Supplementary

Impact of spatial soil and climate input data aggregation on regional yield simulations

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Tables

Table A. Aggregated model input data. If not specified, soil data was available for each soil layer.

Domain	Variable	Unit
Climate	Precipitation, daily sum [a]	mm d^{-1}
Climate	Air temperature at 2 m above ground, daily minimum, mean, maximum [a]	°C
Climate	Global radiation, daily sum [a]	MJ m^{-2} d^{-1}
Climate	Wind speed, daily average [a]	m s^{-1}
Climate	Relative humidity, daily average	%
Soil	Soil type [b,c]	-
Soil	Number of layers[c]	-
Soil	Layer depth (D) and thickness (T)	m
Soil	Water capacity at air dryness (assumed to be 50 % of wilting point) [d]	m^3 m^{-3}
Soil	Water capacity at wilting point (WCWP, pF 4.2) [d]	m^3 m^{-3}
Soil	Water capacity at field capacity (WCFC, pF 2.5)[d]	m^3 m^{-3}
Soil	Water capacity at saturation (WCST, pF 0) [d]	m^3 m^{-3}
Soil	Air Capacity [d,e]	m^3 m^{-3}
Soil	Clay fraction of fine earth	%
Soil	Silt fraction of fine earth	%
Soil	Sand fraction of fine earth	%
Soil	Gravel content (mass)	%
Soil	Gravel content (volumetric) [f]	%
Soil	Bulk density of fine earth (excluding gravel)	g cm^{-3}
Soil	Bulk density of total soil (including gravel) [g]	g cm^{-3}
Soil	Organic carbon content [h]	[%]

Soil	C:N-ratio [h,i]	-
Soil	pH	-
Soil	surface albedo [c,j]	-
Soil	Calcium Carbonate content	%
Soil	Plant available water capacity (awc) [k]	mm

a) See [1] for a more detailed description of data origin and processing. b) This is metadata. c) One value per profile. d) Original values from fine earth fraction (Clay + Silt + Sand = 100 %) were corrected for gravel content. e) calculated as difference WCST – WCFC. f) Calculated from gravel content on mass/mass ratio via Nomogram [2]. g) Approximated via Nomogramm (Poesen & Lavee, 1994). h) For deeper layers, approximated via pedotransfer functions [6-7]. i) Top soil layer C:N-ratio was set to 10. j) Estimated from soil organic carbon of soil top layer (R^2=0.97), eq. 1. k) awc = (WCFC-WCWP)·T·10.

Table B. Crop model settings and assumptions.

Domain	Unit	Winter Wheat	Silage Maize
Sowing date	DOY[a]	274	110
Harvest date (calibration)	DOY[a]	213	263
Harvest date (simulation)	DOY[a]	at simulated maturity	at simulated maturity
Average Yield[b] (calibration)	t ha^{-1}	7.2	14.3
Max. rooting depth	m	1.5	1.5
Time of ploughing	-	autumn	autumn
Planting density	m^{-2}	400	10
Sowing depth	m	0.04	0.06
Initial soil moisture relative to available field capacity[c]	%	50	80
Initial Nmin[d]	kg ha^{-1}	56	56
Nitrogen fertilization	kg ha^{-1}	130, 52, 26	30, 208
Date of fertilization	DOY[a]	60, 105, 152	91, 152

[a] Day of the year of a non-leap year. [b] Area weighted average yield derived from county statistics, moisture content: 0 %. [c] Set for each soil layer. [d] Total mineral Nitrogen of the soil profile. Values differ with soil layer.

Table C. Effect of aggregation on soil (available water capacity) and climate data (annual precipitation and mean temperature) spatial statistics. Values were calculated across the space and for climate data subsequently averaged over the years.

Data type	Variable	Resolution	Min	Median	Max	standard deviation	Skewness [-]	Kurtosis [-]
Soil	AWC[a]	0.3	10	160	412	78	0.23	2.63
Soil	AWC[a]	1	10	160	412	83	0.32	2.64
Soil	AWC[a]	10	16	160	412	89	0.36	2.52
Soil	AWC[a]	25	22	171	347	91	0.25	2.13
Soil	AWC[a]	50	22	178	347	81	0.32	2.61
Soil	AWC[a]	100	22	182	347	100	0.46	2.24
Climate	T2[b]	1	5.6	10.0	11.6	1.0	-0.96	3.44
Climate	T2[b]	10	6.7	9.9	11.3	0.9	-0.89	3.14
Climate	T2[b]	25	7.2	9.9	10.9	0.9	-0.85	2.93
Climate	T2[b]	50	7.6	9.8	10.6	0.8	-0.92	2.98
Climate	T2[b]	100	8.4	9.8	10.4	0.7	-0.64	1.85
Climate	An. Pr.[c]	1	548	846	1592	183	0.99	3.39
Climate	An. Pr.[c]	10	587	834	1408	177	0.97	3.24
Climate	An. Pr.[c]	25	630	831	1329	163	0.96	3.19
Climate	An. Pr.[c]	50	669	833	1185	139	1.02	3.05
Climate	An. Pr.[c]	100	703	823	1081	113	1.26	2.99

