HRSC Map & reference issues

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Map & reference frame issues

Map & reference frame

- HRSC Level4 data are map-projected:
  - Sinusoidal projection (Latitudes from 85° S to 85° N)
  - Polar-Stereographic projection (polar areas)
- The map reference body is a sphere with r = 3396.0 km
- The vertical reference for DEM is either:
  - A sphere with r = 3396.0 km (DT4)
  - An aeroid (DA4) directly comparable with MOLA MEGDR grids

MAP REFERENCE

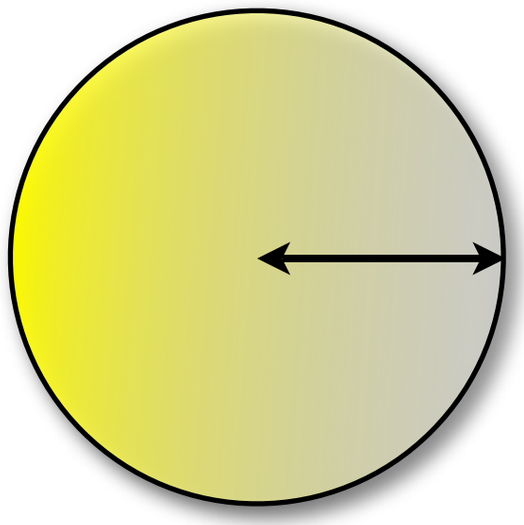
HEIGHT REFERENCE

http://pds-geosciences.wustl.edu/missions/mgs/megdr.html

Sphere & ellipsoid

MAP REFERENCE

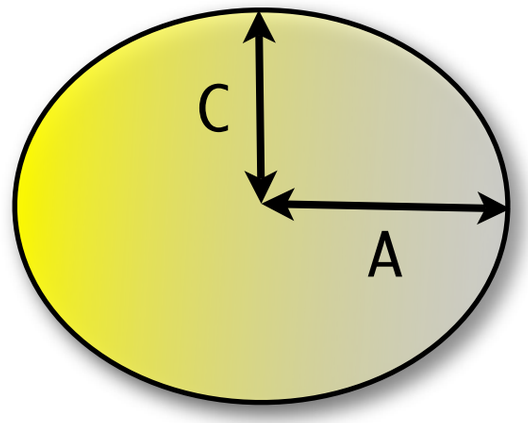
~ Mars MOLA sphere



A_AXIS = 3396.0 km
B_AXIS = 3396.0 km
C_AXIS = 3396.0 km

HRSC LEVEL4

Mars IAU2000 ellipsoid



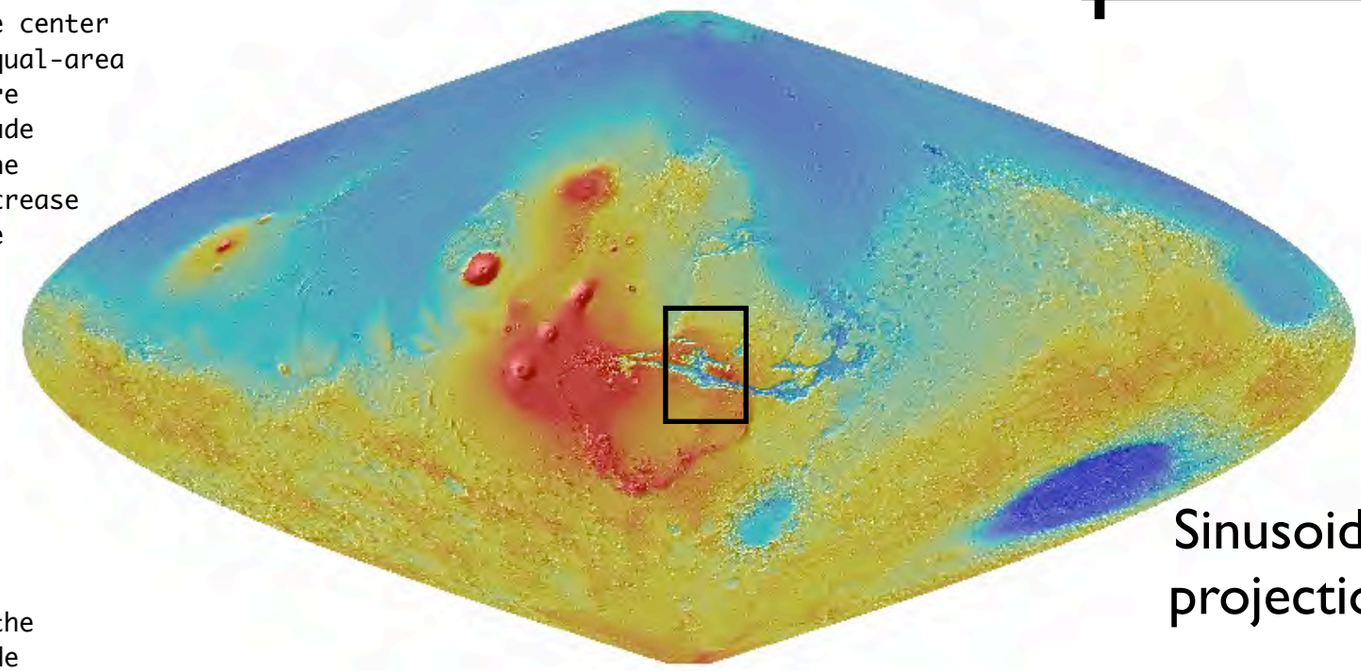
A_AXIS = 3396.19 km
B_AXIS = 3396.19 km
C_AXIS = 3376.2 km

