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Overview of OSSIM and ImageLinker

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Overview of OSSIM Filters

Overview of Open Source Software Image Map (OSSIM)

- Open source, written in C++ language
- Library to perform wide variety of remote sensing, image processing, GIS tasks.
- Ability to read in and process very large satellite images (6+ GB), shape files, DEMs, and much more.
- Highly accurate sensor models to determine precise lat/lon for image coordinates.
- Extendable, can create new detection/analysis algorithms.

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OSSIM Open Source Software Links

Open Source Software Image Map (OSSIM)

Download OSSIM: http://download.osgeo.org/ossim/

OSSIM Project website: http://www.ossim.org
OSSIM Wiki: http://trac.osgeo.org/ossim/
OSSIM Project tutorials: http://download.osgeo.org/ossim/tutorials/
OSSIM API Documentation: http://trac.osgeo.org/ossim/doxygen/
OSSIM Mailing list: https://lists.sourceforge.net/lists/listinfo/ossim-developer

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Basic OSSIM Filters and Operations

- 3x3 Convolution
- Band Averaging
- Band Merging
- Band Clipping
- Mosaic
- Brightness Match (mosaicing function)
- Band Select
- Band Math (Equation Combiner)
- FFT
- Grid PolyCutter
- MaskFilter (apply shape file to image)
- Histogram Remapper
- Histogram Threshold
- Gaussian Filtering
- Mean/Median Filtering
- Sharpening Filter
- Topographic Correction
- Color Conversions (HSI to RGB, etc)
- Pixel Flipper (assign source value to destination value)
- RIevel Filter (select resolution level)
- Image Scaling Filter
- Watermark Filter
- 1-D Convolution Filter

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OSSIM Plugins Provide Additional Functionality

- CFAR Detector (we will show you how to load this one)
- Additional Image Handlers (RS2, TSX, CEOS, Landsat, etc)
- Support for new image formats (JPEG2000, PNG, etc)
- All of these come in the plug-ins folder
- To compile some of these you'll need specialized libraries; for example, JPEG2000 requires the kakadu library which you need to buy ($$)

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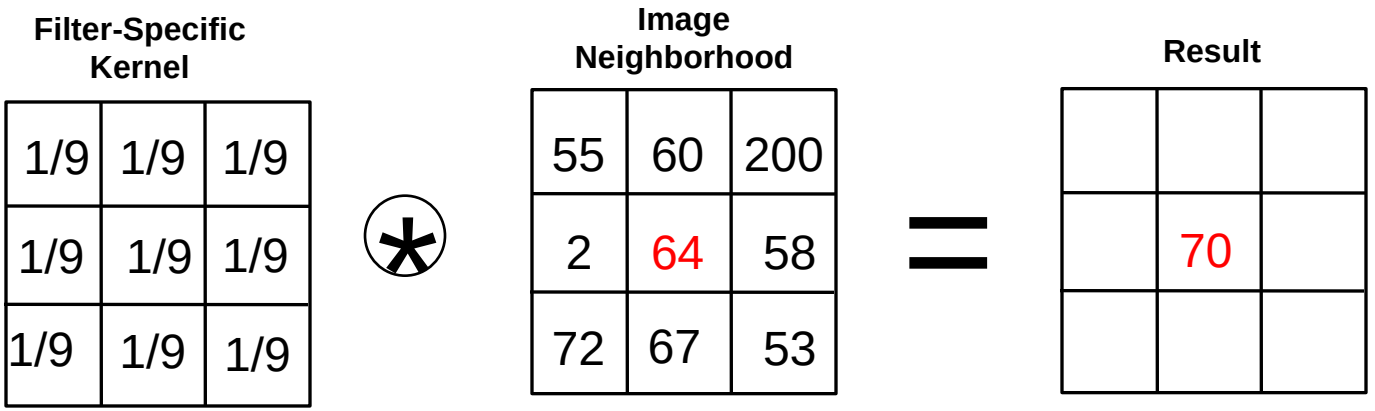
Noise Filtering Example

Image Filtering - Convolution

- Image filtering techniques can be used to help reduce noise in an image
  - Smoothing Filter (Mean Filter) – calculating the mean of a neighborhood of pixels



1/9 * (55+60+200+2+64+58+72+67+53) = 70

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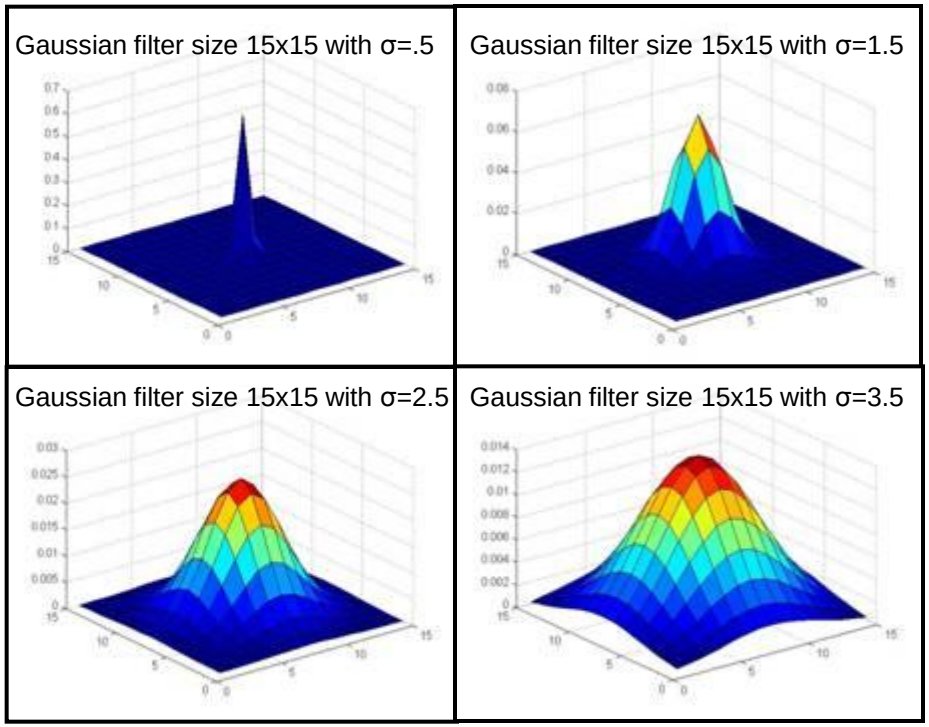
Noise Filtering Overview - Types

- Several approaches for noise filtering
  - Mean filtering – linear filter, with kernel, where the new value at every pixel is the mean of the pixels in it's 3x3 neighborhood (blurs and removes high noise)
  - Median filtering – non-linear, no kernel, similar to mean filtering using the median of the pixel values (gets rid of salt and pepper noise)
  - Gaussian filtering – 3x3 convolution filter where the kernel is a 2D Gaussian function. Has the effect of smoothing the image.

