HRSC & GIS

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HRSC & GIS

- HRSC header information relevant for GIS ingestion
- PDS & Vicar labels
- HRSC sphere/spheroid & minivicar

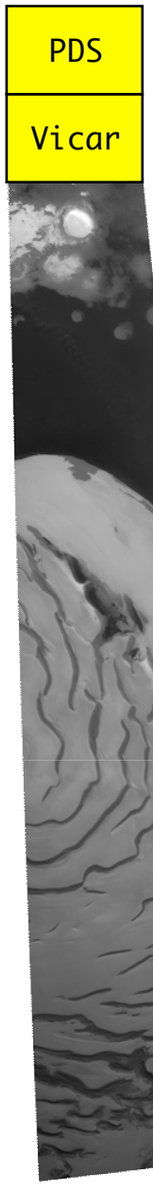
HRSC PDS & Vicar labels

label(s) →

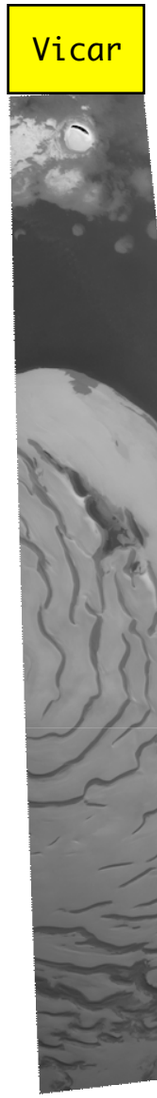
image →

processing level →

Level2



Level3



home-brewed Level3/3+

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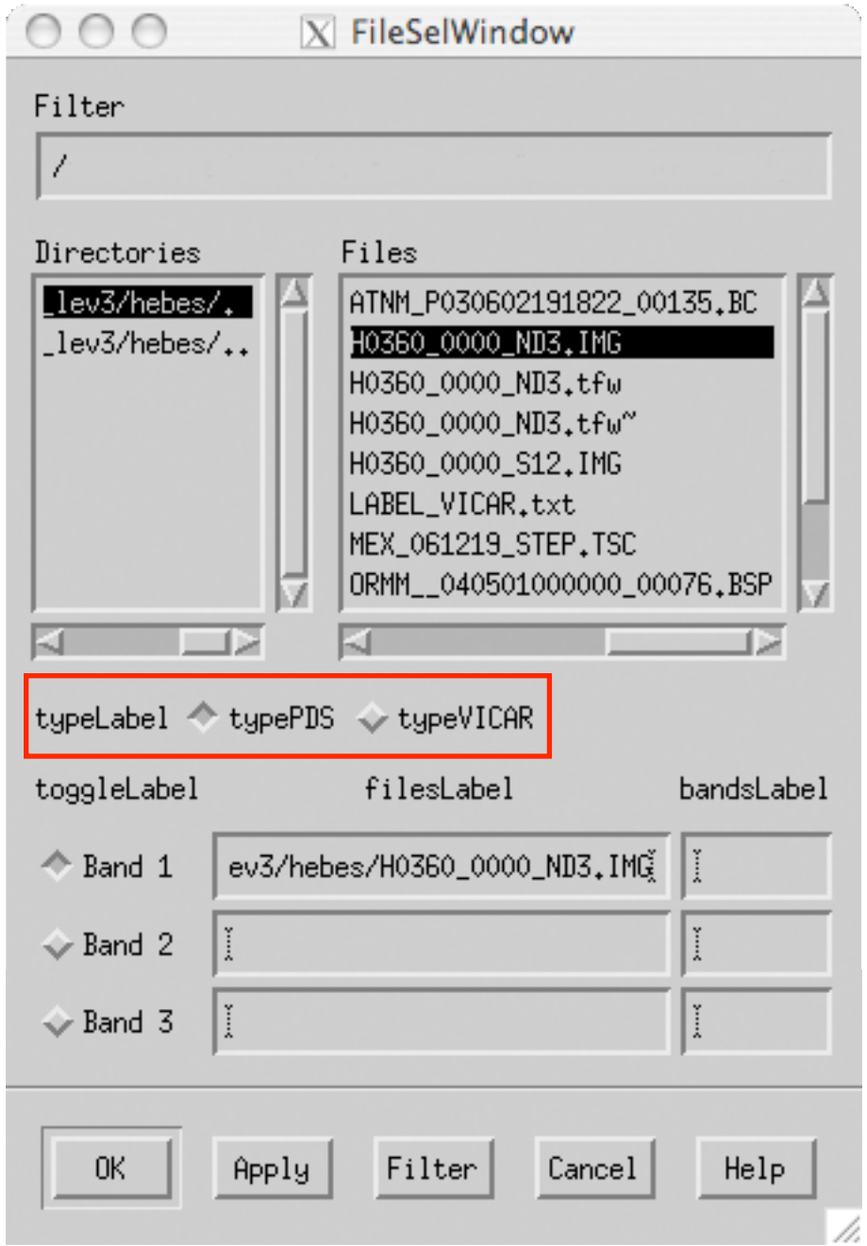
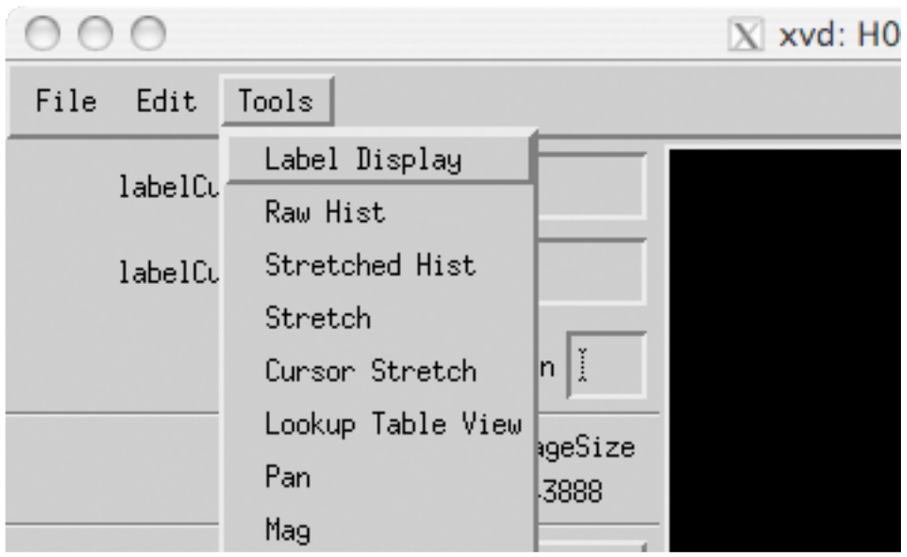
Viewing labels



a) choose label opening the file

Both PDS and VICAR labels can be viewed in xvd



b) view the label from xvd

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Viewing labels

PDS

```
 PDS_VERSION_ID  =  PDS3

/* FILE DATA ELEMENTS */

   RECORD_TYPE  =  FIXED_LENGTH
   RECORD_BYTES  =  10383
   FILE_RECORDS  =  43891
   LABEL_RECORDS  =  2

/* POINTERS TO DATA OBJECTS */

   ^IMAGE_HEADER  =  3
   ^IMAGE  =  4

/* IDENTIFICATION DATA ELEMENTS */

   FILE_NAME  =  "H0360_0000_ND3.IMG"
   DATA_SET_ID  =  "MEX-M-HRSC-5-REFDR-MAPPROJECTED-V2.0"
   DETECTOR_ID  =  MEX_HRSC_NADIR
   EVENT_TYPE  =  "MARS-GLOBAL-MAPPING-Te-Fl-Lc"
   INSTRUMENT_HOST_ID  =  MEX
   INSTRUMENT_HOST_NAME  =  "MARS EXPRESS"
   INSTRUMENT_ID  =  HRSC
   INSTRUMENT_NAME  =  "HIGH RESOLUTION STEREO CAMERA"
   MISSION_NAME  =  "MARS EXPRESS"
   MISSION_PHASE_NAME  =  MC_Phase_6
   PROCESSING_LEVEL_ID  =  3
   PRODUCT_CREATION_TIME  =  2006-07-28T17:46:42.000Z
   PRODUCT_ID  =  "H0360_0000_ND3.IMG"
   RELEASE_ID  =  0006
   REVISION_ID  =  0000
....
....
....
```

