



*Supplement of*

## **Evaluation of root zone soil moisture products over the Huai River basin**

**En Liu et al.**

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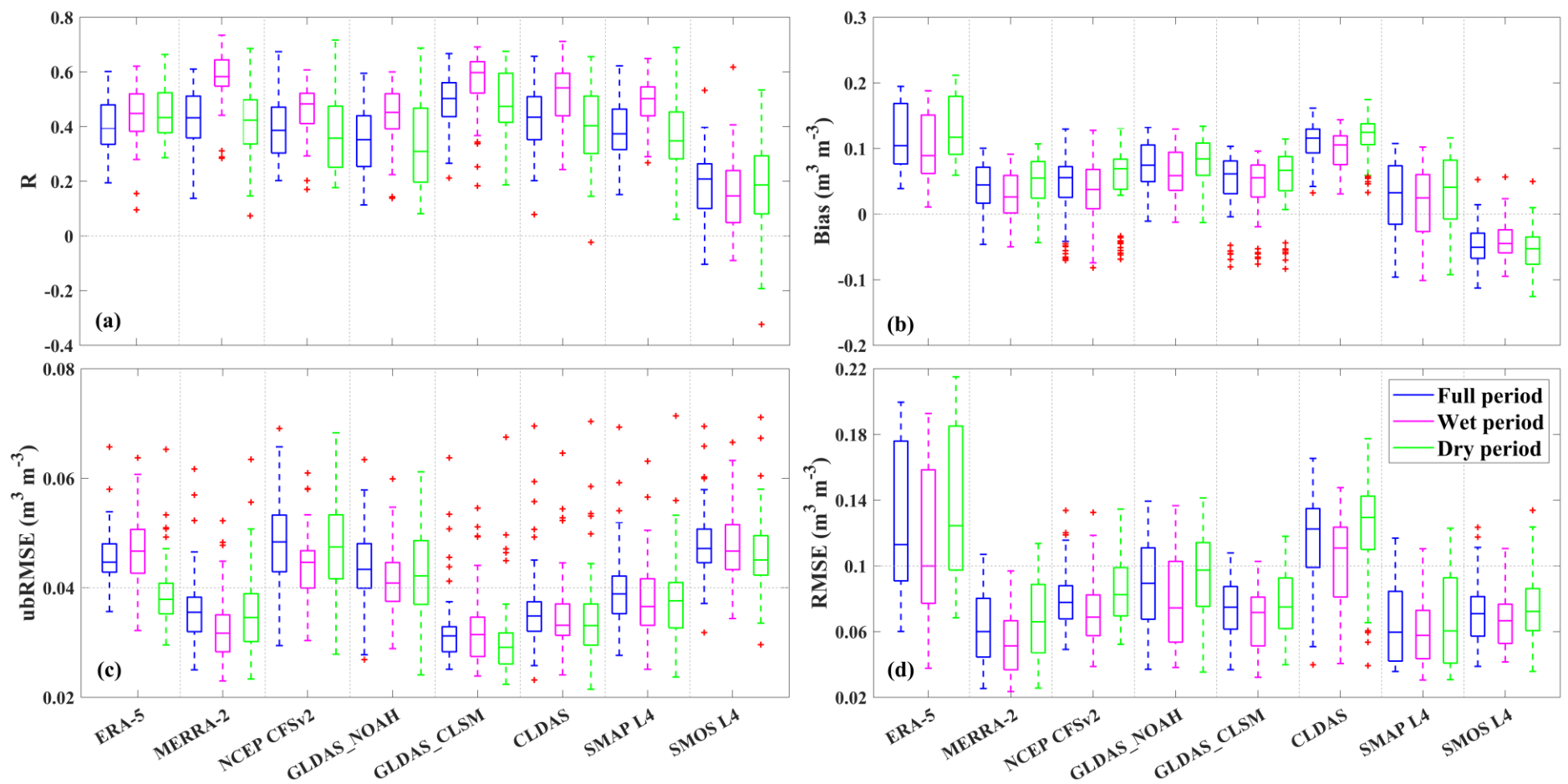


