Processing of ISM/Phobos data

This file describes the software provided with the ISM data base. The programs used to generate calibrated data and coordinates files are included, as well as fortran and IDL programs to read, plot and extract the information. IDL routines provided here are only intended as skeletons of procedures to be developed by the user, while fortran programs are completely functional.

All fortran programs were originally written to run on Vax / VMS machines, and use Digital fortran with non-standard instructions. The decompression programs are not intended to run under other systems, and this is normally not required (their outputs are all available in the directories EDT_DATA and GEOMETRY). Graphic programs in fortran were used in early processing of the data; they are again written in Digital fortran, and rely on the UNIRAS graphic library to perform plotting and mapping. They use graphic formats that are probably obsolete now, and are provided as is to look at the data without using IDL.

IDL routines have been tested on under MacOS, Unix, and Window in IDL version 4 and 5 (up to 5.4). They assume an X-like device with 240 colours. IDL routines use the PDS-like directories' hierarchy of the data base, and normally adjust the path names to the system in use; they also swap byte order automatically depending on the machine architecture (little-endian vs big-endian). However, the routines may need to be adapted to local systems, in particular for use with a version of IDL older than 3.6.

Instructions to read the data files with the SIPS software under IDL are also included at the end of this file.

1) WRITING THE DECOMPRESSED DATA

Convert.for

Decompresses raw telemetry files in directory /RAW_DATA/FLIGHT and corrects some telemetry errors. Can process files partially or in totality. The output of the program must be considered as the primary raw data files (EDR).

Input

Telemetry data files in the directory /RAW_DATA/FLIGHT. The program prompts for the month and day of observation, then for time limits. The default is to process only the science observations in the main sessions. Providing time limits allows to process separately the sky observations and secondary sessions.

Processing

Telemetry files are written so that any parameter is coded on the minimum number of bits required to store all its possible values. This program decompacts measured reflectances and important instrument parameters, and stores them as 16-bits integers in a more standard format. Timing continuity is restored, and obvious telemetry errors are corrected. The program must be linked with the routine "DDISM.for" that decompresses the telemetry blocks. This routine uses specific Vax Fortran functions and can run only under Vax-VMS. The output can be read easily on any system, and is strictly equivalent to the original telemetry files for all practical purposes.

Output

The program writes two files for each session, corresponding respectively to odd and even channels (xxxeven.edt and xxxodd.edt). The spectra are written in sequence (bands interleaved by pixel, or BIP format) along the North-South lines of the image (the order of acquisition). Each record is composed of 72 integers :

spec(1 to 4) are hour, minute, second and eighth-second of acquisition (spacecraft time)

spec(5 and 6) are x and y, respectively line (W to E) and sample number (N to S) in the acquisition grid

spec(7) is a code for focal plane temperature

spec(8) is a code for mirror position

spec(9 to 72) are reflectance measurements in increasing wavelength order for odd or even channels. This is the exact output of the instrument, except for correction of telemetry errors. The data are actually coded on a 12-bit scale (ranging from 0 to 4096).

The data are signed 16-bits Vax integers, i. e. little-endian format. The files characteristics are described in "Files.pdf".

DDISM.for

This is the routine used by "convert.for" and other fortran programs to read and decompress the original telemetry files. It makes calls to bits-shifting functions that are specific to Vax Fortran, and may work only under Digital machines.

Corpho.for

This program performs a resampling of the Phobos window. A three pixels spatial convolution is applied to minimize registration discrepancies in the image. Although the data are modified, the output files can be considered the primary data files for the main Phobos image. This step is pertinent only to the Phobos window, and replaces the registration correction applied on Mars data as a step of the calibration process in "Etalonne.for".

Input

Uses the two files Phoeven.edt and Phoodd.edt in the directory /EDT_DATA/PHOBOS (written by Convert.for), Pixloc.ctr in the directory /GEOMETRY, and
Decal2.dat in the directory /CALIB.

Output

Writes files Phoeven.res and Phoodd.res, with format similar to the input, located in the same directory.

2) WRITING THE CALIBRATED DATA

Etalonne.for

Calibrates the data and writes data files located in the directory /CAL_DATA/MARS. The program is adapted only to the main eleven sessions on Mars. Files corresponding to even channels form the core of the data set for Mars. Calibrated data are also provided for odd channels, but it must be understood that the calibration process is not optimized for those channels, and very often is not satisfying (ie., the final relative accuracy is much better for even channels). An 'atmosphere removed' version on the files can be written also; the correction for atmospheric absorptions relies on a very simple model and is only intended to compensate a part of the absorption. This model is not adapted to the whole

range of surface elevations observed, and doesn't take atmospheric scattering into account. More accurate atmospheric correction is part of the scientific processing of the data an dis not handled here.