$$h(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$



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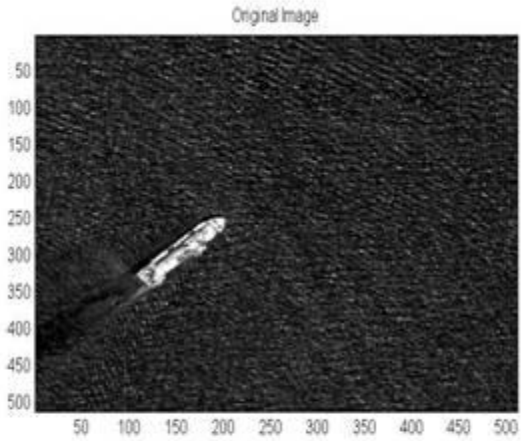
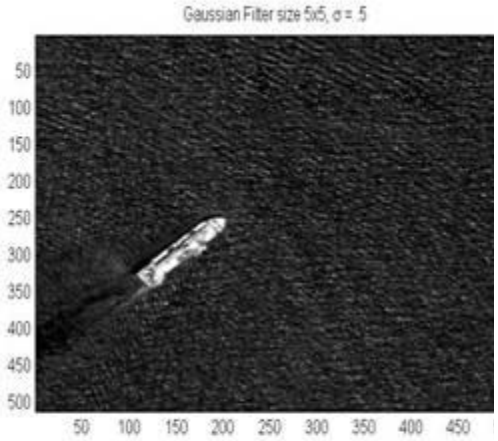
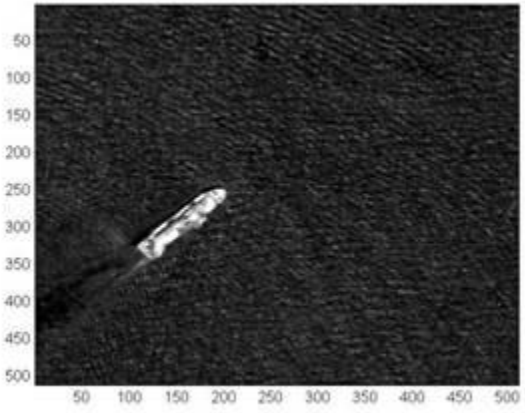
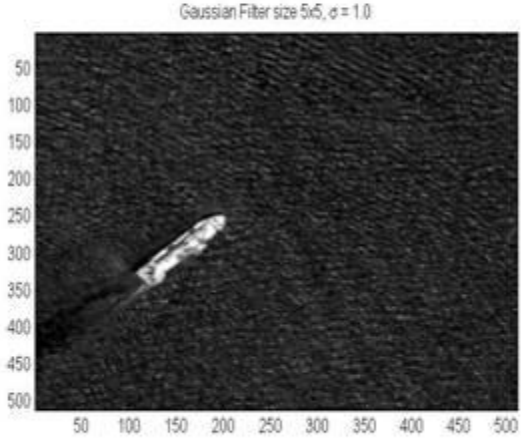
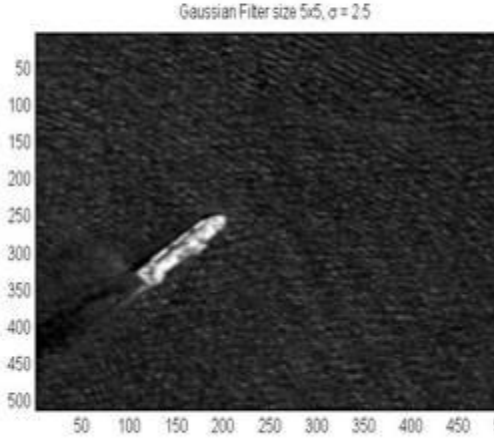
Noise Filtering Overview - Gaussian

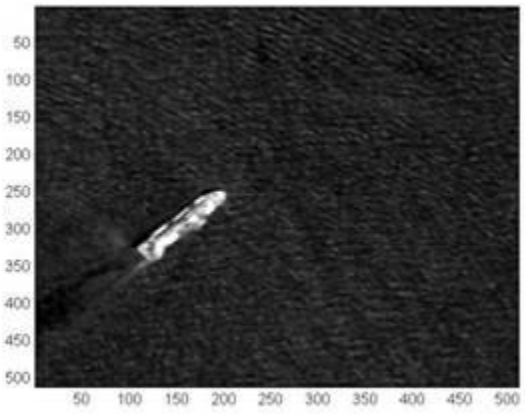












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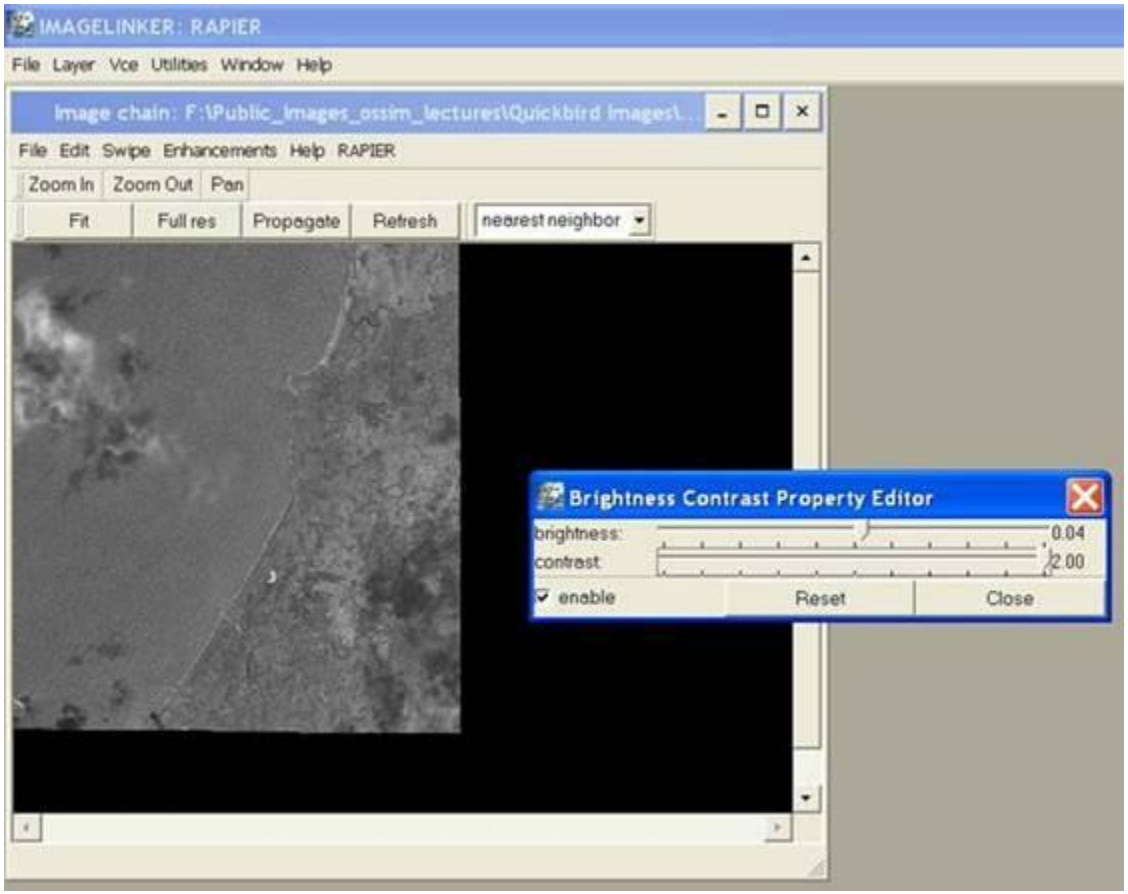
Noise Filtering Example

- File → Open
  - ..\02_ImageLinker\Images\2.1.11_pan_imagen1.tif

- On the Image menu, choose Enhancements ->Brightness Contrast.
- Adjust the contrast to 2.0 and brightness to .04.