Level3 data STILL with A=B=C = 3396.19 km

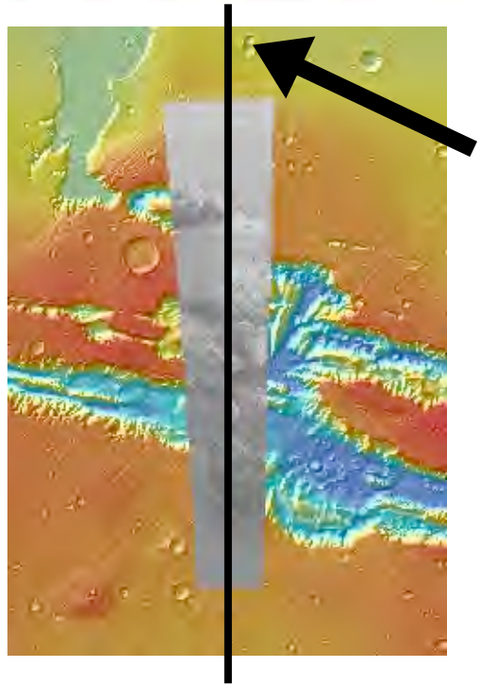
DSMAP.CAT

MAP REFERENCE

```
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

Proj. Offset

MAP REFERENCE

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

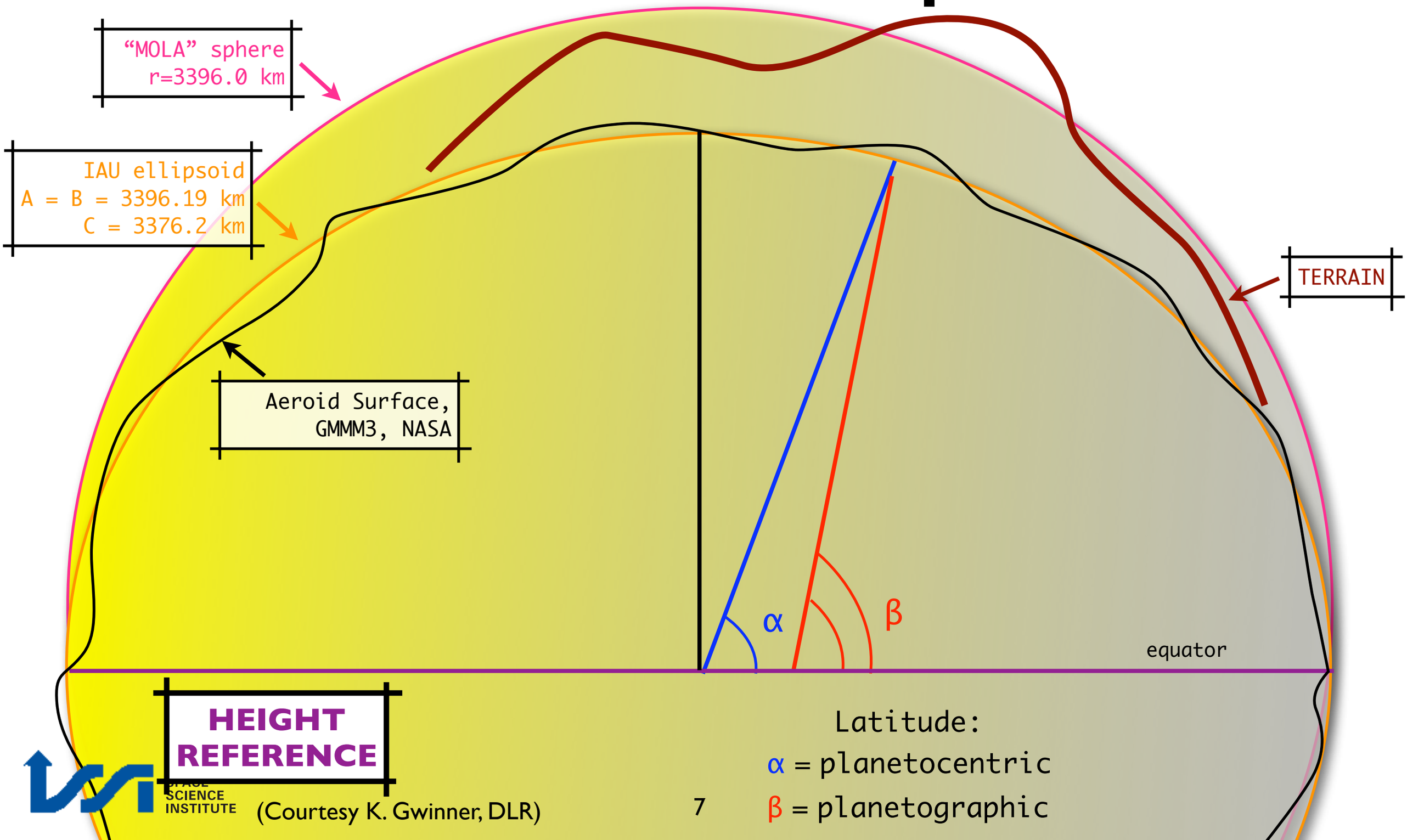
LINE_PROJECTION_OFFSET is the line number minus one on which the map projection origin occurs. The map projection origin is