African Rainforest Images

The Center for Earth Observation (CEO) has acquired a large collection of images covering much of the humid rainforests of Central Africa. These images are in either Landsat MSS or Landsat TM format and are stored on individual 8mm tapes in the CEO Lab. Each image has been catalogued by country, path, and row on our Data Archive web pages for Africa with an identifying tape number AFRnnnn.

Data has been stored on the tapes in either of two formats. These are the National LANDSAT Archive Production System (NLAPS) data format and a non-standard Humid Forest format. Examine the physical label glued to the tape. The NLAPS tapes have the following printed on the label "EROS DATA CENTER". These can be easily imported with proper coordinate information (**Section B**). The Humid Forest formatted tapes require several different processing steps (**Section C**).

The CEO PC workstation ***terra114*** (back left corner of the lab) has a tape drive that can be used for this process. Data extracted from the tapes should be stored locally in the C:\temp directory to improve the speed of tape extract. Make a new subdirectory for yourself called **c:\temp\<yourNetID>** and remove it entirely when you are finished. The system name for tape drive is: **/dev/a0t2l0**.

> **IMPORTANT NOTE**: The tape drive name must be all in lowercase and the second to the last character is a lower case L).

Extracting Data from the Tape

Image data are stored in several individual files. The first file on the tape contains the header records. The other files on the tape consist of one band of image data each. Landsat TM images have files 2 through 8 for image bands 1 through 7. Landsat MSS images have files 2 through 5 for image bands 1 through 4.

The first step in extracting data should be to extract and print the header file. This provides important information about the scene such as; the number of lines (rows) and samples (columns), geographic coordinates of the four image corners, pixel size, projection, date of acquisition, and sensor. Sample header files can be found in the appendices at the end of this document.

A - Processing the Header Record

1) Login in to ***terra114*** and turn on the tape drive. The power switch is located on the back of the drive on the left side. When the drive states “Ready – No Tape” slide the 8 mm tape into tape drive. The display will change to “Ready – Tape”.

2) Load the program ENVI from the desktop icon. This will open the main ENVI menu window (Figure 1).

Figure 1

3) From the menu select: **File | Tape Utilities | Dump Tape**

This loads the dump tape utility window (Figure 2). Enter the Tape Device name **/dev/a0t2l0**. Since the header file is the first file on the tape, you should Dump Files "**1**" to "**1**".

4) Finally enter a path and name for the header file and click on the OK button. Use a filename that will help to identify it file as a header file. When the extract is completed print the header file using a text editor on the system.

See note on page 1

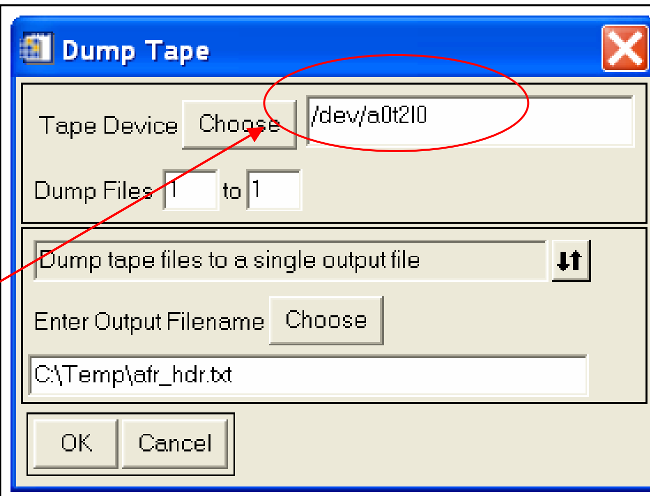


Figure 2

The next step is to dump the data file from the tape to an ENVI image file. Follow the appropriate section; **B** for NLAPS or **C** for Humid Forest formatted data.

