# ARAmap

Remote Sensing Data Processing Package

## Reference Manual

**Revision MAR2000**

Airborne Research Australia

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## Contributors

The origin of ARAmap lies in a collection of C programs for the processing of data from the ARA/AWI tri-spectral linescanner system, created by Axel Bochert in early 1999. The underlying algorithms were analyzed and re-programmed in Delphi 2.0 by Wolfgang Lieff in the second half of 1999; a script-driven front/end was added, and many new and extended functions followed.

In early 2000, basic processing capability for the Quadrant Engineering SLFMR microwave radiometer and the Riegl Laser Range Scanner was added.

The current development team are:

Wolfgang Lieff - programmer
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# 2 Introduction

While the original C-programs were used for the processing of the initial tests of the ARA/AWI tri-spectral linescanner, it quickly became apparent that these were not suitable for the routine processing of large amounts of data.

In order to make the best possible use of existing infrastructure (e.g. the command file preprocessor APREP) and established procedures (e.g. the use of a script oriented data processing system like ARAmf), the underlying algorithms were analyzed and then re-programmed into a Delphi 2.0 based, script controlled system.

This very open structure, where the actual sequence of processing steps is determined by the controlling script at run-time has allowed the relatively simple addition of new features as they appeared necessary or useful. To date, the system has grown to incorporate more than 60 separate processing commands and parameters...

# 3 Installation

To install ARAmap on a Windows 9x or NT PC, please unpack the distribution archive (using the appropriate options of your archiving program to preserve the directory tree structure contained in it).

The resulting subdirectory tree with its root in 'ARA' can be installed anywhere on a system, but the preferred location is C:\. If a C:\ARA subdirectory already exists (e.g. containing an older version of ARAmap or other ARA software), the new tree can be copied on top of it without any problem.

Use a text editor to review, and if necessary modify, the initial settings as defined in 'ARA\Install\ARAmap.reg'. When this step is completed double-click on this file or select the 'Merge' option of the context menu. (ARAmap.reg can be merged into the registry at any time later, if it becomes necessary to correct any corrupted settings which would otherwise prevent the program from working properly).

Set up a shortcut to the executable ARAmap.exe to a location of your choice, i.e. the Windows desktop or the start menu (located in C:\WINDOWS\Start Menu\).

When all these steps are completed, a double-click on the ARAmap shortcut should start the program, launching the GUI described in the next section of this manual.

# 4 Graphical User Interface

When ARAmap is launched, the Graphical User Interface (GUI) will start up in the same configuration as it was last terminated (when started up for the very first time, it will come up with the parameters set to the values in ARA.reg).

The screen is subdivided into two main parts:

- the protocol console takes up most of the screen

- to its right, the file selection panel controls the program

The file selection panel is further subdivided into three parts:

- on top, the drive selector

- below that, the directory selector

- and at the bottom the file selector

Right-clicking on a file entry in the file selector opens up a context sensitive menu offering a selection of actions for that specific file:

- Run (also selected by double-clicking)
  Sends the respective file to the preprocessor and then processes the resulting script file.

  Edit
  Opens the file in an editor (as selected in the settings)

# 5 ARAmap Scripting Concept

## 5.1 Command Structure

ARAmap scripts consist of a sequence of lines containing instructions (not case sensitive - for demonstration purposes, all code quotes are written in upper case in this manual) of the following basic structure:

```
COMMAND [parameter 1] [parameter 2] ... [parameter n]
```

The command parser tries to match the `COMMAND` part of each line with its internal command list. Lines for which a match can not be found are ignored (as well as empty lines and lines beginning with an '!').

Execution is then passed on to the respective subroutine which then extracts the parameters it needs from the remainder of the command line. If parameters are ommitted or given in an incorrect format, they will default to a preset value, e.g.

