UNIVERSITY OF BAYREUTH

Department of Micrometeorology

# Documentation of reference data for the experimental areas of the Bayreuth Centre for Ecology and Environmental Research (BayCEER) at the Waldstein site

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# Content

# 1 Introduction

This work is a collection of reference data for the experimental areas of the Bayreuth Center for ecology and environmental research (BayCEER), former BITÖK, at the Waldstein site in the Fichtelgebirge The focus was set on the Weidenbrunnen site, where the standard micrometeorological measurements as well as the field experiments of the Department for Micrometeorology of the University of Bayreuth are conducted. It is clear that this collection of data is not exhaustive, as a vast number of literature has been published since the beginning of the research activities in the Waldstein region, even though the most important papers that were recently published should have been considered. This work is intended to serve as a guidance for general reference data for upcoming publications. Therefore, recommended data for citations is marked in the data collections and shaded in grey in tables.

# 2 Reference data

## *2.1 Geographical coordinates*

### Data collection

Main tower (FLUXNET)

| | Latitude | Longitude | Elevation [m] |
|---|---|---|---|
| **Valentini (2000)** | 50°09'N | -- | 780 |
| **Gerstberger (2004)** | 50°09'N | 11°52'E | 765 |
| **Thomas (2005; 2007a; 2007b)** | 50°08'N | 11°52'E | 775 |
| **Thomas (2004)** | 50°08'31" N | 11°52'01" E | 775 |
| **Carbo-Europe website** | 50° 09' N | 11°52' E | 780 |
| **TEMS website** | 50°08'32" N | 11°52' 03" E | 775 |
| **Carbo-Data website** | 50°09'00" N | 11°52'00" E | 780 |
| **Flux-Net website** | 50°08'31" N | 11°52'01"E | 765 |
| **Measured (2002)** | 50°08'32" N | 11°52'03"E | 776 |
| **Implementation Plan EGER** | 50°08'31.9" N | 11°52'01.0" E | 774 |
| **Google Earth** | 50°08'32" N | 11°52'01" E | |
| **Measured (2007)** | 50°08'31.3" N | 11°52'00.8" E | |

Pflanzgarten (air chemistry)

| | Latitude | Longitude | Elevation [m] |
|---|---|---|---|
| **Thomas (2004)** | 50°08'39" N | 11°52'00" E | 765 |
| **Measured (2002)** | 50°08'35" N | 11°51'49" E | 766 |
| **Klemm (2004)** | 50°08'40" N | 11°51'55" E | 765 |
| **Implementation Plan EGER** | 50°08'35.4" N | 11°51'48.6" E | |
| **Google Earth** | 50°08'35" N | 11°51'48.5" E | |

New turbulence tower

| | Latitude | Longitude | Elevation [m] |
|---|---|---|---|
| **Implementation Plan EGER** | 50°08'30.1" N | 11°52'03.3" E | |
| **Google Earth** | 50°08'30" N | 11°52'03" E | |
| **Measured (2007)** | 50°08'29.8" N | 11°52'03.2" E | |

### Recommended coordiantes

| | Latitude | Longitude | Elevation [m] |
|---|---|---|---|
| **Weidenbrunnen main tower (FLUXNET)** | 50°08'31" N | 11°52'01" E | 775 |
| **Pflanzgarten** | 50°08'35" N | 11°51'49" E | 765 |
| **Weidenbrunnen new turbulence tower** | 50°08'30" N | 11°52'03" E | 773 |

## 2.2 *Aerodynamic quantities*

### 2.2.1 Canopy height

**Data collection**

| | $h_c$ [m] | d [m] | year | |
|---|---|---|---|---|
| **Alsheimer (1997)** | 16.1 | -- | 1993 | measured |
| **Gerstberger et al. (2004)** | 16.1 | -- | -- | |
| **Heindl et al. (1995)** | 16.5 | -- | 1993 | |
| **Falge (2001)** | 16.1 | -- | 1993 | Alsheimer (1997) |
| | 17.8 | -- | 1995 | Mund (1996) |
| **Mund (1996)** | 17.8 | -- | 1995 | measured |
| **Mund et al. (2002)** | 18.3 | -- | 1995 | |
| **Carbo-Data website** | 18 | -- | 2000 | |
| **Rebmann (2004)** | 19 | -- | -- | |
| **Forkel et al. (2006)** | 20 | -- | 2001 | |
| **Rebmann et al. (2004)** | 19 | -- | 2003 | |
| **Thomas and Foken (2005; 2007a; 2007b)** | 19 | -- | 2003 | |
| **Flux-Net website** | -- | 12 | -- | |
| **Thomas et al. (2004)** | 19 | 12.5 | 2003 | measured |
| **Implementation Plan EGER** | 23 | 15.3 | 2007 | measured |

$h_c$: canopy height, d: displacement height

**Recommended data:** Alsheimer (1997), Mund (1996), Thomas et al. (2004), Implementation Plan EGER

### 2.2.2 Footprint area

| | footprint length [m] | homogeneous fetch [m] | | | $z_0$ [m] |
|---|---|---|---|---|---|
| | | in prevail. wind dir. | length | width | |
| **Carbo-Data website** | -- | 250 | 200 | 100 | -- |
| **Flux-Net website** | 448 | 100 | 250 | 200 | 2 |
| **CarboEurope-IP QA/QC** | 500 unstabl.<br>1500 stable | | | | |

$z_0$: roughness length

For more details see Rebmann et al. (2004) and Göckede et al. (2007)

## 2.3 Climate and meteorology

### 2.3.1 Description of the climate

| | Climate | |
|---|---|---|
| **Foken (2003)** | continental temperate climate (Dc) | effective climate classification by Köppen (modification by Trewatha, Hupfer, 1996) |
| | Moist-continental (high precipitation) | Eiden et al. (1989) |
| **Rebmann (2004)** | continental character but with high precipitation in summer | |
| **Gerstberger et al. (2004)** | continental temperate climate (Dc) | effective climate classification by Köppen (modification by Trewatha, Hupfer, 1996) |
| | maritime character because of high precipitation sums | |
| | moist-continental | Henning and Henning (1977) |
| **Carbo-data website** | temperate, montane | |

**Recommended data:** Foken (2003) or Gerstberger et al. (2004)

### 2.3.2 Air temperature

**Data collection**

| | Mean | Max | Min | year | |
|---|---|---|---|---|---|
| **Peters and Gerchau (1995)** | 5.75 | | | 1992-1994 | April 1992 – September 1994 |
| **BITÖK (2000)** | 5.14 | 8.13 | 2.15 | 1993 | 18 d missing |
| | 5.69 | 9.24 | 2.14 | 1994 | 3 d missing |
| | 6.07 | 9.69 | 2.44 | 1995 | 0 d missing |
| | 4.22 | 7.65 | 0.78 | 1996 | 13 d missing |
| | 6.40 | 10.27 | 2.53 | 1997 | 0 d missing |
| **Valentini et al. (2000)** | 5.8 | -- | -- | -- | |
| **Subke et al. (2003)** | 5.8 | -- | -- | -- | Manderscheid and Göttlein (1995) |
| **Foken (2003)** | 5.0 | -- | -- | 1961–1990 | |
| | 5.3 | -- | -- | 1971–2000 | |
| **Falge et al. (2003)** | 6.2 | -- | -- | 1997 | |
| **Gerstberger et al. (2004)** | 5.3 | -- | -- | 1971-2000 | Foken (2003) |
| **Rebmann (2004)** | 6.2 | -- | -- | 1997 | |
| | 6.3 | -- | -- | 1998 | |
| | 6.3 | -- | -- | 1999 | |

BITÖK (2000): maximum and minimum values are means of monthly values

| | Mean | Max | Min | year | |
|---|---|---|---|---|---|
| **Rebmann et al. (2004)** | 6.1 | | | 1997 | Calculated from monthly mean values as in reference |
| | 6.2 | | | 1998 | |
| | 6.3 | | | 1999 | |
| | 7.1 | | | 2000 | |
| | 6.1 | | | 2001 | |
| | 6.6 | | | 2002 | |
| **Carbo-Europe website** | 5.8 | -- | -- | -- | |
| **TEMS website** | 5.3 | -- | -- | -- | |
| **Carbo-Data website** | 5.8 | -- | -- | -- | |
| **Flux-Net website** | 5.8 | -- | -- | -- | EUROFLUX Database, Version 1.0 (CD-ROM) |
| | 6.16 | 22 | -14 | 1997 | Falge's gap filling code, 2/04 |
| | 6.19 | 25.05 | -13.7 | 1998 | Falge's gap filling code, 2/04 |
| | 6.37 | 23.04 | -12.25 | 1999 | Falge's gap filling code, 2/04 |
| | 5.85 | 19.7 | -6.7 | -- | Sanderman et al. (2003) |
| | 11.9 | -- | -- | -- | Sanderman et al. (2003) |
| | 5.47 | 19.7 | -6.7 | 1961-1990 | Cramer & Leemans Climate Database Version 2.1 |
| | 6.17 | 10.25 | 2.34 | -- | FAO LOCCLIM - LOCCLIM estimator |

**Recommended data:** Foken (2003) or Rebmann et al. (2004)

Mean monthly and annual air temperatures [°C] after Rebmann et al (2004)

| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Ann. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1997** | -4.0 | 0.4 | 2.9 | 2.9 | 10.0 | 12.6 | 14.0 | 17.4 | 12.4 | 4.8 | 1.1 | -1.3 | 6.1 |
| **1998** | -0.2 | 1.6 | 1.1 | 6.3 | 11.4 | 14.2 | 13.2 | 15.1 | 10.1 | 5.4 | -1.5 | -2.2 | 6.2 |
| **1999** | -1.0 | -3.6 | 2.6 | 5.7 | 10.5 | 12.1 | 16.0 | 14.5 | 14.7 | 5.7 | 0.0 | -1.8 | 6.3 |
| **2000** | -2.9 | 0.4 | 1.7 | 7.8 | 12.7 | 15.0 | 12.1 | 16.3 | 11.2 | 8.0 | 3.0 | -0.1 | 7.1 |
| **2001** | -2.8 | -0.4 | 1.2 | 3.9 | 11.6 | 11.4 | 15.8 | 16.6 | 8.4 | 10.6 | 0.6 | -3.3 | 6.1 |
| **2002** | -1.8 | 1.6 | 2.6 | 4.8 | 11.2 | 15.0 | 15.4 | 16.2 | 10.1 | 5.2 | 2.5 | -3.2 | 6.6 |

