



# SMAPVEX16 Iowa Manual ThetaProbe Soil Moisture, Version 1

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## USER GUIDE

### How to Cite These Data

As a condition of using these data, you must include a citation:

Cosh, M. 2021. *SMAPVEX16-Iowa Manual ThetaProbe Soil Moisture, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center.  
<https://doi.org/10.5067/QUZD7OEEVRFZ>. [Date Accessed].

FOR QUESTIONS ABOUT THESE DATA, CONTACT [NSIDC@NSIDC.ORG](mailto:NSIDC@NSIDC.ORG)

FOR CURRENT INFORMATION, VISIT [https://nsidc.org/data/SV16I\\_TPSM](https://nsidc.org/data/SV16I_TPSM)



National Snow and Ice Data Center

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# 1 DATA DESCRIPTION

## 1.1 Parameters

Parameter for this data set is soil moisture.

These data consist of calibrated soil moisture sensor measurements recorded by manual sampling at the SMAPVEX16-Iowa experiment domain during two intensive observation periods, IOP1 and IOP2, in June and August of 2016, respectively. The sampling sites were spread out over an experiment domain of about 30 km by 40 km located about 30 km north of Ames, Iowa.

## 1.2 File Information

### 1.2.1 Format

Data provided in comma-separated values, (.csv) file. Data volume approximately 0.5 MB.

### 1.2.2 File Contents

The data file contains the calibrated ThetaProbe soil moisture measurements, sampling date, crop type at the site (field), site name, and sampling point at the site. The ThetaProbe measurement was collected four times at each sampling point. There are two location files, one each, for sampling done in June and August of 2016.

	A	B	C	D	E	F	G	H
1	Date	Site	Crop	Point	A	B	C	D
2	5/31/16	JPL Corn	Corn	1				
3	5/31/16	JPL Corn	Corn	2	0.31540857	0.26078863	0.33422888	0.265465
4	5/31/16	JPL Corn	Corn	3	0.27271464	0.24958742	0.33422888	0.25747697
5	5/31/16	JPL Corn	Corn	4	0.28374255	0.25593775	0.33422888	0.25703684
6	5/31/16	JPL Corn	Corn	5	0.26658688	0.25968248	0.27225626	0.25549857
7	5/31/16	JPL Corn	Corn	6	0.27851505	0.24017806	0.2612318	0.2412755
8	5/31/16	JPL Corn	Corn	7	0.24805779	0.21333712	0.25901992	0.24871331
9	5/31/16	JPL Corn	Corn	8	0.29109203	0.24543525	0.27020287	0.25440164
10	5/31/16	JPL Corn	Corn	9	0.27548186	0.25968248	0.21970734	0.27898519
11	5/31/16	JPL Corn	Corn	10	0.28063847	0.25133636	0.28591888	0.28640571

Figure 1. Sample of data file contents.

## 1.2.3 Naming Convention

File Name: SMAPVEX16\_IA\_GVSM\_v[N]\_ThetaProbe.csv

File Name Components:

- Campaign: SMAPVEX16
- Site: IA; Iowa
- Experiment: GVSM; gravimetric soil moisture
- Version: v[N]
- Instrument: ThetaProbe
- File format or extension: .csv

## 1.3 Spatial Information

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### 1.3.1 Coverage

The Iowa experiment domain may be defined by the following coordinates:

Latitude: 42.39N – 42.64N

Longitude: 93.19W – 93.57W

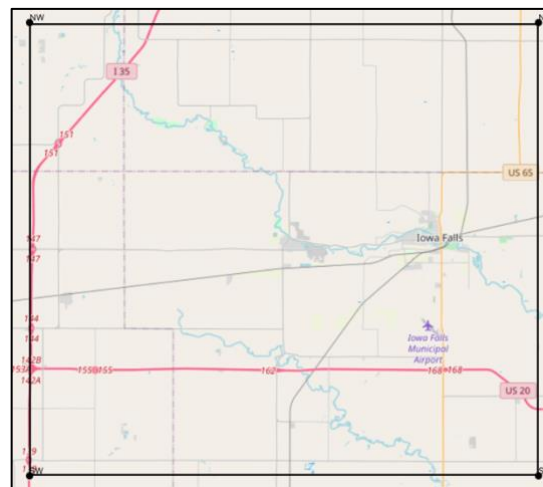


Figure 1. SV161\_TPSM Experiment Domain

### 1.3.2 Resolution

Does not apply.

### 1.3.3 Geolocation

Coordinate Reference System: WGS 84

See the appendices for location data for each intensive observation period.

## 1.4 Temporal Information

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### 1.4.1 Coverage

Start Date: 31 May 2016

End Date: 15 August 2016

### 1.4.2 Resolution

Two to three days.

## 2 DATA ACQUISITION AND PROCESSING

### 2.1 Acquisition

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Manual sampling teams traversed two predetermined transects, two fields, within the experiment domain measuring soil moisture with the Delta ThetaProbe. At predetermined sample sites and points along each transect measurements were conducted by inserting the probe into the soil and recording the results. Location data were collected for each point sampled.

