ASAR GM SSM Widget

(widget for processing of the ASAR GM Surface soil moisture dataset)

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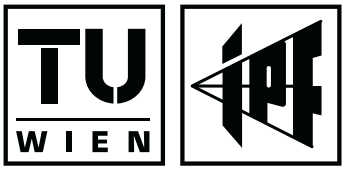

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Introduction

This document describes:

a) the functionality and installation of the widget for processing of the ASAR GM Surface Soil Moisture (SSM) dataset

b) the ASAR GM SSM dataset itself

The ASAR GM SSM data are derived from the ENVISAT ASAR Global Mode (GM) database. The database was developed at the Institute of Photogrammetry and Remote Sensing (IPF), Technical University of Vienna, Austria (TU WIEN).

The ASAR GM SSM widget is stored as an IDL Virtual Machine (VM) – freeware IDL utility. The widget offers options for:

a) extraction of the ENVI binary files for selected regions
b) conversion to GeoTIFF formats
c) computation of monthly means from existing ENVI binary files
d) extraction of time-series for a specific cell or region..

1 Widget installation

The output widget file is stored as an IDL VM file.

If you have IDL or IDL VM running on your computer you will be able to start the ASAR GM SSM Widget automatically by simply downloading the sav file from our website (http://www.ipf.tuwien.ac.at/radar/share/asar_user_widget.sav).

If you don't have IDL or IDL VM running on your computer first download the free IDL runtime utility from http://www.exelisvis.com. The registration on the website is required. The authorisation of the account takes usually one business day; if longer, contact the exelisvis technical support.

The download and installation of the entire IDL software package is required to be able to run the IDL VM. **However, no license is required to run IDL VM!** After the installation, the IDL VM can be found under IDL-Tools-IDL Virtual Machine.

2 Widget function

A set of ENVI binary georeferenced images representing Surface Soil Moisture from ASAR GM is delivered to a user. The ENVI binary files maintain convention for naming as discussed in section 4.1. User is advised to store all files into one folder.

The delivered ENVI binary files may but do not have to share a common extent. This is given by the irregularity (Figure 1) of the ENVISAT ASAR orbit. Especially for requests covering large areas it's efficient to extract to ENVI file only that part of the region that is covered by the ASAR orbit.

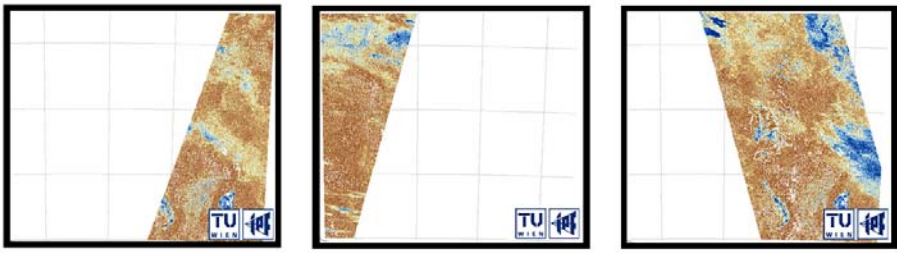

Figure 1
A figure demonstrates the irregularity of the ENVISAT ASAR orbits.

For easier manipulation with the large amount of files a widget program has been generated in the IDL software that offers function for:

Image extraction(Tab1)

1) Extracting smaller size area within existing region of interest
2) Converting ENVI binary to GEOTIFF formats
3) Computing monthly mean for selected months

Time-series extraction (Tab2)

