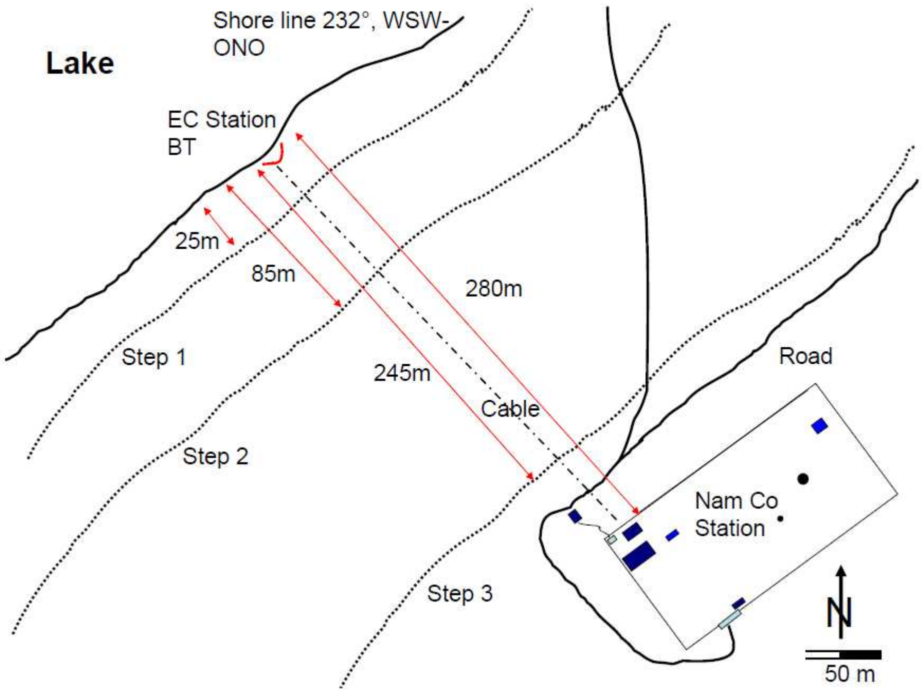

Figure 2-6: Map of the Nam Tso Station and the small lake, including distances between the main station and the measuring site.

2.2.1. Turbulence measurement complex

The following section will list the measurement devices which were used to equip the turbulence measurement complex. Figure 2-7 shows the orientation of the devices to each other and their orientation against North. An overview of the alignment and specifications of these devices are given in Table 2-2.

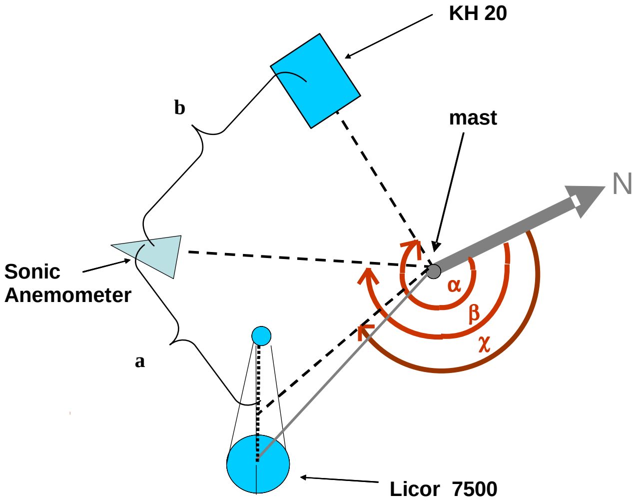

Figure 2-7: Setup of the turbulence measurement system.

Table 2-2: Instrumentation of EC Station

Parameter	**Device**	**SN**	**Calibration factor**	**Calibration /Conversion**	**Height [m]**	**Angle against north**	**Logger-channel**
Wind vector and sonic temp.	CSAT3	1756	---	Calibration in device	2.97	236° (β)	SDM
Humidity	LI7500	75B-1200	Licor Calibration Appendix B	Calibration in device	2.91 Distance To CSAT 0.27 (a)	Sensor Middle of path-length 221° (χ)	SDM
CO_2	LI7500	75B-1200	Licor Calibration Appendix B	Calibration in device	2.91 Distance to CSAT 0.27 (a)	---	SDM
Humidity	KH20	1649	V_0: 8127.6 mV X: 1.50 cm k_w: -0.1593	---	2,90 Distance from CSAT 0.24 (b)	243° (α)	SE 4
Humidity	HMP	T465 0013	---	Conversion in Logger mV to g m^{-3}	3.01	---	Diff. 1
Temperature	HMP	T465 0013	---	Conversion in Logger mV to °C	3.01	---	Diff. 1
Pressure	Vaisalla	E 81000 3	0-5V equals 500- 1100 hPa	Conversion in Logger mV to hPa	0.20	---	SE 3

2.2.2. Radiation and Precipitation

The Radiation was measured separated from the turbulent quantities with a CNR1 Net Radiometer from Kipp & Zonen, mounted to a black pole southeast of the turbulence complex. The precipitation was measured with a weighing rain gauge Northeast of the turbulence complex.

Table 2-3: Instrumentation of radiation and precipitation complex

Parameter	**Device**	**SN**	**Calibration factor**	**Calibration/ Conversion**	**Height [m]**	**Angle against north**	**Logger-channel**
Radiation	CNR1	990197	10.82 x 10^6 V/Wm²	Calibration in Logger	1.99	156°	Diff. 8-14
Rain	Rain Gauge	010291	1 Pulse = 0.1 mm	---	1 m	---	P 1

2.2.3. Soil measurement complex

The soil complex was installed close to the turbulence complex. Figure 2-8 shows a scheme of the setup of the measurements while Table 2-4 contains calibration coefficients and more specifications concerning the used devices. A more detailed discussion of the soil properties can be found in chapter 3.3. The TDR probes had a wiring problem, one of the two grounds was not connected leading to spikes and offsets in the data, which needs to be filtered for that.