In addition, teams collected two soil core samples. The core samples were weighed before and after drying to determine water mass in the soil. Bulk density of the soil for each field was also determined based on the core samples.

### 2.2 Processing

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The ground-based estimation of surface soil moisture over large regions is important in the study of hydrology, when modeling climate and land surface, and for satellite validation including the Advanced Microwave Scanning Radiometer (AMSR-E) (Njoku et al., 2003). The most accurate method of estimation, gravimetric sampling, is also a time intensive procedure. Modern instrumentation, developed to capture the dielectric characteristics of soil and water, provide a faster and easier method to estimate soil moisture. However, use of these instruments require a

conversion between dielectric constant and volumetric soil moisture (Topp and Ferre, 2002) and (Cosh et al., 2005).

The soil moisture and bulk density obtained from the core samples were used to calibrate the ThetaProbe measurements. Separate calibrations were made for each field, resulting in field-specific calibrations of the ThetaProbe measurements.

The processing included determining core sample gravimetric soil moisture from the weighing and drying procedure, the transformation to volumetric soil moisture using the bulk density results, least squares fitting of the ThetaProbe values which were taken simultaneously with the core samples, and assignment of volumetric soil moisture values to the ThetaProbe readings based on the fitted parameters (see Cosh et al., 2005).

## 2.3 Quality, Errors, and Limitations

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The root-mean-square (RMS) fit between the core sample soil moisture and the ThetaProbe measurements was  $0.0395 \text{ m}^3/\text{m}^3$ . This value provides an indication of the accuracy of the field-specific calibration for the probes. The number includes unknown errors related correspondence of the core sample soil moisture and probe measurements. In general, unknown errors are not assumed to dominate the calibration (Cosh et al., 2005).

Blank cells in the data files represent “no data collected”. Due to a variety of conditions on the ground or with instrumentation, gaps exist in the data.

Blank cells in the station location data files exist when not data was collected at a location thus no coordinates were recorded.

## 2.4 Instrumentation

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### 2.4.1 Description

Delta ThetaProbe (ML3 ThetaProbe Soil Moisture Sensor)

## 3 SOFTWARE AND TOOLS

Access the data with software capable of reading comma-separated values, .csv, files.

## 4 RELATED DATA SETS

[SMAP Validation Data 2016](#)

## 5 RELATED WEBSITES

[Soil Moisture Active Passive Data](#)

[Soil Moisture Active Passive Validation Data](#)

## 6 CONTACTS AND ACKNOWLEDGMENTS

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## 7 REFERENCES

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## 8 DOCUMENT INFORMATION

### 8.1 Publication Date

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07 January 2021

## 1.1 Revision Date

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11 January 2021



## 2 APPENDIX A – IOP1 LOCATION DATA

The following table provides geographic coordinates for each site and sample point during intensive observation period one (IOP1). Blanks cells reflect sites or points where data was not collected during IOP1.

Table A - 1. Sample Point Coordinates for IOP1

Site	Point	Latitude	Longitude
JPL-Corn	1		
JPL-Corn	2		
JPL-Corn	3		
JPL-Corn	4		
JPL-Corn	5		
JPL-Corn	6		
JPL-Corn	7		
JPL-Corn	8		
JPL-Corn	9		
JPL-Corn	10		
JPL-Corn	11		
JPL-Corn	12		
JPL-Corn	13		
JPL-Corn	14		
LTAR-Corn	1	42.48391	-93.52766
LTAR-Corn	2	42.48324	-93.52768
LTAR-Corn	3	42.48254	-93.52766
LTAR-Corn	4	42.4818	-93.52766
LTAR-Corn	5	42.48106	-93.52766
LTAR-Corn	6	42.48027	-93.52766
LTAR-Corn	7	42.4795	-93.52766
LTAR-Corn	8	42.47945	-93.5258
LTAR-Corn	9	42.48024	-93.5258
LTAR-Corn	10	42.48099	-93.52583
LTAR-Corn	11	42.4817	-93.52582
LTAR-Corn	12	42.48243	-93.52583
LTAR-Corn	13	42.48315	-93.52581
LTAR-Corn	14	42.48387	-93.52582

Site	Point	Latitude	Longitude
LTAR-Soy	1	42.48627	-93.52357
LTAR-Soy	2	42.48697	-93.5236
LTAR-Soy	3	42.48762	-93.5236
LTAR-Soy	4	42.4883	-93.52358
LTAR-Soy	5		
LTAR-Soy	6		
LTAR-Soy	7		
LTAR-Soy	8		
LTAR-Soy	9		
LTAR-Soy	10		
LTAR-Soy	11	42.48835	-93.52117
LTAR-Soy	12	42.4877	-93.52115
LTAR-Soy	13	42.48702	-93.52112
LTAR-Soy	14	42.48635	-93.52115
NASA04	1	42.63683	-93.34207
NASA04	2	42.63685	-93.343
NASA04	3	42.63687	-93.34386
NASA04	4	42.63689	-93.34472
NASA04	5	42.63688	-93.34551
NASA04	6	42.63689	-93.34636
NASA04	7	42.63689	-93.34722
NASA04	8	42.63514	-93.34719
NASA04	9	42.63513	-93.34633
NASA04	10	42.63513	-93.34546
NASA04	11	42.63512	-93.34461
NASA04	12	42.6351	-93.34375
NASA04	13	42.63509	-93.34286
NASA04	14	42.63509	-93.34184
S02	1		
S02	2		
S02	3		
S02	4		
S02	5		
S02	6		

