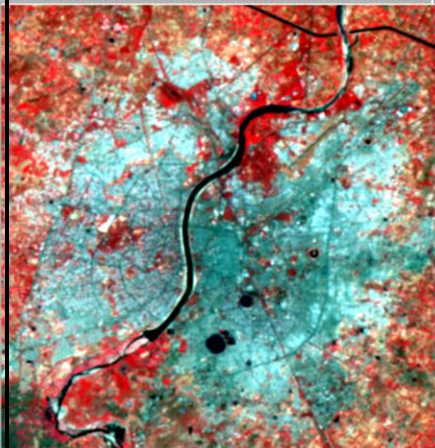




# SACRS2- A Scheme for Atmospheric Correction of Resourcesat-2 AWiFS data

## User Guide, Version 1

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# **SACRS2: Scheme for Atmospheric Correction for Resourcesat-2 AWiFS**

## **1. INTRODUCTION:**

The signal received at the satellite-based sensor in the visible-near infrared spectral region is attenuated by the atmospheric gases and aerosols through absorption and scattering processes, which has to be compensated by an appropriate procedure to obtain accurate reflectance of the surface. The procedure for removing the atmospheric effects from the satellite-measured signal to retrieve the surface reflectance is called atmospheric correction.

This document presents a user guide for utilizing the SACRS2 (Scheme for the Atmospheric Correction of ReSourceSat-2 AWiFS data) model. The AWiFS is one of the three payloads onboard Resourcesat-2 (RS2) satellite having four spectral channels in green (0.52-0.59  $\mu\text{m}$ ), red (0.62-0.68  $\mu\text{m}$ ), near-infrared (NIR) (0.77-0.86  $\mu\text{m}$ ) and shortwave infrared (SWIR) (1.55-1.70  $\mu\text{m}$ ) spectral regions with a nominal spatial resolution of 56 m.

The package named SACRS2 has been developed using a C-program written for atmospheric correction of the RS2 AWiFS data. The code uses a method developed by Pandya *et al.* (2013) to correct the remote sensing signal perturbed due to molecular and aerosol scattering. The scheme is based on the radiative transfer model simulations by 6SV code (Vermote *et al.*, 2006).

User has to provide the raw data (digital numbers) of RS2-AWiFS and inputs related to atmospheric parameters and viewing geometry to obtain the atmospherically corrected surface reflectance. The present SACRS2 model for atmospheric correction is tuned for continental aerosols and tropical atmospheric conditions.

The inputs, outputs and procedure to perform atmospheric correction with SACRS2 are described in following sections.

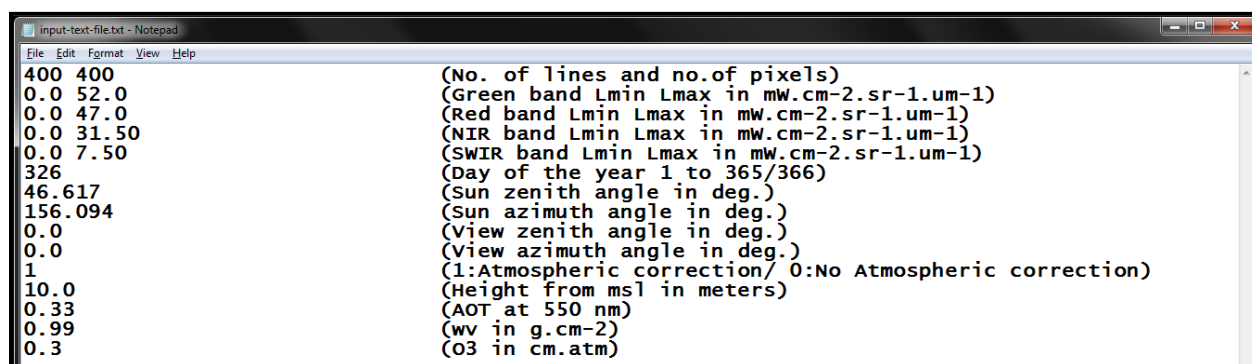
## 2. DESCRIPTION OF INPUTS TO PERFORM ATMOSPHERIC CORRECTION:

The SACRS2 requires two sets of inputs,

- (A) An input text file containing information of atmosphere and viewing geometry,
- (B) Raw RS2-AWiFS image (digital numbers) with 4 spectral bands (radiometrically corrected Level-2 products).

### (A) Description of input text file:

An example of text file containing essential inputs for atmospheric correction is shown in figure 1. The inputs are written along with their description in the text file. **Note that it is essential to write the description of inputs in the text file (provided in the brackets).** The limit of characters to name the input text file is 25. The details of inputs in the text file are described in the following page.