4) Extracting point time-series
5) Extracting area time-series

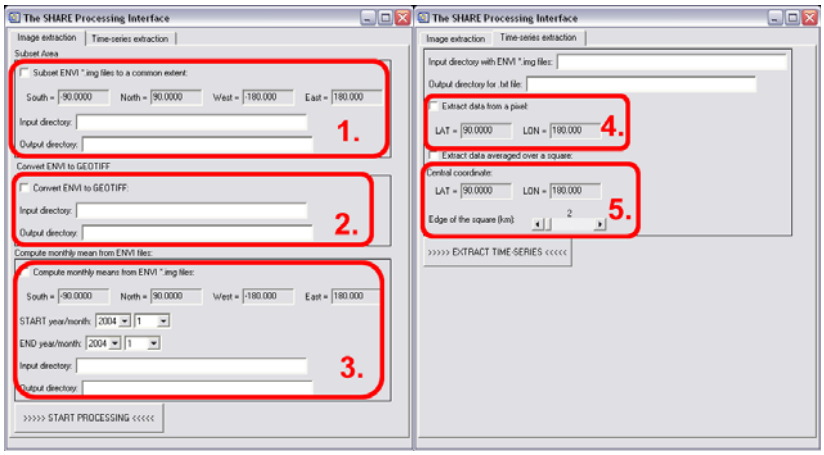

Figure 2
The SAHRE processing interface.

2.1 Subseting ENVI images to common extent

In order to generate ENVI images with a constant extent of similar or smaller size as the original images a menu "Subset ENVI *.img files to a common extent" should be selected. This searches for all *.img files in the input directory, subsets these according to provided coordinates, and stores into the output directory. The maximum extent of the subset area is 20 by 20 degrees.

Please note that at least one of the border coordinates must lie within the coordinates of the originally requested area. The background value of extracted images is set to -9999, the masked areas retain the value -10000.

2.2 Converting ENVI images to GeoTIFF

"Convert ENVI to GeoTIFF" procedure converts all existing *.img files in the input directory to a GeoTIFF format and saves them into the output directory.

Please note that at least one of the border coordinates must lie within the coordinates of the original image. The background value of extracted images is set to 255; the masked areas retain the value 254.

2.3 Computing monthly means from ENVI images

"Compute monthly means from ENVI" selects all existing images in the input folder and computes the monthly means. The year and the month of the acquisition from the header file are used for the selection of the file corresponding to a particular year and month. Thus, it's important that the input files follow the TU WIEN naming routine - TUW_ASAGW_SSM_M02_YYYYMMDD_HHMMSS_XXXX*.img.
The monthly mean is generated only when 6 or more images are available.

2.4 Extracting point time-series from a point

Many data users requested the ASAR SSM for performing a cross-comparison with other in-situ or remote sensing data. A time-series is re-

quired in these cases. For this purpose a procedure - "Extract data from a pixel" - is provided in a second Tab of the widget. When selected a widget extracts point time-series from all existing ENVI binary *.img files in the input directory. The time-series are extracted form a grid nearest to the specified coordinates. The time-series representing Surface soil moisture and the date are stored into a txt file (see Figure X) in the output folder. The exact coordinate of the pixel is included in the file name.

The date of the acquisition from the header file is also written to the output txt file. Thus, it's important that the input files follow the TU WIEN naming routine - TUW_ASAGW_SSM_M02_YYYYMMDD_HHMMSS_XXXX*.img.

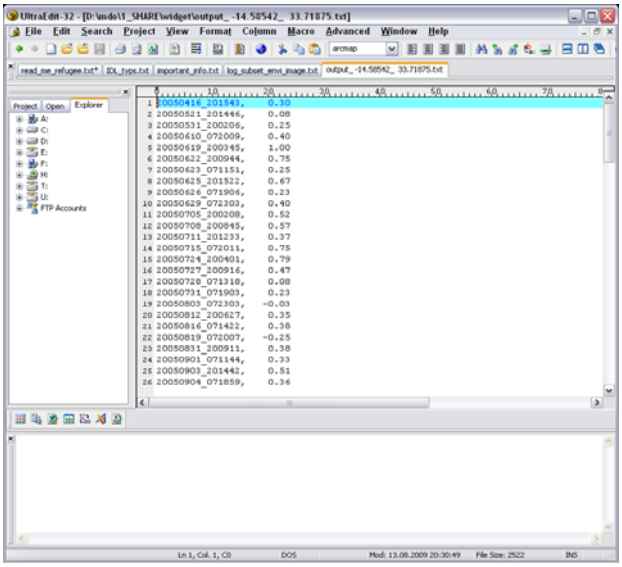

Figure 3
An example of the output txt file from the procedure - "Extract data from a pixel".