the intersection of the equator and the projection longitude. The value of LINE_PROJECTION_OFFSET is positive for images starting north of the equator and is negative for images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

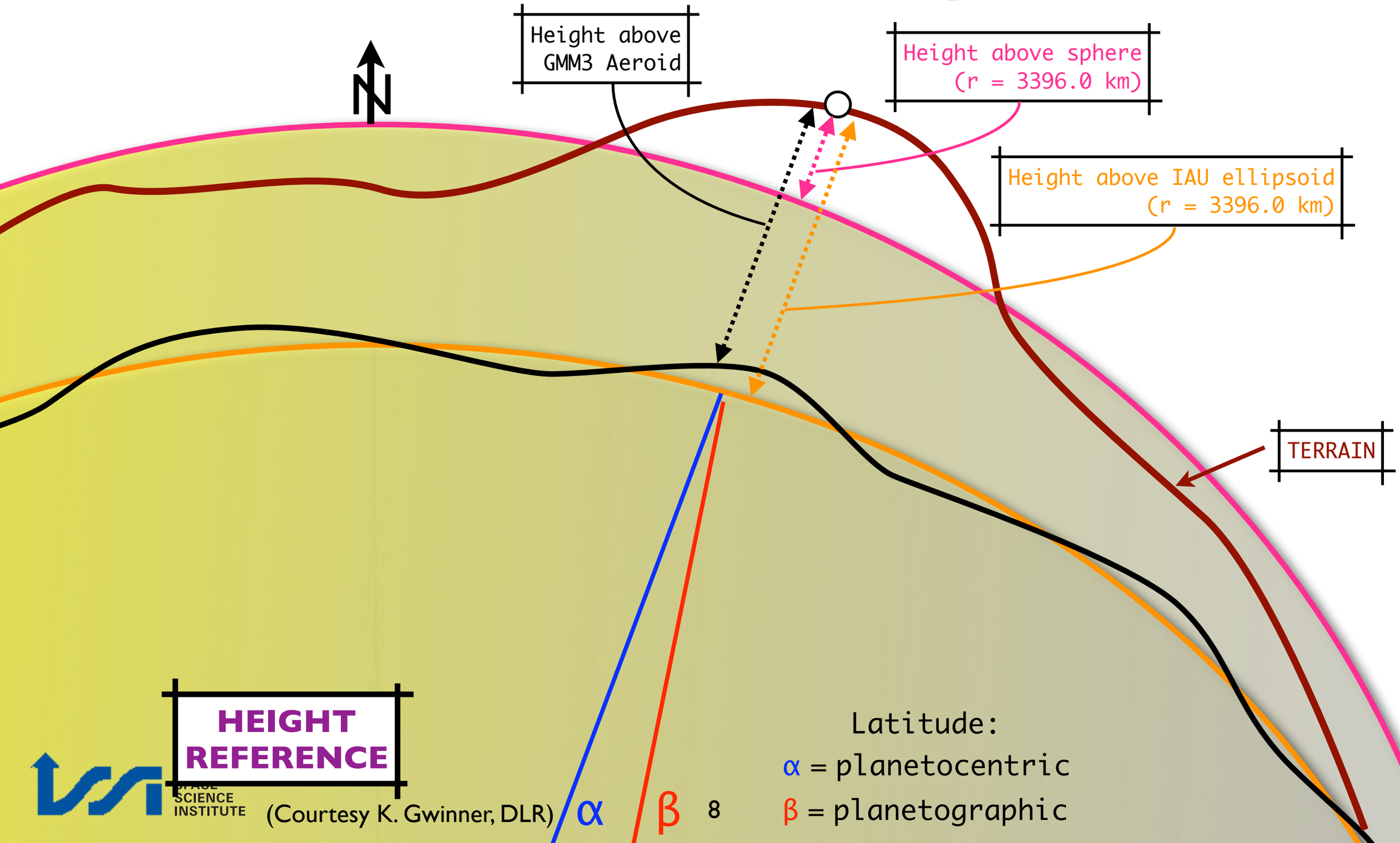
ftp://psa.esac.esa.int/pub/mirror/MARS-EXPRESS/HRSC/MEX-M-HRSC-5-REFDR-MAPPROJECTED-V2.0/CATALOG/DSMAP.CAT

DEM: aeroid vs. spheroid

