- Final Report -

Evaluation of wind speed measurements published by the German Meteorological Service (DWD) for the years 2004 to 2020

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1 Introduction

Sowing of seeds treated with agrochemicals is common practice in agriculture. German regulatory authorities are requesting that seeds treated with plant protection products must not be sown at average hourly wind speeds exceeding 5 m/s (at 2 m above ground) unless the environmental risk assessment indicates a large margin of safety. This label restriction, coded 'NH681-3'[1],is being issued for an increasing number of products. However, it is unclear to which extent this regulation limits the time in which treated seeds can be sown in Germany, and which limitations would arise if other wind speed thresholds would apply.

To get more information concerning prevailing wind velocities in Germany, we analysed a wind dataset publicly available from the German Meteorological Service (Deutscher Wetterdienst, DWD) to answer specifically questions on:

(1) the frequency of hours with an average hourly wind speed above a given threshold (5, 6, 7, 8, 9 or 10 m/s), during a typical farmer's working day (deliberately set to a 16 hour window from 04:00 to 20:00 UTC corresponding to 6:00 – 22:00 CEST), further on denominated "hourly endpoint"

(2) the frequency of days that have at least one hour (between 04:00 – 20:00 UTC) with an average hourly wind speed above a given threshold (5, 6, 7, 8, 9 or 10 m/s), further on denominated "daily endpoint".

[1] https://www.bvl.bund.de/SharedDocs/Fachmeldungen/04_pflanzenschutzmittel/2022/2022_06_16_Fa_Risikomanagement_Saatgutbeizen_2022.html [accessed 2023-01-12]

2 Material and methods

2.1 Preprocessing of the wind speed data

The dataset for wind speed measurements was obtained from the DWD open data platform[2]. The data on this platform is provided as one zip-file per station.

Only stations with wind data recorded between 2004 and 2020 were selected. The station's observation period was identified from the zip-file name that contains the 5-digit station ID, the 8-digit observation starting date and likewise the ending date. All stations available on the DWD open data platform (436 in total by the time this analysis was conducted) are listed in Table 6. Those stations that were excluded from further analysis based on the filename (96 in total) are indicated.

For each of the remaining stations, the following two files were extracted from the zip-files

- 'produkt_ff_stunde_yyyymmdd_yyyymmdd_xxxxx.txt'
- 'Metadaten_Geraete_Windgeschwindigkeit_xxxxx.txt'

The tables with data were linked by ID and time. In case of a missing file the respective station was excluded from further analysis (a total of 2 stations, see Table 6).

From these datasets, only endpoints recorded between 01.01.2004 and 31.12.2020 and from 04:00 to 20:00 UTC (to cover the main activity period of farmers sowing seeds) were considered; all other data points were not used. If no data were reported for this period the station was excluded from further analysis (a total of 2 stations, see Table 6).
In detail, the selection based on date and time was done based on the column "**MESS_DATUM"**, which is according to the DWD standardized to UTC (personally communication with DWD, 2022/10/10).

According to the DWD (personal communication, 2022/10/10), the wind speed for all stations in the data set is standardised to a height of 10 m above ground. Therefore, in a next step, the wind speed (column "F" in the data set) was recalculated to a height of 2 m above ground. This was done by using the logarithmic wind speed profile (Equation 1) which describes the relationship between the wind velocity and the height above ground with a roughness length of 0.1 m and a reference height of 10 m.

$$\mathrm{u}(z) = u_{\mathrm{r}} \frac{\ln(z/z_0)}{\ln(z_r/z_0)} \qquad \text{Equation 1}$$

$u(z)$:	wind speed in target height z [m/s]
u_r:	measured wind speed [m/s] in reference height z_r
z:	target height [m]
z_r:	reference height [m] for the actual wind speed
z_0:	surface roughness [m]

2.2 Analysis of the wind speed data

For the analysis,

[2] https://opendata.dwd.de/climate_environment/CDC/observations_germany/climate/hourly/wind/historical/ [accessed 2022-09-19]

- the number of hours between 04:00 and 20:00 UTC with average wind speeds above a given threshold (i.e., 5, 6, 7, 8, 9 and 10 m/s, respectively) and
- the number of days with at least one hour between 04:00 and 20:00 UTC above this threshold

were counted and further aggregated.

The data was aggregated on three different levels:

1. Aggregated to the Julian day for each station separately (supplementary data "R2260075-1-S1.zip"; results for this aggregation are not shown in this report).
2. Aggregated to half months for each station separately (supplementary data "R2260075-1-S2.zip"; results for this aggregation are not shown in this report). A half month is defined either as the first half of a month, i.e., from 1st until the 15th of each month, or as the second half month follows, i.e. from the 16th until the end of the month.
3. Aggregated to half months (see above) of all stations combined (supplementary data "R2260075-1-S3.zip").

For each of these levels of aggregation the relative frequency of hours exceeding the wind speed threshold was given. In addition, the relative frequency of the number of days on which the threshold was exceeded for at least one hour, were calculated.

Based on a proposal from the German regulatory authorities, the half-months from beginning of February to end of May (Feb.1 - May.2) and from the second half of August to end of October (Aug.2 - Oct.2) were regarded as periods where sowing of treated seeds might happen. Results for all half-month of the year are reported in the results section below, with the half-month relevant for the sowing of treated seeds highlighted in the tables.

In addition to the analysis with all available weather stations, the analysis was repeated for a subset of stations, excluding those which can reasonably be assumed to be not representative for agricultural areas (a total of 40 stations, see Table 6). The analysis was carried out by using the CORINE land cover database (Kosztra et al. 2019) where the class "arable land" (internal CLC code 2.1) was defined as being potentially relevant for sowing of treated seeds (cf. Figure 1). All other areas including urban areas, forests, permanent crops, pastures, etc. are seen not relevant.

The selection of "non relevant stations" was based on two criteria.

(a) Height above sea level: All stations above 800 m, and stations between 700 and 800 m height if visual assessment revealed no arable land in the vicinity.

(b) Coastal areas and islands: If it could be confirmed by visual assessment that no arable crops are grown in the surroundings of the station. This includes areas on islands in the North and Baltic Sea or on the coast of the mainland.

A GIS-based proximity analysis, considering the distance of a weather station from arable land, was not performed at this stage of the evaluation. Stations in locations without relevance for field crops, but not meeting criteria (a) or (b) above were therefore not excluded from the analysis (e.g. on hilltops lower than 700m in forests). Hence the exclusion criteria are regarded as conservative because average wind speeds on hilltops are normally higher than on arable fields in the neighbouring lowland.

A list of stations, indicating for which analysis they were used, can be found in the Appendix (Table 6).