The program was developed on a Vax-VMS machine but should run with any Fortran compiler; the input may need to be adapted to read files of Vax integers.

Input

Decompressed even and odd channels data files in the directory /EDT_DATA/MARS and calibration files in directory /CALIB. The program prompts for the month and day of observation, then asks whether an atmospheric correction should be performed.

Processing

The program corrects for registration discrepancies using a three-pixels convolution, and interpolates missing spectra wherever possible. Corrections are performed for dark current, analogic gain, detectivity variations with temperature, grating orders overlap, transfer function and stray light. A rough compensation of atmospheric absorptions can be optionally performed. The corrections applied are described in details in "DocISM.pdf".

Output

The output format is similar to that of the input files; the only differences are channels output (now calibrated as radiance factors) and focal plane temperatures (now in degrees Celsius). Two files are written for each session, corresponding respectively to odd and even channels. The spectra are written in sequence (bands interleaved by pixel, or BIP format) along the North-South lines of the image (order of acquisition). Each record is composed of 72 integers :

spec(1 to 4) are hour, minute, second and eighth-second of acquisition (spacecraft time)

spec(5 and 6) are x and y, respectively line (W to E) and sample number (N to S) in the acquisition grid

spec(7) is the focal plane temperature (degrees C x 100)

spec(8) is a code for mirror position

spec(9 to 72) are reflectance measurements in increasing wavelength order for odd or even channels. The values are coded from 0.0 to 0.5 on a range of 0 to 32767. This conversion range preserves signal-to-noise without providing numerical saturation.

The data are signed 16-bits Vax integers, i. e. little-endian. The sessions modes and parameters are described in "Files.pdf".

Output files

Calibrated data are written as "xxxeven.cal" and "xxxodd.cal". For the Ascraeus session, a file "asceven.ca0" is written. Calibrated data with atmospheric correction are written as "xxxeven.atm" and "xxxodd.atm". These files are located in directory /CAL_DATA/MARS.

CorAsc.for

Writes the even channels calibrated data file for the Ascraeus image cube. This session was acquired at gain 3, and some even channels are saturated or non-linear in the brightest part of the image. The program interpolate reflectance estimates in the saturated channels, and is adapted only to this observation session.

Input

Calibrated data for even channels "Asceven.ca0" in directory /EDT_DATA/MARS (output of Etalonne.for).

Processing

Reflectances in saturated channels are computed from correlation with neighbouring channels where no saturation occurs.

Output
Calibrated data "Asceven.cal" in directory /CAL_DATA/MARS. The format is similar to that of the input files, and similar to the output of "Etalonne.for".

EtalPho.for

Writes the calibrated data files for the Phobos image cube. The program is adapted only to this observation session. The calibration process is optimized for even channels, although calibrated data are also provided for odd channels. The program was developed on a Vax-VMS machine but should run with any Fortran compiler; on other machines the input may need to be adapted to read files of Vax integers.

Input
Decompressed and resampled data files "Phoeven.res" and "Phoodd.res" in directory /EDT_DATA/PHOBOS (output of CorPho.for), plus calibration files in directory /CALIB.

Processing
Corrections are performed for dark current, analogic gain, detectivity variations with temperature, grating orders overlaps and transfer function.

Output
Calibrated data "Phoeven.cal" and "Phoodd.cal" in directory /CAL_DATA/PHOBOS. The format is similar to that of the input files, and similar to the output of "Etalonne.for" for Mars sessions.

3) WRITING THE COORDINATES FILES

Coord.for

This program computes the coordinates and viewing angles for the Mars image cubes. It must be linked with "Orbit.for".

Input
"xxxeven.cal" in the directory /CAL_DATA/MARS; "orbit.dat" in the directory /GEOMETRY.

Output
"xxx_coor.dat", located in the directory /GEOMETRY. The file has a BIP structure with one record per pixel. Each record consists of 14 16-bits signed integers (Vax format):
coord(1-2): line and sample number
coord(3-4): long/lat of the first corner
coord(5-10): long/lat of the other three corners
coord(11-13): incidence, emergence and phase angles
coord(14): mirror position (coded, 0 if no data). All angles are given in degrees, and multiplied by 100 to preserve accuracy. Longitudes are given using the terrestrial convention (-180 degrees to 180 degrees eastward) to fit the 16-bits format; this convention is used by most cartography programs, including IDL, although is differs from the planetary standard.

