atmosphere

MDPI

Supplementary Materials

Spatio-Temporal Variation of Ozone Concentrations and Ozone Uptake Conditions in Forests in Western Germany

Hanieh Eghdami [1,*], Willy Werner [1] and Patrick Büker [2]

Table S1. Yearly and total summary of meteorological parameters of the investigated stations, which are important as input data estimating ozone flux. All means and sums rest on hourly resolution: sum of Ozone (O_3) [ppm], mean of (O_3) [ppb], air temperature [°C], sums of precipitation [mm], mean of vapor pressure deficit (VPD) [kPa], mean of global radiation [W/cm²], mean of wind speed [m/s] and mean of air pressure [hPa].

Hortenkopf (606 m a.s.l.)								
Year	Sum O_3 (ppm) (canopy height)	Mean (O_3) (ppb)	Mean temperature(°C)	Sum Precipitation (mm)	Mean Vapor pressure deficit (VPD)	Mean Global radiation (W/cm²)	Mean Wind speed (m/s)	Mean Air pressure (hPa)
1998	352.73	37.58	7.67	1074.28	0.28	110.73	3.70	95.11
1999	359.38	38.06	8.47	1052.95	0.26	119.62	2.80	93.58
2000	323.32	34.15	9.17	1168.62	0.23	116.52	2.74	97.83
2001	311.70	32.99	8.51	1155.61	0.25	120.58	2.79	98.05
2002	321.57	34.09	9.32	1158.67	0.26	117.80	2.80	93.64
2003	373.92	39.63	9.47	703.45	0.43	139.88	2.75	97.94
2004	323.32	34.15	8.29	889.74	0.27	114.36	2.72	93.73
2005	323.21	34.25	8.85	769.64	0.36	118.36	2.73	93.84
2006	325.34	35.02	9.27	915.62	0.38	118.24	2.83	97.77
2007	310.69	33.01	9.41	988.05	0.34	119.63	2.96	93.80
2008	305.56	32.36	8.71	898.84	0.32	116.45	2.88	93.66
2009	318.49	33.80	8.75	909.69	0.32	121.69	2.77	93.58
2010	319.33	33.79	7.35	1022.64	0.32	116.14	2.60	93.46
2011	318.44	33.88	9.42	680.02	0.33	125.52	3.16	93.85
2012	321.71	33.98	8.62	781.11	0.32	122.32	2.53	93.72
2013	313.79	33.18	7.80	962.91	0.29	112.98	2.41	93.65
2014	321.98	34.22	9.88	867.98	0.31	125.33	3.12	100.84
2015	323.60	34.41	9.47	691.33	0.37	132.12	3.05	95.07
2016	281.10	29.45	8.42	863.57	0.25	117.99	2.08	101.60
2017	329.21	34.03	9.12	898.46	0.30	133.01	0.84	94.95
2018	352.96	36.87	10.18	899.84	0.37	141.68	1.06	94.93
2019	346.37	36.13	9.80	882.75	0.36	123.41	1.17	94.78
Mean	326.26	34.48	8.96	919,81	0.31	122.02	2.57	95.43
Min	281.10	29.45	7.35	680,02	0.23	110.73	0.84	93.46
Max	373.92	39.63	10.18	1168.62	0.43	141.68	3.70	101.60
Sx	23.14	2.13	0.73	144.93	0.05	8.14	0.70	2.46

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Neuhäusel (540 m a.s.l.)								
Year	**Sum O_3 (ppm) (canopy height)**	**Mean* (O_3) (ppb)**	**Mean temperature(°C)**	**Sum Precipitation (mm)**	**Mean Vapor pressure deficit (VPD)**	**Mean Global radiation (W/cm²)**	**Mean Wind speed (m/s)**	**Mean Air pressure (hPa)**
1998	186.29	-	7.96	1002.46	0.23	105.07	2.27	101.71
1999	294.61	30.38	8.53	951.80	0.30	120.04	2.24	101.64
2000	270.55	27.65	8.39	826.90	0.23	112.45	2.04	101.64
2001	269.10	27.67	7.91	1031.07	0.27	114.49	2.10	101.66
2002	272.97	28.07	8.69	1042.57	0.26	112.64	2.03	101.78
2003	330.97	34.04	8.51	630.50	0.38	136.01	1.96	102.01
2004	266.88	27.19	7.24	721.06	0.26	100.11	1.98	101.58
2005	315.57	29.71	8.51	703.21	0.28	107.48	1.85	101.76
2006	320.75	29.19	8.47	816.69	0.32	108.91	2.02	101.67
2007	273.03	28.18	8.80	878.54	0.27	105.83	2.06	101.71
2008	299.88	30.63	8.26	831.22	0.26	109.98	2.03	101.58
2009	188.45	29.47	7.88	816.88	0.26	114.34	1.99	101.49
2010	192.01	30.15	6.25	790.53	0.30	115.34	1.97	101.34
2011	192.70	30.31	8.41	684.12	0.32	122.49	2.11	101.77
2012	212.61	30.01	7.94	846.09	0.28	119.54	1.22	101.75
2013	292.15	29.93	7.39	817.10	0.27	117.66	2.11	101.69
2014	289.58	29.77	9.23	764.20	0.25	121.38	2.23	101.66
2015	273.23	28.14	8.85	827.55	0.28	127.30	2.18	102.03
2016	286.52	29.45	8.42	863.57	0.25	117.99	2.08	101.60
2017	289.40	29.96	8.74	1057.21	0.26	122.51	2.11	101.67
2018	338.37	34.97	9.75	660.87	0.40	136.23	2.05	101.59
2019	316.66	32.82	9.26	890.18	0.34	128.92	2.13	101.43
Mean	284.48	29.89	8.34	838.83	0.29	117.12	2.03	101.67
Min	186.29	27.19	6.25	630.50	0.23	100.11	1.22	101.34
Max	338.37	34.97	9.75	1057.21	0.40	136.23	2.27	102.03
Sx	41.64	2.00	0.75	121.80	0.04	9.49	0.21	0.16

Herdorf (480 m a.s.l.)								
Year	**Sum O_3 (ppm) (canopy height)**	**Mean (O_3) (ppb)**	**Mean temperature(°C)**	**Sum Precipitation (mm)**	**Mean Vapor pressure deficit (VPD)**	**Mean Global radiation (W/cm²)**	**Mean Wind speed (m/s)**	**Mean Air pressure (hPa)**
1998	272.35	28.80	8.34	1166.48	0.25	97.34	3.31	95.89
1999	297.56	31.41	8.97	1042.96	0.30	110.36	3.33	95.72
2000	261.99	27.68	9.20	1019.32	0.25	100.87	3.45	95.74
2001	271.07	28.76	8.56	1184.45	0.27	101.97	2.85	95.80
2002	274.49	28.99	8.99	1235.25	0.25	99.07	3.16	95.78
2003	322.66	33.94	9.05	974.07	0.35	123.40	2.93	95.96
2004	264.30	27.81	8.19	984.71	0.26	101.34	2.99	95.86
2005	276.46	29.12	8.75	1032.06	0.30	105.39	2.78	95.98
2006	293.33	30.97	9.22	994.25	0.33	104.97	2.95	95.92
2007	265.78	28.04	9.42	1327.50	0.30	101.23	2.91	95.93