`MAPLINES 1 5`
: would read the first two parameters, whereas the second two would be set to their respective default values, because they are ommitted

`MAPLINES * * 20 400`
: would set the 3rd and 4th parameters to the given value, whereas the first two would be defaulting as they are given in a non-numerical format

In order to make a string parameter default, use the term " (the empty string). For more information on possible formats for parameters, please refer to Annex A.

## 5.2 Program Structure

All ARAmap scripts manipulate a central object called 'Image Map' - a two dimensional array of pixels used to store the generated information. The central parameters of an image map are the position of its top left corner in lat/lon space, its dimensions in x/y space and the pixel scale used to transform between lat/lon and x/y coordinates. Only when all these parameters are known, memory can be allocated to store the image map (Either by using `OPENMAP` to create a new, blank map, or by `LOADBMP` to pre-load an existing bitmap)

**CAVEAT:** as ARAmap assumes a rectagular projection between latitude/longitude and x/y coordinates ('flat Earth'), the accuracy of the conversion decreases with the distance from the top left corner of the image and is not suitable for images spanning large intervals in latitude.

Once an image map is resident in memory, a multitude of commands can be used to

- map data from remote sensing sources onto the image map
- plot implicit data or data read from files onto the map
- manipulate the colour mapping

In a final processing step the finished image map can be exported in various formats, including BMP, TIFF, and Surfer GRD format.

In order to release any allocated resources, the command `CLOSEMAP` should be used once an image map is not needed any more.

# 6 Alphabetical Reference

## ALGORITHM [type] [a0] [a1]

Define the channel/algorithm to use for mapping.

Parameters:

| | |
|---|---|
| [type] | - selects the mapping type (default = A), currently implemented are:<br>A - use scan file A<br>B - use scan file B<br>(A-B)/(A+B) - calculate a normalized differential |
| [a0] | - offset (default = 0) |
| [a1] | - scale (default = 1) |

## ATTITUDEFILE [filename]

Define which attitude file to use for all subsequent operations.

Parameters:

| | |
|---|---|
| [filename] | - the name of the file to use (refer to Appendix B for a format description) |

## AUTOSIZE [startline] [endline] [buffer radius]

Evaluates the attitude file to calculate the image boundaries. The data generated by multiple consecutive calls to AUTOSIZE (without CLOSEMAP or RESETDEFAULTS in between) will be merged

Parameters:

| | |
|---|---|
| [startline] | - first line to evaluate (default = first line of file) |
| [endline] | - last line to evaluate (default = last line of file) |
| [buffer radius] | - buffer radius to use around the aircraft underpoint in metres (default = 500m) |

## BOTTOMLATITUDE [value]

Explicitely define the bottom boundary of the image area.

Parameters:

| | |
|---|---|
| [value] | - the value in degrees or AMG (refer to Appendix A for possible formats) |

## BLANKINGTHRESHOLD [threshold] [colour]

Defines what to do with pixels where both channels have very small values, i.e. where the signal/noise ratio for NDVI calculation is very low.

Parameters:

`[threshold]` - threshold value below which to assume bad pixels (default = 0)

`[colour]` - colour to use for water pixels (default = cEmptyPixel)

## BLUEWATER [mode] [threshold] [colour]

Defines what to do with suspected water pixels (NDVI<0)

Parameters:

`[mode]` - ON/OFF switches this feature on or off

`[threshold]` - threshold value below which to assume water (default = 0)

`[colour]` - colour to use for water pixels (default = cDeepBlue)

## CALCULATEVIGNETTE [startline] [endline] [which] [width]

Calculate the vignettation coefficients for the given range of lines in the respective scan file (depending on the 'which' parameter).