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Noise Filtering Example (cont)

- Pan around the image and zoom in. What do you notice about the texture of the ocean? Is it smooth or rough?
- Now, we will apply several smoothing filters to the image and observe the effects.

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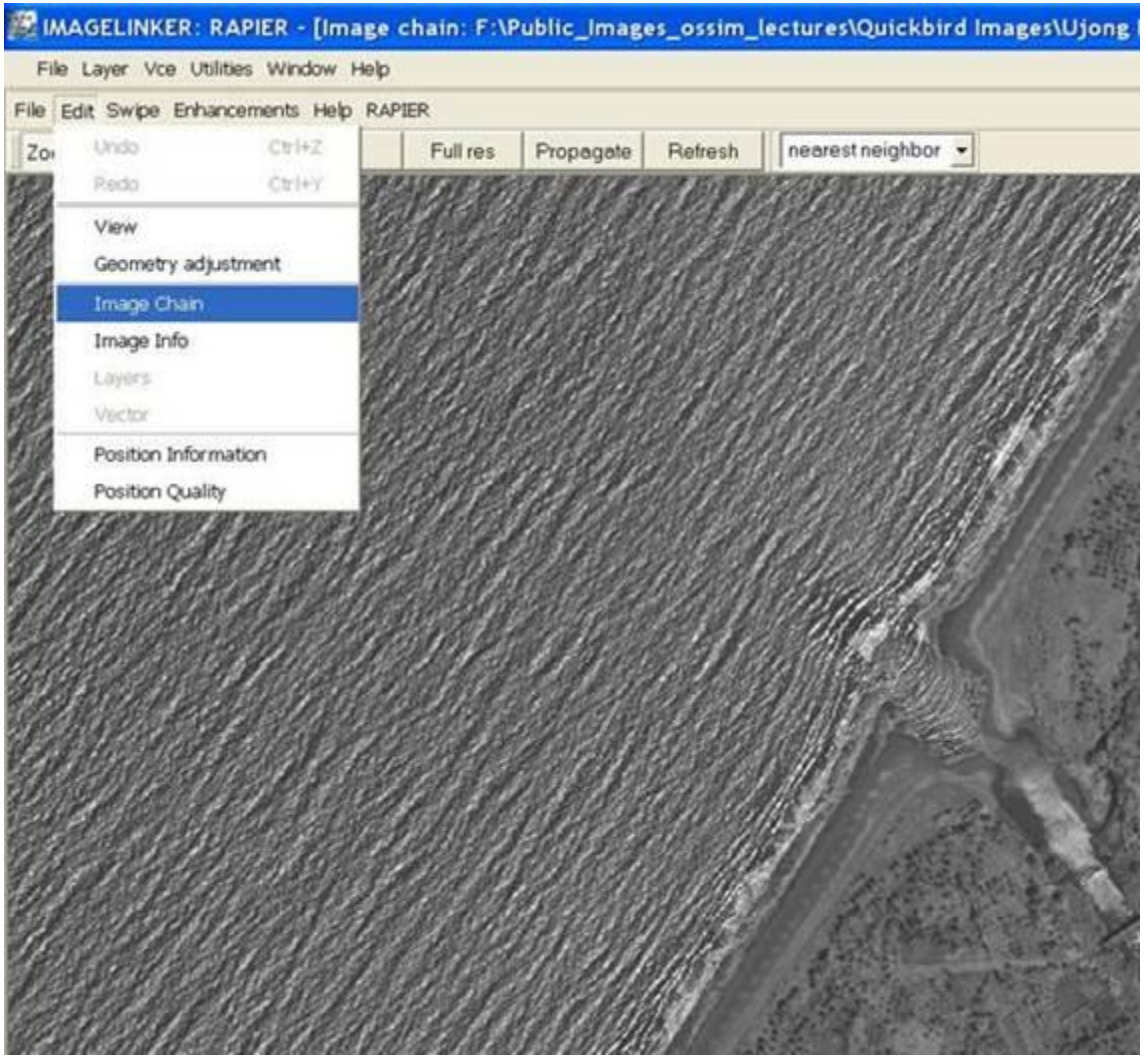
Noise Filtering Example (cont)

- From the image menu, select Edit->Image Chain



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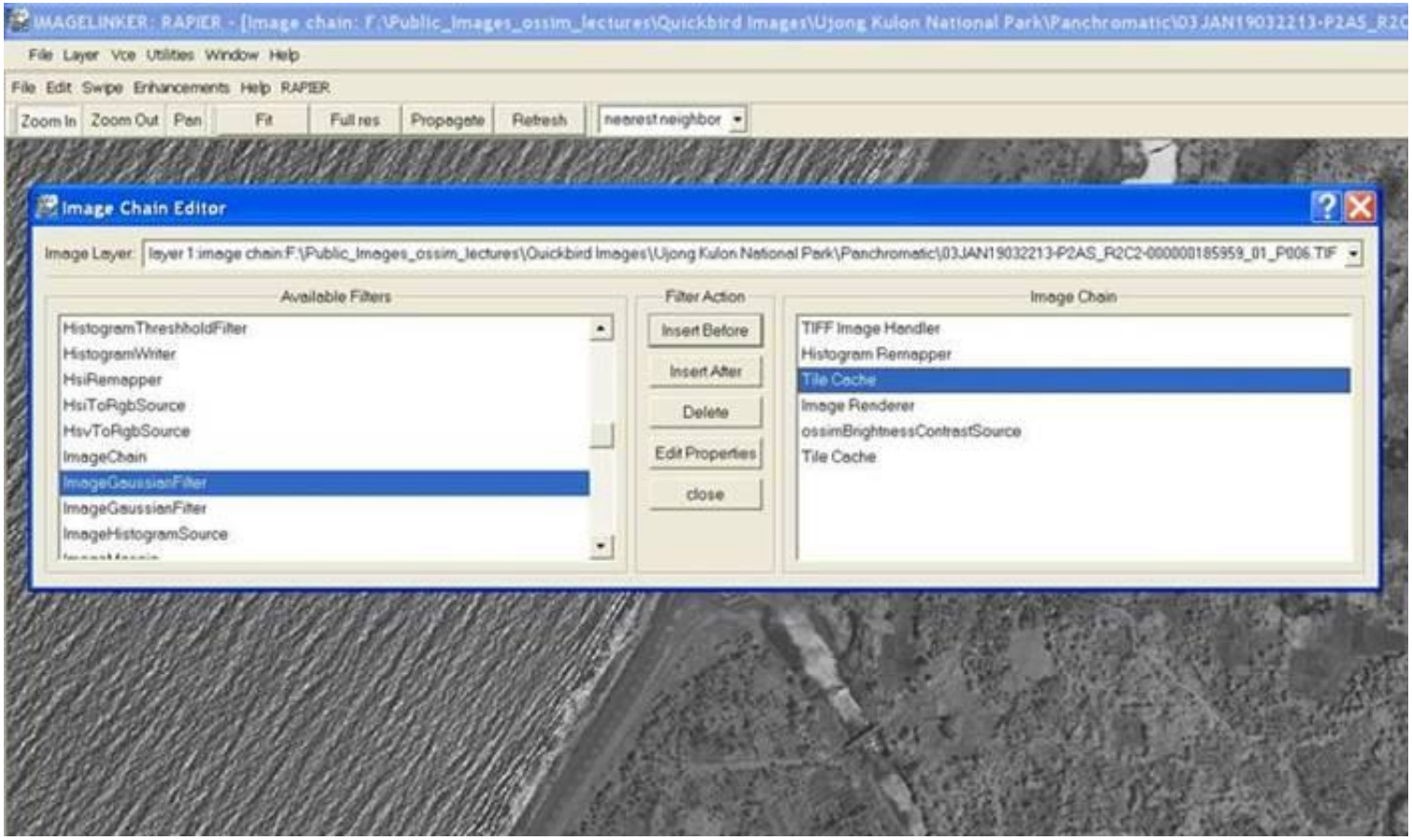
Noise Filtering Example (cont)

- On the left, under Available Filters, scroll down to the ImageGaussianFilter and select it.
- On the right, select the first occurrence of Tile Cache (the top one).
- Now, hit the Insert After button.



