Finding, Importing and Making Subsets of Free Landsat Data

This document is intended to help users find, download, and use free Landsat data for almost any land surface in the world using a freeware software program, MultiSpec ©.

General Note: When following the steps in this tutorial, it may help you to read *all* the notes about each step before taking it.

Introduction

Many professional and educational programs use satellite data and images to study our changing Earth. In particular, the Landsat Program has provided over 30 years of calibrated high spatial resolution data of the Earth's surface to a broad and varied user community, including agribusiness, global change researchers, academia, state and local governments, commercial users, military, and the international community. This uninterrupted record provides abundant opportunity for "before and after" comparisons of Earth's land surface throughout the past 30 years. To read more about Landsat data and its uses please visit http://landsat.gsfc.nasa.gov or http://landsat.usgs.gov.

For details about the data and use of the data please examine the Landsat Data Users Handbook at http://landsat.gsfc.NASA.gov/IAS/handbook/handbook_toc.html.

This tutorial provides instruction on how to obtain and import free Landsat data into a free software program, make subsets of the data, and create images that can be used to examine change over time.

The data used in this tutorial are from the Global Land Cover Facility (GLCF) at the University of Maryland's Institute for Advanced Computer Studies in College Park, MD. The two data sets (one from circa 1990, and one from circa 2000) cover the entire globe except

Antarctica. Together these data sets constitute the "Landsat Geocover Data Set."

The free software used in this tutorial is Multispec©, developed at Purdue University, West Lafayette, IN, by David Landgrebe and Larry Biehl from the School of Electrical Computer Engineering, Agronomy and Laboratory for Applications of Remote Sensing.

Getting the Free Software

It is recommended that users take the MultiSpec© tutorial before using the software. The tutorial is available through the GLOBE program at:
http://www.globe.unh.edu/Training/New_Training.html

Software Step 1: Go to http://dynamo.ecn.purdue.edu/~biehl/MultiSpec©/ and download MultiSpec©. Make sure to download the correct version for your computer. There are versions for Macintosh and Windows software. MultiSpec© is updated regularly with additional features. Users who want to conduct more advanced operations may want to visit the site and upgrade their software twice a year.

Getting the Free Data

About the Data: Landsat observations of the Earth's surface are divided into "scenes," each of which is approximately 185 km by 172 km. A grid system of "paths" and "rows" is used to provide a reference number for each scene. The satellite is in a circumpolar orbit that provides repeat coverage of the same area every 16 days. The data used in this tutorial are orthorectified. Orthorectified scenes are georeferenced, meaning that if one lays a scene from one locality directly on top of another scene from that same locality, all of the map locations will match up exactly. This makes Orthorectified Landsat scenes especially useful for detecting change over time. More information about change detection is available from NASA's Landsat Change Detection subset pair web site. *[URL to this will be provided here prior to publication.]*

Data Step 1: Go to the Global Land Cover Facility's web site at: http://glcf.umiacs.umd.edu/index.shtml

The Global Land Cover Facility (GLCF) provides Earth science data and products free to anyone via FTP. The GLCF provides other datasets in addition to the one used in this tutorial. The Landsat GeoCover data set is the subject of this tutorial.

Data Step 2: At the Global Land Cover Facility's Web site, select the Earth Science Data Interface by clicking on the map within the Download Data option (at right of screen).
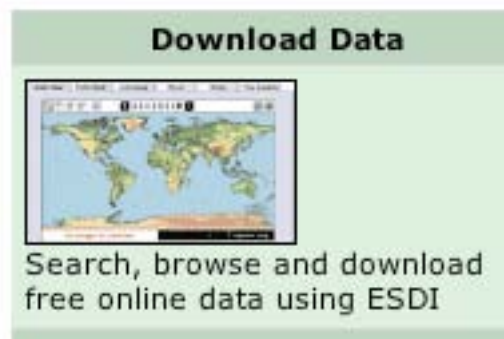
Data Step 3: Select the Map Search option.
You can also use the Map Search to browse and query using an interactive map. **You must use the Map Search when looking for Landsat GeoCover data.** The Map Search will provide two geoferenced scenes for anywhere in the United States from around 1990 and 2000. These scenes are excellent for change detection.


Data Step 4: Select all three instruments from the Landsat Imagery box (Ignore the other options.)
"ETM+", "TM", and "MSS" refer to different sensors that have flown on different Landsat satellites through the years. The GeoCover 1990 data is Landsat TM data and the GeoCover 2000 data is Landsat ETM+. Data from other years may be available for your chosen geographic location, so select all three instruments.
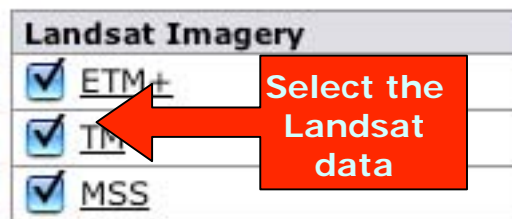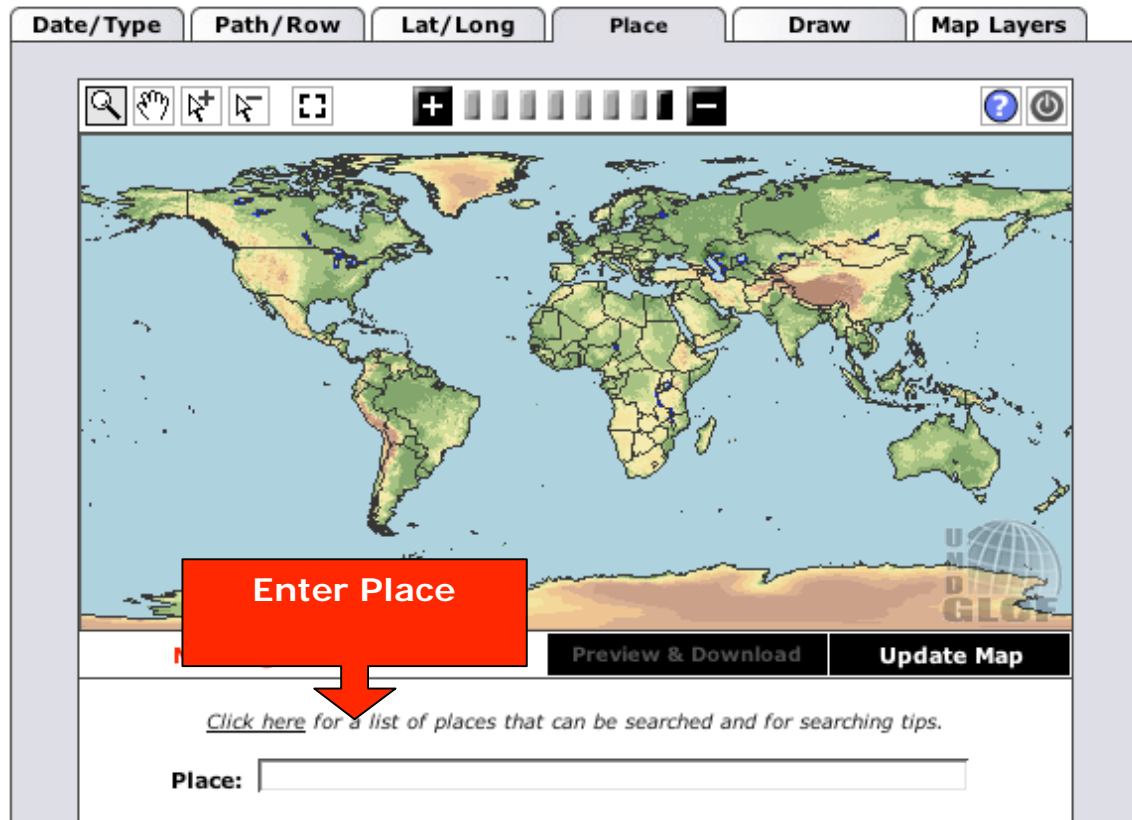
Data Step 5: Select the "Place" tab.