Mean monthly and annual air temperatures [°C] in the Waldstein region (Fichtelgebirge, Foken (2003)) (synthetic time series)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Ann. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1961–1990** | | | | | | | | | | | | | |
| **Voitsumra** | -3.6 | -2.0 | 0.8 | 4.8 | 9.1 | 12.5 | 14.1 | 13.1 | 10.5 | 6.1 | 1.4 | -1.7 | 5.4 |
| **Wst./Wb.** | -4.2 | -3.1 | 0.2 | 4.3 | 9.0 | 12.3 | 14.1 | 13.7 | 10.5 | 5.8 | 0.2 | -2.9 | 5.0 |
| | | | | | | | | | | | | | |
| **1971–2000** | | | | | | | | | | | | | |
| **Voitsumra** | -2.9 | -1.7 | 1.5 | 4.9 | 9.6 | 12.6 | 14.6 | 13.8 | 10.4 | 6.0 | 1.2 | -1.3 | 5.8 |
| **Wst./Wb.** | -3.6 | -3.0 | 0.8 | 4.3 | 9.6 | 12.3 | 14.4 | 14.5 | 10.5 | 5.7 | 0.2 | -2.2 | 5.3 |

Wst./Wb. = Waldstein/Weidenbrunnen

### 2.3.3 Precipitation

**Data collection**

| | Annual sum [mm] | year | |
|---|---|---|---|
| **Peters and Gerchau (1995)** | 884.5 | 1992-1994 | April 1992-September 1994 |
| **BITÖK (2000)** | 831.50 | 1993 | 18 d missing |
| | 1078.20 | 1994 | 3 d missing |
| | 1270.00 | 1995 | 0 d missing |
| | 726.60 | 1996 | 13 d missing |
| | 543.90 | 1997 | 0 d missing |
| **Valentini et al. (2000)** | 885 | -- | |
| **Subke et al. (2003)** | 1020 | -- | Manderscheid and Göttlein (1995) |
| **Foken (2003)** | 1156.20 | 1961–1990 | |
| | 1162.50 | 1971–2000 | |
| **Falge et al. (2003)** | 572.00 | 1997 | |
| **Gerstberger et al. (2004)** | 1162.5 | 1971-2000 | Foken (2003) |
| **Rebmann (2004)** | 864 | 1997 | |
| | 1600 | 1998 | |
| | 1542 | 1999 | |
| **Carbo-Europe website** | 885 | -- | |
| **TEMS website** | 1,162 | -- | |
| **Carbo-Data website** | 885 | -- | |
| **Flux-Net website** | 571.9 | 1997 | Falge's gap filling code, 2/04 |
| | 1304.2 | 1998 | Falge's gap filling code, 2/04 |
| | 1211.9 | 1999 | Falge's gap filling code, 2/04 |
| | 885 | -- | Sanderman (2003) |
| | 955.9 | 1961-1990 | Cramer & Leemans Climate Database Version 2.1 |
| | 799.46 | -- | FAO LOCCLIM - LOCCLIM estimator |

### Recommended data

Monthly and annual precipitation sums [mm] in the Waldstein region (Fichtelgebirge, Foken (2003))

| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1961–1990** | | | | | | | | | | | | | |
| **Weißenstadt** | 93.4 | 73.2 | 79.4 | 79.1 | 80.2 | 98.6 | 93.5 | 94.5 | 76.9 | 76.2 | 95.8 | 118.9 | 1059.8 |
| **Wst./Wb.** | 102.0 | 79.9 | 86.6 | 86.3 | 94.2 | 105.1 | 104.5 | 99.1 | 80.8 | 83.2 | 104.5 | 129.8 | 1156.2 |
| | | | | | | | | | | | | | |
| **1971–2000** | | | | | | | | | | | | | |
| **Weißenstadt** | 99.9 | 76.2 | 82.5 | 67.0 | 71.5 | 98.5 | 107.4 | 85.4 | 79.1 | 85.7 | 91.7 | 121.0 | 1065.8 |
| **Wst./Wb.** | 101.8 | 79.8 | 86.5 | 86.2 | 83.4 | 106.4 | 127.0 | 91.3 | 83.1 | 83.1 | 104.4 | 129.6 | 1162.5 |

Wst./Wb. = Waldstein/Weidenbrunnen

Monthly and annual precipitation sums [mm] for Waldstein after Rebmann (2004)

| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1997** | 32.7 | 200.3 | 109.5 | 66.6 | 55.9 | 70.7 | 154.2 | 42.5 | 29.4 | 70.6 | 31.8 | 101.9 | 966.1 |
| **1998** | 83.8 | 23.4 | 119.2 | 59.3 | 64.9 | 117.1 | 178.5 | 91.3 | 197.6 | 308.7 | 112.9 | 67.1 | 1423.8 |
| **1999** | 124.0 | 137.0 | 93.6 | 55.0 | 119 | 108.6 | 156.8 | 115 | 105.5 | 89.1 | 88.9 | 189.0 | 1381.6 |
| **2000** | 110.6 | 137.1 | 210.7 | 48.5 | 46.5 | 105.7 | 185.8 | 53.6 | 65.8 | 65.0 | 54.7 | 82.4 | 1166.4 |
| **2001** | 91.3 | 71.8 | 196.1 | 97.3 | 22.8 | 107.1 | 128.5 | 27.8 | 171.4 | 53.3 | 145.7 | 204.5 | 1317.6 |
| **2002** | 109.5 | 247.6 | 96.7 | 43.7 | 75.6 | 79.6 | 58.9 | 180.3 | 83.7 | 177.3 | 222.1 | 117.4 | 1492.4 |

Shaded in dark grey means that more than 50% of the data are modelled

## 2.3.4 Humidity

### Data collection

| Rel. humidity [%] | Mean | Max | Min | year | |
|---|---|---|---|---|---|
| **Foken (2003)** | 81 | | | 1961–1990 | Fichtelberg-Hüttstadel |
| | 82 | | | 1971–2000 | Fichtelberg-Hüttstadel |
| **Flux-Net website** | 80.03 | 100 | 43.3 | 1997 | Falge's gap filling code, 2/04 |
| | 82.89 | 100 | 29.9 | 1998 | Falge's gap filling code, 2/04 |
| | 83.21 | 100 | 37.4 | 1999 | Falge's gap filling code, 2/04 |

| Vapour pressure [hPa] | | Early morning | year | |
|---|---|---|---|---|
| **BITÖK (2000)** | | 2.304 | 1994 | 2 d missing |
| | | 0.775 | 1995 | 0 d missing |
| | | 0.670 | 1996 | 15 d missing |
| | | 0.95 | 1997 | 0 d missing |
| **Flux-Net website** | 8.23 | | | Local Climate Estimate Software Version 1.0 (best fit) |

BITÖK (2000): early morning means 6:00

**Recommended data**

Relative humidity, fog days and number of days with inversion at Waldstein/Weidenbrunnen (Fichtelberg-Hüttstadel) (Foken, 2003)

| | Jan | Feb | Mar | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **RH [%]** | | | | | | | | | | | | | |
| **1961–1990** | 89 | 86 | 82 | 76 | 74 | 74 | 74 | 76 | 81 | 84 | 89 | 90 | 81 |
| **1971–2000** | 90 | 86 | 82 | 76 | 73 | 75 | 74 | 76 | 82 | 85 | 90 | 91 | 82 |
| | | | | | | | | | | | | | |
| **No of fog days** | | | | | | | | | | | | | |
| **1998–2000** | 21 | 15 | 18 | 10 | 12 | 7 | 17 | 11 | 16 | 22 | 24 | 24 | 195 |
| | | | | | | | | | | | | | |
| **No of days with inversion** | | | | | | | | | | | | | |
| **1997–1999** | 12 | 11 | 6 | 9 | 13 | 9 | 6 | 13 | 17 | 8 | 6 | 6 | 114 |

## 2.3.5 Wind

**Data collection**

| | **Speed [m s$^{-1}$]** | **Direction** | **year** | |
|---|---|---|---|---|
| **BITÖK (2000)** | 3.02 | -- | 1993 | 18 d missing |
| | 2.19 | -- | 1994 | 12 d missing |
| | 1.77 | -- | 1995 | 1 d missing |
| | 1.77 | -- | 1996 | 21 d missing |
| | 1.75 | -- | 1997 | 0 d missing |
| **Gerstberger et al. (2004)** | -- | W, SW | 2001-2002 | 1 April 01 –1 April 02 |
| **Rebmann (2004)** | -- | W, SE | -- | |
| **TEMS website** | -- | SW | -- | |
| **Flux-Net website** | 3.08 | -- | 1997 | Falge's gap filling code, 2/04 |
| | 3.25 | -- | 1998 | Falge's gap filling code, 2/04 |
| | 3.33 | -- | 1999 | Falge's gap filling code, 2/04 |

BITÖK (2000): measured at 2m above the canopy

**Recommended data:** Gerstberger et al. (2004)

### 2.3.6 Radiation

**Data collection**

| Global radiation | mean | month. mean | sum | year | |
|---|---|---|---|---|---|
| **Peters and Gerchau (1995)** | 50.3 | | | 1992-94 | |
| **BITÖK (2000)** | | | 3111.5 | 1994 | 32 d missing |
| | | | 3640.3 | 1995 | 1 d missing |
| | | | 3568.1 | 1996 | 1 d missing |
| | | | 4091.5 | 1997 | 0 d missing |
| **Rebmann (2004)** | 115 | 187 | | 1997 | |
| | 108 | 172 | | 1998 | |
| | 113 | 181 | | 1999 | |
| **Rebmann et al. (2004)** | | | 3617.1 | 1997 | |
| | | | 3409.5 | 1998 | |
| | | | 3557.9 | 1999 | |
| | | | 3787.1 | 2000 | |
| | | | 3563.7 | 2001 | |
| | | | 3507.7 | 2002 | |
| **Flux-Net website** | | | 3581.1 | 1997 | Falge's gap filling code, 2/04 |
| | | | 3387.4 | 1998 | Falge's gap filling code, 2/04 |
| | | | 3536.9 | 1999 | Falge's gap filling code, 2/04 |

Units: Mean and monthly mean global radiation: [W/m²], Sum of global radiation: [MJ m⁻²]
Monthly mean: April to September

| | Net radiation | PAR | year | |
|---|---|---|---|---|
| **Falge et al. (2003)** | 3610 | | 1997 | Tenhunen (1998) |
| **Flux-Net website** | 2220 | 6287 | 1997 | Falge's gap filling code, 2/04 |
| | 1874 | 7165 | 1998 | Falge's gap filling code, 2/04 |
| | 2378.5 | 7722.9 | 1999 | Falge's gap filling code, 2/04 |

Units : Net radiation: [MJ m-²], PAR: [mol m-²]