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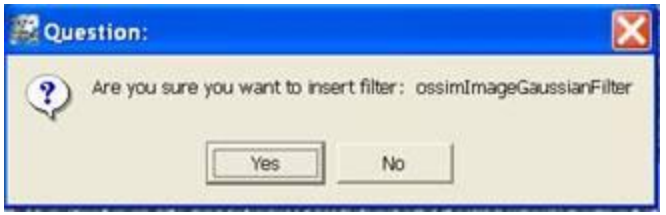
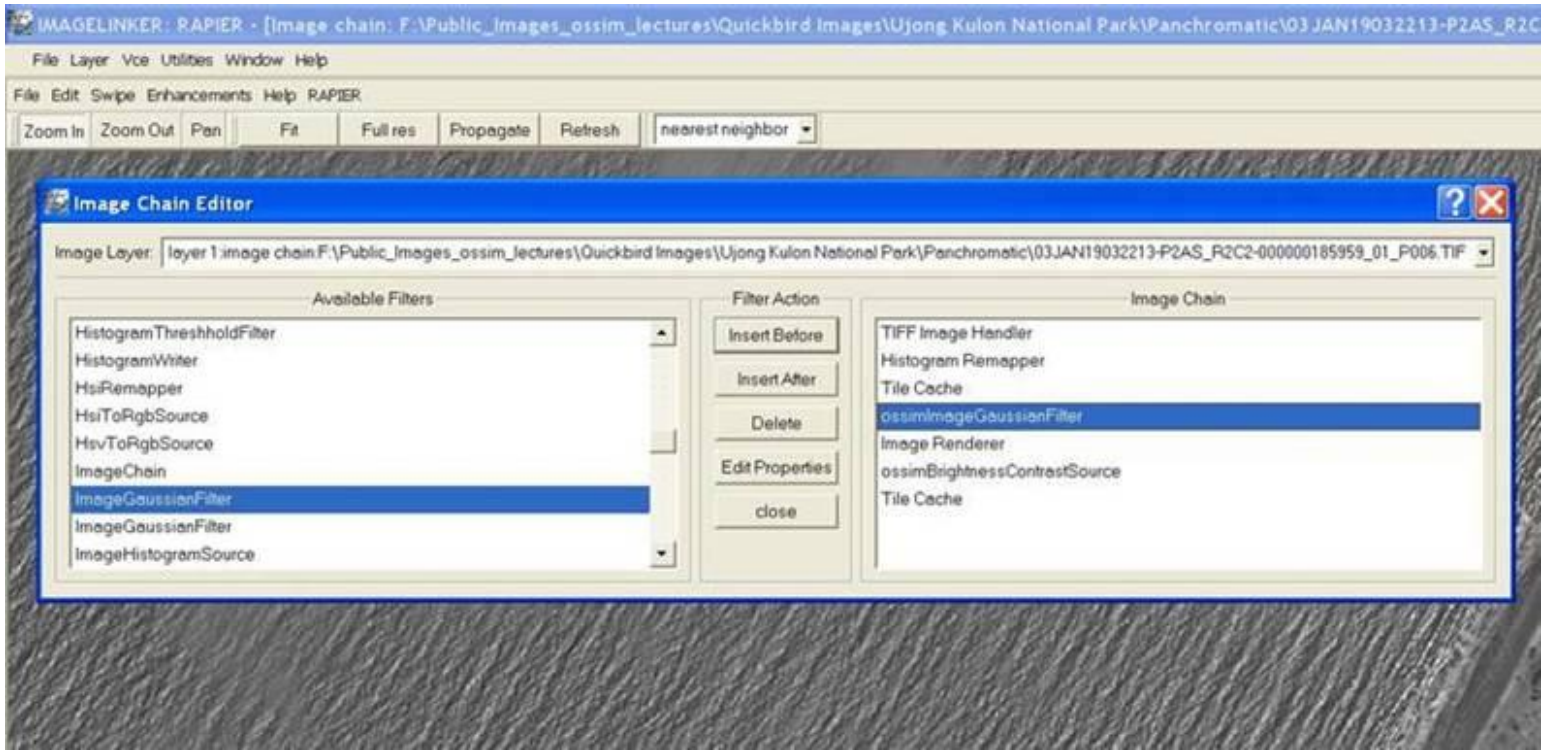
Noise Filtering Example (cont)

- You'll see the message, "Are you sure you want to insert filter : ossimImageGaussianFilter."
  - Select *Yes*



- You should now see the filter on the right hand side, and the image should change slightly.



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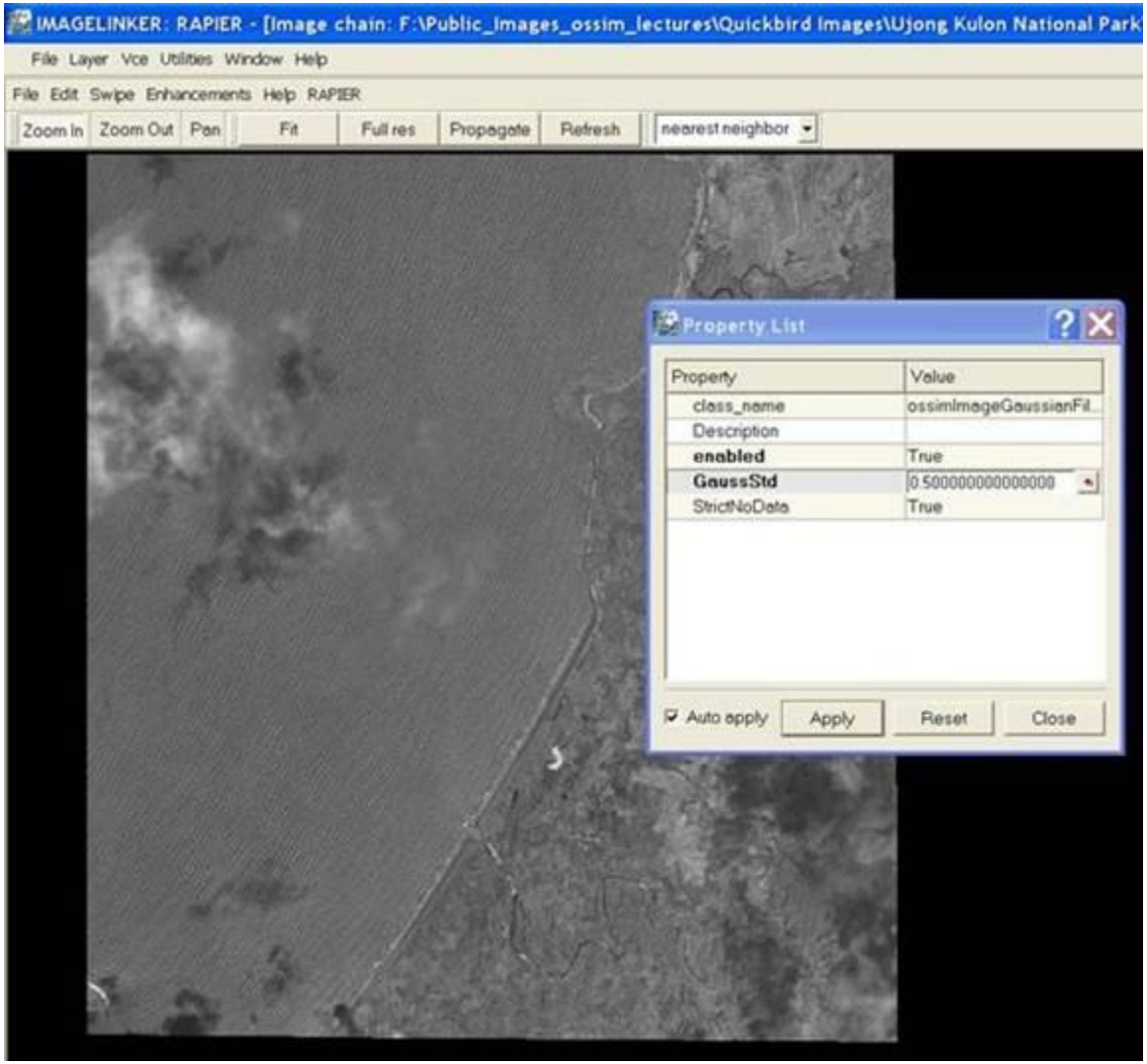
Noise Filtering Example (cont)

