

Chapter 2

Description of the Waldstein Measuring Site

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2.1 Introduction

The measuring sites of the Bayreuth Center of Ecology and Environmental Research (BayCEER) at the Waldstein area in the Fichtelgebirge Mountains (Fig. 2.1) have a well-documented history over a period of more than 20 years (see Chap. 1). The most comprehensive description of each of the measurement sites can be found in Gerstberger (2001) and Gerstberger et al. (2004). Between the two mountains “Großer Waldstein” (879 m a.s.l.) and the “Bergkopf” (857 m a.s.l.) is located the

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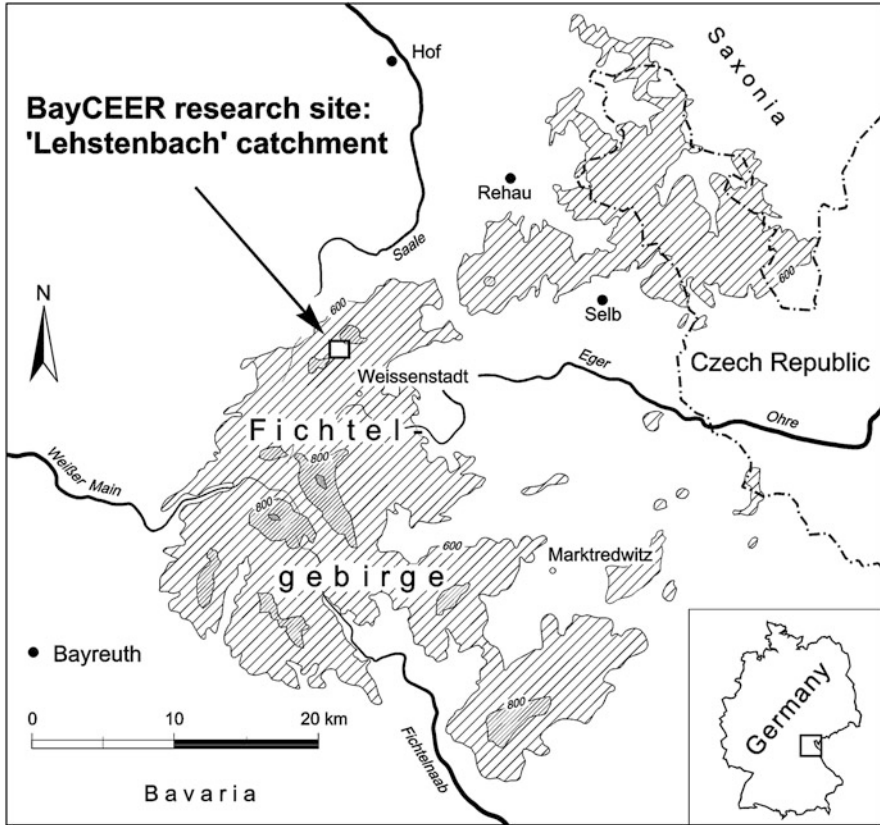


Fig. 2.1 Fichtelgebirge Mountains with the location of the Lehstenbach catchment; the contour lines are 600, 800, and 1000 m a.s.l. (Gerstberger et al. 2004, published with kind permission of © Springer-Verlag Berlin, Heidelberg, All rights reserved)

“Lehestenbach Catchment,” with several measuring sites (Fig. 2.2). The present documentation is mainly for the Pflanzgarten site, with air quality and some climatological measurements, and the Weidenbrunnen site with forest climate measurements and the FLUXNET station (DE-Bay). Both sites were established in 1994. Furthermore, in some of the chapters of this volume, the Weidenbrunnen II

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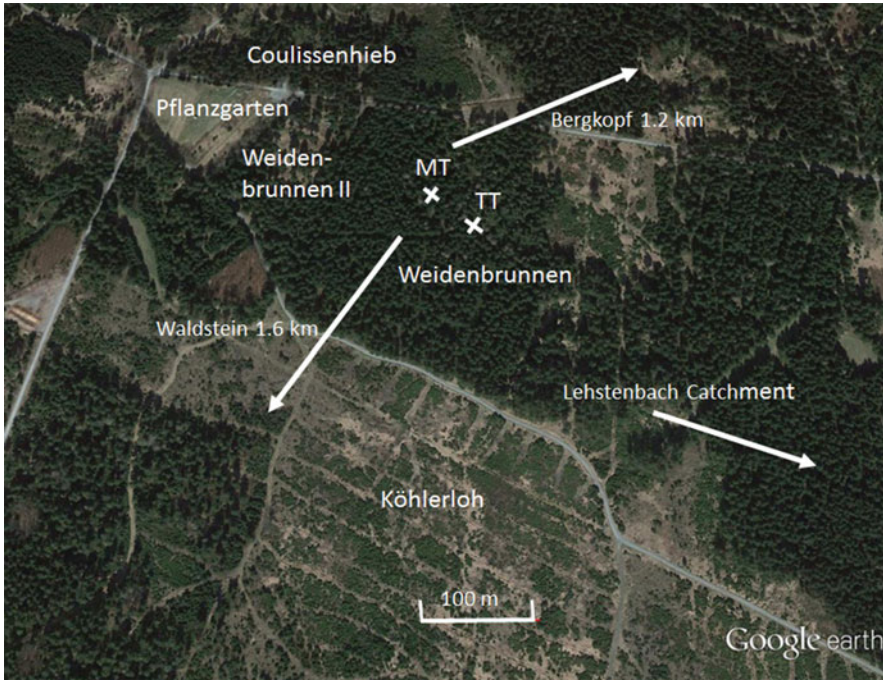