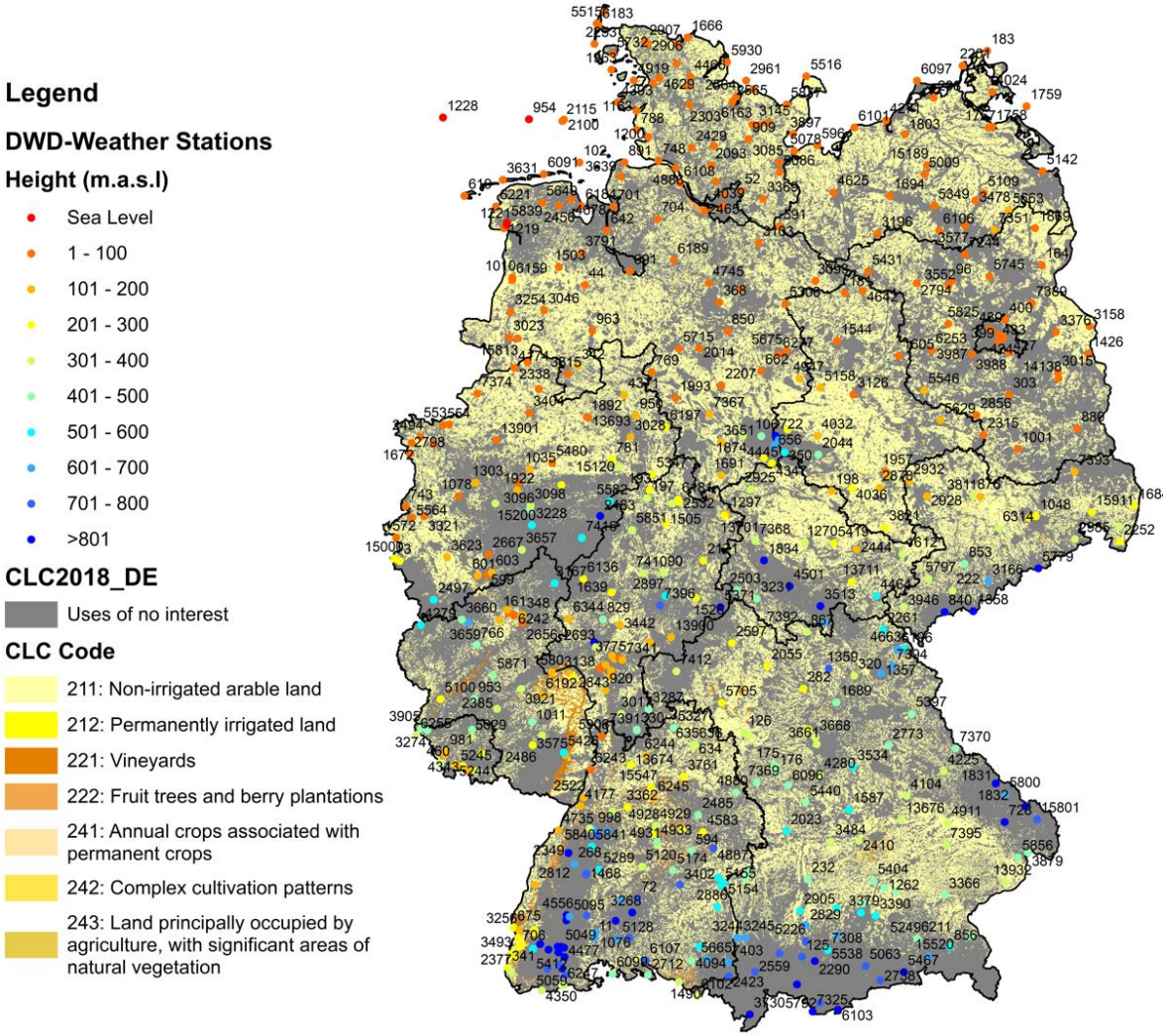

Figure 1: Visualisation of height above sea level and Corine Land Cover context for the weather stations used in the analysis.

3 Results

3.1 Results for all available weather stations

In total 336 stations were analyzed which comprised 26’472’090 hours and 1’660’977 days from 2004 until 2020 during a daytime of 4:00-20:00 UTC. Aggregation of all stations to half-months revealed generally lower relative frequencies in the summer half-year compared to the winter half-year for both the hourly and daily endpoints.

3.1.1 “Hourly endpoints”

The highest relative frequency of the hourly endpoint was 0.15 (15.1%) during the first half month of January for a threshold of 5 m/s (Figure 2, Table 1). For all thresholds there is a general trend of declining wind speeds from the beginning of the year until the first half of August - with frequencies of on average 0.05 (5%) in the summer months - that is followed by an increasing trend from August till winter. Wind speed of 6 m/s are exceeded only about half as often as wind speeds of 5 m/s, and exceedances of 7 m/s are about 3 – 4 times less frequent than of 5 m/s. Less than 0.05 (5%) of all hours have recorded wind speeds exceeding 7 m/s, and less than 0.03 (3%) exceed 8 m/s.

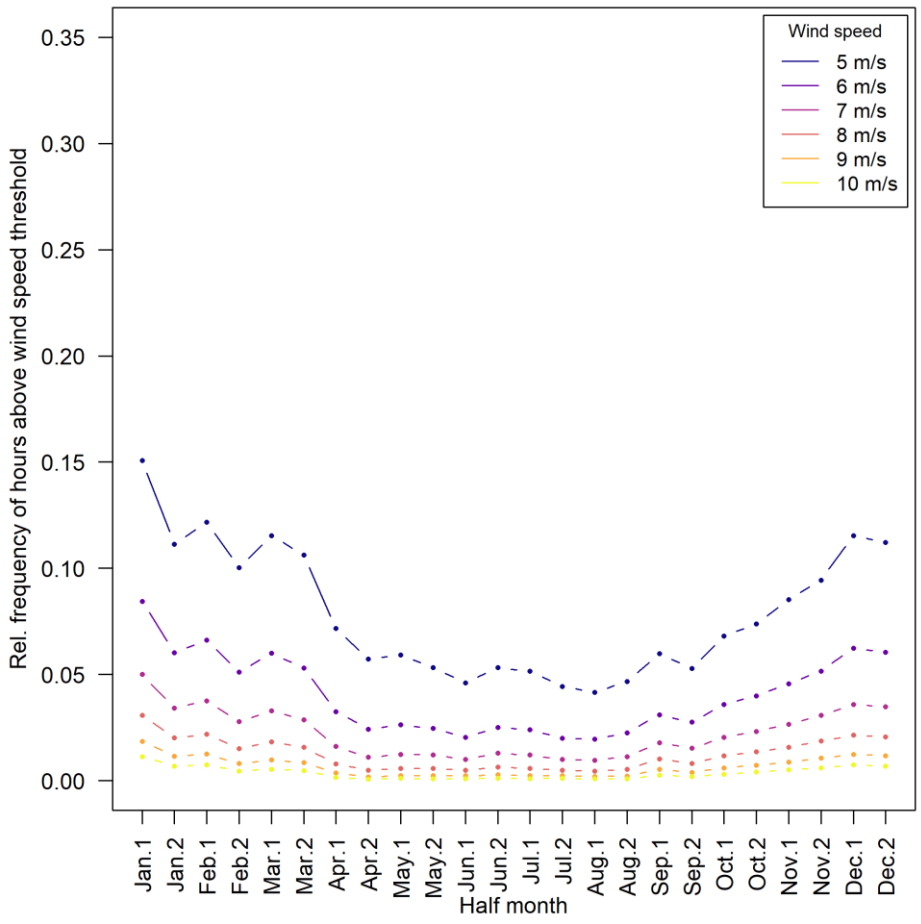

Figure 2: Relative frequencies (per half-month) of hours with an average wind speed exceeding a given threshold (5, 6, 7, 8, 9, or 10 m/s) at a height of 2 m above ground. Data for all available weather stations, combined from 2004 to 2020.