**Recommended data**

Monthly and annual radiation sums [MJ $m^{-2}$] for Waldstein after Rebmann et al. (2004)

| | Jan | Feb | March | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1997** | 15.7 | 88.9 | 188.8 | 370 | 566 | 563.7 | 461.3 | 551 | 436.7 | 233.4 | 101 | 40.3 | 3617.1 |
| **1998** | 80.9 | 160 | 266.4 | 367 | 564 | 540 | 456.5 | 533 | 250.7 | 89.2 | 49.4 | 53.8 | 3409.5 |
| **1999** | 59.8 | 100 | 231.6 | 366 | 555 | 519.5 | 553.5 | 481 | 385.8 | 186.7 | 76.5 | 42.3 | 3557.9 |
| **2000** | 91.2 | 122 | 208.9 | 453 | 623 | 681.5 | 428.8 | 522 | 321.9 | 162.5 | 99.5 | 72.9 | 3787.1 |
| **2001** | 91.4 | 164 | 206.1 | 343 | 614 | 486.3 | 587.9 | 511 | 194.5 | 213.5 | 92.6 | 59 | 3563.7 |
| **2002** | 101 | 112 | 279.2 | 382 | 471 | 619.7 | 506.9 | 414 | 327.8 | 153.3 | 80.7 | 60.5 | 3507.7 |

## 2.3.7 Pressure

| | barometric pressure [kPa] | year | |
|---|---|---|---|
| **Flux-Net website** | 90.45 | 1997 | Falge's gap filling code, 2/04 |
| | 90.36 | 1998 | Falge's gap filling code, 2/04 |
| | 90.28 | 1999 | Falge's gap filling code, 2/04 |

## 2.3.8 $CO_2$ concentration

$CO_2$ concentration in air (tower top) of time period [ppm]

| | average | max | min | year | |
|---|---|---|---|---|---|
| **Flux-Net website** | 385.9 | 479.4 | 343 | 1997 | Falge's gap filling code, 2/04 |
| | 358.3 | 399.9 | 328.1 | 1998 | Falge's gap filling code, 2/04 |
| | 355.3 | 378.2 | 334.4 | 1999 | Falge's gap filling code, 2/04 |

## 2.3.9 Deposition

| | Total N [kg $ha^{-1}$ $a^{-1}$] | type of data |
|---|---|---|
| **Carbo-data website** | 9-12 (?) | throughfall measurements |

For trends in deposition and canopy leaching of mineral elements at Coulissenhieb see Matzner et al. (2004). This book chapter contains numerous tables of fluxes with deposition for the years 1993 to 2001.

**Mean fluxes with bulk deposition, throughfall and calculated total deposition of mineral elements at Coulissenhieb [kg ha$^{-1}$ year$^{-1}$] (1993-2001) (Matzner et al., 2004):**

| | $H_2O$ [mm] | H | Na | K | Ca | Mg | $NH_4$-N | $NO_3$-N | $SO_4$-S | Cl |
|---|---|---|---|---|---|---|---|---|---|---|
| **Bulk deposition** | 1066 | 0.35 | 3.9 | 2.5 | 2.8 | 0.3 | 6.7 | 5.9 | 7.5 | 6.3 |
| **Throughfall** | 812 | 0.70 | 6.3 | 21.9 | 10.4 | 1.6 | 9.7 | 12.5 | 20.6 | 11.6 |
| **Total deposition** | | 0.85 | 6.3 | 4.3 | 4.8 | 0.6 | | | 20.6 | 11.6 |
| **Total deposition - throughfall** | | 0.16 | | -17.1 | -5.5 | -1 | | | | |

**Wet deposition (Manderscheid, 2000) (unit: [kg ha$^{-1}$])**

| year | month | $SO_4$-S | Cl | $NO_3$-N | $NH_4$-N | Ca | Mg | K | Na | H |
|---|---|---|---|---|---|---|---|---|---|---|
| 1993 | Total | 10.5 | 8.79 | 6.13 | 8.02 | 4.16 | 0.43 | 3.68 | 5.45 | 0.43 |
| 1994 | Total | 10.93 | 7.9 | 6.66 | 8.09 | 2.87 | 0.42 | 2.28 | 4.8 | 0.26 |
| 1995 | Total | 11.11 | 7.92 | 6.71 | 7.26 | 2.26 | 0.27 | 2.73 | 5.82 | 0.31 |
| 1996 | Total | 7.59 | 6.38 | 4.62 | 6.65 | 0.89 | 0.52 | 1.31 | 1.19 | 0.41 |

**Throughfall data (Manderscheid, 2000) (unit: [kg ha$^{-1}$])**

| year | month | $SO_4$-S | Cl | $NO_3$-N | $NH_4$-N | Ca | Mg | K | Na | H |
|---|---|---|---|---|---|---|---|---|---|---|
| 1993 | Total | 31.79 | 12.08 | 9.3 | 8.78 | 11.67 | 1.45 | 22.94 | 6.18 | 1.18 |
| 1994 | Total | 31.57 | 14.68 | 13.92 | 10.75 | 12.83 | 2.23 | 25.05 | 8.43 | 0.81 |
| 1995 | Total | 33.03 | 13.6 | 14.39 | 11.33 | 13.09 | 2.17 | 27.51 | 7.82 | 0.72 |
| 1996 | Total | 30.48 | 10.09 | 11.02 | 9.2 | 11 | 1.33 | 22.69 | 5.32 | 1.19 |

**Dry depostion data (Barrett and Berge, 1996; Berge, 1997) (unit: [kg ha$^{-1}$])**

| year | month | $NH_4$-N | $NO_3$-N | $SO_x$-S |
|---|---|---|---|---|
| 1993 | Total | 4.01708 | 2.79395 | 7.9189702 |
| 1994 | Total | 3.96581 | 2.51394 | 6.3347802 |
| 1995 | Total | 3.81504 | 2.43356 | 6.1456301 |
| 1996 | Total | 4.54719 | 2.30483 | 7.5234402 |

### 2.3.10 Turbulent Fluxes

**Data collection**

| | NEE | year | |
|---|---|---|---|
| | [t C $ha^{-1}$ $yr^{-1}$] | | |
| **Valentini et al. (2000)** | -0.77 | 1997/1998 | 01/05/97-30/04/98 |
| | [g C $m^{-2}$] | | |
| **Rebmann (2004)** | -84.4 | 1997 | |
| | -81.9 | 1998 | |
| | -91.2 | 1999 | |
| **Rebmann et al. (2004)** | -55 | 1997 | measurements in 32 m |
| | -41 | 1998 | |
| | -35 | 1999 | |
| | -28 | 2001 | |
| **Flux-Net website** | -77 | 1997 | Valentini et al (2000) |
| | 112.4 | 1997 | Falge's gap filling code, 2/04 |
| | 45.3 | 1998 | Falge's gap filling code, 2/04 |
| | -76.3 | 1999 | Falge's gap filling code, 2/04 |

| | Sensible heat flux [MJ $m^{-2}$] | Latent heat flux [MJ $m^{-2}$] | year | |
|---|---|---|---|---|
| **Flux-Net website** | 118 | 767.3 | 1997 | Falge's gap filling code, 2/04 |
| | -507.4 | 745.4 | 1998 | Falge's gap filling code, 2/04 |
| | 359.4 | 824.9 | 1999 | Falge's gap filling code, 2/04 |

**Recommended data:** Rebmann et al. (2004)

### 2.3.11 Evapotranspiration

| | Total evapo-transpiration [mm] | year | |
|---|---|---|---|
| **Rebmann (2004)** | 311 | 1997 | |
| | 320 | 1998 | |
| | 341 | 1999 | |
| **Flux-Net website** | -4094.594595 | 1997 | Valentini (2000) |
| | 314.209664 | 1997 | Falge's gap filling code, 2/04 |
| | 305.241605 | 1998 | Falge's gap filling code, 2/04 |
| | 337.796888 | 1999 | Falge's gap filling code, 2/04 |

## 2.4 Vegetation

### Data collection

| | | |
|---|---|---|
| **Carbo-Europe website** | ecosystem | Forest |
| | forest type | Evergreen needleleaf forest |
| **Carbo-Data website** | Vegetation type | Coniferous forest |
| **Flux-Net website** | Biome: | Evergreen coniferous, temperate |
| | IGBP Class (from MODIS 12Q1): | Evergreen needleleaf forest |
| | Vegetation type: | Evergeen coniferous forest, spruce |
| **Reif (1989)** | potential natural vegetation | beech-fir-mixed forest |
| **Carbo-Data website** | Dom. species (sci./com.): | Picea abies/Norway spruce |
| **Gerstberger et al. (2004)** | Tree species | Norway spruce (Picea abies) |
| | Main understory species | Calamagrostis villosa, Deschampsia flexuosa, Vaccinium myrtikkus, Dryopteris dilatata, Oxalis acetosella, Dicranum scoparium |
| | Understorey cover | 60-80% |
| **Flux-Net website** | Dominant Species: | Picea abies, Deschampsia flexuosa |
| **Valentini et al. (2000)** | Species | Coniferous |
| | Ecosystem type | Natural origin and managed |
| **Carbo-Data website** | Understorey | Deschampsia flexuosa |
| **Flux-Net website** | Understorey | Deschampia flexuosa |

**Recommended data:** Reif (1989) and Gerstberger et al. (2004)

### 2.4.1 Canopy structure (LAI, tree density, stand age)

| | LAI | LAI underst. | STEI | height of max. LAI | year | |
|---|---|---|---|---|---|---|
| **Alsheimer (1997)** | 5.3 | 0.31 | -- | -- | 1993 | |
| **Heindl and Bott (1995)** | 5.3 | -- | -- | -- | 1993 | |
| **Valentini et al. (2000)** | 6.7 | -- | -- | -- | -- | |
| **Falge (2001)** | 5.3 | 0.31 | -- | -- | 1993 | Alsheimer (1997) |
| | 8.1 | -- | -- | -- | 1995 | Mund (1996) |
| **Mund et al. (2002)** | 9.5 | -- | -- | -- | 1995 | |
| **Buchmann (2000)** | 10.4 | | | | | Data provided by Mund |
| **Gerstberger et al. (2004)** | 5.3 | 0.31 | -- | -- | -- | Alsheimer (1997) |
| **Thomas and Foken (2005; 2007a; 2007b)** | 5.2 (PAI) | -- | -- | 0.5-0.9$h_c$ | 2003 | |
| **Forkel et al. (2006)** | 5.3 | -- | -- | 13.5 m | 2001 | |
| **Berger et al. (2004)** | 4 | -- | 0.13 | -- | 1998 | |
| **Carbo-Data website** | 5 | -- | -- | -- | 2000 | |
| **Flux-Net website** | 5 | -- | -- | -- | -- | Sanderman et al. (2003) |
| | 6.5 | -- | -- | -- | -- | EUROFLUX Database, Version 1.0 (CD-ROM) |