- Hit the Full res button then the Fit button to zoom out to the entire image.
- Select the ossimImageGaussianFilter and then hit Edit Properties.
- You'll see the Gaussian Std value is set to 0.5 by default.
- Close the Image Chain Editor (larger window)



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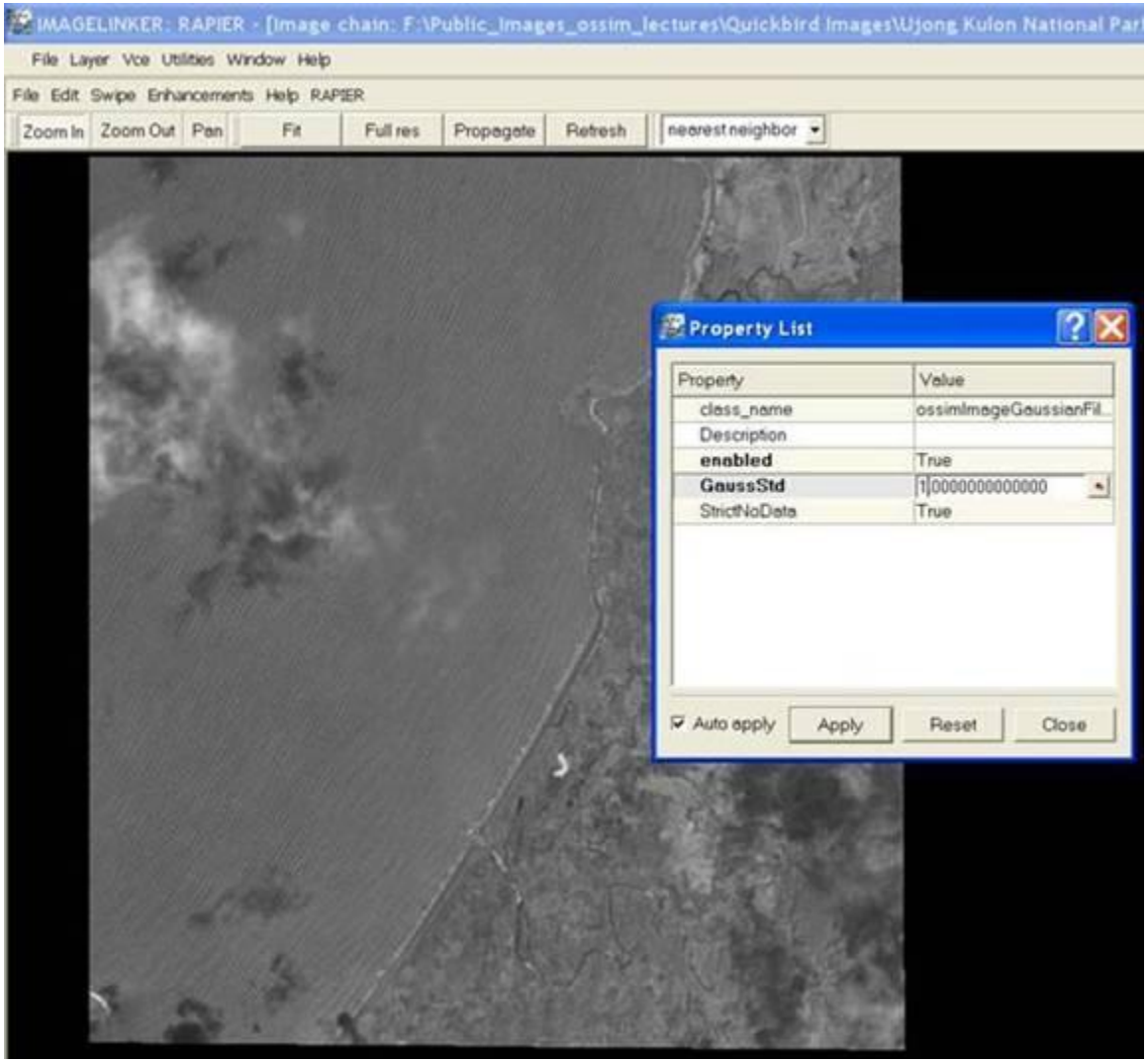
Noise Filtering Example (cont)

- Now change the std value to be 1 (press RETURN after entering to get the change to take place).
  - Notice the effect this has on the image