Table 1: Relative frequencies (per half-months) of hours with an average wind speed exceeding a given threshold (5, 6, 7, 8, 9, or 10 m/s) at a height of 2 m above ground. Data for all available weather stations, combined from 2004 to 2020. Half-months relevant for the sowing of treated seeds highlighted in bold.

Half month	Wind speed thresholds					
	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s
Jan.1	0.151	0.084	0.050	0.031	0.019	0.011
Jan.2	0.111	0.060	0.034	0.020	0.012	0.007
Feb.1	**0.122**	**0.066**	**0.038**	**0.022**	**0.013**	**0.007**
Feb.2	**0.100**	**0.051**	**0.028**	**0.015**	**0.008**	**0.005**
Mar.1	**0.115**	**0.060**	**0.033**	**0.018**	**0.010**	**0.005**
Mar.2	**0.106**	**0.053**	**0.029**	**0.016**	**0.009**	**0.005**
Apr.1	**0.072**	**0.033**	**0.016**	**0.008**	**0.004**	**0.002**
Apr.2	**0.057**	**0.024**	**0.011**	**0.005**	**0.002**	**0.001**
May.1	**0.059**	**0.026**	**0.012**	**0.006**	**0.002**	**0.001**
May.2	**0.053**	**0.025**	**0.012**	**0.006**	**0.002**	**0.001**
Jun.1	0.046	0.021	0.010	0.005	0.002	0.001
Jun.2	0.053	0.025	0.013	0.006	0.003	0.001
Jul.1	0.052	0.024	0.012	0.006	0.002	0.001
Jul.2	0.044	0.020	0.010	0.005	0.002	0.001
Aug.1	0.042	0.020	0.010	0.005	0.002	0.001
Aug.2	**0.047**	**0.023**	**0.011**	**0.005**	**0.002**	**0.001**
Sep.1	**0.060**	**0.031**	**0.018**	**0.010**	**0.005**	**0.003**
Sep.2	**0.053**	**0.028**	**0.015**	**0.008**	**0.004**	**0.002**
Oct.1	**0.068**	**0.036**	**0.021**	**0.012**	**0.006**	**0.003**
Oct.2	**0.074**	**0.040**	**0.023**	**0.014**	**0.007**	**0.004**
Nov.1	**0.085**	**0.046**	**0.027**	**0.016**	**0.009**	**0.005**
Nov.2	**0.094**	**0.052**	**0.031**	**0.019**	**0.011**	**0.006**
Dec.1	0.115	0.062	0.036	0.021	0.012	0.008
Dec.2	0.112	0.061	0.035	0.021	0.012	0.007
Average (whole year)	0.079	0.040	0.022	0.013	0.007	0.004
Average (sowing relevant months)	0.078	0.040	0.022	0.012	0.006	0.003

3.1.2 "Daily endpoints"

For the results based on the daily endpoint (Figure 3) the dynamics over the year are similar compared to the hourly endpoint, but overall the frequencies here are higher (around two to three times higher). This is an expected outcome as already with one single hour above the threshold a day is counted as exceedance.

For the wind speed threshold of 5 m/s the highest frequency is 0.296 (29.6%) and drops below 0.15 (15%) in the summer months (Table 2). Like for the hourly endpoint, increasing the threshold from 5 m/s to 6 m/s decreases the exceedance frequencies by about a factor of 2. Exceedances of average wind speeds > 7m/s are rare and calculated between 0.003 (0.3%) and 0.067 (6.7%).

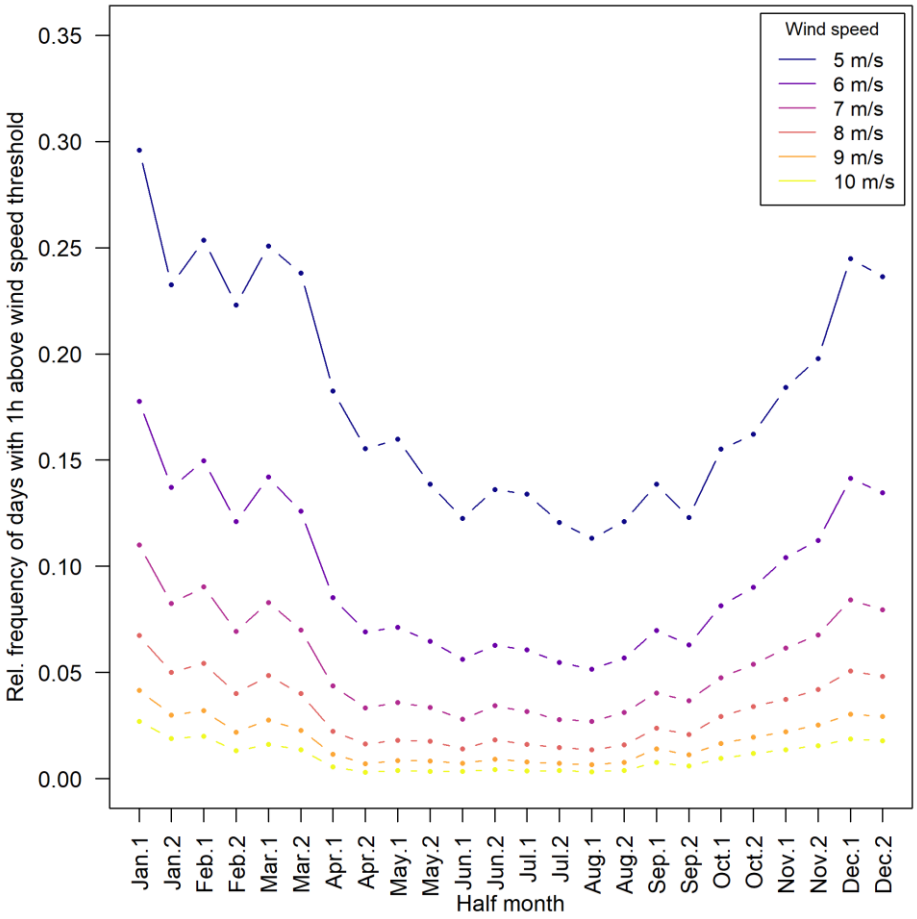

Figure 3: Relative frequencies (per half-month) of days with at least one hour with an average wind speed exceeding a given threshold (5, 6, 7, 8, 9, or 10 m/s) at a height of 2 m above ground. Data for all available weather stations, combined from 2004 to 2020.

