SMAPVEX12 UAVSAR Incidence-Angle Normalized Backscatter Data, Version 1

USER GUIDE

How to Cite These Data

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

Xu, X. 2014. *SMAPVEX12 UAVSAR Incidence-Angle Normalized Backscatter Data, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/1A09OKL9G4QW. [Date Accessed].

FOR QUESTIONS ABOUT THESE DATA, CONTACT NSIDC@NSIDC.ORG

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/SV12UBK

National Snow and Ice Data Center

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1 DATA DESCRIPTION

This data set contains backscatter data obtained by the Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR) instrument. The data were collected as part of the Soil Moisture Active Passive Validation Experiment 2012 (SMAPVEX12).

1.1 Parameters

The parameter for this data set is normalized radar cross-section (dB). Valid parameter values range between -50 and 20 dB.

1.2 File Information

1.2.1 Format and File Contents

The data files are provided in flat binary format on an equi-angular grid. Files contain vertically-polarized, horizontally-polarized, and cross-polarized data. Associated Extensible Markup Language (XML) metadata files are also provided.

1.2.2 Naming Convention

Files are named according to the following convention, and as described in Table 1:

```
SV12UBK_Combined4_(3050)_YYMMDD_Ldddxyxy_CX_vv.ngrd
```

Where:

Table 1. File Naming Convention

Variable	Description
SV12UBK	Short Name
Combined4	Indicates this file contains both vertically and horizontally polarized (V- and H-pol) data
3050	Indicates 30–50 deg and refers to the incidence angle range applied in the processing. If this number is not reported, in the file name, the full range of incidence angle is applied: 20–60 deg.
YYMMDD	2-Digit Year, 2-Digit Month, and 2-Digit Day
L	L-band
ddd	Steering angle
xyxy	Polarization: HVHV, HHHH, or VVVV
CX	Cross Polarized

Variable	Description
vv	Processing version
.ngrd	Indicates this is a normalized data file
.MET.xml	Indicates this is an XML metadata file

Example: `SV12UBK_Combined4_120629_L090HHHH_CX_02.ngrd`

1.3 Spatial Information

1.3.1 Coverage

Southernmost Latitude: 49.32°N

Northernmost Latitude: 50.01°N

Westernmost Longitude: 98.67°W

Easternmost Longitude: 97.62°W

1.3.2 Resolution

The radar footprint size is approximately 6 m.

1.3.3 Geolocation

Data are provided in Universal Transverse Mercator (UTM), Zone 14 N, World Geodetic System 1984 (WGS84) coordinates.

The following table provides information for geolocating this data set.

Table 2. Grid Dimensions

North-West Corner Latitude	50.01050052°
North-West Corner Longitude	-98.67267096°
Rows	12411
Columns	18792
Latitudinal Pixel Size	$5.556e^{-5}$
Longitudinal Pixel Size	$5.556e^{-5}$

1.4 Temporal Information

1.4.1 Coverage and Resolution

Data were collected every 1 to 6 days from 17 June 2012 through 17 July 2012.

2 DATA ACQUISITION AND PROCESSING

2.1 Theory of Measurements

The UAVSAR instrument collects data over a wide range of incidence angles between 25 and 65 degrees. The nominal swath is approximately 21 km. The SMAP instrument operates at a fixed angle of 40 degrees. Since the incidence angle has a significant effect on backscattering, it is necessary to normalize the UAVSAR data to fully utilize the swath.

2.2 Processing

The incidence angle correction is based on the HIST method (Mladenova et al, 2013). The method is based on histogram matching as opposed to normalization with cumulative frequencies. As indicated in the paper, the HIST technique will preserve the natural signal variability as opposed to the cumulative distribution function (CDF) technique where it is going to be limited by and to the variability observed in the reference line. The lowest two central moments are used in the calculation, the mean and variation for every 1 degree incidence angle.

For SMAPVEX12, four diagonal flight lines covered the study domain and two horizontal lines were flown over to complement the Passive Active L-band System (PALS) instrument coverage in a day (as shown in Figure 1). To minimize the statistical error, we group the four diagonal images of the same day for the statistical (mean and variation) calculation. The other two horizontal images are calculated together but are separated from the diagonal images for determining azimuthal angle. In addition, data values lower than the noise equivalent values suggested by the UAVSAR team and greater than 5 dB were excluded for statistical calculation. Refer to the correction flow chart shown in Figure 2.