Parameters:

`[startline]` - first line to use (defaults to 0)

`[endline]` - last line to use (defaults to the number of lines in the attitude file)

`[which]` - selects scan file 'A' or 'B' (defaults to 'A')

`[width]` - width of centre strip to use as reference (defaults to 128)

## CALPATH [path]

Define the path where ARAmap can find calibration data

Parameters:

`[path]` - the fully qualified path to the calibration data directory

### `CLIPPOINTLATLON [lat] [lon]`

Add a point to the clipping polygon corner list

Parameters:

`[lat]` - latitude of point (refer to Appendix A for possible formats)

`[lon]` - longitude of point (refer to Appendix A for possible formats)

## CLIPPOINTXY [X] [Y]

Add a point to the clipping polygon corner list

Parameters:

[X] - x coordinate of pixel, measured from the left edge

[Y] - y coordinate of pixel, measured from the top edge

## CLOSEMAP

Close an image map and free all allocated resources

## CLSNO [value]

Set the serial number of the line scanner used (this value is used to look up the correct calibration coefficients).

Parameters:

[value] - serial number of the line scanner

## COLOURINDEX [X] [Y] [colour] [left legend] [right legend] [title]

Plots an index of the palette used into the image map

Parameters:

[X] - x coordinate of top left corner of index

[Y] - y coordinate of top left corner of index

[colour] - colour of frame and text

[left legend] - text to plot at the beginning of the colour scale

[right legend] - text to plot at the end of the colour scale

[title] - text to plot above the colour scale

## ECCENTRICITY [value]

Set the offset between the centre of the line scanner CCD and the centre of the optics.

Parameters:

[value] - eccentricity offset in pixels (default = 0)

## END

Terminate the execution of the current script.

## EXTRACTBAND `[filename] [band] [firstline] [lastline] [offset] [scale]`

Extract a band file from a raw file (as specified in 'RawFile'), applying the correction table, and optionally scaling and offset. If 'RawFile' is a fully qualified filename, including an extension, this file will be used, otherwise the extensions will be cycled from .000, .001, etc.

Parameters:

`[filename]` - name of the file to write to

`[band]` - the band/mode to extract (currently implemented: red, green, blue, ir, and SLFMR) - defaults to 'red'

`[firstline]` - the first line to extract (defaults to 0)

`[lastline]` - the last line to extract (defaults to length of file)

`[offset]` - linear offset to apply to the data (default = 0)

`[scale]` - scaling factor to apply to the data (default = 1)

## FILLGAPS [nRepetitions] [nRequired]

Attemps to fill single pixel gaps in the image by averaging the values of neighbouring pixels

Parameters:

`[nRepetitions]` - how often to repeat the fillgap cycle (default=1)

`[nRequired]` - - how many non-blank neighbouring pixels are required to fill a gap (default = 5)

## FILTERVIGNETTE [filterlength]

Apply a running mean filter to the current vignette A

Parameters:

`[filterlength]` - length of the running mean filter (defaults to 10)

## FOCALLENGTH [value]

Set the focal length of the lens used.

Parameters:

`[value]` - focal length in millimetre (default = 28)

## HEADINGOFFSET [value]

Set the offset between the CCD 'forward' and attitude system 'forward' angles.

Parameters:

`[value]` - offset in degrees (default = 0)

## LEFTLONGITUDE [value]

Explicitely define the left boundary of the image area.

Parameters:

`[value]` - the value in degrees or AMG (refer to Appendix A for possible formats)

## LOADBMP [filename] [latTop] [lonLeft] [latpixels] [lonpixels]

Open a new image map using a pre-fabricated bitmap file as a template. The colour palette of the bitmap has to fit into the ARAmap colour system; this can be achieved by re-mapping it to aramap.cpl in Corel Photopaint.

Parameters:

`[filename]` - name of the BMP file to read

`[latTop]` - latitude of top left corner of bitmap

`[lonLeft]` - longitude of top left corner of bitmap

`[latPixels]` - latitude scale in pixels/degree

`[lonPixels]` - longitude scale in pixels/degree

### LOADPALETTE [filename] [reverse]

Loads a colour palette from an ASCII file (refer to Appendix B for file format description).

