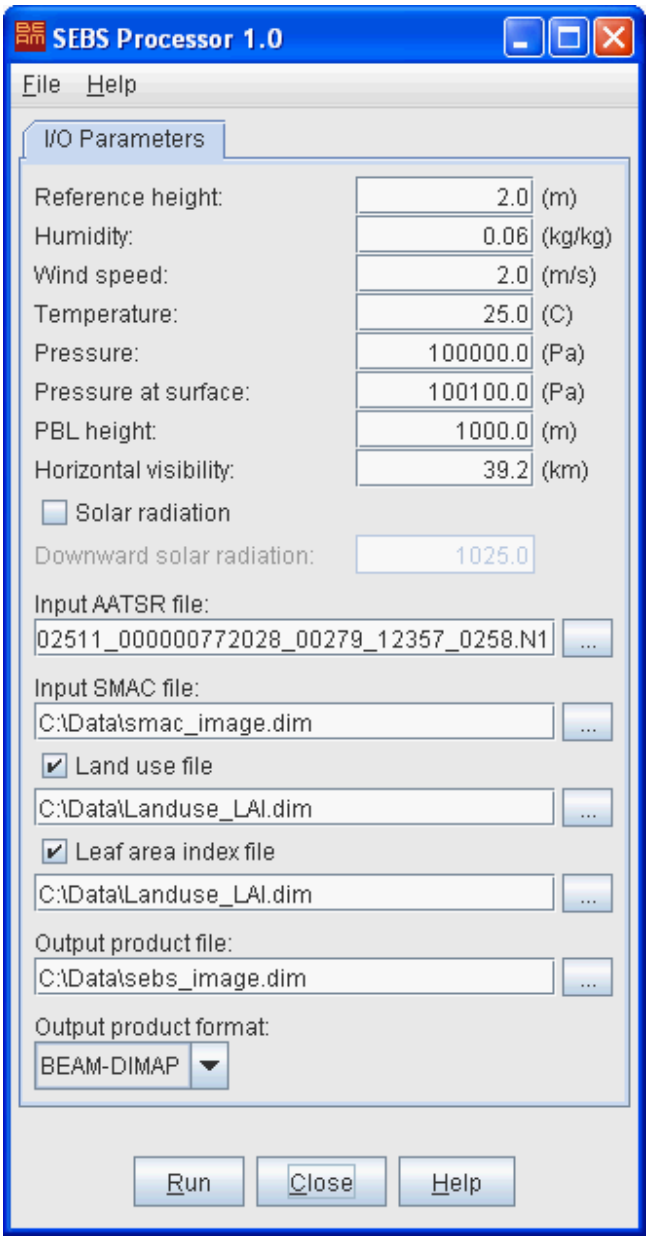
BEAM plug-in for SEBS Documentation

The document provides a general description for SEBS processor (Plugin) for BEAM as regards the use of AATSR data. It describes the user interface, the request input parameters and presents the results of the SEBS. The algorithm in SEBS for retrieval of bio-geophysical parameters including surface albedo, temperature, and emissivity e.g. is briefly presented.