Table 2: Relative frequencies (per half-months) of days with at least one hour with an average wind speed exceeding a given threshold (5, 6, 7, 8, 9, and 10 m/s) at a height of 2 m above ground. Data for all available weather stations, combined from 2004 to 2020. Half-months relevant for the sowing of treated seeds highlighted in bold.

Half month	Wind speed thresholds					
	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s
Jan.1	0.296	0.178	0.110	0.067	0.042	0.027
Jan.2	0.232	0.137	0.082	0.050	0.030	0.019
Feb.1	**0.254**	**0.150**	**0.090**	**0.054**	**0.032**	**0.020**
Feb.2	**0.223**	**0.121**	**0.069**	**0.040**	**0.022**	**0.013**
Mar.1	**0.251**	**0.142**	**0.083**	**0.049**	**0.028**	**0.016**
Mar.2	**0.238**	**0.126**	**0.070**	**0.040**	**0.023**	**0.014**
Apr.1	**0.182**	**0.085**	**0.044**	**0.022**	**0.012**	**0.006**
Apr.2	**0.155**	**0.069**	**0.033**	**0.016**	**0.007**	**0.003**
May.1	**0.160**	**0.071**	**0.036**	**0.018**	**0.009**	**0.004**
May.2	**0.139**	**0.065**	**0.034**	**0.018**	**0.008**	**0.003**
Jun.1	0.123	0.056	0.028	0.014	0.007	0.003
Jun.2	0.136	0.063	0.034	0.018	0.009	0.004
Jul.1	0.134	0.061	0.032	0.016	0.008	0.004
Jul.2	0.121	0.055	0.028	0.015	0.007	0.004
Aug.1	0.113	0.052	0.027	0.014	0.007	0.003
Aug.2	**0.121**	**0.057**	**0.031**	**0.016**	**0.008**	**0.004**
Sep.1	**0.139**	**0.070**	**0.040**	**0.024**	**0.014**	**0.008**
Sep.2	**0.123**	**0.063**	**0.037**	**0.021**	**0.011**	**0.006**
Oct.1	**0.155**	**0.081**	**0.048**	**0.029**	**0.017**	**0.010**
Oct.2	**0.162**	**0.090**	**0.054**	**0.034**	**0.020**	**0.012**
Nov.1	**0.184**	**0.104**	**0.061**	**0.037**	**0.022**	**0.014**
Nov.2	**0.198**	**0.112**	**0.068**	**0.042**	**0.025**	**0.016**
Dec.1	0.245	0.141	0.084	0.051	0.030	0.019
Dec.2	0.236	0.135	0.080	0.048	0.029	0.018
Average (whole year)	0.180	0.095	0.054	0.031	0.018	0.010
Average (sowing relevant months)	0.179	0.094	0.053	0.031	0.017	0.010

3.2 Results for weather stations representative for arable areas

In total 296 weather stations were selected as being representative for arable areas. These stations comprised 23’271’018 hours and 1’459’520 days from 2004 until 2020 during a daytime of 4-20 UTC. Aggregation of arable land representative stations to half-month revealed generally lower relative frequencies throughout the year compared to the analysis including all stations. Nevertheless, the yearly dynamics of the relative frequencies at the arable land representative stations is very similar to the analysis for all stations.

3.2.1 “Hourly endpoints”

The highest frequency for the hourly endpoint was detected in the first half of January, which is 0.117 (11.7%; Figure 4, Table 3). This is followed by a decline to about 0.3 (3%) in the summer months. Likewise, as for all stations, the higher the wind speed threshold the lower the relative frequencies.

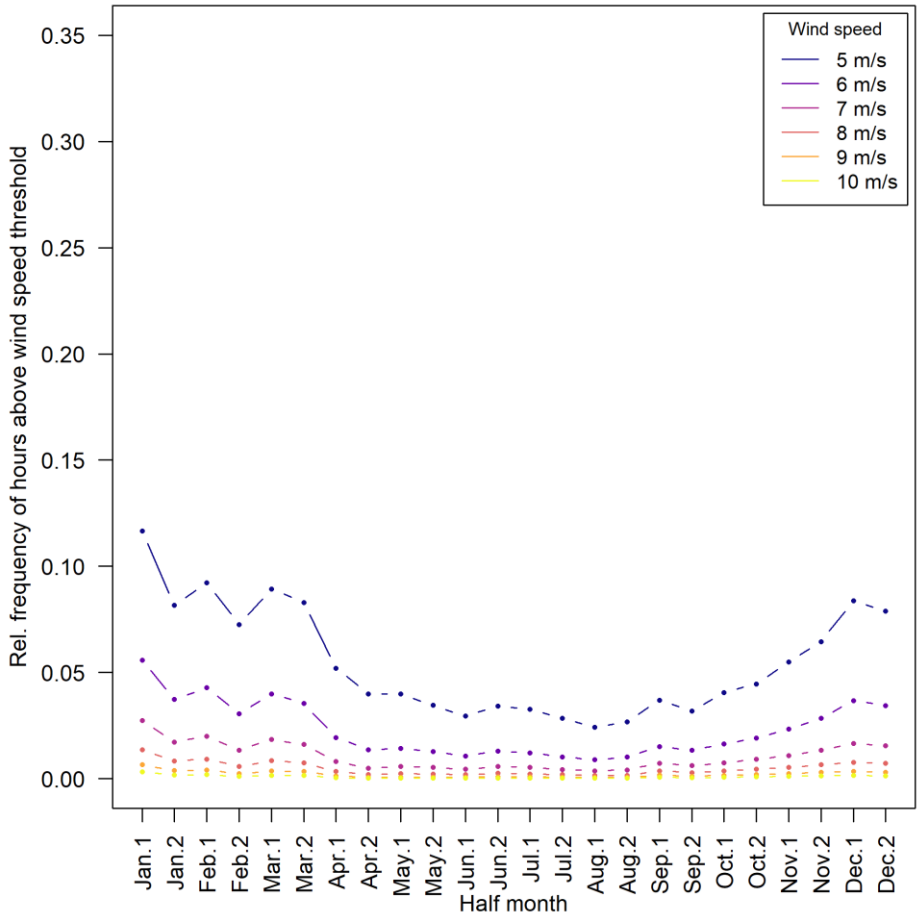

Figure 4: Relative frequencies (per half-month) of hours with an average wind speed exceeding a given threshold (5, 6, 7, 8, 9, or 10 m/s) at a height of 2 m above ground. Data for weather stations representative for arable areas only, combined from 2004 to 2020.