<b>Site</b>	<b>Point</b>	<b>Latitude</b>	<b>Longitude</b>
S02	7		
S02	8		
S02	9		
S02	10		
S02	11		
S02	12		
S02	13		
S02	14		
S03	1		
S03	2		
S03	3		
S03	4		
S03	5		
S03	6		
S03	7		
S03	8		
S03	9		
S03	10		
S03	11		
S03	12		
S03	13		
S03	14		
S04	1		
S04	2		
S04	3		
S04	4		
S04	5		
S04	6		
S04	7		
S04	8		
S04	9		
S04	10		
S04	11		
S04	12		

Site	Point	Latitude	Longitude
S04	13		
S04	14		
S09	1	42.41508	-93.36755
S09	2	42.41507	-93.36805
S09	3	42.41508	-93.36887
S09	4	42.41507	-93.36963
S09	5	42.41508	-93.3704
S09	6	42.41507	-93.37123
S09	7	42.41508	-93.37205
S09	8	42.41295	-93.37213
S09	9	42.41293	-93.3711
S09	10	42.41295	-93.37025
S09	11	42.41295	-93.36947
S09	12	42.41295	-93.36863
S09	13	42.41293	-93.36775
S09	14	42.41295	-93.36703
S10	1	42.411	-93.55907
S10	2	42.41115	-93.55813
S10	3	42.41117	-93.55738
S10	4	42.41118	-93.55653
S10	5	42.41117	-93.5556
S10	6	42.4112	-93.55465
S10	7	42.4112	-93.55375
S10	8	42.40963	-93.5537
S10	9	42.40963	-93.5545
S10	10	42.40963	-93.55517
S10	11	42.40963	-93.55617
S10	12	42.40962	-93.55703
S10	13	42.4096	-93.55793
S10	14	42.4096	-93.55883
S11	1	42.4108	-93.53329
S11	2	42.41019	-93.53329
S11	3	42.40948	-93.53329
S11	4	42.40885	-93.53334

<b>Site</b>	<b>Point</b>	<b>Latitude</b>	<b>Longitude</b>
S11	5	42.40815	-93.53331
S11	6	42.40738	-93.53332
S11	7	42.40673	-93.53332
S11	8	42.40671	-93.53525
S11	9	42.40745	-93.53525
S11	10	42.40835	-93.53528
S11	11	42.40895	-93.53526
S11	12	42.40947	-93.53526
S11	13	42.41014	-93.53524
S11	14	42.41075	-93.53522
S13	1	42.41708	-93.51791
S13	2	42.41647	-93.51792
S13	3	42.41583	-93.51794
S13	4	42.41522	-93.51794
S13	5	42.4147	-93.51794
S13	6	42.4142	-93.51794
S13	7	42.41381	-93.51794
S13	8	42.41385	-93.51984
S13	9	42.41439	-93.51971
S13	10	42.41496	-93.51971
S13	11	42.41547	-93.5197
S13	12	42.41602	-93.5197
S13	13	42.4165	-93.51971
S13	14	42.41707	-93.51971
S14	1	42.41438	-93.5418
S14	2	42.41498	-93.54178
S14	3	42.41563	-93.54177
S14	4	42.41632	-93.54178
S14	5	42.417	-93.54175
S14	6	42.41767	-93.54175
S14	7	42.41838	-93.54175
S14	8	42.4184	-93.54417
S14	9	42.41777	-93.54415
S14	10	42.4170167	-93.54417

<b>Site</b>	<b>Point</b>	<b>Latitude</b>	<b>Longitude</b>
S14	11	42.4163667	-93.54417
S14	12	42.4156833	-93.54417
S14	13	42.415	-93.54417
S14	14	42.4143333	-93.54417
S16	1	42.42273	-93.38678
S16	2	42.42204	-93.38676
S16	3	42.42141	-93.38677
S16	4	42.4207	-93.38678
S16	5	42.42006	-93.38677
S16	6	42.41939	-93.38677
S16	7	42.41872	-93.38679
S16	8	42.41867	-93.38911
S16	9	42.41936	-93.38909
S16	10	42.42004	-93.38909
S16	11	42.42077	-93.3891
S16	12	42.42144	-93.38909
S16	13	42.42208	-93.38909
S16	14	42.42272	-93.38908
S17	1	42.4241	-93.42345
S17	2	42.4241	-93.42258
S17	3	42.4241	-93.42177
S17	4	42.4241	-93.42097
S17	5	42.4241	-93.42018
S17	6	42.4241	-93.41932
S17	7	42.4241	-93.41855
S17	8	42.42627	-93.41852
S17	9	42.42627	-93.41937
S17	10	42.42627	-93.42017
S17	11	42.42627	-93.42105
S17	12	42.42627	-93.42187
S17	13	42.42627	-93.42273
S17	14	42.42627	-93.42353
S18	1	42.42053	-93.3782
S18	2	42.42112	-93.3782