Orbit.for

A library of fortran routines used by "Coord.for" to compute spacecraft location and viewing direction at a given time. These routines must be linked with the main program.

4) EXTRACTING DATA

Extrait.for

A fortran program to extract a calibrated spectrum from data files. All 128 channels are read and written in sequence of increasing wavelength.

Input
Files "xxxeven.cal", "xxxodd.cal" located in directory /CAL_DATA/MARS, or any other couple of data files with similar format.
Wavelength file "Lambda.dat" in directory /CALIB.

Output
ASCII file with 3 columns (channel number, reflectance and wavelength) and 128 lines. A trailer gives the reference line and sample numbers. These files can be plotted by the IDL routine "Affspe.pro".

Fiche.for

Reads the telemetry data files located in the directory /RAW_DATA/FLIGHT, and lists the value of any parameter through time. This is specially useful to follow ancillary parameters (focal plane temperature, gain) and to check files continuity.

Input
Telemetry data files in directory /RAW_DATA/FLIGHT. The program prompts for a file name, then for the code of the parameter to be followed. Important parameters are discussed in "DocISM.pdf"; a more complete list is provided as comments in ddISM.for, and in the hardcopy documentation.

Processing
The program follows one parameter and write its new value each time the parameter is updated. When focal plane temperature is selected, it is listed both coded and translated in Celsius degrees. The program must be linked with the routine "DDISM.for" that decompresses the telemetry files. This routine uses peculiar Vax Fortran functions and can run only under Vax-VMS.

Output
The program writes a nameless files on logical unit 2 (For002.dat under VMS).

5) MAPPING PROGRAMS IN FORTRAN

Pixtrace.for

A versatile fortran program to plot geographic maps of spectral parameters for the eleven sessions on Mars. Spectral parameters consist in reflectance averaged in several channels, or in ratios of several spectral channels. Several sessions can be plotted together, in areas that are delimited by the user; cylindrical equidistant projection with an

arbitrary aspect ratio is used; altimetry lines from Mariner 9 can be superimposed on the maps as an option. This program must be linked with "Fenetre.for". The routines use the Uniras graphic library to write on various devices, but also write directly in Regis language. This ability makes it possible to use the program without Uniras on a Regis terminal (VT240, VT340, DecWindow...) and to write graphic files for Regis/Sixel printers, although lots of warnings would occur when linking without Uniras (Regis and Sixel formats are now obsolete).

Input

Mars data files "xxxeven.cal" and "xxxodd.cal" in directory /CAL_DATA/MARS,
Orbital parameters in "Orbit.dat" and coordinate files "xxx_coor.dat" in directory /GEOMETRY,
Color Table "Tabcol.dat" in directory /CALIB when selecting Regis file or screen,
Elevation files "Mars%%h.dat" in directory /GEOMETRY.

Processing

Sessions are identified by the month and day of acquisition. Several sessions can be entered in a sequence finishing by 0.

Spatial smoothing can be selected to reduce noise; smoothing uses the four adjacent pixels, with half the weight of the central pixel.

The program then prompts for two series of channels to study; each series is ended with a 0. If a series contains more than one channel, reflectance is computed as the geometric average of the selected channels. The spectral parameter plotted is the ratio of reflectances in the two series of channels. The next option allows to use the squared value of the result (this is useful for some spectral parameters, to preserve physical dimensions).

If no channel is entered in the second series (2nd channel=0), the average reflectance is converted to normal albedo through a Minnaert correction; this correction minimizes the effects of limb darkening, but relies on several assumptions.

If the parameter corresponds to the 2.0 or 1.4 microns atmospheric CO2 bands (first channel = 80 or 79, 56 or 57), it is automatically corrected from geometrical variations of the atmospheric path length; the result will then be a measure of atmospheric pressure at the surface (i.e., a non-linear estimate of surface elevation); this assumes that atmospheric lines are not saturated, which may no be true wherever absorption becomes large.