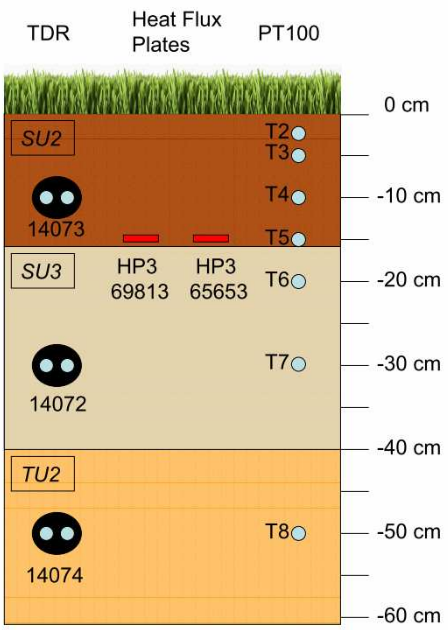

Figure 2-8: Soil profile with installation to measure water content, temperature and heat flux, including serial numbers and information about the horizons of the soil profile.

Table 2-4: Instrumentation of soil pit

Parameter	Device	SN	Calibration factor	Calibration /Conversion	Height [m]	Angle against north	Logger-channel	Name in file
SoilTmp1	Pt100	T2	---	Conversion in Logger mV to °C	-0.025	235°	MUX 2	PT100_a5
SoilTmp2	Pt100	T3	---	Conversion in Logger mV to °C	-0.05	235°	MUX 3	PT100_a10
SoilTmp3	Pt100	T4	---	Conversion in Logger mV to °C	-0.10	235°	MUX 4	PT100_a25
SoilTmp4	Pt100	T5	---	Conversion in Logger mV to °C	-0.15	235°	MUX 5	PT100_b2
SoilTmp5	Pt100	T6	---	Conversion in Logger mV to °C	-0.20	235°	MUX 6	PT100_b5
SoilTmp6	Pt100	T7	---	Conversion in Logger mV to °C	-0.30	235°	MUX 7	PT100_b10
SoilTmp7	Pt100	T8	---	Conversion in Logger mV to °C	-0.50	235°	MUX 8	PT100_b25
Soil moisture	TDR-IMKO	14073	---	---	-0.10	235°	SE 25	TDRa_1
Soil moisture	TDR-IMKO	14072	---	---	-0.30	235°	SE 26	TDRa_2
Soil moisture	TDR-IMKO	14074	---	---	-0.50	235°	SE 27	TDRb_1
Ground heat flux	HP3	69813	227µV/m W/cm²	----	-0.15	235°	MUX 9	HFTa_10
Ground heat flux	HP3	65653	243µV/m W/cm²	---	-0.15	235°	MUX10	HFTa_30

2.2.4. Water temperature

The water temperature was measured in about 30 cm depth with a Pt 100 installed underneath a float.

Table 2-5: Water temperature measurements

Parameter	Device	SN	Calibration factor	Conversion in Logger	Height [m]	Logger-channel	Name in file
Water Temp	Pt100	T1	---	Conversion in Logger mV to °C	-0.30	MUX 1	PT100_a2

3. Surface parameters

3.1. Meteorological site characteristics and land use types

A classification of land-use has already been worked out by Metzger et al. (2006), refining classified Landsat ETM images in the field. A re-evaluation in 2009 showed no significant changes to the existing maps near the site, therefore they are used unchanged. Preliminary analysis was performed in order to characterize wind field and footprint climatology of the measuring period from June, 25^{th} to the 8^{th} of August. Momentum flux and sensible heat flux were calculated with TK 2.1 (Version 090903) using a sector-wise planar fit rotation to account for the special flow field at the coastline: The two sectors were in clockwise direction 52° - 232° (land) and 232° - 52° (lake). Thereby, a sector of 7° - 97° was excluded from determination of the planar-fit coefficients due to flow distortion from the sensors. Figure 3-1 displays the wind direction and wind speed over the whole measurement period, showing that the wind came mainly from WSW – ENE for the land side and from NNW – SSO for the lake side. The footprint climatology was calculated using TERRAFEX. The underlying footprint model is a lagrangian stochastic forward trajectory model, as proposed in Göckede et al. (2004, 2006), who adapted the original model from Rannik et al, 2003. The diurnal distribution of wind directions over the period is displayed in a Hovmøller plot (Figure 3-2). The blue colors indicate wind coming from the lake; the green colors indicate a wind direction from land while the orange colors mark the wind directions where the wind might be influenced by obstacles on the site and the measurement devices. Beside the data gaps the figure shows a stable diurnal cycle over the whole period with prevailing winds from the lake, beginning from the late morning until the evening, then the regime changes to land winds at all other times. While land wind also might occur during daytime, lake wind during nighttime were very sparse. The footprint climatology for the whole period is displayed for all stratifications (Figure 3-3 a) and separately for unstable, stable and neutral conditions (Figure 3-3 b-d). In general, the footprint area (95% contribution) extends about 160 m WSW – ENE and 280m in NNW – SSO direction with more influence from the land due to more frequent wind from the respective directions (Figure 3-1). The measured fluxes from land almost stem from the nearby areas with taller and denser grass (grass+), the influence of the more disturbed meadow (grass-) is below 20% and occurs mainly under stable conditions. Contributions from the lake dominate under unstable stratification, but situations with stable stratification over the lake never occurred.