When looking for data, the place function is the easiest to use.

Select the
Place Tab

| Date/Type | Path/Row | Lat/Long | Place | Draw | Map Layers |
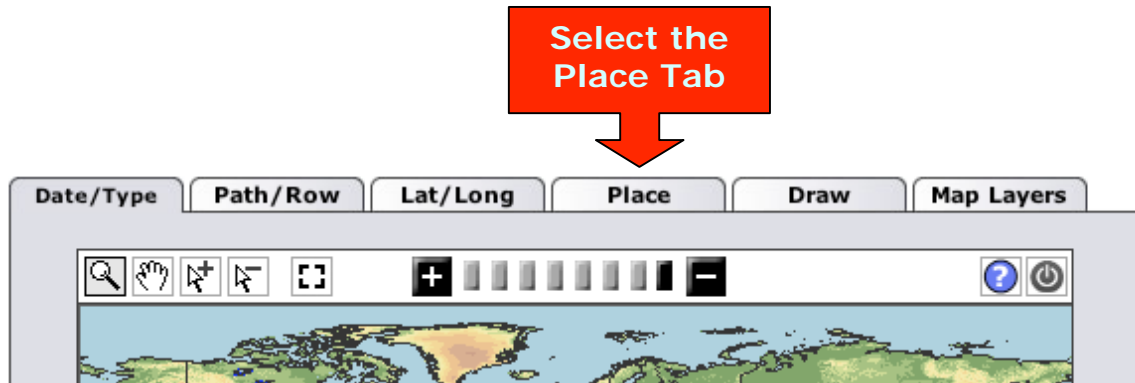
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Data Step 6: Enter the major place name nearest your area of interest.

At the bottom of the new window is a blank box labeled "Place." In this box enter a major place (city, for example.)

Available Place Names
The database currently contains the following place names that can be searched:
- All countries.
- Worldwide states, provinces, and equivalent country administrative units (i.e., Oblasts).
- Major world cities.
- United States cities with population greater than 10,000 (circa 1998).

Note: For more information regarding the place name search refer to the "searching tips" available at the Earth Science Data Interface (ESDI) at the Global Land Cover Facility. Or, click the link directly above where the place name is entered.
http://glcf.umiacs.umd.edu/esdi2help/place.html#availPlaceNames

Data Step 7: Select Update Map (just below the map).

Data Step 8: Once a place name has been indicated, select the Preview & Download button (just below the map).

When the selection area is displayed, a red square (or a few squares) will appear on the map, representing the extent of the Landsat scene(s) you have selected. If your desired location is not in the area covered by the red square(s), go back and select using "map area" instead of "place."
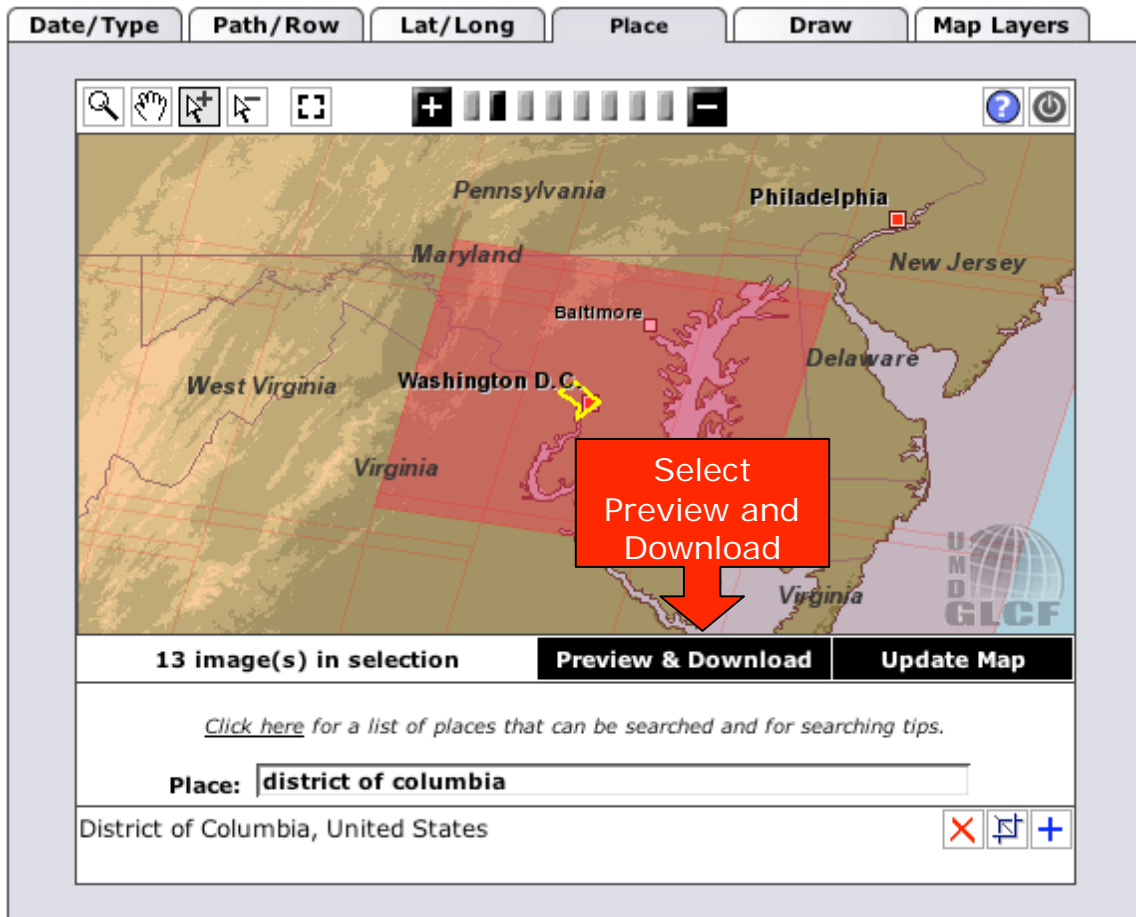
Note: The Preview & Download option will not work if no scene has been selected.

Data Step 9: Select the Preview & Download option from the selection map.

