Climate and soil input data aggregation effects in crop models

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Abstract: This dataset contains interpolated and aggregated soil and climate data of the region of North Rhine-Westphalia (Germany). The data is provided for grids of 1, 10, 25, 50 and 100 km resolutions. These data grids represent spatial aggregations of the climate of approximately 1 km resolution and soil data of approximately 300 m resolution raster. The purpose of this data is the use as input for crop models. It thus contains the key relevant soil and climate variables for running crop models. Additionally, the data is specifically designed to analyze effects of scale and resolution in crop models, e.g. data aggregation effects. It has been used for several studies on spatial scales with regard to different scaling approaches, crops, crop models, model output variables, production situations and crop management among others.

Keywords: Aggregation effects, climate, crop simulation, input data, model comparison, soil, scaling

1 PURPOSE: The purpose of this data is the use as input for crop models. Furthermore, the data is designed explicitly to assess spatial aggregation effects due to the spatial aggregation of crop models input data (Hoffmann et al., 2015; 2016; Zhao et al., 2015a,b) as well as to investigate sampling approaches for upscaling (Van Bussel et al., 2016; Zhao et al., 2016). These studies are part of the scaling activities (http://www.scale-it.net) of the “Modelling European Agriculture with Climate Change for Food Security” (MACSUR) project (http://www.macsur.eu) and the Agricultural Model Intercomparison and Improvement project (http://www.agmip.org/).

2 DATA PROCESSING AND GRIDS:

2.1 Climate data: Daily minimum, mean and maximum air temperature (2 m above ground), precipitation, global radiation, wind speed and relative humidity from 280 weather stations were retrieved from the German Meteorological Service, for the period 01/01/1982 until 31-01-2012. With respect to these data, the following reference and links are relevant:

– Rauthe et al., 2013
– https://opendata.dwd.de/climate_environment/CDC/grids_germany/daily
– https://opendata.dwd.de/climate_environment/CDC/Terms_of_use.pdf.

The weather data were combined with an interpolated grid of 1 km resolution of monthly time series in order to obtain daily time series of climate data at 1 km resolution as described in detail by Zhao et al. (2015b). Climate properties at 1 km resolution for the different resolutions are given by Hoffmann et al. (2015). The daily climate data in spatial resolution of 1 km were then spatially averaged for four different coarser grid sizes of 10, 25, 50 and 100 km (see Hoffmann et al. 2015 for equations). Coarser grids were aggregated starting in the north-west corner of the study region. The climate data has been used in the studies of Hoffmann et al., 2015; 2016; Zhao et al., 2015a,b, 2016 as well as Van Bussel et al., 2016, providing further information and illustrations.

2.2 Soil data: The vector map of soil distribution published by the Geological Service NRW (2015), was converted into a 300 m raster map by selecting the dominant soil type. This map was then again aggregated by selecting the dominant soil type within each grid cell of the coarser resolution to a 1 km raster map. A dominant soil type was chosen by selecting the mapping unit of the largest area coverage (area majority) within the grid cell of the coarser resolution. The main soil types and properties across resolutions are shown by Hoffmann et al., 2016. Soil profile data with their physical parameters were then joined to 1 km raster cells (Angulo et al., 2014; AG-Boden, 2005).
Further soil parameters were obtained as follows: 1) Topsoil organic carbon and pH were taken from the database FIS StoBo (LANUV, 2014); 2) Organic carbon and C:N-ratio of deeper soil layer was approximated using pedotransfer functions (Angulo et al., 2014; AG-Boden, 2005); 3) Top soil layer C:N-ratio was set to 10; 4) Volumetric gravel content and gravel content corrected bulk density were

approximated following Poesen & Lavee (1994) and Torri et al. (1994); 5) Soil surface albedo was estimated from soil organic carbon as described by Hoffmann et al., 2016 (S1 File, eq. 1). Data were spatially further aggregated in order to obtain grids of 10, 25, 50 and 100 km resolution. The soil data has been used in the studies of Hoffmann et al., 2016 and Zhao et al., 2016, providing further information and illustrations.