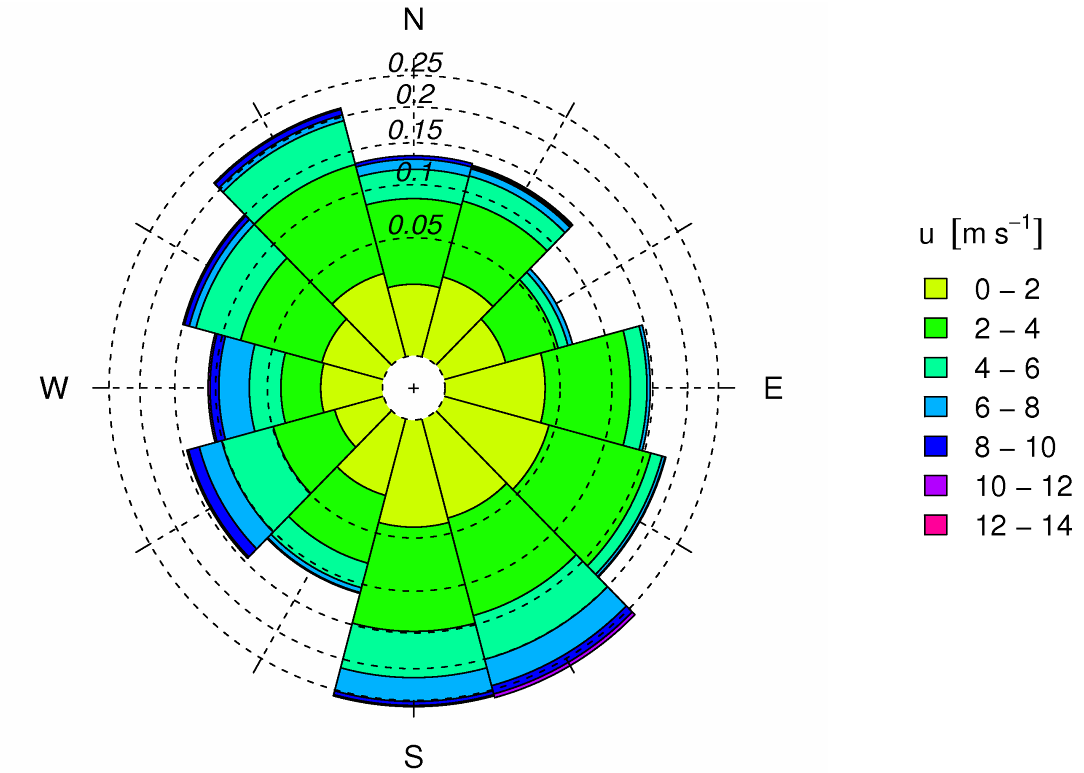

Figure 3-1: Wind rose displaying the wind direction and wind speed over the whole measurement period from 26.06 till 08.08.09.

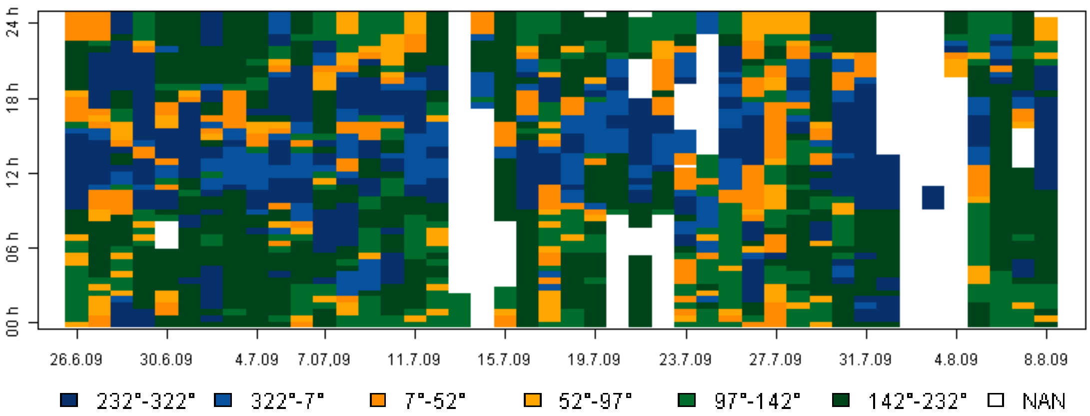

Figure 3-2: Wind distribution for the measuring period. In blue the sector with wind directions from the lake, in green the sector with wind from land and in orange the sector with influence from the sensors.

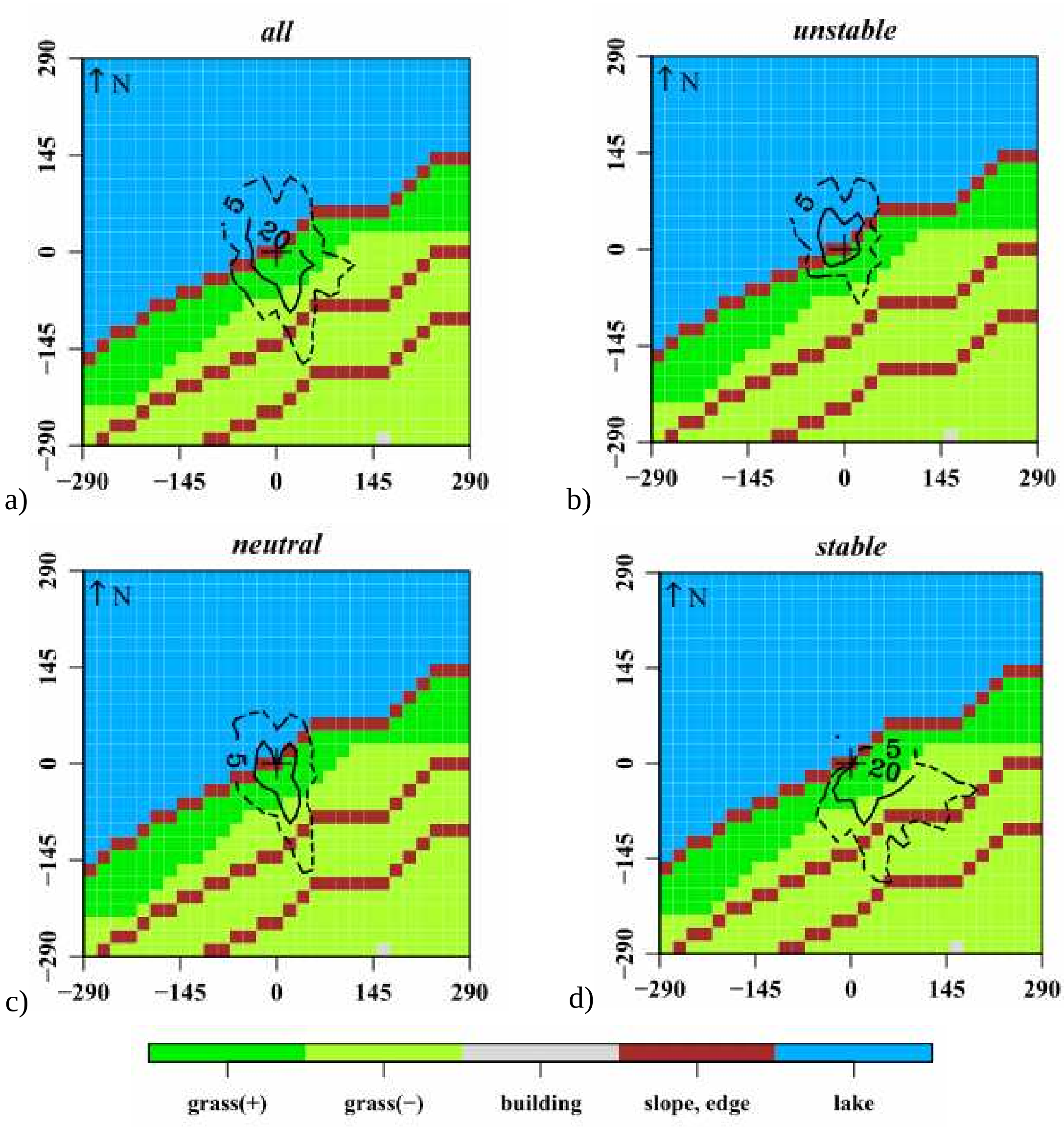

Figure 3-3: Footprint climatology of the turbulence complex at Nam Tso, marked by the black cross, including an overview of the land use types surrounding the station. The solid line enclosed 80% and the dashed line 95% of the data. The footprints are calculated for a combination of all cases (a), for the stratification regime unstable (b) neutral (c) and stable (d).