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2008	265.26	27.89	8.73	1101.38	0.27	105.46	2.88	95.80
2009	259.92	27.34	8.61	999.47	0.30	104.70	2.65	95.72
2010	269.54	28.30	7.40	919.36	0.33	102.71	2.38	95.59
2011	275.99	29.05	9.23	961.69	0.38	110.68	2.69	95.99
2012	268.55	28.18	8.44	1038.50	0.34	102.01	2.55	95.86
2013	269.81	28.37	8.08	877.49	0.31	100.74	2.39	95.79
2014	267.30	28.06	9.80	861.25	0.29	103.20	2.43	95.69
2015	281.20	29.60	9.25	965.35	0.31	116.40	2.63	96.07
2016	269.91	28.22	8.95	842.75	0.30	108.08	2.37	99.06
2017	266.20	27.93	8.98	1104.19	0.26	110.07	2.47	95.82
2018	311.03	32.61	10.11	795.54	0.43	126.26	2.34	95.78
2019	303.51	31.83	9.65	969.91	0.36	118.57	2.44	95.65
Mean	277.65	29.22	8.79	1018.09	0.31	107.04	2.77	95.97
Min	259.92	27.34	7.40	795.54	0.25	97.34	2.34	95.59
Max	322.66	33.94	10.11	1327.50	0.43	126.26	3.45	99.06
Sx	18.70	1.78	0.61	129.98	0.05	7.85	0.34	0.70
Leisel (650 m a.s.l)								
Year	**Sum O_3 (ppm) (canopy height)**	**Mean (O_3) (ppb)**	**Mean temperature(°C)**	**Sum Precipitation (mm)**	**Mean Vapor pressure deficit (VPD)**	**Mean Global radiation (W/cm^2)**	**Mean Wind speed (m/s)**	**Mean Air pressure (hPa)**
1998	313.71	33.22	8.09	770.10	0.27	106.50	2.03	93.69
1999	327.12	34.20	8.01	1011.43	0.28	112.77	2.79	93.61
2000	303.87	31.52	8.71	1108.97	0.22	109.34	2.81	93.59
2001	299.40	31.97	8.12	991.51	0.24	111.89	2.79	93.70
2002	305.67	32.11	8.46	1085.73	0.26	108.48	2.80	93.62
2003	334.73	35.94	8.68	848.43	0.43	133.67	2.75	93.85
2004	303.58	31.59	8.43	916.81	0.26	102.22	2.81	93.75
2005	316.27	33.30	8.84	792.44	0.27	110.38	2.73	93.85
2006	321.56	34.50	9.34	1002.22	0.33	111.45	2.83	93.81
2007	320.99	33.35	8.88	1098.06	0.27	107.11	2.96	93.81
2008	319.59	33.65	8.08	970.17	0.24	106.77	2.88	93.66
2009	317.58	33.57	7.97	988.09	0.20	117.54	2.77	93.58
2010	313.66	33.23	6.65	958.84	0.21	113.80	2.61	93.46
2011	305.03	32.06	8.46	798.90	0.19	126.25	2.59	93.85
2012	310.78	32.84	7.64	1033.76	0.21	119.72	2.53	93.72
2013	309.83	32.75	7.13	976.58	0.21	113.26	2.41	93.65
2014	307.45	32.62	8.94	922.12	0.20	115.82	2.48	93.55
2015	323.55	34.29	8.54	773.92	0.27	121.30	2.53	93.93
2016	314.80	32.07	8.18	1171.17	0.22	111.65	2.52	93.77
2017	328.94	33.62	8.44	981.08	0.26	120.25	2.56	93.58
2018	357.49	36.58	9.46	971.16	0.35	129.99	2.65	93.59
2019	345.20	35.39	9.25	981.97	0.35	126.43	2.60	93.40
Mean	318.22	33.38	8.38	961.52	0.26	115.30	2.66	93.68
Min	357.49	31.52	6.65	770.10	0.19	102.22	2.03	93.40
Max	299.40	36.58	9.46	1171.17	0.43	133.67	2.96	93.93
Sx	15.90	1.36	0.67	110.23	0.06	8.25	0.20	0.14

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Wascheid (680 m a.s.l)								
Year	**Sum O_3 (ppm) (canopy height)**	**Mean (O_3) (ppb)**	**Mean temperature(°C)**	**Sum Precipitation (mm)**	**Mean Vapor pressure deficit (VPD)**	**Mean Global radiation (W/cm^2)**	**Mean Wind speed (m/s)**	**Mean Air pressure (hPa)**
1998	319.48	32.75	6.70	1336.84	0.25	103.40	2.49	93.35
1999	339.12	34.83	7.31	1333.28	0.30	116.28	2.66	93.27
2000	295.98	30.35	7.57	1439.06	0.19	110.86	2.75	93.24
2001	325.26	33.42	7.00	1537.02	0.20	112.79	2.72	93.36
2002	322.35	33.11	7.65	1369.32	0.17	111.62	2.75	93.31
2003	366.54	37.65	7.72	866.71	0.34	132.36	2.67	93.49
2004	310.05	31.72	6.85	796.91	0.18	108.41	2.56	93.39
2005	334.01	34.23	7.14	830.21	0.22	109.47	2.49	93.51
2006	340.82	34.99	7.68	980.85	0.24	109.29	2.58	93.46
2007	313.50	32.18	7.79	868.47	0.20	106.60	2.62	93.46
2008	314.58	32.15	6.95	1023.81	0.18	106.87	2.47	93.33
2009	312.04	31.88	7.17	959.72	0.19	116.39	2.40	93.25
2010	311.43	31.81	5.94	882.71	0.23	119.22	2.22	93.13
2011	322.29	32.95	8.03	793.46	0.25	126.01	2.32	93.52
2012	308.37	31.36	7.03	1135.17	0.20	117.38	2.25	93.39
2013	307.88	31.45	6.36	918.04	0.20	115.02	2.22	93.32
2014	300.99	30.59	8.10	906.97	0.20	117.13	2.11	93.22
2015	300.16	30.60	7.74	996.25	0.24	123.46	2.16	93.60
2016	309.58	31.42	7.54	950.22	0.19	115.10	2.07	93.28
2017	316.00	32.06	7.68	1047.79	0.20	120.11	1.94	93.32
2018	341.25	34.64	8.56	991.94	0.32	130.48	2.02	93.35
2019	330.67	33.59	8.26	1179	0.29	125.08	1.98	93.15
Mean	320.11	32.72	7.40	1051.99	0.23	116.06	2.38	93.35
Min	295.98	30.35	5.94	793.46	0.17	103.40	1.94	93.13
Max	366.54	37.65	8.56	1537.02	0.34	132.36	2.75	93.60
Sx	18.85	1.76	0.63	220.09	0.05	7.81	0.27	0.12

*In 1998, there are a large data gap.

Table S2. Differences of monthly means of air pollutants in the time series from 1998 to 2019 at five stations.Values with different letters in each group are significantly different during months (Scheffe'test, α= 0.05). O_3 concentration in ppb, NO_2 concentration in µg/m^3 and n=number of years.

