PRE-PROCESSING SOFTWARE

USER'S GUIDE

Version 2.02

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Version history

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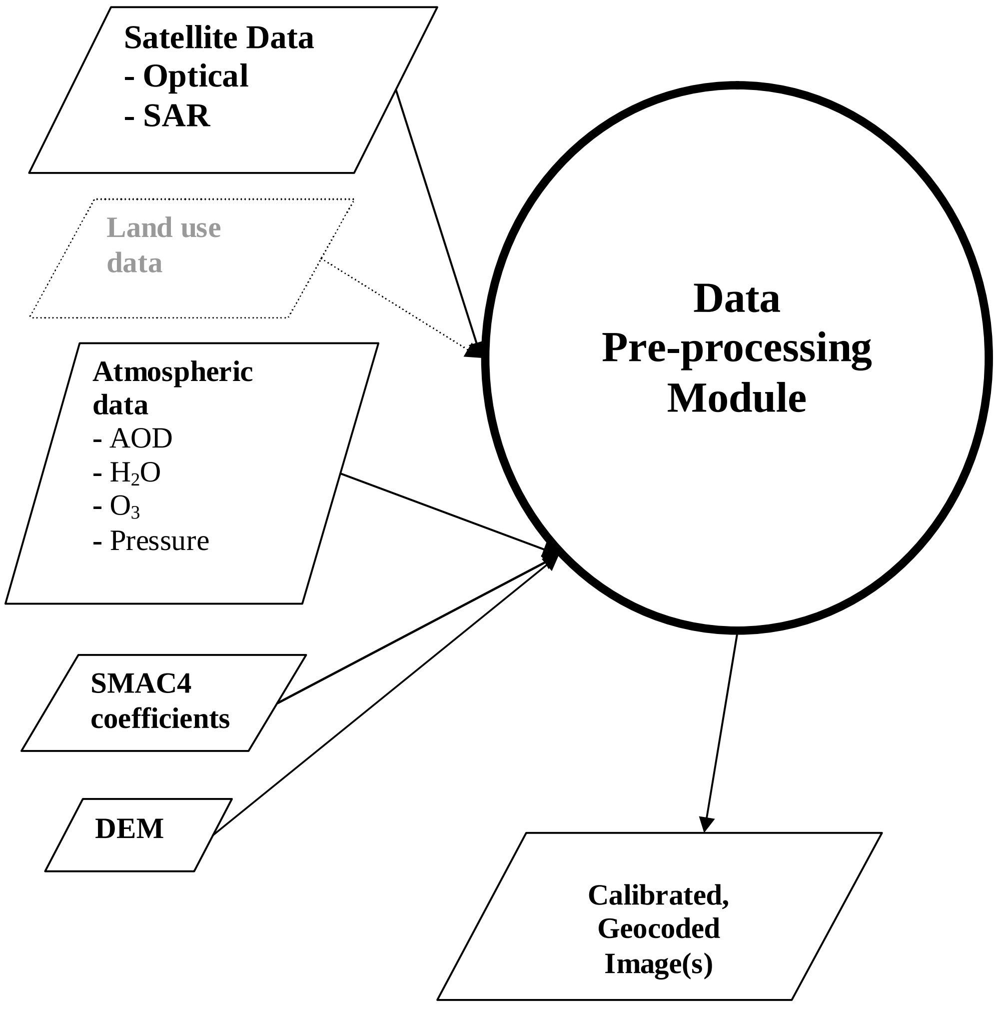
1 Installation of the software

Follow the following steps to install the software:

1. Copy all executables and library files to a directory which is on the path.
2. Copy SMAC coefficient files to an empty directory.
3. Set up an environment variable **SMAC4_DIR** and point that to the directory where the coefficients are.

2 Data pre-processing

2.1 Data pre-processing overview



2.2 Data pre-processing functionality

Envimon pre-processing software carries out all tasks from data unpacking and radiometric calibration to geometric corrections. The basic principle is that only the unpacking module is sensor dependent. Radiometric calibration for optical data and geometric correction modules are generic, and they can handle (almost) any kind of data as long as it is in correct format. SAR data calibration is carried out in different ways for different sensors, so the calibration is in this case sensor dependent.

The pre-processing software is operated through instruction files. These are text files describing the file names and processing parameters. The name of the instructions file is given on the command line as an argument for each processing module. Individual processing parameters or file names are recognised from a key-tag ending with a colon. Processing parameters follow the key-tags on the same line. The order of the tags is not defined, and any free format text will be regarded as comments.

An Envimon graphical user interface exists also. It gets the user inputs through dialog windows and writes them to instruction files. The interface can be used for executing the command line programs.

There are four different Envimon data pre-processing programs, one help program for generating the instruction files and a graphical user interface.

1. **em_unpack**, for unpacking data from the distribution volume.
2. **em_radio**, for carrying out radiometric calibration.
3. **em_geo**, for carrying out geometric correction.
4. **em_gen_inputs**, for generating instruction files and batch scripts automatically.
5. **envimon_gui,** the graphical user interface for executing individual programs

The syntax for executing the image processing software (1-3) is:

program_name input_parameters_file new_log_flag

alternatively, all contents of the inputs_parameters file can be written on the command line.

The new_log_flag is a string “nl”. If this string is given on the command line, a new log file with a time tag will be created. Else, there will be no time tag on the log file name and the possibly existing log file will be overwritten.

Data processing flow is shown in the next figure.