In the Preview & Download results window, seen below, there are numerous features. All of the scenes of the user's selected location available from the GLCF are listed. Yellowish highlight indicates a selected scene. A thumbnail of that selected scene appears at the upper left side of the screen. (The thumbnail is a false color composite image (usually a 4,3,2 band combination, which means that vegetation is shown as red.) Additionally, this screen includes a reference map indicating the spatial extent covered by the scene. (The reference map is especially helpful when there are multiple scenes in the list.)

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Reference Map for selected image

List of images available at GLCF

[ID]	Status	[WRS: P/R]	[Acq. Date]	Dataset	Producer	Attr.	Type	Location
012-736	Online	2: 015/033	1987-05-16	TM	EarthSat	Ortho, GeoCover	GeoTIFF	United States
017-799	Online	2: 015/033	1986-05-29	TM	USGS	L1G	BSQ	United States
017-800	Online	2: 015/033	1990-08-12	TM	USGS	L1	BSQ	United States
017-808	Online	2: 015/033	1984-08-27	TM	USGS		BSQ	United States

Data Step 10: Choose a Landsat scene (data) from the list.

If there are more than two scenes in the list, the best scenes to select are the ETM+ (Landsat 7) scenes. ETM+ scenes if they are available will result in higher quality images, though a user may wish to choose data based upon date, depending upon need. To select another scene in the list, select its [ID] number or the "Next" button. A preview image and a table will be displayed at the top of the Web page.

In the Attribute column, "Ortho, GeoCover" refers to orthorectified, a process that corrects and improves the geographic coordinates associated with the scenes.

Attr.
Ortho, GeoCover

Data Step 11: Re-sort the list of scenes if desired.

Use the lists [Acq. Date] function to re-sort the list. Click it once to sort the data with the oldest scene/data at top and click again to reverse the order, with the oldest scene/data at bottom.

[ID]	Status	[WRS: P/R]	[Acq. Date]	Dataset
012-736	Online	2: 015/033	1987-05-16	TM

[ID]	Status	[WRS: P/R]	[Acq. Date]	Dataset
034-100	Online	2: 015/033	2003-01-12	ETM+

Data Step 12: Choose the desired scene (for example, the most recent) from the list.
Click on the identification [ID] number to select the scene.

Data Step 13: Open the download page for the selected scene.

> **Note:** In the example below, the downloadable file is 171 MB. The download rate will depend greatly on the type of Internet connection being used. Downloading is a one-time process, and can be done anywhere with access to a high speed Internet connection.
>
> Additionally, Landsat scenes are separated into individual files, so each one is not very large. The process may take some time, but should be manageable.

Click the Download button.


```
TM
WRS-2, Path 015, Row 033
1987-05-16
EarthSat
Ortho, GeoCover
United States

Online: 012-736
Compressed Size: 171 MB; Actual Size: 412 MB
```

Download the image

Download

Data Step 14: Understanding the file name protocol

At the top of the page you will see the file name for your selected scene; below this you will find a list of file names. The file names follow a protocol, and contain important information.

The GLCF scene file-naming protocol may appear a bit complex to a novice user. In our example, the file names begin with p015r33_5t879516. So what is in the Landsat data file name?

p015
Landsat 7 orbits the Earth in a preplanned ground track. The sensor onboard the spacecraft obtains data along the ground track at a fixed width or swath. When mapped, the swaths are called "paths." The

concept of path is somewhat analogous to longitude. Thus, <u>p015</u> stands for Path 15. Our scene example shows Washington, D.C. Path 14 is to the east, and path 16 is to the west, of Washington D.C.

<u>r33</u> means Row 33, which signifies how far down from the North Pole the scene was acquired. There are no negative rows or paths.

<u>5t870516</u> tells us that the scene is from Landsat 5, and the date is shortened from 1987, May 16th to 870516.

> **Note:** Our example uses Landsat 5 TM data files (signified by the **5t** in the file name <u>p015r33_**5t**870516</u>). Landsat 7 data files have a L7 in the front of the file name (**<u>L7</u>**<u>1015033),</u> and Landsat 1-4 MSS data have a 1 to a 4 with an m after it (<u>p016r33_**1m**1972).</u>

Note that all the files begin with the path/row and date. The remaining portion of the file names vary as follows:

<u>browse.jpg</u> is a jpeg color composite image.

<u>hdr</u> is header file, and it is not always included.

<u>met</u> stands for metadata. It is a very important file, especially if you plan to use the scene in GIS applications. It includes all of the Landsat scene information specific to how and when this scene was acquired. Additionally, all the processing and geographic information is included in the met file.

<u>preview.jpg</u> is a smaller version of the <u>browse.jpg</u> image.

The remaining file names represent the Landsat data itself. They are listed in numerical order, and the number represents the band. For example, **<u>nn10tif.gz</u>** signifies band 1, **<u>nn20.tif.gz</u>** signifies band 2 and so on. Table 1, "Landsat Data Characterizations for the Various Missions," indicates the bands of data used by the various Landsat satellites. Notice that the numbers and wavelengths have changed over time, with different Landsat satellites. Landsat 7 has nine bands of data; Landsat 1-3 have only four bands of data.

Data Step 15: Download and uncompress the selected scene files.

Click on each link and download only **one** file at a time. Download all the files and place them in a folder. (It is important that they all be placed in the same folder.) The data is a compressed TIFF file. The gz at the end as in, nn7.tif.gz, means that the file is compressed.

Some files may not automatically download, but may open in your browser or other image viewing software (such as Preview). In those cases, you must manually save them to your folder. To manually download and save the files with a Windows program, right-click the file name and select "Download the Link to Disk" or "Save Target As." With a Mac, hold down the Control key, "ctrl", and click on the file. Then select the "Download the Link to Disk."
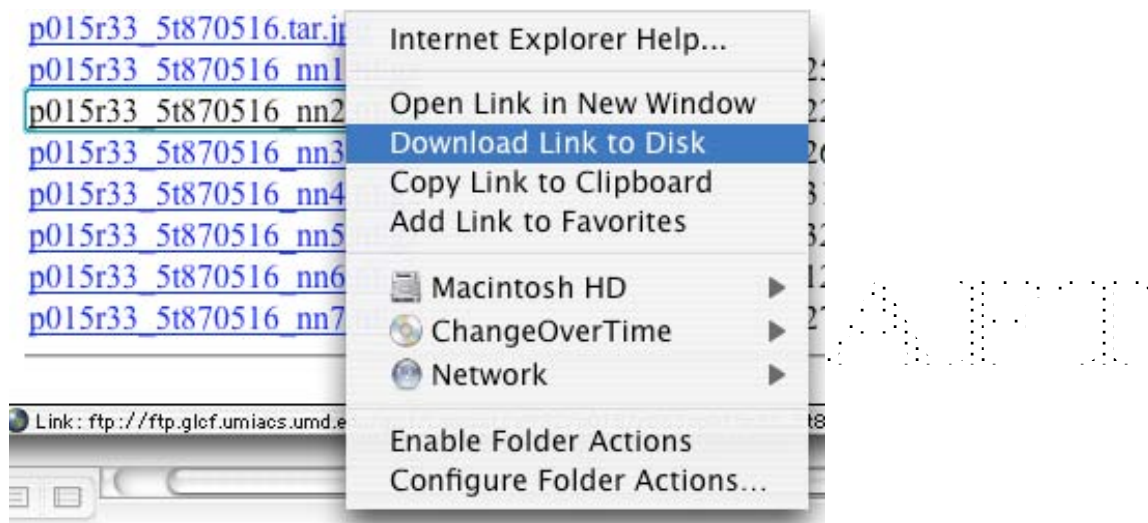
(This image is from Mac OS X.)