**Recommended data:** Alsheimer (1997) and Thomas and Foken (2007a)

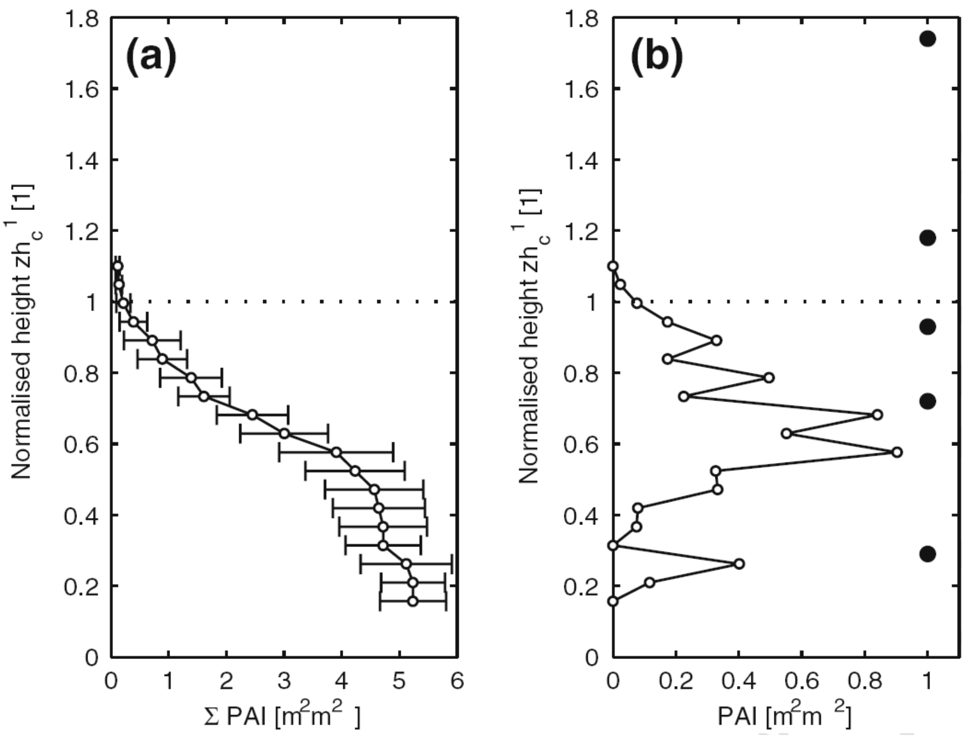



Figure 1: Vertical profile of the (a) cumulative and (b) absolute plant area index (PAI) of the experimental site in WALDATEM-2003. Black dots in subplot (b) mark the heights of observation levels used in this study (Thomas and Foken, 2007a).

| | **Stand-age** | **Tree density [ha$^{-1}$]** | **year** | |
|---|---|---|---|---|
| **Alsheimer (1997)** | 40 | 1007 | 1993 | |
| **Heindl and Bott (1995)** | 40 | 1007 | 1993 | |
| **Valentini et al. (2000)** | 45 | -- | -- | |
| **Falge (2001)** | 43 | -- | -- | |
| | -- | 1007 | 1993 | Alsheimer (1997) |
| | -- | 1018 | 1995 | Mund (1996) |
| **Mund (1996)** | 43 | 1018 | 1995 | |
| **Mund et al. (2002)** | 43 | 1018 | 1995 | |
| **Buchmann (2000)** | 47 | | | Data provided by Mund |
| **Rebmann (2004)** | 45 | 1018 | 1999 | Mund (2002) |
| **Gerstberger et al. (2004)** | 50 | -- | -- | Alsheimer (1997) |
| **Carbo-Data website** | 43 | 1000 | 2000 | |
| **Flux-Net website** | 40 | | -- | Sanderman (2003) |
| | -- | 1000 | -- | EUROFLUX Database, Version 1.0 (CD-ROM) |

**Recommended data:** Alsheimer (1997)

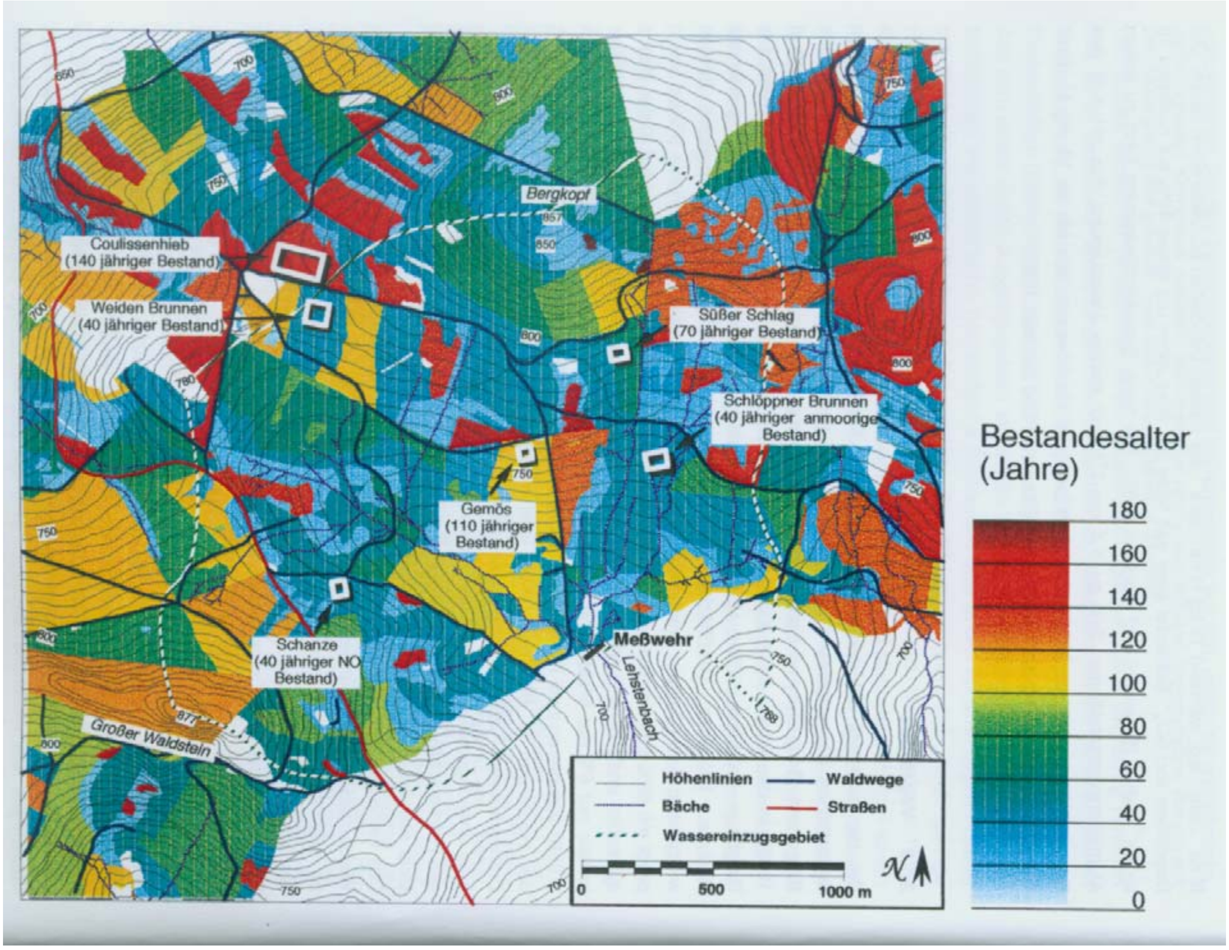



Figure 2: Age structure in the Lehstenbach catchment and position of the areas that were investigated by Alsheimer (1997) (source: Alsheimer, 1997).

### 2.4.2 Growing season

| | growing season [d] | year |
|---|---|---|
| **Peters and Gerchau(1995)** | 100-130 | |
| **Rebmann (2004)** | 171 | 1997 |
| | 165 | 1998 |
| | 177 | 1999 |

### 2.4.3 Land cover information

| | Type | TEMS website | CarboEurope QA/QC (within the footprint area) |
|---|---|---|---|
| | | % Total | % Total |
| **Agriculture** | | 5 | 0.5 |
| **Forest** | Evergreen needleleaf forest | 80 | 46.2 |
| **Grassland** | | 5 | 0.2 |
| **Other** | Forest clearing | 10 | 53.2 |

### 2.4.4 Biomass

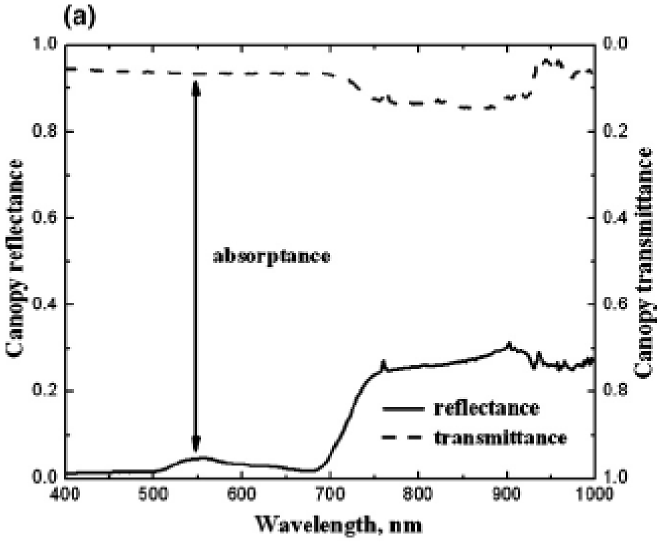
| [t TG/ha] | woody stem | stem bark | needles | twigs | bran-ches | dead branches | fine roots | year | |
|---|---|---|---|---|---|---|---|---|---|
| **Mund (1996)** | 115.2 | 12.8 | 19.4 | 9.9 | 15.7 | 4.1 | | 1995 | |
| **Falge (2001)** | | | 12.3 | | | | 4.2 | 1993 | Alsheimer (1997) |
| | 115.2 | 12.8 | 19.4 | 9.9 | 15.7 | 4.1 | | 1995 | Mund (1996) |

| | Wood biomass [t C $ha^{-1}$ $yr^{-1}$] | Wood increment [$m^3$ $ha^{-1}$] | |
|---|---|---|---|
| **Flux-Net website** | 122 | 5 | EUROFLUX Database, Version 1.0 (CD-ROM) |
| **Carbo-Data website** | | 5 | |

### 2.4.5 Optical properties of the leaves

| | leaf transmissivity | | | leaf albedo | | | dry soil albedo | | |
|---|---|---|---|---|---|---|---|---|---|
| | vis. | near-IR. | IR | vis. | near-IR. | IR | vis. | near-IR. | IR |
| **Berger et al. (2004)** | 0.03 | 0.43 | 0 | 0.1 | 0.4 | 0.04 | 0.1 | 0.2 | 0.1 |

**Recommended values:**



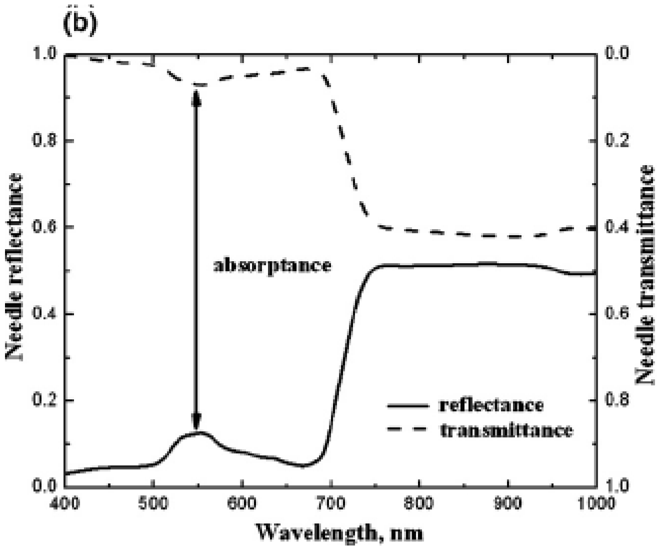




Figure 3: Canopy (panel a) and needle (panel b) spectral reflectance (vertical axis on the left side) and transmittance (vertical axis on the right side) for a Norway spruce (P. abies (L.) Karst) stand. Arrows show needle and canopy absorptance. The needle transmittance and albedo follow the regression line $\tau L=0.47\omega-0.02$ with $R^2=0.999$ and RMSE=0.004. Measurements were taken during an international field campaign in Flakaliden, Sweden, June 25–July 4, 2002 (Huang et al., 2007).