Table 3: Relative frequencies (per half-months) of hours with an average wind speed exceeding a given threshold (5, 6, 7, 8, 9, and 10 m/s) at a height of 2 m above ground. Data for the arable land relevant stations, combined from 2004 to 2020. Half-months relevant for the sowing of treated seeds highlighted in bold.

Half month	Wind speed thresholds					
	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s
Jan.1	0.117	0.056	0.027	0.014	0.007	0.003
Jan.2	0.082	0.037	0.017	0.008	0.004	0.002
Feb.1	**0.092**	**0.043**	**0.020**	**0.009**	**0.004**	**0.002**
Feb.2	**0.073**	**0.031**	**0.013**	**0.006**	**0.002**	**0.001**
Mar.1	**0.089**	**0.040**	**0.019**	**0.008**	**0.004**	**0.002**
Mar.2	**0.083**	**0.036**	**0.016**	**0.007**	**0.003**	**0.002**
Apr.1	**0.052**	**0.019**	**0.008**	**0.003**	**0.001**	**0.001**
Apr.2	**0.040**	**0.014**	**0.005**	**0.002**	**0.001**	**<0.001**
May.1	**0.040**	**0.014**	**0.006**	**0.002**	**0.001**	**<0.001**
May.2	**0.035**	**0.013**	**0.005**	**0.002**	**0.001**	**<0.001**
Jun.1	0.030	0.011	0.004	0.002	0.001	<0.001
Jun.2	0.034	0.013	0.006	0.003	0.001	<0.001
Jul.1	0.033	0.012	0.005	0.002	0.001	<0.001
Jul.2	0.028	0.010	0.004	0.002	0.001	<0.001
Aug.1	0.024	0.009	0.004	0.002	0.001	<0.001
Aug.2	**0.027**	**0.010**	**0.004**	**0.002**	**0.001**	**<0.001**
Sep.1	**0.037**	**0.015**	**0.007**	**0.004**	**0.002**	**0.001**
Sep.2	**0.032**	**0.013**	**0.006**	**0.003**	**0.001**	**<0.001**
Oct.1	**0.041**	**0.016**	**0.008**	**0.004**	**0.002**	**0.001**
Oct.2	**0.045**	**0.019**	**0.009**	**0.005**	**0.002**	**0.001**
Nov.1	**0.055**	**0.023**	**0.011**	**0.005**	**0.002**	**0.001**
Nov.2	**0.065**	**0.028**	**0.013**	**0.007**	**0.003**	**0.001**
Dec.1	0.084	0.037	0.017	0.008	0.003	0.002
Dec.2	0.079	0.034	0.016	0.007	0.003	0.001
Average (whole year)	0.055	0.023	0.010	0.005	0.002	0.002
Average (sowing relevant months)	0.054	0.022	0.010	0.005	0.002	0.001

3.2.2 "Daily endpoints"

Also for the stations that are representative for arable land, the dynamics of the results of the daily endpoint over the year is similar to the dynamics for the hourly endpoint. The highest relative frequency of the daily endpoint for a threshold of 5 m/s was 0.257 (25.7%) during the first half month of January (Table 4) and declined to about 0.09 (9%) of the summer months (Figure 5).

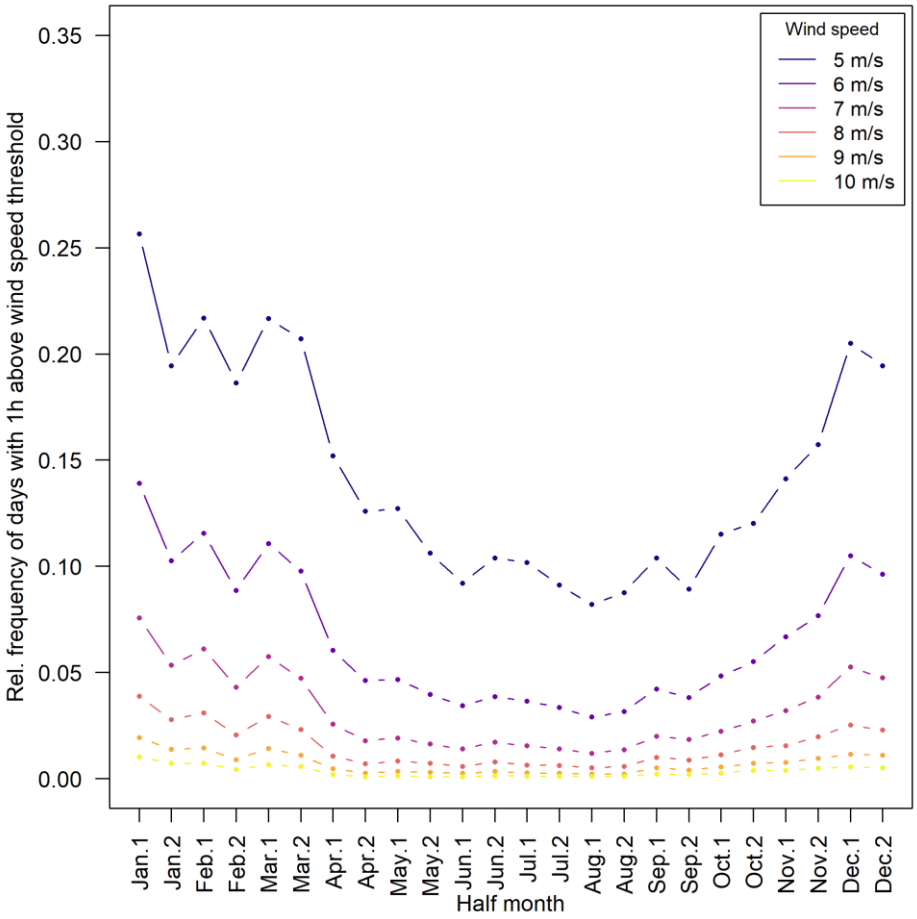

Figure 5: Relative frequencies (per half-month) of days with at least one hour with an average wind speed exceeding a given threshold (5, 6, 7, 8, 9, or 10 m/s) at a height of 2 m above ground. Data for weather stations representative for arable areas only, combined from 2004 to 2020.

Table 4: Relative frequencies (per half-months) of days with an average wind speed exceeding a given threshold (5, 6, 7, 8, 9, or 10 m/s) at a height of 2 m above ground. Data for the weather stations representative for arable areas, combined from 2004 to 2020. Half-months relevant for the sowing of treated seeds highlighted in bold.