**Figure 1:** Input text file containing inputs for Atmospheric Correction.

### Description of each input:

- a. **No. of lines and pixels:** (Variable type: int) First enter number of lines (i.e. rows) of the image and then enter the number of pixels (i.e. columns) of the image.  
e.g. 400 400
- b. **Lmin and Lmax:** (Variable type: float) Enter the minimum and maximum saturation radiance values of a sensor (Lmin & Lmax, in  $\text{mW}/\text{cm}^2/\mu\text{m}/\text{sr}$ ) for the four bands (in the order 2345). Please leave a space between the values of Lmin and Lmax. The values for Lmin and Lmax of each band are generally provided in the Band\_Meta file.  
e.g. 0.0 52.0  
0.0 47.0  
0.0 31.5  
0.0 7.50
- c. **Day of the year:** (Variable type: int) Enter day of the year (1 to 365/366) on which the image is acquired.  
e.g. 326 (for 22 November)
- d. **Sun Zenith angle:** (Variable type: float) Enter sun zenith angle in degrees. Generally the solar elevation angle is provided with Band\_Meta file. The sun zenith angle can be computed from the solar elevation angle, as  $(90^\circ - \text{solar elevation angle})$ .  
e.g. 46.617
- e. **Sun Azimuth angle:** (Variable type: float) Enter sun azimuth angle in degrees (range: 0-180 degrees).  
e.g. 156.094
- f. **View Zenith angle:** (Variable type: float) Enter view zenith angle in degrees (range: 0-26 degrees).  
e.g. 0.0
- g. **View Azimuth angle:** (Variable type: float) Enter view azimuth angle in degrees (range: 0-180 degrees).  
e.g. 0.0
- h. **Option for Atmospheric Correction (0 or 1):** (Variable type: int) Select the option for performing atmospheric correction (1: Atmospheric Correction ON /0: No

Atmospheric Correction). If atmospheric correction is not performed then the code will only return the top-of-atmosphere reflectance. If the Atmospheric correction option is turned ON then the following essential inputs (j to m) will be considered in the correction procedure and surface reflectance will be computed.

- i. **Height from mean sea level:** (variable type: float) Enter the terrain height from mean sea level in meters.

e.g. 10.0

- j. **Aerosol Optical Thickness (AOT at 550 nm) at 550 nm:** (variable type: float) Enter value of AOT at 550 nm (unit less). AOT can be acquired from *in-situ* (Sunphotometer or AERONET) data or can be downloaded from MODIS data website (<http://ladsweb.nascom.nasa.gov>, MOD04 product). A single representative value should be provided for the study site/image.

e.g. 0.33

[Typical AOT value → Clear: 0.1, Medium aerosol load: 0.25, High aerosol load: >0.4]

- k. **Water Vapor:** (variable type: float) Enter the value of columnar water vapor in  $\text{g.cm}^{-2}$ . The water vapor values can be acquired from hand-held Sunphotometer or downloaded from (<http://ladsweb.nascom.nasa.gov>, MOD05 product). A single representative value should be provided for the study site/image.

e.g. 0.99

[Typical values of water vapor → Low: 0.5, Medium: 1.5, High: >2.0]

- l. **Ozone:** (variable type: float) Enter the value of ozone concentration in  $\text{cm-atm}$ . The ozone content values can be acquired from hand-held Ozonometer or downloaded from (<http://ladsweb.nascom.nasa.gov>, MOD08\_M3/ozone product). A single representative value should be provided for the study site/image.

e.g. 0.3

[Typical values of ozone → Low: 0.24, Medium: 0.28, High: 0.32]