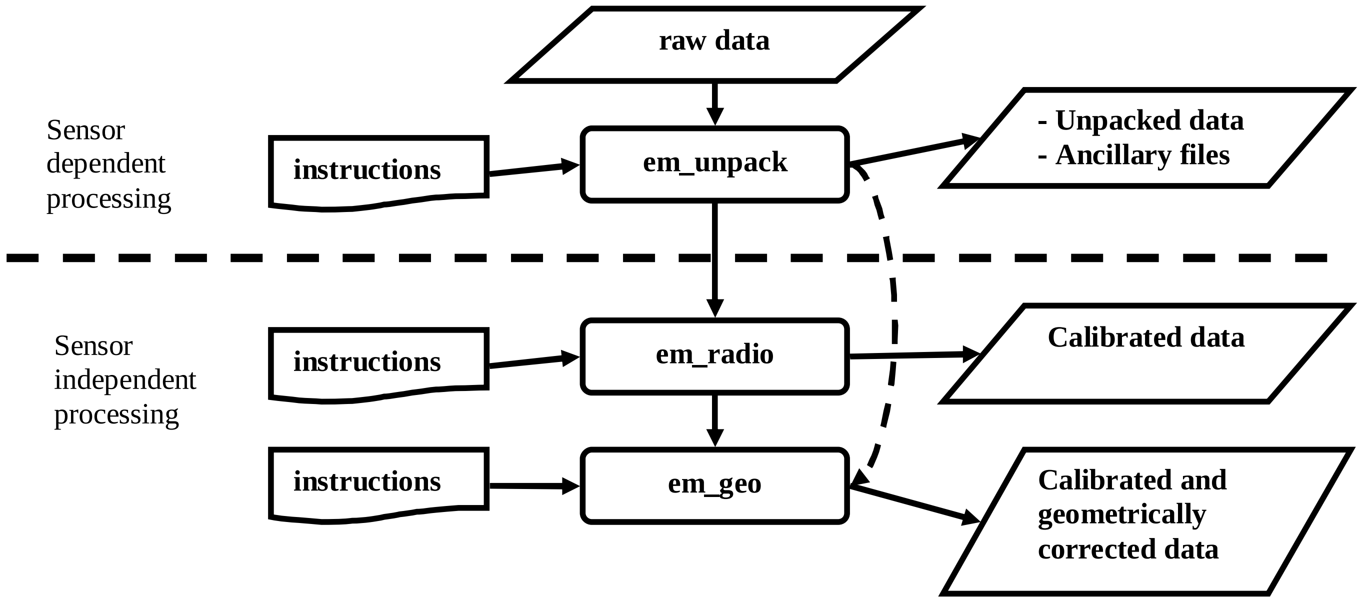
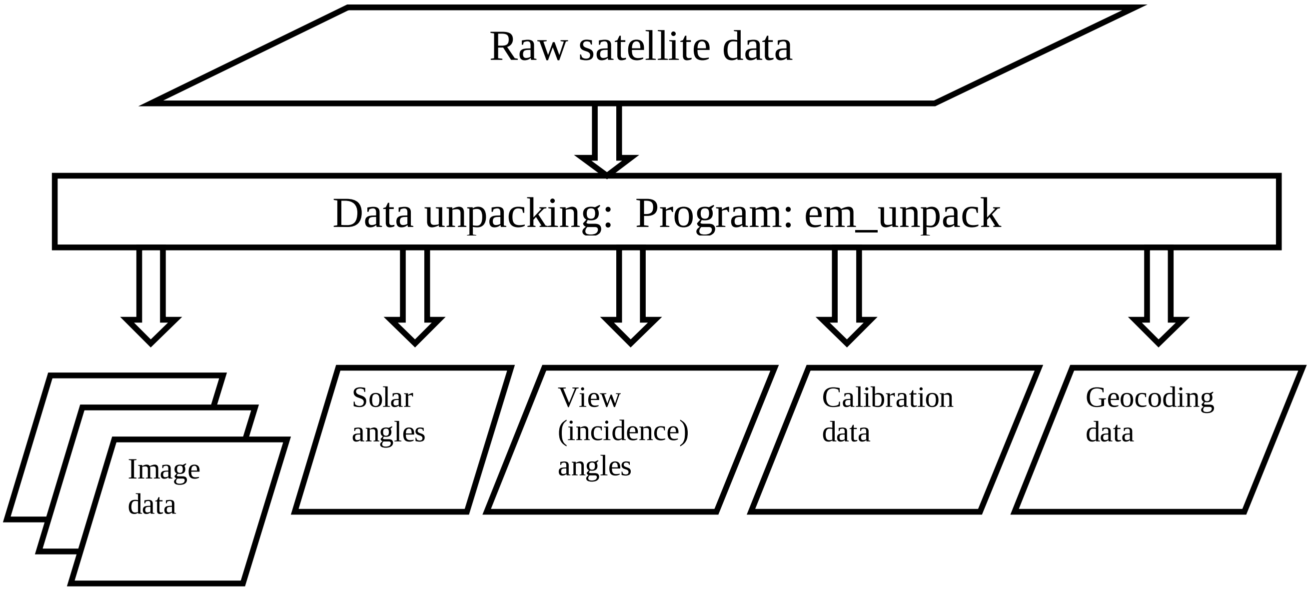


Figure 1. Data processing flow. The program em_unpack is sensor dependent but em_radio and em_geo are not.

3 Data unpacking

3.1 Data unpacking overview



Program em_unpack writes out some or all of the data listed in the figure above. The SAR module does not write out solar angles or calibration data.

The files which em_unpack writes out are not sensor dependent. Image data and solar and view angles are either in ER Mapper or Erdas Imagine format. Calibration and geocoding data is in text format. Unpacking SAR data produces files that are not completely independent of the sensor.

3.2 Data unpacking functionality

Raw data unpacking is carried out using the routine em_unpack. The syntax for em_unpack is:

em_unpack instructions_file_name new_log_flag

Unpacking instructions are read from a text file. An example for optical data unpacking can be seen in Figure 2. The next table (Table 4) describes the required input fields. The use of "new_log_flag" is explained in paragraph 2.2.

An alternative way to execute the em_unpack program is to write the contents of the instructions file on the command line.

3.2.1 Sensors and formats

Program em_unpack supports the processing of different types of satellite data.

Table 1. Currently supported sensors and formats

Sensor	Format
AATSR	ENVISAT Level 1
ASAR	ENVISAT
ASAR	VEXCEL (n/a)
ASTER	HDFEOS, HDF4
AVHRR from NOAA 15	HRPT
AWiFS, LISS3	SuperStructure
ERS	ENVISAT
ETM/TM5	FastFormat
ETM/TM5	Geotiff
Geotiff	Geotiff (general case)
Ikonos	Geotiff
JERS	VEXCEL (n/a)
MERIS	ENVISAT Level 1
MODIS	HDFEOS, HDF4
Quickbird	Geotiff
Radarsat2	Geotiff
Sensor	Format
SPOT5	Geotiff / DIMAP

The program supports currently only Level-1 data for ENVISAT formatted data.

Table 2. Currently supported ASAR formatted products.

ASA_APS_1P	ASAR alternating polarization mode complex image
ASA_APP_1P	ASAR alternating polarization precision image
ASA_APM_1P	ASAR alternating polarization medium resolution image
ASA_WSM_1P	ASAR wide swath standard image
ASA_IMS_1P	ASAR image single look complex
ASA_GM1_1P	ASAR global monitoring mode image
ASA_IMP_1P	ASAR image mode precision image
ASA_IMM_1P	ASAR image mode medium resolution image
ERS_IMP_1P	ERS image mode precision image

Table 3. Input and outputs files for different sensors

Sensor	input	outputs
ASTER	Aster file name metadata file	- tie points grid, - calibration data - vnir, swir & tir image data
MODIS	MODIS file name(s)	- reflective & emissive image data - calibration data (reflective & emissive) - lat/long files (250m & MOD03) - satellite & solar angles files
ETM, TM5	header file (*.HRF, *.HPN or *.HTM) or Geotiff file with metadata (*_WO.txt)	- reflective & emissive image data - calibration data - tie points grid with satellite and solar angles
AVHRR	Data file (*.dun, *.hmf) TBUS file sensor calibration data file	- image data - calibration data - tie points grid with satellite and solar angles
Quickbird	Geotiff file Metadata (IMD)	- image file - tie points grid
Ikonos	hdr file (*.hdr)	- image file - calibration data - tie points grid with satellite and solar angles
MERIS	ENVISAT file name (*.N1)	- image file - calibration data - tie points grid with satellite and solar angles
AATSR	ENVISAT file name (*.N1)	- image files for nadir and forward looks with cloud mask as the last band - calibration data - tie points grid with satellite and solar angles for both nadir and forward looks
ASAR	ENVISAT External calibration	- image file - tie points grid with incidence angles
ERS	ENVISAT	- image file

		- tie points grid with incidence angles
Radarsat2	Geotiff, product.xml	- image file - tie points grid file - calibration LUT file
AWiFS & LISS3 on IRS-P6	volume file VOLUME.DAT	- image file - calibration data - tie points grid with satellite and solar angles
SPOT5 (PAN not yet implemented)	imagery.tif metadata.dim	- image file - calibration data - tie points grid with satellite and solar angles

3.2.2 Input files

Input parameters file

The inputs parameters file for em_unpack is described in the following table. In most cases only the file name is needed. Input parameters may be in any order in the parameters file.

Table 4. Unpacking instructions consist of only one compulsory input field.