[a] Available water capacity corrected for gravel content [mm]; [b] Daily mean air temperature at 2 m aboveground [°C]; [c] Annual precipitation [mm]

Table D. Characterization of differences in yield due to data aggregation (ΔY) as related to yield (Y), soil water holding capacity (SWHC), climatic water balance during the growing season (CWB) and the corresponding differences from coarser resolutions to 1 km resolution due to data aggregation (ΔY, ΔSWHC, ΔCWB), shown as parallel coordinates plot. The ΔY of each model, crop and aggregation type (soil: aggregation of soil at 1 km climate resolution; climate: aggregation of climate at 1 km soil resolution; soil x climate: simultaneous aggregation of soil and climate) was grouped as follows. LL: $\Delta Y<\mu-2\sigma$; L0: $\mu-2\sigma<\Delta Y<\mu-\sigma$; MM: $\mu-\sigma<\Delta Y<\mu+\sigma$; H0: $\mu+\sigma<\Delta Y<\mu+2\sigma$; HH: $\Delta Y>\mu+2\sigma$ where μ: mean of ΔY and σ: standard deviation of ΔY. W: winter wheat; M: silage maize; s: soil aggregation at 1 km climate; c: climate aggregation at 1 km soil; sxc: aggregation of soil x climate; n: number of cells and years in group. Values were taken from resolutions 10, 25, 50 and 100 km.

					Average							Standard deviation			
Crop	**type**	**group**	***n***	***Y***	***ΔY***	***SWHC***	***ΔSWHC***	***CWB***	***ΔCWB***	***Ys***	***ΔY***	***SWHCs***	***ΔSWHC***	***CWBs***	***ΔCWB***
W	s	LL	145555	8.1	**-3.8**	190	-100	-63	0	41590	0.7	1.9	30	25	22
W	s	L0	232578	7.7	**-2**	180	-45	-63	0	112470	0.6	1.1	18	39	15
W	s	MM	3210481	7.4	**-0.1**	161	8	-27	0	221270	0.5	0.4	4	2	5
W	s	H0	227006	5.9	**1.8**	133	68	-59	0	85660	0.9	1.3	20	25	19
W	s	HH	145147	4.3	**3.7**	114	93	-63	0	47770	1.2	2	43	36	26
W	c	LL	105813	7.8	**-2.1**	113	0	-11	-38	38550	0.8	0.9	29	0	32

W	c	L0	267803	7.5	**-1.1**	127	0	-21	-23	73350	0.7	0.7	21	0	23
W	c	MM	3122257	7.3	**0**	165	0	-34	-6	382260	0.5	0.3	4	0	5
W	c	H0	265441	6.4	**1**	147	0	-34	1	92300	0.6	0.5	18	0	22
W	c	HH	114234	5.3	**2.3**	144	0	-43	6	31210	1	1.1	28	0	43
W	sxc	LL	144424	8.1	**-3.9**	175	-86	-49	-12	34830	0.6	1.8	33	39	36
W	sxc	L0	282341	7.8	**-2.1**	166	-36	-45	-10	74280	0.6	1	21	30	23
W	sxc	MM	3110315	7.5	**0**	162	8	-29	-7	128570	0.5	0.2	4	2	6
W	sxc	H0	282780	5.7	**2.1**	135	57	-51	-4	62230	0.8	1.1	19	28	22
W	sxc	HH	141696	4.1	**3.9**	113	85	-54	-5	36830	1.2	1.8	37	37	36
M	s	LL	107675	17.3	**-8.2**	190	-91	-76	0	56570	2.6	3.3	31	42	35
M	s	L0	187567	16.2	**-4**	189	-55	-73	0	122470	2.7	1.9	18	38	17
M	s	MM	2700401	15	**0.1**	159	7	-27	0	1351520	2.5	0.2	4	2	4
M	s	H0	207316	12.2	**4.4**	138	73	-74	0	158010	3	2.3	23	33	21
M	s	HH	126193	8.7	**8.7**	113	93	-73	0	64450	3.6	3.4	44	45	38
M	c	LL	74157	15.6	**-4.5**	134	0	-25	-25	49350	2.7	2.2	28	0	32
M	c	L0	222180	15.3	**-1.9**	142	0	-26	-17	139780	2.6	0.7	22	0	16

M	c	MM	2686404	15	**0.1**	163	0	-36	-7	1344610	2.5	0.2	4	0	6
M	c	H0	233368	12.7	**2.3**	142	0	-31	-7	140380	2.5	0.8	28	0	40
M	c	HH	114427	10.4	**5**	147	0	-39	-1	61220	3.4	2.7	37	0	49
M	sxc	LL	98476	17.4	**-8.5**	184	-86	-67	-7	53070	2.6	3.1	25	41	32
M	sxc	L0	228541	16.3	**-4.2**	180	-44	-55	-5	122800	2.6	1.8	18	34	15
M	sxc	MM	2629461	15.1	**0.1**	161	7	-29	-7	1305030	2.5	0.2	4	2	4
M	sxc	H0	241814	11.6	**4.8**	135	59	-55	-9	130600	2.7	1.8	24	28	32
M	sxc	HH	131946	8.1	**9.2**	114	83	-62	-9	68920	3.3	3.1	41	46	31

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