VICAR

```
************************************************************
     +++++ System Label of file H0360_0000_ND3.IMG +++++
           3 dimensional IMAGE file
           File organization is BSQ
           Pixels are in BYTE format from a JAVA host
           1 bands
           43888 lines per band
           10383 samples per line
           0 lines of binary header of type
           0 bytes of binary prefix per line

************************************************************

************************************************************
      +++++ Property Label of file H0360_0000_ND3.IMG +++++

    ------------------------------------------

  PROPERTY = 'M94_ORBIT'

    ORBIT_NUMBER=360
    ASCENDING_NODE_LONGITUDE=221.55
    ORBITAL_ECCENTRICITY=0.606
    ORBITAL_INCLINATION=86.56
    PERIAPSIS_ARGUMENT_ANGLE=298.62
    PERIAPSIS_TIME='2004-05-02T21:06:37.000Z'
    PERIAPSIS_ALTITUDE=266.17
    ORBITAL_SEMIMAJOR_AXIS=9261.67
    SPACECRAFT_SOLAR_DISTANCE=2.42487e+08
    SPACECRAFT_CLOCK_START_COUNT='1/0031612651.56187'
    SPACECRAFT_CLOCK_STOP_COUNT='1/0031613373.19695'
    START_TIME='2004-05-02T21:18:50.969Z'
    STOP_TIME='2004-05-02T21:25:19.970Z'
    SPACECRAFT_POINTING_MODE='NADIR'
     ....
     ....
     ....
```

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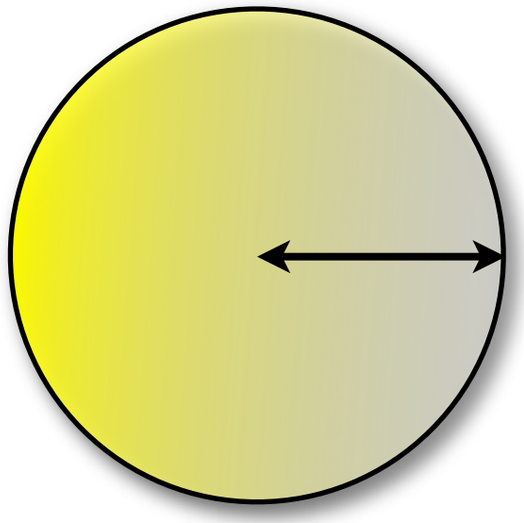
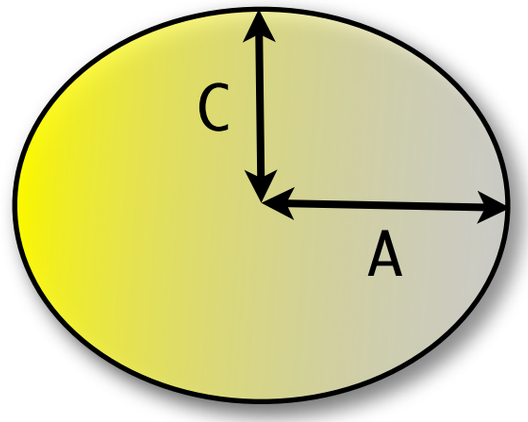
Sphere & ellipsoid

~ Mars IAU2000 sphere



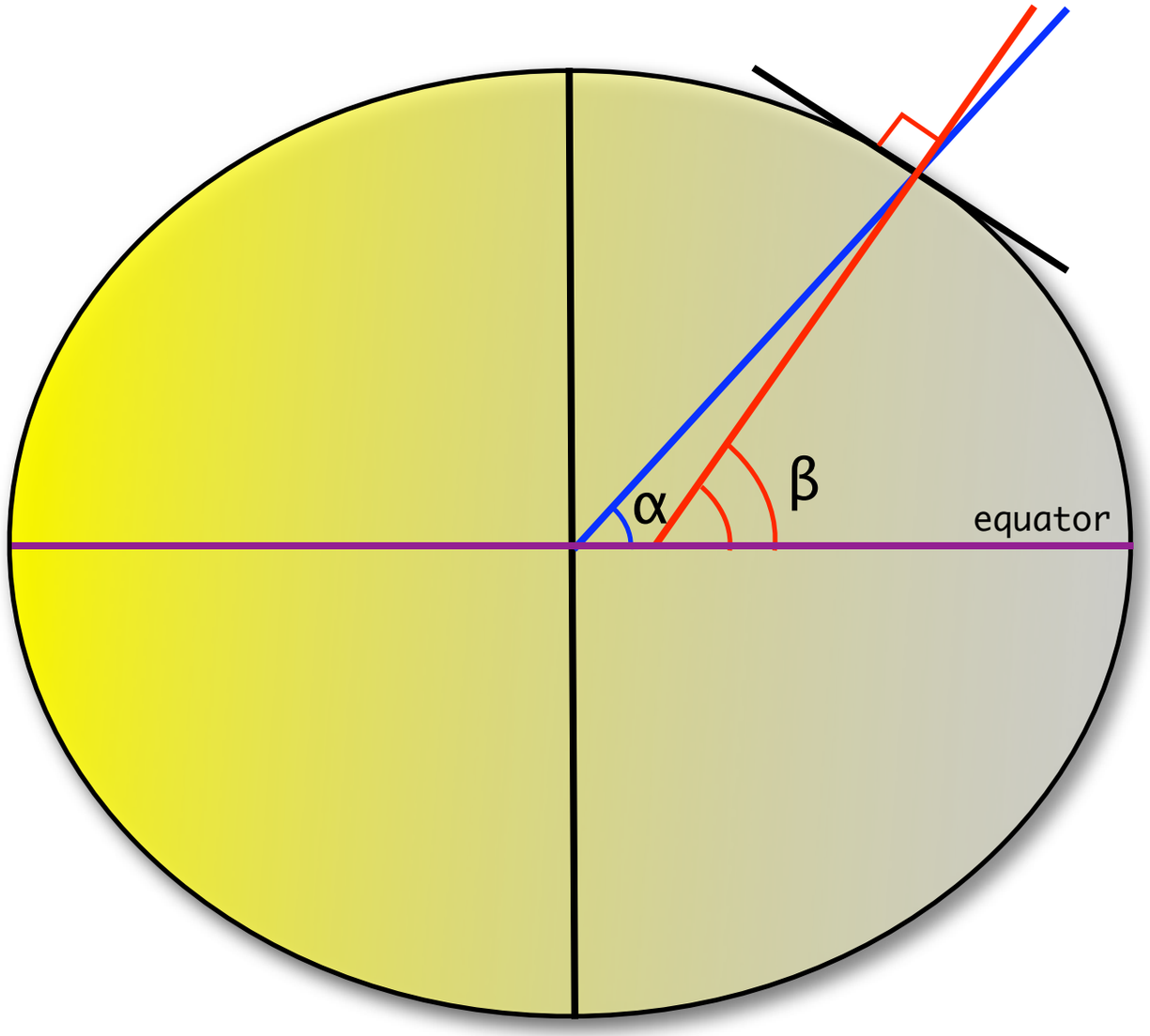
```
A_AXIS = 3396.19 km
B_AXIS = 3396.19 km
C_AXIS = 3396.19 km
```

Mars IAU2000 ellipsoid




```
A_AXIS = 3396.19 km
B_AXIS = 3396.19 km
C_AXIS = 3376.2 km
```

Centric vs. graphic Lat.