Your computer may give you a message stating that you cannot save a ".tar" file without ".jpg" at the end. That is OK; go ahead and allow ".jpg" to be added to the file name.

After each manual file save, use the "Back" button to return to the list of files to be downloaded.

> *Hint:* It may help you to keep track of which files you have successfully downloaded if you copy the list from the Web site and paste it into a Word document. You can mark each file downloaded as you proceed through the list.

Once the files are downloaded, most computers will automatically uncompress the files. If they do not do so, double click the file. The compression software should open and ask you to uncompress the files.

What if the computer does not open the files?
In this case, your computer does not have compression software. (Most computers do have this software.) Use the steps below, under "Using Compression Software," to download the software, and then extract or uncompress the files.

To help with file management, it is recommended that the user create a new folder for all the data. In educational settings, the Landsat TM band 6 or Landsat ETM+ bands of data 61, 62 or 80, are not typically used, so most teachers or students would not need to download them. These file names end with either B80.L1G.gz for band 8 or B62.L1G.gz for band 62. Also note that Landsat MSS data has only four bands of data (no blue data, but green, visible red and two infrared bands). More information about the files is available in Table 1 below.

Example of typical set of downloaded Landsat files:

File Name	Download Size	Actual Size
p015r33_5t870516.browse.jpg	77564 bytes	
p015r33_5t870516.hdr	2635 bytes	
p015r33_5t870516.met	361 bytes	
p015r33_5t870516.preview.jpg	8645 bytes	
p015r33_5t870516.tar.jpg	77564 bytes	
p015r33_5t870516_nn1.tif.gz	25946026 bytes	61625338 bytes
p015r33_5t870516_nn2.tif.gz	22784521 bytes	61625338 bytes
p015r33_5t870516_nn3.tif.gz	26405598 bytes	61625338 bytes
p015r33_5t870516_nn4.tif.gz	31810459 bytes	61625338 bytes
p015r33_5t870516_nn5.tif.gz	32862658 bytes	61625338 bytes
p015r33_5t870516_nn6.tif.gz	12444511 bytes	61625338 bytes
p015r33_5t870516_nn7.tif.gz	27801311 bytes	61625338 bytes

Table 1: Data Characterizations for Various Landsat Missions

	Landsat 1-3	Landsat 4-5	Landsat 7
Sensor	**MSS - MultiSpec©tral Scanner**	**MSS - MultiSpec©tral Scanner & TM - Thematic Mapper**	**ETM - Enhanced Thematic Mapper**
Mission coverage dates	August 7, 1972 to February 7, 1983	August 17, 1982 to October 1999	July 1999 to present
MultiSpec©tral Bands	**(band 1-4)**	**(band 1-5,7)**	**(band 1-5,7)**
Resolution	80 m	30 m	30 m
Band (microns)	0.5-0.6 0.6-0.7 0.7-0.8 0.8-1.1	.45-.52 .52-.60 .63-.69 .76-.90 1.55-1.75 2.08-2.35	0.45-0.52 0.52-0.60 0.63-0.69 0.76-0.90 1.55-1.75 2.08-2.35
Thermal Band		**(band 6)**	**(band 61 & 62)**
Resolution	N/A	120 m	60 m
Band (microns)	N/A	10.4-12.5 (Landsat 5 only)	10.4-12.5
Panchromatic Band			**(band 8)**
Resolution	N/A	N/A	15 m
Band (microns)	N/A	N/A	0.5-0.9 (Panchromatic)

Using Compression Software

Windows Users:

Compression Step 1: Open the folder on your computer where the images are downloaded.

Compression Step 2: Highlight all the files and right-click.

Compression Step 3: Select the "Extract files" option and follow the steps.

Note: Users who do not have the "Extract files" option will need to download compression software. It is available from **Winzip,** at:
www.PCSHAREWARE.com/download/download_unzipwiz32.htm
Download the Unzip Wizard, which is needed to unzip the Landsat data. Make sure to download the correct version for your computer. Or
If you do not have the compression software, go to **Aladdin Systems, Inc**. StuffIt Expander for Macintosh or StuffIt Expander for Windows
http://www.stuffit.com/mac/expander/download.html
StuffIt Expander easily expands, decodes, and unzips the data. Make sure to download the correct version for your computer.

Mac Users:

Compression Step 1: Open the folder where the images are downloaded.

Compression Step 2: Highlight all the files, hold down the control keyand mouse click. This will open the menu shown below (for OS X platform).

Compression Step 3: Select the "Open With" option and select "Stuffit Expander."
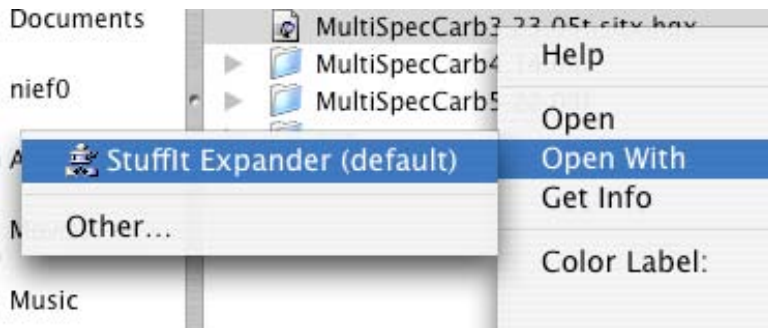
Compression Step 4: The uncompressed files will be opened into the same folder.

Note: Compression software is available from **Aladdin Systems, Inc**. StuffIt Expander for Macintosh or StuffIt Expander for Windows
http://www.stuffit.com/mac/expander/download.html
StuffIt Expander easily expands and decodes all the Landsat files you downloaded from the Web. Make sure to download the correct version for your computer.
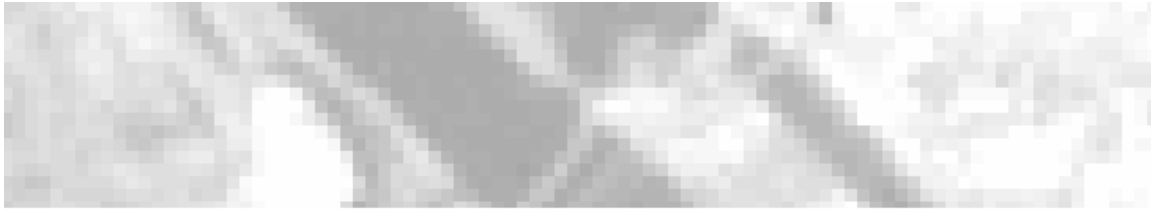
Preparing the Thermal Band

If you plan on using all the Landsat bands of data, you will need to modify band 6 (thermal data) to work with the 30-meter band data.

As noted in Table MLI 1, all Landsat missions had different spatial resolutions for the thermal band data and the multispectral data. The Landsat 7 MultiSpectral data have a resolution of 30 meters, whereas the Thermal data have a resolution of 60 meters. Study the images below to see the spatial resolution differences between the two Landsat bands.