Key	Explanation of user input	Compulsory
file_in:	Name of the native format data file.	yes
sensor:	Sensor name and possible number. Supported sensors are listed in Table 1. If sensor name is not given, the software tries to get it from the file name.	no
format:	Input file format type. Supported formats are listed in Table 1.	no
out_format:	Output file format, ERMapper or Erdas. The default is set upon compilation.	no
work_dir:	The output directory. If omitted the current directory will be used.	no
ext_cal:	- ASAR external calibration data file. Used for ASAR calibration. - Radarsat2 calibration lut file. - Quickbird imd file - Metadata file. - AVHRR calibration data file	no
nesz_cor:	File name that includes noise correction (NETZ) data. Used currently only for ASAR APM data.	no
tbus:	AVHRR TBUS filter. For example "d:\tbus*.tlx".	no

```
MODIS HDFEOS unpacking instructions file

  compulsory inputs

file_in:  D:\test_data\ MYD02QKM.A2003050.1030.004.2004074020652.hdf

  optional inputs

sensor:   MODIS
format:   hdfeos
work_dir: e:\out
```

Figure 2. An example of hdfeos unpacking instructions file.

NESZ data file

Correction factors for given incidence angles are listed in the nesz file. Using this data, correction values will be computed for each incidence angle in the image. The correction value from this file will be added to the computed dB-value when it's value is less than the dB-limit given in this file. See "Analysis of the Influence of NESZ Variations on Cross-Polarized Signatures of Sea Ice. B. Scheuchl and I. Cummings. 2005 IEEE". http://ieeexplore.ieee.org/iel5/10226/32601/01526844.pdf

```
id:    ASA_APM
swath: IS4
ang:   30.5 31.0 31.5 32.0 32.5 33.0 33.5 34.0 34.5 35.0 35.5 36.0 36.5 37.0
db:    0.2 -0.5 -1.2 -1.6 -1.3 -0.6 -0.7 -1.0 -1.7 -2.7 -3.6 -4.1 -4.5 -4.8
lim:  -18.0
```

Figure 3. An example of an NESZ file with incidence angles and corresponding delta dB-values.

AVHRR sensor calibration data file

AVHRR sensor calibration data is read from an external file with a name "avhrr_sensor_calibration.data". This file is supplied with the software and it must be located on the path. Alternatively the file name can be given in the inputs file after the tag ext_cal:. File contents are described in **Appendix 1**. All coefficients can be found from: http://www2.ncdc.noaa.gov/docs/klm/ .

Output files:

Unpacking routines extract all image data on the distribution volume, and write them out in ER Mapper or Erdas Imagine image format. Geocoding information and calibration coefficients are written out in text format. Geocoding information may be either latitude/longitude files, control points or a tie point grid. Calibration coefficients define the coefficients either for converting digital numbers to TOA (Top Of Atmosphere) reflectance, or for converting digital numbers to apparent radiance. The latter case is used for thermal data calibration.

Calibration data file includes one row for each band. Reflective bands consist of calibration coefficients and the SMAC coefficients file name. Thermal bands consist of calibration coefficients and the central wavelength.

If the gain is set to 0.0, then the data on that band will not be calibrated. The data will be passed through the calibration procedure as it is, with no re-scaling. Some data (for example AATSR) contain a cloud mask (0/1) as the last band and it will not be calibrated.

Figure 4 shows an example of a calibration file. For example, the digital number 10000 on band 1, is converted to a (not sun corrected) TOA reflectance as 10000 * 0.00139295 – 0.441526 = 13.48%.

```
# Calibration coefficients
# (VISIBLE: band gain bias smac4_coeffs_file)
# (THERMAL:   "    "    "  central_wavelength (um))
# TOA reflectance or radiance = dn * gain + bias
# reflectance in %-units  (not sun corrected)
# radiance in    W/m2/sr/um-units
 1 0.001393 -0.441526  coef_MODIS8_CONT.dat
 2 0.000797 -0.252784  coef_MODIS9_CONT.dat
 3 0.000568 -0.180016  coef_MODIS10_CONT.dat
 4 0.000464 -0.147162  coef_MODIS11_CONT.dat
 5 0.000368 -0.116731  coef_MODIS12_CONT.dat
 6 0.000226 -0.071636  coef_MODIS13_CONT.dat
 7 0.000168 -0.053348  coef_MODIS13_CONT.dat
 8 0.000227 -0.072075  coef_MODIS14_CONT.dat
 9 0.000127 -0.040174  coef_MODIS14_CONT.dat
10 0.000223 -0.070798  coef_MODIS15_CONT.dat
11 0.000287 -0.090925  coef_MODIS16_CONT.dat
12 0.002210 -0.700591  coef_MODIS17_CONT.dat
13 0.003227 -1.022843  coef_MODIS18_CONT.dat
14 0.002355 -0.746393  coef_MODIS19_CONT.dat
15 0.002463 -0.780838  coef_MODIS26_CONT.dat
```

Figure 4. An example of a MODIS radiometric calibration file for reflective bands produced by em_unpack

```
# Calibration coefficients:
# (VISIBLE: band gain bias smac4_coeffs_file (dual AVHRR slope coeffs))
# (THERMAL:   "    "    "  central_wavelength (um))
# TOA reflectance or radiance = dn * gain + offset
# reflectance in %-units  (not sun corrected)
# radiance in    W/m2/sr/um-units
 1    0.0540000   -2.130   coef_NOAA16VIS_CONT.dat   500  0.161000  -55.370
 2    0.0529000   -2.084   coef_NOAA16NIR_CONT.dat   500  0.158700  -55.310
 3   -0.0019314    1.915    3.76
 4   -0.0157580   15.370   10.77
 5   -0.0139065   13.734   12.00
```

Figure 5. An example of an AVHRR radiometric calibration file produced by em_unpack. AVHRR sensor has dual gain range for channels 1, 2 and 3A

```
! image file name
! grid columns, grid rows, projection, datum
! column, row, east, north, sat_zenit, sat_azimut, sun_zenit, sun_azimut
!
filename.ers
19 19 GEODETIC WGS84
    1.0     1.0  31.0070270  63.3201030    39.6   302.0    50.5   178.6
   65.0     1.0  30.7247670  63.3989920    38.8   301.8    50.6   178.3
  129.0     1.0  30.4409570  63.4773180    37.8   301.5    50.6   177.9
  193.0     1.0  30.1555960  63.5550790    36.9   301.3    50.7   177.5
. . .
 1025.0  1153.0  23.2730060  61.7698470    23.2   295.3    49.3   168.9
 1089.0  1153.0  22.9875360  61.8334420    22.0   295.1    49.4   168.5
 1153.0  1153.0  22.7008880  61.8964410    20.8   294.8    49.5   168.2
```

Figure 6. An example o the grid file format. First data row contains the file name, the second one the grid size and projection and datum information. Following rows contain pixel coordinates, geographic coordinates, satellite angles and solar angles at constant steps throughout the whole image.

Table 5.ASAR APS data calibration file includes the following fields. All fields, except the last one, are compulsory.

Key	Explanation
ext_cal:	ASAR APS calibration data file name. The file can be downloaded from http://envisat.esa.int/services/auxiliary_data/asar/
slr_times:	11 slant range times in seconds. These refer to column locations in the tie points grid. All numbers on the same row.
swath:	One of IS1 to IS7.
polar:	Polarisation for both data sets.
spacing:	Range spacing in meters.
dist:	Distance from earth centre to satellite.
nesz_cor:	File name with incidence angles and db-correction values.

```
# ASAR APS calibration data file

ext_cal: ASA_XCA_AXVIEC20030827_140210_20030211_000000_20031231_000000
slr_times: 0.00606138800 0.00609377100 0.00612615400 0.00615853700
0.00619091950 0.00622325050 0.00625568550 0.00628806850 0.00632045100
0.00635283400 0.00638506100
swath:      IS4
polar:      V/V H/H
spacing:    7.803974630
dist:       7155280.76
nesz_cor:   d:\police\nesz_cor.data
```

Figure 7. An example of an ASAR APS calibration data file produced by em_unpack

```
#Radarsat2 calibration data LUT file
#lutBeta lutSigma lutGamma

0.000000 0.000000 0.000000
636.716  1038.78  1000
638.288  1039.14  1000
639.85   1039.5   1000
. . . .
1113.16  1261.87  1000
1113.6   1262.16  1000
1114.03  1262.46  1000
```

Figure 8. An example of a Radarsat calibration LUT file. Offsets are on the first data row, then three coefficients for each image column.