Fig. S1 Single-station RZSM comparison between model-derived RZSM and in situ soil moisture observations for different periods, including the Full period (from 1 April 2015 to 31 March 2020), Wet period (from June to September) and Dry period (from October to May). Each outlier “+” represents an *in situ* station. The five horizontal lines of the box plot represent the minimum, 25<sup>th</sup> percentile, 50<sup>th</sup> percentile, 75<sup>th</sup> percentile and maximum from bottom to top, respectively.

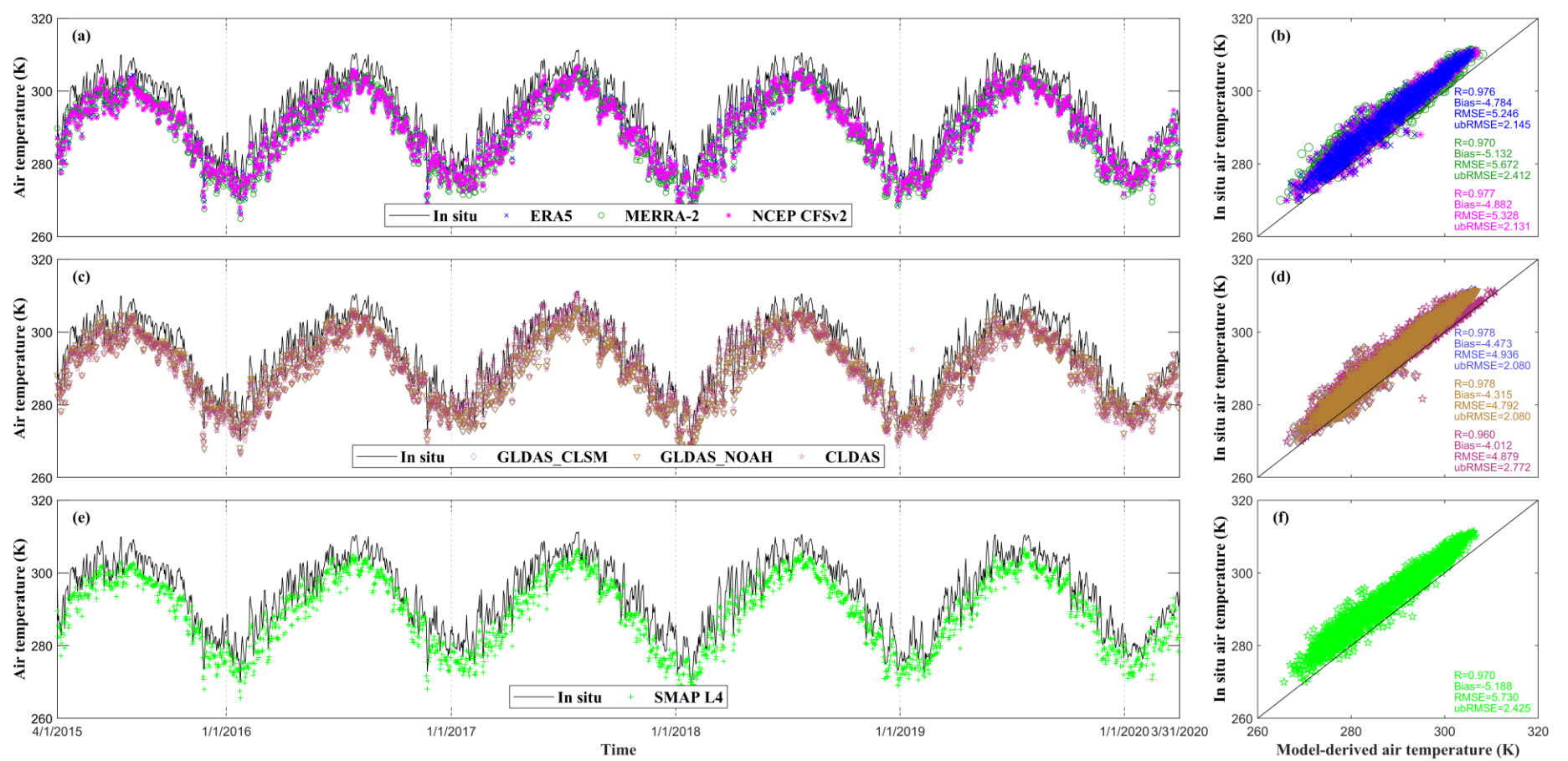
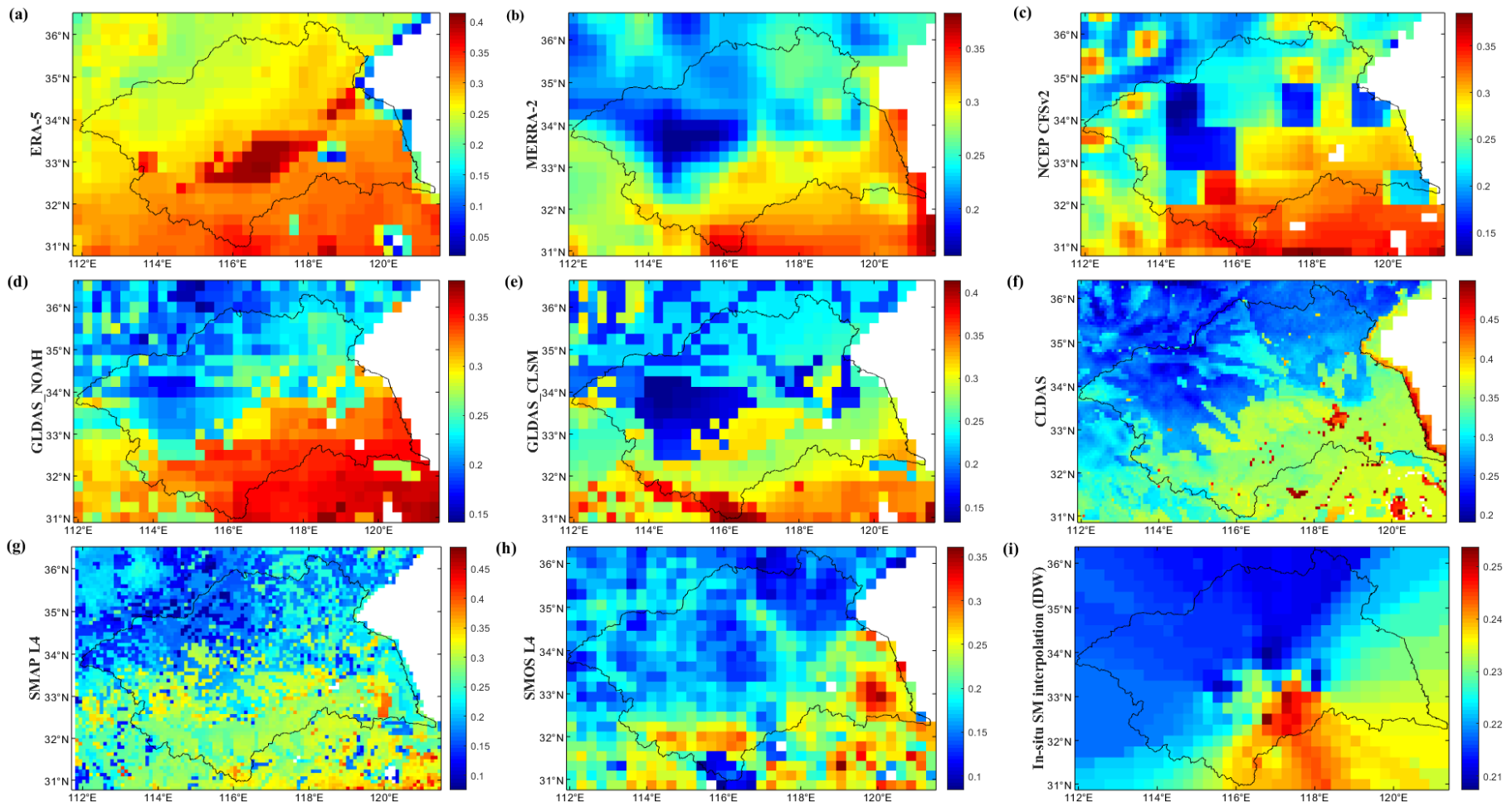