Fig. 2.2 Aerial view of the Waldstein sites in the Lehstenbach catchment (photograph from April 19, 2015, showing nearly no changes since 2007), with the different measuring sites and distances to relevant hills in the surrounding landscape (Published with kind permission of © Google earth, 2015, All rights reserved), MT: Main Tower, TT: Turbulence Tower

site (later on called Coulissenhieb II), the Schlöpnerbrunnen site, and the Köhlerloh site are also included in the analysis. The necessary details of these sites are given in the relevant chapters. The main site for ecological and soil research, Coulissenhieb, has no relevant atmospheric measurements and is not included in this book. Many details have been published in a separate book (Matzner 2004) and later on by Muhr et al. (2009).

In the period of the existence of the Bayreuth Institute of Terrestrial Ecosystem Research (BITÖK) from 1994 to 2004 and of the European EUROFLUX project (see Chap. 1), all the Waldstein sites were worked on by many researchers and were the subjects of a great number of scientific and popular scientific publications including site documentations. Staudt (now Köck) and Foken (2007) made a comparison of all published data and selected recommended values, and this constituted a major step toward providing harmonized and quality-controlled consistent data. In this chapter, we follow this documentation.

2.2 The Waldstein Area

The densely forested Fichtelgebirge Mountains located in the northeast of Bavaria (Fig. 2.1) originated from a large granitic pluton surrounded by metamorphic rock series such as gneiss, mica schists, and phyllites. The highest summits are “Schneeberg” (1053 m) and “Ochsenkopf” (1023 m) and do not reach the timberline. In the Pleistocene, the Fichtelgebirge was not glaciated, but erosion and solifluction occurred, leaving behind typical “woolsack” rock formations of granite (e.g., the Waldstein, Rudolphstein). The region was, for several decades, heavily influenced by air pollution, mainly SO_2 (see Chap. 3) and reactive nitrogen.

The long-lasting pollution of the region resulted in severe acidification of the already acid soils, and forest decline at higher altitudes (above 800 m) of the Fichtelgebirge occurred in the 1980s (Schulze et al. 1989). Today the input of sulfur has dropped dramatically. However, the input of nitrogen compounds (as NO_x and NH_4^+) is still high and shows no decreasing trend (Matzner 2004); the continuing high levels of NO_2 are given in Chap. 3.

The main experimental plots are located in the Lehstenbach catchment, which has an area of 4.5 km^2 and an altitude of 695 m to 877 m a.s.l., with the Waldstein-Weidenbrunnen site at 875 m. The annual precipitation is 1.162 mm and the mean temperature 5.3°C (Foken 2003, updated in Chap. 3) for the period 1971–2000. Most of the measurement sites are in the vicinity of the Weidenbrunnen site (Fig. 2.2). All sites, with the exception of the Weidenbrunnen site, were limed in the 1990s using dolomitic lime. The Weidenbrunnen site, due to a later liming, was therefore the most affected by acidification of all sites, with characteristic yellowing of the older needles of Norway spruce (*Picea abies*) and more than 30 % needle loss (Gerstberger 2001). However, it was decided in 2001 to lime this site as well and to stop any investigations of the forest decline in the period after the acid rain. In the following years, the forest regained its green color and had a growth similar to the whole forest (see Chap. 4). A description of all forest stands in this area can be found in Alsheimer (1997). The potential natural vegetation of the area is a beech-fir-mixed forest (Reif 1989).

The forest structure was severely disturbed by two storm events: Kyrill on January 18, 2007 and Emma on February 29, 2008. Kyrill mainly destroyed large parts of the Köhlerloh site, with a wind throw of about 1.5 km length in that site, and parts in the Weidenbrunnen II site (Fig. 2.2). For the Waldstein area, we should therefore separate a period with a widely intact forest site before 2007, with the exception of some degradations due to acid rain before 2002 for the Weidenbrunnen site, and a period with large areas destroyed by windfall and bark beetle infestation since 2007. An overview of the characteristic data of all sites is given in Table 2.1.