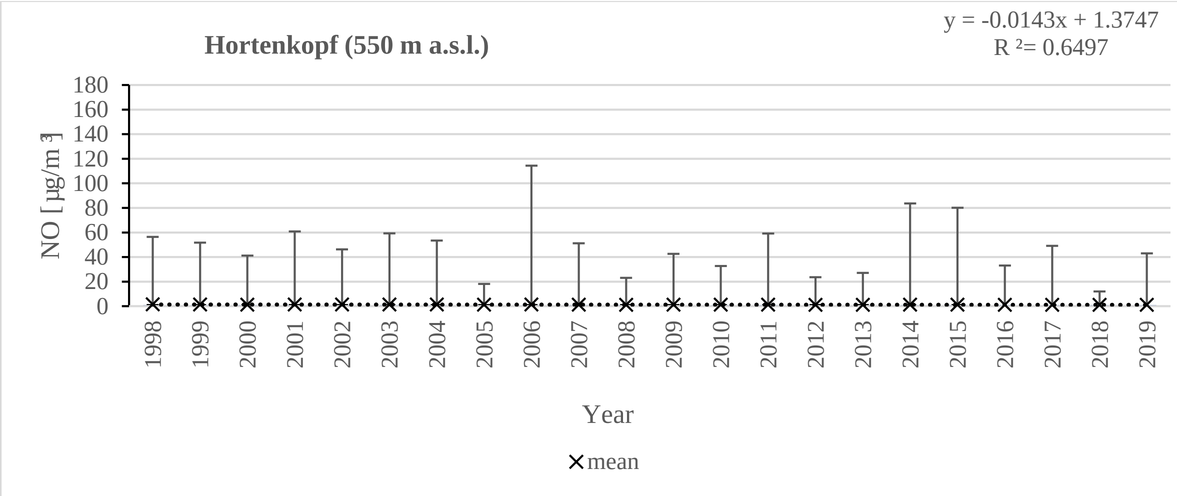
O_3

Station	**Hortenkopf (550 m a.s.l.)**	**Neuhäusel (390 m a.s.l.)**	**Herdorf (440 m a.s.l.)**	**Leisel (660 m a.s.l.)**	**Wascheid (690 m a.s.l.)**
n / Month	**18**	**17**	**18**	**18**	**18**
Jan.	24.2^{ab}	20.6^{d}	21.1^{fg}	24.8^{hi}	29.2^{k}
Feb.	28.9^{ab}	23.4^{d}	24.7^{fg}	28.3^{hi}	32.6^{k}
Mar.	35.8^{bc}	29.7^{d}	31.0^{fg}	34.2^{hij}	36.5^{m}
Apr.	44.0^{b}	37.8^{d}	38.7^{fg}	41.4^{hi}	43.0^{kl}
May	44.4^{a}	39.4^{d}	38.8^{f}	42.5^{h}	43.9^{k}
June	45.5^{b}	39.9^{de}	37.8^{f}	43.5^{hi}	42.9^{kl}
July	44.0^{a}	39.2^{d}	36.8^{f}	42.7^{h}	41.9^{k}
Aug.	43.0^{a}	38.2^{d}	35.4^{f}	40.7^{h}	41.2^{k}
Sept.	34.4^{a}	30.0^{d}	27.7^{f}	33.0^{h}	35.4^{k}
Oct.	25.1^{ab}	20.4^{de}	20.2^{f}	23.5^{hi}	28.4^{l}
Nov.	21.4^{ab}	16.5^{d}	17.0^{f}	20.8^{hi}	26.5^{l}
Dec.	23.1^{ab}	17.6^{d}	18.7^{fg}	22.5^{hi}	27.8^{l}

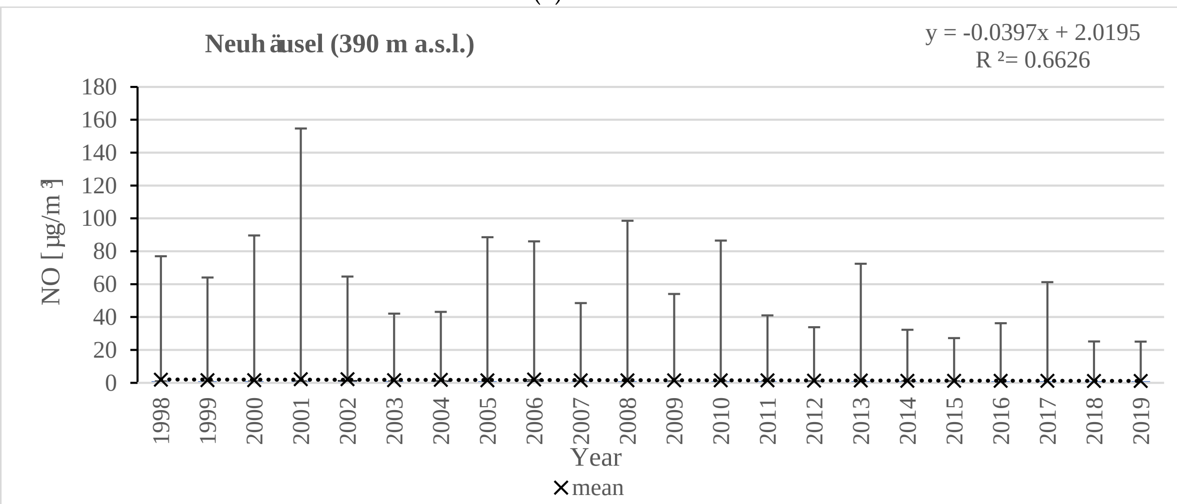
NO_2.

Station.	**Hortenkopf (550 m a.s.l.)**	**Neuhäusel (390 m a.s.l.)**	**Herdorf (440 m a.s.l.)**	**Leisel (660 m a.s.l.)**	**Wascheid (690 m a.s.l.)**
n / Month	**18**	**18**	**18**	**18**	**16**
Jan.	12.6^{ab}	17.4^{d}	15.7^{fg}	12.8^{hi}	11.5^{j}
Feb.	11.8^{a}	17.4^{d}	15.6^{fg}	12.5^{hi}	11.3^{j}
Mar.	9.6^{a}	14.5^{c}	12.3^{ef}	11.1^{h}	11.5^{jk}
Apr.	7.1^{a}	11.7^{c}	9.1^{e}	8.6^{h}	8.3^{j}
May	5.5^{a}	10.1^{c}	7.6^{e}	6.4^{h}	6.9^{j}
June	4.8^{a}	9.4^{d}	6.8^{f}	5.6^{hi}	6.2^{jk}
July	4.6^{a}	8.7^{d}	6.4^{f}	5.3^{hi}	5.0^{jk}
Aug.	4.7^{a}	9.2^{d}	6.7^{f}	5.5^{hi}	5.4^{jk}
Sept.	6.2^{a}	10.9^{d}	8.5^{f}	7.2^{hi}	6.9^{jk}
Oct.	8.9^{a}	13.2^{c}	10.7^{e}	10.1^{h}	9.1^{j}
Nov.	12.2^{ab}	16.3^{c}	15.2^{ef}	11.9^{hi}	10.8^{jk}
Dec.	11.5^{ab}	16.5^{d}	15.4^{fg}	12.0^{hi}	11.0^{j}