In MultiSpec©, if the 30 meter and 60 meter data are linked without modifying the 60 meter thermal data, the software will automatically degrade the other bands of 30 meter data resolution to 60 meter resolution. Instead, you can use MultiSpec© to increase the thermal band area and file size to match the other bands, thus preserving the 30-meter resolution of the data.

Part of Washington D.C. where bridges cross the Potomac River, in Near Infrared Band 4 (30 meter resolution, upper) and Thermal Band 6 (60 meter resolution, lower)

> **Note**: Currently the preparation of the thermal data can be done only in MultiSpec© Mac versions (as of April 1, 2005). The same preparation can be done on other platforms using image or photo software such PhotoShop, by doubling the image size for both lines and columns.

Steps to preparing Thermal band data:

Thermal Step 1: Open MultiSpec©. Open the Thermal band 6 (TM) or 61 (ETM+) band data file. Go to File>Open Image, then select the thermal band data (example of file name on GLCF: p015r33_5t870516_nn6.tif.gz).

**A box that asks for specifications will appear. Click "OK".**
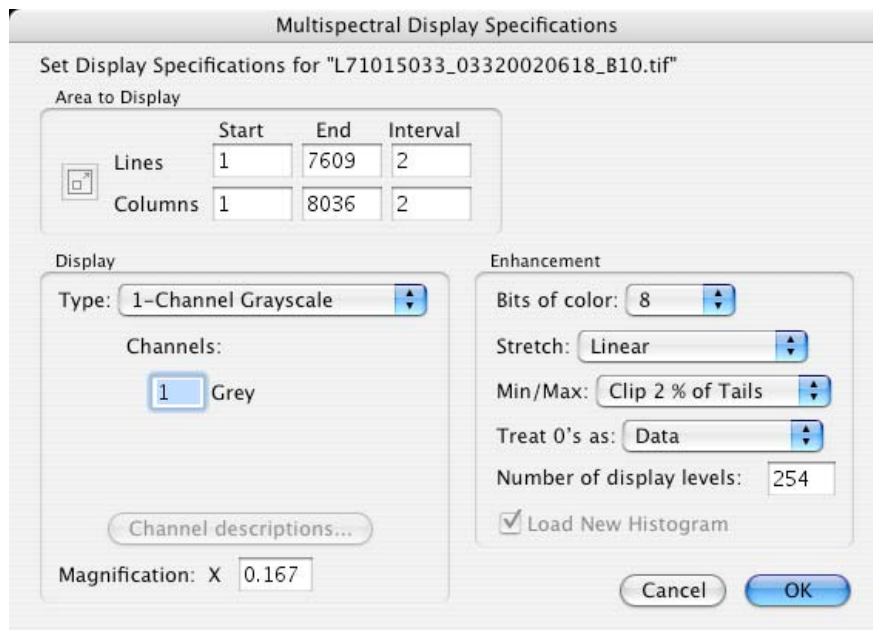
Click "OK" for the next screen as well. The computer will now compute image statistics and ask you to save this new file.

You must change the name of the file from the default, or the program will write this file over your original data file. Simply change the name of the file and save it to your data folder. Now an image in grey scale will appear

Thermal Step 2: Under the "Processor" menu select "Reformat," and then the "Rectify Image" option.

Thermal Step 3: The "Set Image Rectification Parameters" window will open. Change the "Rectification Settings" Scale to 2 for both the Lines and Columns windows. Click "OK".

> **Note:** this step will take quite some time to complete if you are doing this for a full scene.
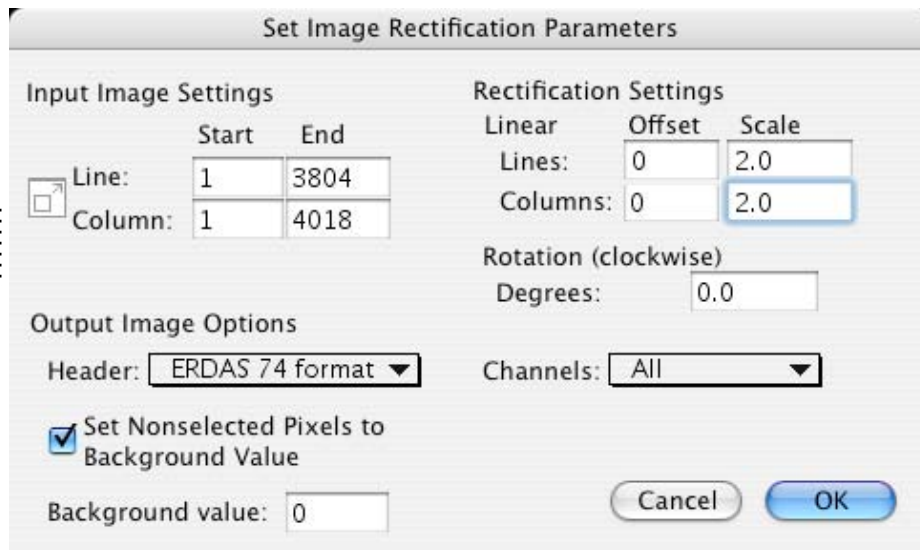
Thermal Step 4: Save the Image in the same folder as the other satellite images. Remember to save the image with both the date and the band number. See the example in the image below:
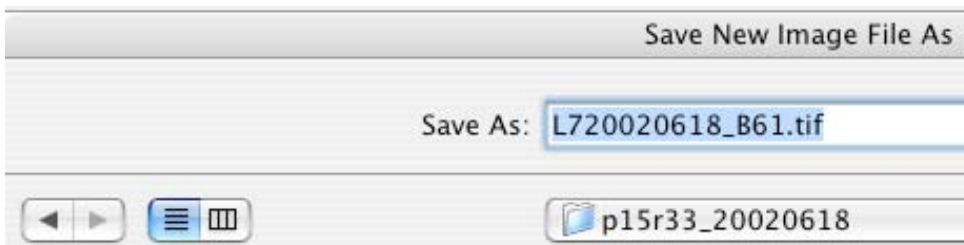
Thermal Step 5: Compare the new image file to the other data files, and make sure that the new one is the same file size and also covers the same area (that is, be sure the path and row are the same for each file).

Before the scaling (Thermal Step 4)

Multispectral Display Specifications

Set Display Specifications for "L71015033_03320020618_B61.tif"

Area to Display

	Start	End	Interval
Lines	1	3804	1
Columns	1	4018	1

After the scaling

Multispectral Display Specifications

Set Display Specifications for "L720020618_B61.tif"

Area to Display

	Start	End	Interval
Lines	1	7607	1
Columns	1	8035	1

**Now the Thermal band is ready to be linked with the other bands.**

Linking Bands of Data

(Combining Landsat bands into one image file)

Linking Step 1: Open MultiSpec©. Under "File" go to "Open Image." Locate your downloaded image files (see Data Step 12), and highlight the blue band (band 1) image file.

(For a description of the file names see **Data Step 14: Understanding the file name protocol**, above.)