B - Extract Image Data Files - NLAPS Data

1) From the ENVI main menu select:
File | Tape Utilities | Read Known Tape Formats | NLAPS

2) This will open the NLPAS Load Tape window (Figure 3). Enter the device name **/dev/a0t2l0** and click OK

3) The Landsat NLAPS Tape Output window (Figure 4) opens. Make sure all bands are selected and enter an output file name. Click OK and the tape import process begins.

After you have imported the file, view the image in ENVI. If the top and bottom margins of the image are horizontal (like Figure 7 but without the borders) the image must be rotated.

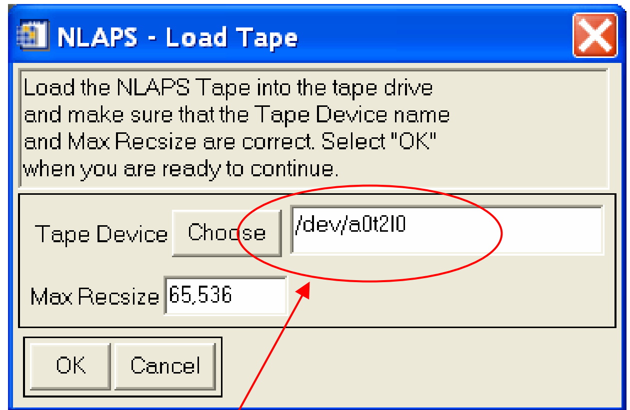


Figure 3

4) This can be done very simply in ENVI. From the main menu select: **Basic Tools | Rotate/Flip Data**. Select your input file from previous step and enter a new output file name.

5) When this is done, convert the file to ERMapper format by selecting:
File | Save File As | ERMapper File.

When you have completed the import, move this new ERMapper file and its header file to your network drive U:\ and remove all intermediate datasets that have been created as part of this process. Notify the CEO Staff so someone can prepare a CD for the CEO Data Archive. Remove the tape and turn off the tape drive.

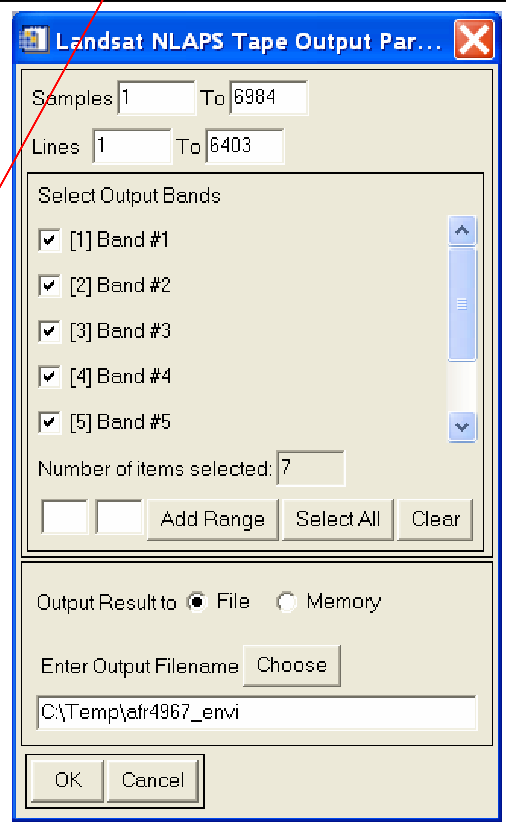


Figure 4

See note on page 1

C - Extract Image Data Files - Humid Forest Data

The "Humid Forest" formatted tapes cannot be imported directly into ERMapper. As a result, there are several processing steps that must be performed before an image can be used. First, an image must be extracted from the tape and converted into an image-processing format such as ERMapper. Next the image must be geo-referenced, or "warped", to provide accurate geographic coordinates. Finally, any remaining image borders should be converted to "null" values. The product of this processing is an image that can be used in ERMapper or other software with accurate coordinates and image statistics. This image should be copied to a CD using the standard CEO archive format and the Data Archive web page should be updated.