Fig. S2 Stations-averaged air temperature comparison between modeled air temperature and CMA air temperature dataset spanning the period from April 1, 2015 to March 31, 2020, including the time series (left panel) and scatterplots (right panel). ERA5, MERRA-2, NCEP CFSv2, GLDAS\_CLSM, GLDAS\_NOAH, CLDAS and CMA products provide the air temperature datasets at the 2-m screen level. SMAP L4 product provides the air temperature at center height of the lowest atmospheric model layer.



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Fig. S3 Spatial distribution pattern of eight RZSM products and in situ observations interpolated using Inverse Distance Weighting (IDW) averaged over from 1 April 2015 to 31 March 2020.

Table. S1 Statistical metrics of eight RZSM products validated by *in situ* measurements (0-100 cm) at each station from 1 April 2015 to 31 March 2020. Mean score values and their standard deviation (brackets) are given for all seasons, wet season, and dry season.

Dataset	Period	<i>In situ</i> validation (raw)			<i>In situ</i> validation (anomaly)		
		R	ubRMSE (m <sup>3</sup> m <sup>-3</sup> )	Bias (m <sup>3</sup> m <sup>-3</sup> )	R	ubRMSE (-)	Bias (-)
ERA-5	All	0.40 (0.10)	0.045 (0.005)	0.104 (0.047)	0.41 (0.08)	0.94 (0.07)	-0.00 (0.01)
	Wet	0.45 (0.10)	0.047 (0.006)	0.089 (0.048)	0.49 (0.11)	0.91 (0.09)	-0.02 (0.02)
	Dry	0.43 (0.10)	0.038 (0.006)	0.117 (0.046)	0.33 (0.08)	0.97 (0.06)	0.01 (0.01)
MERRA-2	All	0.43 (0.10)	0.036 (0.007)	0.044 (0.036)	0.51(0.11)	0.89 (0.09)	-0.00 (0.01)
	Wet	0.58 (0.09)	0.032 (0.006)	0.026 (0.035)	0.61 (0.14)	0.81 (0.12)	-0.03 (0.02)
	Dry	0.42 (0.12)	0.035 (0.008)	0.055 (0.038)	0.42 (0.10)	0.94 (0.07)	0.02 (0.01)
NCEP CFSv2	All	0.39 (0.11)	0.048 (0.008)	0.056 (0.052)	0.43 (0.10)	0.92(0.08)	-0.01 (0.01)
	Wet	0.48 (0.09)	0.045 (0.006)	0.038 (0.051)	0.51 (0.12)	0.88 (0.10)	-0.03 (0.02)
	Dry	0.36 (0.14)	0.047 (0.010)	0.069 (0.053)	0.36 (0.09)	0.96 (0.08)	0.01 (0.02)
GLDAS_NOAH	All	0.35 (0.12)	0.043 (0.007)	0.075 (0.038)	0.31 (0.08)	1.02 (0.07)	-0.01 (0.01)
	Wet	0.45 (0.11)	0.041 (0.006)	0.059 (0.040)	0.40 (0.11)	0.97 (0.11)	-0.02 (0.02)
	Dry	0.31 (0.15)	0.042 (0.008)	0.084 (0.038)	0.22 (0.06)	1.05 (0.06)	-0.01 (0.01)
GLDAS_CLSM	All	<b>0.50</b> (0.09)	<b>0.031</b> (0.007)	0.061 (0.051)	0.49 (0.12)	0.91 (0.10)	-0.01 (0.01)
	Wet	<b>0.60</b> (0.11)	<b>0.031</b> (0.007)	0.055 (0.050)	0.58 (0.15)	0.84 (0.13)	-0.03 (0.02)
	Dry	<b>0.47</b> (0.12)	<b>0.029</b> (0.007)	0.067 (0.052)	0.42 (0.11)	0.96 (0.086)	<b>0.00</b> (0.01)
CLDAS	All	0.44 (0.12)	0.035 (0.008)	0.116 (0.032)	<b>0.53</b> (0.12)	<b>0.86</b> (0.10)	-0.01 (0.01)
	Wet	0.54 (0.11)	0.033 (0.007)	0.105 (0.032)	<b>0.65</b> (0.16)	<b>0.76</b> (0.14)	-0.02 (0.02)
	Dry	0.40 (0.14)	0.033 (0.009)	0.125 (0.033)	<b>0.44</b> (0.10)	<b>0.93</b> (0.08)	0.00 (0.01)
SMAP L4	All	0.37 (0.10)	0.039 (0.007)	<b>0.033</b> (0.049)	0.49 (0.11)	0.90 (0.08)	<b>0.00</b> (0.01)
	Wet	0.50 (0.08)	0.037 (0.007)	<b>0.025</b> (0.049)	0.60 (0.14)	0.81 (0.11)	-0.02 (0.02)
	Dry	0.35 (0.12)	0.038 (0.008)	<b>0.041</b> (0.049)	0.41 (0.09)	0.95 (0.07)	0.02 (0.01)
SMOS L4	All	0.21 (0.13)	0.048 (0.007)	-0.050 (0.030)	0.06 (0.06)	1.14 (0.05)	-0.00 (0.03)
	Wet	0.15 (0.13)	0.047 (0.007)	-0.045 (0.030)	0.07 (0.07)	1.16 (0.06)	<b>-0.01</b> (0.05)
	Dry	0.19 (0.16)	0.045 (0.007)	-0.053 (0.032)	0.05 (0.08)	1.14 (0.06)	0.01 (0.04)