## 2.5 Soil

Soil data as listed here refers to the Coulissenhieb site, a 140-year old norway spruce stand next to Weidenbrunnen.

### 2.5.1 Soil type

| | Soil type | Depth [cm] | |
|---|---|---|---|
| **Gerstberger et al. (2004)** | **G.c.:** Braunerde-Podsol<br>**US T.:** Orthic Spodosol<br>**FAO:** Haplic Podzol | | |
| **Subke et al. (2003)** | **FAO:** Cambic podzol over granitic bedrock | | |
| **Carbo-data website** | **FAO:** Acidic Cambisol | 100 | |
| **TEMS** | **FAO:** Haplic Podzols, Cambic Podzols, Cambisols | | |
| **Flux-net website** | **G.c.:** brown earth<br>**FAO:** Acidic cambisol | 100 | EUROFLUX Database, Version 1.0 (CD-ROM) |

Soil types: G.c. = German classification, US T. = US Taxonomy

| | texture |
|---|---|
| **Gerstberger et al. (2004)** | sandy loam to loam, with a relatively high clay content in the Bh horizon |
| **Berger et al. (2004)** | borderline between clay-loam and **loam** |

**Göttlein et al. (1995):** Cambic Podzol on Granite; Humus: raw humus (rohhumusartiger Moder in German)

| Soil layer | Depth [cm] | Description (in words) |
|---|---|---|
| **L** | 8.5-7.9 | *Deschampsia flexuosa* + needles |
| **Of** | 7.9-3.5 | *Deschampsia* roots + needle fragments |
| **Oh** | 3.5-0.0 | many spruce roots |
| **Ahe** | 0.0-9.0 | sandy loam |
| **Bhs** | 9.0-23.6 | loam |
| **Bsv** | 23.6-37.5 | loam |
| **BvCv** | 37.5-54.3 | loam |
| **(II)Cv** | >54.3 | sandy loam |

Soil layers (GeoTeam, 2007):

| Depth [m] | | Soil class (DIN 18 300) |
|---|---|---|
| 0.3-0.5 | top soil | 1 |
| 0.5-0.8(-1.4) | smooth to stiff, sandy silt | 4 |
| below | silty, pebbly sand in mostly loose stratification | 4 |
| > 6 | rock horizon | |

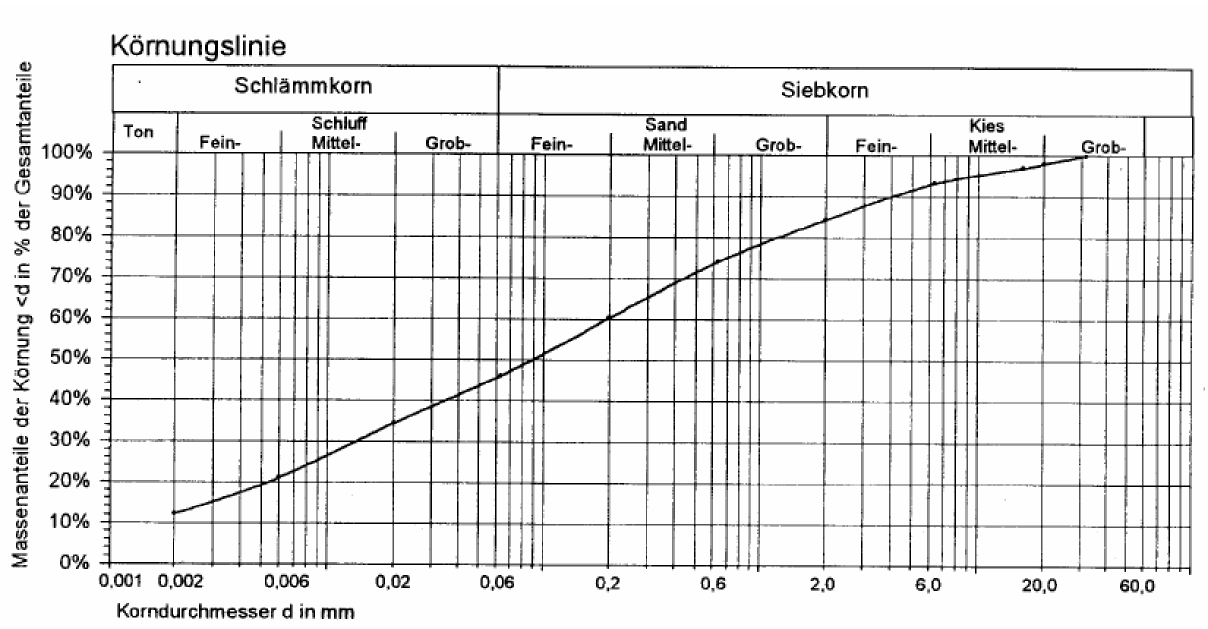



Figure 4: Körnungslinie. Soil depth: 0.3-0.8, 4.5.2007, soil moisture (DIN 18 121): 0.245 %, soil type: Silt, strongly sandy, pebbly. (GeoTeam, 2007)

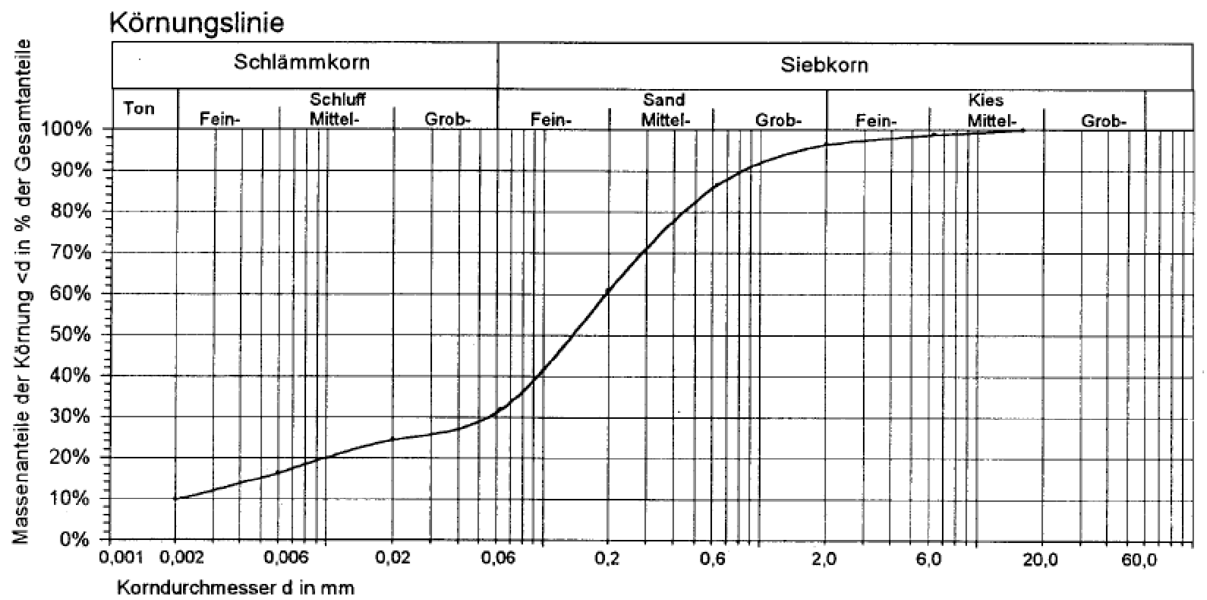



Figure 5: Körnungslinie. Soil depth: 0.8-1.3 m, 4.5.2007, soil moisture (DIN 18 121): 0.133 %, soil type: sand, strongly silty. (GeoTeam, 2007)

### 2.5.2 Soil properties

**Physical properties:**

| | Soil temperature [°C] | | | year | |
|---|---|---|---|---|---|
| | **mean** | **max** | **min** | | |
| **Falge et al. (2003)** | 6.3 | | | 1997 | |
| **Flux-Net website** | 6.07 | 15.32 | 0.84 | 1997 | Falge's gap filling code, 2/04 |
| | 6.81 | 15.44 | 0.47 | 1998 | Falge's gap filling code, 2/04 |
| | 6.56 | 15.47 | -0.05 | 1999 | Falge's gap filling code, 2/04 |

**Texture, water content at different tensions, bulk density, and hydrologic conductivity (kf value) of the soil at Coulissenhieb site. (Gerstberger et al., 2004)**:

| Horizon | Depth [cm] | Sand [%] | Silt [%] | Clay [%] | WC at 60 hPa | P 300 hPa | dB 15 bar | kf | | |
|---|---|---|---|---|---|---|---|---|---|---|
| EA | 0–10 | 51.6 | 38 | 10.4 | 47.2 | 38.9 | 7.8 | 62 | 1 | 0.01 |
| Bh | 10–12 | 34 | 50 | 16.4 | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |
| Bs | 12–30 | 44.7 | 45 | 10.4 | 50.5 | 40.8 | 15.2 | 71 | 0.7 | 0.02 |
| Bw | 30–55 | 45.8 | 43 | 10.8 | 31 | 25.8 | 9.6 | 48 | 1.4 | 0.01 |
| C1 | 55–70 | 56.4 | 34 | 9.6 | 28 | 21.6 | 7.7 | 38 | 1.6 | 0 |
| C2 | >70 | 50.8 | 38 | 11.2 | n.d. | n.d. | n.d. | n.d. | n.d. | n.d. |

*WC* Water content in vol% at a definite tension; *P* porosity volume in vol%; *dB* bulk density in g $cm^{-3}$; *kf* hydrologic conductivity (for saturated soil) in cm $s^{-1}$; *n.d.* not determined