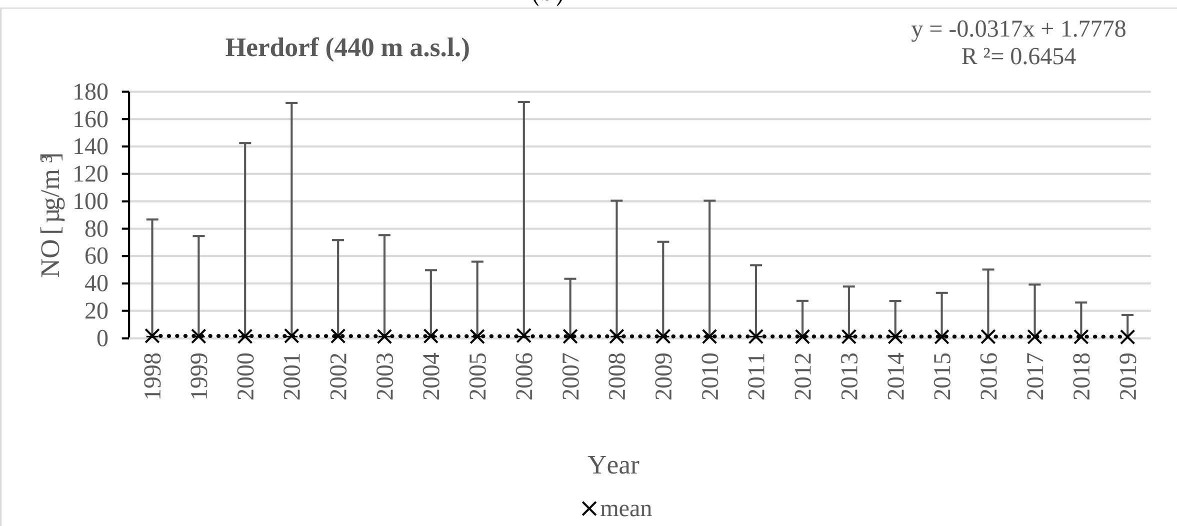
Figure S1. Boxplot of hourly NO concentrations (μg/m³) with annual variance and trends at the stations (S3.a-S3.e). The temporal trend is shown as the regression line of annual means for n=22 years (only Wascheid n=20) with the regression equation and coefficient of determination. The significance of the correlations is documented in Table 3.



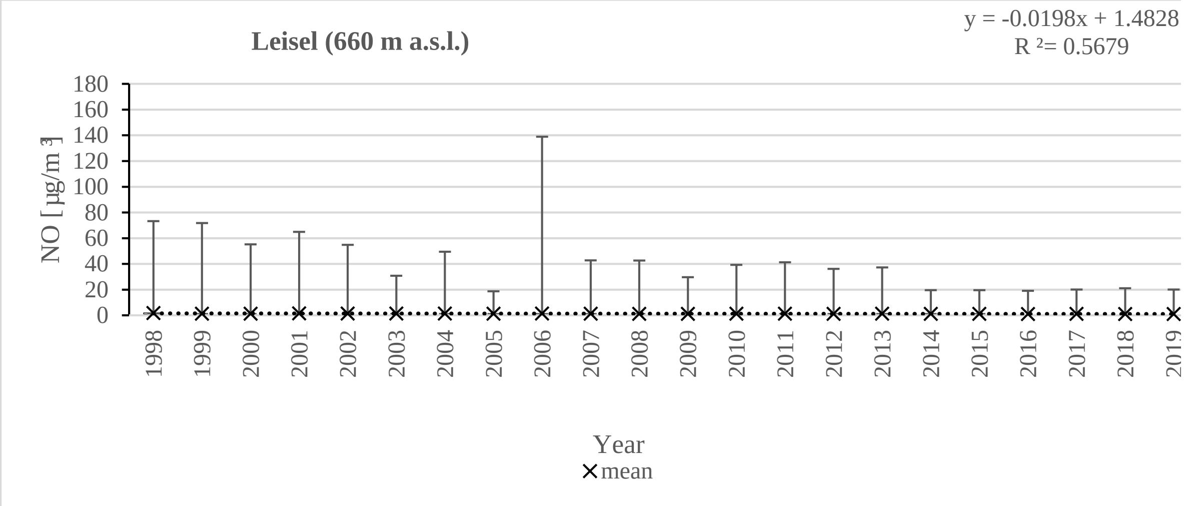
(**a**)



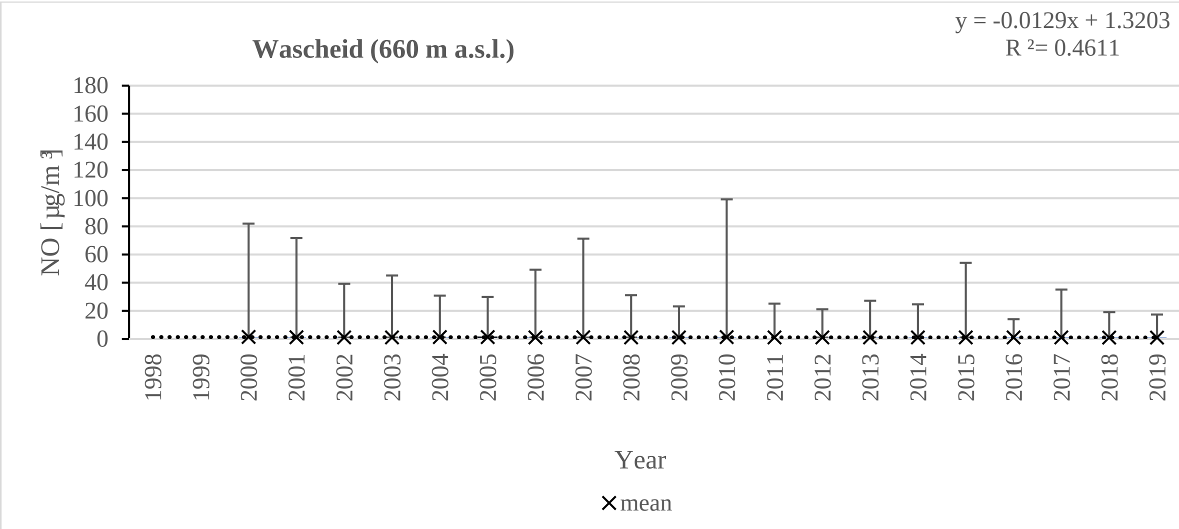
(**b**)



(**c**)