Note: Bold values denote the optimal values for each period. Data points used in this study at each station are 1827.

Table. S2 Overview of in situ stations in the Huai River Basin.

Station ID	Station Name	Longitude (E)	Latitude (N)	Elevation (m)	Land cover	Total soil moisture observations	Number of missing soil moisture observations
50402241	Taolaoba	117.164	32.184	48	Irrigated Crop	1827	18
50403609	Chahua	116.022	33.033	39	Rainfed Crop	1827	23
50403809	Hanting	116.319	33.021	28	Rainfed Crop	1827	20
50420400	Songji	115.271	32.815	39	Rainfed Crop	1827	25
50421000	Funan	115.571	32.637	33	Rainfed Crop	1827	51
50421800	Santa	115.697	32.808	33	Rainfed Crop	1827	51
50423201	Yaoli	116.172	31.823	58	Irrigated Crop	1827	75
50424701	Guanting	116.851	31.797	51	Irrigated Crop	1827	19
50426001	Zhuangmu	117.112	32.363	27	Irrigated Crop	1827	15
50426072	Guiji	116.623	32.778	23	Irrigated Crop	1827	20
50426801	Xiaji	116.540	32.654	25	Rainfed Crop	1827	18
50429700	Shuangfu	115.569	33.342	37	Rainfed Crop	1827	52
50430100	Fentai	115.727	33.455	35	Rainfed Crop	1827	51
50430117	Santang	115.829	33.314	32	Rainfed Crop	1827	26
50430709	Lixin	116.209	33.143	28	Rainfed Crop	1827	47
50601600	Jieshou	115.359	33.265	42	Rainfed Crop	1827	51
50609001	Yangqiao	115.392	33.017	28	Rainfed Crop	1827	52
50634550	Guangwu	115.334	33.374	42	Rainfed Crop	1827	25
50636750	Huangling	115.134	33.041	37	Rainfed Crop	1827	51