> **Note:** If the image file names do not appear when you open the folder, select the "All Files" option in the "Files of Type" pull down menu.
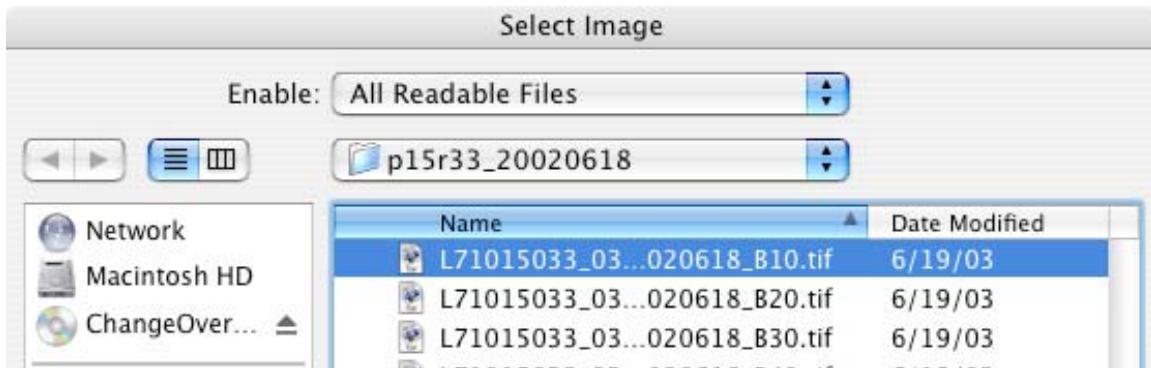

Linking Step 2: Click on "open." A box that asks for specifications will appear. Click "OK."
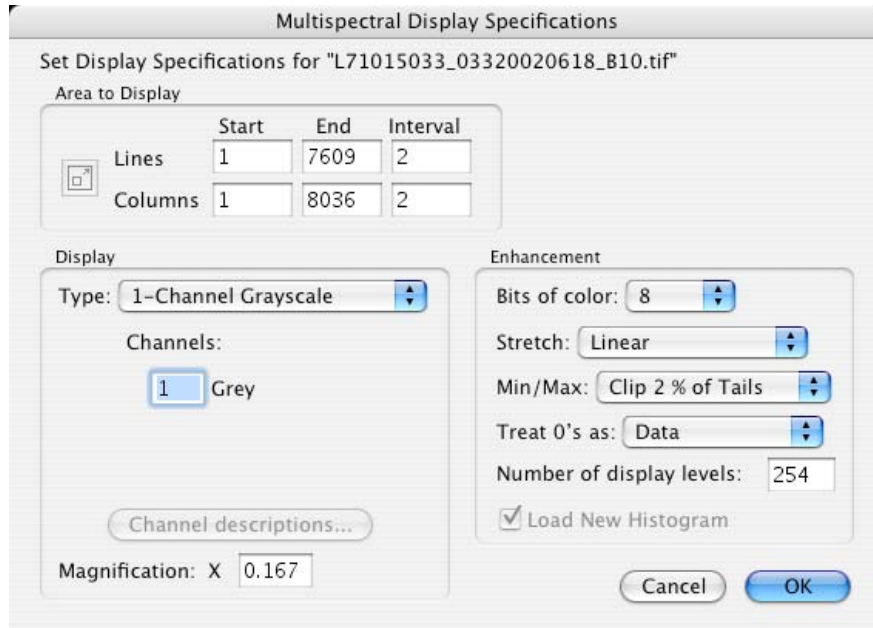
Click "OK" for the next screen as well. The computer will now compute image statistics and ask you to save this new file.

You must change the name of the file from the default, or the program will write this file over your original data file. Simply change the name of the file and save it to your data folder. Now an image in grey scale will appear.

Linking Step 3: Go back to "File" and again click on "Open Image". Highlight ...B20.tif file name, and **before you click OK,** click the box beside "Link to active image window". Then click "open".
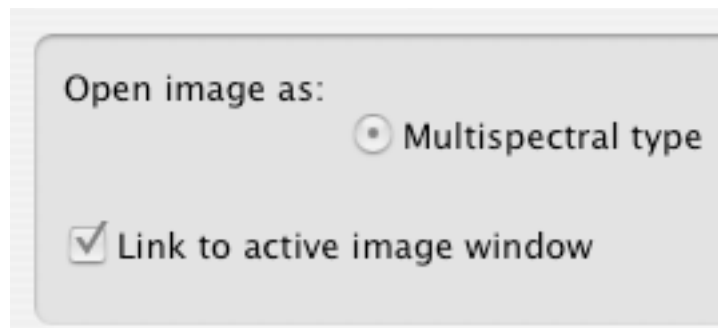
Linking Step 4: Continue this process until you have opened and linked all the data files. Link them in numerical order starting with the lowest number (B10, B20, B30, B40, B50, B61, B70). Once all of the
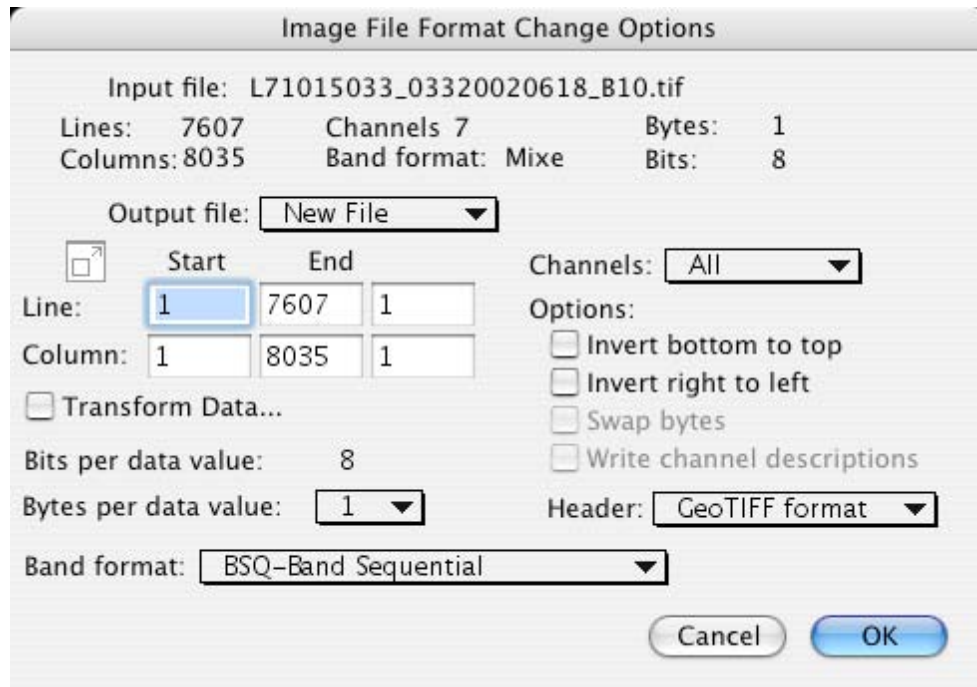
files you need have been opened, click "Cancel". Open and link only the Landsat data files (example of data file name: **L71015033_03320020618_B10.tif**), Avoid linking the other kinds of files, as it will confuse the software.