Parameters:

`[filename]` - the path/name of the file to read

`[reverse]` - if set to 'REVERSE', the palette will be reversed

### LOADPIXELMAP [filename]

Read an alternative pixel mapping table (e.g. for the SLFMR)

Parameters:

`[filename]` - name of the pixel map file to read

### LOADVIGNETTE [filename]

Load vignette A from a binary file

Parameters:

`[filename]` - name of the file to read from

### MAPLINES [startline] [endline] [startpixel] [endpixel]

Map the data from raw scan lines (contained in the file(s) designated by `SCANFILE` (or the pair `SCANFILEA/SCANFILEB`), using the algorithm selected by `ALGORITHM`, and the attitude data from `ATTITUDEFILE`) to the lat/lon grid represented by the currently opened map.

Parameters:

`[startline]` - first line to map (defaults to 0)

`[endline]` - last line to map (defaults to the number of lines in the attitude file)

`[startpixel]` - first pixel of the scan line to use (defaults to 0)

`[endpixel]` - last pixel of the scan line to use (defaults to size of the scan line)

## MAPRANGES [startline] [endline] [ratio]

Map the data from raw scan lines (contained in the file designated by SCANFILE using the attitude data from ATTITUDEFILE) to the lat/lon grid represented by the currently opened map. All 'line' references are referring to the 50Hz data in the attitude file.

Parameters:

[startline] - first line to map (defaults to 0)

[endline] - last line to map (defaults to the number of lines in the attitude file)

[ratio] - extrapolation ratio to elongate pixels along the track

## NORMALIZE

Offsets and scales the pixel values of the image map so that the darkest the colour index 0 and the brightest pixel the maximum available value

## OPENMAP [bytesperpixel] [averaging]

Open an image map using the image boundaries and resolution set either explicitely or generated by AUTOSIZE

Parameters:

[bytesperpixel] - number of bytes per pixel for internal rendering of the image map; permitted values are 1,2,4 (default = 1)

[averaging] - use averaging mode (ON/OFF) (default = OFF)

## PITCHOFFSET [value]

Set the offset between the CCD 'up' and attitude system 'up' angles.

Parameters:

[value] - offset in degrees (default = 0)

## PLOTBOXXY [X1] [Y1] [X2] [Y2] [Colour]

Plots a rectangular filled box with cornerpoints X1,Y1 and X2,Y2

Parameters:

[X1] - x coordinate of corner1, measured from the left edge

[Y1] - y coordinate of corner1, measured from the top edge

[X2] - x coordinate of corner2, measured from the left edge

[Y2] - y coordinate of corner2, measured from the top edge

[Colour] - colour

## PLOTDETAILS [X] [Y] [size] [colour]

Plots a text description of the lat/lon -> X/Y mapping

Parameters:

[X] - x coordinate of top left corner of text block

[Y] - y coordinate of top left corner of text block

[size] - text size

[colour] - colour

## PLOTFILELATLON [name] [colour] [type] [latcol] [loncol] [a1] [b1] [a0] [b0]

Plots data from an ASCII file into the image map. A value outside the permissible range for lat/lon will cause a break in the line.

Parameters:

[name] - filename of the data file

[colour] - colour

[type] - 'LINES' or 'DOTS' (default=lines)

[latcol] - column in file to use for latitude (default=1)

[loncol] - column in file to use for longitude (default=2)

[a1] - scaling factor for latitude (default=1)

[b1] - scaling factor for longitude (default=1)

[a0] - offset value for latitude (default=0)

[b0] - offset value for longitude (default=0)

## PLOTFRAMEXY [X1] [Y1] [X2] [Y2] [Colour]

Plots a rectangular frame with cornerpoints X1,Y1 and X2,Y2

Parameters:

`[X1]` - x coordinate of corner1, measured from the left edge

`[Y1]` - y coordinate of corner1, measured from the top edge

`[X2]` - x coordinate of corner2, measured from the left edge

`[Y2]` - y coordinate of corner2, measured from the top edge

`[Colour]` - colour

## PLOTGRIDLATLON [lat1] [lat1] [Dlat] [Dlon] [Colour]

Plots a rectangular grid

Parameters:

`[lat1]` - latitude of top left node

`[lon1]` - longitude of top left node

`[Dlat]` - grid spacing in latitude direction

`[Dlon]` - grid spacing in longitude direction

`[Colour]` - colour

## PLOTGRIDXY [X1] [Y1] [DX] [DY] [Colour]

Plots a rectangular grid

Parameters:

`[X1]` - x coordinate of top left node, measured from the left edge

`[Y1]` - y coordinate of top left node, measured from the top edge

`[DX]` - grid spacing in X direction

`[DY]` - grid spacing in Y direction

`[Colour]` - colour

## PLOTLINELATLON [lat1] [lon1] [lat2] [lon2] [Colour]

Plots a line from location lat1,lon1 to lat2,lon2

Parameters:

`[lat1]` - latitude of start pixel

`[lon1]` - longitude of start pixel

`[lat2]` - latitude of end pixel

`[lon2]` - longitude of end pixel

`[Colour]` - colour

## PLOTLINENUMBERS [startline] [endline] [delta] [colour]

Uses the attitude file to plot line numbers onto the ground track

Parameters:

`[startline]` - first line to plot

`[endline]` - last line to plot

`[delta]` - interval between lines

`[colour]` - colour

## PLOTLINEXY [X1] [Y1] [X2] [Y2] [Colour]

Plots a line from location X1,Y1 to X2,Y2

Parameters:

`[X1]` - x coordinate of start pixel, measured from the left edge

`[Y1]` - y coordinate of start pixel, measured from the top edge

`[X2]` - x coordinate of end pixel, measured from the left edge

`[Y2]` - y coordinate of end pixel, measured from the top edge

`[Colour]` - colour

### PLOTMARKERLATLON [lat] [lon] [type] [size] [colour]

Plots a marker into the image map

Parameters:

`[lat]` - latitude of marker

`[lon]` - longitude of marker

`[type]` - designates the marker to plot

`[size]` - size

`[colour]` - colour

### PLOTMARKERXY [X] [Y] [type] [size] [colour]

Plots a marker into the image map

Parameters:

`[X]` - x coordinate of marker

`[Y]` - y coordinate of marker

`[type]` - designates the marker to plot

`[size]` - size

`[colour]` - colour

### PLOTPIXELLATLON [lat] [lon] [colour]

Plots a pixel at coordinates lat/lon into the image map

Parameters:

`[lat]` - latitude of pixel

`[lon]` - longitude of pixel

`[colour]` - colour value of pixel

## PLOTPIXELXY [X] [Y] [Colour]

Plots a pixel at location X,Y into the image map

Parameters:

`[X]` - x coordinate of pixel, measured from the left edge

`[Y]` - y coordinate of pixel, measured from the top edge

`[Colour]` - colour value of pixel

## PLOTTEXTLATLON [lat] [lon] [text] [size] [colour] [font]

Plots a text into the image map

Parameters:

`[lat]` - latitude of top left corner of text block

`[lon]` - longitude of top left corner of text block

`[text]` - the text to plot

`[size]` - text size

`[colour]` - colour

`[font]` - name of the font to use

## PLOTTEXTXY [X] [Y] [text] [size] [colour] [font]

Plots a text into the image map

Parameters:

`[X]` - x coordinate of top left corner of text block

`[Y]` - y coordinate of top left corner of text block

`[text]` - the text to plot

`[size]` - text size

`[colour]` - colour

`[font]` - name of the font to use

## PLOTTRACK [startline] [endline] [colour]

Uses the attitude file to plot the ground track into the image map

Parameters:

`[startline]` - first line to plot

`[endline]` - last line to plot

`[colour]` - colour

## RAWFILE [filename]

Define which raw file(s) to use for all subsequent extraction operations.