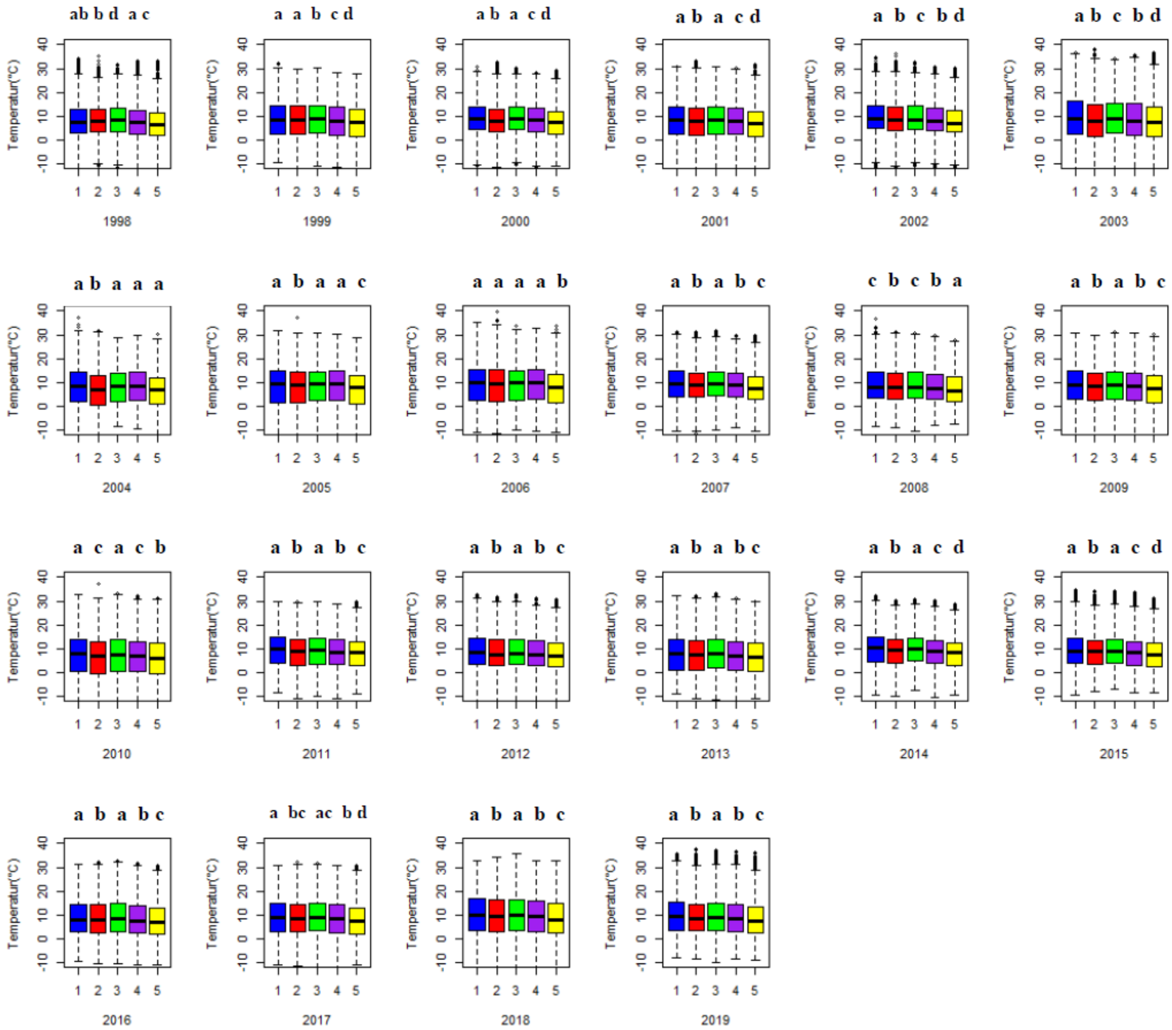

Leisel (660 m a.s.l.)
y = -0.0198x + 1.4828
R ²= 0.5679
NO [µg/m ³]
180
160
140
120
100
80
60
40
20
0
1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019
Year
mean

(**d**)

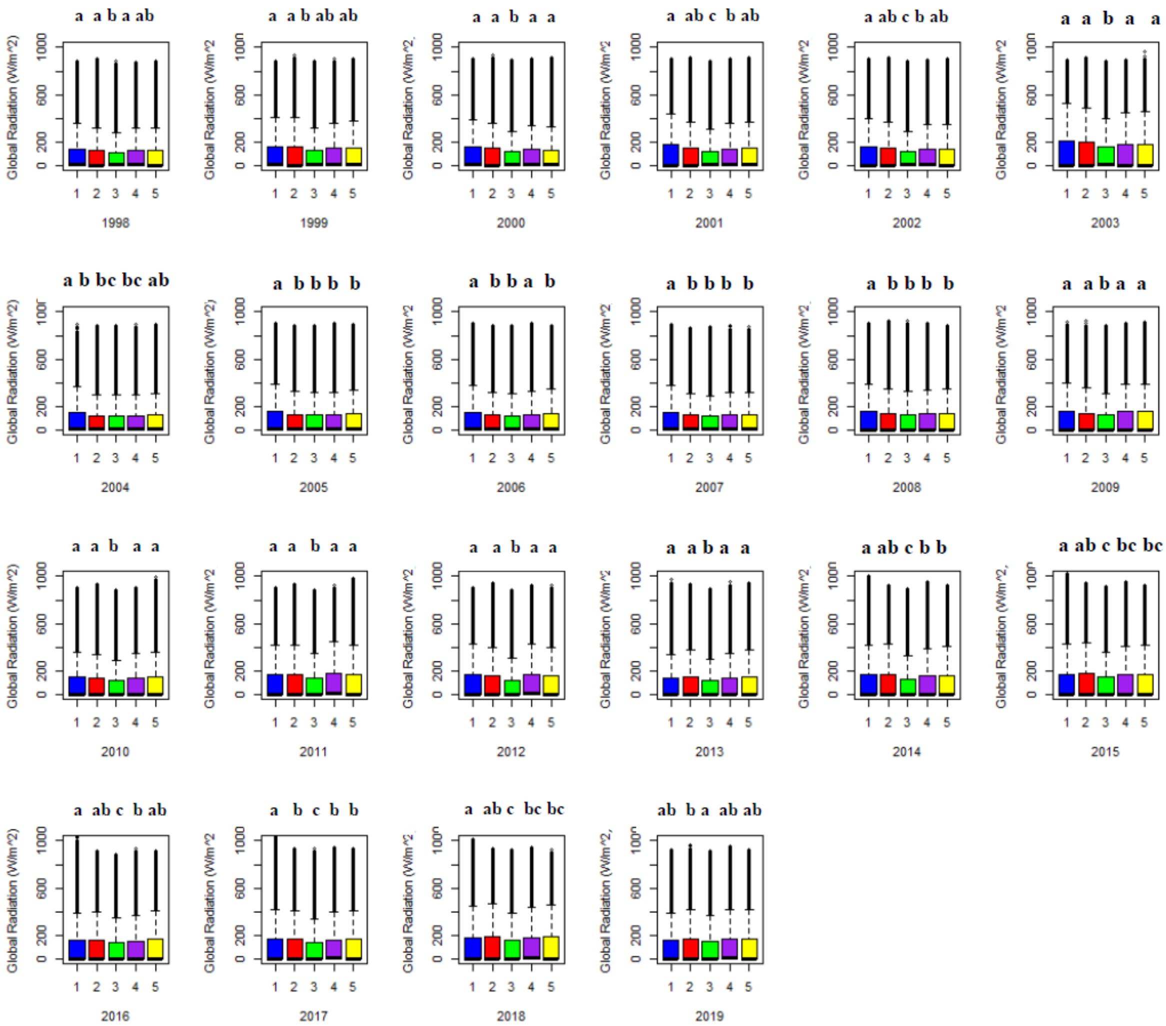

Wascheid (660 m a.s.l.)
y = -0.0129x + 1.3203
R ²= 0.4611
NO [µg/m ³]
180
160
140
120
100
80
60
40
20
0
1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019
Year
mean

(**e**)