Table 2.1 Main characteristics of the different sites

	Weidenbrunnen	Pflanzgarten	Köhlerloh
Latitude	50°08'31" N (MT) 50°08'30" N (TT)	50°08'35"N	50°08'22"N
Longitude	11°52'01" E (MT) 11°52'03" E (TT)	11°51'49"E	11°52'02"E
Elevation	775 m (MT) 773 m (TT)	765 m	749 m
Forest	Norway spruce (<i>Picea abies</i>) Age: 60 years (2013)	–	–
Understory	<i>Calamagrostis villosa</i> , <i>Deschampsia flexuosa</i> , <i>Vaccinium myrtillus</i> , <i>Dryopteris dilatata</i> , <i>Oxalis acetosella</i> , <i>Dicranum scoparium</i> cover: 60–80 %	Mown grass meadow, scrub	<i>Deschampsia flexuosa</i> , <i>Picea abies</i> , <i>Vaccinium myrtillus</i> (together 60 %); <i>Calamagrostis villosa</i> , (9 %); <i>Juncaceae</i> , <i>Cyperaceae</i> (together 3 %); others: dead wood, bare soil
References	Staudt and Foken (2007)		Serafimovich et al. (2011)

MT Main Tower, TT Turbulence Tower

Table 2.2 Time-dependent characteristics of the forest stand

Year	Canopy height in m	Leaf area index in m ² m ^{−2}	Reference
1993	16.1	5.3	Alsheimer (1997)
1995	17.8		Mund (1996)
2003	19	5.2	Thomas et al. (2004) and Thomas and Foken (2007a)
2008	25	4.8	Foken et al. (2012)
2011	27		Serafimovich et al. (2011)

2.3 Specific Details of the Measuring Sites

2.3.1 Waldstein-Weidenbrunnen

2.3.1.1 Forest Stand

The Norway spruce forest (*Picea abies* (L.) KARST.) has an age of 60 years (2013) with 60–80 % understory (Table 2.1). Because of beetle attacks and storm events, the forest has become more and more heterogeneous in the last 10 years with a lower tree density, which was about 1000 ha^{−1} at the end of the 1990s. The tree height and the leaf area index are given in Table 2.2. Measurements of the horizontal distribution of plant area index (PAI) were made with two optical area meters (Plant Canopy Analyzer, LAI2000, LiCor, USA) and are available for 2003 (Thomas and Foken 2007a) and 2008, with 5.6 ± 2.1 m² m^{−2} for the overstory trees and 3.5 m² m^{−2} (LAI 0.5 m² m^{−2}) for the understory (Foken et al. 2012); both are shown in Fig. 2.3. For the spatial distribution of the plant parameters and its use in

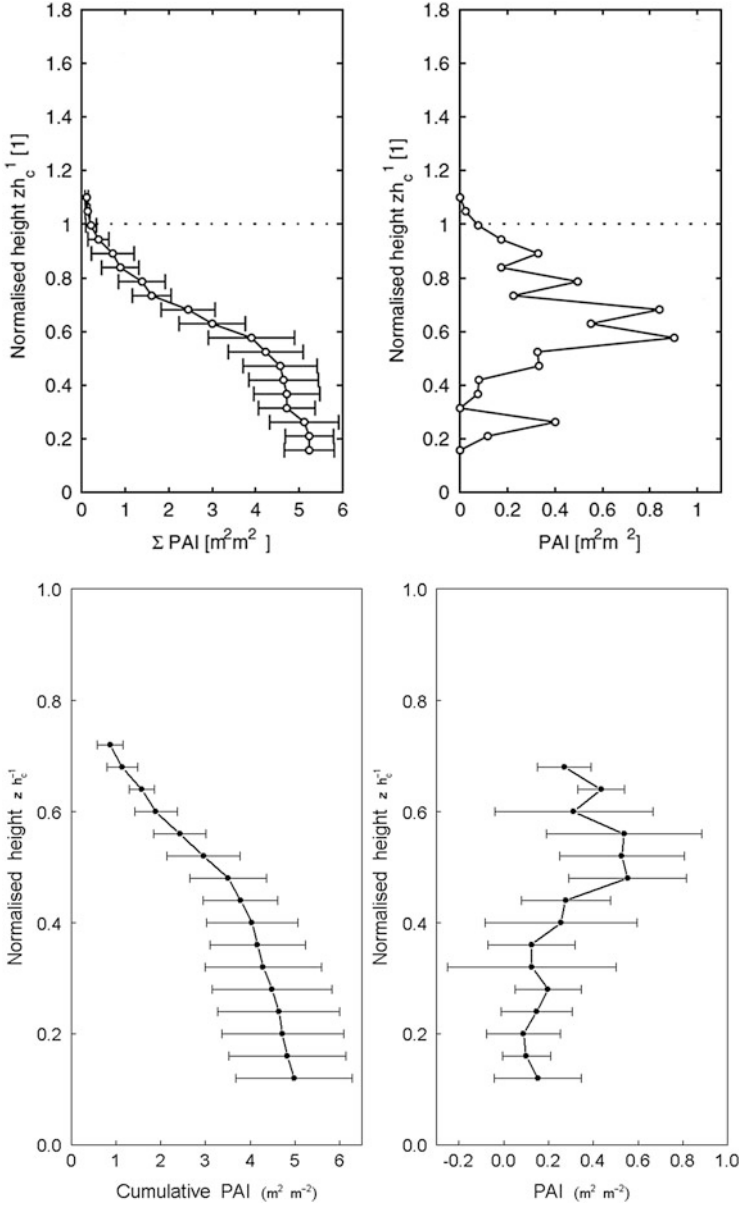


Fig. 2.3 Vertical profile of the (left) cumulative and (right) absolute overstory plant area index (PAI) of the Waldstein-Weidenbrunnen site for 2003 (above Thomas and Foken 2007a) and 2008 (below Foken et al. 2012). The height is normalized by a canopy height according to Table 2.2. Published with kind permission of (above) © Springer-Verlag Berlin, Heidelberg, and (below) © Copernicus publications, distributed under the Creative Commons Attribution 3.0 Licence. 2012, All rights reserved