<b>Site</b>	<b>Point</b>	<b>Latitude</b>	<b>Longitude</b>
S18	3	42.42176	-93.37822
S18	4	42.42243	-93.37819
S18	5	42.42308	-93.3782
S18	6	42.42372	-93.37817
S18	7	42.42447	-93.37815
S18	8	42.42457	-93.38041
S18	9	42.42385	-93.38041
S18	10	42.42327	-93.38042
S18	11	42.42264	-93.38042
S18	12	42.42203	-93.38043
S18	13	42.42142	-93.38045
S18	14	42.42076	-93.38045
S19	1	42.4247	-93.44213
S19	2	42.42473	-93.441
S19	3	42.42473	-93.43985
S19	4	42.42472	-93.43902
S19	5	42.42472	-93.43823
S19	6	42.42472	-93.43738
S19	7	42.42472	-93.4366
S19	8	42.4262	-93.43662
S19	9	42.42622	-93.43748
S19	10	42.42622	-93.43828
S19	11	42.4262	-93.4391
S19	12	42.4262	-93.43988
S19	13	42.42622	-93.44075
S19	14	42.42622	-93.44157
S21	1	42.42751	-93.54109
S21	2	42.42816	-93.54108
S21	3	42.42883	-93.54108
S21	4	42.42946	-93.54106
S21	5	42.43016	-93.54105
S21	6	42.43084	-93.54105
S21	7	42.43153	-93.54104
S21	8	42.43154	-93.54149

<b>Site</b>	<b>Point</b>	<b>Latitude</b>	<b>Longitude</b>
S21	9	42.43091	-93.5415
S21	10	42.43024	-93.54152
S21	11	42.42959	-93.54152
S21	12	42.42899	-93.54153
S21	13	42.42834	-93.54153
S21	14	42.42767	-93.54154
S31	1		
S31	2		
S31	3		
S31	4		
S31	5		
S31	6		
S31	7		
S31	8		
S31	9		
S31	10		
S31	11		
S31	12		
S31	13		
S31	14		
S32	1		
S32	2		
S32	3		
S32	4		
S32	5		
S32	6		
S32	7		
S32	8		
S32	9		
S32	10		
S32	11		
S32	12		
S32	13		
S32	14		



<b>Site</b>	<b>Point</b>	<b>Latitude</b>	<b>Longitude</b>
S36	1	42.62856	-93.19315
S36	2	42.62857	-93.19397
S36	3	42.62857	-93.19482
S36	4	42.62857	-93.19577
S36	5	42.62858	-93.19668
S36	6	42.62861	-93.19756
S36	7	42.62861	-93.19845
S36	8	42.62727	-93.19847
S36	9	42.62727	-93.19758
S36	10	42.62727	-93.19675
S36	11	42.62725	-93.19593
S36	12	42.62726	-93.19479
S36	13	42.62725	-93.19397
S36	14	42.62727	-93.19311
SF01-Corn	1	42.38992	-93.39207
SF01-Corn	2	42.38951	-93.39205
SF01-Corn	3	42.38902	-93.39202
SF01-Corn	4	42.38857	-93.39202
SF01-Corn	5	42.3882	-93.39189
SF01-Corn	6	42.38778	-93.39172
SF01-Corn	7	42.38748	-93.39162
SF01-Corn	8	42.38748	-93.39041
SF01-Corn	9	42.38791	-93.39033
SF01-Corn	10	42.38839	-93.39028
SF01-Corn	11	42.38889	-93.39021
SF01-Corn	12	42.38938	-93.39014
SF01-Corn	13	42.38978	-93.39007
SF01-Corn	14	42.39027	-93.38998
SF01-Soy	1		
SF01-Soy	2		
SF01-Soy	3		
SF01-Soy	4		
SF01-Soy	5		
SF01-Soy	6		

Site	Point	Latitude	Longitude
SF01-Soy	7		
SF01-Soy	8		
SF01-Soy	9		
SF01-Soy	10		
SF01-Soy	11		
SF01-Soy	12		
SF01-Soy	13		
SF01-Soy	14		
SF02	1	42.46879	-93.564
SF02	2	42.46838	-93.56399
SF02	3	42.46792	-93.56398
SF02	4	42.4674	-93.56398
SF02	5	42.46679	-93.56398
SF02	6	42.46617	-93.56399
SF02	7	42.46554	-93.56399
SF02	8	42.46546	-93.56256
SF02	9	42.46608	-93.56257
SF02	10	42.46673	-93.56257
SF02	11	42.46741	-93.56258
SF02	12	42.46797	-93.56258
SF02	13	42.4684	-93.56258
SF02	14	42.46891	-93.56258
SF03	1	42.45229	-93.56163
SF03	2	42.45223	-93.56239
SF03	3	42.45236	-93.56306
SF03	4	42.45237	-93.56369
SF03	5	42.4524	-93.56444
SF03	6	42.45242	-93.5652
SF03	7	42.45247	-93.56596
SF03	8	42.45332	-93.56596
SF03	9	42.45329	-93.56526
SF03	10	42.45327	-93.56452
SF03	11	42.45323	-93.56372
SF03	12	42.4532	-93.56295