2.5 Extracting point time-series from a region

The procedure "Extract data averaged over a square" extracts soil moisture from all pixels within the specified region and from all images in the input folder and average these spatially. A region is specified by an edge of a square and coordinate of the square centre. The output is similar to that displayed in Figure X.

The date of the acquisition from the header file is also written to the output txt file. Thus, its important that the input files follow the TU WIEN naming routine - TUW_ASAGW_SSM_M02_YYYYMMDD_HHMMSS_XXXX*.img.

3 ASAR Surface Soil Moisture (in a nutshell)

3.1 Parameter information

Parameter name:
ASAR Surface Soil Moisture 1 km

Physical Definition:
The data represent relative surface soil moisture (for the top few centimetres of soil profile) at the time of acquisition (acquisition date and time is given by the filename). The surface soil moisture is derived by scaling the backscatter amplitudes between references, which approximates the wilting level and field capacity. Thus, 0% corresponds to completely dry conditions and 100% corresponds to completely wet (saturated) conditions.

Unit: Percent

3.2 Product information

Product format:
The products are available as ENVI files or GeoTIFF files.

Range of the parameter values:
0.0 - 1.0 (ENVI format)
0 - 100 (GeoTIFF format)

Background values:
-9999 (ENVI format)
255 (GeoTIFF format)

Values of masked pixels
(due to land cover or low correlation in Scaling Layer)
ENVI files: -10000
GeoTIFF files: 254

File naming:
TUW_ASAGW_SSM_001_YYYYMMDD_HHMMSS_ZZZZZ
e.g., TUW_ASAGW_SSM_001_20041211_070626_02tg7

Temporal coverage (yyyy-mm-dd):
Start: 2004-12-11
End: regularly updated

Temporal resolution:

Irregular, can range from 2 to 350 days. Additional modes are available from ENVISAT ASAR sensor which compete for data acquisition with Global Mode. Extensive coverage is available for the region of southern Africa. (see gm_coverage_2005_2006.JPG)

Spatial coverage of the product:
Currently, data are processed only over African (SADC region) and Australian continent. The potential, however, exist to process data globally.

Spatial resolution:
30 arcseconds (~1 km at equator)

Sampling interval:
15 arcseconds

Projection:
Coordinates are geographic (lon/lat)

Datum:
WGS84

Processing software:
IDL 6.3 on Windows

3.3 Sensor information

Sensor name:
ENVISAT Advanced Synthetic Aperture Radar (ASAR), Global Mode

Summary of the retrieval methodology:
The backscatter measurements are scaled between reference values corresponding to the driest and wettest soil moisture conditions observed within the time series at each pixel location. The reference values are derived from ENVISAT ASAR data using probabilities for wet and dry conditions from a multi-year ERS-1/2 scatterometer soil moisture archive (1992 - 2000).

Radiometric resolution:
~1.2 dB

References for ASAR:
1. M. Doubková, A.I.J.M. Van Dijk, D. Sabel, W. Wagner, G. Bloeschl, "Evaluation of predicted soil moisture retrieval error from C-Band SAR by comparison against soil moisture estimates over Australia," Remote Sensing of Environment, in press.
2. C. Pathe, D. Sabel, M. Doubkova, J. Basara (2009), Using ENVISAT ASAR Global Mode Data for Surface Soil Moisture Retrieval

Over Oklahoma, USA, IEEE Transactions on Geoscience and Remote Sensing 47(2), art. no. 4773463,468-480.

3. W. Wagner, K. Scipal, C. Pathe, D. Gerten, W. Lucht, B. Rudolf (2003) Evaluation of the agreement between the first global remotely sensed soil moisture data with model and precipitation data, Journal of Geophysical Research - Atmospheres, Vol. 108, No. D19, 4611, doi:10.1029/2003JD003663

Known problems:

- The vegetation and roughness "correction" is static. We are aware that this is a critical simplification.
- The method to retrieve soil moisture is in principal a change detection method. Temporal variations can therefore be retrieved accurately, whereas the absolute level of soil moisture can be biased in certain regions.
- The azimuthal viewing geometry of the sensor is not taken into account during the retrieval. Azimuthal artefacts occur mainly in mountainous and sand desert regions.
- Retrieval of soil moisture is not possible under snow and frozen soil conditions.
- Open water surfaces are known to cause errors in the retrieval.