Half month	Wind speed thresholds					
	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s
Jan.1	0.257	0.139	0.076	0.039	0.019	0.010
Jan.2	0.194	0.103	0.054	0.028	0.014	0.007
Feb.1	**0.217**	**0.116**	**0.061**	**0.031**	**0.015**	**0.007**
Feb.2	**0.186**	**0.089**	**0.043**	**0.021**	**0.009**	**0.004**
Mar.1	**0.217**	**0.111**	**0.058**	**0.029**	**0.014**	**0.007**
Mar.2	**0.207**	**0.098**	**0.047**	**0.023**	**0.011**	**0.006**
Apr.1	**0.152**	**0.060**	**0.026**	**0.011**	**0.005**	**0.002**
Apr.2	**0.126**	**0.046**	**0.018**	**0.007**	**0.003**	**0.001**
May.1	**0.127**	**0.047**	**0.019**	**0.008**	**0.003**	**0.001**
May.2	**0.106**	**0.040**	**0.016**	**0.007**	**0.003**	**0.001**
Jun.1	0.092	0.035	0.014	0.006	0.003	0.001
Jun.2	0.104	0.039	0.017	0.008	0.003	0.001
Jul.1	0.102	0.036	0.015	0.007	0.003	0.001
Jul.2	0.091	0.034	0.014	0.006	0.003	0.001
Aug.1	0.082	0.029	0.012	0.005	0.002	0.001
Aug.2	**0.088**	**0.032**	**0.014**	**0.006**	**0.002**	**0.001**
Sep.1	**0.104**	**0.042**	**0.020**	**0.010**	**0.005**	**0.002**
Sep.2	**0.089**	**0.038**	**0.019**	**0.009**	**0.004**	**0.002**
Oct.1	**0.115**	**0.048**	**0.022**	**0.011**	**0.006**	**0.003**
Oct.2	**0.120**	**0.055**	**0.027**	**0.015**	**0.007**	**0.004**
Nov.1	**0.141**	**0.067**	**0.032**	**0.016**	**0.008**	**0.004**
Nov.2	**0.157**	**0.077**	**0.039**	**0.020**	**0.010**	**0.005**
Dec.1	0.205	0.105	0.053	0.025	0.012	0.006
Dec.2	0.194	0.096	0.047	0.023	0.011	0.005
Average (whole year)	0.145	0.066	0.032	0.015	0.007	0.003
Average (sowing relevant months)	0.143	0.064	0.031	0.015	0.007	0.003

4 Conclusion

Overall, the results show that the highest wind speeds occur during the winter months, when treated seeds are normally not sown. Of those half-months in which sowing of treated seeds is relevant, Feb.1 is the worst case. A summary of the highest threshold exceedance rates during the half-months relevant for the sowing of treated seeds is shown in Table 5 below.

Table 5: Maximum relative frequencies of hours or days (with at least one hour) exceeding a given hourly average wind speed threshold, during the half-months relevant for sowing of treated seeds (Feb.1 - May.2, Aug.2 - Nov.2). Worst case half month was Feb.1 for all scenarios.

Wind speed threshold (2 m above ground)	5 m/s	6 m/s	7 m/s	8 m/s	9 m/s	10 m/s
Maximum relative frequency of hours above threshold, all stations	0.122	0.066	0.038	0.022	0.013	0.007
Maximum relative frequency of days above threshold, all stations	0.254	0.150	0.090	0.054	0.032	0.020
Maximum relative frequency of hours above threshold, arable land relevant stations only	0.092	0.043	0.020	0.009	0.004	0.002
Maximum relative frequency of days above threshold, arable land relevant stations only	0.217	0.116	0.061	0.031	0.015	0.007

Regarding arable land relevant stations, the worst-case half-month (1st half of February) shows average hourly wind speeds above 5 m/s in slightly less than 10% of a farmer's typical working hours (deliberately set to 04:00 – 20:00 UTC). In the same period, 21.7% of the days have at least one hour with an average wind speed above 5 m/s, which already triggers sowing restrictions for the farmer according to the current regulation. For a threshold of 7 m/s, 2% of hours or 6% of days would be affected. For a threshold of 10 m/s only 0.2% of hours of 0.7% of days would be affected.

For any half-month, relative frequencies of wind speeds are higher for all stations than for the subset of arable land relevant stations only. This indicates the necessity of reflecting topography and land-use in the selection of relevant stations in analyses of wind speed measures. Specifically, as seeds treated with agrochemicals will only be sown in areas of arable use, only stations that are representative for such areas should be considered for the assessment of the risk associated with the sowing of treated seeds.

5 References

Kosztra, B., Büttner, G., Hazeu, G., Arnold, S. (2019) Updated CLC illustrated nomenclature guidelines. Service Contract No 3436/R0-Copernicus/EEA.57441 Task 3, D3.1 – Part 1. https://land.copernicus.eu/user-corner/technical-library/corine-land-cover-nomenclature-guidelines/docs/pdf/CLC2018_Nomenclature_illustrated_guide_20190510.pdf

6 Appendix

6.1 Overview table of used weather stations

Table 6: Overview of the weather stations. It is indicated if and for which analysis the stations are included. If stations were excluded from the analysis the reason of exclusion is specified.

Station ID	Used for the analysis with all weather stations	Used for the analysis with only weather stations in areas an arable surrounding	Comment
00003	x	x	
00011	x	x	
00044			excluded based on filename; outside time period
00052			excluded based on filename; outside time period
00072			excluded based on filename; outside time period
00090	x	x	
00096	x	x	
00102	x		weather station at island or coastal area and visually checked to be not relevant for field crops
00125	x	x	
00126	x	x	
00161	x	x	
00164	x	x	
00175			excluded based on filename; outside time period
00181			excluded since metadate file was missing from the zip-file
00183	x	x	
00193			excluded based on filename; outside time period
00197	x	x	
00198	x	x	
00222	x	x	
00232	x	x	
00259			excluded based on filename; outside time period
00282	x	x	
00298	x	x	
00303	x	x	
00320			excluded based on filename; outside time period
00330	x	x	
00342	x	x	
00348	x	x	
00368	x	x	
00399	x	x	
00400			excluded based on filename; outside time period
00424			excluded based on filename; outside time period

Table 6 (continued): Overview of the weather stations. It is indicated if and for which analysis the stations are included. If stations were excluded from the analysis the reason of exclusion is specified.

Station ID	Used for the analysis with all weather stations	Used for the analysis with only weather stations in arable areas	Comment
00427	x	x	
00430	x	x	
00433	x	x	
00460	x	x	
00553			excluded based on filename; outside time period
00554	x	x	
00591	x	x	
00596	x	x	
00599			excluded based on filename; outside time period
00603	x	x	
00619	x	x	
00642	x	x	
00656	x	x	
00662	x	x	
00691	x	x	
00701	x		weather station at island or coastal area and visually checked to be not relevant for field crops
00704	x	x	
00706			excluded based on filename; outside time period
00722	x		weather station at more than 800 m height and therefore not relevant for field crops
00766	x	x	
00769	x	x	
00788	x	x	
00840	x		weather station at more than 800 m height and therefore not relevant for field crops
00850	x	x	
00853	x	x	
00856	x	x	
00867	x	x	
00876			excluded based on filename; outside time period
00880	x	x	
00891	x		weather station at island or coastal area and visually checked to be not relevant for field crops
00953	x	x	
00954	x		weather station at island or coastal area and visually checked to be not relevant for field crops
00963	x	x	
00998			excluded since wind speed measurements were only available until end of 1951
01001	x	x	
01010	x	x	

Table 6 (continued): Overview of the weather stations. It is indicated if and for which analysis the stations are included. If stations were excluded from the analysis the reason of exclusion is specified.