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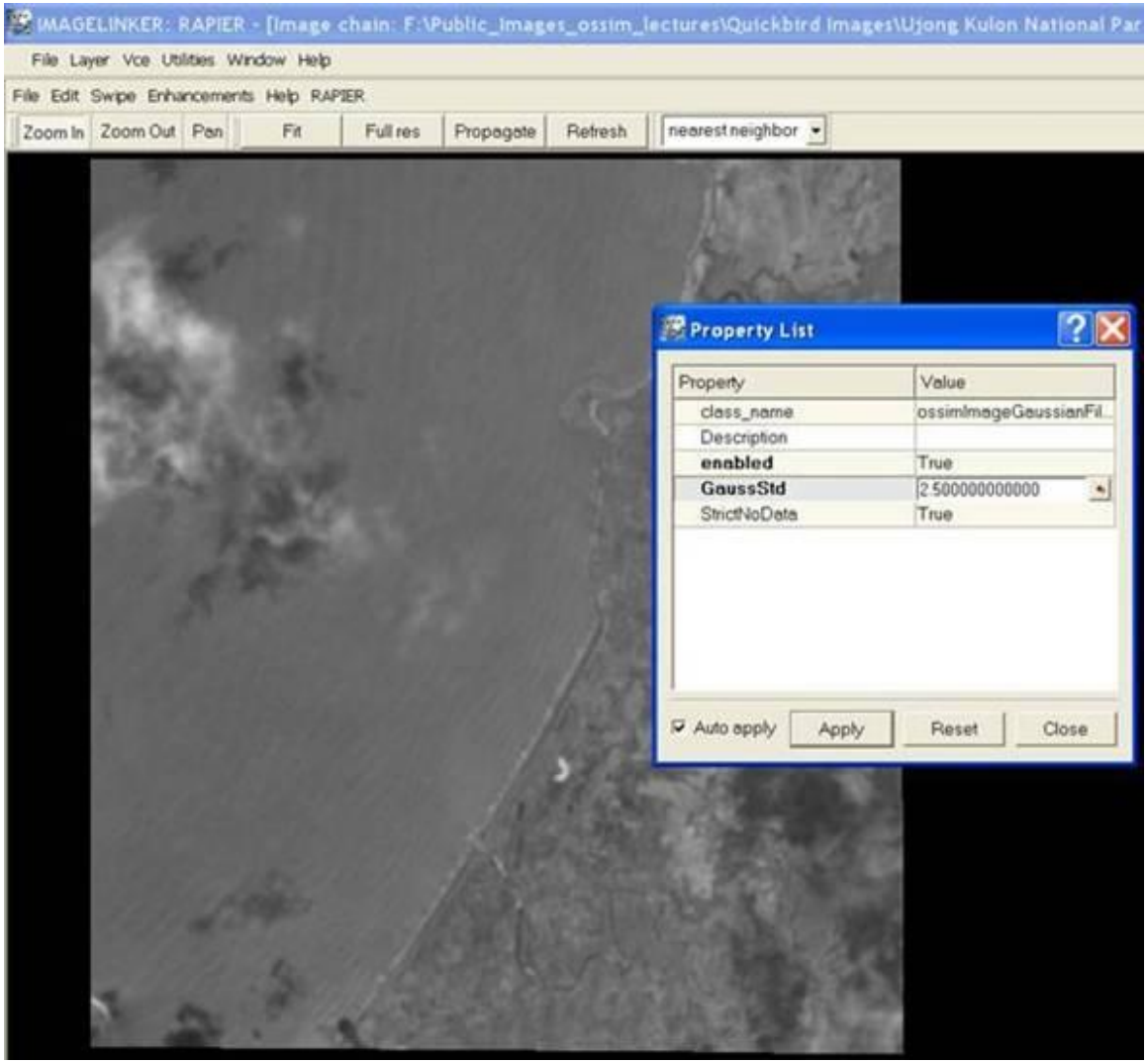
Noise Filtering Example (cont)

- Now change the std value to 2.5 (press RETURN).



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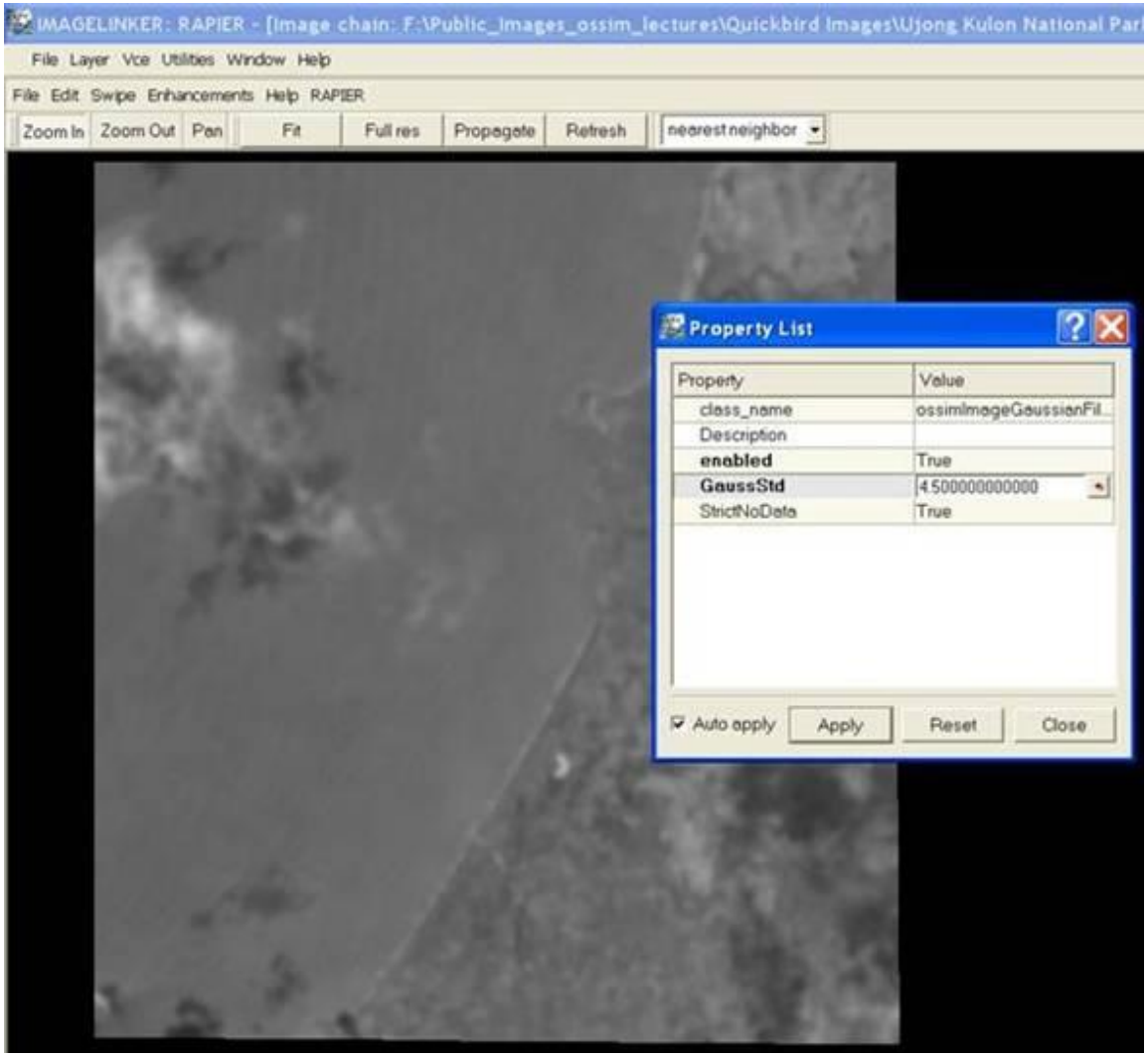
Noise Filtering Example (cont)

- Finally, change the value to 4.5 (press RETURN).
- Zoom in on the water region of the image, notice the effect on the ripples/noise.