3.2.3 Processing example:

em_unpack modis_unp.txt nl

or alternatively

em_unpack file_in: MYD02QKM.A2003050.1030.004.2004074020652.hdf nl

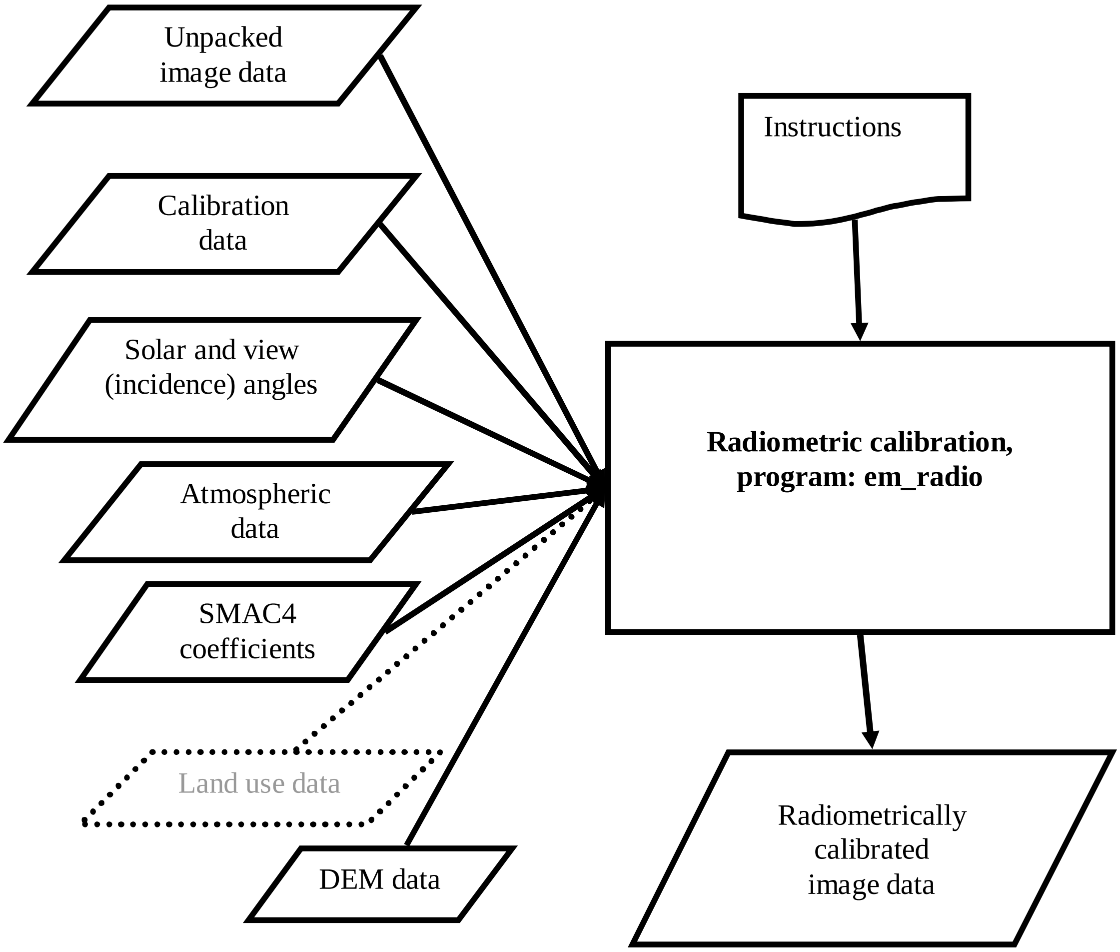
or

em_unpack file_in: MYD02QKM.A2003050.1030.004.2004074020652.hdf format: hdfeos work_dir: e:\out

In the first case, default values are used for sensor, file-format and output directory information.

4 Radiometric calibration

4.1 Radiometric calibration process overview



4.2 Radiometric calibration process functionality

Radiometric calibration is carried out using the routine em_radio. The syntax for em_radio is:

em_radio instructions_file_name new_log_flag

The meaning of new_log_flag is described in chapter 2.2.

Table 6. Calibration instructions file fields for reflective bands

Key	Explanation of user input	Compulsory
file_in:	Name of the input data file.	yes
cal:	Calibration data file. This file is written by em_unpack and the file name extension is .cal.	yes/no
solzen:	Solar zenith angles file name. This may also be a constant value.	yes/ no for thermal data
solazi:	Solar azimuth (image file or a constant)	no
senzen:	Sensor zenith (image file or a constant)	no
senazi:	Sensor azimuth (image file or a constant)	no
sensor:	Sensor name. Supported sensors are listed in Table 4. If the sensor name is not given, the software tries to get it from the file name. Normally required only for SAR files.	yes (no)
grid:	Grid file name. This is an alternative to solar and sensor angles files or to constant view and solar angles.	no
ang_scale:	Scaling factor for angles files. The default is 1.0 and this works for files with angles in degrees units.	no
bands:	List of band sequence numbers (1 based) separated by spaces. If omitted, all bands will be processed. All bands need to be either reflective or thermal.	no
aod:	Aerosol optical depth at 550 µm. If omitted, the default will be used. This may be a constant or a file with a value for each image pixel. This applies to other atmospheric (h2o, o3, pressure) variables as well. These files may be smaller in dimensions the satellite image itself. In this case these atmospheric images will be expanded in dimensions to cover the satellite image in size. If the constant aod is set to: 0, the TOA reflectance with no sun angle correction will be computed. < 0, the TOA reflectance with sun angle correction will be computed.	no
o3:	Ozone contents in Dobson units	no
pressure:	Surface pressure in hPa.	no
h2o:	Water vapour contents in g/cm^2	no
brfd:	Surface type for BRDF corrections. One of the following: FOREST, BARREN, CROPLAND, GRASSLAND, SNOW	no
rednir:	Red and NIR band (sequence) numbers. Needed for BRDF corrections.	yes (no)
view_limit:	Max satellite view limit in degrees. If omitted, the default 45° will be used.	no
sun_limit:	Max solar zenith angle in degrees. Default 70°.	no

data_unit:	Data unit for SAR image. Options db or sigma. The latter stands for the sqrt(sigma-nought).	no
smac4_dir:	Directory for smac4 coefficients. If omitted, the directory name is extracted from the environment variable SMAC4_DIR.	no
work_dir:	The output directory. If omitted, the current directory will be used.	no
suncorrected:	If "yes", the input image is already sun-corrected and no sun-correction will be carried out. The default is "no". This is a special case for images that have been pre-processed outside the Envimon software.	no

```
Optical data calibration instructions file

file_in:    e:\out\Modis_1km_02Mar16_1045_EV_1KM_RefSB.ers
cal:        e:\out\Modis_1km_02Mar16_1045_1km.cal
solzen:     e:\out\Modis_LL_02Mar16_1045_SolarZenith.ers
sensor:     modis
solazi:     e:\out\Modis_LL_02Mar16_1045_SolarAzimuth.ers
senzen:     e:\out\Modis_LL_02Mar16_1045_SensorZenith.ers
senazi:     e:\out\Modis_LL_02Mar16_1045_SensorAzimuth.ers
ang_scale:  0.01
bands:      1 6 10
aod:        0.15
h2o:        2.5
o3:         350
pressure:   1020
brdf:       forest
rednir:     6 11
view_limit: 40
sun_limit:  60
work_dir:   e:\out
```