modeling approaches, see Chap. 16. The distribution of the understory in 2008 is shown in Fig. 2.4 (Behrendt 2010), with more understory in the northeastern part and a higher tree density in the southwestern part. The corresponding distribution of the plant area index is given in Fig. 2.5, which corresponds to the mean vertical profile in Fig. 2.3 (below).

The podzolic soils of the upper parts of the Fichtelgebirge developed from deeply weathered (up to 30 m) granite or gneiss bedrock. The forest floor is moor type and well stratified and consists of a litter (Oi), a fermented (Oe), and a humified (Oa) horizon. The soil texture is sandy loam to loam (US Soil Taxonomy), with a relatively high clay content in the Bh horizon. The content of rock fragments is about 10–25 % vol. in the A and B horizons and increases in the C horizon (deeper than 55 cm) to 50–75 % vol. Detailed information about soil texture and soil chemistry are available for the Coulissenhieb site (Gerstberger et al. 2004; Staudt and Foken 2007). During the installation of a new measuring profile for soil temperature and moisture at the Weidenbrunnen site, a soil profile was obtained to a depth of 2 m and is shown in Fig. 2.6.

2.3.1.2 Instrumentation

The main installation of the measuring site is the 32 m high walk-up scaffold tower (Fig. 2.7) with balcony-like platforms in the crown level of the forest, called the “Main Tower” (MT). This tower was erected in 1994 to allow plant ecological measurements in the crown and is still in use. Starting at the end of 1996, carbon dioxide fluxes were measured as part of the EUROFLUX program (see Chap. 4). From that point on, additional meteorological instrumentation was successively installed, such as for short period flux measurements at two levels above the crown (Rebmann 2003), or implemented as long-term standard measurements of temperature, humidity, wind velocity, and radiation components.

After the closing down of the Bayreuth Institute of Terrestrial Ecosystem Research (BITÖK) and the establishment of the Bayreuth Center of Ecology and Environmental Research (BayCEER) in 2004 (see Chap. 1), the full responsibility for the Waldstein-Weidenbrunnen site moved to the Department of Micrometeorology. From that time, the instrumentation was stepwise renewed and upgraded when necessary (Appendix A, Table 2.3), with no significant changes in the last 10 years. This standard measurement program also offered the possibility of testing sensors under the harsh environmental conditions of the site occurring mainly in winter, with fog and heavy frost. For instance, the heating system of the two-dimensional sonic anemometer of Adolf Thies GmbH & Co. KG, Göttingen was tested as well as a ship rain gauge (Eigenbrodt GmbH & Co. KG, Königsmoor) for precipitation measurements above the canopy. A good agreement found between precipitation above the forest and that obtained by a standard rain gauge at the Waldstein-Pflanzgarten site and the data analysis yielded the finding that the wind speed was not so strong above the forest that a correction for rain on a vertical and horizontal collector was necessary.