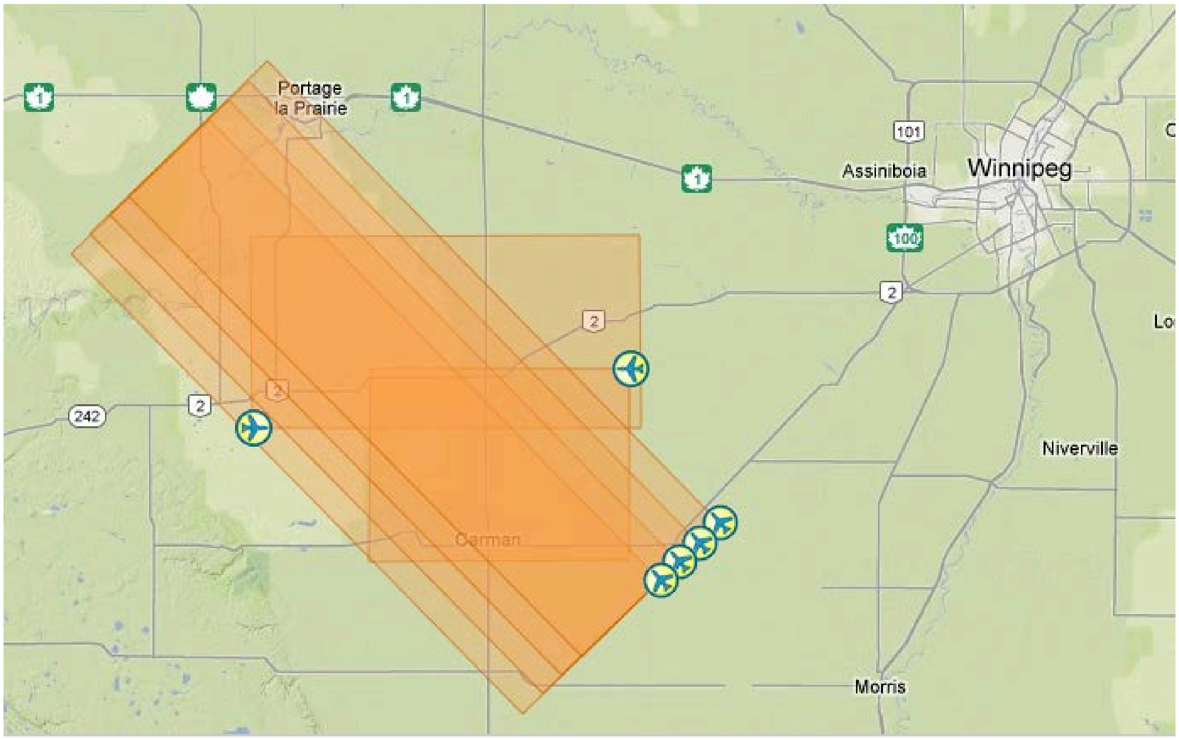

Figure 1. Map showing UAVSAR flight line and coverage.