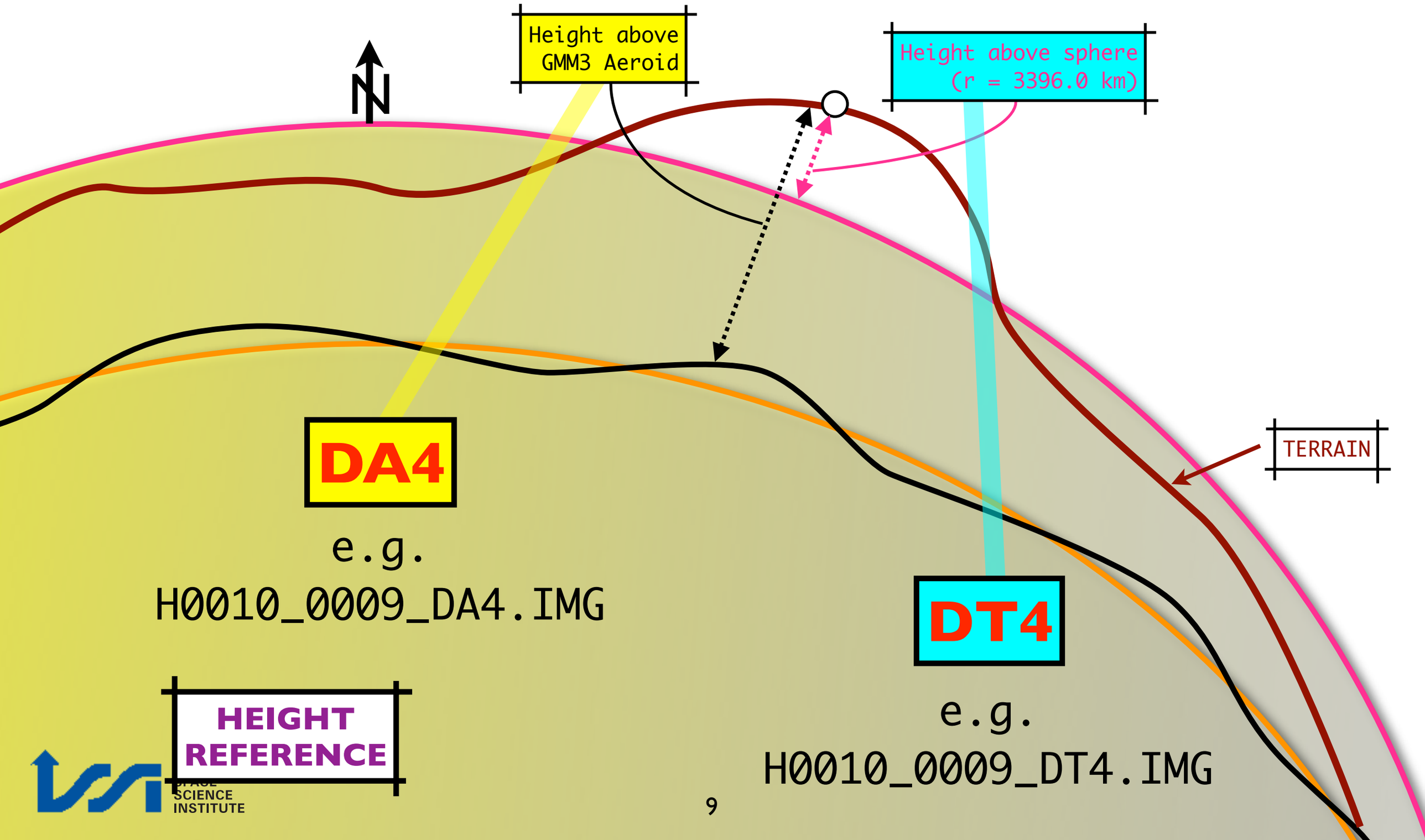


(Courtesy K. Gwinner, DLR)

DTM: aeroid vs. spheroid



DTM: DT4 vs. DA4



HRSC Level4 DEM (dt4 & da4 products)

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DEM: Summary

- HRSC DT4 DEMs:
  - HEIGHT reference = sphere
- HRSC DA4 DEMs:
  - HEIGHT reference = aeroid (~MEGDR)
- ALL HRSC Level4 data use as MAP reference a sphere with r = 3396.0 km

DT4 vs. DA4: Labels

DT4