**Göttlein et al. (1995):**

| Soil layer | Depth [cm] | Soil density [g $cm^{-3}$] | Stoniness [%] | % Clay [%] | % Org C [%] |
|---|---|---|---|---|---|
| **L** | 8.5-7.9 | | | | |
| **Of** | 7.9-3.5 | | | | |
| **Oh** | 3.5-0.0 | | | | |
| **Ahe** | 0.0-9.0 | 0.95 | 3 | 12 | |
| **Bhs** | 9.0-23.6 | 0.73 | 10 | 12 | |
| **Bsv** | 23.6-37.5 | 1 | 20 | 15 | |
| **BvCv** | 37.5-54.3 | 1.35 | 5 | | |
| **(II)Cv** | >54.3 | 1.59 | 30 | | |

**Soil water retention characteristics (Lischeid, 2000):**

| | Soil moisture content at | | | |
|---|---|---|---|---|
| | **Saturation** | **Field capacity** | **Air dry** | **Permanent wilting point** |
| **Soil layer** | [%] | [%] | [%] | [%] |
| **L** | | | | |
| **FH** | | | | |
| **Ahe** | 64 | 50.1 | 38.4 | n.m. |
| **Bhs** | 72 | 55.9 | 45.1 | n.m. |
| **Bsv** | 62 | 43 | 35.6 | n.m. |
| **BvCv** | 49 | 34.2 | 29.1 | n.m. |
| **(II)Cv** | 40 | 27.6 | 20.5 | n.m. |

## Chemical properties (Cation exchange capacity, pH, exchangable cations etc.)

| | Carbon [kg/m²] | pH | C/N | |
|---|---|---|---|---|
| **Subke et al. (2003)** | | 3.3-3.9 | | Heindl and Bott (1995) |
| **Gerstberger et al. (2004)** | | extremely acidic | 21-25 | |
| **Flux-Net website** | 15 | | | Sanderman et al (2003) |
| | 18 | | | Sanderman et al (2003) |

**Gerstberger et al. (2004):**

| **Horizon** | **pH $H_2O$** | **pH $CaCl_2$** | **Ca** | **Mg** | **K** | **Na** | **Al** | **$H^+$** | **$CEC_{eff}$** | **BS** |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | **[$mmol_c\ kg^{-1}$ soil]** | | | | | | | **[%]** |
| Oi | 4.50 | 3.60 | 38.9 | 6.94 | 6.64 | 2.3 | 163.3 | 9.59 | 245.8 | 22.7 |
| Oe | 3.80 | 2.90 | 84.6 | 11.2 | 10.6 | 2.07 | 56.9 | 59.6 | 237.4 | 46.2 |
| Oa | 3.50 | 2.60 | 111.4 | 18.4 | 21.8 | 2.3 | 5.16 | 104.3 | 274.2 | 56.8 |
| EA | 3.70 | 2.90 | 1.31 | 0.00 | 1.03 | 0.00 | 75.6 | 16.5 | 97.6 | 2.54 |
| Bh | 3.80 | 3.30 | 1.82 | 0.99 | 1.97 | 0.00 | 208.2 | 9.35 | 246.3 | 2.01 |
| Bs | 4.40 | 3.90 | 0.00 | 0.00 | 0.97 | 0.00 | 130.8 | 1.42 | 137.5 | 0.80 |
| Bw | 4.50 | 4.30 | 0.00 | 0.00 | 0.92 | 0.00 | 41.4 | 0.12 | 42.5 | 2.39 |
| C1 | 4.50 | 4.20 | 0.00 | 0.00 | 0.77 | 0.00 | 31.0 | 0.08 | 31.8 | 2.42 |
| C2 | 4.50 | 4.10 | 0.00 | 0.00 | 1.12 | 0.00 | 31.3 | 0.37 | 32.9 | 3.60 |

pH value, element content in 1 M $NH_4Cl$ extract (exchangeable cations), calculated $CEC_{eff}$, and base saturation at the Coulissenhieb site (Kalbitz, 1991). *$CEC_{eff}$* Effective cation exchange capacity; *BS* base saturation of the CEC

**Soil characteristics** (Persson, 2000):
Method: Persson et al. (2000)
Sampling date 26 & 27 April 1995; number of samplings is 4.

| | **Dry weight [g $m^{-2}$]** | | **%C** | | **%N** | | **pH(H2O)** | | **pH(KCl)** | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Soil layer** | **mean** | **stdev** | **mean** | **stdev** | **mean** | **stdev** | **mean** | **stdev** | **mean** | **stdev** |
| **L** | 874 | 212 | 49.66 | 0.78 | 2.06 | 0.11 | 4.72 | 0.17 | 3.55 | 0.12 |
| **FH** | 14758 | 2724 | 37.71 | 4.96 | 1.70 | 0.27 | 3.69 | 0.17 | 2.67 | 0.02 |
| **0-10** | 80322 | 18465 | 5.91 | 2.11 | 0.24 | 0.11 | 3.52 | 0.07 | 2.70 | 0.05 |
| **10-20** | 61721 | 17672 | 5.80 | 1.82 | 0.23 | 0.08 | 3.80 | 0.11 | 3.20 | 0.21 |
| **20-30** | 60160 | 11883 | 5.17 | 1.53 | 0.20 | 0.06 | 4.26 | 0.08 | 3.88 | 0.16 |
| **30-50** | 180522 | 33261 | 2.01 | 0.75 | 0.09 | 0.03 | 4.44 | 0.06 | 4.11 | 0.07 |

**Stocks of C, N, S, pedogenic Fe oxides, and exchangeable cations in the soil horizons at the Coulissenhieb site (Kalbitz, 1991). (Gerstberger et al., 2004):**

| Hor. | Depth [cm] | C-stock | N-stock | S-tot | S-inorg | S-org | ox-Fe | dith-Fe |
|---|---|---|---|---|---|---|---|---|
| Oi | 8.5–8 | 3.6 | 0.16 | 20.3 | 1.1 | 190.8 | n.d. | n.d. |
| Oe | 8–3 | 25.4 | 1.26 | 192 | | | n.d. | n.d. |
| Oa | 3–0 | 31.1 | 1.49 | 253.6 | 2.3 | 251.3 | n.d. | n.d. |
| EA | 0–10 | 27.4 | 1.2 | 245.2 | 4.4 | 240.8 | 387 | 1,174 |
| Bh | 10–12 | 8.5 | 0.38 | 43.3 | 1.9 | 41.4 | 311 | 2,308 |
| Bs | 12–30 | 51.1 | 3.62 | 442.1 | 84.3 | 357.8 | 9590 | 15579 |
| BvCv | 30–55 | 20.7 | 1.23 | 393.6 | 141.6 | 252.1 | 4040 | 15765 |
| C1 | 55–70 | 1.5 | 0.14 | n.d. | 379 | 2,506 | n.dt. | n.dt. |
| C2 | 70–80 | 0.9 | 0.09 | n.d. | 268 | 2,018 | n.dt. | n.dt. |
| Total | | 170.2 | 9.57 | 1590.10 | 235.6 | 1334.20 | 14,975 | 39350 |

Units: C-stock [mg $ha^{-1}$], N-stock [kg $ha^{-1}$]
*ox-Fe* Oxalate-soluble iron; *dith-Fe* dithionite-soluble iron, *n.d.* not determinded, *n.dt.* not detectable

| Hor. | Depth [cm] | $Ca^{2+}$ | $Mg^{2+}$ | $K^{+}$ | $Na^{+}$ | $Al^{3+}$ |
|---|---|---|---|---|---|---|
| Oi | 8.5–8 | 5.9 | 0.6 | 2 | 0.4 | 11.2 |
| Oe | 8–3 | 103.6 | 8.3 | 25.4 | 2.9 | 31.3 |
| Oa | 3–0 | 224.4 | 22.5 | 85.7 | 5.3 | 4.7 |
| EA | 0–10 | 18.4 | n.dt. | 28.4 | n.dt. | 478.2 |
| Bh | 10–12 | 3.4 | 1.1 | 7.3 | n.dt. | 176.4 |
| Bs | 12–30 | n.dt. | n.dt. | 36.3 | n.dt. | 1120.40 |
| BvCv | 30–55 | n.dt. | n.dt. | 89.1 | n.dt. | 917 |
| C1 | 55–70 | 20.3 | n.dt. | 188.6 | | |
| C2 | 70–80 | 19.7 | n.dt. | 127 | | |
| Total | | 355.7 | 32.5 | 314.2 | 8.6 | 3054.80 |

*n.dt.* not detectable

**Cation exchange capacity and exchangeable fractions:**
Remarks:
1992 data from Matschonat and Matzner (1995): NH4-N: extracted with 1 M KCl, other data from Göttlein et al. (1995) 1n NH4Cl-extract

| Soil layer | year | CEC | Base saturation | pH-$H_2O$ |
|---|---|---|---|---|
| **L** | | 206.15 | 80.07 | 4.04 |
| **Of** | | 206.25 | 47.55 | 3.57 |
| **Oh** | | 151.44 | 38.74 | 3.39 |
| **Ahe** | | 84.58 | 11.4 | 3.47 |
| **Bhs** | | 166.08 | 3.79 | 3.79 |
| **Bsv** | | 75.17 | 6.6 | 4.21 |
| **BvCv** | | 43.54 | 10.91 | 4.32 |
| **(II) Cv** | | 29.98 | 14.01 | 4.36 |

Units: CEC[$mmol_c\ kg^{-1}$], Base saturation [%],

| Soil layer | year | Exchangeable cations | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **H** | **Na** | **K** | **$NH_4$-N** | **Ca** | **Mg** | **Al** |
| **L** | | 36.39 | 4.48 | 35.68 | | 106.83 | 15.83 | 21.27 |
| **Of** | | 106.79 | 4.41 | 6.78 | | 75.78 | 9.01 | 67.56 |
| **Oh** | | 91.86 | 3.65 | 4.98 | | 42.58 | 6.06 | 116.73 |
| **Oh** | 1992 | | | | 286 | | | |
| **Ahe** | | 28.1 | 1.53 | 1.32 | | 4.21 | 0.91 | 88.92 |
| **Ahe** | 1992 | | | | 139 | | | |
| **Bhs** | | 3.09 | 1.43 | 0.82 | | 1.74 | 0.53 | 152.73 |
| **Bhs** | 1992 | | | | 116 | | | |
| **Bsv** | | 0.57 | 1.32 | 0.77 | | 0.67 | 0.18 | 69.72 |
| **Bsv** | 1992 | | | | 171 | | | |
| **BvCv** | | 0.18 | 1.37 | 1.04 | | 0.39 | 0.09 | 38.65 |
| **(II) Cv** | | 0.11 | 1.13 | 0.86 | | 0.3 | 0.09 | 25.69 |

Units: Exchangeable cations [$mmol_c\ kg^{-1}$]