Station ID	Station Name	Longitude (E)	Latitude (N)	Elevation (m)	Land cover	Total soil moisture observations	Number of missing soil moisture observations
50637371	Quanyang	115.437	33.112	35	Rainfed Crop	1827	26
50637413	Kanheliu	115.852	33.099	33	Rainfed Crop	1827	52
50637427	Kouziji	116.087	32.844	26	Rainfed Crop	1827	51
50637450	Sanshilipu	116.106	32.697	27	Rainfed Crop	1827	52
50637459	Xiaqiao	116.384	32.643	26	Rainfed Crop	1827	53
50700401	Hengpaitou	116.364	31.590	72	Woodland	1827	58
50701303	Xianghongdianxiakuxia	116.177	31.580	116	Woodland	1827	48
50725311	Wangchenggang	116.526	31.740	76	Irrigated Crop	1827	43
50830409	Lumiao	115.795	33.998	39	Rainfed Crop	1827	51
50830419	Dasi	115.873	33.802	42	Rainfed Crop	1827	49
50830439	Youhe	115.789	33.631	38	Rainfed Crop	1827	24
50830449	Huagou	116.063	33.510	33	Rainfed Crop	1827	16
50830480	Dahu	116.351	33.515	31	Rainfed Crop	1827	18
50830489	Chenqiao	116.561	33.094	25	Rainfed Crop	1827	50
50830601	Heliu	116.967	33.033	25	Rainfed Crop	1827	18
50900601	Linhuanzha	116.567	33.667	29	Rainfed Crop	1827	18
50901501	Guzhenzha	117.333	33.300	18	Rainfed Crop	1827	16
50903176	Wudaogou	117.341	33.156	21	Rainfed Crop	1827	19
50903421	Hexiangzha	117.183	33.000	18	Rainfed Crop	1827	21
50903600	Tancheng	116.557	33.441	29	Rainfed Crop	1827	23

Station ID	Station Name	Longitude (E)	Latitude (N)	Elevation (m)	Land cover	Total soil moisture observations	Number of missing soil moisture observations
50903541	Xibakou	117.867	33.150	11	Rainfed Crop	1827	18
50907801	Xulouzha	116.750	33.917	30	Rainfed Crop	1827	15
50908001	Suxianzha	117.083	33.667	28	Rainfed Crop	1827	16
50909701	Gukouzha	116.450	34.267	39	Rainfed Crop	1827	17
50912201	Kuaitanggou	117.550	33.750	20	Rainfed Crop	1827	17
50913201	Yanglou	116.783	34.317	39	Rainfed Crop	1827	18
50913901	Langanji	117.233	33.934	25	Rainfed Crop	1827	16
50922032	Dulou	116.850	34.200	37	Rainfed Crop	1827	16
50922072	Xiangyang	117.583	33.467	24	Rainfed Crop	1827	18
50922172	Shuangdui	116.900	33.417	25	Rainfed Crop	1827	16
50922232	Shuoli	116.900	34.033	32	Rainfed Crop	1827	15
50922332	Huangmiao	117.652	33.079	19	Rainfed Crop	1827	17
50924801	Baoji	117.113	33.158	22	Rainfed Crop	1827	20
50925801	Dinghouying	117.338	33.457	24	Rainfed Crop	1827	16
50931578	Xuanmiao	116.267	34.517	54	Rainfed Crop	1827	17
50932801	Longhai	116.350	34.400	45	Rainfed Crop	1827	16
50933001	Zhangzhuangzhai	116.600	34.117	37	Rainfed Crop	1827	16
50935201	Sixian	117.917	33.434	16	Rainfed Crop	1827	16
50938101	Dazhuang	117.867	33.667	20	Rainfed Crop	1827	15