Often confusing, make sure your choices are consistent

Latitude:

α = planetocentric

β = planetographic

of course, if:

A_AXIS = 3396.19 km
B_AXIS = 3396.19 km
C_AXIS = 3396.19 km

α = β

and life is easier...

HRSC & ellipsoid

- HRSC level3 data are provided with a coordinate system based on a sphere with R=3396.19 km

- Minivicar can produce map-projected data with different a_axis, b_axis, c_axis, e.g. :

```
A_AXIS = 3396.19 km
B_AXIS = 3396.19 km
C_AXIS = 3376.2 km
```

- Working with sphere often easier (e.g. with GIS, when planetocentric latitude is not supported using a spheroid)

HRSC level3 PDS label

```
   PDS_VERSION_ID  =  PDS3

/* FILE DATA ELEMENTS */

   RECORD_TYPE  =  FIXED_LENGTH
   RECORD_BYTES  =  10383
   FILE_RECORDS  =  43891
   LABEL_RECORDS  =  2

/* POINTERS TO DATA OBJECTS */

   ^IMAGE_HEADER  =  3
   ^IMAGE  =  4

/* IDENTIFICATION DATA ELEMENTS */

   FILE_NAME  =  "H0360_0000_ND3.IMG"
   DATA_SET_ID  =  "MEX-M-HRSC-5-REFDR-
MAPPROJECTED-V2.0"
   DETECTOR_ID  =  MEX_HRSC_NADIR
   EVENT_TYPE  =  "MARS-GLOBAL-MAPPING-Te-Fl-Lc"
   INSTRUMENT_HOST_ID  =  MEX
   INSTRUMENT_HOST_NAME  =  "MARS EXPRESS"
   INSTRUMENT_ID  =  HRSC
   INSTRUMENT_NAME  =  "HIGH RESOLUTION STEREO
CAMERA"
   MISSION_NAME  =  "MARS EXPRESS"
   MISSION_PHASE_NAME  =  MC_Phase_6
   PROCESSING_LEVEL_ID  =  3
   PRODUCT_CREATION_TIME  =
2006-07-28T17:46:42.000Z
   PRODUCT_ID  =  "H0360_0000_ND3.IMG"
   RELEASE_ID  =  0006
   REVISION_ID  =  0000

/* TIME DATA ELEMENTS */

   SPACECRAFT_CLOCK_START_COUNT  =
"1/0031612651.56187"
   SPACECRAFT_CLOCK_STOP_COUNT  =
"1/0031613373.19695"
   START_TIME  =  2004-05-02T21:18:50.969Z
   STOP_TIME  =  2004-05-02T21:25:19.970Z

/* ORBITAL DATA ELEMENTS */

   ASCENDING_NODE_LONGITUDE  =  221.55
   MAXIMUM_RESOLUTION  =  29.1 <m/pixel>
   FOOTPRINT_POINT_LATITUDE  =
(-15.382,-15.3534,-15.3529,-15.146,

-12.9014,-12.7003,-12.4995,-12.2993,

-12.0993,-11.8999,-11.5024,-11.3042,

-11.1065,-10.9093,-10.7127,-10.5165,

-10.3207,-8.77061,-8.57868,-8.38733,

-8.19672,-8.00626,-7.81638,-7.62704,

-6.87366,-6.68636,-6.49958,-6.31325,

-5.94186,-5.75685,-5.57239,-5.38824,

-5.20448,-5.0211,-4.65621,-4.47412,

-4.29264,-3.93106,-3.57147,-3.39217,

-3.21306,-3.03456,1.95326,3.10472,

3.12821,2.96824,2.96712,1.66348,

0.500825,0.333026,-0.00392688,-0.173461
                                ,-0.34332,-0.5
13724,-0.684095,-1.02517,

-1.19668,-1.36929,-1.54209,-1.71509,

-1.88829,-2.06162,-2.23564,-2.76106,

-4.36124,-4.54153,-4.72254,-4.90355,

-5.08486,-5.26649,-5.44843,-5.63117,

-5.81426,-5.99786,-6.18199,-6.55193,

-6.73734,-6.92279,-7.10896,-7.29577,

-7.48312,-7.67076,-7.85958,-8.04861,

-8.23774,-8.42715,-8.61712,-8.8076,

-9.19006,-9.38183,-9.57415,-9.76684,

-9.95991,-10.3471,-11.7192,-12.9134,

-13.1142,-13.3152,-15.3523,-15.382)
   FOOTPRINT_POINT_LONGITUDE  =
(284.211,286.834,286.846,286.849,

286.899,286.909,286.915,286.922,286.927
                                ,
286.933,286.941,286.942,286.945,286.95
                                ,
286.958,286.964,286.969,287.005,

287.001,287.003,287.015,287.016,287.021
                                ,
287.03,287.047,287.048,287.052,287.057
                                ,
287.062,287.065,287.073,287.076,

287.076,287.074,287.091,287.088,287.091
                                ,
287.1,287.119,287.122,287.114,287.114,

287.239,287.273,287.274,282.91,282.889,

283.021,283.133,283.149,283.179,283.19,

283.201,283.211,283.226,283.267,283.284
                                ,
283.293,283.305,283.319,283.336,

283.357,283.374,283.418,283.546,283.556
                                ,
283.563,283.575,283.59,283.606,283.623
                                ,
283.636,283.651,283.664,283.677,

283.697,283.71,283.729,283.744,283.757,

283.768,283.782,283.785,283.792,283.804
                                ,
283.818,283.831,283.843,283.864,

283.877,283.889,283.902,283.916,283.95,

284.028,284.092,284.101,284.113,284.21,
                                284.211)
   ORBIT_NUMBER  =  360
   ORBITAL_ECCENTRICITY  =  0.606
   ORBITAL_INCLINATION  =  86.56
   ORBITAL_SEMIMAJOR_AXIS  =  9261.67
   PERIAPSIS_ALTITUDE  =  266.17
   PERIAPSIS_ARGUMENT_ANGLE  =  298.62
   PERIAPSIS_TIME  =  2004-05-02T21:06:37.000Z
   SPACECRAFT_ORIENTATION  =  (0.0,-1.0,0.0)
   ^MEX_ORIENTATION_DESC  =
"MEX_ORIENTATION_DESC.TXT"
   SPACECRAFT_POINTING_MODE  =  NADIR
   ^MEX_POINTING_DESC  =  "MEX_POINTING_DESC.TXT"
   RIGHT_ASCENSION  =  -1e+32
   DECLINATION  =  -1e+32
   OFFSET_ANGLE  =  -1e+32
   SPACECRAFT_SOLAR_DISTANCE  =  2.42487e+08
   TARGET_NAME  =  MARS
```