## 2.5.3 Soil $CO_2$ efflux dependencies

**Dependencies of soil $CO_2$ efflux on temperature following Buchmann (2000)**

$$y = \beta_0 \cdot e^{(\beta_1 \cdot T)}$$
$$Q_{10} = e^{10 \cdot \beta}$$

Relationships between soil respiration rates (µmol $CO_2$ $m^{-2}$ $s^{-1}$) and soil temperatures (°C) measured in the $O_f$ and $O_h$ layers at 5 and 10 cm depth and in the $A_h$ horizon at 15 cm depth for the Weidenbrunnen Picea abies stand in the Fichtelgebirge during the 1998 growing season (Buchmann, 2000).

| $y = \beta_0 \cdot e^{(\beta_1 \cdot T)}$ | **SEβ0** | **SEβ1** | **$Q_{10}$** | **n** | **F** | **$r^2$** | **P** |
|---|---|---|---|---|---|---|---|
| $y = 0.98 \cdot e^{(0.088 \cdot T_5)}$ | 0.13 | 0.011 | 2.41 | 20 | 70.2 | 0.8 | <0.0001 |
| $y = 1.24 \cdot e^{(0.085 \cdot T_{10})}$ | 0.18 | 0.014 | 2.34 | 23 | 34.7 | 0.62 | <0.0001 |
| $y = 0.99 \cdot e^{(0.109 \cdot T_{15})}$ | 0.18 | 0.018 | 2.34 | 16 | 38.2 | 0.73 | <0.0001 |

**Dependencies of soil $CO_2$ efflux on temperature following Matteucci et al. (2000)**

$$Rs = R_{10} \cdot Q_{10}^{\frac{(Ts-10)}{10}}$$

Parameters of the $Q_{10}$ regressions fitted on the soil respiration data (Matteucci et al., 2000).

| **$R_{10}$** [µmol $CO_2$ $m^{-2}$ $s^{-1}$] | **$Q_{10}$** | **$r^2$** |
|---|---|---|
| 2.50 ± 0.18 | 2.16 ± 0.29 | 0.72 |

**Dependencies of soil $CO_2$ efflux on temperature and soil water content following Subke et al. (2003)**

Temperature functions:

$$f_{(T)} = R_{ref} e^{E_0((1/56.02)-(1/T+46.02))}$$ (1 - after Lloyd and Taylor, 1994)

$$f_{(T)} = R_{ref} Q_{10}^{(T-T_{ref}/10)}$$ (2 - $Q_{10}$)

$$f_{(T)} = R_{ref} + m(T - T_{ref})$$ (3 – Linear)

Soil water content functions:

$$f_{(SWC)} = \frac{SWC}{SWC_{1/2} + SWC}$$ (4 - Bunnell et al., 1977)

$$f_{(SWC)} = e^{-e^{(a-b \cdot SWC)}}$$ (5 - Gompertz function after Janssens et al., 2003)

Parameters and coefficients of determination for all combinations of temperature and soil water content dependencies. T-par refers to the respective parameters of the temperature sensitive parts of Eqs. (1)-(3), all other parameters are the same as for Eqs. (1)-(5). The coefficient of determination has been adjusted for the respective numbers of parameters; n=822 for all regressions. (Subke et al., 2003)

| Moisture limitation function | | Temperature function | | |
|---|---|---|---|---|
| | | Lloyd and Taylor | $Q_{10}$ | Linear |
| None | $R_{ref}$ | 2.05 ± 0.01 | 2.03 ± 0.01 | 2.1 ± 0.01 |
| | T-par | 304 ± 8 | 2.61 ± 0.07 | 0.199 ± 0.004 |
| | adj. $R^2$ | 0.72 | 0.7 | 0.74 |
| Gompertz | $R_{ref}$ | 2.65 ± 0.13 | 2.58 ± 0.11 | 2.6 ± 0.12 |
| | T-par | 403 ± 8 | 3.64 ± 0.1 | 0.286 ± 0.015 |
| | a | 0.364 ± 0.079 | 0.452 ± 0.086 | 0.167 ± 0.107 |
| | b | 8.38 ± 1.13 | 8.09 ± 1.14 | 7.9 ± 1.45 |
| | adj. $R^2$ | 0.83 | 0.82 | 0.82 |
| Bunnell | $R_{ref}$ | 3.57 ± 0.13 | 3.66 ± 0.15 | 3.22 ± 0.1 |
| | T-par | 403 ± 8 | 3.65 ± 0.1 | 0.355 ± 0.014 |
| | $SWC_{1/2}$ | 0.172 ± 0.015 | 0.188 ± 0.017 | 0.116 ± 0.01 |
| | adj. $R^2$ | 0.83 | 0.82 | 0.82 |

## 2.6 Hydrogeology

Groundwater level in 5.4 m below top ground surface (GeoTeam, 2007)

## 2.7 Canopy exchange modelling studies

**FLAME (Berger et al., 2004):**

| Description | Value | Unit |
|---|---|---|
| Horizontal length in x, y direction | 3.5 | m |
| Diameter of tree trunk | 0.2 | m |
| Leaf area index | 4 | $m^2 m^{-2}$ |
| Index of area occupied by stems and trunk | 0.13 | |
| Minimum stomata resistance | 150 | $s m^{-1}$ |
| Leaf reflectivity in VIS, NIR and IR bands | 0.1,0.4,0.04 | |
| Soil reflectivity in VIS, NIR and IR bands | 0.1,0.2,0.1 | |
| Leaf transmissivity in VIS, NIR and IR bands | 0.03,0.43,0.0 | |
| Leaf water potential for stomata response | -10,-25 | bar |
| Diameter of canopy at zM | 1.6 | m |
| Diameter of canopy at zT | 0.8 | m |
| Trunk height | 6 | m |
| Height of maximum LAI | 13.5 | m |
| Vegetation height | 19 | m |
| Leaf area index increment | 0.8 | |

**STAND-FLUX – Physiological parameters:**

| | | **Falge et al.(2003)** | units |
|---|---|---|---|
| Dark respiration | f(Rd) | 0.51 | $\mu mol m^{-2} s^{-1}$ |
| | Ea(Rd) | 63500 | $J mol^{-1}$ |
| Electron transport capacity | c(Pml) | 13.851 | $\mu mol m^{-2} s^{-1}$ |
| | Δ Ha(Pml) | 47170 | $J mol^{-1}$ |
| | Δ Hd(Pml) | 200000 | $J mol^{-1}$ |
| | Δ S(Pml) | 643 | $J K^{-1} mol^{-1}$ |
| Carboxylase capacity | c(Vcmax) | 19.099 | $\mu mol m^{-2} s^{-1}$ |
| | Δ Ha(Vcmax) | 75750 | $J mol^{-1}$ |
| | Δ Hd(Vcmax) | 200000 | $J mol^{-1}$ |
| | Δ S(Vcmax) | 656 | $J K^{-1} mol^{-1}$ |
| Carboxylase kinetics | f(Kc) | 299.469 | $\mu mol mol^{-1}$ |
| | Ea(Kc) | 65000 | $J mol^{-1}$ |
| | f(Ko) | 159.597 | $mmol mol^{-1}$ |
| | Ea(Ko) | 36000 | $J mol^{-1}$ |
| | f(tau) | 2339.53 | -- |
| | Ea(tau) | -28990 | $J mol^{-1}$ |
| Light use efficiency | alpha | 0.0146 | mol CO2 $m^{-2}$ leaf area |
| stomatal conductance | gmin | 1 | $mmol m^{-2} s^{-1}$ |
| | gfac | 9.8 | -- |

| | | Falge et al.(2000) | | units |
|---|---|---|---|---|
| Dark respiration | f(Rd) | 25 | | |
| | Ea(Rd) | May-June | 63500 | J $mol^{-1}$ |
| | | July-Aug. 15 | 64500 | J $mol^{-1}$ |
| | | Aug. 16-Sept | 64000 | J $mol^{-1}$ |
| | | Oct.-April | 64000 | J $mol^{-1}$ |
| Electron transport capacity | c(Pml) | May-June | 19.55 | -- |
| | | July-Aug. 15 | 19.2 | -- |
| | | Aug. 16-Sept | 19.3 | -- |
| | | Oct.-April | 19.35 | -- |
| | Δ Ha(Pml) | 55000 | | J $mol^{-1}$ |
| | Δ Hd(Pml) | 215000 | | J $mol^{-1}$ |
| | Δ S(Pml) | 725 | | J $K^{-1}$ $mol^{-1}$ |
| Carboxylase capacity | c(Vcmax) | May-June | 34.5 | -- |
| | | July-Aug. 15 | 34.25 | -- |
| | | Aug. 16-Sept | 34.3 | -- |
| | | Oct.-April | 34.3 | -- |
| | Δ Ha(Vcmax) | | 77000 | J $mol^{-1}$ |
| | Δ Hd(Vcmax) | | 215000 | J $mol^{-1}$ |
| | Δ S(Vcmax) | | 725 | J $K^{-1}$ $mol^{-1}$ |
| Carboxylase kinetics | f(Kc) | | 31.95 | -- |
| | Ea(Kc) | | 65000 | J $mol^{-1}$ |
| | f(Ko) | | 19.61 | -- |
| | Ea(Ko) | | 36000 | J $mol^{-1}$ |
| | f(tau) | | 3.9489 | -- |
| | Ea(tau) | | -28990 | J $mol^{-1}$ |
| Light use efficiency | alpha | | 0.015 | mol CO2/(mol photons) |
| stomatal conductance | gmin | | 0 | mmol $m^{-2}$ $s^{-1}$ |
| | gfac | | 9.8 | -- |

# 3 References

## 3.1 Responsible persons (FLUXNET site)

1996-1999

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## 3.2 Websites

CarboEurope website: http://gaia.agraria.unitus.it/database/sites.asp?id=143
CarboEurope QA/QC website: http://www.bayceer.uni-bayreuth.de/qaqc/
TEMS website: http://www.fao.org/gtos/tems/logout.jsp
Carbo-Data website: http://carbodat.jrc.it/index.html
Flux-Net website:
http://www.fluxnet.ornl.gov/modis/webpage2url.cfm?KEYID=de.weidenbrunnen.01
(November 15,2007)

## 3.3 Literature

Alsheimer, M., 1997. Charakterisierung räumlicher und zeitlicher Heterogenität der Transpiration unterschiedlicher montaner Fichtenbestände (Picea abies (L.) KARST.) durch Xylemflußmessungen. Bayreuther Forum Ökologie, 49: 1-143.

Barrett, K. and Berge, E., 1996. Transboundary air pollution in Europe. MSC-W Status Report 1996. EMEP/MSC-W: Report 1/96, Norwegian Meteorological Institute, Oslo, Norway.

Berge, E., 1997. Transboundary air pollution in Europe. MSC-W Status Report 1997, Norwegian Meteorological Institute, Oslo, Norway.

Berger, M., Dlugi, R. and Foken, T., 2004. Modelling the vegetation atmospheric exchange with a transilient model. In: E. Matzner (Editor), Biogeochemistry of Forested Catchments in a Changing Environment: A German Case Study. Springer, Berlin, Heidelberg, pp. 177-190.