Station ID	Used for the analysis with all weather stations	Used for the analysis with only weather stations in arable areas	Comment
01011	x	x	
01013	x	x	
01048	x	x	
01078	x	x	
01130	x	x	
01200	x	x	
01219			excluded based on filename; outside time period
01221			excluded based on filename; outside time period
01228	x		weather station at island or coastal area and visually checked to be not relevant for field crops
01261			excluded based on filename; outside time period
01262	x	x	
01270	x	x	
01297			excluded based on filename; outside time period
01303	x	x	
01339	x	x	
01346	x		weather station at more than 800 m height and therefore not relevant for field crops
01357	x	x	
01358	x		weather station at more than 800 m height and therefore not relevant for field crops
01359			excluded based on filename; outside time period
01379	x	x	
01415			excluded based on filename; outside time period
01416			excluded based on filename; outside time period
01420	x	x	
01422			excluded based on filename; outside time period
01423			excluded based on filename; outside time period
01425			excluded based on filename; outside time period
01426			excluded based on filename; outside time period
01443	x	x	
01468	x		weather station at more than 700 m height and visually checked to be not relevant for field crops
01490	x	x	
01503	x	x	
01505	x	x	
01515			excluded based on filename; outside time period
01526			excluded based on filename; outside time period
01544	x	x	
01550	x		weather station at more than 700 m height and visually checked to be not relevant for field crops
01580	x	x	

Table 6 (continued): Overview of the weather stations. It is indicated if and for which analysis the stations are included. If stations were excluded from the analysis the reason of exclusion is specified.

Station ID	Used for the analysis with all weather stations	Used for the analysis with only weather stations in arable areas	Comment
01587	x	x	
01605	x	x	
01612	x	x	
01639	x	x	
01666	x	x	
01684	x	x	
01689			excluded based on filename; outside time period
01691	x	x	
01694	x	x	
01757	x	x	
01758			excluded based on filename; outside time period
01759	x		weather station at island or coastal area and visually checked to be not relevant for field crops
01766	x	x	
01803	x	x	
01831	x		weather station at more than 800 m height and therefore not relevant for field crops
01832	x		weather station at more than 800 m height and therefore not relevant for field crops
01834			excluded based on filename; outside time period
01869	x	x	
01886	x	x	
01920			excluded based on filename; outside time period
01957	x	x	
01960			excluded based on filename; outside time period
01963	x		weather station at island or coastal area and visually checked to be not relevant for field crops
01975	x	x	
01987			excluded based on filename; outside time period
01993	x	x	
02014	x	x	
02023	x	x	
02044	x	x	
02055	x	x	
02093			excluded based on filename; outside time period
02100	x		weather station at island or coastal area and visually checked to be not relevant for field crops
02115	x		weather station at island or coastal area and visually checked to be not relevant for field crops
02166			excluded based on filename; outside time period
02171	x	x	
02201			excluded based on filename; outside time period

Table 6 (continued): Overview of the weather stations. It is indicated if and for which analysis the stations are included. If stations were excluded from the analysis the reason of exclusion is specified.

Station ID	Used for the analysis with all weather stations	Used for the analysis with only weather stations in arable areas	Comment
02207			excluded based on filename; outside time period
02252	x	x	
02253			excluded based on filename; outside time period
02261	x	x	
02290	x		weather station at more than 800 m height and therefore not relevant for field crops
02303	x	x	
02315	x	x	
02338	x	x	
02349	x		weather station at more than 800 m height and therefore not relevant for field crops
02374			excluded based on filename; outside time period
02377	x	x	
02385	x	x	
02410	x	x	
02429	x	x	
02437	x	x	
02444			excluded based on filename; outside time period
02456	x	x	
02465			excluded based on filename; outside time period
02482			excluded based on filename; outside time period
02483	x		weather station at more than 800 m height and therefore not relevant for field crops
02485	x	x	
02486			excluded based on filename; outside time period
02494	x	x	
02497	x	x	
02503			excluded based on filename; outside time period
02522	x	x	
02532	x	x	
02559	x		weather station at more than 700 m height and visually checked to be not relevant for field crops
02564	x	x	
02565			excluded based on filename; outside time period
02573	x	x	
02597	x	x	
02601	x		weather station at more than 800 m height and therefore not relevant for field crops
02638	x		weather station at more than 800 m height and therefore not relevant for field crops
02656			excluded based on filename; outside time period
02667	x	x	

Table 6 (continued): Overview of the weather stations. It is indicated if and for which analysis the stations are included. If stations were excluded from the analysis the reason of exclusion is specified.

Station ID	Used for the analysis with all weather stations	Used for the analysis with only weather stations in arable areas	Comment
02712	x	x	
02773	x	x	
02794	x	x	
02812	x	x	
02829	x	x	
02856	x	x	
02878	x	x	
02886	x	x	
02897	x	x	
02905	x	x	
02907	x	x	
02925	x	x	
02926			excluded based on filename; outside time period
02928	x	x	
02932	x	x	
02961	x		weather station at island or coastal area and visually checked to be not relevant for field crops
02985	x	x	
03015	x	x	
03023	x	x	
03028	x	x	
03032	x		weather station at island or coastal area and visually checked to be not relevant for field crops
03046			excluded based on filename; outside time period
03085			excluded based on filename; outside time period
03086	x	x	
03093	x	x	
03096			excluded based on filename; outside time period
03098	x	x	
03103			excluded based on filename; outside time period
03126	x	x	
03158	x	x	
03166	x	x	
03167	x	x	
03196	x	x	
03228			excluded based on filename; outside time period
03231	x	x	
03244	x	x	
03245			excluded based on filename; outside time period
03246	x	x	

Table 6 (continued): Overview of the weather stations. It is indicated if and for which analysis the stations are included. If stations were excluded from the analysis the reason of exclusion is specified.