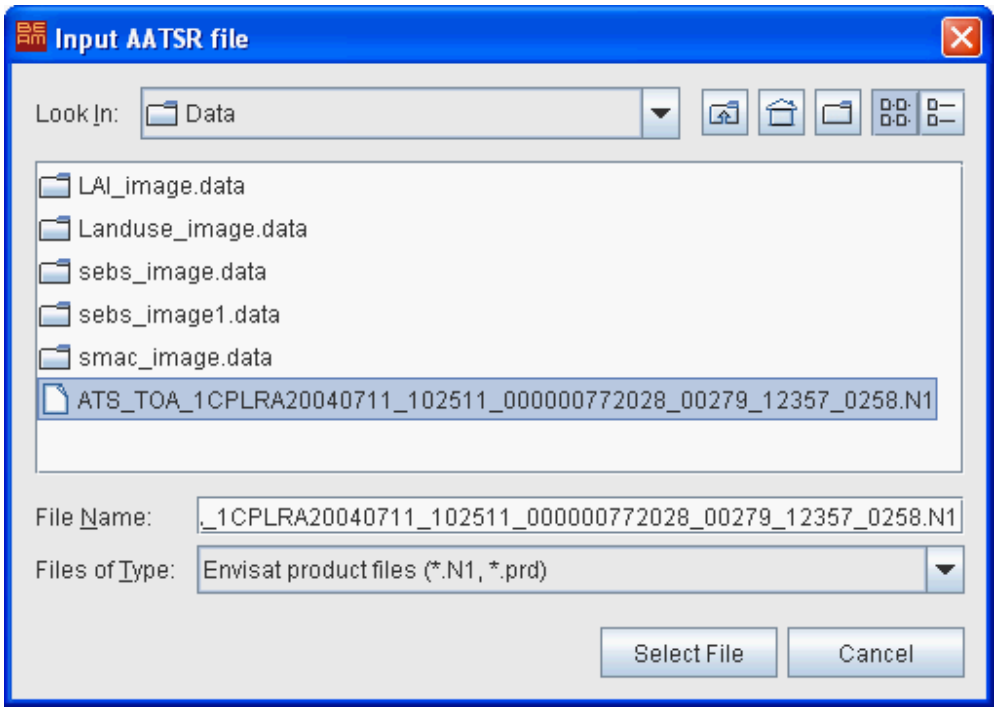
The SEBS request value parameters

1. **Reference height**: Type a value for the reference height in meters.
2. **Humidity:** Type a value for the specific humidity at reference height in kg per kg.

3. **Wind speed**: Type a value for the wind speed at reference height in meters per second.
4. **Temperature**: Type a value for the air temperature at reference height in degree C.
5. **Pressure**: Type a value for the pressure at reference height in Pa.
6. **Pressure at surface**: Type a value for the pressure at surface in Pa.
7. **Horizontal visibility**: Type a value for the horizontal visibility in kilo meters.
8. **Solar radiation**: Select the solar radiation by typing in a value for the downward solar radiation, and turns the routine in SEBS to calculate the downward radiation value of.

The SEBS request files

1. **Input AATSR file**: Select the AATSR file by either typing the file path into the text field or pressing the file selection button ... to invoke input AATSR file dialog.



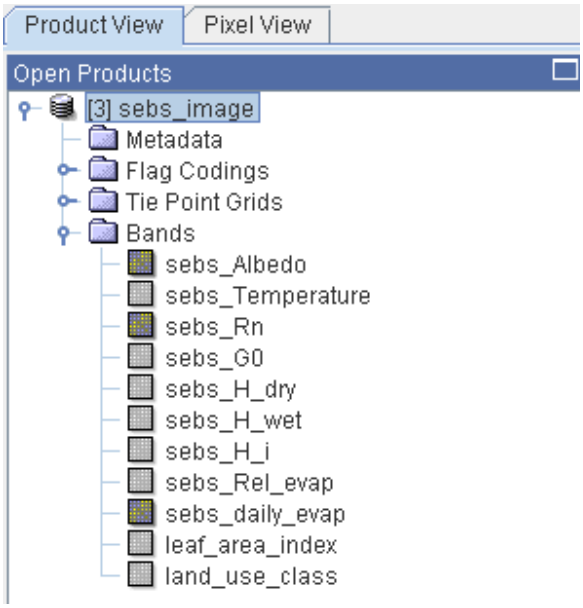
In the file selection dialog that appears, navigate to the folder that contains the dataset, and select Envisat product files (*.N1, *.prd) from the list of the Files of Type. This input AASTR file must contain bands named btemp_nadir_1200 and btemp_nadir_1200.

2. **Input SMAC file**: Select the input SMAC file. In the input SMAC file dialog, select BEMP DIMAP Files (*.dim), then select the SMAC file. This input SMAC file must contain bands named reflect_nadir_0670 and reflect_nadir_0870. These bands must be atmospherically corrected (use the SMAC processor on the AATSR product in BEAM). The generation of SMAC as input for SEBS is described in the Generation of SMAC in the document.
3. **Land use file**: Select this option and select an input file containing the land use classes. By using the land use class file, the roughness height values regarding the land use classes found in the land_use_class.txt are used in SEBS to provide the estimation of

sensible heat fluxes. This input land use file must contain a band named land_use_class. Unselect this option if you simply wish to use the routine in SEBS to estimate the roughness height values. For additional information over the input land use file, refer to the “Generation of Land use and Leaf area index files” in this document.