L7-L71015033_03320020618_B10.tif (ch. 1)

Note: At the top of the image (see example above), the file name should read, "L7…" This signifies that you have linked seven bands together. Make sure that the number of files you intended to link is the same as the file name shows.

Note: If the images open in separate windows, the images were opened without the "Link to active image window" box being selected. Close the windows and restart the linking process from Linking Step 1.

Note: if you want to work with the entire Landsat scene, save the image with all the linked bands using the reformat function in MultiSpec©. (Pull down the Processor menu, select Reformat, then Image File Format).

Image File Format Change Options

Input file: L71015033_03320020618_B10.tif

Lines:	7607	Channels 7		Bytes:	1
Columns:	8035	Band format: Mixe		Bits:	8

Output file: New File ▼

	Start	End		Channels:	All ▼
Line:	1	7607	1	Options:	
Column:	1	8035	1	☐ Invert bottom to top	

☐ Transform Data...   ☐ Invert right to left
                         ☐ Swap bytes

Bits per data value: 8   ☐ Write channel descriptions

Bytes per data value: 1 ▼   Header: GeoTIFF format ▼

Band format: BSQ–Band Sequential ▼

(Cancel)   (OK)

**Now you are ready to subset the scene.**

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Subsetting

Many users of Landsat data find that they do not need the entire scene for analysis. Teachers often find that large spatial areas, especially an entire scene, will overwhelm students and their computers. If you want to subset an area from a large Landsat image, follow these steps.

Subsetting Single Images

The data files must be linked prior to following the subsetting instructions! See section above "Linking Bands of Data."

Subsetting: Single Image Step 1: Select the area on the image to be subsetted. A recommended area would not be larger than 2000 pixels by 2000. In MultiSpec© you can see how large the selection area is by using the coordinate view. Pull down the "Window" menu and select the "Show Coordinate View" option.
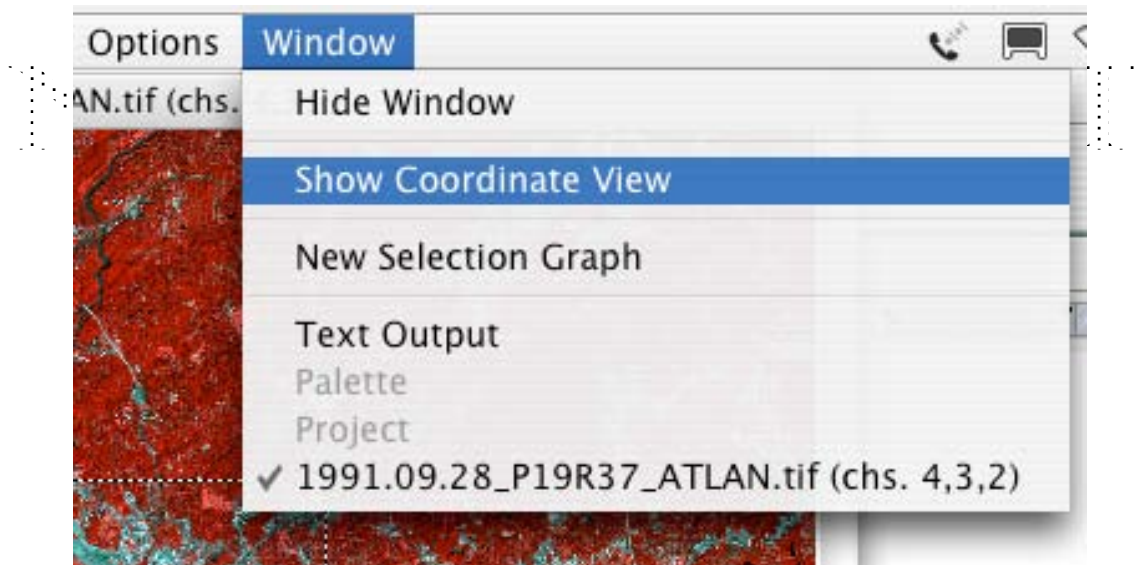
This will show the Coordinates of the image at the top. On the top left there is a pull down menu showing the MultiSpec© default Coordinate View of Lines-Columns.

Using the Coordinate View you can select an area to subset. The "Number pixels" function gives you a good clue about how many pixels have been selected. To select an area, place your cursor at the upper left corner of the area you wish to select, click the mouse and drag down to the lower right. The coordinates will change, and the number of pixels in the selected area will be calculated. For a 2000 by 2000 pixel area there are 4,000,000 pixels. Teachers note: If the "number pixels" is higher than 4,000,000 it may be too large of an area to work with for students.

Subsetting: Single Image Step 2: Pull down the "Processor" menu, and select "Reformat." A box will appear; select "Change Image File Format."

Subsetting: Single Image Step 3: In the "Image File Format Change Options" window, find the "Header" pull down menu, and select the GeoTIFF format. (This option will only work if the Landsat data is originally a GeoTIFF. The GeoTIFF file format is ideal because the file header contains all of the geographic information.)

Subsetting: Single Image Step 4: Click "OK". When the next box pops up, don't change the start and end lines and columns, but make sure the intervals are set at one.

	Start	End	
Line:	6398	6928	1
Column:	2416	2964	1

Subsetting: Single Image Step 5: Click "OK." The next box to pop up is for you to name and save the multi-channeled image. Give the image a name such as "name of county" and the date the image was acquired.   End the file name with the file extension ".tif" An example would be "**Seattle_06_23_01.tif**" Make sure you are saving the image to the same file where you have all the previous images. Click "save."

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Subsetting: Change Detection Images

The Landsat satellites have been acquiring imagery of the Earth since 1973. It is the longest record of a MultiSpectral high-resolution global data. Many data users find observing change over time one of the most engaging uses for Landsat data. For example, the GLOBE Program has developed a new change detection protocol (http://www.globe.gov/tctg/land_prot_changedetect.pdf?sectionId=213) that asks students around the world to document how the Earth is changing.

Subsetting: Change Detection Images Step 1: (This step requires the most recent version of MultiSpec©.) Download all the bands of data for each scene to be used from the Global Land Cover Facility download website. Be sure that the scenes you have selected to be compared have identical path and row numbers.

Subsetting: Change Detection Images Step 2: If you plan to use the thermal data, band 61, prepare the data using the procedure outlined in *Preparing the Thermal Band* (above).