3.2. Vegetation

The vegetation cover on the first terrace were the experiment was set up is at most places very dense and covers about 95% of the surface, only interrupted by burrows of picas (*Ochotona curzoniae)* and occasionally some gravel and sand. The vegetation in the footprint of the EC Station is mostly *Kobresia pygmeae,* which covered together with some other Kobresia species about 80% of the surface. Additionally following species were found: *Potentilla saundersiana, Potentilla spec., Potentilla bifurca, Potentilla anserina, Leontopodium pusillum, Lanea tibetica, Oxytropis spec, Astragalus spec, Pedicularis spec, Primula spec, Gentiana spec, Aster flaccidus, Taraxacum spec, Arenaria bryophylla, Oxytropis moorocroftii, Carex moorereftii.* The height of the vegetation was 3 cm at the start of the experiment at the 25th of June and 7 cm on the 18th of July. From 27th of July till 8th of August the average height of the vegetation was10 cm while on July, 27, the tallest stems had a height of 25cm and on August 8, of 42 cm. On the upper terraces the vegetation became sparser with increasing distance the lake, and the height did not increase above 10 cm.

3.3. Soil properties

3.3.1. Soil moisture, bulk density and Porosity

During the excavation of the pit for the soil measurements, soil cores, 100 cm ^{3}, were taken as a reference to the installed TDR-Probes in order to estimate the soil water content and the bulk density. The average values for the horizon from 08 to 12 cm depth were ρ = 0.88 (std. = 0.13) and volumetric water content θ_v = 0.25 (std. = 0.03), for the horizon from 18 to 22 cm depth ρ was 0.88 (std. = 0.19) and the volumetric water content was 0.22(std. = 0.04), from 28 to 32 cm depth ρ was 0.98 (std. = 0.09) and the volumetric water content $_v$ = 0.20 (std. = 0.01) and from 51 to 55 cm depth ρ was 1.03 (std. = 0.09) and the volumetric water content was 0.48 (std. = 0.02). Figure 3-4 displays the average profile of the bulk density and the volumetric water content, the individual soil core results are documented in the Table 3-1 and Table 3-2 for June 25th and August 8th, respectively. The results from core 8 were not used for the averaging since they seem to be wrong, due to some loss of soil or other mistakes.

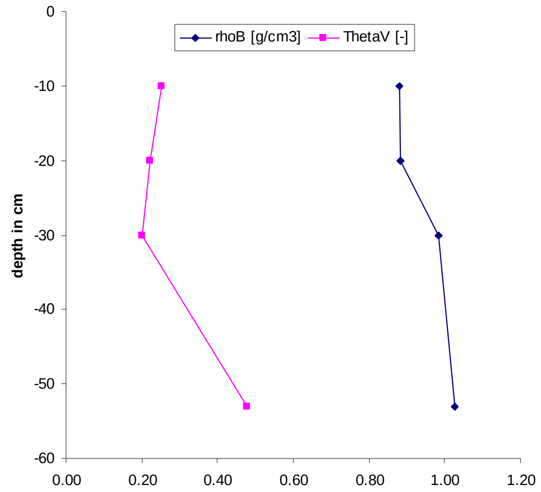

Figure 3-4: Profile of soil bulk density and volumetric water content at Nam Tso lake from June 25th 2009.

Table 3-1: Soil water content estimated with soil cores, 100 cm^3, June 25, 2009.

depth [cm]	**Number of soil core cylinder**	**weight cylinder [g] Nam Tso**	**weight cylinder [g] Lhasa**	**weight moist [g]**	**weight dry [g]**	**vol. water content [%]**	**grav. water content [%]**	**Porosity**	**Bulk density [g cm^{-3}]**
08-12	25	118.1	118.4	235.3	215.0	0.21	0.08	0.64	0.97
08-12	50	117.4	117.8	243.5	219.0	0.25	0.09	0.62	1.01
08-12	22	118.1	118.4	221.7	194.0	0.28	0.11	0.71	0.76
08-12	34	117.8	118.1	223.6	196.8	0.27	0.10	0.70	0.79
18-22	10	117.9	118.2	209.1	188.2	0.21	0.08	0.74	0.70
18-22	18	118.3	118.5	238.8	218.8	0.20	0.08	0.62	1.00
18-22	13	118.3	118.5	256.2	228.0	0.28	0.11	0.59	1.10
18-22	16	118.4	118.7	211.4	192.8	0.19	0.07	0.72	0.74
28-32	39	117.6	117.9	223.6	205.7	0.18	0.07	0.67	0.88
28-32	49	118.7	119.0	238.0	216.6	0.22	0.08	0.63	0.98
28-32	6	117.5	117.8	246.2	226.3	0.20	0.08	0.59	1.09
28-32	12	117.5	117.8	244.1	222.7	0.21	0.08	0.62	1.00
51-55	38	117.7	118.0	267.3	219.5	0.48	0.18	0.62	1.02
51-55	17	117.4	117.7	277.3	227.5	0.50	0.19	0.59	1.10
51-55	32	117.3	117.5	258.0	213.4	0.45	0.17	0.64	0.96
51-55	7	117.3	117.7	268.0	220.7	0.48	0.18	0.61	1.03