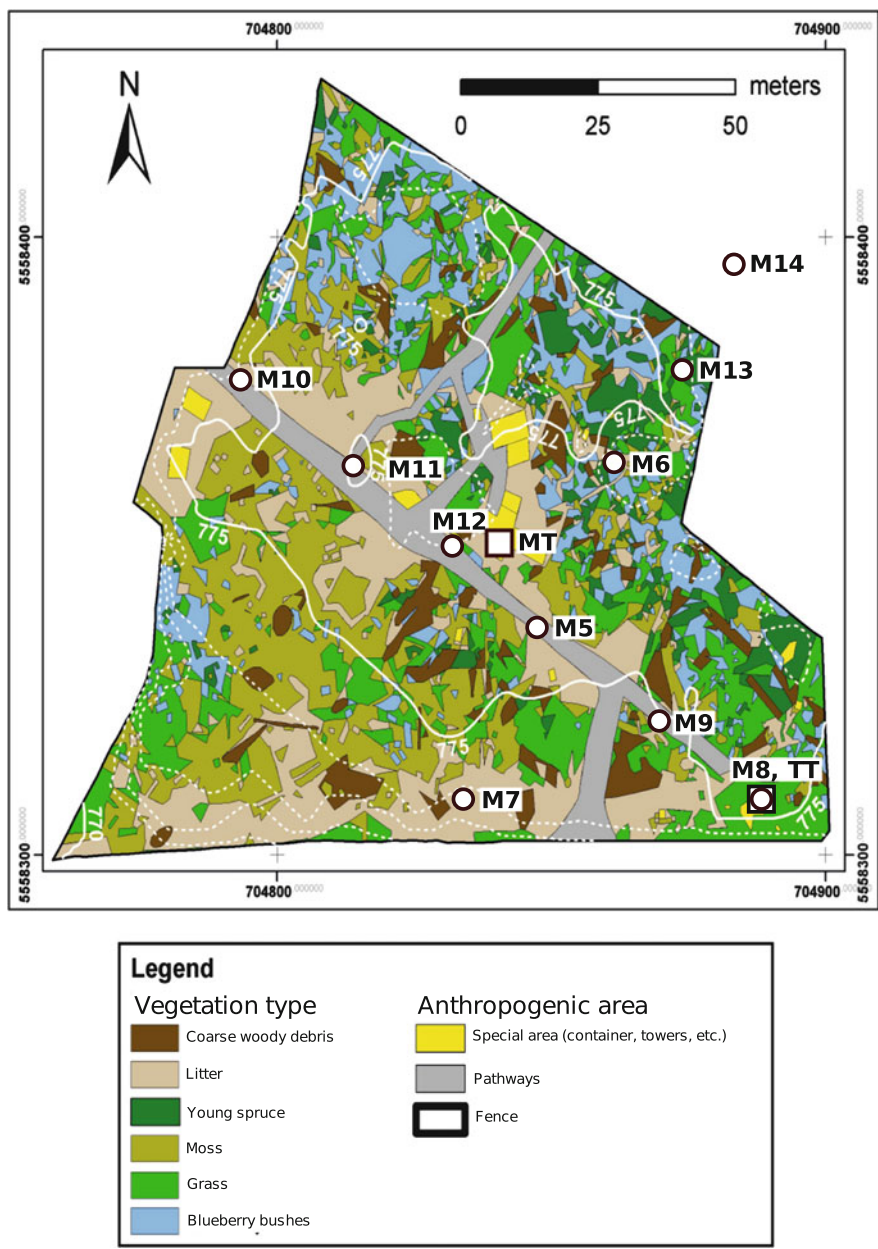


Fig. 2.4 Understory vegetation and topography (shown as *white isolines*). Equidistance of *dashed lines*, 1 m. Circles indicate position of 2 m masts after Siebicke (2011), see Table 2.5, and squares indicate position of tall towers: “Main Tower” (MT) and “Turbulence Tower” (TT) during the EGER-IOP 1 and EGER-IOP 2 (see Appendix A). Understory vegetation data and graphics produced by Behrendt (2010)

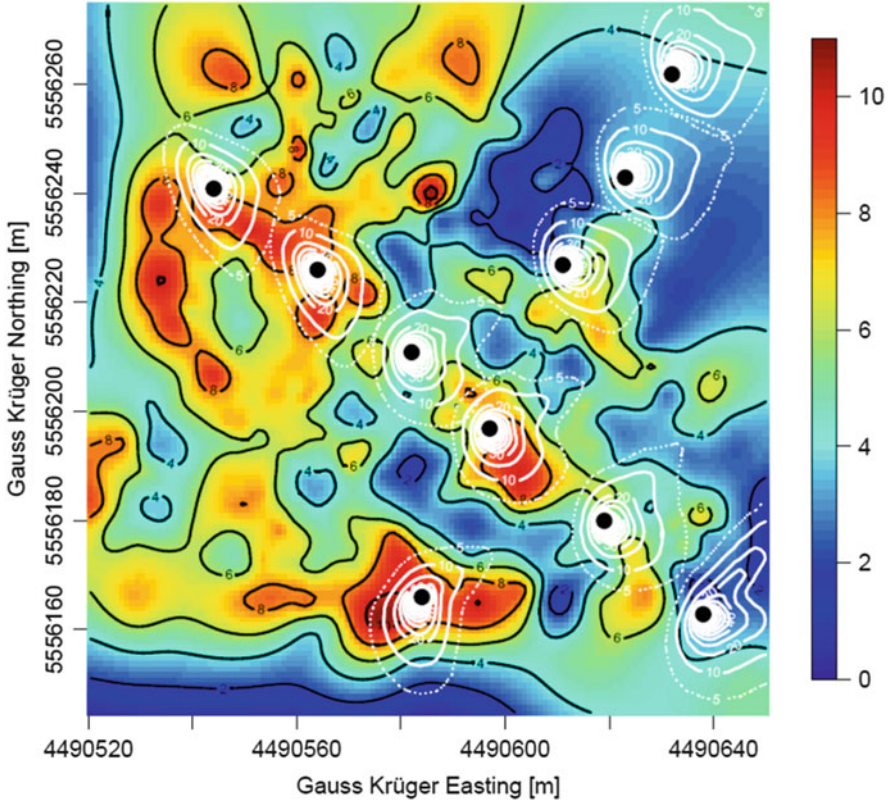


Fig. 2.5 Map of plant area index given as colors and black contour lines. Black points show the positions of the towers for sub-canopy measurements; see Table 2.5. X- and Y-axis are distances in meters in the Gauss-Krüger coordinate system. White isolines show the relative flux contribution of the corresponding footprint area in 10 % intervals for stable cases only (2008). The outermost, dashed isoline indicates the area where 95 % of the flux originates. Raw data of PAI were provided by E. Falge (Siebicke 2011)