Figure 9. An example of a MODIS calibration instructions file for reflective bands

```
Thermal data calibration instructions file

file_in:    E:\modis\Modis_1km_02Mar16_1045_EV_1KM_Emissive.ers
cal:        E:\modis\Modis_1km_02Mar16_1045_emi.cal
bands:      1 2 3 13 16
work_dir:   e:\out
```

Figure 10. An example of a MODIS calibration instructions file for emissive (thermal bands)

The input file may contain both reflective and thermal bands, but the output cannot. The input file channels should be selected so that they contain either reflective or thermal bands.

```
ASAR APS data calibration instructions file

file_in:   e:\envisat\ASA_APS_28OCT2004_1942.ers
cal:       e:\envisat\ASA_APS_28OCT2004_1942.cal
grid:      e:\envisat\ASA_APS_28OCT2004_1942.grid
work_dir:  e:\
```

Figure 11. An example of an ASAR calibration instructions file

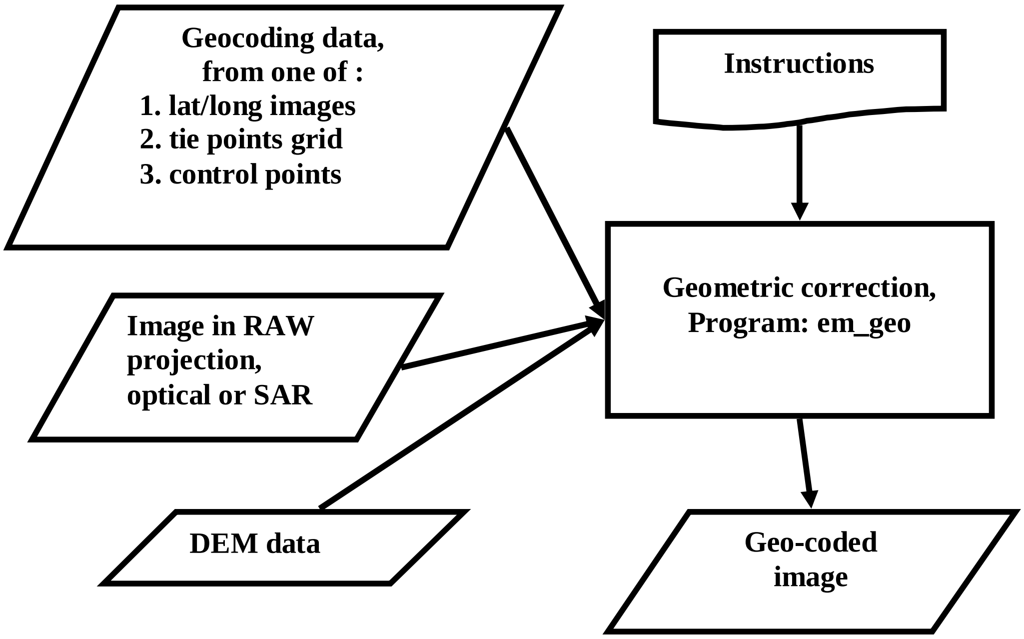
Output file:

The output file name will be generated from the input file name by adding the string "_smac" and/or "_brdf" before the file name extension. In case no atmospheric calibration is performed, the string "_toa" will be inserted to the file name. The data type will be 4-byte floats representing %-units. For thermal data, the string "_kelvin" will be added before the file name extension and the data will be expressed in Kelvin degrees units.

SAR file names get the string "_cal" before the file name extension.

5 Geometric corrections

5.1 Geometric corrections process overview



5.2 Geometric corrections process functionality

Geometric corrections are carried out using the routine em_geo. The program can project raw data to a geographic map projection using different methods. Geocoding information can be introduced in different ways; 1) Latitude/Longitude files, 2) ER Mapper control points file, 3) Grid file produced by em_unpack. If the image is already geocoded, it can be re-projected to a different coordinate system.

The syntax for em_geo is:

em_geo instructions_file_name new_log_flag

or

em_geo "instructions on command line"

Table 7. Instructions file fields for geometric corrections

Key	Explanation of user input	Compulsory
file_in:	Name of the input data file to be rectified.	yes
lat_file:	Latitudes file (degrees on WGS84). The dimensions of this file should be same than on the image file. With MODIS, latitudes file resolution should be 1km. This can be extracted from MOD03 product.	yes/no
lon_file:	Longitudes data file. If omitted, longitudes will be read from band 2 on the latitudes file.	yes/no
grid_file:	Tie points grid file name. This is an alternative to latitudes/longitudes files.	yes/no
gcp_file:	Control points file (ER Mapper format). This is an alternative to latitude/longitude files.	yes/no
geofile:	This is a flag. If present, geocoding will be read from image file header. This option may be used for map to map reprojection.	yes/no
bands:	List of band sequence numbers separated by spaces. If omitted, all bands will be processed.	no
proj:	ER Mapper projection name for the rectified image. Supported projections are listed in Table 8.	yes
datum:	Datum name. WGS84 or KKJ. EUREF89 equals to WGS84.	yes
area:	6 values defining the area limits and pixel sizes: east_min east_max east_inc north_min north_max north_inc. Any of these values may be replaced with a default character 'd'. In this case the default value will be computed from geocoding information.	no
work_dir:	The output directory. If omitted the current directory will be used.	no
se:	Shift output image this much in meters towards east.	no
sn:	Shift output image this much in meters towards north.	no
dem_file:	Name of the DEM file. Units in meters.	no applied only for SAR data

Table 8. Currently supported map projections on either a WGS84- or KKJ-datum.

GEODETIC	Latitude – longitude grid
TMFINX	Finnish UTM grid, X stands for zone number (0-5)
NUTMX	North UTM zone X (0-60)
PSNTH70	Polar Stereographic, true latitude 70 deg north
SNWORLD	Sinusoidal
MRWORLD2	Mercator

Table 9. An example of MODIS geometric corrections instructions file. The image will be rectified to the Finnish "TMFIN3" projection on a "KKJ" datum. Image area limits are given, but the pixel size will be computed.

```
Instructions file for MODIS geometric corrections

file_in:  e:\out\modis_1km_02mar16_1045_ev_1km_refsb.ers
lat_file: e:\out\Modis_LL_02Mar16_1045_Latitude.ers
lon_file: e:\out\Modis_LL_02Mar16_1045_Longitude.ers
proj:     tmfin3
datum:    kkj
bands:    1 2
area:     3370000 3430000 d 7170000 7240000 d
work_dir: e:\gcal
```

Output file:

The output file name will be generated from the input file name by adding the string "_rect" before the file name extension. ER Mapper datum and projection names will be written to image header file. Currently no projection/datum information will be written to Erdas images. The output file size is limited to 64K by 64K pixels.

6 Generating instruction files

Instruction files may be generated manually with a text editor, or automatically using the program **em_gen_inputs**. This program fills all the fields with default values and the user may edit these. It is also possible to replace default values from another file. The syntax for em_gen_inputs is:

em_gen_inputs file: file_name [optional arguments]

optional arguments are:
sensor: sensor_name
par: replacements file name

where:
file_name. The raw distribution file name of the image. In case of fast format data, the header name should be given.
sensor_name. One of the sensors listed in Table 1. If the sensor name is missing, the system tries to get the sensor name from the file name.
par. File name for replacement parameters.