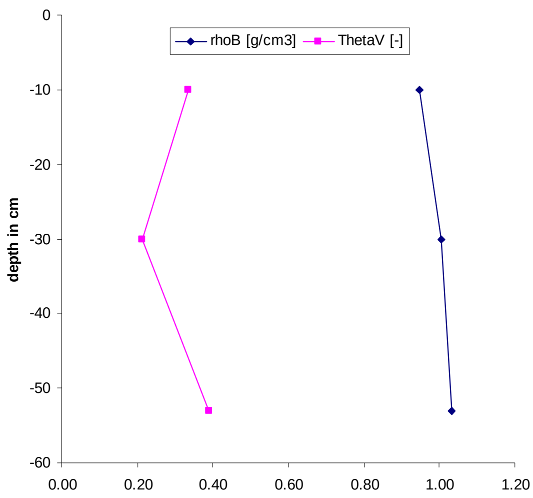

Figure 3-5: Profile of soil bulk density and volumetric water content at Nam Tso lake from August 8th 2009

Table 3-2: Soil water content estimated with soil cores, 100 cm^3, August 8, 2009

depth [cm]	Number of soil core cylinder	weight cylinder [g]	weight moist [g]	weight dry [g]	vol. water content [%]	grav. water content [%]	Porosity	Bulk density [g cm^{-3}]
10-14	47	118.0	231.8	200.8	0.31	0.12	0.69	0.83
10-14	23	118.6	254.7	219.6	0.35	0.13	0.62	1.01
10-14	20	118.4	252.9	219.0	0.34	0.13	0.62	1.01
30-34	26	118.4	246.0	224.5	0.22	0.08	0.60	1.06
30-34	3	119.3	235.3	214.5	0.21	0.08	0.64	0.95
30-34	8	117.9	236.8	230.4	0.06	0.02	0.58	1.13
51-55	33	117.7	265.6	215.2	0.50	0.19	0.63	0.98
51-55	21	118.8	251.9	218.0	0.34	0.13	0.63	0.99
51-55	4	119.2	265.2	232.5	0.33	0.12	0.57	1.13

3.3.2. Soil profile

Also during the installation of the soil measurement field more information about the soil properties were estimated. The excavated soil pit had a depth of 60 cm. The rooting depth of the grass was nearly 60 cm, and at the bottom of the pit water was accumulating. The profile could be separated into three horizons. The first horizon with the most organic content stretches from 0-16 cm depth, the second stretches from 16-40 cm with a high amount of sand and sandy loam and the third with a great amount of loam and clay from 40-60 cm. At 60 cm water accumulates on top of a layer of hard clay. Table 3-3 summarizes the soil characteristics as recorded in the field, using the “Bodenkundliche Kartieranleitung KA 5” and Figure 3-6 gives an impression of the profile.

Table 3-3: Soil profile at the measurement site, characterized after KA 5.

depth [cm]	**Signature after KA5**	**Description**	**color**
0-16	SU2 Coherence 1 Plasticity 0	High organic fraction, sandy	brown
16-40	SU3 Coherence 1 Plasticity 0	sandy, with a slight fraction of loam	grey/brown
40-60	TU2 Coherence 5 Plasticity 5	loam, higher fraction of clay towards the bottom	grey/orange spots

Figure 3-6: Soil profile at Nam Tso site, depth 60cm.

4. Weather conditions

From 29.06.2009 till 06.07.2009 every night rain around midnight and strong winds.

Date	**Weather condition**
29.06.2009	- Heavy rain during the night
30.06.2009	- 12:19 o'clock short rain event
01.07.2009	- In the morning cloudy with short light intense rain events - From noon on the weather became friendlier - In the afternoon a mix of clouds and sunshine
02.07.2009	- Most of the day sunshine storm in the late afternoon and night
03.07.2009	Sunny day, strong wind in the afternoon and evening
04.07.2009	- From 19:36 o'clock thunderstorm around the station but not at the lake - Mix of clouds and sunshine during the day
05.07.2009	- Mostly sunny, strong wind
06.07.2009	- Up till 16:00 o'clock mix from clouds and sun, afterwards thunderstorm till about 17:30
07.07.2009	- Rain in the morning from around 6:00 o'clock till 8:30, than up till 16:00 o'clock the weather improved, but afterwards thunderstorm in the mountains and bad weather and wind around the station - No thunderstorm in the night nearly clear sky only short light rain/snow events
08.07.2009	- Heavy rain in the morning till about 9 o'clock afterwards sunny
09.07.2009	- Rain until noon, afterwards sunny
10.07. 2009	- Rain in morning (all night) till noon afterwards thunderstorm from Lake evening nice
11.07. 2009	- No rain, very hot and calm
12.07. 2009	- Nice day no rain
13.07. 2009	- Rain before 7:00 o'clock afterwards cloudy
14.07. 2009	- Rain during night, nice day
15.07. 2009	- fair weather, strong wind
16.07. 2009	- fair weather till about 7:00 o'clock afterwards short hail/rain event (strong)
17.07. 2009	- Heavy thunderstorm in the mountains and over the lake
18.07. 2009	- Sunny weather till 18 o'clock and afterwards thunderstorm for about 1,5 hours
19.07.2009	- fair weather, with passing clouds, quite sunny day
20.07.2009	- fair weather, with passing clouds, quite sunny day
21.07.2009	- Rain at 13 and 16 o'clock

Date	Weather condition
22.07.2009	- morning sunny, rain over big lake, heavy rain at 17 o'clock, and hail storm at 20.40 till 20.56 o'clock
23.07.2009	- rain during night and in the morning with strong wind
24.07.2009	- light rain and strong wind in the morning
25.07.2009	- 19.00 till 23.00 o'clock heavy thunderstorm with hail
26.07.2009	---
27.07.2009	- weather starts to get worse
28.07.2009	- cloudy all day
29.07.2009	- rain till noon, thunderstorm in the evening
30.07.2009	- heavy thunderstorm at 3.00 till 4.00 o'clock in the morning
31.07.2009	---
01.08.2009	---
02.08.2009	---
03.08.2009	---
04.08.2009	- fair weather, with passing clouds
05.08.2009	- fair weather, with passing clouds
06.08.2009	- fair weather, with passing clouds
07.08.2009	- snow in the morning
08.08.2009	- rain from 11.00 till 13.00 o'clock

Additionally Weather maps can be found in the DVD Archive; Nr. 494 under "A_Documentation", "3_weather_maps".

5. Data

5.2. Data logging and structure

Data was collected with high and low frequency. The used logger program was "TIBET_VOITSUMRA_090508_FINAL_2.CR3". The logging time was Beijing Standard Time, which is UTC/GMT +8 hours and has no daylight savings time in 2009.