1) The image data must be extracted from tape using the ENVI Dump Tape utility. From the ENVI menu (Figure 1) select: **File | Tape Utilities | Dump Tape**

This will open the Dump Tape window (Figure 5). Enter the number of files to dump beginning with file number 2. For Landsat TM images the range should be 2 to 8. For Landsat MSS images the range should be 2 to 5. Make sure that the option "Dump tape files to a single output file" is selected and enter an appropriate filename. It is suggested that the filename indicates this is in ENVI format e.g. **C:\temp\afr4634_envi**.

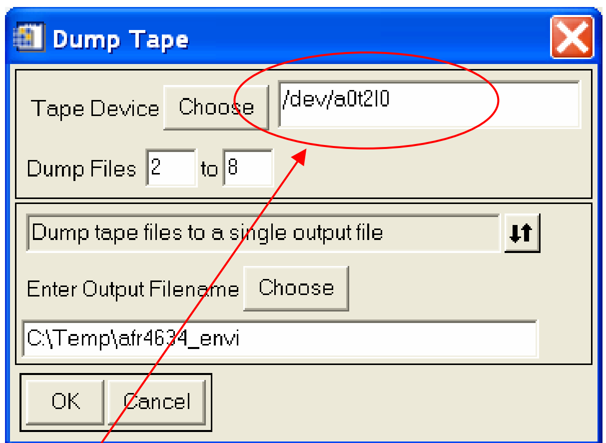


Figure 5

2) View the file in ENVI to verify that the tape extract was successful. To do this select: **File | Open Image File** and fill in the number of samples, lines and bands in the header info window (Figure 6). This information is in the original header file you extracted earlier. You can view the image as a single band gray scale or an RGB image.

See note on page 1

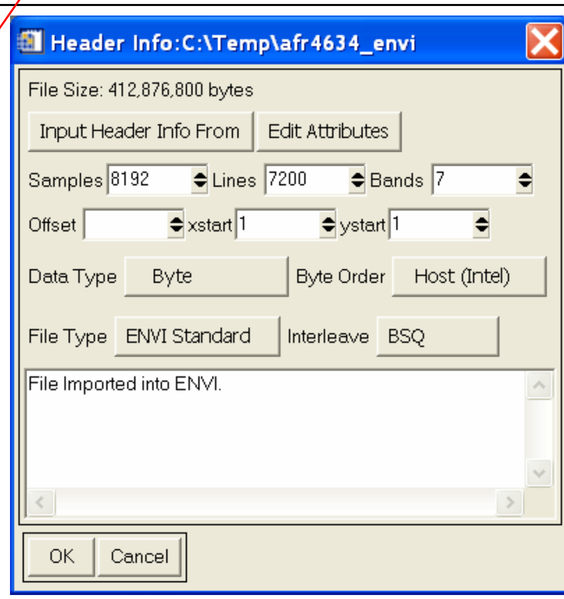


Figure 6

3) Export the ENVI image to ERMapper using the following menu selections:

File | Save File As | ERMapper File

Select the ENVI file imported in the previous step and click OK. When the file has been exported to ERMapper format, close ENVI

4) Eject the tape (button on the front right side of the drive) and place it back in its case. Turn off the tape drive.

Load ERMapper and open the new file you have just created as an RGB image. You should see an image similar to that in Figure 7. Notice the large white border with small black marks in the corners. The white border and black marks will need to be converted to *null* values later and the image will be trimmed.