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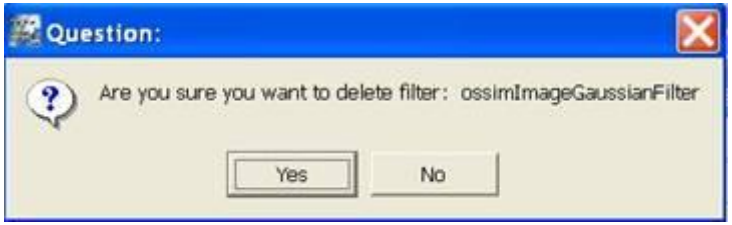
Noise Filtering Example: Median/Mean Filtering

- Open the image chain again by selecting Edit->Image chain.
- On the right hand side, select the ossimImageGaussianFilter and hit delete.
  - You'll see the message, "Are you sure you want to delete filter: ossimImageGaussianFilter. Select *Yes*



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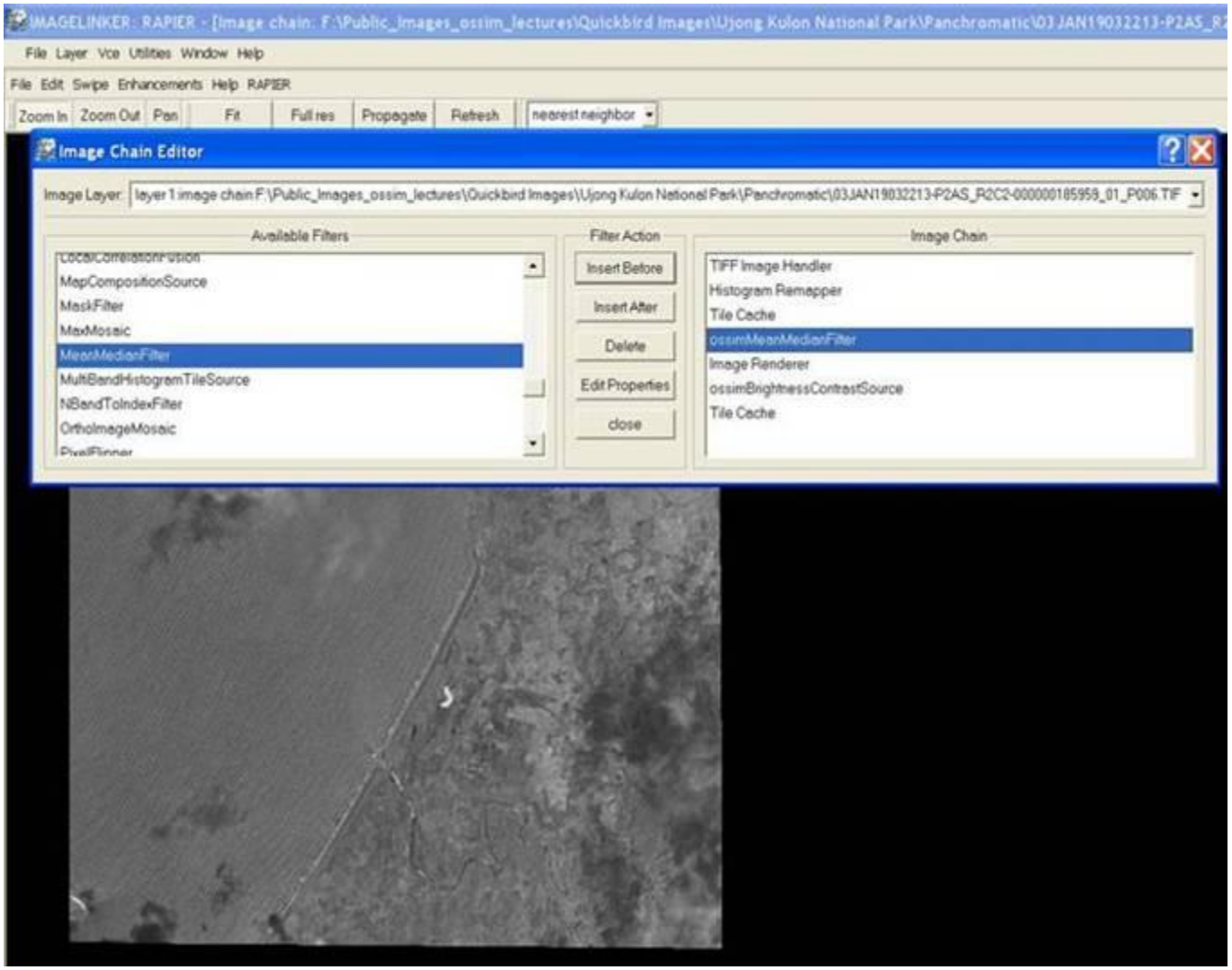
Noise Filtering Example: Median/Mean Filtering

- Now, scroll down to MeanMedianFilter.
- Select Tile Cache (the top one) on the right and choose Insert After.
- You should see the filter on the right



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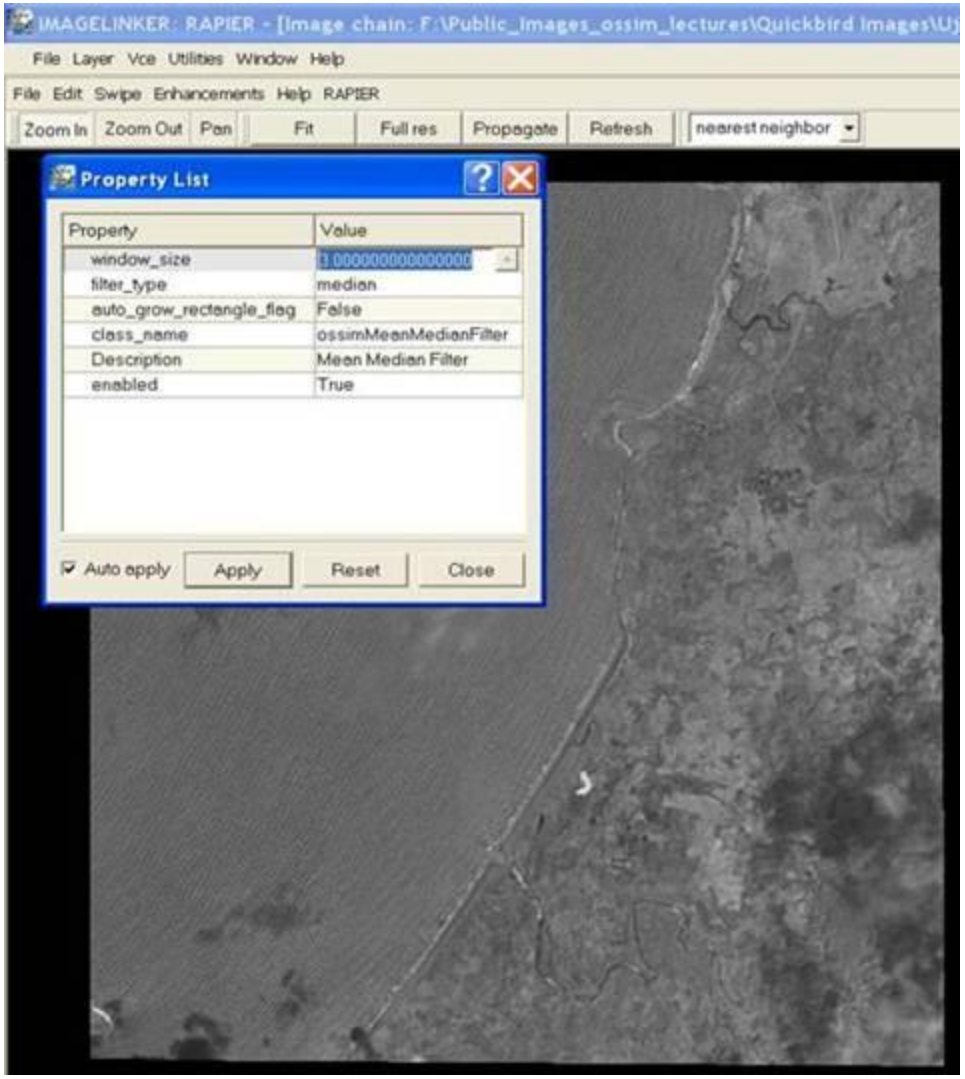
Noise Filtering Example: Median/Mean Filtering