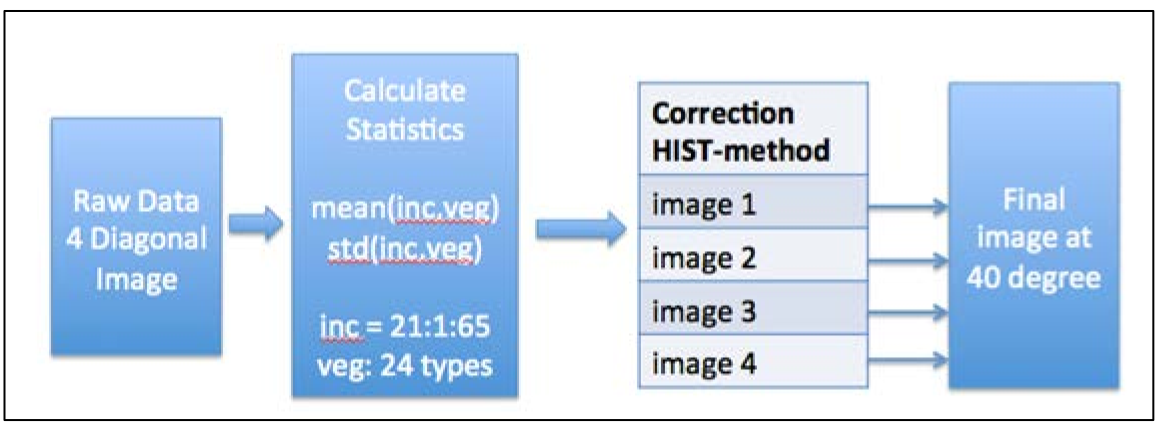

Figure 2. Flow chart of the incidence angle normalization process.

Based on the vegetation map from Agriculture and Agri-Food Canada (AAFC), the mean and variation for the covered 24 vegetation classes are calculated at one-degree intervals from 21° to 65°; for example, 21° represents all pixels from 20.5° to 21.5° for vertically and horizontally cross-polarized measurements (VV and HH, respectively). A more narrow range (from 21° to 50°) is used for cross-polarization due to the large error at the edge. The normalized backscattering for each pixel can be calculated as follows:

$$\sigma_{norm,VC} = \bar{\sigma}_{ref=40,VC} + \hat{\sigma}_{ref=40,VC} \cdot \frac{\sigma_{raw\_inc,VC} - \bar{\sigma}_{raw\_inc,VC}}{\hat{\sigma}_{raw\_inc,VC}}$$

where $\sigma_{raw\_inc,VC}$ is the radar backscattering (dB) in the raw data, and raw_inc,VC indicates the raw data with original incidence angle and corresponding vegetation class.

The mean and standard deviation— $\bar{\sigma}$ and $\hat{\sigma}$, respectively—are computed for each vegetation class (VC) and every degree of incidence angle (21° to 65° for VV & HH, 21° to 50° for HV). In our case, the reference line is at 40 degrees.

After processing each diagonal image, the final image will average the overlapping areas and combine the four images into one. Most ground study areas are covered by the overlapping areas (across three or four images).

2.2.1 Data Sets

The vegetation map used in the normalization is shown in Figure 3.

To match up with the UAVSAR data, the map is re-gridded into the same equiangular coordinate system in which the normalized radar cross-section is found.