Table 5-1: Overview of logged parameter, their Units, the measurement devices and the structure of the stored data.

Parameter	Unit	Device	File name	Stored in	Frequency
Wind components	m s^{-1}	CSat3	NamCoHxxxx	B_1	20Hz
Sonic temperature	° C	CSat3	NamCoHxxxx	B_1	20Hz
CO_2	mmol m^{-3}	Licor 7500	NamCoHxxxx	B_1	20Hz
H_2O	mmol m^{-3}	Licor 7500	NamCoHxxxx	B_1	20Hz
H_2O	mmol m^{-3}	KH 20	NamCoHxxxx	B_1	20Hz
Inclination	mV	Inclinometer	NamCoHxxxx	B_1	20Hz
H_2O	mmol m^{-3}	HMP 45	NamCoLxxxx	B_2	5 min
Temperature	° C	HMP 45	NamCoLxxxx	B_2	5 min
Pressure	hPa	Vaisalla PS	NamCoLxxxx	B_2	5 min
Precipitation	counts	Rain gauge	rain_xxxxxx	B_4	5 min
Net radiation	W m^{-2}	CNR 1	rad_xxxxxx	B_5	10 sec (from 29.06.09, before 5min)
Soil heat flux	W m^{-2}	HFP	pt_xxxxxx	B_6	5 min
Soil temperature	° C	Pt 100	pt_xxxxxx	B_6	5 min
Soil moisture	mV	TDR	tdr_xxxxxx	B_6	1 sec

5.3. Data availability

Table 5-2: File structure high frequency data

Filename	Begin Time	End Time	remark
NamCoH0001	"2009-06-25 14:17:22.35"	"2009-06-25 15:45:20.65"	only 1h than gap of 5 h
NamCoH0002	"2009-06-25 22:57:52.2"	"2009-06-26 17:02:33.1"	
NamCoH0003	"2009-06-26 17:02:33.15"	"2009-06-26 19:01:37.55"	
NamCoH0004	"2009-06-26 19:12:48.3"	"2009-06-29 08:19:08.5"	10 min gap
NamCoH0005	"2009-06-29 08:19:08.55"	"2009-06-29 08:45:09.85"	
NamCoH0006	"2009-06-29 08:49:59.4"	"2009-06-30 07:24:35.5"	
NamCoH0007	"2009-06-30 07:24:34.55"	"2009-06-30 12:11:49.45"	
NamCoH0008	"2009-06-30 12:43:14.08"	"2009-07-02 20:26:12.15"	30 min gap
NamCoH0009	"2009-07-02 20:26:54.8"	"2009-07-05 17:40:31.4"	30 sec gap
NamCoH0010	"2009-07-05 17:40:31.41"	"2009-07-08 10:36:31.65"	
NamCoH0011	"2009-07-08 10:36:31.7"	"2009-07-11 11:47:40.45"	
NamCoH0012	"2009-07-11 11:47:40.5"	"2009-07-14 17:04:32.8"	gap: "2009-07-13 01:13:56.9" - "2009-07-14 17:04:32.8"
NamCoH0013	"2009-07-14 17:04:32.85"	"2009-07-14 23:59:59.95"	
NamCoH0014	"2009-07-15 00:00:00"	"2009-07-15 23:59:59.95"	
NamCoH0015	"2009-07-16 00:00:00"	"2009-07-15 23:59:59.95"	
NamCoH0016	"2009-07-17 00:00:00"	"2009-07-17 23:59:59.95"	
NamCoH0017	"2009-07-18 00:00:00"	"2009-07-18 12:36:56.55"	
NamCoH0018	"2009-07-18 12:36:56.6"	"2009-07-20 10:29:42.7"	gap: "2009-07-20 10:29:42.75" - "2009-07-21 15:44:25.7"
NamCoH0019	"2009-07-21 15:44:25.7"	"2009-07-22 20:35:05.35"	gaps: 2000-07-21 16:31:13 - 20:45:46; 20:53:29 - 21:14:37; 23:02:40 - 2009-07-22 08:38:14
NamCoH0020	"2009-07-22 20:35:05.35"	"2009-07-23 18:48:30.35"	
NamCoH0021	"2009-07-23 18:48:30.4"	"2009-07-24 11:18:15.25"	
NamCoH0022	"2009-07-24 11:18:15.3"	"2009-07-26 14:37:49.35"	
NamCoH0023	"2009-07-26 14:37:49.4"	"2009-07-28 14:01:38.35"	
NamCoH0024	"2009-07-28 14:01:38.4"	"2009-07-29 17:16:10.8"	
NamCoH0025	"2009-07-29 17:16:10.85"	"2009-08-03 09:23:41.45"	
NamCoH0026	"2009-08-03 09:23:41.5"	"2009-08-06 20:33:15.7"	
NamCoH0027	"2009-08-06 20:33:15.75"	"2009-08-09 16:25:37.7"	

Table 5-3: File structure low frequency data

Filename	Begin Time	End Time
NamCoL0001	176, 1120	176,02310
NamCoL0002	177, 1050	178, 0000
NamCoL0003	178, 0000	179, 0000
NamCoL0004	179, 0000	180, 0000
NamCoL0005	180, 0000	181, 0000
NamCoL0006	181, 0000	182, 0000
NamCoL0007	182, 0000	183, 0000
NamCoL0008	183, 0020	184, 0000
NamCoL0009	184, 0000	185, 0000
NamCoL0010	185, 0000	186, 0000
NamCoL0011	186, 0000	187, 0000
NamCoL0012	187, 0000	188, 0000
NamCoL0013	188, 0000	189, 0000
NamCoL0014	189, 0000	190, 0000
NamCoL0015	190, 0000	191, 0000
NamCoL0016	191, 0000	192, 0000
NamCoL0017	192, 0000	193, 0000
NamCoL0018	193, 0000	194, 0000
NamCoL0019	194, 0000	195, 0000
NamCoL0020	195, 0000	195, 1705
NamCoL0021	199, 1240	200, 0000
NamCoL0022	200, 0000	200, 2315
NamCoL0023	201, 0855	202, 0000
NamCoL0024	202, 0000	202, 2305
NamCoL0025	203, 0840	204, 0000
NamCoL0026	204, 0000	205, 0000
NamCoL0027	205, 0000	205, 1120
NamCoL0028	207, 1440	208, 0000
NamCoL0029	208, 0000	209, 0000
NamCoL0030	209, 0000	210, 0000
NamCoL0031	210, 0000	211, 0000
NamCoL0032	211, 0000	212, 0000
NamCoL0033	212, 0000	213, 0000
NamCoL0034	213, 0000	213, 1205
NamCoL0035	214, 1340	214, 1355
NamCoL0036	215, 0925	216, 0000
NamCoL0037	216, 1935	217, 0000
NamCoL0038	217, 0000	218, 0000
NamCoL0039	218, 0000	218, 2035

The radiation, precipitation data and the data from the soil complex are stored as daily files, but there might be gaps in the time stamp.