Subsetting: Change Detection Images Step 3: Link all the bands you wish to use from one scene. Subset a study area from this same scene, following directions under *Subsetting Single Images*, above.
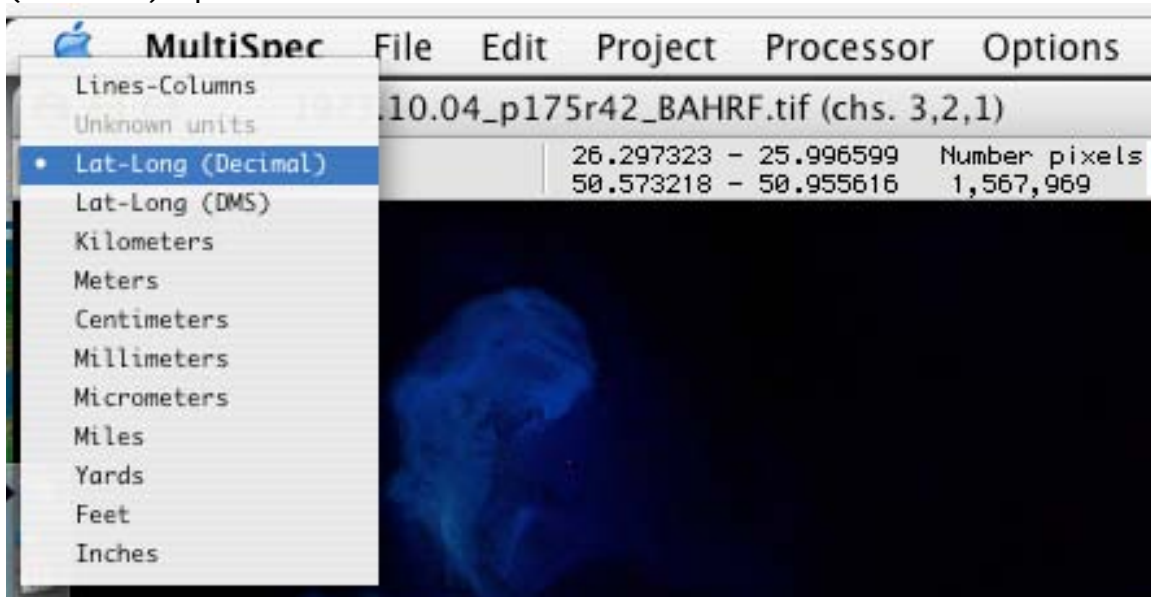
Subsetting: Change Detection Images Step 4: Open the B1 or blue band of the second scene and link the bands using the procedure outlined in *Linking Bands of Data* (above).

Subsetting: Change Detection Images Step 5: Once all of the bands are linked in the second scene, pull down the "Window" menu and select "Show Coordinate View."
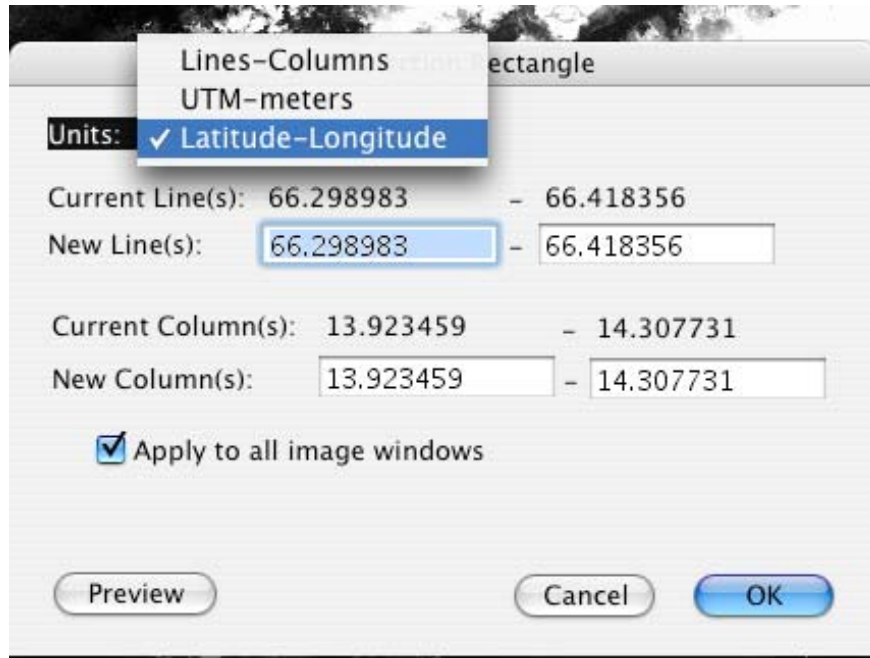

Subsetting: Change Detection Images Step 6: Open the subsetted image and select "Show Coordinate View."

Subsetting: Change Detection Images Step 7: In each image select the "Coordinate" pull down menu and select the Lat-Lon (Decimal) option.

Subsetting: Change Detection Images Step 8: Bring the subsetted image to the front.

Subsetting: Change Detection Images Step 9: Pull down the Edit menu and Select All to select the entire image. Go back to the Edit pull down menu, and select "Selection Rectangle." When the window pops up, click on the "Units" pull down menu, and change the units to Latitude-Longitude. Check the box labeled "apply to all image windows."

Follow the next steps for each image:

Subsetting: Change Detection Images Step 10: Pull down the "Processor" menu, and highlight "Reformat image." A box will appear; select "Change Image File Format."

Subsetting: Change Detection Images Step 11: In the "Image File Format Change Options" window find the "header" pull down menu, and select GeoTIFF format. (This option will only work if the Landsat data is originally a GeoTIFF. The GeoTIFF file format is ideal because the file header contains all of the geographic information.)

Subsetting: Change Detection Images Step 12: Click "OK". When the next box pops up, don't change the start and end lines and columns, but make sure the intervals are set at one. Click OK.

Subsetting: Change Detection Images Step 13: The next box to pop up is for you to name and save the multi-channeled image. Give the image a name such as "name of county" and the date the image was taken. End the file name with the file extension ".tif" An example would be "**Seattle_06_23_01.tif**" Make sure you are saving the image to the same file where you have all the previous images. Click "save".

Subsetting: Change Detection Images Step 14: Repeat the steps 10 through 12 for the second image.

Once each image is created, you are ready to study how the area has changed over time. To help with this procedure you can use the GLOBE Program's Change Detection protocol (http://www.globe.gov/tctg/land_prot_changedetect.pdf?sectionId=213) and tutorial (http://www.globe.unh.edu/MultiSpec©/Change/Change.html), NASA's Grow Smarter web site (http://growsmart.gsfc.nasa.gov) or the NASA Landsat Change Detection Website (http://landsat.gsfc.nasa.gov/change/)

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HELPFUL TIPS

File size

- To determine the amount of storage capacity required by Landsat data, use the following formula: multiple the number of lines by the number of columns by the number of bands you are using. for example, the GLOBE program's Landsat scenes are 512 X 512 pixels, and include only the first 5 Landsat bands of data. (This format was selected partly so that the image file would fit on a floppy disk.) The GLOBE program's Landsat file is 1.31 MB.(512 lines x 512 columns x 5 bands = 1,310,720 bytes or 1.31 MB) The area a 512 X 512 pixel image covers is 15.36 Km by 15.36 Km. Remember that each pixel is 30 meters by 30 meters.

- The largest area that will fit on a floppy disc if you are using all 7 bands of data is 430 X 430 pixels

- The area a 450 X 450 pixel image covers is 13.50 Km by 13.50 Km. If you want to make an image with a larger spatial extent be aware that these images will test both the CPU speed and RAM memory of your computer. A laptop computer with 192 RAM and a CPU speed of 466 loads full Landsat scenes very slowly and MultiSpec© has difficulty displaying these scenes at full resolution. A full Landsat scene has approximately 7,000 lines or rows by 8,000 columns of pixel data.