A correct parameter for a band depth centered at wavelength λ with half-width $d\lambda$ would be $r(\lambda) / sqrt(r(\lambda-d\lambda)*r(\lambda+d\lambda))$. A possible parameters for Fe2+ absorption at 1 micron is for example: 18, 0, 10, 26, 0. This kind of ratio is proportional to the second logarithmic derivative, and depends on calibration errors only through a scaling coefficient (see e.g., Erard *et al.* 1991).

Limit values must be entered. The corresponding interval is sliced into 16 classes. The mean value and standard deviation are printed after the map is displayed to help refining these limits.

Coordinates are entered using the Mars convention (longitudes from 0 to 360 westward); the display uses an aspect ratio of 4/5 in latitude/longitude. Values adapted to VMC, HEB and ASC image cubes are for instance: 50, 120, -28, 28. If the option "Hypsometry" is selected, altimetry lines will be superimposed on the map in areas comprised between -30 and 30 degrees in latitude; these data were hand-digitized from Mariner-9/Viking maps (UV measurements + stereophotogrametry) and may be relatively inaccurate.

Output

The output device can be a color Regis screen (VT340); a Regis file that can be later typed on the screen or converted to a Sixel file for use with a Digital color printer (Regis file); a color level-1 PostScript file (PostScript); a Digital GPX terminal (GPX); any other device available in the local implementation of Uniras (the display parameters may then need optimization). The program writes directly in Regis, so no graphic library is required with the first two options. Other devices are addressed through the Uniras

graphic library. The Regis/VT output uses a color table optimized for a VT340 terminal, that may not give good results on other models.
A log file "carte.dat" is written.

Photrace.for

A program to plot geographic maps of spectral parameters for the Phobos session. The functioning is similar to "Pixtrace.for". The projection used is stereoscopic (similar to a camera view acquired from the spacecraft), with fixed geographic boundaries. This program must be linked with "FeneX.for" that contains plotting functions for this single image cube.

Input
Phobos calibrated data files "Phoeven.cal" and "Phoodd.cal" in the directory /CAL_DATA/PHOBOS. Screen coordinate files "Pho_scrn.dat" in the directory /GEOMETRY, Color Table "Tabcol.dat" in the directory /CALIB, topographic file "Gricor.dat" in directory /GEOMETRY.

Processing
A spatial smoothing option can be selected. Spectral channels are then entered in two series. The interface is identical to "Pixtrace.for". No limb darkening is performed on reflectance maps (the Minnaert exponent is unknown in the infrared, although close to 0.5), and of course atmospheric absorption is not considered.
Coordinates limits are fixed since there is a single view of Phobos, and reference topographic lines (from Tom Duxbury's 1991 model) are always plotted. Pixels acquired in the dark sky or near the limb are not plotted.

Output
Output devices are handled in the same manner as in "Pixtrace.for".

Fenetre.for

A library of fortran routines used by "Pixtrace.for" to display maps of spectral ratios on various devices. These routines must be linked with the program even if the Uniras library is not available.

FeneX.for

A library of fortran routines used by "Photrace.for" to display maps of spectral ratios on various devices. These routines must be linked with the program even if the Uniras library is not available. Routines have similar names than those in "Fenetre.for" but may be different.

6) IDL ROUTINES TO READ AND PLOT THE MAIN SESSIONS

comp

A main IDL program to compile the various routines and functions in the correct order (may be required on some Unix systems because of upper case routine names). Runs IDLdef.pro. Type @comp at the IDL batch.

ISMdef

A small routine that defines the path to the data files, according to the operating system in use. Normally uses the data volume structure. Requires adaptation to the local directory structure on MacOS (only absolute paths are accepted, so this string must contain the hard disk name). This can be adapted to run the software from a hard disk.

Pixtrace2.pro

A routine that reads ISM calibrated data and plots a geographic map of a session. Allows to plot any spectral parameters (not only ratios) using a hand-written function (/USER). Optionally plots albedo instead of radiance factor, as estimated with a Minnaert correction (k=0.7 on Mars, k = 0.55 on Phobos). Optionally plots odd (/ODD) or even channels, or viewing angle. Processes only the main observation sessions, Mars and Phobos. Normally

Input
Request the session's acronym and a channel to be mapped (even or odd channel number, ranging from 1 to 64).
Calls ISM_sess, ISM_lam, ISM_data, ISM_noise, and ISM_coor.
Keyword /ALBEDO plots an albedo map.
If keyword ANGLE is set to 'emergence', 'incidence' or 'phase', viewing angles are plotted instead of reflectance values.
If keyword NONOISE is set, plots classes with width of 1 sigma minimum (reduces the number of colors to the number of significant classes).