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HRSC level3 PDS label (ii)

```
/* CAMERA DATA ELEMENTS */

   DETECTOR_TEMPERATURE  =  18.1666 <degC>
   FOCAL_PLANE_TEMPERATURE  =  8.7872 <degC>
   INST_CMPRS_NAME  =  "DISCRETE COSINE TRANSFORMATION (DCT)"
   INST_CMPRS_RATIO  =  6.56318
   INST_CMPRS_QUALITY  =  0
   INST_CMPRS_QUANTZ_TBL_ID  =  0
   INSTRUMENT_TEMPERATURE  =  11.234 <degC>
   LENS_TEMPERATURE  =  9.195 <degC>
   MACROPIXEL_SIZE  =  1
   MISSING_FRAMES  =  0
   PIXEL_SUBSAMPLING_FLAG  =  N
   SIGNAL_CHAIN_ID  =  0

/* RADIOMETRIC DATA ELEMENTS */

   BANDWIDTH  =  177.0 <nm>
   CENTER_FILTER_WAVELENGTH  =  677.5 <nm>
   RADIANCE_OFFSET  =  2.42491 <W*m**-2*sr**-1>
   RADIANCE_SCALING_FACTOR  =  0.0347461 <W*m**-2*sr**-1>
   REFLECTANCE_SCALING_FACTOR  =  0.00108536
   MEX:REFLECTANCE_OFFSET  =  0.0757466

/* DATA OBJECT DEFINITIONS */

  OBJECT = IMAGE
     INTERCHANGE_FORMAT  =  BINARY
     LINES  =  43888
     LINE_SAMPLES  =  10383
     SAMPLE_TYPE  =  UNSIGNED_INTEGER
     SAMPLE_BITS  =  8
     BANDS  =  1
     BAND_STORAGE_TYPE  =  BAND_SEQUENTIAL
     MAXIMUM  =  128
     MEAN  =  74.1284
     MINIMUM  =  20
     STANDARD_DEVIATION  =  17.8966

  END_OBJECT = IMAGE
```

```
/* MAP OBJECT DEFINITIONS */

  OBJECT = IMAGE_MAP_PROJECTION
     ^DATA_SET_MAP_PROJECTION_CATALOG  =  "DSMAP.CAT"
     A_AXIS_RADIUS  =  3396.19 <km>
     B_AXIS_RADIUS  =  3396.19 <km>
     C_AXIS_RADIUS  =  3396.19 <km>
     CENTER_LATITUDE  =  0.0
     CENTER_LONGITUDE  =  285.0
     COORDINATE_SYSTEM_NAME  =  PLANETOGRAPHIC
     COORDINATE_SYSTEM_TYPE  =  "BODY-FIXED ROTATING"
     EASTERNMOST_LONGITUDE  =  287.274
     FIRST_STANDARD_PARALLEL  =  "N/A"
     LINE_FIRST_PIXEL  =  1
     LINE_LAST_PIXEL  =  43888
     LINE_PROJECTION_OFFSET  =  7416.0
     MAP_PROJECTION_ROTATION  =  0.0
     MAP_PROJECTION_TYPE  =  SINUSOIDAL
     MAP_RESOLUTION  =  2370.98786048756 <pixel/degree>
     MAP_SCALE  =  0.025 <km/pixel>
     MAXIMUM_LATITUDE  =  3.12821
     MINIMUM_LATITUDE  =  -15.382
     POSITIVE_LONGITUDE_DIRECTION  =  EAST
     REFERENCE_LATITUDE  =  "N/A"
     REFERENCE_LONGITUDE  =  "N/A"
     SAMPLE_FIRST_PIXEL  =  1
     SAMPLE_LAST_PIXEL  =  10383
     SAMPLE_PROJECTION_OFFSET  =  4998.0
     SECOND_STANDARD_PARALLEL  =  "N/A"
     WESTERNMOST_LONGITUDE  =  282.889

  END_OBJECT = IMAGE_MAP_PROJECTION

/* IMAGE HEADER DATA ELEMENTS */

  OBJECT = IMAGE_HEADER
     HEADER_TYPE  =  VICAR2
     INTERCHANGE_FORMAT  =  ASCII
     BYTES  =  10383
     ^DESCRIPTION  =  "VICAR2.TXT"

  END_OBJECT = IMAGE_HEADER
END
```

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HRSC level3 PDS label

MAP "OBJECT"

```
OBJECT = IMAGE_MAP_PROJECTION
     ^DATA_SET_MAP_PROJECTION_CATALOG  =  "DSMAP.CAT"
     A_AXIS_RADIUS  =  3396.19 <km>
     B_AXIS_RADIUS  =  3396.19 <km>
     C_AXIS_RADIUS  =  3396.19 <km>
     CENTER_LATITUDE  =  0.0
     CENTER_LONGITUDE  =  285.0
     COORDINATE_SYSTEM_NAME  =  PLANETOGRAPHIC
     COORDINATE_SYSTEM_TYPE  =  "BODY-FIXED ROTATING"
     EASTERNMOST_LONGITUDE  =  287.274
     FIRST_STANDARD_PARALLEL  =  "N/A"
     LINE_FIRST_PIXEL  =  1
     LINE_LAST_PIXEL  =  43888
     LINE_PROJECTION_OFFSET  =  7416.0
     MAP_PROJECTION_ROTATION  =  0.0
     MAP_PROJECTION_TYPE  =  SINUSOIDAL
     MAP_RESOLUTION  =  2370.98786048756 <pixel/degree>
     MAP_SCALE  =  0.025 <km/pixel>
     MAXIMUM_LATITUDE  =  3.12821
     MINIMUM_LATITUDE  =  -15.382
     POSITIVE_LONGITUDE_DIRECTION  =  EAST
     REFERENCE_LATITUDE  =  "N/A"
     REFERENCE_LONGITUDE  =  "N/A"
     SAMPLE_FIRST_PIXEL  =  1
     SAMPLE_LAST_PIXEL  =  10383
     SAMPLE_PROJECTION_OFFSET  =  4998.0
     SECOND_STANDARD_PARALLEL  =  "N/A"
     WESTERNMOST_LONGITUDE  =  282.889

END_OBJECT = IMAGE_MAP_PROJECTION
```

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Georef. info in PDS header

e.g. from PSA PDS label

Elements/keywords	Example (H0360_0000_ND3.IMG)	Parameter
MAP_SCALE	0.025 <km/pixel>	pixel size
LINE_PROJECTION_OFFSET	7416.0	projection parameter
SAMPLE_PROJECTION_OFFSET	4998.0	projection parameter
FILE_RECORDS	43891	header size (skipbytes)
LINES	43888	number of lines
LINE_SAMPLES	10383	number of samples (columns)
MAP_PROJECTION_TYPE	SINUSOIDAL	map projection
CENTER_LONGITUDE	285.0	projection parameter
CENTER_LATITUDE	0.0	projection parameter

+

```
A_AXIS = XXXX.XX km
B_AXIS = XXXX.XX km
C_AXIS = XXXX.XX km
```

→ what we need to put HRSC onto a GIS

Line, sample. proj. offset

PDS Data Dictionary Lookup Detail

Column Name = line_projection_offset
BL Name = lineprojoff
Terse Name =
Gen Data Type = REAL
Unit Id = pixel
Std Value Type = RANGE
Minimum Column Value = N/A
Maximum Column Value = UNK
Minimum Length = N/A
Maximum Length = N/A

...
...

Description

The line_projection_offset element provides the line offset value of the map projection origin position from the line and sample 1,1 (line and sample 1,1 is considered the upper left corner of the digital array).
Note: that the positive direction is to the right and down.

PDS Data Dictionary Lookup Detail

Column Name = sample_projection_offset
BL Name = sampprojoff
Terse Name =
Gen Data Type = REAL
Unit Id = pixel
Std Value Type = RANGE
Minimum Column Value = N/A
Maximum Column Value = UNK
Minimum Length = N/A
Maximum Length = N/A

...
...

Description

The sample_projection_offset element provides the sample offset value of the map projection origin position from line and sample 1,1 (line and sample 1,1 is considered the upper left corner of the digital array).
Note: that the positive direction is to the right and down.

source:

http://pds.nasa.gov/tools/data_dictionary_lookup.cfm

LINE_PROJECTION_OFFSET is the line number minus one on which the map projection origin occurs. The map projection origin is the intersection of the equator and the projection longitude. The value of LINE_PROJECTION_OFFSET is positive for images starting north of the equator and is negative for images starting south of the equator.