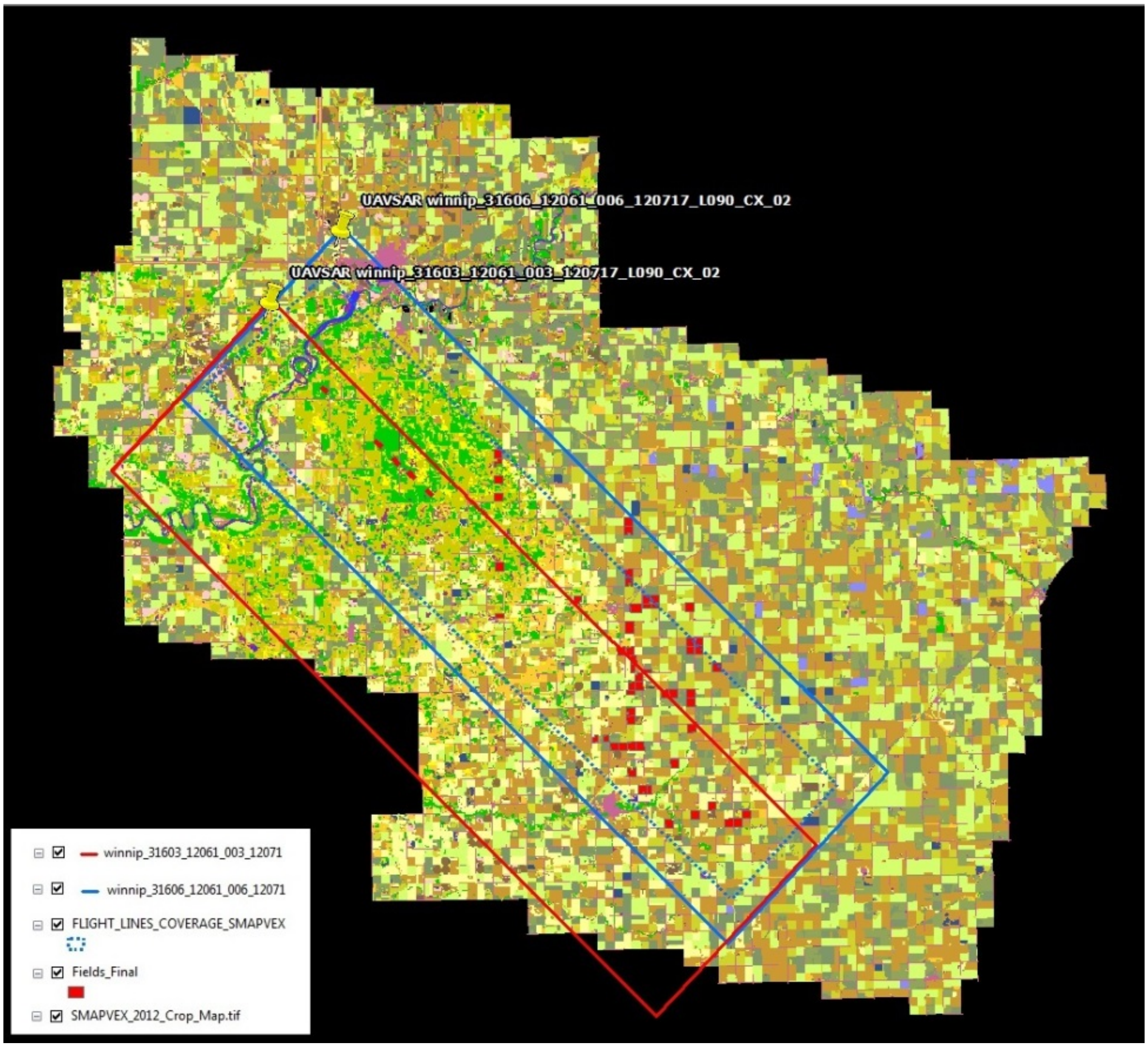

Figure 3. Vegetation map used in the incidence angle normalization process.

2.2.2 Raw Data & Normalized Data

The ground-projected file (.grd) is taken as the raw data.

According to the Jet Propulsion Laboratory (JPL) UAVSAR Web page:

UAVSAR projects slant range images to ground range using the backward projection method. An equiangular grid is found with latitude and longitude boundaries that cover the entire slant range image. For each point on the ground range grid, the corresponding indices are calculated on the multilooked slant range image. The data value closest to the coordinates pointed by the calculated slant range indices is assigned to the point on the ground range grid.

The normalized image (`.ngrd`) will keep the same naming convention and format. The only difference is the `.grd` file is power in natural number while `.ngrd` is in dB.

2.2.3 Final Image

Each final image is an average of four diagonal images. Since there are a few missing diagonal images in the current version, the 19 June final image is a combination of two images, and the 22, 23, and 25 June final images are a combination of three images.

2.3 Quality, Errors, and Limitations

As stated in the Final Image section above, there are a few missing diagonal images in the current version. This increases the uncertainty of the incidence-angle normalized values on these days. See Mladenova et al, 2013 for the quality assessment of the method.

3 CONTACTS

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4 REFERENCES

McNairn,H., T. Jackson, G. Wiseman, S. Belair, A. Berg, P. Bullock, A. Colliander, M. Cosh, S. Kim, R. Magagi, M. Moghaddam, J. Adams, S. Homayouni, E. Ojo, T. Rowlandson, J. Shang, K. Goita, M. Hosseini. 2013. In Review. The Soil Moisture Active Passive Validation Experiment 2012 (SMAPVEX12): Pre-Launch Calibration and Validation of the SMAP Satellite. *IEEE Trans. Geosci. Rem. Sens.*

Mladenova, I. E., T. J. Jackson, R. Bindlish, S. Hensley. 2013. Incidence Angle Normalization of Radar Backscatter Data. *IEEE Transactions on Geoscience and Remote Sensing*. 51(3):1791-1804. http://dx.doi.org/10.1109/TGRS.2012.2205264.

5 DOCUMENT INFORMATION

5.1 Publication Date

April 2014

5.2 Date Last Updated

March 2020