Site	Point	Latitude	Longitude
SF03	13	42.45318	-93.56239
SF03	14	42.45314	-93.56168
SF04	1	42.54528	-93.52532
SF04	2	42.54587	-93.52528
SF04	3	42.54642	-93.5253
SF04	4	42.54703	-93.52528
SF04	5	42.54762	-93.52528
SF04	6	42.54822	-93.52528
SF04	7	42.54882	-93.52528
SF04	8	42.54877	-93.52295
SF04	9	42.5482	-93.52293
SF04	10	42.54762	-93.52297
SF04	11	42.54702	-93.52297
SF04	12	42.54643	-93.52297
SF04	13	42.54585	-93.52295
SF04	14	42.54527	-93.52298
SF07	1	42.51333	-93.47288
SF07	2	42.51268	-93.47283
SF07	3	42.51217	-93.47283
SF07	4	42.51158	-93.47285
SF07	5	42.511	-93.47287
SF07	6	42.51043	-93.47282
SF07	7	42.50988	-93.47282
SF07	8	42.50983	-93.47515
SF07	9	42.51045	-93.4752
SF07	10	42.511	-93.4752
SF07	11	42.51158	-93.4752
SF07	12	42.51218	-93.47522
SF07	13	42.51273	-93.47523
SF07	14	42.5133	-93.47525
SF10	1		
SF10	2		
SF10	3		
SF10	4		

Site	Point	Latitude	Longitude
SF10	5		
SF10	6		
SF10	7		
SF10	8		
SF10	9		
SF10	10		
SF10	11		
SF10	12		
SF10	13		
SF10	14		
SF14	1		
SF14	2		
SF14	3		
SF14	4		
SF14	5		
SF14	6		
SF14	7		
SF14	8		
SF14	9		
SF14	10		
SF14	11		
SF14	12		
SF14	13		
SF14	14		
SF15	1	42.41985	-93.22656
SF15	2	42.42052	-93.22662
SF15	3	42.42115	-93.22661
SF15	4	42.42188	-93.2266
SF15	5	42.42253	-93.22661
SF15	6	42.42321	-93.22661
SF15	7	42.42382	-93.22659
SF15	8	42.42391	-93.22432
SF15	9	42.42327	-93.2243
SF15	10	42.42262	-93.22429

<b>Site</b>	<b>Point</b>	<b>Latitude</b>	<b>Longitude</b>
SF15	11	42.42199	-93.22431
SF15	12	42.42136	-93.22427
SF15	13	42.42073	-93.22424
SF15	14	42.42006	-93.22424

### 3 APPENDIX B – IOP2 LOCATION DATA

The following table provides geographic coordinates for each site and sample point during intensive observation period two (IOP2).

Table B - 2. Sample Point Coordinates for IOP2

Site	Point	Latitude	Longitude
JPL-Corn	1	42.6032	-93.31215
JPL-Corn	2	42.60321	-93.31291
JPL-Corn	3	42.60322	-93.31379
JPL-Corn	4	42.60324	-93.31462
JPL-Corn	5	42.60325	-93.31549
JPL-Corn	6	42.60326	-93.31637
JPL-Corn	7	42.60329	-93.31726
JPL-Corn	8	42.60199	-93.31728
JPL-Corn	9	42.60191	-93.31646
JPL-Corn	10	42.60191	-93.31555
JPL-Corn	11	42.60188	-93.3147
JPL-Corn	12	42.60187	-93.31381
JPL-Corn	13	42.60185	-93.31297
JPL-Corn	14	42.60182	-93.31218
LTAR-Corn	1	42.48396	-93.52765
LTAR-Corn	2	42.48362	-93.5276
LTAR-Corn	3	42.4831	-93.5276
LTAR-Corn	4	42.48261	-93.5276
LTAR-Corn	5	42.48205	-93.5276
LTAR-Corn	6	42.48151	-93.52759
LTAR-Corn	7	42.48104	-93.52759
LTAR-Corn	8	42.481	-93.5267
LTAR-Corn	9	42.48159	-93.52667
LTAR-Corn	10	42.4821	-93.52667
LTAR-Corn	11	42.48264	-93.52666
LTAR-Corn	12	42.48317	-93.52666
LTAR-Corn	13	42.4837	-93.52666
LTAR-Corn	14	42.4842	-93.52667
LTAR-Soy	1	42.48599	-93.52606