SAMPLE_PROJECTION_OFFSET is the nearest sample number to the left of the projection longitude. The value of SAMPLE_PROJECTION_OFFSET is positive for images starting to the west of the projection longitude and is negative for images starting to the east of the projection longitude.

source:

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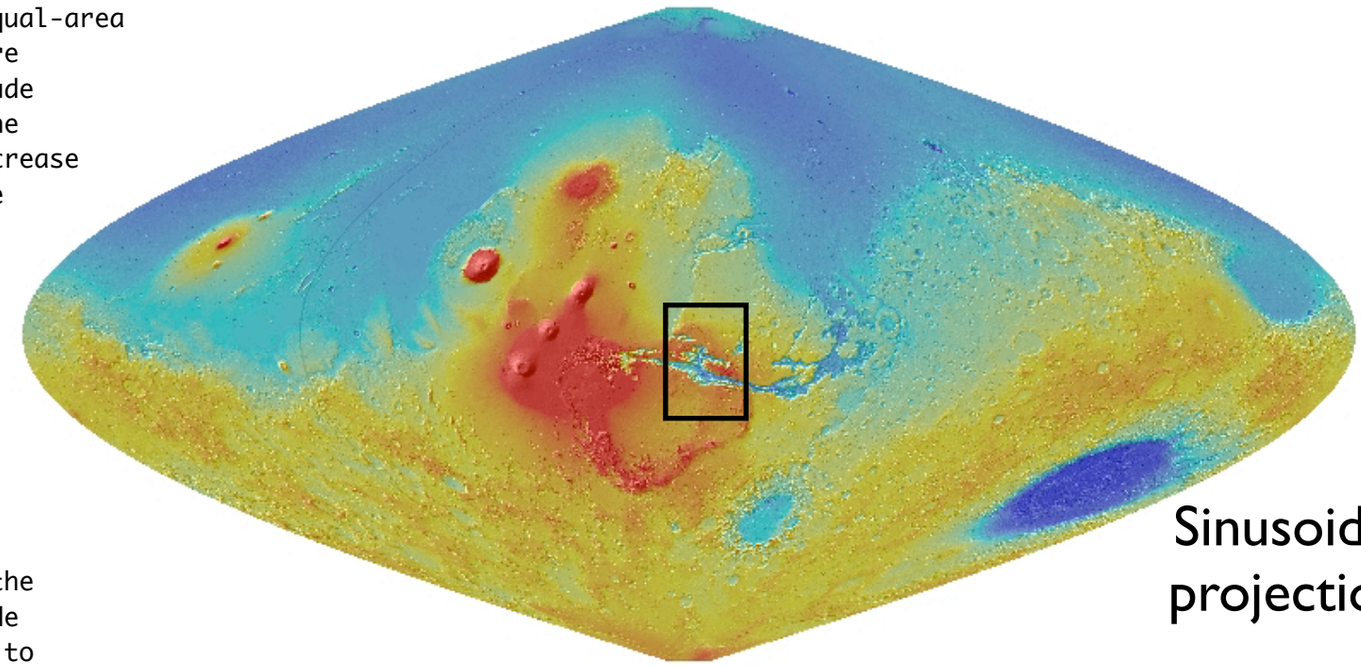
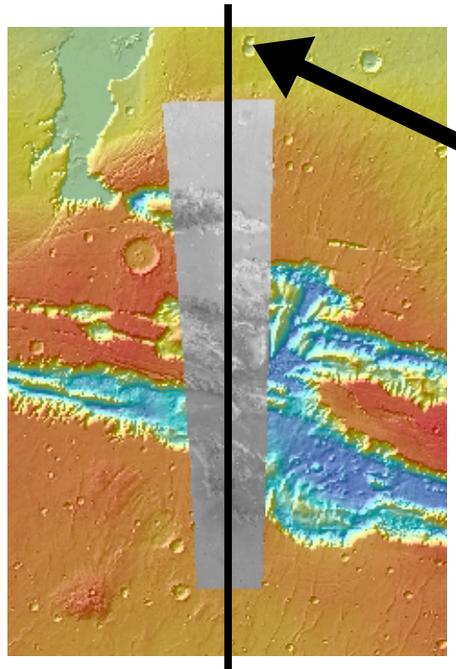
ftp://psa.esac.esa.int/pub/mirror/MARS-EXPRESS/HRSC/MEX-M-HRSC-5-REFDR-MAPPROJECTED-V2.0/CATALOG/DSMAP.CAT

DSMAP.CAT

```
MAP_PROJECTION_TYPE           = "SINUSOIDAL"
    MAP_PROJECTION_DESC           = "The HRSC data with a latitude center
      between -85 and +85 degrees are presented in a sinusoidal equal-area
      map projection. In this projection, parallels of latitude are
      straight lines, with constant distances between equal latitude
      intervals.  Lines of constant longitude on either side of the
      projection meridian are curved since longitude intervals decrease
      with the cosine of latitude to account for their convergence
      toward the poles.

      The transformation from latitude and longitude to line and
      sample is given by the following equations:

      line = INT(LINE_PROJECTION_OFFSET - lat*MAP_RESOLUTION)

      sample = INT(SAMPLE_PROJECTION_OFFSET + (lon -
               CENTER_LONGITUDE)*MAP_RESOLUTION*cos(lat))

      Note that integral values of line and sample correspond to the
      center of a pixel. Lat and lon are the latitude and longitude
      of a given spot on the surface. Line and sample are assumed to
      be 1-based, rather than 0-based.

      LINE_PROJECTION_OFFSET is the line number minus one on which
      the map projection origin occurs. The map projection origin
      is the intersection of the equator and the projection
      longitude. The value of LINE_PROJECTION_OFFSET is positive for
      images starting north of the equator and is negative for images
      starting south of the equator.

      SAMPLE_PROJECTION_OFFSET is the nearest sample number to the
      left of the projection longitude. The value of SAMPLE_
      PROJECTION_OFFSET is positive for images starting to the west
      of the projection longitude and is negative for images starting
      to the east of the projection longitude.

      CENTER_LONGITUDE is the value of the projection longitude,
      which is the longitude that passes through the center of the
      projection.

      MAP_RESOLUTION is measured in pixels/degree.
```



Sinusoidal projection



source:

ftp://psa.esac.esa.int/pub/mirror/MARS-EXPRESS/HRSC/MEX-M-HRSC-5-REFDR-MAPPROJECTED-V2.0/CATALOG/DSMAP.CAT

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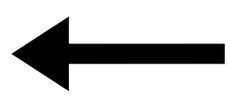
HRSC & GIS

- Constants:

```
Byteorder =          I
Number of bands = 1
File structure =  BSQ
byte depth =         8*
```

using x86 (minivicar binaries)

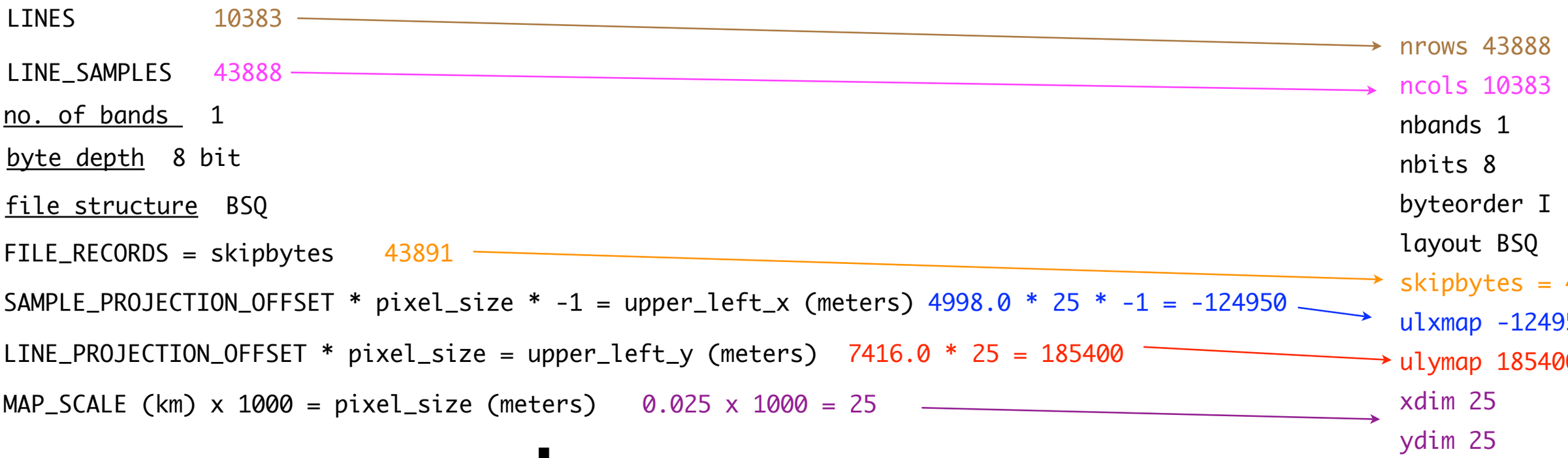


bands in separate files

* in Level3 data and, after 16 to 8bit conversion in home-brewed level3/3+ data

What we need to do

e.g. for building an Esri .hdr file (or other, e.g. .tfw):