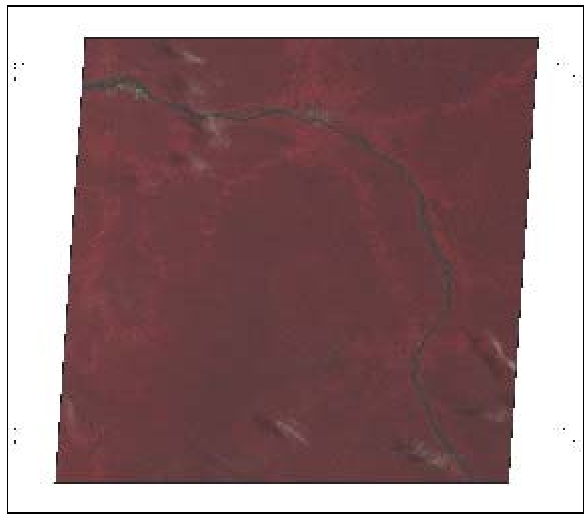


Figure 7

First the image must be georeferenced using the coordinate information found on the original header file produced in **Section A - Processing the Header Record** above. This document is not intended to provide detailed instructions on how to georeference an image using ERMapper. It does provide specific parameter information for the Humid Forest formatted tapes. A sample header file can be viewed in Appendix B.

1) Begin the image rectification process by opening the Geocoding Wizard (see Figure 8) and selecting the new ERMapper file as your Input File. Make sure the Geocoding Type is Polynomial and then on tab **2) Polynomial Setup** select Linear.

2) In tab **3) GCP Setup** under Output Coordinate Space click on the Change button and enter the correct datum, projection, and coordinate type from the header file extracted from the tape. You should assume that the Datum is ***WGS84*** and that the UTM zone is ***North***.

Note: For regions completely below the equator all Northing values will be negative. You could then select a UTM ***South*** zone and subtract all Northing values from 10,000,000.

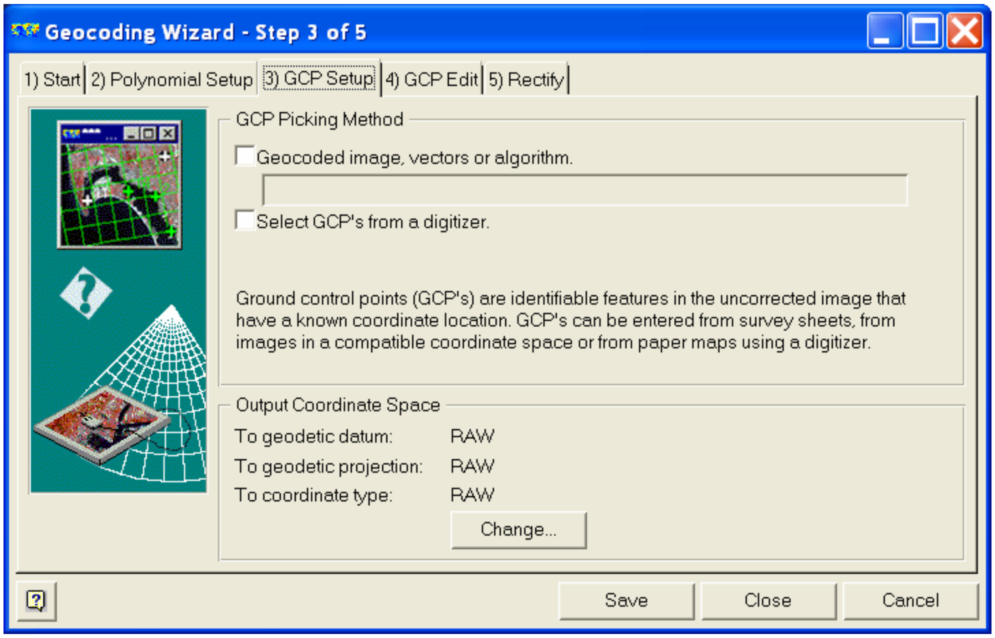
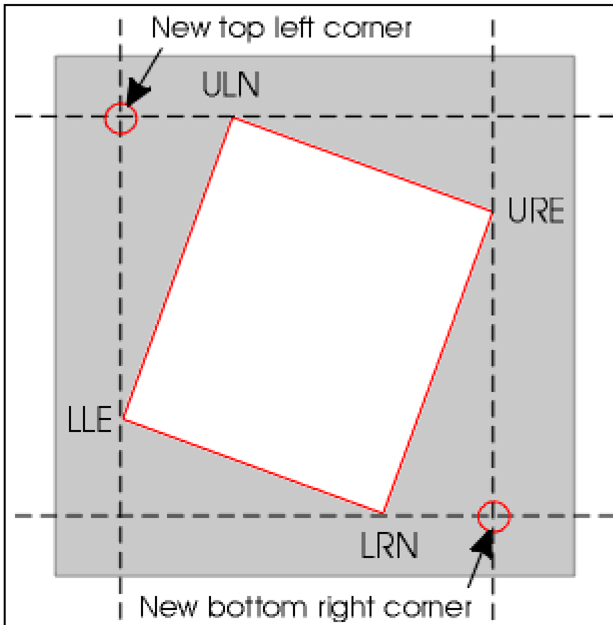