Output
Plots a Mercator map on the current device. Writes an optimized Postscript file when keyword PS is set. The map is plotted using the terrestrial convention for longitudes, due to limitations in the standard IDL mapping routine (map_set.pro).

ISMcom

Widget tool to map the main ISM sessions (Mars and Phobos) and to plot spectra. This is a frontend interface to ISM_map and ISM_plot. Maps are plotted using the terrestrial convention for longitudes, due to limitations in the standard IDL mapping routine (map_set.pro). OInly one session can be plotted at a time.

ISM_plot.pro

A routine that reads ISM calibrated data, plots a small image of the session and extracts calibrated spectra. Optionally plots odd or even channels. Processes only the main observation sessions, Mars and Phobos.

Input
Requests the session's acronym and a channel number to be mapped.
Calls ISM_sess, ISM_lam, and ISM_data.

Output
Plots spectra on the current device. Optionally writes an optimized Postscript file.

ISM_raw.pro

A routine that reads ISM raw data, plots a small image of the session and extracts uncalibrated spectra. Optionally plots odd or even channels. Processes only the main observation sessions, Mars and Phobos.

Input
Request the session's acronym and a channel number to be mapped.
Calls ISM_sess, ISM_lam, and ISM_data.

Output
Plots spectra on the current device. Optionally writes an optimized Postscript file.

ISM_cal.pro

A routine that reads extra ISM sessions, plots a small image of the session and extracts uncalibrated spectra. Optionally plots odd or even channels. Processes only the extra sessions: Spinning session, limb observations, flight calibrations, extra Phobos sessions, and cruise tests.

Input
Request the session's acronym and a channel number to be mapped (acronym is on 3 or 4 characters, depending on session).
Calls ISM_ses2, ISM_lam, and ISM_data.

Output
Plots spectra on the current device. Optionally writes an optimized Postscript file.

ISM_map.pro

A routine that reads ISM calibrated data, and plots a geographic map of the session. Optionally plots albedo instead of radiance factor, as estimated with a Minnaert correction (k=0.7 in all situations). Optionally plots odd (/ODD) or even channels, or viewing angle. Processes only the main observation sessions, Mars and Phobos.

Input
Request the session's acronym and a channel to be mapped (even or odd channel number, ranging from 1 to 64).
Calls ISM_sess, ISM_lam, ISM_data, and ISM_coor.
Keyword /albedo plots an albedo map; if keyword ANGLE is set to 'emergence', 'incidence' or 'phase', viewing angles are plotted.

Output
Plots a Mercator map on the current device. Writes an optimized Postscript file when keyword PS is set. The map is plotted using the terrestrial convention for longitudes, due to limitations in the standard IDL mapping routine (map_set.pro).

ISM_pho.pro

A routine that plots a "satellite" projection of the Phobos image. Optionally plots odd (/ODD) or even channels, or viewing angle (ANGLE='emergence', 'incidence', or 'phase').

Input
Request a channel number to be mapped.

Calls ISM_sess, ISM_lam, ISM_data, and ISM_coor.

Output
Plots a map on the current device. Optionally writes an optimized Postscript file (/PS). The projection used mimics a snapshot from the spacecraft. Default is to use rounded coordinates so as to get a continuous map (adjacent pixels). Optionally, the actual pixel corner positions can be used (/REAL).

ISM_sess.pro

A function that defines the session parameters for ISM sessions (both Mars and Phobos). Does not attempt to read the information from the PDS labels.

Output
Returns session parameters in a structure.

ISM_ses2.pro

Similar to ISM_sess for other, uncalibrated, sessions (limb observations, flight calibrations…).

Output
Returns session parameters in a structure.

ISM_data.pro

A function that reads ISM data files, even or odd channels, for the session of interest. Adjusts file path syntax on some operating systems (VMS, Unix). Change byte order on some computers using big-endian encoding (Unix except OFS, and MacOS).

Input
Request the session parameters in a structure as initialized by ISM_sess.pro.
Reads files xxxeven.cal or xxxodd.cal (or other files with similar structure, as *.atm or *.edt).

Output
Returns session data and main housekeeping parameters in a structure.

ISM_coor.pro

A function that reads ISM coordinate files for the session of interest. Adjusts file path syntax on some operating systems (VMS, Unix). Change byte order on some computers using big-endian encoding (Unix except OFS, and MacOS).