+

e.g. for building an Esri .prj file:

```
PROJCS["Mars_Sinusoidal_clon80",GEOGCS["GCS_Mars_2000_Sphere",DATUM
["D_Mars_2000_Sphere",SPHEROID["Mars_2000_IAU_IAG_Sphere",3396190.0,0.0]],PRIMEM
["Reference_Meridian",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION
["Sinusoidal"],PARAMETER["False_Easting",0.0],PARAMETER["False_Northing",
0.0],PARAMETER["Central_Meridian",80.0],UNIT["Meter",1.0]]
```

GIS header: examples

Envi .hdr

```
ENVI
description = {
   test}
samples = 6591
lines   = 8653
bands   = 1
header offset = 0
file type = ENVI Standard
data type = 2
interleave = bsq
sensor type = Unknown
byte order = 2
map info = {mars_mercator, 1.0000, 1.0000, -394750.0000, -389250.0000, 10000000000e+01, 10000000000e+01, , units=Meters}
projection info = {20, 3396190.0, 3376200.0, 0.000000, 0.000000, 0.0, 0.0, mars_mercator, units=Meters}
wavelength units = Unknown
data ignore value = -32768
default stretch = default stretch = 0.0% linear
band names = {
 Gray Scale (Band 1:ir)}
```

.tfw

```
25
0.0
-25
-124950
185400
```

Esri .hdr

```
nrows 43888
ncols 10383
nbands 1
nbits 8
byteorder I
layout BSQ
skipbytes = 43891
ulxmap -124950
ulymap 185400
xdim 25
ydim 25
```

low risk of making mistakes:
minivicar binaries are only for x86 linux

esa SCIENCE

HRSC level3 VICAR label

```
************************************************************
     +++++ System Label of file H0360_0000_ND3.IMG +++++
            3 dimensional IMAGE file
            File organization is BSQ
            Pixels are in BYTE format from a JAVA host
            1 bands
            43888 lines per band
            10383 samples per line
            0 lines of binary header of type
            0 bytes of binary prefix per line
 ************************************************************


     ************************************************************
     +++++ Property Label of file H0360_0000_ND3.IMG +++++

   ------------------------------------------

 PROPERTY = 'M94_ORBIT'

   ORBIT_NUMBER=360
   ASCENDING_NODE_LONGITUDE=221.55
   ORBITAL_ECCENTRICITY=0.606
   ORBITAL_INCLINATION=86.56
   PERIAPSIS_ARGUMENT_ANGLE=298.62
   PERIAPSIS_TIME='2004-05-02T21:06:37.000Z'
   PERIAPSIS_ALTITUDE=266.17
   ORBITAL_SEMIMAJOR_AXIS=9261.67
   SPACECRAFT_SOLAR_DISTANCE=2.42487e+08
   SPACECRAFT_CLOCK_START_COUNT='1/0031612651.56187'
   SPACECRAFT_CLOCK_STOP_COUNT='1/0031613373.19695'
   START_TIME='2004-05-02T21:18:50.969Z'
   STOP_TIME='2004-05-02T21:25:19.970Z'
   SPACECRAFT_POINTING_MODE='NADIR'
   RIGHT_ASCENSION=-1e+32
   DECLINATION=-1e+32
   OFFSET_ANGLE=-1e+32
   SPACECRAFT_ORIENTATION=(0.0, -1.0, 0.0)
   PRODUCT_CREATION_TIME='2006-07-28T17:46:42.000Z'
   MEX_ORIENTATION_DESC='MEX_ORIENTATION_DESC.TXT'
   MEX_POINTING_DESC='MEX_POINTING_DESC.TXT'
   DATA_SET_MAP_PROJECTION_CATALOG='DSMAP.CAT'
   ------------------------------------------

 PROPERTY = 'M94_CAMERAS'

   CLOCK_ID=0
   PARAMETER_SEQUENCE_NUMBER=0
   PMEM_FILE_NAME='scivis3.prm'
   SIGNAL_CHAIN_ID=0
   INST_CMPRS_RATIO=6.56318
   INST_CMPRS_QUANTZ_TBL_ID=0
   INST_CMPRS_QUALITY=0
   MACROPIXEL_SIZE=1
   PIXEL_SUBSAMPLING_FLAG='N'
   INST_CMPRS_NAME='DISCRETE COSINE TRANSFORMATION (DCT)'
   SAMPLE_FIRST_PIXEL=1
   SAMPLE_LAST_PIXEL=10383
   LINE_FIRST_PIXEL=1
   LINE_LAST_PIXEL=43888
   ------------------------------------------

 PROPERTY = 'FILE'

   EVENT_TYPE='MARS-GLOBAL-MAPPING-Te-Fl-Lc'
   FILE_NAME='h0360_0000.nd3.07'
   PRODUCT_ID='h0360_0000.nd3.07'
   PROCESSING_LEVEL_ID=3
   RELEASE_ID='0006'
   REVISION_ID='0000'
   DATA_SET_ID='MEX-M-HRSC-5-REFDR-MAPPROJECTED-V2.0'
   ------------------------------------------

 PROPERTY = 'M94_INSTRUMENT'

   MISSION_NAME='MARS EXPRESS'
   INSTRUMENT_HOST_NAME='MARS EXPRESS'
   INSTRUMENT_HOST_ID='MEX'
   INSTRUMENT_NAME='HIGH RESOLUTION STEREO CAMERA'
   INSTRUMENT_ID='HRSC'
   DETECTOR_ID='MEX_HRSC_NADIR'
   MISSION_PHASE_NAME='MC_Phase_6'
   ------------------------------------------
```