Figure 8

3) Select tab **4) GCP Edit** to enter reference pixels and coordinate values. The header file contains Northing and Easting coordinate data for the four corners of the image. These are in meters stored in scientific notation, i.e. 4.3882066E+05 equals 438820.66 meters. Zoom in to each corner pixel of the image (not the border) and input the appropriate coordinates.

4) The image rectification can now be performed by selecting tab **5) Rectify**. Select a new output file name and make sure that the cell size width and height are correct. This will produce a raster file that will be considerably larger than the original file. Figure 9 provides an example of this. The output of the unrestricted rectification is represented by the large gray rectangle. The actual satellite image corresponds to the rotated interior white rectangle. You should limit the size of the new file by defining image extents.

5) Click on the "*Edit Extents…*" button to open the Geocode Output Extents window (Figure 10).



ULN - Upper Left Northing (+500)
URE - Upper Right Easting (+500)
LLE - Lower Left Easting (-500)
LRN - Lower Right Northing (-500)

Figure 9

Note: The coordinates of the minimum bounding box for the new image are found in the original header file. The coordinates for the new top left corner are obtained from the Upper Left Northing and Lower Left Easting values. The coordinates for the new bottom right corner are obtained from the Lower Right Northing and Upper Right Easting values. You should pad each coordinate by 500 meters

6) Select *Custom Extents* and enter the Easting and Northing coordinates, in meters, for the new Top Left and Bottom Right corners. Close the Geocode Output Extents window and continue with the rectification process. This step will produce a new rectified image which is trimmed to the minimum bounding box.

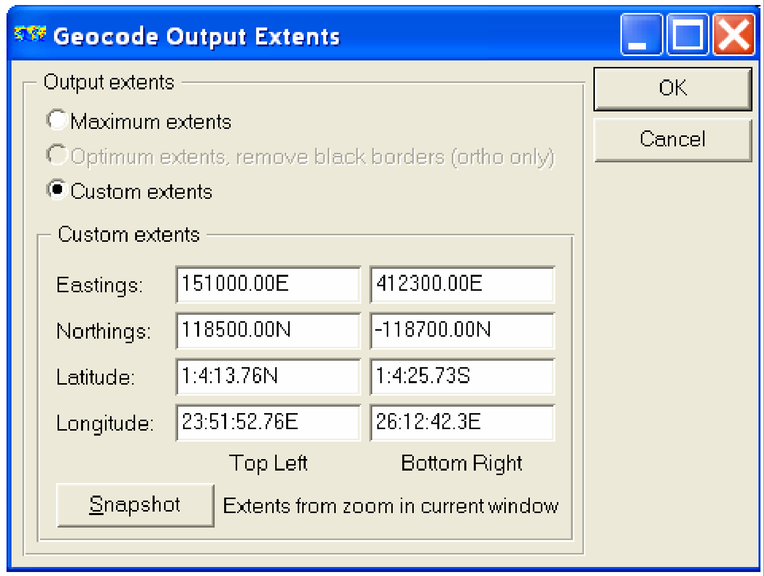


Figure 10

View the new image to verify the rectification process has been completed successfully. Check the cell values for the remaining border areas in the corners of the image**.** When you click in the border area you should find that all of the pixels in the white regions contain the value 255 in each of the bands and the pixels in the black regions contain the value 0 in each of the bands. This will affect image statistics and visual display using contrast stretching. These border pixels must be converted to null values.