For example the command :

em_gen_inputs file: L71191017_01720020416_HRF.FST sensor: etm par: replace_par.txt

will generate following instructions files with default values:

1. ETM_2002Apr16_hrf.bat
2. ETM_2002Apr16_hrf_unp.txt
3. ETM_2002Apr16_hrf_cal.txt
4. ETM_2002Apr16_hrf_geo.txt

File replace_par.txt includes the following records:
aod: 0.2
area: 3195000 3210000 25 6790000 6810000 25
work_dir: e:\L7

This means that the default aod value will be replaced and set to 0.2, and the area to be rectified will be set to 3195000 3210000 25 6790000 6810000 25. All output will go to directory e:\L7 instead of the default directory.

The batch file will include the following rows:
em_unpack ETM_2002Apr16_hrf_unp.txt nl
em_radio ETM_2002Apr16_hrf_cal.txt nl
em_geo ETM_2002Apr16_hrf_geo.txt nl

By executing this bat-file, the ETM image will be unpacked, calibrated and rectified.

7 Graphical user interface

The graphical user interface (name: **envimon_gui**) start pane is shown in the next figure.

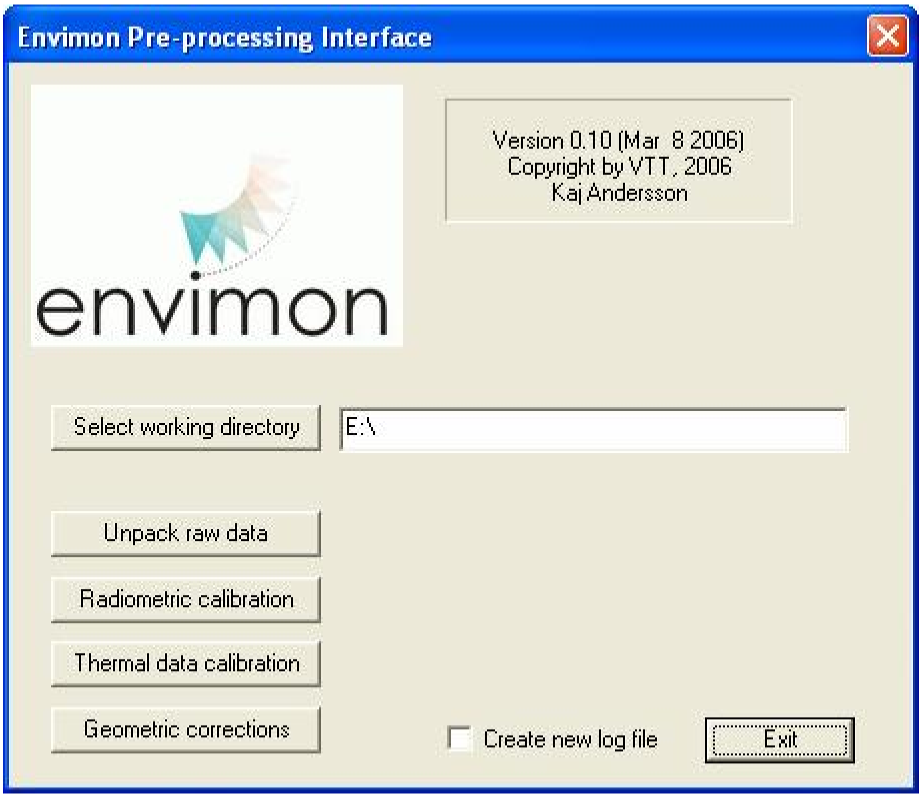


Figure 12. Envimon pre-processing graphical user interface

First the user should select a working directory where the output files are written. By checking the “Create new log” checkmark, a new log file with a time stamp will be created. Else the log will be written to the file “envimon_gui.log”.

Four processing buttons exist on the main pane. Button texts explain their functionality. The data should be first unpacked, then calibrated and finally remapped to a geographical map projection.

7.1 Data unpacking

By pressing the “Unpack raw data” button, the following dialog window is opened.

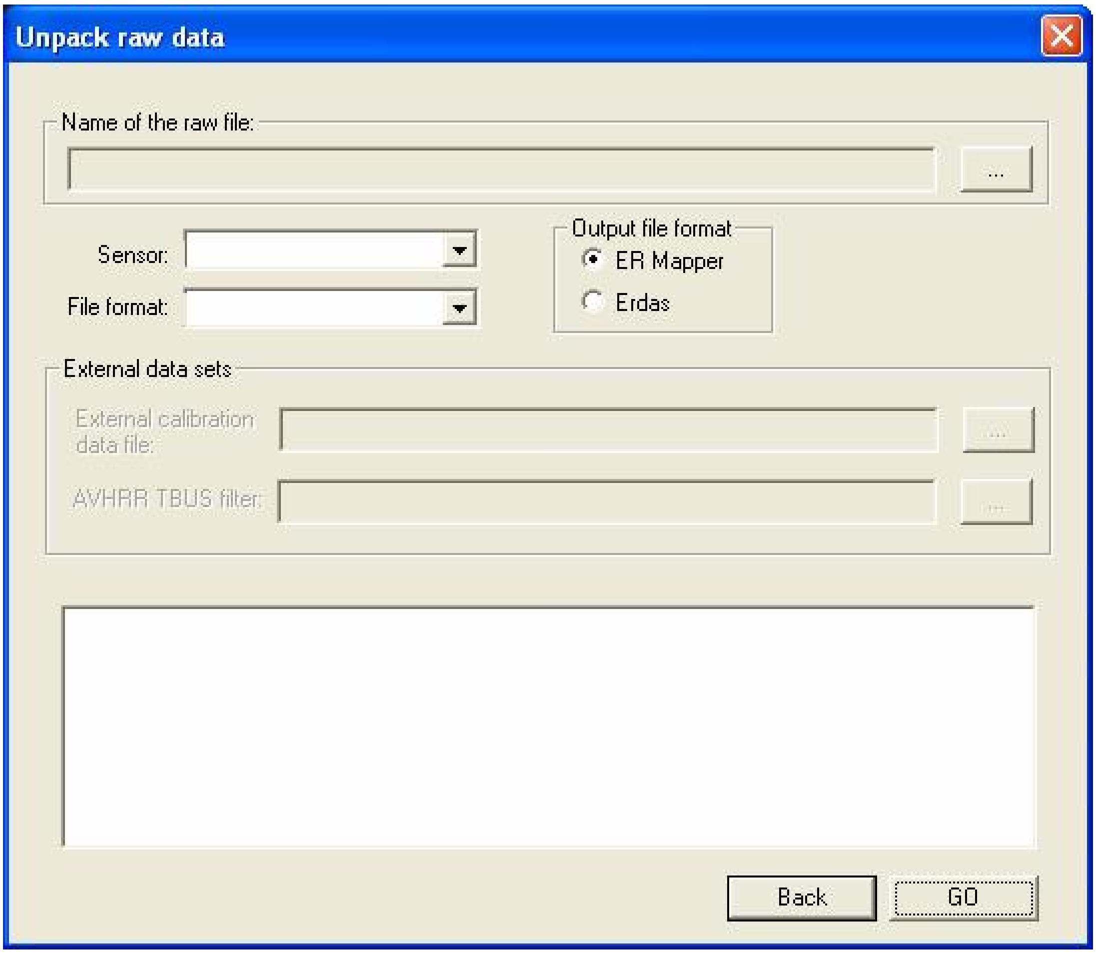


Figure 13. Envimon unpacking dialog window

First the user has to select the file to be unpacked. After that the sensor box and file format box are filled automatically. If any of these are incorrect, the user may correct them. In case of ASA_APS data, the name of external calibration data file may given. For AVHRR data, the TBUS file filter is required for computing the tie points grid. By pressing the “GO” button, the instructions file is written and the command line program **em_unpack** is started.