4. **Leaf area index file**: Select this option and select an input file. The input file must contain a band named leaf_area_index. Unselect this option if you wish to use the routine in SEBS to estimate the leaf area index values. For additional information, refer to “Generation of Land use and Leaf area index files” in this document.
5. **Output product file**: Select the SEBS output product file by typing the product path into the text box or by pressing to invoke the file selection button.
6. **Output product format**: Select the output format (BEAM-DIMAP).

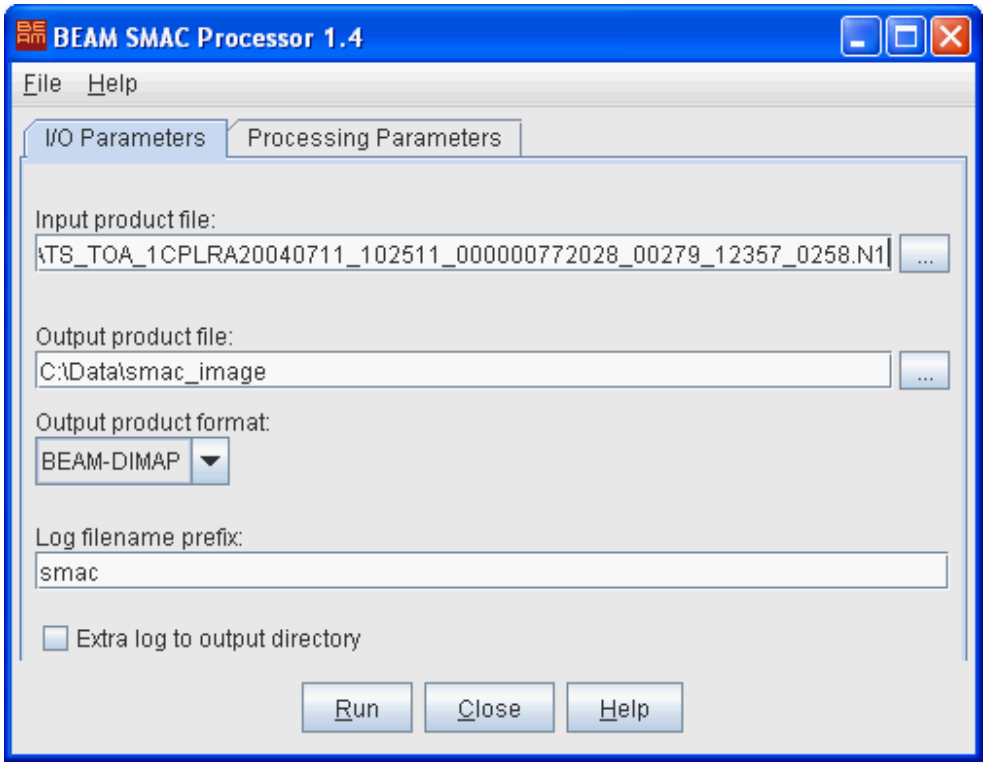
Note that after the successful completion of the SEBS processor, you should see the following bands over the SEBS output file in the BEAM (VISAT) application.