Input
Request the session parameters in a structure as initialized by ISM_sess.pro.
Reads files xxx_coor.dat for Mars and Phobos. In the case of Phobos, screen coordinates can be read also (pho_scrn.dat and pho_scor.dat).

Output
Returns session coordinates and viewing angles in a structure.

ISM_lam.pro

A function that returns ISM channels wavelengths for odd or even channels.

Input
Reads file lambda.dat (ascii file).

Output
Returns 64 wavelengths in an array.

ISM_noise.pro

A function that returns estimates of noise in ISM channels for odd or even channels. Used by Pixtrace2.pro to set class limits when option NONOISE is set.

Input
Reads file sigtonoi.dat (ascii file).

Output
Returns 64 noise estimates in an array.

7) ADDITIONAL PLOTTING AND CONVOLUTION

Lecspe.for

A Fortran program that convolves any spectrum with ISM spectral response. The result mimics the calibrated output of ISM looking at the same object; it would work properly only if the spectral resolution of the input spectrum is at least equal to that of ISM. The program may write files containing the spectral response ("reponses.dat") and widths at half-eight ("Largeurs.dat").

Input
Any spectrum with overlapping spectral range can be processed, but the input format must be modified accordingly. Originally set for Relab ascii format.

Output
Formatted ascii file with 128 lines of 3 columns: channel number (integer), reflectance, wavelengths in microns (reals). Such files can be plotted by the routine "Affspe.pro".

Affspe.pro

An IDL procedure to plot calibration files and spectra. The routine reads an ascii file with 128 lines (channels in increasing wavelength order) and three columns, respectively channel number (integer), data and wavelength in microns (reals). Values for odd and even channels are plotted separately (in green and red respectively).

Input
Output files from "Lecspe.for" (spectra integrated to ISM wavelength format),
output files from "extrait.for" (spectra extracted from data files),
most data files in directory /CALIB (except "Sourvol.det" which has a different format),
"CNChaud" and "CNFroid" in /EDT_DATA/GROUND.
Keyword DIR allows to select the directory where the file is.

Output
Optimized for a 240-colours X-window device and PostScript device (/PS).

ISM_rep.pro

An IDL procedure to read the spectral response of even or odd channels (files "reponses.dat" and "reponsesi.dat"). These values are the result of spectral calibrations with a monochromator, they are computed by "Lecspe.for".

Input
Files "reponses.dat" or "reponsesI.dat" in the directory /CALIB.

Output
Two (64,12) arrays, containing respectively 12 measurements per channel and the corresponding wavelength. These values can be plotted by the routine "Affspe.pro". They can be used to convolve any spectrum to ISM spectral resolution.

Affrep.pro

An IDL procedure to plot the spectral response of even channels (file "reponses.dat"). These values are the result of spectral calibrations with a monochromator, they are computed in "Lecspe.for". A similar file exists for odd channels.

Input
Calls ISM_REP.PRO that reads "reponses.dat" or "reponsesI.dat" in the directory /CALIB.

Litbidim.pro

An IDL procedure to plot the ground calibration file "Bidim.dat". The instrument was mounted on a mobile platform, in front of a black body at about 120 Celsius degrees with non-uniform temperature, i.e. with a spatial structure. The movement of the platform was used to scan the source, while the instrument mirror remained in its rest position. This routine reconstitutes and plots images of the source in each spectral channel. The shift between these images is a measure of channels misregistration, and was used to compute correction coefficients in "Decal2.dat".

Input
"Bidim.dat" in the directory /EDT_DATA/GROUND.

Litalt.pro

An IDL procedure to read the altimetry data base in directory /DRV_DATA/TOPO (see Rosenqvist *et al.*, Icarus, 1992). The routine plots a geographical map of elevation from the files. The file also contains measurements of vertical pressure from the data; elevation values are retrieved from depth of the 2.0 microns CO2 band and atmospheric modeling. The image is resampled in the longitude/latitude plane with a step of 0.3 degrees. Accuracy is 0.1 mb in pressure, 100 m in elevation; latitude and longitude may be different and are probably less accurate than the values in the coordinate files (in the directory /GEOMETRY). The files have 7 columns, respectively sample/line numbers, latitude and longitude (planetary convention), airmass factor, pressure (mb) and elevation (km).

Input
Files "xxxalt.dat" in directory /DRV_DATA/TOPO, except "Pavalt.dat".