7) An algorithm has been created to correct these TM images. Load the algorithm:

N:\ERM_files\CEO_formulas\Clean_TM_Borders.alg

This algorithm loads seven pseudo layers. Change the input dataset for each layer to your rectified ERMapper image. Verify the formula for each layer. The first layer should use all seven bands and should pass a value for "**i1**" if it is not null, the second layer passes the value for "**i2**", etc. When you are sure that the algorithm and formulas have been modified for your use, save this as a new ERMapper raster dataset. Make sure that the output transforms are deleted.

When you have completed the import, move this new ERMapper file and its header file to your network drive U:\ and remove all intermediate datasets that have been created as part of this process. Notify the CEO Staff so someone can prepare a CD for the CEO Data Archive.

Appendix A - NLAPS Header File

NDF_REVISION=0.00;
PRODUCT_NUMBER=01198042800190003;
DATA_FILE_INTERLEAVING=BSQ;
TAPE_SPANNING_FLAG=1/1;
START_LINE_NUMBER=1;
START_DATA_FILE=1;
BLOCKING_FACTOR=1;
MAP_PROJECTION_NAME=UTM;
USGS_PROJECTION_NUMBER=1;
USGS_MAP_ZONE=-37;
USGS_PROJECTION_PARAMETERS=6378206.400000000400000,6356583.799999999800000,0.000000000
000000,0.000000000000000,0.000000000000000,0.000000000000000,0.000000000000000,0.00000
0000000000,0.000000000000000,0.000000000000000,0.000000000000000,0.000000000000000,0.0
00000000000000,0.000000000000000,0.000000000000000;
HORIZONTAL_DATUM=NAD27;
EARTH_ELLIPSOID_SEMI-MAJOR_AXIS=6378206.400;
EARTH_ELLIPSOID_SEMI-MINOR_AXIS=6356583.800;
EARTH_ELLIPSOID_ORIGIN_OFFSET=0.000,0.000,0.000;
EARTH_ELLIPSOID_ROTATION_OFFSET=0.000000,0.000000,0.000000;
PRODUCT_SIZE=FULL_SCENE;
RESAMPLING=NN;
PROCESSING_DATE/TIME=043098/16180200;
PROCESSING_SOFTWARE=NLAPS_3_5_1E;
DATA_SET_TYPE=EDC_TM;
PIXEL_FORMAT=BYTE;
PIXEL_ORDER=NOT_INVERTED;
BITS_PER_PIXEL=8;
PIXELS_PER_LINE=7800;
LINES_PER_DATA_FILE=7241;
DATA_ORIENTATION=UPPER_LEFT/RIGHT;
NUMBER_OF_DATA_FILES=7;
LINES_PER_VOLUME=50687;
RECORD_SIZE=7800;
UPPER_LEFT_CORNER=0375816.3882E,0061826.7885S,386203.500,9302742.000;
UPPER_RIGHT_CORNER=0395850.4363E,0061827.1224S,608475.000,9302742.000;
LOWER_RIGHT_CORNER=0395904.9827E,0081026.0291S,608475.000,9096402.000;
LOWER_LEFT_CORNER=0375801.1286E,0081025.5953S,386203.500,9096402.000;
REFERENCE_POINT=SCENE_CENTER;
REFERENCE_POSITION=0385833.2321E,0071430.4621S,497339.250,9199572.000,3900.50,3621.00;
REFERENCE_OFFSET=-164.88,-32.80;
ORIENTATION=0.000000;
WRS=166/065.0;
ACQUISITION_DATE/TIME=112994/06463331;
SATELLITE=LANDSAT_5;
SATELLITE_INSTRUMENT=TM;
PIXEL_SPACING=28.5000,28.5000;
PIXEL_SPACING_UNITS=METERS;
PROCESSING_LEVEL=08;
SUN_ELEVATION=53.07;
SUN_AZIMUTH=116.15;
NUMBER_OF_BANDS_IN_VOLUME=7;
BAND1_NAME=TM_BAND_1;
BAND1_WAVELENGTHS=0.45,0.52;
BAND1_RADIOMETRIC_GAINS/BIAS=0.6024314,-1.5200000;
BAND2_NAME=TM_BAND_2;
BAND2_WAVELENGTHS=0.52,0.60;
BAND2_RADIOMETRIC_GAINS/BIAS=1.1750981,-2.8399999;
BAND3_NAME=TM_BAND_3;
BAND3_WAVELENGTHS=0.63,0.69;
BAND3_RADIOMETRIC_GAINS/BIAS=0.8057647,-1.1700000;

```
BAND4_NAME=TM_BAND_4;
BAND4_WAVELENGTHS=0.76,0.90;
BAND4_RADIOMETRIC_GAINS/BIAS=0.8145490,-1.5100000;
BAND5_NAME=TM_BAND_5;
BAND5_WAVELENGTHS=1.55,1.75;
BAND5_RADIOMETRIC_GAINS/BIAS=0.1080784,-0.3700000;
BAND6_NAME=TM_BAND_6;
BAND6_WAVELENGTHS=10.40,12.50;
BAND6_RADIOMETRIC_GAINS/BIAS=0.0551582,1.2377996;
BAND7_NAME=TM_BAND_7;
BAND7_WAVELENGTHS=2.08,2.35;
BAND7_RADIOMETRIC_GAINS/BIAS=0.0569804,-0.1500000;
END_OF_HDR;
```