7.2 Radiometric calibration

The next figure shows the radiometric calibration dialog window.

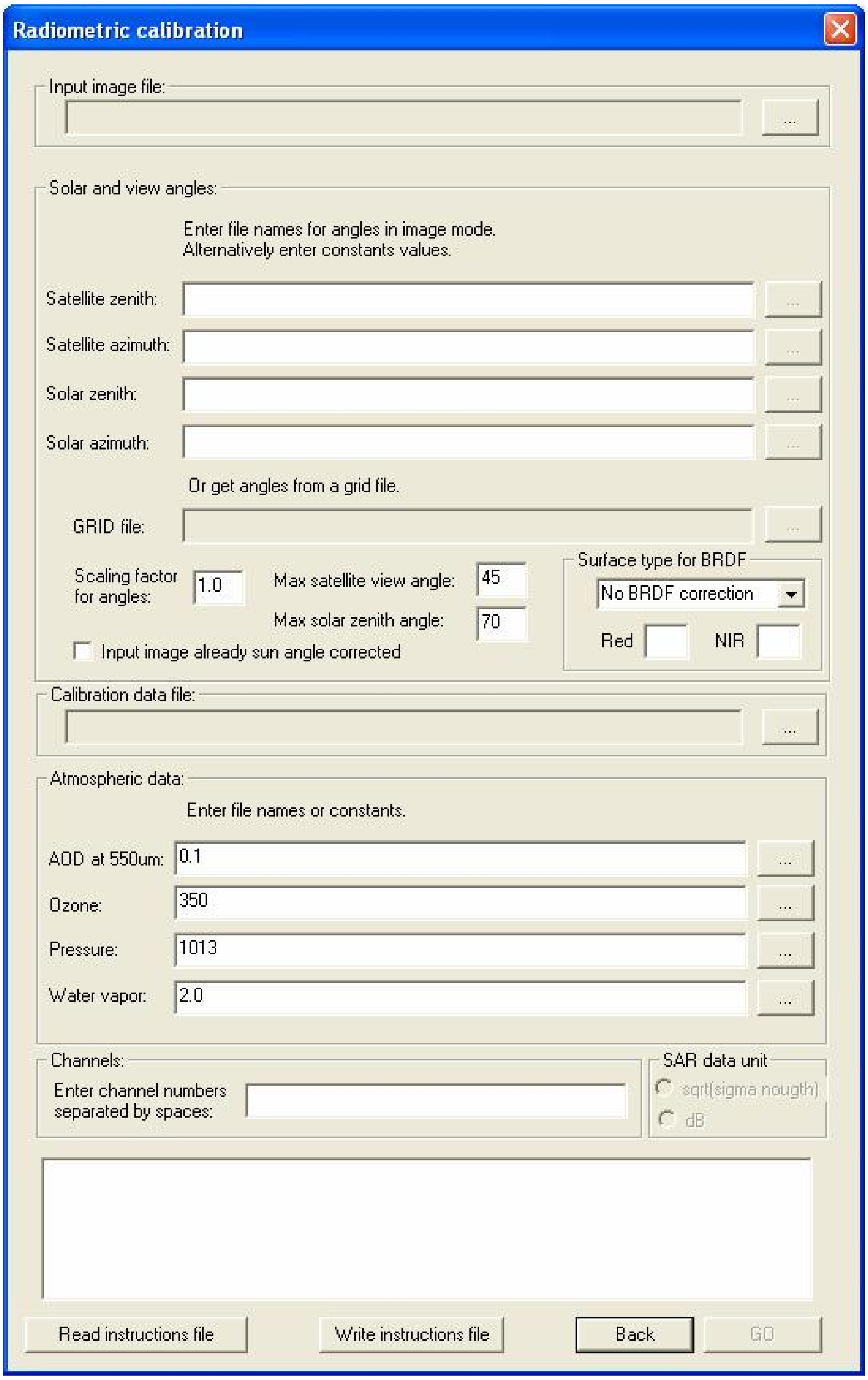


Figure 14. Envimon radiometric calibration dialog window

First the user has to select the input image file and the calibration data file, which have been unpacked by the **em_unpack** program. Solar and view angles are read either from image files or a grid file, depending on the data. Solar and view angles may also be expressed as constant values. For example in case of a high resolution image with very small footprint on the ground like Ikonos, solar and viewing angles can be considered as constants throughout the whole image area.

If a BRDF correction is requested, the user needs to specify the red and NIR band channel numbers. Atmospheric data may be read from image files or constant values may be used. Atmospheric data image files need not to have same dimensions than the image file. If their dimensions are less, they will be “stretched” to image dimensions. All channels in the image need to be reflective bands. Reflective and thermal bands need to be in separate files.

The program **em_radio** is launched by pressing the “GO” button. At this stage the instructions file is written. Dialog windows may be filled from an existing instructions file by pressing the “read instructions file” button.

This same dialog window is used also for calibrating SAR images. Unnecessary controls (related to optical data) are greyed.