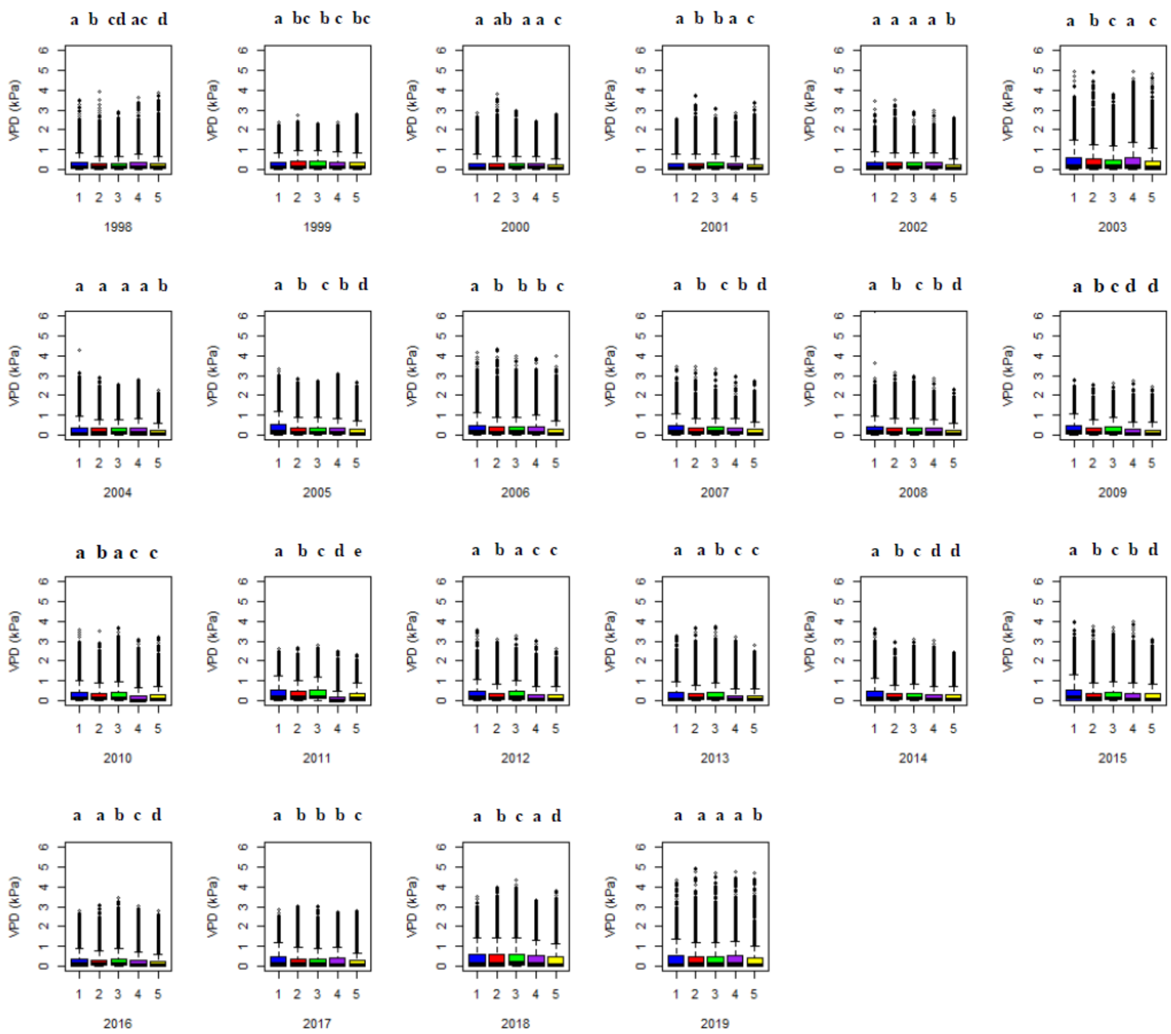
Figure S2. The boxplots present the variation of meteorological parameters for the 22 years (1998-2019) among five stations, which are mentioned in legend. Values with different letters in each year are significantly different between stations (Tukey test, α= 0.05).



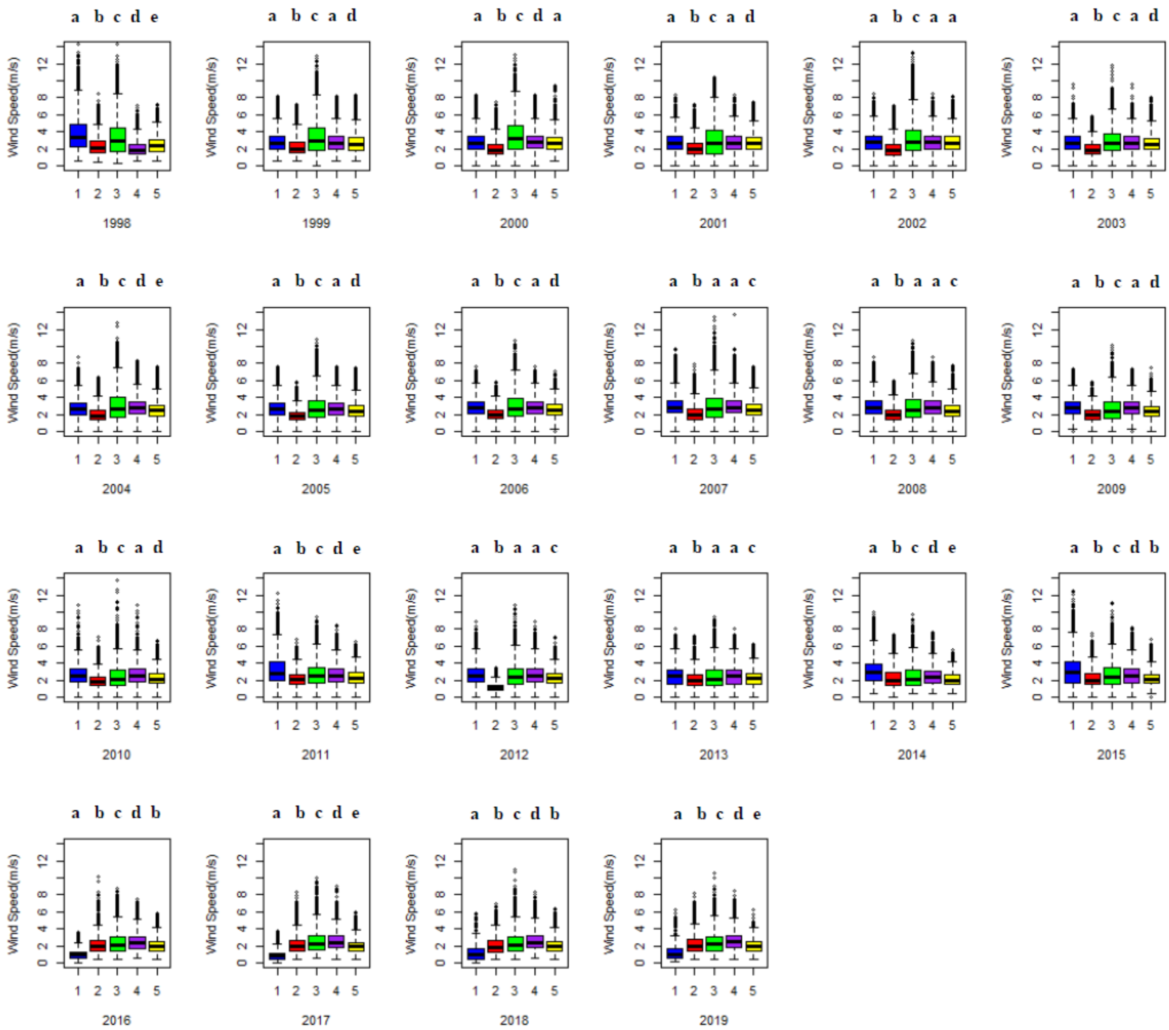
(a) Temperature (°C)



(b) Global radiation (W/m²)


a b cd ac d
a bc b c bc
a ab a a c
a b b a c
a a a a b
a b c a c
a a a a b
a b c b d
a b b b c
a b c b d
a b c b d
a b c d d
a b a c c
a b c d e
a b a c c
a a b c c
a b c d d
a b c b d
a a b c d
a b b b c
a b c a d
a a a a b
VPD (kPa)
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019

(c) VPD (kPa)



(d) Wind Speed (m/s)

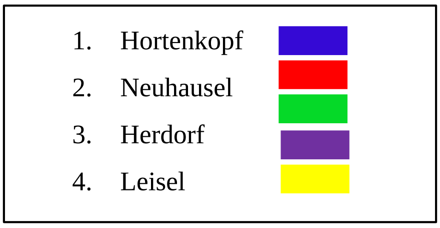


Table S3. Pearson correlation coefficients between NO, NO_2, O3 as well as to selected meteorological parameters for the all stations. Ozone (O_3; ppb), air temperature (T; °C), sums of precipitation (P; mm), mean of global radiation (G; W/cm²), mean of wind speed (W; m/s), mean of vapor pressure deficit (VPD; kPa) and mean of air pressure (P_{air}; hPa).