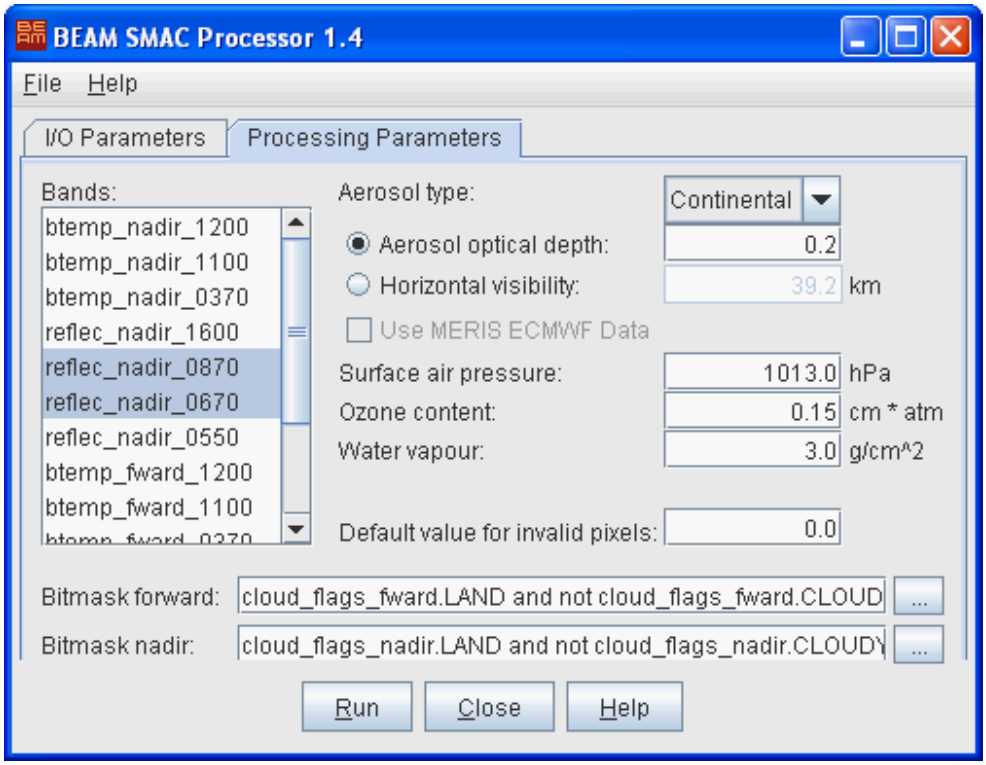
1. sebs_Albodo: Surface albedo
2. sebs_Temperature: Land surface temperature
3. sebs_Rn: Net radiation
4. sebs_G0: Soil heat flux
5. sebs_H_dry: Sensible heat flux at the dry limit
6. sebs_H_wet: Sensible heat flux at the wet limit
7. sebs_H_i: Sensible heat flux
8. sebs_Rel_evap: Evaporative fraction
9. sebs_daily_evap: Actual evaporation on daily base
10. leaf_area_index: Leaf area index
11. land_use_class: Land use class

Generation of SMAC

Start BEAM (VISAT) and go to Tools-> SMAC processor

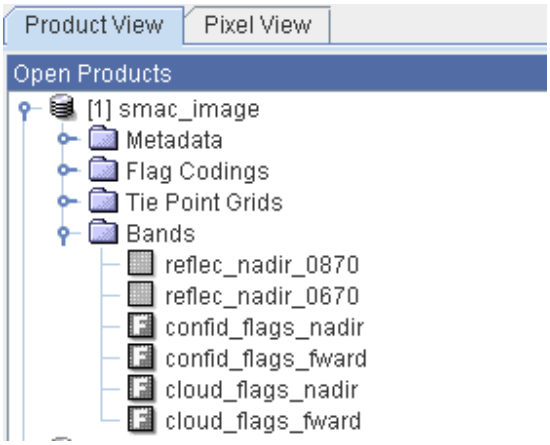


1. **Input product file**: Select the input AATSR file to be atmospherically corrected as request input for SEBS processing. This input product file is the same as the input AATSR file of the SEBS processor.
2. **Output product file**: Select the SMAC output file.
3. **Output product format**: Select BEAM-DIMAP format.



4. **Bands**: Select the bands named reflect_nadir_0870 and reflect_nadir_0670 from the list of available bands.

Change the other request input parameters as shown in the picture above as needed, then press “Run” button to start the SMAC processing. After a successful completion of the SMAC processor, you should see the following contents of the SMAC output file in the BEAM (VISAT) application.