BITÖK, 2000. Climate data – site Waldstein. CD-ROM-Data base. In: E.-D. Schulze (Editor), Carbon and nitrogen cycling in European forest ecosystems. Ecological Studies. Springer, Berlin.

Buchmann, N., 2000. Biotic and abiotic factors controlling soil respiration rates in Picea abies stands. Soil Biology & Biochemistry, 32(11-12): 1625-1635.

Bunnell, F.L., Tait, D.E.N., P.W., F. and van Cleve, K., 1977. Microbial respiration and substrate weight loss. I. A general model of the influences of abiotic variables. Soil Biology & Biochemistry, 9: 33-40.

Eiden, R. et al., 1989. Air pollution and deposition. In: E.D. Schulze, O.L. Lange and R. Oren (Editors), Forest decline and air pollution. Ecological Studies. Springer, Berlin, pp. 57-103.

Falge, E., 2001. Forstliche Charakterisierung der BITÖK-Messflächen: Biomasse, LAI und Transpiration. In: P. Gerstberger (Editor), Waldökosystemforschung in Nordbayern: Die BITÖK-Untersuchungsflächen im Fichtelgebirge und Steigerwald. BITÖK, Bayreuth, pp. 11-15.

Falge, E. et al., 2003. A model-based study of carbon fluxes at ten European forest sites. In: R. Valentini (Editor), Fluxes of Carbon, Water and Energy of European Forests. Ecological Studies. Springer, Berlin, pp. 151-177.

Falge, E., Tenhunen, J.D., Ryel, R., Alsheimer, M. and Kostner, B., 2000. Modelling age- and density-related gas exchange of Picea abies canopies in the Fichtelgebirge, Germany. Annals of Forest Science, 57(3): 229-243.

Foken, T., 2003. Lufthygienisch-bioklimatische Kennzeichnung des oberen Egertales (Fichtelgebirge bis Karlovy Vary). Bayreuther Forum Ökologie, 100: 1-70.

Forkel, R. et al., 2006. Trace gas exchange and gas phase chemistry in a Norway spruce forest: A study with a coupled 1-dimensional canopy atmospheric chemistry emission model. Atmospheric Environment, 40: S28-S42.

GeoTeam, 2007. Geotechnisches Gutachten. BV: Messmast Waldstein/Weidenbrunnen, GeoTeam, Naila.

Gerstberger, P., Foken, T. and Kalbitz, K., 2004. The Lehstenbach and Steinkreuz Catchments in NE Bavaria, Germany. In: E. Matzner (Editor), Biogeochemistry of Forested Catchments in a Changing Environment: A German Case Study. Ecological Studies. Springer, Berlin, Heidelberg, pp. 15-44.

Göckede, M. et al., 2007. Sensitivity of Lagrangian Stochastic footprints to turbulence statistics. Tellus.

Göttlein, A., Manderscheid, B., Blasek, R. and Hell, U., 1995. Bodenkundliche Charakterisierung der Intensivmeßfläche Coulissenhieb. In: B. Manderscheid and A. Göttlein (Editors), Wassereinzugsgebiet 'Lehstenbach' - das BITÖK-Untersuchungsgebiet am Waldstein (Fichtelgebirge, NO-Bayern). Bayreuther Forum Ökologie. BITÖK, Bayreuth, pp. 64-73.

Heindl, B. and Bott, H., 1995. Charakterisierung der Bodenvegetation im Einzugsgebiet Lehstenbach. In: B. Manderscheidt and A. Göttlein (Editors), Wassereinzugsgebiet Lehstenbach - das BITÖK Untersuchungsgebiet am Waldstein (Fichtelgebirge, NO-Bayern). BITÖK, Bayreuth, pp. 49-63.

Heindl, B., Ostendorf, B. and Köstner, B., 1995. Lage und forstliche Charakterisierung des Einzugsgebietes Lehstenbach. In: B. Manderscheid and A. Göttlein (Editors), Wassereinzugsgebiet 'Lehstenbach' - das BITÖK-Untersuchungsgebiet am Waldstein (Fichtelgebirge, NO-Bayern). Bayreuther Forum Ökologie. BITÖK, Bayreuth, pp. 7-14.

Henning, I. and Henning, D., 1977. Klimatologische Wasserbilanz von Deutschland. Annals of Meteorology, 12: 119-123.

Huang, D. et al., 2007. Canopy spectral invariants for remote sensing and model applications. Remote Sensing of Environment, 106(1): 106-122.

Hupfer, P., 1996. Unsere Umwelt: Das Klima. Teubner, Stuttgart.

Janssens, I.A. et al., 2003. Climatic influences on seasonal and spatial differences in soil $CO_2$ efflux. In: R. Valentini (Editor), Fluxes of Energy, Water and Carbon Dioxide of European Forests. Ecological Studies. Springer, Berlin.

Kalbitz, K., 1991. Bodenkundliche Charakterisierung der Intensiv-Messfläche, Coulissenhieb. In: P. Gerstberger (Editor), Waldökosystemforschung in Nordbayern: Die BITÖK-Untersuchungsflächen im Fichtelgebirge und Steigerwald. Bayreuther Forum Ökologie. BITÖK, Bayreuth, pp. 27-36.

Klemm, O., 2004. Trace gases and particles in the atmospheric boundary layer at the Waldstein site: present state and historic trends. In: E. Matzner (Editor), Biogeochemistry of Forested Catchments in a Changing Environment. Ecological Studies. Springer, Berlin, Heidelberg, pp. 45-58.

Lischeid, G., 2000. Soil moisture data - site Waldstein. CD-ROM-Data base. In: E.D. Schulze (Editor), Carbon and nitrogen cycling in European Forest Ecosystems. Ecological Studies. Springer, Berlin.

Lloyd, J. and Taylor, J.A., 1994. On the temperature dependence of soil respiration. Functional Ecology, 8: 315-323.

Manderscheid, B., 2000. Wet deposition and throughfall data - site Waldstein. CD-ROM-Data base. In: E.D. Schulze (Editor), Carbon and nitrogen cycling in European Forest Ecosystems. Ecological Studies. Springer, Berlin.

Manderscheid, B. and Göttlein, A., 1995. Wassereinzugsgebiet 'Lehstenbach' - das BITÖK-Untersuchungsgebiet am Waldstein (Fichtelgebirge, NO-Bayern). Bayreuther Forum Ökologie, 18. BITÖK, Bayreuth, 84 pp.

Matteucci, G., Dore, S., Stivanello, S., Rebmann, C. and Buchmann, N., 2000. Soil respiration in beech and spruce forests in Europe: trends, controlling factors, annual budgets and implications for the ecosystem carbon balance. In: E.-D. Schulze (Editor), Carbon and Nitrogen Cycling in European Forest Ecosystems. Ecological Studies. Springer, Berlin, pp. 217-236.

Matzner, E., Zuber, T., Alewell, C., Lischeid, G. and Moritz, K., 2004. Trends in deposition and canopy leaching of mineral elements as indicated by bulk deposition and throughfall measurements. In: E. Matzner (Editor), Biogeochemistry of Forested Catchments in a Changing Environment. Ecological Studies. Springer, Berlin Heidelberg, pp. 233-250.

Mund, M., 1996. Wachstum und oberirdische Biomasse von Fichtenbeständen (*Picea abies* [L.] KARST.) in einer Periode anthropogener Stickstoffeinträge. Diploma Thesis, Universität Bayreuth.

Mund, M., Kummetz, E., Hein, M., Bauer, G.A. and Schulze, E.D., 2002. Growth and carbon stocks of a spruce forest chronosequence in central Europe. Forest Ecology and Management, 171(3): 275-296.

Persson, T., 2000. Soil characteristic data. CD-ROM-Data base. In: E.D. Schulze (Editor), Carbon and nitrogen cycling in European Forest Ecosystems. Ecological Studies. Springer, Berlin.

Persson, T. et al., 2000. Experimental sites in the NIPHYS/CANIF project. In: E.D. Schulze (Editor), Carbon and nitrogen cycling in European forest ecosystems. Ecological Studies. Springer, Berlin.

Peters, K. and Gerchau, J., 1995. Klima und luftchemische Situation des Fichtelgebirges unter besonderer Berücksichtigung des Einzugsgebietes Lehstenbach. In: B. Manderscheid and A. Göttlein (Editors), Wassereinzugsgebiet 'Lehstenbach' - das BITÖK-Untersuchungsgebiet am Waldstein (Fichtelgebirge, NO-Bayern). Bayreuther Forum Ökologie, pp. 15-39.

Rebmann, C., 2004. Kohlendioxid-, Wasserdampf- und Energieaustausch eines Fichtenwaldes in Mittelgebirgslage in Nordostbayern. Bayreuther Forum Ökologie, 106: 1-140.

Rebmann, C. et al., 2004. Carbon Budget of a Spruce Forest Ecosystem. In: E. Matzner (Editor), Biogeochemistry of Forested Catchments in a Changing Environment: A German Case Study. Springer, Berlin, Heidelberg, pp. 143-160.

Reif, A., 1989. The vegetation of the Fichtelgebirge: origin, site conditions, and present status. In: E.D. Schulze, O.L. Lange and R. Oren (Editors), Forest Decline and Air Pollution. A Study of Spruce (Picea abies) on Acid Soils. Springer, Berlin, pp. 8-22.

Sanderman, J., Amundson, R.G. and Baldocchi, D.D., 2003. Application of eddy covariance measurements to the temperature dependence of soil organic matter mean residence time - art. no. 1061. Global Biogeochemical Cycles, 17(2): 1061-1061.

Subke, J.A., Reichstein, M. and Tenhunen, J.D., 2003. Explaining temporal variation in soil CO2 efflux in a mature spruce forest in Southern Germany. Soil Biology & Biochemistry, 35(11): 1467-1483.

Tenhunen, J.D., Valentini, R., Köstner, B., Zimmermann, R. and Granier, A., 1998. Variation in forest gas exchange at landscape to continental scales. Annals of Forest Science, 55: 1-11.

Thomas, C. and Foken, T., 2005. Detection of long-term coherent exchange over spruce forest using wavelet analysis. Theoretical and Applied Climatology, 80(2-4): 91-104.

Thomas, C. and Foken, T., 2007a. Flux contribution of coherent structures and its implications for the exchange of energy and matter in a tall spruce canopy. Boundary-Layer Meteorology, DOI 10.1007/s10546-006-9144-7.

Thomas, C. and Foken, T., 2007b. Organised motion in a tall spruce canopy: temporal scales, structure spacing and terrain effects. Boundary-Layer Meteorology, DOI: 10.1007/s10546-006-9087-z.

Thomas, C. et al., 2004. Documentation of the WALDATEM-2003 Experiment. 24, University of Bayreuth, Abteilung Mikrometeorologie, Bayreuth.

Valentini, R. et al., 2000. Respiration as the main determinant of carbon balance in European forests. Nature, 404(6780): 861-865.

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