7.3 Thermal data calibration

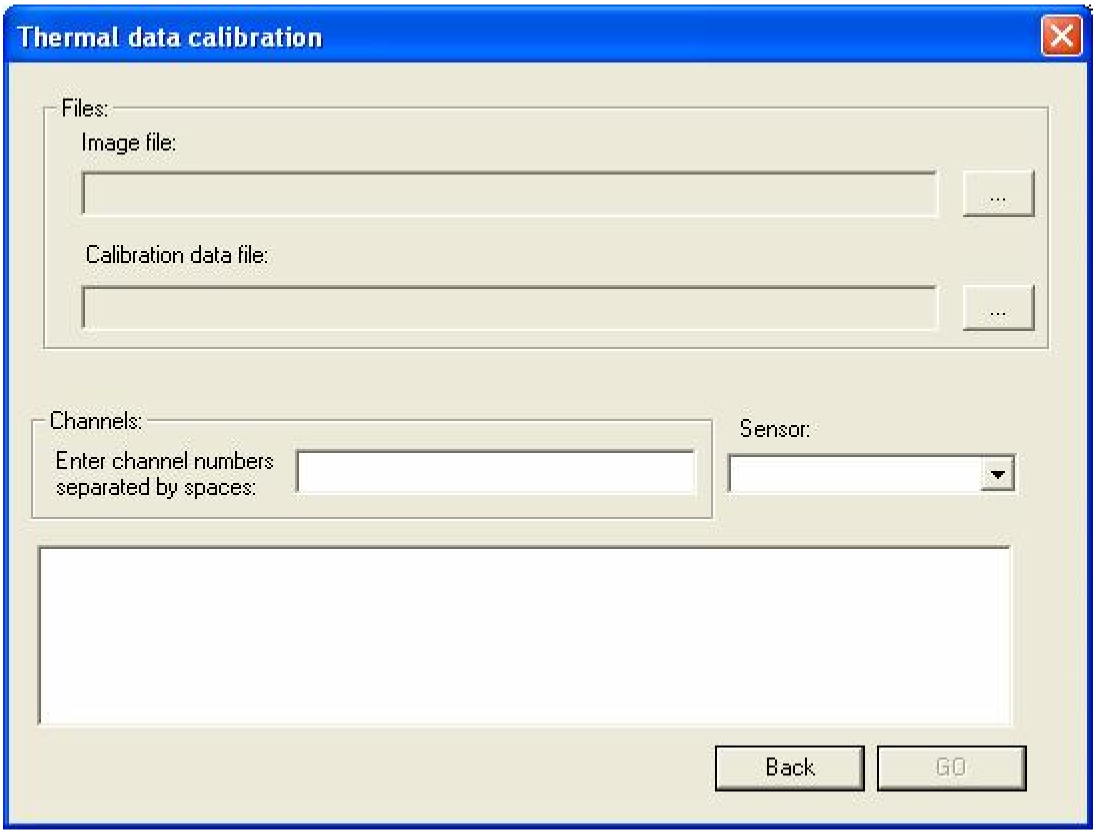
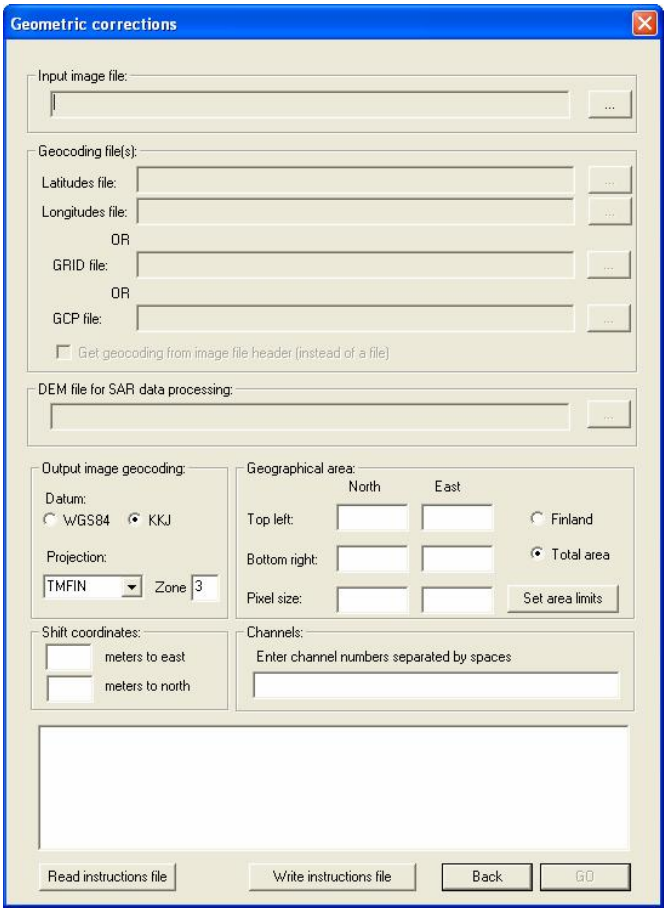


Figure 15. Envimon thermal data calibration dialog window

Thermal image file name and calibration data file name need to be selected by the user. The channel numbers edit box should include only thermal bands. After pressing the “GO” button, the instructions are written to file and the **em_radio** program is launched.

7.4 Geometric corrections

The following figure shows the geometric corrections pane.



First the input file has to be selected. There are four options for carrying out image geocoding:

1. Latitude/longitudes file(s). This is an image file with latitude and longitude values for each image pixel.
2. Tie points grid generated by the **em_unpack** program.
3. ER Mapper control points file.
4. Using geocoding information in the image header. This is used for remapping the image to another projection.

A DEM is currently used only for geocoding SAR images.

The output datum may be selected to either WGS84 or KKJ. Supported projections are listed in Table 8. The output image may be shifted by typing in proper shift values.

After pressing the “GO” button, the instructions are written to file and the **em_geo** program is launched.

APPENDIX 1.

AVHRR sensor calibration data for AVHRR 15 - 18. All coefficients can be found from: http://www2.ncdc.noaa.gov/docs/klm/ .

```
# AVHRR calibration coefficients for visible and emissive bands
# 4.4.2006 by Kaj Andersson VTT
#
# Explanations:
# AVHRRNN
# launch_date:    YYYYMMDD gain_low[3] offset_low[3] gain_high[3] offset_high[3], intersection[ 3 ], several rows
# temp coeffs:    C a[4][ ] 4 rows, 3-5 columns
# central wave numbers for thermal bands: V 3 values
# A coefficients: A 3 values
# B coefficients: B 3 values
# N radiance of space & nonlinear correction factors: NS b0 b1 b2 (mW/m2/sr/cm-1)
# N     ...   first row band 4 and second band 5
# empty row

AVHRR15
19980513  0.0568 0.0596 0.0275 -2.1874 -2.4096 -1.0684 0.1633 0.1629 0.1846 -54.9928 -55.2436 -78.1691 496 511 491
C  276.60157  276.62531  276.67413  276.59258
C  0.051045   0.050909   0.050907   0.050966
C  1.36328e-6 1.47266e-6 1.47656e-6 1.47656e-6
V  2695.9743 925.4075 839.8979
A 1.621256 0.337810 0.304558
B 0.998015 0.998719 0.999024
N -4.50 4.76 -0.0932 0.0004524
N -3.61 3.83 -0.0659 0.0002811

AVHRR16
20000921  0.0568 0.0596 0.0275 -2.1874 -2.4096 -1.0684 0.1633 0.1629 0.1846 -54.9928 -55.2436 -78.1691 496 511 491
20010101  0.0543 0.0531 0.0307 -2.0980 -2.0080 -1.3460 0.1580 0.1550 0.1910 -53.6200 -52.9600 -81.2400 496 511 491
20010801  0.0523 0.0513 0.0287 -2.0160 -1.9430 -2.0430 0.1530 0.1510 0.1810 -53.6200 -52.9600 -81.2400 496 511 491
C 276.355 276.142 276.996 276.132
C 0.05562 0.05605 0.05486 0.05494
C 1.590e-5 -1.707e-5 -1.223e-5 -1.344e-5
C 2.486e-8 2.595e-8 1.862e-8 2.112e-8
C -1.199e-11 -1.224e-11 -0.853e-11 -1.001e-11
V 2700.1148 917.2289 838.1255
A 1.592459 0.332380 0.674623
B 0.998147 0.998522 0.998363
N -2.467 2.96 -0.05411 0.00024532
N -2.009 2.25 -0.03665 0.00014854

AVHRR17
20020624  0.0540 0.0529 0.0262 -2.1300 -2.0840 -0.9820 0.1610 0.1587 0.1849 -55.3700 -55.3100 -80.8800 500 500 499
C 276.628 276.538 276.761 276.660
C 0.05098 0.05098 0.05097 0.05100
C 1.371e-6 1.371e-6 1.369e-6 1.348e-6
```

```
V 2669.3554 926.2947 839.8246
A 1.702380 0.271683 0.309180
B 0.997378 0.998794 0.999012
N -8.55 8.22 -0.15795 0.00075579
N -3.97 4.31 -0.07318 0.00030976

AVHRR18
20050520  0.0540 0.0529 0.0262 -2.1300 -2.0840 -0.9820 0.1610 0.1587 0.1849 -55.3700 -55.3100 -80.8800 500 500 499
C 276.601 276.683 276.565 276.615
C 0.05090 0.05101 0.05117 0.05103
C 1.657e-6 1.482e-6 1.313e-6 1.484e-6
V 2659.7952 928.146 833.2532
A 1.698704 0.436645 0.253179
B 0.996960 0.998607 0.999057
N -5.53 5.82 -0.11069 0.00052337
N -2.22 2.67 -0.04360 0.00017715
```