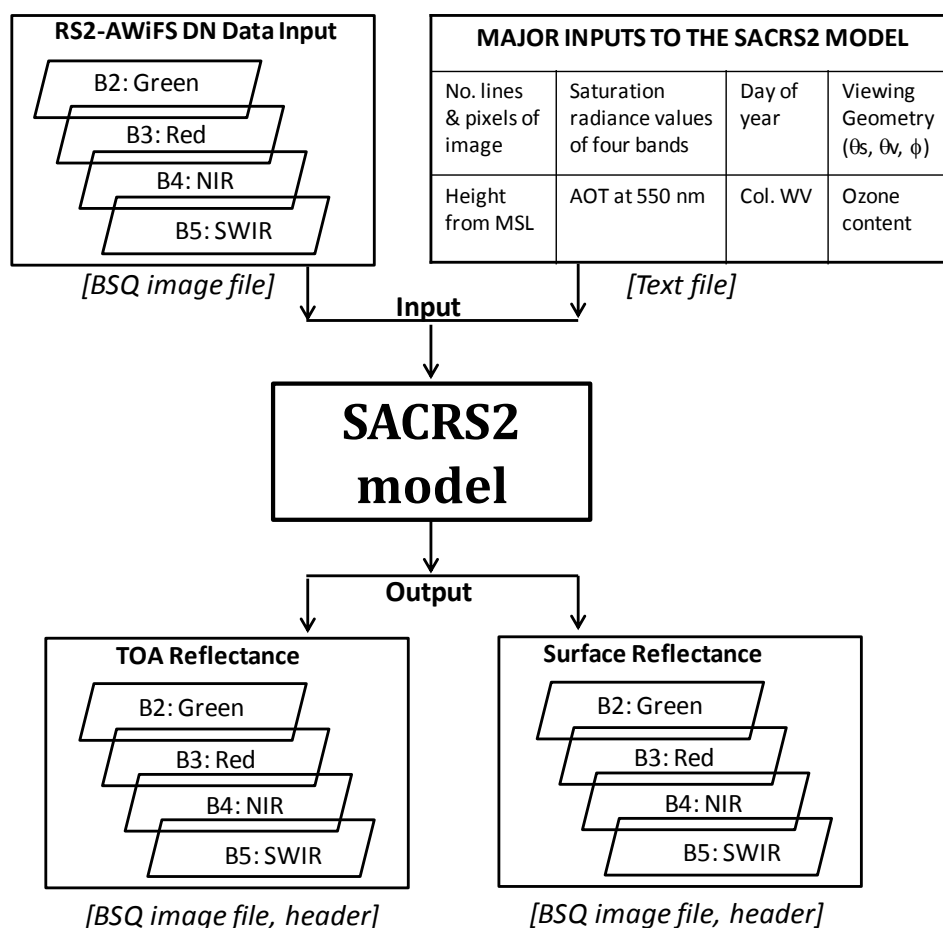
**(B) Important Instructions to organize Resourcesat-2 AWiFS Data before using SACRS2:**

1. The radiometrically corrected Level-2 raw data (digital numbers) of Resourcesat-2 AWiFS is generally available in TIFF format (each band separately). Before correcting for atmospheric effects user needs to prepare a binary file having stack of the digital number data.
2. With the help of image processing software (for e.g. ENVI) save the stack of 4 bands in the order 2345 (i.e. green, red, NIR and SWIR bands respectively) in BSQ interleave and 2 byte Unsigned integer format. The byte order of the image must be set to 0 before correcting for atmospheric effects with SACRS2.
3. The file must be a binary file (for e.g. Standard ENVI file format is a binary file format).
4. Input image file should be named in manner so that there should not be any space in between the two characters. The number of characters in the image filename should not exceed 25.



### 3. PROCEDURE FOR ATMOSPHERIC CORRECTION WITH SACRS2:

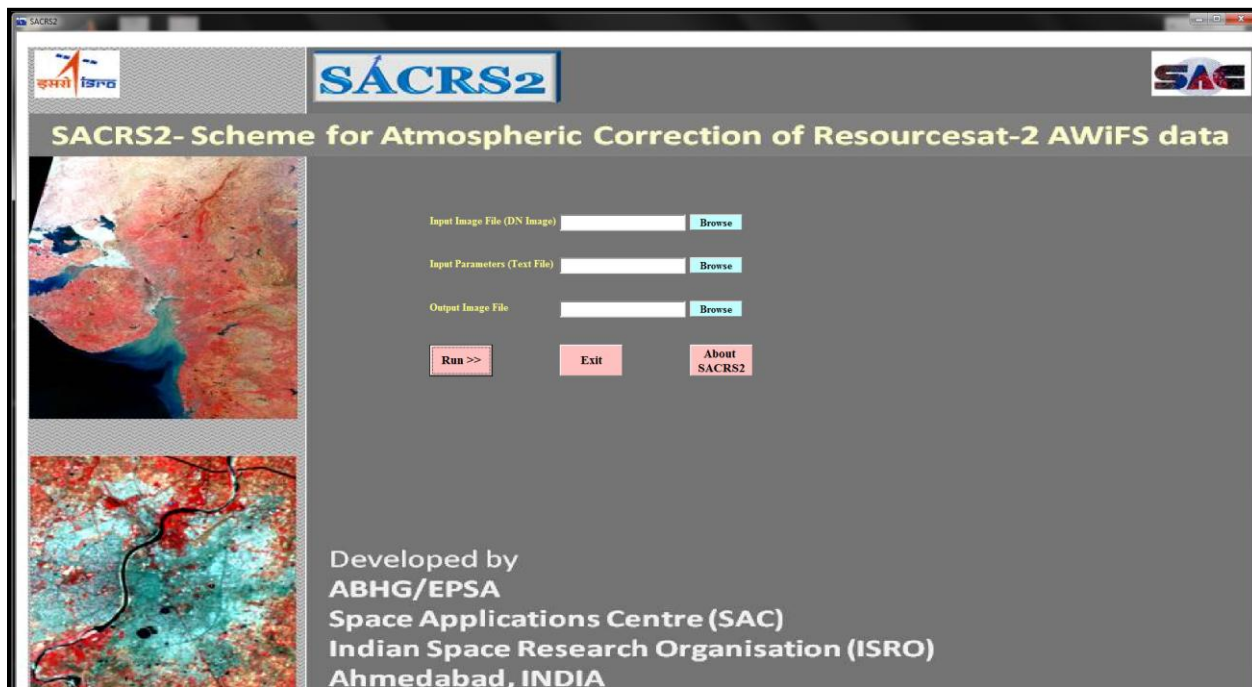
In order to perform atmospheric correction with SACRS2; the procedure shown in the following figure is implemented to obtain the surface reflectance from the uncorrected digital number (DN) data.