<b>Site</b>	<b>Point</b>	<b>Latitude</b>	<b>Longitude</b>
LTAR-Soy	2	42.48665	-93.52606
LTAR-Soy	3	42.48732	-93.52606
LTAR-Soy	4	42.48803	-93.52606
LTAR-Soy	5	42.48871	-93.52606
LTAR-Soy	6	42.48941	-93.52606
LTAR-Soy	7	42.49012	-93.52606
LTAR-Soy	8	42.49074	-93.52151
LTAR-Soy	9	42.49008	-93.52151
LTAR-Soy	10	42.48943	-93.52152
LTAR-Soy	11	42.48874	-93.52152
LTAR-Soy	12	42.48806	-93.52151
LTAR-Soy	13	42.48743	-93.52151
LTAR-Soy	14	42.48673	-93.52152
NASA04	1	42.63683	-93.34207
NASA04	2	42.63685	-93.343
NASA04	3	42.63687	-93.34386
NASA04	4	42.63689	-93.34472
NASA04	5	42.63688	-93.34551
NASA04	6	42.63689	-93.34636
NASA04	7	42.63689	-93.34722
NASA04	8	42.63514	-93.34719
NASA04	9	42.63513	-93.34633
NASA04	10	42.63513	-93.34546
NASA04	11	42.63512	-93.34461
NASA04	12	42.6351	-93.34375
NASA04	13	42.63509	-93.34286
NASA04	14	42.63509	-93.34184
S02	1	42.29509	-93.22806
S02	2	42.29477	-93.22807
S02	3	42.29443	-93.22807
S02	4	42.2944	-93.22806
S02	5	42.29379	-93.22807
S02	6	42.2935	-93.22807
S02	7	42.2932	-93.22806

<b>Site</b>	<b>Point</b>	<b>Latitude</b>	<b>Longitude</b>
S02	8	42.29253	-93.2253
S02	9	42.29284	-93.2253
S02	10	42.29314	-93.2253
S02	11	42.29345	-93.2253
S02	12	42.29376	-93.2253
S02	13	42.29408	-93.2253
S02	14	42.2941	-93.2253
S03	1	42.29694	-93.39023
S03	2	42.29749	-93.39023
S03	3	42.298	-93.39023
S03	4	42.29855	-93.39023
S03	5	42.29908	-93.39023
S03	6	42.29961	-93.39018
S03	7	42.30015	-93.39017
S03	8	42.30017	-93.38794
S03	9	42.29959	-93.38795
S03	10	42.299	-93.38794
S03	11	42.29847	-93.38795
S03	12	42.29789	-93.38795
S03	13	42.29731	-93.38795
S03	14	42.29677	-93.38796
S04	1	42.33378	-93.44603
S04	2	42.3338	-93.44692
S04	3	42.3338	-93.44755
S04	4	42.3338	-93.44833
S04	5	42.3338	-93.44907
S04	6	42.33382	-93.44978
S04	7	42.33382	-93.45058
S04	8	42.33278	-93.45065
S04	9	42.3328	-93.44992
S04	10	42.33278	-93.44915
S04	11	42.33278	-93.44833
S04	12	42.33278	-93.44753
S04	13	42.3328	-93.44687



<b>Site</b>	<b>Point</b>	<b>Latitude</b>	<b>Longitude</b>
S04	14	42.3328	-93.44617
S09	1	42.40868	-93.36641
S09	2	42.40869	-93.36659
S09	3	42.40869	-93.36679
S09	4	42.40868	-93.36697
S09	5	42.4087	-93.36721
S09	6	42.40869	-93.36742
S09	7	42.40869	-93.36765
S09	8	42.40888	-93.36763
S09	9	42.40887	-93.36742
S09	10	42.40887	-93.36724
S09	11	42.40887	-93.36706
S09	12	42.40887	-93.36684
S09	13	42.40887	-93.36665
S09	14	42.40886	-93.36644
S10	1	42.41175	-93.55922
S10	2	42.41175	-93.55869
S10	3	42.41175	-93.55806
S10	4	42.41175	-93.55745
S10	5	42.41175	-93.55685
S10	6	42.41175	-93.55627
S10	7	42.41175	-93.55566
S10	8	42.41128	-93.55572
S10	9	42.41128	-93.55632
S10	10	42.41128	-93.55702
S10	11	42.41128	-93.55758
S10	12	42.41128	-93.55822
S10	13	42.41128	-93.55885
S10	14	42.41128	-93.55944
S11	1	42.41193	-93.53194
S11	2	42.41193	-93.53278
S11	3	42.41195	-93.53334
S11	4	42.41193	-93.5338
S11	5	42.41196	-93.53461

<b>Site</b>	<b>Point</b>	<b>Latitude</b>	<b>Longitude</b>
S11	6	42.41196	-93.53513
S11	7	42.41196	-93.53584
S11	8	42.41168	-93.53586
S11	9	42.41168	-93.53511
S11	10	42.41166	-93.53452
S11	11	42.41165	-93.53389
S11	12	42.41166	-93.5331
S11	13	42.41166	-93.53241
S11	14	42.41166	-93.53181
S13	1	42.41756	-93.52097
S13	2	42.41726	-93.52096
S13	3	42.417	-93.52094
S13	4	42.4165	-93.52095
S13	5	42.41595	-93.52096
S13	6	42.41452	-93.52098
S13	7	42.41528	-93.52095
S13	8	42.41441	-93.51975
S13	9	42.41502	-93.51974
S13	10	42.41571	-93.51974
S13	11	42.41628	-93.51973
S13	12	42.41671	-93.51972
S13	13	42.41702	-93.51973
S13	14	42.41768	-93.51967
S16	1	42.41647	-93.3866
S16	2	42.41706	-93.38663
S16	3	42.418	-93.38659
S16	4	42.41858	-93.38661
S16	5	42.41927	-93.38661
S16	6	42.41986	-93.38662
S16	7	42.42047	-93.39173
S16	8	42.42045	-93.39175
S16	9	42.41997	-93.39171
S16	10	42.41933	-93.39168
S16	11	42.41875	-93.3917