With the help provided by the funding of several large research projects by the German Science Foundation between 2006 and 2013, it was possible to erect a 36 m slim tower (Fig. 2.8) for turbulence measurements only. From the end of 2007, this so-called “Turbulence Tower” (TT) hosted a second carbon dioxide flux measurement complex in addition to the device on the Main Tower. Flux profile measurements (Foken et al. 2012) were possible on the Turbulence Tower with a much better quality than in an earlier experiment in 2003 that used just the Main Tower (Thomas and Foken 2007b). Furthermore, the power supply was stabilized with a separate transformer near the site (2011), which allowed more extensive chemical and remote sensing measurements, even at the Köhlerloh site. At the top of both towers, the carbon dioxide flux measurements within the FLUXNET program (Baldocchi et al. 2001) have been running since 1996 as station DE-1



Fig. 2.6 Soil profile up to 2 m depth near the Main Tower in 2007 (Photograph: J. Lüers)

(EUROFLUX), later DE-Wei, and now DE-Bay. The main land cover was classified as Evergreen Needleleaf Forest (ENF). Nineteen percent of all measurements had more than 95 % of the target area in the footprint of the measurements, while 65 % of all measurements had more than 80 % (Göckede et al. 2008). The remaining flux contribution originated from the Pflanzgarten clearing and other small clearings nearby. After the storm event Kyrill in January 2007, the measurements for southerly winds, mainly for stable stratification, were significantly influenced by the Köhlerloh clearing. This is shown in Fig. 2.9 for the Main Tower and the Turbulence Tower, where the Turbulence Tower is slightly more affected (Siebicke 2008).

Besides the FLUXNET measurements and the meteorological routine program, both towers served as platforms for many short-term research projects, such as



Fig. 2.7 Main Tower at Waldstein-Weidenbrunnen site (2008, Photograph T. Foken)

the work on fog deposition (Wrzesinsky and Klemm 2000, see Chap. 3) or studies of ^{13}C -isotope fluxes (Chap. 10). Furthermore, large experiments, sometimes with international participation, were realized at the Waldstein-Weidenbrunnen site (Table 2.4). During these 2–3-month-long experiments, several additional devices operated at the towers. An overview is given in Appendix A. Additional towers were erected during the EGER experiments: in IOP 1 and IOP 2 a 40 m tower about 80 m westward of the Main Tower and a network of small towers in the trunk space, which can be seen in Figs. 2.4 and 2.5. During IOP 3 the 40 m tower was installed at the forest edge south of the Turbulence Tower, and the network of small towers was relocated to form a line along the forest edge and in the Köhlerloh clear-cut. It should be mentioned that these experiments made the site more visible in the

Table 2.3 Basic instrumentations at Waldstein-Weidenbrunnen site (Main Tower); for details, see Appendix A, and for flux measurements, see Chap. 4

Height in m	Parameter	Sensor
2, 21, 31	Temperature, moisture	Pt100, capacitive sensor, unventilated
0, 2, 5, 12, 21, 31	Temperature, moisture	Psychrometer (ventilated, moisture only April–October)
2, 5, 10, 16, 18, 21, 25, 32	Wind speed	Cup anemometer
32	Wind speed and direction	2D sonic anemometer
30	Short- and long-wave radiation balance	
31	Precipitation	Ship rain gauge
33	Turbulent fluxes	3D sonic anemometer, gas analyzer
21	Visibility, weather code	Present weather sensor
−0.02, −0.05, −0.1, −0.2, −0.5, −0.7, −1.0, −2.0	Soil temperature	Pt100
−0.1, −0.5	Soil humidity	TDR
−0.1 (2x)	Soil heat flux	Soil heat flux plate

scientific literature than did the continuously running programs. For an overview of all towers and their operation times, see Table 2.5.

2.3.2 Waldstein-Pflanzgarten

The Waldstein-Pflanzgarten site is now a forest clearing cultivated mainly as a meadow. Prior to more than 10 years ago, it was used as a nursery. The current clearing has a size of approximately 0.5 ha and is, in main parts, only meadow. Since 1994 concentrations of trace gases like SO₂, NO, NO₂, and O₃ have been measured. Short-term observations of NH₃ have only shown significant concentrations during days of fertilization with liquid manure in the agricultural area about 2 km westward. Since 2007, permanent wet deposition measurements of cationic and anionic atoms or molecules and heavy metals have been running. The results are reported in Chap. 3. An overview of the site is given in Fig. 2.10.

The site is furthermore equipped with standard meteorological instrumentation to obtain temperature, humidity, wind, radiation, and precipitation. All measuring parameters are shown in Appendix A and Table 2.6. During large experiments (Table 2.4), the site was also used for additional chemical measurements, like aerosol measurements (Held et al. 2004). During all three EGER campaigns, a sodar-RASS system was in operation to characterize the wind field above the forest.