esa SCIENCE

HRSC level3 VICAR label (ii)

```
   PROPERTY = 'FOOTPRINT'

     FOOTPRINT_POINT_LATITUDE=(-15.382, -15.3534, -15.3529, -15.146,
-12.9014,
     -12.7003, -12.4995, -12.2993, -12.0993, -11.8999, -11.5024, -11.3042,
     -11.1065, -10.9093, -10.7127, -10.5165, -10.3207, -8.77061, -8.57868,
     -8.38733, -8.19672, -8.00626, -7.81638, -7.62704, -6.87366, -6.68636,
     -6.49958, -6.31325, -5.94186, -5.75685, -5.57239, -5.38824, -5.20448,
     -5.0211, -4.65621, -4.47412, -4.29264, -3.93106, -3.57147, -3.39217,
     -3.21306, -3.03456, 1.95326, 3.10472, 3.12821, 2.96824, 2.96712,
1.66348,
     0.500825, 0.333026, -0.00392688, -0.173461, -0.34332, -0.513724,
-0.684095,
     -1.02517, -1.19668, -1.36929, -1.54209, -1.71509, -1.88829, -2.06162,
     -2.23564, -2.76106, -4.36124, -4.54153, -4.72254, -4.90355, -5.08486,
     -5.26649, -5.44843, -5.63117, -5.81426, -5.99786, -6.18199, -6.55193,
     -6.73734, -6.92279, -7.10896, -7.29577, -7.48312, -7.67076, -7.85958,
     -8.04861, -8.23774, -8.42715, -8.61712, -8.8076, -9.19006, -9.38183,
     -9.57415, -9.76684, -9.95991, -10.3471, -11.7192, -12.9134, -13.1142,
     -13.3152, -15.3523, -15.382)
     FOOTPRINT_POINT_LONGITUDE=(284.211, 286.834, 286.846, 286.849, 286.899,
     286.909, 286.915, 286.922, 286.927, 286.933, 286.941, 286.942, 286.945,
     286.95, 286.958, 286.964, 286.969, 287.005, 287.001, 287.003, 287.015,
     287.016, 287.021, 287.03, 287.047, 287.048, 287.052, 287.057, 287.062,
     287.065, 287.073, 287.076, 287.076, 287.074, 287.091, 287.088, 287.091,
     287.1, 287.119, 287.122, 287.114, 287.114, 287.239, 287.273, 287.274,
     282.91, 282.889, 283.021, 283.133, 283.149, 283.179, 283.19, 283.201,
     283.211, 283.226, 283.267, 283.284, 283.293, 283.305, 283.319, 283.336,
     283.357, 283.374, 283.418, 283.546, 283.556, 283.563, 283.575, 283.59,
     283.606, 283.623, 283.636, 283.651, 283.664, 283.677, 283.697, 283.71,
     283.729, 283.744, 283.757, 283.768, 283.782, 283.785, 283.792, 283.804,
     283.818, 283.831, 283.843, 283.864, 283.877, 283.889, 283.902, 283.916,
     283.95, 284.028, 284.092, 284.101, 284.113, 284.21, 284.211)
     ----------------------------------------
```

```
PROPERTY = 'MAP'

  TARGET_NAME='MARS'
  MAP_PROJECTION_TYPE='SINUSOIDAL'
  COORDINATE_SYSTEM_NAME='PLANETOGRAPHIC'
  POSITIVE_LONGITUDE_DIRECTION='EAST'
  BODY_LONG_AXIS=0.0
  CENTER_LATITUDE=0.0
  CENTER_LONGITUDE=285.0
  SPHERICAL_AZIMUTH=0.0
  CARTESIAN_AZIMUTH=0.0
  LINE_PROJECTION_OFFSET=7416.0
  SAMPLE_PROJECTION_OFFSET=4998.0
  MAP_SCALE=0.025
  MAP_SCALE__UNIT='km/pixel'
  A_AXIS_RADIUS=3396.19
  A_AXIS_RADIUS__UNIT='km'
  B_AXIS_RADIUS=3396.19
  B_AXIS_RADIUS__UNIT='km'
  C_AXIS_RADIUS=3396.19
  C_AXIS_RADIUS__UNIT='km'
  COORDINATE_SYSTEM_TYPE='BODY-FIXED ROTATING'
  FIRST_STANDARD_PARALLEL='N/A'
  SECOND_STANDARD_PARALLEL='N/A'
  REFERENCE_LATITUDE='N/A'
  REFERENCE_LONGITUDE='N/A'
  MAP_PROJECTION_ROTATION=0.0
  MAP_RESOLUTION=2370.98786048756
  MAP_RESOLUTION__UNIT='pixel/degree'
  EASTERNMOST_LONGITUDE=287.274
  WESTERNMOST_LONGITUDE=282.889
  MINIMUM_LATITUDE=-15.382
  MAXIMUM_LATITUDE=3.12821
  ------------------------------------------
```

HRSC level3 VICAR label (ii)

```
   PROPERTY = 'PHOT'

     PHO_FUNC='NONE'
        ************************************************************

        ************************************************************
       +++++ History Label of file H0360_0000_ND3.IMG +++++

  ---- Task: HRCONVER -- User: mexsyst -- Mon Aug 15 00:31:59 2005
----

     SPICE_FILE_NAME=('NAIF0008.TLS', 'MEX_050624_STEP.TSC',
     'ORMM_MERGED_00140.ORB')
     SPICE_FILE_ID='(LSK,SCLK,ON)'
     DETECTOR_TEMPERATURE=18.1666
     DETECTOR_TEMPERATURE__UNIT='degC'
     FOCAL_PLANE_TEMPERATURE=8.7872
     FOCAL_PLANE_TEMPERATURE__UNIT='degC'
     INSTRUMENT_TEMPERATURE=11.234
     INSTRUMENT_TEMPERATURE__UNIT='degC'
     LENS_TEMPERATURE=9.195
     LENS_TEMPERATURE__UNIT='degC'
     SOURCE_FILE_NAME='h20040502_img_20040804_hrsc_1'
     MISSING_FRAMES=0
     OVERFLOW_FRAMES=0
     ERROR_FRAMES=0
       ---- Task: HRCATLAB -- User: mexsyst -- Mon Aug 15 00:36:34
2005 ----

  ---- Task: HRCAL -- User: mexsyst -- Mon Aug 15 00:39:43 2005 ----

     PROCESSING_HISTORY_TEXT='hrcal v5.4     13.06.2005'
     BLEMISH_FILE_NAME='h2end_09.cal'
     DARK_CURRENT_FILE_NAME='h2dnd_09.cal'
     RESPONSE_FILE_NAME='h2pnd_09.cal'
     GAIN_FILE_NAME='h2vnd_09.cal'
     MINIMUM=20
     MAXIMUM=128
     MEAN=74.1284
     STANDARD_DEVIATION=17.8966
     CENTER_FILTER_WAVELENGTH=677.5
     CENTER_FILTER_WAVELENGTH__UNIT='nm'
     BANDWIDTH=177.0
     BANDWIDTH__UNIT='nm'
     ABSOLUTE_FLUX_CALIB_FLAG='Y'
     DARK_CURRENT_CORRECTION_FLAG='Y'
     FLAT_FIELD_CORRECTION_FLAG='Y'
     OVERFLOW_VALUE=-8
     SATURATED_DARKS_FLAG='N'
   ---- Task: HRFOOT -- User: mexsyst -- Mon Aug 15 00:42:34 2005 ----

     EXTORI_FILE_NAME='h0360_0000.nd2.07_ext'
     SPICE_FILE_NAME='MARS_IAU2000_V0.TPC'
     SPICE_FILE_ID='PCK'
     GEOMETRIC_CALIB_FILE_NAME='h2gnd_01.cal'
     BEST_GROUND_SAMPLING_DISTANCE=0.0291
     CENTRIC_LATITUDE_AT_CENTER=-5.60456
     EASTERN_LONGITUDE_AT_CENTER=285.348
       ---- Task: HRFILLCA -- User: mexsyst -- Mon Aug 15 00:55:51
2005 ----

  ---- Task: DLRTO8 -- User: mexsyst -- Fri Jul 28 20:51:15 2006 ----

     RADIANCE_SCALING_FACTOR=0.0347461
     RADIANCE_SCALING_FACTOR__UNIT='W*m**-2*sr**-1'
     RADIANCE_OFFSET=2.42491
     RADIANCE_OFFSET__UNIT='W*m**-2*sr**-1'
     REFLECTANCE_SCALING_FACTOR=0.00108536
     REFLECTANCE_OFFSET=0.0757466
   ---- Task: HRORTHO -- User: mexsyst -- Fri Jul 28 20:51:21 2006
----

     DTM_NAME='/vicsys/data/mola5km_cenlo0'
     START_INPUT_LINE=1
     NUMBER_OF_INPUT_LINES=56984
     INTERPOLATION_TYPE='BILINEAR_INTERPOLATION'
     ANCHORPOINT_DISTANCE=100
     EXTORI_FILE_NAME='/mex2/0360/h0360_0000.nd2.07_ext'
     SPICE_FILE_NAME='PCK00008.TPC'
     SPICE_FILE_ID='PCK'
     GEOMETRIC_CALIB_FILE_NAME='h2gnd_01.cal'
     MAXIMUM_RESOLUTION=29.1
     MAXIMUM_RESOLUTION__UNIT='m/pixel'
    ************************************************************
```