Litpav.pro

An IDL procedure to read the altimetry file for Pavonis Mons in directory /DRV_DATA/TOPO. This routine is similar to Litalt.pro, but works only for observations of Pavonis Mons' caldera. In addition, a block diagram is plotted from the data.

Input
File "Pavalt.dat" in the directory /DRV_DATA/TOPO.

8) INSTRUCTIONS FOR USING ISM DATA FILES WITH SIPS

SIPS is an IDL program developed at the University of Colorado to process data from terrestrial imaging spectrometers (mainly AVIRIS). Although it bears no relationship with ISM, this program may be helpful to process ISM image cubes. SIPS is distributed free of charge by the University of Colorado with accompanying spectral libraries; it runs on several Unix machines with recent versions of IDL implemented (contact sips@cses.colorado.edu). An atmospheric removal program (ATREM) is provided with SIPS, but it is not adapted for the Martian atmosphere.

ISM data have been tested with version 1.5 of SIPS and version 3.6.1 of IDL on HP-700 and -900 computers. SIPS can be used with IDL 4.0.1, provided that the IDL routine XMENU can be accessed (it was part of the 3.6 distribution, but in version 4.0 it was moved to the directory "obsolete"). The files must be converted for use with SIPS, using the following procedure:

• Under IDL, go to the directory containing the data. Type 'Util' to restore the SIPS utilities. You will be prompted with a widget menu. Click on the 'subset_sips' button. A conversion menu will appear. Fill it with the required information (all fields must be validated by Return):

- Name of input file (calibrated file from "Etalonne.for" e.g., "syreven.cal" for the Syrtis-Isidis image cube, even channels without atmospheric correction)
- Name of output file (e.g., "syrevencal_bip.cub"; the "_bip.cub" suffix is a useful default for SIPS input files)
- Storage order: BIP
- Number of samples: 25 (medium resolution sessions like Syrtis-Isidis) or 8 (high resolution sessions)
- Number of lines: depending on the session (121 for Syrtis-Isidis)
- Number of bands: 72 (8 parameters + 64 measurements)
- Header size: 0
- Byte order: Little Endian (this is required to convert from VMS format)
- Data type: Integer
- Image type: Other image
- Sample Mini/Max: 1 and number of samples per line (25 or 8)
- Line Mini/Max: 1 and total number of lines
- Band Mini/Max: 9 and 72. This allows to skip the ancillary data at the beginning of the spectra.

Once this is done, click on 'Start' and exit both menus.

• DN numbers can optionally be converted back to reflectance values, using the 'flat_field' utility:

- If the input file is the one you have just converted, most of the fields will fill up automatically.
- Enter 'norm.dat' as removal spectrum file name.
- Enter a name for the output file (using the '_bip.cub' suffix makes life easier)

• To work with its spectral libraries, SIPS needs a wavelength file corresponding to the session. Such files are provided for even and odd channels separately ("waveleven.dat" and "wavelodd.dat" in directory /CALIB) and are identical for all observations files in the data base. They must have the same root name as the input file with a '.wav' extension (e.g., 'syrevencal.wav' in the previous example) to take advantage of SIPS defaults. When no wavelength file is provided, SIPS will use the channel number instead of wavelengths; beware that spectral interval between ISM channels is twice larger in the first order (from channel 32 among 64).

• In the main IDL window type: "sips_view, 'syrevencal'".
This will start the SIPS session opening the file "syrevencal_bip.cub" and looking for a wavelength file named 'syrevencal.wav'. The two spectra windows must be adapted to the file format:

- Click on 'Functions/Scale/Text entry' in the pop-up menu beneath the windows.
- Enter 9 for X Min if working with the band numbers instead of wavelengths, and validate with Return.
- Enter 32767 (or slightly less) for Y Max if working with DN numbers. The default value of 1000 is adapted for files converted to reflectance values with the 'flat_field' utility. However the reflectance level in the data is never larger than 500 and usually less than 400 (those numbers are radiance factors multiplied by 1000).

• The image displayed is a not a map of the region observed, but is plotted on the acquisition grid (line and sample numbers). This results in a shift of approximately one pixel per line in the E-W direction. Also, the scene is both rotated and transposed, so that East is on top and South is at the right of the screen. This can be fixed with the 'rotate' utility of SIPS, but this routine will only work on a cube with BSQ structure. Such a file can be created in SIPS with the 'convert' utility.