Appendix B - Humid Forest Header File

```
  IMAGE NAME:4182058009033010!182!058!112690.conc;img
          NL:7200          NS:8192           NB:1          DTYPE:BYTE
  LAST MODIFIED:         DATE:              TIME:         SYSTEM:ieee-std
  PROJ. CODE:(1)UTM                                        Valid:VALID
   ZONE CODE:33                                            Valid:VALID
  DATUM CODE:0                                             Valid:VALID
  PROJ. PARM:                                              Valid:VALID
  A:   0.00000000000000E+00   0.00000000000000E+00   0.00000000000000E+00
  B:   0.00000000000000E+00   0.00000000000000E+00   0.00000000000000E+00
  C:   0.00000000000000E+00   0.00000000000000E+00   0.00000000000000E+00
  D:   0.00000000000000E+00   0.00000000000000E+00   0.00000000000000E+00
  E:   0.00000000000000E+00   0.00000000000000E+00   0.00000000000000E+00
 CORNER COOR:                                              Valid:VALID
    ULcorner:4.38882066590457E+05   5.47401970356812E+05
    URcorner:4.05818425571013E+05   7.78492133835532E+05
    LLcorner:2.35778892612568E+05   5.18342617859686E+05
    LRcorner:2.02715251593124E+05   7.49432781338406E+05
  PROJ. DIST:2.85000000000000E+01   2.85000000000000E+01   Valid:VALID
 PROJ. UNITS:meters                                        Valid:VALID
   INCREMENT:1.00000000000000E+00   1.00000000000000E+00   Valid:VALID
 MASTER COOR:1       1
```

Note: The image name field contains the image path, row, and date separated by exclamation points "!". Corner coordinates are given in meters using scientific notation. Values are Northings followed by Eastings.

In the above example:

Landsat Path 182 and Row 058
Image date is November 26, 1990
NL - number of lines is 7200
NS - number of samples (columns) is 8192,
Projection is UTM zone 33
Cell size is 28.5 meters
Upper left coordinates are 438882.067N 547401.970E