

Supplementary Materials: Characterizing Cropland Phenology in Major Grain Production Areas of Russia, Ukraine, and Kazakhstan by the Synergistic Use of Passive Microwave and Visible to Near Infrared Data

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Table S1. Comparison of coefficients of determination (r^2) for GDD CxQ model fit from the AMSR-E surface air temperature data and the MODIS land surface temperature data. At almost every study site, the coefficient of determination for the AMSR-E GDD is greater than that for the MODIS GDD. At four sites at lower latitudes and one site at higher latitude, the MODIS GDD is greater than the AMSR-E GDD. These exceptional fits are bold underlined in the table. Paired sample t-test on the coefficients of determination indicate that the CxQ model fits for the AMSR-E data are significantly higher ($p < 0.00001$) than for the MODIS data.

Site No.	Name	Latitude	Longitude	r^2 (AMSR-E)	r^2 (MODIS)	Site No.	Name	Latitude	Longitude	r^2 (AMSR-E)	r^2 (MODIS)
1	Cherkessk, RU	44.4	43.5	0.92	<u>0.94</u>	26	Kursk, RU	52.1	37.5	0.96	0.88
2	Stavropol, RU	45.0	42.4	0.95	0.95	27	Orenburg, RU	52.4	55.2	0.95	0.90
3	Krasnodar, RU	45.6	39.6	0.89	<u>0.91</u>	28	Kokshetau 1, KZ	52.7	69.2	0.96	0.88
4	Simferopol', UA	45.6	34.1	0.96	0.95	29	Barnaul 2, RU	52.7	83.0	0.97	0.89
5	Tulcea, UA	45.8	29.2	0.94	<u>0.95</u>	30	Kuybyshev 2, RU	52.7	50.2	0.96	0.90
6	Rostov-on-Don 2, RU	46.7	39.8	0.88	<u>0.89</u>	31	Orel, RU	52.7	35.7	0.97	0.89
7	Odesa, UA	47.3	30.7	0.94	0.93	32	Kokshetau 2, KZ	53.0	67.4	0.96	0.87
8	Rostov-on-Don 1, RU	47.5	40.9	0.94	0.92	33	Lipetsk, RU	53.0	39.1	0.97	0.89
9	Donets'k, UA	47.5	37.7	0.93	0.90	34	Kokshetau 3, KZ	53.7	68.2	0.96	0.89
10	Mykolayiv, UA	47.5	32.3	0.92	0.92	35	Kostanay 1, KZ	53.7	63.3	0.97	0.90
11	Zaporizhzhya 1, UA	47.8	35.7	0.91	0.89	36	Kostanay 2, KZ	53.7	62.2	0.97	0.89
12	Zaporizhzhya 2, UA	48.1	34.1	0.90	0.88	37	Kurgan, KZ	53.7	65.6	0.96	0.89
13	Luhans'k, RU	48.7	40.4	0.95	0.92	38	Barnaul_1, RU	53.7	79.4	0.96	0.87
14	Volgograd, RU	48.7	44.8	0.97	0.94	39	Kokshetau 4, KZ	54.0	69.0	0.96	0.90
15	Kirovohrad, UA	48.7	31.8	0.94	0.90	40	Kostanay 3, KZ	54.0	64.0	0.96	0.89
16	Kharkiv 2, UA	49.0	36.2	0.92	0.87	41	Petropavlovsk 2, KZ	54.4	70.8	0.96	0.90
17	Khmel'nyts'kyz, UA	49.0	26.8	0.97	0.92	42	Petropavlovsk 3, KZ	54.4	67.4	0.97	0.90
18	Vinnytsya, UA	49.0	28.9	0.96	0.92	43	Kuybyshev 1, RU	54.4	50.8	0.96	0.89
19	Poltava, UA	49.6	35.1	0.92	0.86	44	Ryazan, RU	54.4	39.3	0.97	0.89
20	Kharkiv 1, UA	49.9	37.0	0.95	0.90	45	Petropavlovsk 1, KZ	54.7	69.5	0.97	0.90
21	Saratov 1, RU	50.8	46.9	0.96	0.92	46	Omsk 1, RU	54.7	72.9	0.96	0.90
22	Sumy, UA	50.8	34.1	0.96	0.90	47	Omsk 2, RU	55.0	74.5	0.96	0.91
23	Semipalatinsk, RU	51.4	81.7	0.96	0.90	48	Cheboksary, RU	55.7	47.1	0.95	<u>0.96</u>
24	Voronezh, RU	51.4	39.8	0.95	0.88	49	Kazan', RU	56.1	49.5	0.96	0.89
25	Saratov 4, RU	51.8	45.3	0.96	0.90						

Table S2. Change in land surface phenologies at cropland sites during the study period. Most of the 49 sites exhibited *no change*. Sites with LSP change include those with *one change* (unimodal to bimodal or bimodal to unimodal) and those with *two changes* (unimodal-bimodal-unimodal or bimodal-unimodal-bimodal). The year(s) when these changes occur and the number of years with continuous similar cropping pattern were also identified.

No Change				Change			
Site No.	Name, Country	Site No.	Name, Country	Site No.	Name, Country	Year Change	No. of Years
Unimodal		Unimodal		Unimodal → Bimodal			uni/bi
15	Kirovohrad, UA	34	Kokshetau 3, KZ	7	Odesa, UA	2008	5/3
16	Kharkiv 2, UA	35	Kostanay 1, KZ	10	Mykolayiv, UA	2009	6/2
19	Poltava, UA	36	Kostanay 2, KZ	12	Zaporiyhzhya_2, UA	2010	7/1
20	Kharkiv 1, UA	37	Kurgan, KZ		Bimodal → Unimodal		bi/uni
21	Saratov 1, RU	38	Barnaul_1, RU	11	Zaporiyhzhya_1, UA	2004	1/7
22	Sumy, UA	39	Kokshetau 4, KZ	13	Luhans'k, RU	2003	1/7
23	Semipalatinsk, RU	40	Kostanay 3, KZ	17	Khmelnyskyz, UA	2009	6/2
24	Voronezh, RU	41	Petropavlovsk 2, KZ	18	Vinnytsya, UA	2009	6/2
25	Saratov 4, RU	42	Petropavlovsk 3, KZ		Unimodal → Bimodal → Unimodal		uni/bi/uni
26	Kursk, RU	43	Kuybyshev 1, RU	6	Rostov-on-Don 2, RU	2007; 2008	4/1/3
27	Orenburg, RU	44	Ryazan, RU	8	Rostov-on-Do 1, RU	2007; 2008	4/1/3
28	Kokshetau 1, KZ	45	Petropavlovsk 1, KZ	14	Volgograd, RU	2009; 2010	6/1/1
29	Barnaul 2, RU	46	Omsk 1, RU		Bimodal → Unimodal → Bimodal		bi/uni/bi
30	Kuybyshev 2, RU	47	Omsk 2, RU	1	Cherkessk, RU	2005; 2009	2/4/2
31	Orel, RU	48	Cheboksary, RU	2	Stavropol, RU	2005; 2009	2/4/2
32	Kokshetau 2, KZ	49	Kazan', RU	3	Krasnodar, RU	2007; 2008	4/1/3
33	Lipetsk, RU			4	Simferopol, UA	2005; 2010	2/5/1
				5	Tulcea, UA	2006; 2010	3/4/1
				9	Donetsk, UA	2006; 2008	3/2/3