Station ID	Used for the analysis with all weather stations	Used for the analysis with only weather stations in arable areas	Comment
03254	x	x	
03256			excluded based on filename; outside time period
03268	x		weather station at more than 800 m height and therefore not relevant for field crops
03274			excluded based on filename; outside time period
03287	x	x	
03300			excluded based on filename; outside time period
03321	x	x	
03362	x	x	
03366	x	x	
03369	x	x	
03376	x	x	
03379	x	x	
03390			excluded based on filename; outside time period
03402	x	x	
03404			excluded based on filename; outside time period
03442			excluded based on filename; outside time period
03478	x	x	
03484	x	x	
03513	x		weather station at more than 800 m height and therefore not relevant for field crops
03518			excluded based on filename; outside time period
03534	x	x	
03552	x	x	
03575			excluded based on filename; outside time period
03577			excluded based on filename; outside time period
03623	x	x	
03631	x	x	
03639	x	x	
03651	x	x	
03657	x	x	
03659			excluded based on filename; outside time period
03660	x	x	
03661			excluded based on filename; outside time period
03668	x	x	
03730	x		weather station at more than 800 m height and therefore not relevant for field crops
03761	x	x	
03775			excluded based on filename; outside time period
03791	x	x	
03811	x	x	

Table 6 (continued): Overview of the weather stations. It is indicated if and for which analysis the stations are included. If stations were excluded from the analysis the reason of exclusion is specified.

Station ID	Used for the analysis with all weather stations	Used for the analysis with only weather stations in arable areas	Comment
03815	x	x	
03821	x	x	
03879			excluded based on filename; outside time period
03897	x	x	
03905	x	x	
03921			excluded based on filename; outside time period
03925	x	x	
03946	x	x	
03954			excluded based on filename; outside time period
03987	x	x	
03988			excluded based on filename; outside time period
04024	x	x	
04032	x	x	
04036	x	x	
04039	x	x	
04094	x	x	
04104	x	x	
04174	x	x	
04177	x	x	
04225	x	x	
04271	x	x	
04279	x	x	
04280	x	x	
04336	x	x	
04371	x	x	
04393	x	x	
04445			excluded based on filename; outside time period
04464	x	x	
04466	x	x	
04477	x		weather station at more than 800 m height and therefore not relevant for field crops
04501	x		weather station at more than 800 m height and therefore not relevant for field crops
04549			excluded based on filename; outside time period
04583	x	x	
04625	x	x	
04629			excluded based on filename; outside time period
04642	x	x	
04663	x	x	
04665			excluded based on filename; outside time period

Table 6 (continued): Overview of the weather stations. It is indicated if and for which analysis the stations are included. If stations were excluded from the analysis the reason of exclusion is specified.

Station ID	Used for the analysis with all weather stations	Used for the analysis with only weather stations in arable areas	Comment
04678			excluded based on filename; outside time period
04745	x	x	
04752	x	x	
04880	x	x	
04887	x	x	
04911	x	x	
04919	x	x	
04927			excluded based on filename; outside time period
04928	x	x	
04929			excluded based on filename; outside time period
04931	x	x	
04933			excluded based on filename; outside time period
04947	x	x	
05009	x	x	
05029	x	x	
05049			excluded since metadata were not available for the time period
05063			excluded based on filename; outside time period
05078	x	x	
05100	x	x	
05109	x	x	
05120			excluded based on filename; outside time period
05128			excluded based on filename; outside time period
05142	x		weather station at island or coastal area and visually checked to be not relevant for field crops
05154			excluded based on filename; outside time period
05155	x	x	
05158	x	x	
05226			excluded based on filename; outside time period
05244			excluded based on filename; outside time period
05249			excluded based on filename; outside time period
05282			excluded based on filename; outside time period
05289	x	x	
05306			excluded based on filename; outside time period
05319	x	x	
05327	x	x	
05347	x	x	
05349	x	x	
05371	x		weather station at more than 800 m height and therefore not relevant for field crops
05397	x	x	

Table 6 (continued): Overview of the weather stations. It is indicated if and for which analysis the stations are included. If stations were excluded from the analysis the reason of exclusion is specified.

Station ID	Used for the analysis with all weather stations	Used for the analysis with only weather stations in arable areas	Comment
05404	x	x	
05412	x	x	
05419	x	x	
05426	x	x	
05431			excluded based on filename; outside time period
05440	x	x	
05467	x		weather station at more than 800 m height and therefore not relevant for field crops
05480	x	x	
05490	x	x	
05516	x	x	
05538	x	x	
05546	x	x	
05629	x	x	
05640	x	x	
05663			excluded based on filename; outside time period
05665	x	x	
05675			excluded based on filename; outside time period
05705	x	x	
05715	x	x	
05732			excluded based on filename; outside time period
05745			excluded based on filename; outside time period
05779	x		weather station at more than 800 m height and therefore not relevant for field crops
05792	x		weather station at more than 800 m height and therefore not relevant for field crops
05797	x	x	
05800	x	x	
05825	x	x	
05839	x	x	
05851	x	x	
05856	x	x	
05871	x	x	
05877	x	x	
05906	x	x	
05930	x	x	
06091	x		weather station at island or coastal area and visually checked to be not relevant for field crops
06096	x	x	
06097	x	x	
06098	x	x	

Table 6 (continued): Overview of the weather stations. It is indicated if and for which analysis the stations are included. If stations were excluded from the analysis the reason of exclusion is specified.

Station ID	Used for the analysis with all weather stations	Used for the analysis with only weather stations in arable areas	Comment
06099	x	x	
06101	x	x	
06102	x	x	
06103	x		weather station at more than 800 m height and therefore not relevant for field crops
06106	x	x	
06107	x	x	
06108	x	x	
06136			excluded based on filename; outside time period
06159	x	x	
06163	x	x	
06184			excluded based on filename; outside time period
06189			excluded based on filename; outside time period
06196	x	x	
06197	x	x	
06211	x	x	
06221			excluded based on filename; outside time period
06238	x	x	
06253	x	x	
06277			excluded based on filename; outside time period
06314	x	x	
06344	x	x	
07244	x	x	
07308	x	x	
07341	x	x	
07351	x	x	
07367	x	x	
07368	x	x	
07369	x	x	
07370	x	x	
07374	x	x	
07389	x	x	
07391	x	x	
07392	x	x	
07393	x	x	
07394	x	x	
07395	x	x	
07396	x		weather station at more than 700 m height and visually checked to be not relevant for field crops
07403	x	x	

Table 6 (continued): Overview of the weather stations. It is indicated if and for which analysis the stations are included. If stations were excluded from the analysis the reason of exclusion is specified.

Station ID	Used for the analysis with all weather stations	Used for the analysis with only weather stations in arable areas	Comment
07410	x	x	
07412	x	x	
07416	x	x	
10510	x	x	
13674	x	x	
13676	x	x	
13693	x	x	
13701	x	x	
13711	x	x	
13900	x	x	
13901	x	x	
13932	x	x	
13952	x	x	
13965	x	x	
14003			excluded based on filename; outside time period
15000	x	x	
15044	x	x	
15120	x	x	
15122	x	x	
15189	x	x	
15190	x	x	
15200	x	x	
15207	x	x	
15214	x		weather station at more than 800 m height and therefore not relevant for field crops
15444	x	x	
15520	x	x	
15547	x	x	
15801	x		weather station at more than 700 m height and visually checked to be not relevant for field crops
15911			excluded since wind speed measurements were not available for the time period
15976	x	x	
15978	x	x	
19171	x	x	