**Figure 2:** Schematic diagram showing the inputs and flow for the SACRS2 implementation.

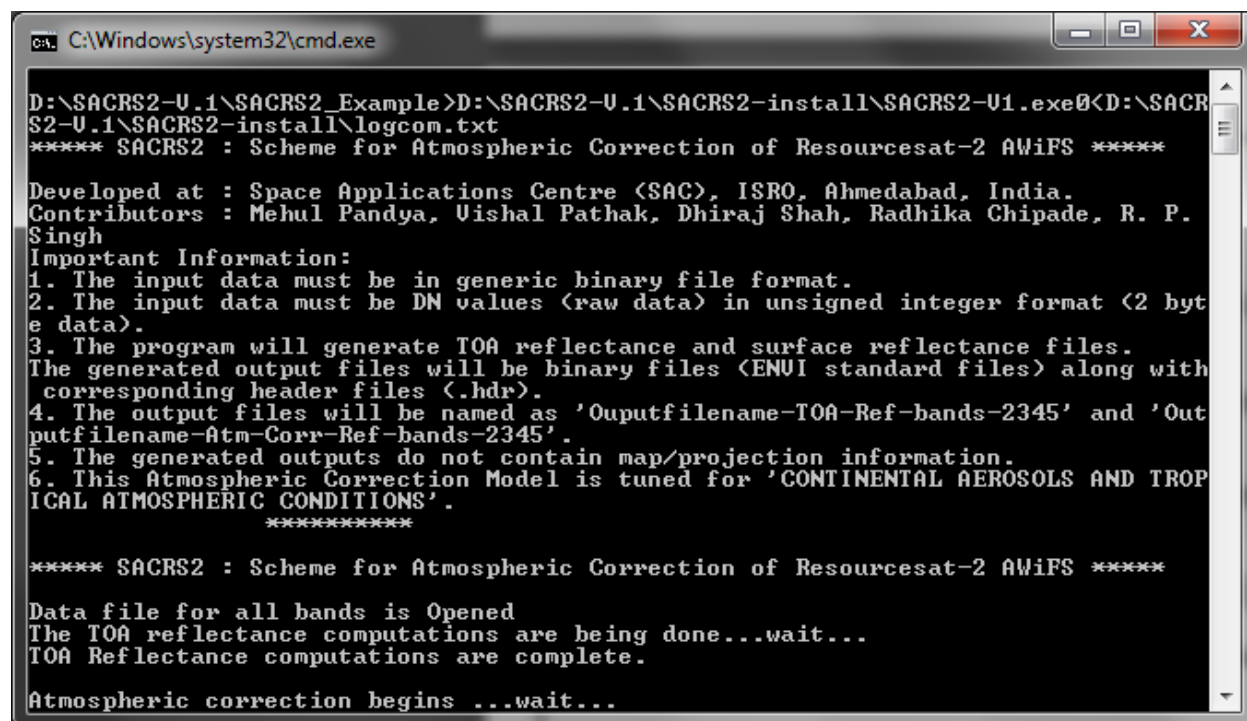
On the execution of the SACRS2 package, it will query for two inputs: (1) RS2-AWiFS input image file (raw data i.e. digital numbers) and (2) input text file and an output file name along with its path as shown in figure 3. User has to browse the input image file and input text file containing all the required inputs. User has to specify the output file name at the location where output files are to be stored. The **Run** command will execute the atmospheric correction model SACRS2. The SACRS2 returns two outputs, (1) top-of-atmosphere reflectance and (2) atmospherically corrected surface reflectance. The description of the output files is given in the next section.