Parameters:

`[filename]` - the name of the file to use (refer to Appendix B for a format description)

## REDUCE

If the image uses more than one byte per pixel, this command forces a reduction to one byte per pixel (this reduction is done implicitely whenever a 8-bit representation is necessary for the requested operation, e.g. writing to BMP or TIFF formats).

## RESETCLIPAREA

Reset any previously defined clipping polygons (i.e. turn off clipping)

## RESETDEFAULTS

Resets various parameters to their initial value.

## RESOLUTION [value]

Define the resolution of the image map

Parameters:

`[value]` - resolution in metres (default = 10)

### RIGHTLONGITUDE [value]

Explicitely define the right boundary of the image area.

Parameters:

`[value]` - the value in degrees or AMG (refer to Appendix A for possible formats)

### ROLLOFFSET [value]

Set the offset between the CCD 'horizontal' and attitude system 'horizontal' angles.

Parameters:

`[value]` - offset in degrees (default = 0)

### ROLLRAW [option]

Switch roll correction on and off.

Parameters:

`[option]` - 'ON' or 'OFF' (default = 'ON')

### SAVEVIGNETTEASCII [filename]

Save vignette A to an ASCII file

Parameters:

`[filename]` - name of the file to write to

### SAVEVIGNETTE [filename]

Save vignette A to a binary file

Parameters:

`[filename]` - name of the file to write to

### SCANFILE [filename] or SCANFILEA [filename]

Define which primary scan file to use for all subsequent mapping operations.

Parameters:

`[filename]` - the name of the file to use (refer to Appendix B for a format description)

### SCANFILEB [filename]

Define which secondary scan file to use for all subsequent mapping operations.

Parameters:

`[filename]` - the name of the file to use (refer to Appendix B for a format description)

### SETPALETTECOLOUR [red] [green] [blue] [startindex] [endindex]

Redefines the red/green/blue composition of palette colours

Parameters:

`[red]` - red component of RGB tripel (0-255)

`[green]` - green component of RGB tripel (0-255)

`[blue]` - blue component of RGB tripel (0-255)

`[startindex]` - first palette entry to overwrite

`[endindex]` - last palette entry to overwrite (defaults to startindex)

### SKIPCOUNT [value]

Define how many lines to skip between two mapped lines.

Parameters:

`[value]` - count (default = 0)

### TOPLATITUDE [value]

Explicitely define the top boundary of the image area.

Parameters:

`[value]` - the value in degrees or AMG (refer to Appendix A for possible formats)

## WRITEBMP [filename]

Writes the current image into a BMP bitmap file

Parameters:

`[filename]` - name of the BMP file to write

## WRITEGRD [filename] [x1] [y1] [dx] [dy]

Writes an extract from the current image into a SURFER binary grid file

Parameters:

`[filename]` - name of the GRD file to write

`[x1]` - x coordinate of top left corner of block to write

`[y1]` - y coordinate of top left corner of block to write

`[dx]` - size of block to write in X direction

`[dy]` - size of block to write in Y direction

`[offset]` - offset to apply

`[factor]` - scaling factor to apply

## WRITEHEADER [filename] [type] [outfilename]

Writes a header file for the current image map

Parameters:

`[filename]` - name of the header file to write

`[type]` - type of the header file to write - currently implemented:

TXT - plain text file
MAP - OziExplorer map file

`[outfilename]` - name of the file described by the header

## WRITELLZ [filename] [x1] [y1] [dx] [dy] [offset] [factor]

Writes an extract from the current image into a lat/lon/z ASCII file

Parameters:

`[filename]` - name of the LLZ file to write

`[x1]` - x coordinate of top left corner of block to write

`[y1]` - y coordinate of top left corner of block to write

`[dx]` - size of block to write in X direction

`[dy]` - size of block to write in Y direction

`[offset]` - offset to apply

`[factor]` - scaling factor to apply

## WRITETIFF [filename]

Writes the current image into a TIFF bitmap file

Parameters:

`[filename]` - name of the TIFF file to write

## XYZOFFSET [x] [y] [alt]

Define the offsets to use for mapping (all default to 0)

Parameters:

`[x]` - horizontal offset in pixels

`[y]` - horizontal offset in pixels

`[alt]` - vertical offset in metres

# 7 Appendix A: Constants and Numerical Data

There are four types of parameters used by ARAmap commands:

- integer

  In its simplest form, an integer parameter is its numerical representation, e.g. '1'. A number of 'named integer constants' is available, which allows the use of a name instead of a value, in particular for the colours: (white, lightgrey, darkgrey, black, aqua, fuchsia, blue, yellow, lime, red, deepblue, green).

  double

  Again, the simplest form is the numerical one, allowing all notation variants of the Pascal language (e.g. '1.34' and 1.45E-5' are both correct). In order to accomodate coordinate values, the following variants are possible:

  If the value is preceeded by the identifier 'A', it is deemed to be in AMG grid coordinates and is internally converted to decimal degrees.

  A 485115 6953069 54

  would be a valid parameter designating the point Easting 485115, Northing 6953069 in AMG zone 54 (if ommitted, the zone will default to 54).

  If the value is preceeded by one of 'S','W','N', or 'E', it is deemed to be in deegrees, minutes, and seconds of the respective hemisphere - the value is then internally converted to decimal degrees.

  S 34 56 54

  and

  S 34 56.9 * (the * can be ommitted if no further parameter follows)

  would both be valid representations of the value

  -34.9483

string

A string parameter is any sequence of non-blank characters separated by blanks. String parameters which are supposed to contain blanks need to be enclosed in quotes (e.g. `'x y'`).

choice

Choice parameters are used to select one of multiple possible options (e.g. 'ON' and 'OFF'), if the selection can not be found in the list of permitted values, the parameter will be set to its default setting.

# 8 Appendix B: File Formats

## 8.1 Data Source Files

### Attitude file

The attitude file is a plain binary file of attitude records consisting of six double precision values, e.g. created as an ARAmf D1/NOHEADER file. The record structure (in Pascal syntax) is as follows:

```
TAttitudeRecord =   packed record
                        Latitude    :   double;
                        Longitude   :   double;
                        Altitude    :   double;
                        PitchAngle  :   double;
                        RollAngle   :   double;
                        Heading     :   double;
                    end;
```

### TSLS line scanner raw file

The TSLS raw data files contain all three bands and their respective dark current correction data in an interleaved format of 6228 bytes record length:

```
TTSLSdata   =   packed record
                    ScanNr      :   integer;
                    Marker      :   word;
                    DarkCal     :   packed array[0..25,0..2] of byte;
                    Pixels      :   packed array[0..2047,0..2] of byte;
                end;
```

### TSLS line scanner band file

After the EXTRACTBAND operation, the line scanner band files contain the plain brightness information for a single band, corrected for dark current and instrument specific offsets and factors:

```
TScanLine   =   packed array[0..PixelsPerLine] of byte;
```

### SLFMR files

SLFMR data are contained in a plain 6-value single precision record:

```
TSLFMRdata  =   packed array[0..5] of single;
```

**Laser Range Scanner files**

Laser Range Scanner data are stored in point by point records in the following format:

```
TScanPoint      =       packed record
                                Range           :       word;
                                Amplitude       :       byte;
                                Angle           :       word;
                                TimeLo          :       word;
                                TimeHi          :       byte;
                        end;
```

## 8.2 Parameter Files

Correction table files

Vignette files

## 8.3 Product Files

BMP files

TIFF files

GRD files

LLZ files

Header files

## 8.4 Auxiliary Files

Palette files

Coordinate files