```
/* DIGITAL TERRAIN MODEL DEFINITIONS */

   GROUP   =  MEX:DTM
   MEX:DTM_A_AXIS_RADIUS   =  3396.0
   MEX:DTM_B_AXIS_RADIUS   =  3396.0
   MEX:DTM_C_AXIS_RADIUS   =  3396.0
   MEX:DTM_DESC   =  HEIGHT_ABOVE_SPHEROID
   MEX:DTM_MISSING_DN   =  -32768
   MEX:DTM_OFFSET   =  0.0
   MEX:DTM_SCALING_FACTOR   =  1.0
   END_GROUP   =  MEX:DTM
```

DA4

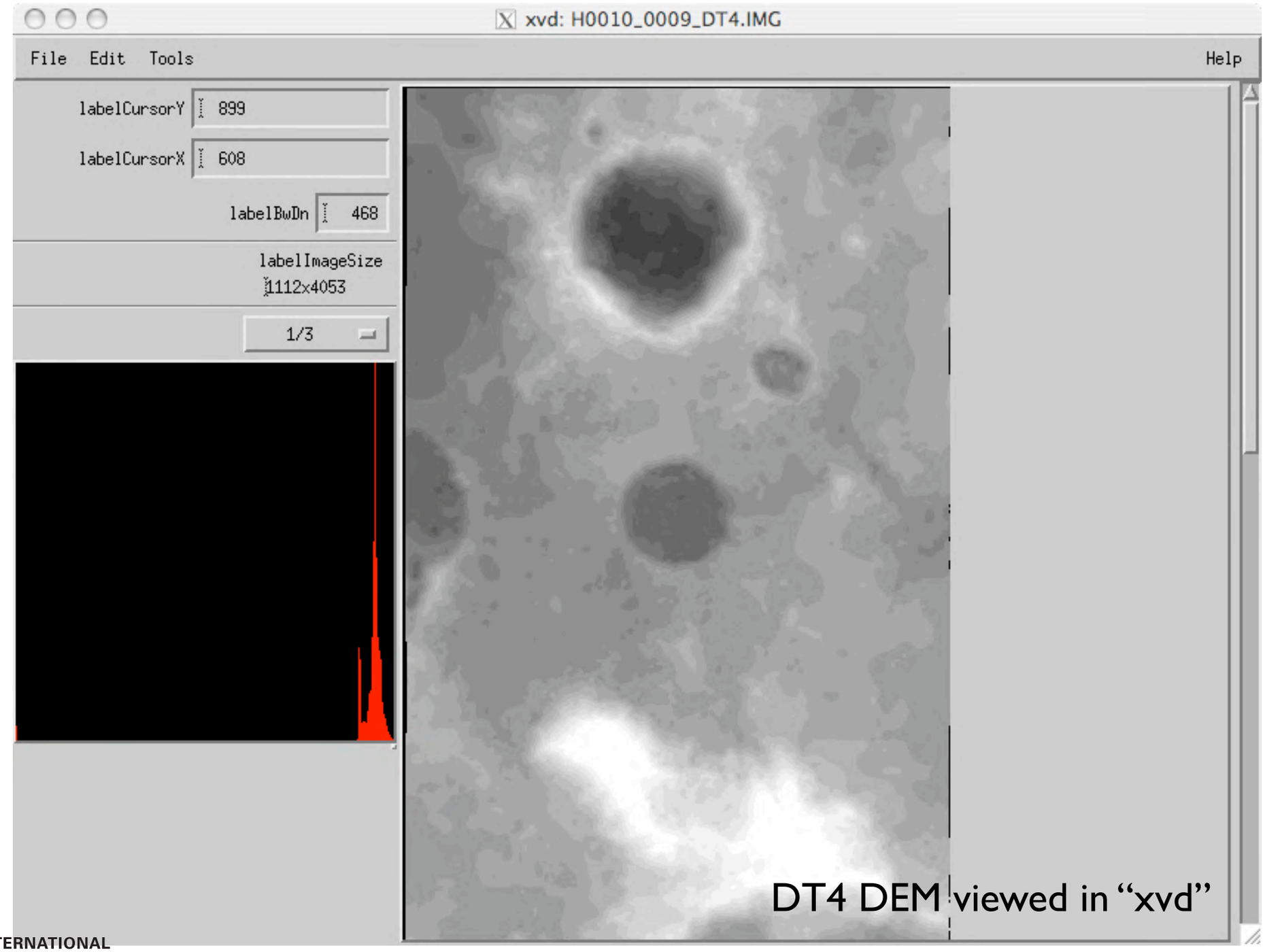
```
/* DIGITAL TERRAIN MODEL DEFINITIONS */