Generation of Land use and Leaf area index files

Land use file: The land use file should contain the codes regarding the land use classes found in land_use_class.txt as shown in the table below :

```
Land-use classes and associated roughness height Z0m values
ClassCode       Z0m (m)                         Land-use class
End_of_head ===================================================================
code 1          0.0340                          Grass
code 2          0.1300                          Maize
code 3          0.0639                          Potatoes
code 4          0.0639                          Beets
code 5          0.1300                          Cereals
code 6          0.0639                          Other_crops
code 7          0.4066                          Greenhouses
code 8          0.6065                          Orchards
code 9          0.0639                          Bulbs0.0639
code 10         1.2214                          Deciduous_forest
code 11         1.2214                          Coniferous_forest
code 12         0.0408                          Heather
code 13         0.0408                          Other_open_spaces_in_natual_areas
code 14         0.0012                          Bare_soil_in_natural_area
code 15         0.0002                          Freshwater
code 16         0.0002                          Salt_water
code 17         1.1052                          Continuous_urban_area
code 18         0.5488                          Build_up_area_in_rural_area
code 19         1.2214                          Deciduous_forest_in_urban_area
code 20         1.2214                          Confiferous_forest_in_urban_area
code 21         1.2214                          Build_up_area_with_dense_forest
code 22         0.0334                          Grass_in_build_up_area
code 23         0.0012                          Bare_soil_in_build_up_area
code 24         0.0035                          Main_roads_and_railways
code 25         0.5488                          Buildings_in_rural_areas
```

The file is available in the BEAM extensions folder (normally C:\Program Files\beam-3.6\extensions)

Leaf area index: SEBS also implemented a function to provide an estimation of Leaf area index in the SEBS output file. The purpose of this implementation is to produce a sample leaf area file to be used in the SEBS processor when the option is selected.

The leaf area index is expressed as a function of the NDVI as:

LAI = NDVI*(1.0+NDVI)/(1.0-NDVI+1.E-6)

Where NDVI is the Normalized Difference Vegetation Index is determined for the given bands named reflect_nadir_0670 and reflect_nadir_0870 from the input SMAC file. LAI is the parameter for the leaf area index.

An example for the generation of Land use and Leaf area index files in SEBS is given as follows.

1. Select SEBS processor in BEAM
2. Change the input value parameters as needed
3. Select the input AATSR file as described in “SEBS request input files”
4. Select the input SMAC file as described in “SEBS request input files”
5. Unselect the option for the use of Land use file.
6. Unselect the option for the use of Leaf area index file.
7. Select the output product file e.g. C:\Data\Landuse_LAI
8. Note that select BEAM-DIMAP for the output product format.
9. Press Run button to obtain the output file containing the land use and leaf area index bands. You can then use the generated output as the inputs for Land use and Leaf area index options.

Algorithm in SEBS processor (plugin)

SEBS provides a set of methods for retrieval of bio-geophysical parameters:

Land surface albedo: The land surface albedo is expressed as a function of the given bands named reflect_nadir_0670 and reflect_nadir_0870 from the input SMAC file as:

Albedo = c4 + c5* reflect_nadir_0670/100 + c6 * reflect_nadir_0870/100

Where c4=0.035, c5=0.545, and c6=0.32 are weight factors.

Land surface temperature and emissivity: The spilt-window method for the retrieval of the temperature is implemented in SEBS.

The land surface temperature is expressed as a function of the given AATSR bands in nadir views named btemp_nadir_1200and btemp_nadir_1100, and water vapor content. The land surface emissivity is expressed as a function of NDVI. For additional information over the algorithms, refer to Sobrino et al. AATSR Land-Surface Temperature & Emissivity algorithm theoretical basis document.

The water vapor algorithm implemented in SEBS is expressed as a function of the transmittance ration estimated from the given AATSR channels in the nadir views (Li et al. 2003. A new approach for retrieving precipitable water from ATSR2 split-window channel data over land area. Int. J. Remote Sens.)

Net radiation, Soil heat flux, Sensible heat flux at the dry limit, Sensible heat flux at the wet limit, Actual sensible heat flux, Evaporative fraction, and Actual evaporation on daily base: You can find the algorithms implemented in Su, 2002, Estimation of the surface energy balance. Hydro. Earth Sys. Sci.

References

Li, Z.-L., L. Jia, Z. Su, Z. Wan, R.H. Zhang, 2003, A new approach for retrieving precipitable water from ATSR-2 split window channel data over land area, *International Journal of Remote Sensing*, 24(24), 5095–5117.

J.A. Sobrino and G. Soria, AATSR Land-Surface Temperature & Emissivity, Algorithm Theoretical Basis Document. EU FP6, GMES EAGLE project, SST3-CT2003-502057.

Z. Su, 2002, The Surface Energy Balance System (SEBS) for estimation of turbulent heat fluxes, *Hydrology and Earth System Sciences*, 6(1), 85-99.