<b>Site</b>	<b>Point</b>	<b>Latitude</b>	<b>Longitude</b>
S16	12	42.41802	-93.39176
S16	13	42.4173	-93.39172
S16	14	42.41653	-93.39171
S17	1	42.42535	-93.41565
S17	2	42.42535	-93.41698
S17	3	42.42536	-93.41811
S17	4	42.42537	-93.41929
S17	5	42.42537	-93.42044
S17	6	42.42538	-93.4215
S17	7	42.42539	-93.42274
S17	8	42.4263	-93.42213
S17	9	42.4263	-93.4218
S17	10	42.42629	-93.42093
S17	11	42.42628	-93.4198
S17	12	42.42628	-93.41856
S17	13	42.42626	-93.41766
S17	14	42.42623	-93.41665
S19	1	42.42644	-93.44193
S19	2	42.42644	-93.44073
S19	3	42.42645	-93.43957
S19	4	42.42645	-93.43845
S19	5	42.42645	-93.43728
S19	6	42.42646	-93.43604
S19	7	42.42646	-93.43481
S19	8	42.42445	-93.43663
S19	9	42.42444	-93.4379
S19	10	42.42443	-93.43898
S19	11	42.42443	-93.43993
S19	12	42.42444	-93.44126
S19	13	42.42442	-93.44182
S19	14	42.42445	-93.44326
S21	1	42.42756	-93.54103
S21	2	42.42823	-93.541
S21	3	42.42889	-93.54099

<b>Site</b>	<b>Point</b>	<b>Latitude</b>	<b>Longitude</b>
S21	4	42.42963	-93.54099
S21	5	42.43033	-93.54099
S21	6	42.43098	-93.54096
S21	7	42.43167	-93.54096
S21	8	42.43167	-93.54096
S21	9	42.43092	-93.54155
S21	10	42.43023	-93.54155
S21	11	42.42952	-93.54154
S21	12	42.42881	-93.54157
S21	13	42.42817	-93.54159
S21	14	42.42752	-93.54158
S31	1	42.54362	-93.42201
S31	2	42.54362	-93.42264
S31	3	42.54362	-93.42319
S31	4	42.54362	-93.42381
S31	5	42.54362	-93.42434
S31	6	42.54362	-93.42491
S31	7	42.54362	-93.42551
S31	8	42.54413	-93.42544
S31	9	42.54413	-93.42488
S31	10	42.54413	-93.42436
S31	11	42.54413	-93.42373
S31	12	42.54413	-93.4231
S31	13	42.54413	-93.42256
S31	14	42.54413	-93.42202
S32	1	42.54876	-93.32944
S32	2	42.5483	-93.32944
S32	3	42.54789	-93.32944
S32	4	42.54745	-93.32944
S32	5	42.54702	-93.32944
S32	6	42.5466	-93.32944
S32	7	42.54616	-93.32944
S32	8	42.54619	-93.33006
S32	9	42.54662	-93.33006

<b>Site</b>	<b>Point</b>	<b>Latitude</b>	<b>Longitude</b>
S32	10	42.54714	-93.33006
S32	11	42.54757	-93.33006
S32	12	42.54805	-93.33006
S32	13	42.54849	-93.33006
S32	14	42.54894	-93.33006
S36	1	42.62856	-93.19315
S36	2	42.62857	-93.19397
S36	3	42.62857	-93.19482
S36	4	42.62857	-93.19577
S36	5	42.62858	-93.19668
S36	6	42.62861	-93.19756
S36	7	42.62861	-93.19845
S36	8	42.62727	-93.19847
S36	9	42.62727	-93.19758
S36	10	42.62727	-93.19675
S36	11	42.62725	-93.19593
S36	12	42.62726	-93.19479
S36	13	42.62725	-93.19397
S36	14	42.62727	-93.19311
SF01-Corn	1	42.39011	-93.388
SF01-Corn	2	42.39013	-93.38948
SF01-Corn	3	42.39011	-93.39012
SF01-Corn	4	42.39011	-93.39088
SF01-Corn	5	42.3901	-93.39163
SF01-Corn	6	42.39012	-93.39229
SF01-Corn	7	42.39013	-93.39295
SF01-Corn	8	42.38954	-93.39276
SF01-Corn	9	42.38953	-93.3921
SF01-Corn	10	42.38954	-93.39159
SF01-Corn	11	42.3895	-93.39063
SF01-Corn	12	42.38952	-93.38976
SF01-Corn	13	42.38948	-93.38905
SF01-Corn	14	42.38951	-93.38823
SF01-Soy	1	42.38435	-93.37772