   GROUP   =  MEX:DTM
   MEX:DTM_A_AXIS_RADIUS   =  -1e+32
   MEX:DTM_B_AXIS_RADIUS   =  -1e+32
   MEX:DTM_C_AXIS_RADIUS   =  -1e+32
   MEX:DTM_DESC   =  "HEIGHT_ABOVE_GM3-AREOID"
   MEX:DTM_MISSING_DN   =  -32768
   MEX:DTM_OFFSET   =  0.0
   MEX:DTM_SCALING_FACTOR   =  1.0
   END_GROUP   =  MEX:DTM
```

SEE HRSC EXPERIMENT TO ARCHIVE INTERFACE CONTROL DOCUMENT (EAICD) IN THE HRSC DATASET IN THE PSA:

http://www.rssd.esa.int/PSA/

Level4 DEM: example



DT4 DEM viewed in “xvd”

HRSC DEM vs. MOLA

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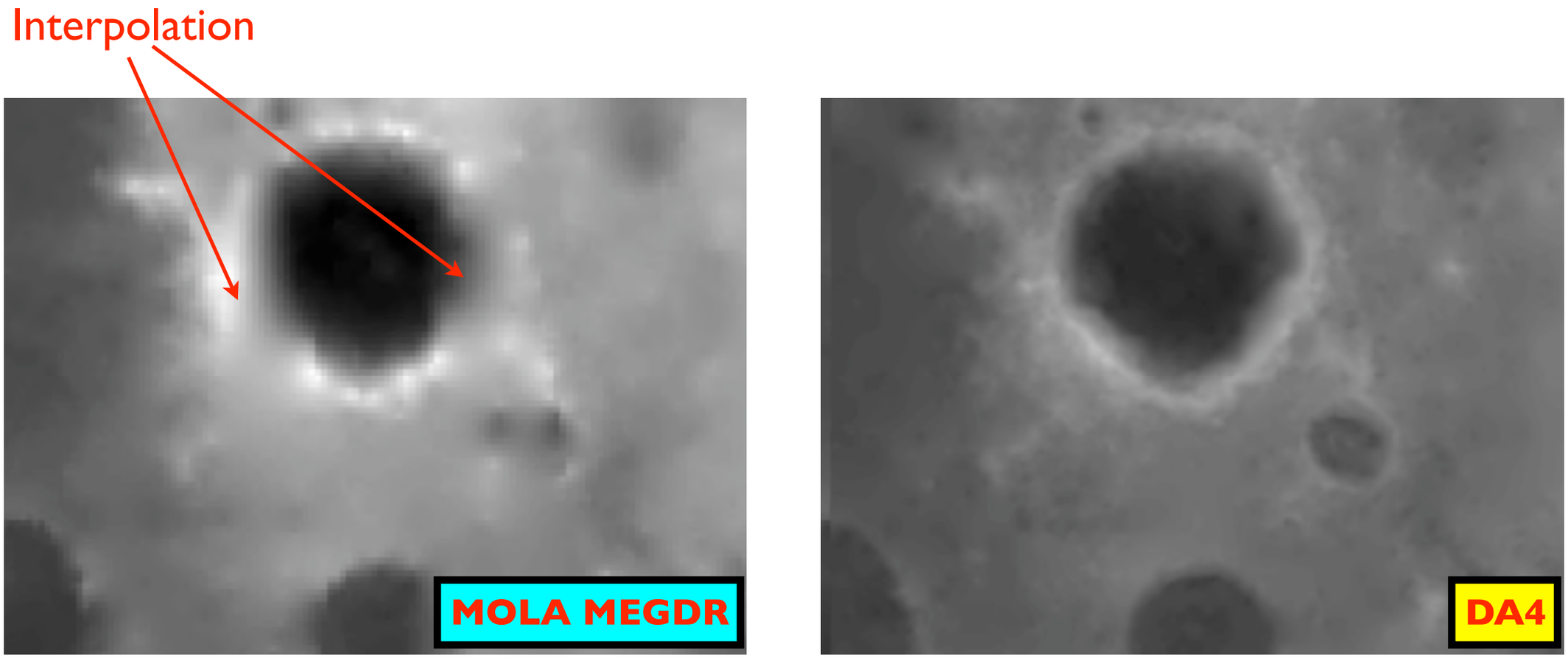
HRSC DEM vs. MOLA

For a comprehensive presentation on the comparison between HRSC Level4 Digital Elevation Models and MOLA (Mars Orbiter Laser Altimeter), please see K. Gwinner's presentation at the 2007 EMSEC Conference (Friday, W.02)

http://sci.esa.int/mars07/

http://www.rssd.esa.int/SYS/include/pubs_display.php?project=MarsEXPRESS&id=2799137

HRSC DTM vs. MOLA



Local high differences in height between MOLA and HRSC *DA4* DEM might be due to the lower resolution of MOLA and its interpolation (due to unevenly spaced MOLA profiles, especially at low latitudes).