The wet deposition measurements have also been used since 2007 by the Bavarian State Office for Environment for environmental control. It is the highest-



Fig. 2.8 Turbulence Tower at Waldstein-Weidenbrunnen site (2008, Photograph T. Foken)

situated station in Northern Bavaria. Furthermore, the rain gauge has been included since 2012 in the Bavarian flood warning system to control precipitation events in the spring catchment of the rivers Main, Saale, Eger (Ohre), and Naab. The site fulfills – together with the trunk space measurements of the Waldstein-Weidenbrunnen site – all criteria for a so-called forest climate station (Dietrich et al. [2006](#)).

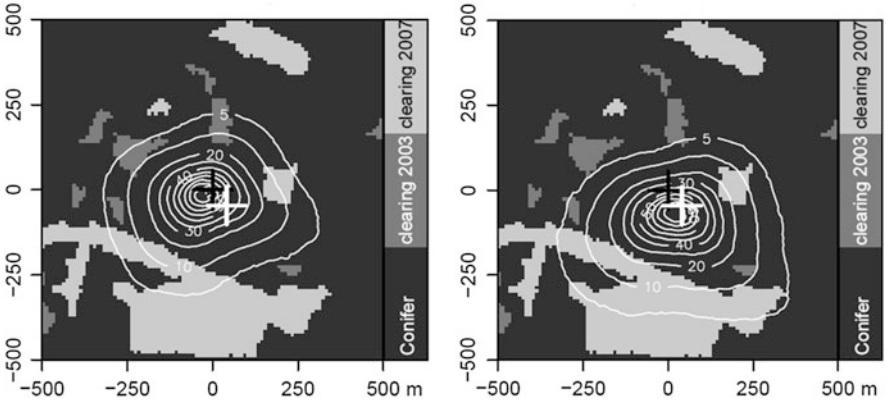


Fig. 2.9 Footprint climatology of the towers of the Waldstein-Weidenbrunnen site (*left figure and black cross*, Main Tower; *right figure and white cross*, Turbulence Tower) on the basis of the data set from September 06 to October 07, 2007 (Siebicke 2008)

Table 2.4 Micrometeorological and air chemistry experiments at Waldstein-Weidenbrunnen site (see Chap. 1)

Date	Experiment	Aim of the experiment	Documentation/reference
09.07.2001–03.08.2001	BEWA* 2001	Emissions of reactive biogenic volatile organic compounds	Klemm et al.(2006)
24.06.2002–02.08.2002	BEWA* 2002		
28.04.2003–03.08.2003	WALDATEM** 2003	Intensive investigation of coherent structures and carbon fluxes within and above a tall spruce forest	Thomas et al. (2004)
06.09.2007–07.10.2007	EGER***-IOP1	Energy and trace gas transport in and above a tall spruce forest	Serafimovich et al. (2008a) and Foken et al. (2012)
01.06.2008–15.07.2008	EGER***-IOP2		Serafimovich et al. (2008b) and Foken et al. (2012)
13.06.2011–26.07.2011	EGER***-IOP3	Interaction between a forest and a clearing	Serafimovich et al. (2011) and this volume

*Regional biogenic emissions of reactive volatile organic compounds (BVOC) from forests: process studies, modeling, and validation experiments
**WALD WAVElet Detection, ATEM Atmospheric Turbulence Exchange Measurements
***Exchange processes in mountainous regions, IOP Intensive Observation Period

Table 2.5 Overview of the tower installations at Waldstein-Weidenbrunnen site

Tower	Operation time	Purpose	Further references
Main Tower (MT), 32 m high, see Table 2.1 and Figs. 2.2 and 2.7	Since 1997	Micrometeorological standard program	Table 2.3; Appendix A, Table A1
	Since 1997	FLUXNET station	Chap. 4; Appendix A, Table A2
	BEWA 2001, 2002, see Table 2.4	Air chemistry measurements	Chap. 9; Appendix A, Table A4
	WALDATEM 2003, see Table 2.4	Micrometeorological and carbon flux studies	Chaps. 6 and 10; Appendix A, Table A5
	EGER, IOP 1,2 in 2007 and 2008, see Table 2.4	Micrometeorological and air chemistry measurements	Chaps. 8, 9, and 12; Appendix A, Table A6
Turbulence Tower (TT) 36 m high see Table 2.1 and Figs. 2.2 and 2.8	Since 2007	Additional FLUXNET station	Chap. 4; Appendix A, Table A3
Bio-tower, 80 m westward of MM 40 m high	EGER, IOP 1,2 in 2007 and 2008, see Table 2.4	Sap flow and plant ecological measurements	Chaps. 5 and 16
Forest-edge tower (M3), south of TT 40 m high	EGER, IOP 3 in 2011, see Table 2.4	Micrometeorological and air chemistry measurements	Chaps. 9 and 13; Appendix A, Table A8 and Fig. A3
Network of small towers	WALDATEM 2003, see Table 2.4	Micrometeorological and carbon flux studies	Chap. 6; Appendix A, Table A5
	EGER, IOP 1 in 2007, see Table 2.4	Micrometeorological and air chemistry measurements	Chaps. 8, 9, and 12; Appendix A, Table A6 and Fig. A1
	EGER, IOP 2 in 2008, see Table 2.4	Micrometeorological and air chemistry measurements	Chaps. 8, 9, and 12; Appendix A, Table A7 and Fig. A2
	EGER, IOP 3 in 2011, see Table 2.4	Micrometeorological and air chemistry measurements	Chaps. 9 and 13; Appendix A, Table A8 and Fig. A3