4 Surface Soil Moisture ASAR processing

4.1 Briefly about the ASAR GM Processing chain

The ASAR Surface Soil Moisture ENVI binary images and GeoTIFFs are derived from the existing ENVISAT GM database at the IPF, TU WIEN. Currently, datasets are processed over SADC region and Australia. There is a potential for global processing. This chapter describes the ASAR processing chain at the IPF.

The processing chain to derive the ENVISAT ASAR products relies on both spatial and time series analysis. Because of the large number of images (more than hundred thousand) it was necessary to organise the information in a database that efficiently facilitates both spatial and temporal analysis.

Raw ASAR images (ESA product name ASA_GM1_1P) are geocoded and then resampled to a fixed regular gridded database. The backscatter dependency on the local incidence angle is normalised in the normalisation step. During filtering erroneous data are removed. The scaling step consists of scaling backscatter between reference values, which represent dry and wet soil surface conditions, to generate the data that is the basis

for the 1 km Surface Soil Moisture (1 km SSM) product (Pathe, 2009). In the final step ENVI binary files are generated over entire SADC region.

For each data request a set of ENVI binary images is extracted from the database that covers the requested area of interest. The delivered ENVI binary files can be viewed and analysed in variety of GIS and Remote Sensing Software (ArcGIS, ENVI, ArsMap, QGIS etc.) An example from ArcGIS software can be seen in Figure 1 (a special plug-in ENVI Reader for ArcGIS is needed, this is available from the ITT website: http://www.ittvis.com/download/download_splash.asp?wdiid=548).

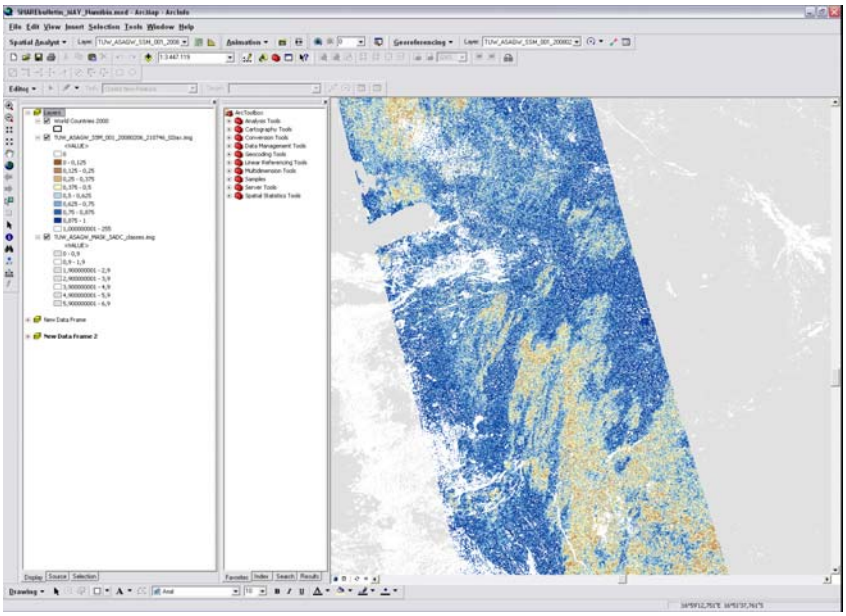

Figure 4
A subset from the ArcGIS software with opened Surface Soil Moisture ENVI binary image from 2nd of June, 2008 (the Arcmap color layer file is available on our ftp).

5 Most Important References

C. Pathe, D. Sabel, M. Doubkova, J. Basara (2009), Using ENVISAT ASAR Global Mode Data for Surface Soil Moisture Retrieval Over Oklahoma, USA, IEEE Transactions on Geoscience and Remote Sensing 47(2), art. no. 4773463,468-480.

W. Wagner, K. Scipal, C. Pathe, D. Gerten, W. Lucht, B. Rudolf (2003) Evaluation of the agreement between the first global remotely sensed soil moisture data with model and precipitation data, Journal of Geophysical Research - Atmospheres, Vol. 108, No. D19, 4611, doi:10.1029/2003JD003663

For more references please visit our website:

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