		T (°C)	P (mm)	G (W/m²)	W (m/s)	VPD (kPa)	P_{air} (hPa)	O_3	NO_2
Hortenkopf	O_3	0.64	-0.02	0.41	-0.02	0.72	0.16	-	-
	NO_2	-0.40	-0.06	-0.21	-0.03	-0.24	-0.07	-0.50	-
	NO	-0.12	-0.01	-0.007	-0.02	-0.06	-0.02	-0.18	0.38
Neuhäusel	O_3	0.56	-0.014	0.42	-0.06	0.61	0.002	-	-
	NO_2	-0.34	-0.04	-0.20	-0.13	-0.22	0.13	-0.36	-
	NO	-0.13	-0.01	-0.014	-0.06	-0.08	0.06	-0.16	0.44
Herdorf	O_3	0.57	-0.04	0.47	0.03	0.73	-0.064	-	-
	NO_2	-0.41	-0.03	-0.22	-0.10	-0.28	0.067	-0.52	-
	NO	-0.127	-0.016	-0.02	-0.07	-0.07	0.04	-0.20	0.43
Leisel	O_3	0.60	-0.016	0.46	0.072	0.69	-0.02	-	-
	NO_2	-0.34	-0.06	-0.18	-0.11	-0.17	0.05	-0.45	-
	NO	-0.108	-0.018	0.002	-0.052	-0.05	0.013	-0.17	0.39
Wascheid	O_3	0.56	-0.02	0.46	0.062	0.705	-0.040	-	-
	NO_2	-0.32	-0.065	-0.19	0.043	-0.17	0.086	-0.38	-
	NO	-0.08	-0.011	-0.02	0.035	-0.019	0.001	-0.11	0.30

Table S4. Drought periods during growing season (1st April to 30th September) of the five stations for the 22 years' time period (1998-2019) in Rhineland-Palatinate, Germany (a-e). It shows maximum amount of accumulated negative AWB, frequency and percentage of negative atmospheric water balance and the DOY of appearance as Julian date (*DOY*= day of the year). Normal risk: There are not elevated daytime O_3 and not drought periods, Low risk: There are drought periods and elevated daytime O_3 and High risk: There are not drought period but elevated daytime O_3 during vegetation period.

Hortenkopf (606 m a.s.l.)									
Year	Start of the first drought period (DOY)	End of the last drought period (DOY)	Max. accumulated water deficit (mm)	Frequency of Periods during the vegetation period	drought duration (days)	Percentage of days within drought periods	Normal risk	Low risk	High risk
1998	203	268	-82.3	2	44	12%	14.2%	27.3%	58.5%
1999	165	274	-176.1	1	110	30%	6.0%	54.6%	39.3%
2000	0	0	0	0	0	0%	22.4%	0.0%	77.6%
2001	153	255	-118.4	2	98	27%	26.2%	42.1%	31.7%
2002	164	274	-78.4	2	104	28%	21.9%	40.4%	37.7%
2003	162	275	-204.2	3	107	30%	7.1%	53.6%	39.3%
2004	170	265	-81.9	2	86	23%	19.7%	41.0%	39.3%
2005	172	274	-86	1	120	33%	20.8%	42.1%	37.2%
2006	172	256	-118	2	75	20%	22.4%	32.2%	45.4%
2007	0	0	0	0	0	0%	32.8%	0.0%	67.2%
2008	174	270	-68.6	4	68	19%	31.1%	35.0%	33.9%
2009	209	274	-56.7	2	64	17%	26.2%	27.9%	45.9%
2010	181	223	-41	2	33	9%	27.3%	14.8%	57.9%
2011	133	274	-53.5	3	131	36%	27.9%	45.9%	26.2%
2012	198	268	-95.7	2	68	19%	18.0%	35.5%	46.4%
2013	197	249	-111.9	1	46	13%	29.5%	25.1%	45.4%
2014	161	204	-75.6	2	32	9%	19.7%	18.6%	61.7%
2015	160	274	-153.7	2	98	27%	18.6%	48.1%	33.3%
2016	240	274	-32.83	3	32	9%	33.3%	12.6%	54.1%
2017	147	272	-86.56	6	84	23%	27.3%	37.2%	35.5%
2018	180	291	-163	4	103	28%	12.0%	40.4%	47.5%
2019	168	265	-95.86	5	86	23%	17.5%	41.0%	41.5%
Mean	-	-	-	-	-	-	21.9%	32.5%	45.6%
Sx	-	-	-	-	-	-	0.08	0.15	0.13

Neuhäusel (540 m a.s.l.)									
Year	Start of the first drought period (DOY)	End of the last drought period (DOY)	Max. accumulated water deficit (mm)	Frequency of Periods during the vegetation period	drought duration (days)	Percentage of days within drought periods	Normal risk	Low risk	High risk
1998	224	232	-31.9	1	9	2%	13.7%	28.4%	57.9%

continue

1999	198	264	-80.4	2	60	16%	29.0%	16.4%	54.6%
2000	172	231	-54.2	3	35	10%	29.0%	24.6%	46.4%
2001	187	245	-65.7	3	45	12%	22.4%	22.4%	55.2%
2002	223	275	-60.6	2	46	13%	9.3%	32.2%	58.5%
2003	193	274	-99.1	3	70	19%	23.5%	4.9%	71.6%
2004	216	224	-15.1	1	9	2%	20.2%	25.1%	54.6%
2005	199	252	-56.6	3	46	13%	21.3%	22.4%	56.3%
2006	200	272	-74.9	3	46	13%	30.6%	0.0%	69.4%
2007	0	0	0	0	0	0	17.5%	27.3%	55.2%
2008	183	273	-33.4	3	59	16%	18.6%	18.6%	62.8%
2009	226	272	-57.4	2	38	10%	25.1%	14.8%	60.1%
2010	185	222	-42.9	2	29	8%	21.9%	24.0%	54.1%
2011	192	278	-33.4	3	50	14%	20.2%	12.0%	67.8%
2012	241	267	-35.9	2	22	6%	24.0%	19.1%	56.8%
2013	202	249	-27.8	2	41	11%	23.5%	0.0%	76.5%
2014	0	0	0	0	0	0%	23.0%	22.4%	54.6%
2015	210	274	-45.6	3	38	10%	26.8%	12.6%	60.7%
2016	243	274	-38	3	28	8%	24.0%	10.9%	65.0%
2017	169	202	-28.8	3	23	6%	8.7%	47.0%	44.3%
2018	173	273	-119.8	4	93	25%	16.4%	35.5%	48.1%
2019	176	265	-64.4	4	75	21%	13.7%	28.4%	57.9%
Mean	-	-	-	-	-	-	21.4%	20.0%	58.6%
Sx	-	-	-	-	-	-	0.06	0.11	0.08

Herdorf (480 m a.s.l.)