**Figure 3:** Snapshot of the SACRS2: Enter the name of input image file, input text file and output file name to perform atmospheric correction.

The turn-around time for the atmospheric correction with SACRS2 will depend upon the image size. The figure 4 shows the message that will be displayed while SACRS2 is performing the atmospheric correction procedure.



**Figure 4:** Snapshot of the SACRS2-V1.exe: Atmospheric Correction is in Progress.

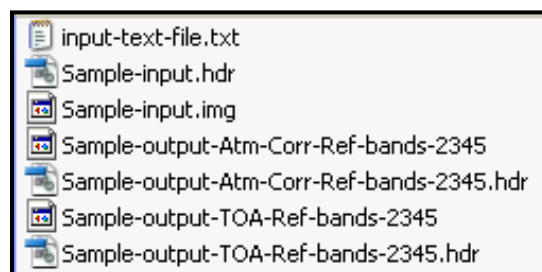
#### 4. DESCRIPTION OF OUTPUT FILES:

1. The program will generate two output files viz. top-of-atmosphere reflectance and surface reflectance. The output files will carry the names 'Outputfilename-TOA-Ref-bands-2345' and 'Outputfilename-Atm-Corr-Ref-bands-2345' (if atmospheric correction option is turned on). If option for atmospheric correction is turned off then only top-of-atmosphere reflectance will be generated.
2. The output files will be binary files in 4 byte floating point format.
3. The output files are supported with the header files 'Outputfilename-TOA-Ref-bands-2345.hdr' and 'Outputfilename-Atm-Corr-Ref-bands-2345.hdr'. Header file will contain the information about the sample, lines, number of bands, interleave, byte order and header offset. (For further details of these individual terms users are directed to any reference related with digital remote sensing).
4. The output files do not contain map/projection information. User may include this information if required.
5. The output files can be opened with image processing software (for e. g. ENVI).

#### Example of Input and Output files:

A set of following seven example files is provided in the SACRS2\_Example folder along with SACRS2 package (shown in figure 5),

- input text file
- sample input image file (400 pixels X 400 lines) with header file
- output image files (Atm. Corrected Reflectance & TOA reflectance) with header files



**Figure 5:** Snapshot showing sample files provided in the SACRS2\_Example folder.

## 5. HANDLING SACRS2 IMAGES WITH IMAGE PROCESSING SOFTWARE (ENVI):

As mentioned earlier, RS2-AWiFS raw data (digital numbers) is available in TIFF format separately for each band. User may follow the following steps to implement SACRS2 on RS2-AWiFS data with image processing software ENVI:

- a. Open the image files for each channel of RS2-AWiFS (bandname.tif files) in ENVI for which select **File** → **Open Image File**.
- b. Before implementing the atmospheric correction, raw data must be organized in a single image file which is a stack of 4 spectral channels of the RS2-AWiFS data in BSQ interleave. To prepare a stack of 4 bands in BSQ interleave, select the option, **Basic Tools** → **Layer Stacking** → **Import File**. The choice of map/projection information is with the user. However, it does not matter whether the projection information is attached with raw data or not, as standard ENVI format is generic binary file format. User may also select the option **File** → **Save File as** → **ENVI Standard**. **Note that by default ENVI Standard Format will store the data in BSQ interleave.**
- c. Perform the atmospheric correction with SACRS2 and the two output files will be stored viz. top-of-atmosphere reflectance and atmospherically corrected surface reflectance.
- d. To open the TOA reflectance and atmospherically corrected reflectance files with ENVI again select the option **File** → **Open Image File**. Files are now ready for the further use.

## REFERENCES

- Pandya M. R., Pathak V. N, Shah D. B., Chipade R. A., Singh R. P., Parihar J. S. and Kirankumar A. S. (2013). Development of a scheme for atmospheric correction of Resourcesat-2 AWiFS data. *Int. J. Applied Earth Obs. Geoinformation*. (communicated).
- Vermote E. F., Tanre D. Deuze J. L., Herman M., Morcrette J. J. and Kotchenova S. Y. (2006), Second Simulation of a Satellite Signal in the Solar Spectrum – Vector (6SV), 6S-User Guide Version 3, Nov. 2006. 243 pp.

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