Site	Point	Latitude	Longitude
SF01-Soy	2	42.38497	-93.3777
SF01-Soy	3	42.38562	-93.37768
SF01-Soy	4	42.38625	-93.3777
SF01-Soy	5	42.3869	-93.3777
SF01-Soy	6	42.38758	-93.3777
SF01-Soy	7	42.3882	-93.3777
SF01-Soy	8	42.3882	-93.37852
SF01-Soy	9	42.3879	-93.37853
SF01-Soy	10	42.38762	-93.37855
SF01-Soy	11	42.38732	-93.37855
SF01-Soy	12	42.38702	-93.37855
SF01-Soy	13	42.3867	-93.37853
SF01-Soy	14	42.38635	-93.37857
SF02	1	42.46891	-93.56406
SF02	2	42.46843	-93.56405
SF02	3	42.46789	-93.56404
SF02	4	42.46739	-93.56402
SF02	5	42.46684	-93.56403
SF02	6	42.46629	-93.56403
SF02	7	42.46573	-93.56403
SF02	8	42.46565	-93.5631
SF02	9	42.46614	-93.5631
SF02	10	42.46666	-93.56311
SF02	11	42.46712	-93.5631
SF02	12	42.46762	-93.5631
SF02	13	42.46807	-93.5631
SF02	14	42.46864	-93.56313
SF03	1	42.45224	-93.56184
SF03	2	42.45227	-93.5623
SF03	3	42.45229	-93.56264
SF03	4	42.45231	-93.563
SF03	5	42.4523	-93.56336
SF03	6	42.45232	-93.56371
SF03	7	42.45231	-93.56412

<b>Site</b>	<b>Point</b>	<b>Latitude</b>	<b>Longitude</b>
SF03	8	42.4531	-93.56419
SF03	9	42.45315	-93.56381
SF03	10	42.45314	-93.56345
SF03	11	42.45312	-93.56307
SF03	12	42.45311	-93.56258
SF03	13	42.45309	-93.56219
SF03	14	42.45308	-93.56178
SF04	1	42.54392	-93.52557
SF04	2	42.54461	-93.52558
SF04	3	42.54529	-93.52555
SF04	4	42.54604	-93.52556
SF04	5	42.54677	-93.52556
SF04	6	42.54751	-93.52557
SF04	7	42.5482	-93.52554
SF04	8	42.54826	-93.52641
SF04	9	42.54747	-93.5264
SF04	10	42.54655	-93.52641
SF04	11	42.54594	-93.52642
SF04	12	42.54523	-93.52643
SF04	13	42.54452	-93.52643
SF04	14	42.5439	-93.52643
SF07	1	42.51322	-93.47271
SF07	2	42.5125	-93.47269
SF07	3	42.51179	-93.47268
SF07	4	42.51107	-93.47267
SF07	5	42.51037	-93.47266
SF07	6	42.50963	-93.47265
SF07	7	42.50889	-93.47263
SF07	8	42.50884	-93.47508
SF07	9	42.50953	-93.47509
SF07	10	42.51026	-93.47511
SF07	11	42.51098	-93.47512
SF07	12	42.51169	-93.47514
SF07	13	42.51244	-93.47514

<b>Site</b>	<b>Point</b>	<b>Latitude</b>	<b>Longitude</b>
SF07	14	42.51315	-93.47516
SF10	1	42.37965	-93.40182
SF10	2	42.37967	-93.40103
SF10	3	42.37965	-93.40028
SF10	4	42.37965	-93.39955
SF10	5	42.37967	-93.39873
SF10	6	42.37962	-93.39802
SF10	7	42.37963	-93.3974
SF10	8	42.37895	-93.3974
SF10	9	42.37895	-93.39818
SF10	10	42.37897	-93.39895
SF10	11	42.37897	-93.3998
SF10	12	42.37895	-93.40062
SF10	13	42.37897	-93.40138
SF10	14	42.37898	-93.40227
SF14	1	42.33219	-93.25246
SF14	2	42.33219	-93.25315
SF14	3	42.33219	-93.25387
SF14	4	42.3322	-93.25457
SF14	5	42.3322	-93.25523
SF14	6	42.33221	-93.25595
SF14	7	42.33223	-93.25663
SF14	8	42.33045	-93.257
SF14	9	42.33086	-93.25653
SF14	10	42.33086	-93.25573
SF14	11	42.33087	-93.25497
SF14	12	42.33087	-93.2542
SF14	13	42.33086	-93.25336
SF14	14	42.33085	-93.25247
SF15	1	42.42007	-93.22187
SF15	2	42.42067	-93.22188
SF15	3	42.42129	-93.22186
SF15	4	42.42194	-93.22188
SF15	5	42.42257	-93.22189



<b>Site</b>	<b>Point</b>	<b>Latitude</b>	<b>Longitude</b>
SF15	6	42.42325	-93.22182
SF15	7	42.42388	-93.22188
SF15	8	42.42418	-93.22697
SF15	9	42.42354	-93.227
SF15	10	42.42287	-93.22699
SF15	11	42.42225	-93.22701
SF15	12	42.4216	-93.22698
SF15	13	42.42098	-93.22697
SF15	14	42.42034	-93.22697