2.3.3 Köhlerloh

As a large forest clearing, the Köhlerloh provides an interesting subject of research, especially since the storm event “Kyrill” in January 2007. In particular, the edge between forest and clearing was part of a deep investigation during the EGER-IOP 3 campaign in 2011. The southern region of this forest was managed by the administration beforehand (felling in 2006), but the north area of the forest was also heavily affected by the severe storm “Kyrill” (Fig. 2.11). During EGER-IOP 3 the site was equipped with a 40 m tall tower and several smaller ones along the



Fig. 2.10 Waldstein-Pflanzgarten site in 2008 with the measurement container (on the top radiation measurements and 10 m wind measurements); in the background the wet-only sampler is visible. Additional instrumentation during EGER-IOP 2 with a measuring container for additional trace gas measurements and a sodar-RASS system in the foreground (2008, Photograph T. Foken)

Table 2.6 Basic instrumentations at Waldstein-Pflanzgarten site; for details, see Appendix A, and for concentration measurements, see Chap. 3

Height in m	Parameter	Sensor
2	Temperature, moisture	Pt100, capacitive sensor, unventilated
10	Wind speed and direction	Cup anemometer, wind vane
4	Down-welling shortwave and diffuse radiation	Pyranometer, shadow ring
1	Precipitation	Tipping bucket and weighing rain gauge
2	Air pressure	Capacitive sensor
1	Wet deposition	Wet only precipitation collector
3	O ₃ concentration	Gas analyzer
3	SO ₂ concentration	Gas analyzer
3	NO and NO ₂ concentration	Gas analyzer

forest edge and on the clear-cut. In addition a sodar system and laser scintillometer pathways were in use. The land cover with the different plant species is shown in Table 2.7.



Fig. 2.11 Köhlerloh clear-cut in 2011 with a mixture of bare soil, deadwood, grass, and small trees. During EGER-IOP 3 the site was equipped with additional measuring systems (View to south with the Waldstein in the background in 2011, Photograph T. Foken)

Table 2.7 Land cover of the Köhlerloh site (Serafimovich et al. 2011), updated

Vegetation	Ground cover in %	Height in m	PAI in $\text{m}^2 \text{m}^{-2}$
<i>Deschampsia flexuosa</i>	21.7	0.17 ± 0.05	2.65 ± 1.08
<i>Picea</i>	21.4	1.21 ± 0.50	8.67 ± 2.29
<i>Vaccinium</i>	15.9	0.27 ± 0.10	3.46 ± 1.05
<i>Calamagrostis</i> , <i>Agrostis</i>	9.0	0.42 ± 0.10	3.43 ± 1.07
<i>Carex</i>	3.1	0.74 ± 0.13	1.77 ± 0.60
Other <i>herbaceous</i>	1.6		
Moss	0.9		
Dead grass, bare soil	7.2		
Dead wood (harvest residuals)	18.8		
Water	0.2		

2.4 Conclusions

The Waldstein-Weidenbrunnen and Waldstein-Pflanzgarten sites have been used for observing air pollutants and meteorological parameters for more than 20 years and trace gases, such as carbon dioxide, for nearly two decades. The duration of measurements and the instrumentation are comparable with stations like Duke Forest, Niwot Ridge (both the USA), and Hyytiälä (Finland); however, the focus was mainly on micrometeorological measurements and less on plant ecological measurements. Therefore, the site is only barely represented in the large FLUXNET

overview papers (see Appendix C). Many data quality issues were tested at this site and have led to now standard methods in the community. The large experiments all had a special focus. They would be scarcely imaginable without the well-equipped sites with their infrastructure and basic measurements.

This offered the possibility of a wide range of scientific investigations in addition to the climate and air pollution studies (Chap. 3) and the water and carbon fluxes (FLUXNET, Chap. 4), with many methodological studies (Chaps. 6 and 12) and investigation of the influences of boundary layer phenomena on these fluxes (Chap. 11). Over short periods, sap flow (Chap. 5), fluxes in the soil (Chap. 7), isotope fluxes (Chap. 10), and catchment fluxes (Chap. 15) were studied. After 2007, fluxes at the heterogeneous site (Chaps. 12, 13, and 17) became a dominant issue of research, as did the related microclimate (Chap. 14). The air chemistry measurements (Chaps. 8 and 9) could be controlled by micrometeorological measurements. And last but not least, several models were tested and applied at these sites (Chaps. 15, 16, 17, and 18).

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