Year	**Start of the first drought period (DOY)**	**End of the last drought period (DOY)**	**Max. accumulated water deficit (mm)**	**Frequency of Periods during the vegetation period**	**drought duration (days)**	**Percentage of days within drought periods**	**Normal risk**	**Low risk**	**High risk**
1998	224	233	-25.8	1	10	3%	30.6%	8.2%	61.2%
1999	208	272	-35.1	2	43	12%	14.8%	24.0%	61.2%
2000	175	182	-10.2	1	7	2%	35.0%	3.8%	61.2%
2001	212	247	-24.4	2	23	6%	26.8%	12.0%	61.2%
2002	178	183	-11.4	1	6	2%	25.1%	2.2%	72.7%
2003	211	270	-24.7	2	36	10%	14.2%	15.3%	70.5%
2004	216	225	-18.4	1	10	3%	29.5%	5.5%	65.0%
2005	174	180	-16.5	1	7	2%	30.1%	4.4%	65.6%
2006	192	232	-33.7	1	41	11%	22.4%	16.9%	60.7%
2007	113	128	-23.8	1	16	4%	41.5%	8.2%	50.3%
2008	150	155	-21.3	1	6	2%	34.4%	6.0%	59.6%
2009	234	274	-22.3	3	33	9%	29.0%	11.5%	59.6%
2010	178	226	-24.8	1	38	10%	37.2%	20.8%	42.1%
2011	122	197	-67.7	2	60	16%	33.3%	30.1%	36.6%
2012	225	266	-33.7	3	35	10%	30.6%	15.3%	54.1%
2013	204	249	-22.4	3	36	10%	33.9%	18.6%	47.5%

continue

2014	164	186	-5.1	1	20	5%	29.5%	8.7%	61.7%
2015	158	226	-34.3	4	37	10%	24.6%	18.6%	56.8%
2016	238	274	-26.7	3	34	9%	30.1%	14.2%	55.7%
2017	167	203	-19.3	3	24	7%	39.9%	9.8%	50.3%
2018	125	295	-65.3	10	141	39%	15.3%	56.8%	27.9%
2019	172	265	-62.2	7	79	22%	16.9%	37.7%	45.4%
Mean	-	-	-	-	-	-	28.4%	15.8%	55.8%
Sx	-	-	-	-	-	-	0.08	0.13	0.11

Leisel (650 m a.s.l.)

Year	**Start of the first drought period (DOY)**	**End of the last drought period (DOY)**	**Max. accumulated water deficit (mm)**	**Frequency of Periods during the vegetation period**	**drought duration (days)**	**Percentage of days within drought periods**	**Normal risk**	**Low risk**	**High risk**
1998	175	244	-52.1	4	51	14%	23.0%	31.1%	45.9%
1999	213	268	-55.5	2	43	12%	13.7%	21.3%	65.0%
2000	0	0	0	0	0	0%	30.1%	0.0%	69.9%
2001	160	245	-25.5	3	38	10%	26.2%	23.0%	50.8%
2002	186	264	-19.1	4	34	9%	19.1%	20.8%	60.1%
2003	194	274	-27.1	2	53	15%	10.4%	27.3%	62.3%
2004	178	222	-21.8	2	13	4%	29.0%	4.9%	66.1%
2005	202	274	-34.4	2	50	14%	20.2%	24.6%	55.2%
2006	173	212	-33.6	2	30	8%	16.9%	16.4%	66.7%
2007	112	126	-48.1	1	15	4%	24.0%	8.2%	67.8%
2008	197	216	-16.1	1	15	4%	20.2%	7.7%	72.1%
2009	0	0	0	0	0	0%	20.8%	0.0%	79.2%
2010	182	203	-22.7	1	18	5%	19.1%	9.3%	71.6%
2011	126	197	-74.7	3	53	15%	28.4%	26.2%	45.4%
2012	224	267	-30.8	2	36	10%	20.8%	15.8%	63.4%
2013	201	249	-25.4	3	36	10%	25.7%	18.0%	56.3%
2014	166	185	-43.3	2	18	5%	21.3%	9.3%	69.4%
2015	160	256	-42.8	3	64	18%	18.6%	30.1%	51.4%
2016	236	274	-49.6	2	33	9%	26.2%	15.8%	57.9%
2017	146	200	-61.8	4	44	12%	23.0%	21.3%	55.7%
2018	200	296	-41.2	6	89	22%	9.8%	30.6%	59.6%
2019	175	265	-55.1	5	78	21%	15.8%	39.3%	44.8%
Mean	-	-	-	-	-	-	21.0%	18.2%	60.8%
Sx	-	-	-	-	-	-	0.06	0.11	0.09

continue

Wascheid (680 m a.s.l.)									
Year	**Start of the first drought period (DOY)**	**End of the last drought period (DOY)**	**Max. accumulated water deficit (mm)**	**Frequency of Periods during the vegetation period**	**drought duration (days)**	**Percentage of days within drought periods**	**Normal risk**	**Low risk**	**High risk**
1998	227	232	-19.4	1	6	2%	21.9%	3.3%	74.9%
1999	208	259	-34.2	2	22	6%	10.4%	12.0%	77.6%
2000	0	0	0	0	0	0%	32.2%	0.0%	67.8%
2001	0	0	0	0	0	0%	21.3%	0.0%	78.7%
2002	177	264	-31.8	3	56	15%	16.9%	31.1%	51.9%
2003	169	274	-46.3	5	81	22%	7.7%	39.9%	52.5%
2004	165	222	-34.6	2	34	9%	19.1%	25.7%	55.2%
2005	172	274	-41.1	4	67	18%	19.1%	35.5%	45.4%
2006	181	219	-45.1	2	30	8%	16.4%	18.0%	65.6%
2007	0	0	0	0	0	0%	31.7%	0.0%	68.3%
2008	172	245	-29.6	3	44	12%	27.3%	21.3%	51.4%
2009	220	274	-17.9	3	40	11%	28.4%	15.3%	56.3%
2010	166	222	-60.5	2	45	12%	23.0%	23.5%	53.6%
2011	176	274	-43.1	3	77	21%	25.7%	30.6%	43.7%
2012	240	274	-10.3	2	21	6%	27.3%	7.1%	65.6%
2013	198	249	-34.5	2	49	13%	33.9%	22.4%	43.7%
2014	164	201	-43.5	3	26	7%	25.1%	20.2%	54.6%
2015	158	238	-47.1	3	64	18%	30.1%	28.4%	41.5%
2016	213	274	-48.5	3	49	13%	29.5%	19.7%	50.8%
2017	152	251	-53.7	6	65	18%	26.2%	26.8%	47.0%
2018	182	295	-45	9	91	25%	14.8%	35.0%	50.3%
2019	165	264	-64.2	5	81	22%	19.1%	39.3%	41.5%
Mean	-	-	-	-	-	-	23.1%	20.7%	56.3%
Sx	-	-	-	-	-	-	0.07	0.13	0.12

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