2.3 Grids: The grids contain the number of cells as given in Table 1.

Table 1. Grids.

Resolution [km]	Number of gridcells
1	34168
10	410
25	80
50	24
100	9
Total	34691

3 DATASET: The dataset is provided as csv-files (https://tools.ietf.org/html/rfc4180) in folders compressed to gzip format (http://www.gnu.org/software/gzip/).

3.1 Climate data. The climate data is provided as csv-file per gridcell (appendix, Table 1). Files are named as follows: 'RES<res>_C<col>R<row>.csv', where <res>,<col> and <row> are the corresponding resolution, column and row of a given grid. Each file contains the variables given in Table 2. The climate data is accompanied by the file 'NRW_Climate_Metadata.csv' containing all metadata.

Table 2. Climate data.

Column	Output variable	Abbreviation	Unit
1	Date	Date	YYYY-MM-DD
2	Daily minimum air temperature (2 m aboveground)	TempMin	°C
3	Daily mean air temperature (2 m aboveground)	TempMean	°C
4	Daily maximum air temperature (2 m aboveground)	TempMax	°C
5	Global radiation sum	Radiation	kJ m^{-2} d^{-1}
6	Daily mean windspeed (2 m aboveground)	Windspeed	m s^{-1}
7	Daily mean relative air humidity	RH	%
8	Precipitation sum	Precipitation	mm d^{-1}

3.2 Soil data. The soil data is provided as a single gzipped csv-file ('NRW_soil.csv.gz'). Variables and units are given in the appendix, Table 3.

Table 3. Soil data.

Column	Output variable	Abbreviation	Unit	Remark
1	Resolution	res	km	
2	ID	id	-	Identifier
3	ProjectID	ProjectID	-	Identifier
4	COLUMN	Column	-	Grid column
5	ROW	Row	-	Grid row
6	Layer	TotalLayer	-	No. of layers in profile
7	Layer	Layer	-	
8	Depth	Depth	m	At lower edge of soil layer
9	Thickness	Thickness	m	
10	Air dryness[a]	WCAD	m^3 m^{-3}	Assumed to be 0.5*WCWP
11	Wilting point[a]	WCWP	m^3 m^{-3}	pF 4.2, 15 bar

Table 3. Soil data (Continued)

Column	Output variable	Abbreviation	Unit	Remark
12	Field capacity[a]	WCFC	$m^3 m^{-3}$	pF 2.5, 0.33 bar
13	Saturation[a]	WCST	$m^3 m^{-3}$	
14	Air capacity[a]	AirCapacit	$m^3 m^{-3}$	Calculated as difference WCST- WCFC
15	Water table minimum	WTmin	m	Distance from soil surface
16	Water table maximum	WTmax	m	Distance from soil surface
17	Clay content[a]	Clay	%	(mass/mass*100)
18	Silt content[a]	Silt	%	(mass/mass*100)
19	Sand content[a]	Sand	%	(mass/mass*100)
20	Gravel content	Gravel_Vol	%	(volume/volume*100), Torri et al. 1994
21	Bulk density of the fine earth	BD_Fe	$g cm^{-3}$	
22	Bulk density of total soil (including)	BD_tot	$g cm^{-3}$	Poesen & Lavee, 1994
23	Organic carbon content	Corg	%	
24	C:N ratio	CN	-	
25	pH	pH	-	
26	Soil albedo	sAlb	-	Estimated from top soil organic carbon
27	Calcium Carbonate content	CaCO3	%	(mass/mass*100)

a) Of fine earth fraction (Not corrected for gravel content)

For each gridcell (same gridcells as for climate data) one soil profile is provided. Soil profiles can thus be identified by the gridcell identifier, e.g. resolution, row and column. The data is furthermore structured as one row per soil layer of a given profile. Missing values are represented with NaN.

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