5.4.Logbook EC Station

Table 5-4: Logbook of EC Station, dates and remarks for data loss and disturbance of measurement

Date	**remark**
25.06.09	Test of rain gauge, no rain that day
29.06.09	New Logger program, loss of data, 9 o’clock running again
30.06.09	Power off, system shut down from 07:28 till 8:00, card change, at 9:00 Prayer flags, Logger shut down from 11:45 till 11:50 due to change of power supply, from 12:19 till 12:50 problems with card change, disturbance of fetch at 20:51
01.07.09	Adjustment of lines from EC complex
02.07.09	20: 26 card change, Power off at 21:23 o’clock at the station, system running
05.07.09	New adjustment of lines for EC complex (18 o’clock), card change
06.07.09	Check of alignment of CSAT at 14:55 o’clock
08.07.09	At 10 o’clock check of lines for EC station
10.07.09	In the morning (8.30) only logger battery, than power off, restart at 11:40 o’clock
11.07.09	New adjustment of lines for EC complex and radiation (2 turns) (11:42 o’clock), card change
14.07.09	17 o’clock card change
15.07.09	Power out during night, restarted at 8:30 o’clock
18.07.09	Card change at 12:37 o’clock, between 15:50 and 16:05 o’clock bracing of EC Station renewed, same at 16:59 o’clock for the radiation
20.07.09	Power off during the night, restart at 9:00 o’clock
21.07.09	Power off during the night, restart at 8:35 o’clock, power was off at 20:50 restart but went off again, than restart at 9.05 o’clock, shut down at 10.00 again, at 20:50 check of bracings
22.07.09	Restart at 8:30 o’clock, start of solar solstice till about 10 o’clock At 20.33 o’clock inclinometer test, at 20.35 o’clock card change
23.07.09	11 o’clock work on power, restart of system 16 o’clock
24.07.09	11.19 o’clock card change and mast shaking, 11.26 o’clock exchange of 12V PS, Power of at 21 o’clock
25.07.09	Power off in the morning, restart at 8.30 o’clock failed, broken fuse at solar panel
26.07.09	14.40 o’clock, only on logger battery since fuse of solar panel broken, exchanged, card change
28.07.09	14.04 o’clock card change, 14.20 o’clock fixing of bracing
29.07.09	17.20 o’clock card change
07.08.09	Disassembling of system
08.08.09	Disassembling of system

6. DVD Archive

The raw data and additional information can be found in the DVD archive of the Department of micrometeorology, University of Bayreuth, on DVD Nr. 494.

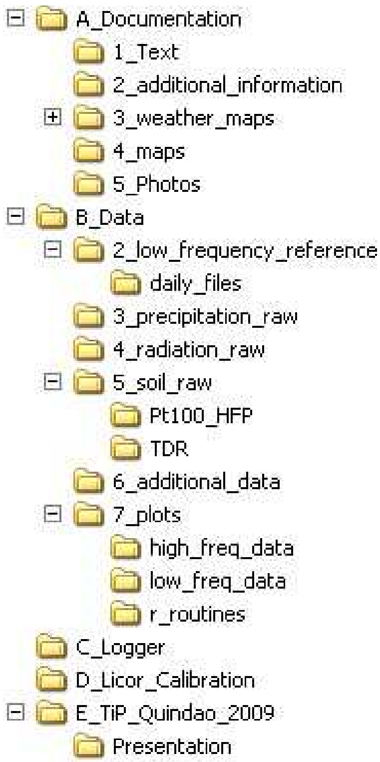

Figure 6-1: Structure of the DVD Nr 494 (Data collected at Nam Tso in 2009).

7. Literature

Ad-hoc-AG Boden (2005), Bodenkundliche Kartieranleitung, 5 Aufl., pp. 438, Hannover

Göckede M., Markkanen T., Hasager C. B., Foken T. (2006): Update of a footprint-based approach for the characterization of complex measurement sites. *Boundary Layer Meteorology 118*, 635-655

Göckede M., Rebmann C., Foken T. (2004): A combination of quality assessment tools for eddy covariance measurements with footprint modeling for the characterization of complex sites. *Agricultural And Forest Meteorology 127*, 175-188

Metzger, S.; Ma, Y.; Markkanen, T.; Göckede, M.;Li, M .& Foken, T. (2006) Quality Assessment of Tibetan Plateau Eddy Covariance Measurements Utilizing Footprint Modeling. *Advances in Earth Science*, 21, 1260-1268

Rannik, U.; Markkanen, T.; Raittila, J.; Hari, P. & Vesala, T. (2003) Turbulence statistics inside and over forest: Influence on footprint prediction *Boundary-Layer Meteorology, 109*, 163-189

http://en.poehali.org/maps
http://www.ceop-aegis.org/
http://www.tip.uni-tuebingen.de/
www.chinatouristmaps.com

8. Appendix

A. Logger configuration

CR3000 Logger configuration S/N Logger: 3545
Experiment: Tibet 2009

Channels					
SE	**Diff**	**Device**	**Serial nr**	**Wiring**	**Comments**
1	1H	HMP	T4650013	yellow	Blue = 12V, purple = Ground
2	1L	HMP	T4650013	brown	
Ground		HMP		red	
3	2H	pressure transmitter	E 1810003	white	pink = 12 V, blue = Ground
4	2L	KH20 signal	1643	white	red = 12V, blue = Ground
Ground		KH20 Ground/shield	1643	black/grey	
5	3H	MUX	E4938	yellow	to MUX COM Even H
6	3L	MUX	E4939	white	to MUX COM Even L
Ground					
7	4H	Inclinometer	Inc.02	green	yellow = 12V, grey = Ground
8	4L	Inclinometer	Inc.02	white	
Ground		Inclinometer	Inc.02	brown	
9	5H				
10	5L				
Ground					
11	6H				
12	6L				
Ground					
13	7H				
14	7L				
Ground					
15	8H	CNR1	990197	red	10.82 x 10^6 V/Wm²
16	8L	CNR1	990197	blue	
Ground					
17	9H	CNR1	990197	white	
18	9L	CNR1	990197	black	
Ground					
19	10H	CNR1	990197	grey	
20	10L	CNR1	990197	yellow	
Ground					
21	11H	CNR1	990197	brown	
22	11L	CNR1	990197	green	
Ground					
23	12H	CNR1	990197	yellow	red = IX1, blue = IXR
24	12L	CNR1	990197	green	
Ground					
25	13H	TDR	14073	white	External Power
26	13L	TDR	14072	white	green = 12V, brown = Ground