esa SCIENCE

HRSC level3 VICAR label

```
PROPERTY = 'MAP'

  TARGET_NAME='MARS'
  MAP_PROJECTION_TYPE='SINUSOIDAL'
  COORDINATE_SYSTEM_NAME='PLANETOGRAPHIC'
  POSITIVE_LONGITUDE_DIRECTION='EAST'
  BODY_LONG_AXIS=0.0
  CENTER_LATITUDE=0.0
  CENTER_LONGITUDE=285.0
  SPHERICAL_AZIMUTH=0.0
  CARTESIAN_AZIMUTH=0.0
  LINE_PROJECTION_OFFSET=7416.0
  SAMPLE_PROJECTION_OFFSET=4998.0
  MAP_SCALE=0.025
  MAP_SCALE__UNIT='km/pixel'
  A_AXIS_RADIUS=3396.19
  A_AXIS_RADIUS__UNIT='km'
  B_AXIS_RADIUS=3396.19
  B_AXIS_RADIUS__UNIT='km'
  C_AXIS_RADIUS=3396.19
  C_AXIS_RADIUS__UNIT='km'
  COORDINATE_SYSTEM_TYPE='BODY-FIXED ROTATING'
  FIRST_STANDARD_PARALLEL='N/A'
  SECOND_STANDARD_PARALLEL='N/A'
  REFERENCE_LATITUDE='N/A'
  REFERENCE_LONGITUDE='N/A'
  MAP_PROJECTION_ROTATION=0.0
  MAP_RESOLUTION=2370.98786048756
  MAP_RESOLUTION__UNIT='pixel/degree'
  EASTERNMOST_LONGITUDE=287.274
  WESTERNMOST_LONGITUDE=282.889
  MINIMUM_LATITUDE=-15.382
  MAXIMUM_LATITUDE=3.12821
```

MAP “PROPERTY”

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Georef. info in VICAR header

e.g. from VICAR label

Elements/keywords	Example (H0360_0000_ND3.IMG)	Parameter
MAP_SCALE	0.025 <km/pixel>	pixel size
LINE_PROJECTION_OFFSET	7416.0	projection parameter
SAMPLE_PROJECTION_OFFSET	4998.0	projection parameter
LBLSIZE	43891	header size (skipbytes)
NL (lines per band)	LINES	number of lines
NS (samples per line)	LINE_SAMPLES	number of samples (columns)
MAP_PROJECTION_TYPE	SINUSOIDAL	map projection
CENTER_LONGITUDE	285.0	projection parameter
CENTER_LATITUDE	0.0	projection parameter

+

```
A_AXIS = XXXX.XX km
B_AXIS = XXXX.XX km
C_AXIS = XXXX.XX km
```

what we need to put
HRSC onto a GIS

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HRSC & GIS

- Constants:

```
Byteorder =          I
Number of bands = 1
File structure =  BSQ
byte depth =         8*
```

using x86 (minivicar binaries)

bands in separate files

* in Level3 data and, after 16 to 8bit conversion in home-brewed level3/3+ data

What we need to do

e.g. for building an Esri .hdr file (or other, e.g. .tfw):

NL 10383

NS 43888

no. of bands 1

byte depth 8 bit

file structure BSQ

FILE_RECORDS = skipbytes 43891

SAMPLE_PROJECTION_OFFSET * pixel_size * -1 = upper_left_x (meters) 4998.0 * 25 * -1 = -124950

LINE_PROJECTION_OFFSET * pixel_size = upper_left_y (meters) 7416.0 * 25 = 185400

MAP_SCALE (km) x 1000 = pixel_size (meters) 0.025 x 1000 = 25

nrows 43888

ncols 10383

nbands 1

nbits 8

byteorder I

layout BSQ

skipbytes = 43891

ulxmap -124950

ulymap 185400

xdim 25

ydim 25

+

e.g. for building an Esri .prj file:

```
PROJCS["Mars_Sinusoidal_clonXX",GEOGCS["GCS_Mars_2000_Sphere",DATUM
["D_Mars_2000_Sphere",SPHEROID["Mars_2000_IAU_IAG_Sphere",3396190.0,0.0]],PRIMEM
["Reference_Meridian",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION
["Sinusoidal"],PARAMETER["False_Easting",0.0],PARAMETER["False_Northing",
0.0],PARAMETER["Central_Meridian",80.0],UNIT["Meter",1.0]]
```

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GIS header: examples

Esri .hdr

```
nrows 43888
ncols 10383
nbands 1
nbits 8
byteorder I
layout BSQ
skipbytes = 43891
ulxmap -124950
ulymap 185400
xdim 25
ydim 25
```

low risk of making mistakes:
minivicar binaries are only for x86 linux

.tfw

```
25
0.0
-25
-124950
185400
```

Envi .hdr

```
ENVI
description = {
   test}
samples = 6591
lines   = 8653
bands   = 1
header offset = 0
file type = ENVI Standard
data type = 2
interleave = bsq
sensor type = Unknown
byte order = 2
map info = {mars_mercator, 1.0000, 1.0000, -394750.0000, -389250.0000, 10000000000e+01, 10000000000e+01, , units=Meters}
projection info = {20, 3396190.0, 3376200.0, 0.000000, 0.000000, 0.0, 0.0, mars_mercator, units=Meters}
wavelength units = Unknown
data ignore value = -32768
default stretch = default stretch = 0.0% linear
band names = {
 Gray Scale (Band 1:ir)}
```

Script examples

Perl scripts to directly ingest (no translation, direct header creation, works on Windows) HRSC PSA/VICAR level3 data in ArcGis (courtesy J. Oosthoek) available:

ftp://gorilla.estec.esa.int/pub/projects/workshop/04_MEX_DW_june_2007/software_data/user_provided_tools/

`hrsc2arcgis.pl` → for PSA PDS Level3 data

`hrsc2arcgisVICAR.pl` → for VICAR Level3/3+ data

Similar scripts can be produced in a variety of languages and/or tools

Gis headers

How to georeference ISIS images for use a GIS

Convert ISIS2 cubes to Tiff format using ISIS2
- o Run TAE t dform
  - + From = imagename.cub
  - + Otype = 1 (8-bit)
  - + Oform = T (.tif file)
  - + gisworld = "yes"

Convert ISIS3 cubes to Tiff format using ISIS3
- o Run isis2std
  - + From=imagename.cub
  - + to format of choice
  - + the woldfile will be automatically generated

Create worldfiles from the ISIS cubes (without using ISIS)
- o At UNIX prompt, make a list of the .cub files
  - + ls –1 *.cub > cub.lst
- o At the UNIX prompt run:
  - + perl isis2world -t myfile.cub
    - # download isis2world.pl or isis3world.pl PERL scripts here.

http://webgis.wr.usgs.gov/pigwad/tutorials/planetarygis/image_georef_isis.htm

information deriving from tools/documents on:

http://webgis.wr.usgs.gov/

Gis headers

- you can get inspiration from:

  ftp://ftpflag.wr.usgs.gov/dist/pigpen/Perl/

Other tools/platforms?

- If you develop any tool/scripts on commercial/ open source platforms (ESRI ArcGis, GRASS, QGIS, etc.) you can make it available to the community. As a starting point:

ftp://gorilla.estec.esa.int/pub/projects/workshop