Ground					
27	14H	TDR	14074	white	Attention: Ground in plug
					was not connected right
Ground					
Excitation Voltage					
VX1					
VX2					
Ground					
VX3					
VX4					
Ground					
Continuous Analog Outputs					
CAO1					
CAO2					
Ground					
Excitation Current					
		Device	**Serial nr**	**Wiring**	**Comments**
IX1		CNR1	990197	red	
IX2		MUX	E4939	green	to MUX COM Odd H
IX3					
IXR		CNR1/MUX		blue/Brown	brown to MUX COM Odd L
Pulse Count					
Ground		Rain gauge	010291	white/red	no matter which cable is ground
P1		Rain gauge	010291	white	Calibration: 0.1 for mm
Ground					
P2					
Ground					
P3					
Ground					
P4					
COM Ports					
C1	Tx1	MUX	E4939	green	to MUX Res / white = 12V
C2	Rx1	MUX	E4939	yellow	to MUX CLK / brown = ground
C3	Tx2				
C4	Rx2				
Ground					
C5	Tx3				
C6	Rx3				
C7	Tx4				
C8	Rx4				

Ground					
Power out					
5V					
Ground					
12V S1					
12V S2					
Ground					
12V 1					
12V 2					
Ground		Licor	75H-1200	black + white	
		Csat3	1756	black	
SDM					
SDM1		Licor	75H-1200	grey	
		Csat3	1756	green	
SDM2		Licor	75H-1200	blue	
		Csat3	1756	white	
SDM3		Licor	75H-1200	brown	
		Csat3	1756	brown	
Power in					
Ground					to 12V power supply + USV
12V					

Multiplexer AM 16/32B S/N Multiplexer: 4939

Experiment: Tibet 2009

Channels					
SE	Diff	Device	Serial nr	Wiring	Comments
1	1H	PT100 long	T1	green	Water temperature
	1L	PT100 long	T1	brown	Water temperature
	Ground				
	2H	PT100 long	T1	yellow	Water temperature
	2L	PT100 long	T1	white	Water temperature
	Ground				
2	3H	PT100 long	T2	green	
	3L	PT100 long	T2	brown	
	Ground				
	4H	PT100 long	T2	yellow	
	4L	PT100 long	T2	white	
	Ground				
3	5H	PT100 long	T3	green	
	5L	PT100 long	T3	brown	

	Ground				
	6H	PT100 long	T3	yellow	
	6L	PT100 long	T3	white	
	Ground				
4	7H	PT100 long	T4	green	
	7L	PT100 long	T4	brown	
	Ground				
	8H	PT100 long	T4	yellow	
	8L	PT100 long	T4	white	
	Ground				
5	9H	PT100 short	T5	black	
	9L	PT100 short	T5	orange	
	Ground				
	10H	PT100 short	T5	brown	
	10L	PT100 short	T5	red	
	Ground				
6	11H	PT100 short	T6	black	
	11L	PT100 short	T6	orange	
	Ground				
	12H	PT100 short	T6	brown	
	12L	PT100 short	T6	red	
	Ground				
7	13H	PT100 short		black	
	13L	PT100 short		orange	
	Ground		T7		
	14H	PT100 short	T7	brown	
	14L	PT100 short		red	
	Ground				
8	15H	PT100 short	T8	black	
	15L	PT100 short	T8	orange	
	Ground				
	16H	PT100 short	T8	brown	
	16L	PT100 short	T8	red	
	Ground				
9	17H				
	17L				
	Ground				
	18H	Heat flux plate	HP3 69813	blue	227µV/mW/cm²
	18L	Heat flux plate	HP3 69813	brown	
	Ground				
10	19H				
	19L				
	Ground				
	20H	Heat flux plate	HP3 65653	blue	243µV/mW/cm²
	20L	Heat flux plate	HP3 65653	brown	must be multiplied with -1
	Ground				
11	21H				
	21L				

	Ground				
	22H				
	22L				
	Ground				
12	Ground				
	23H				
	23L				
	Ground				
	24H				
	24L				
	Ground				
13	25H				
	25L				
	Ground				
	26H				
	26L				
	Ground				
14	27H				
	27L				
	Ground				
	28H				
	28L				
	Ground				
15	29H				
	29L				
	Ground				
	30H				
	30L				
	Ground				
16	31H				
	31L				
	Ground				
	32H				
	32L				
	Ground				

	RES	Logger		green	to Logger C1 Tx (Com1)
	CLK	Logger		yellow	to Logger C1 Rx (Com1)
	Ground	Logger		brown	power from Logger
	12V	Logger		white	power from Logger
COM	Odd H	Logger			
	Odd L	Logger		green	to Logger IX2
	Ground	Logger		brown	to Logger IXR
	Even H	Logger			
	Even L	Logger		yellow	to Logger Diff 3H (SE5)
	Ground	Logger		white	to Logger Diff 3L (SE6)

B. Licor Calibration

Device			must value	actual value	
LiCor7500 SN 1200	zero	CO2	0	0.77 mmol/(m^3)	19.25 µmol/mol
	zero	H20	0	-9.5 mmol/(m^3)	-0.24 mmol/mol
	span	CO2	352.59 µmol/mol	14.41 mmol/(m^3)	365.38 µmol/mol
	span	H20	16.46°C dew point T	17.27°C dew point T	

	A	B	C	D	E	XS	Z
CO_2	153.342	4598.71	4.88349e+07	-1.480160e+10	1.912250e+12	0.0043	-0.0005
H_2O	4936.129	408908.	-1.61506e+08			-0.0006	0.0177

Additional Information can be found in the Configuration file “D_Licor_Calibration” on DVD Nr 494.

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
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