- Highlight the ossimMeanMedianFilter, and select Edit Properties.
- Close the Image Chain Editor.
- You should see several properties:
  - Window_size – size of window for which mean or median is found
  - Filter_type – mean or median, with different variations on how to handle image data
  - auto_grow_rectangle_flag – flag to grow regions



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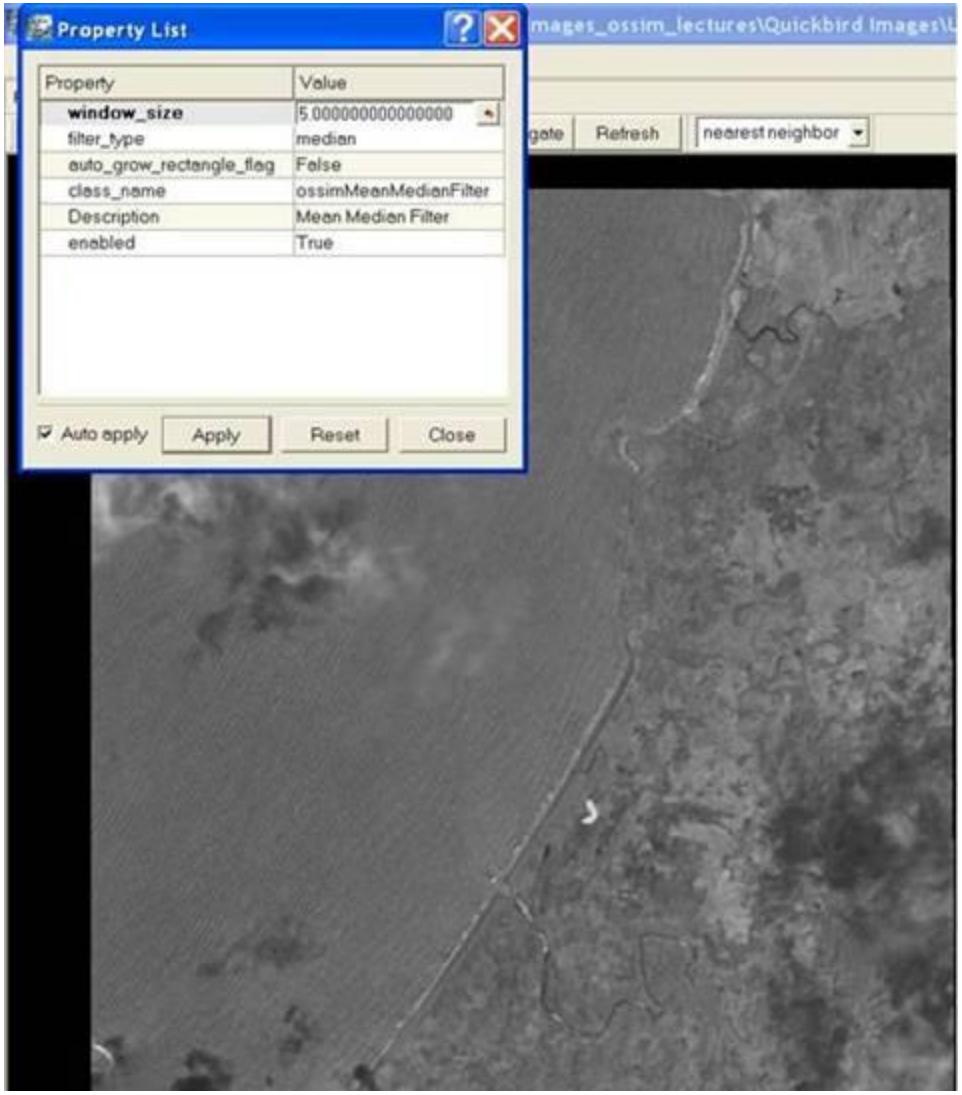
Noise Filtering Example: Median/Mean Filtering

- Change the window_size to 5.0 (and press RETURN) and observe the effect

- What similarities and differences does this method for smoothing have with the GaussianFilter?



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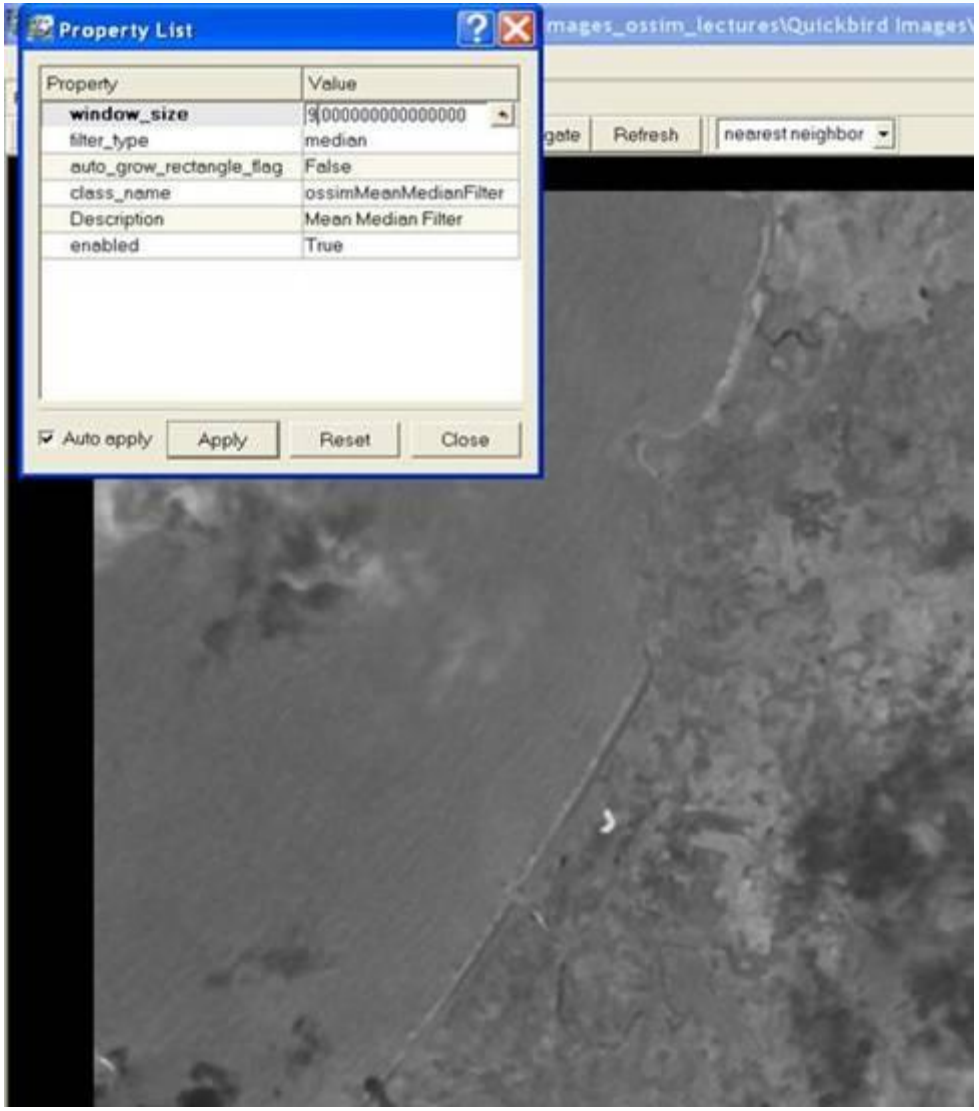
Noise Filtering Example: Median/Mean Filtering

- Change the window_size to 9.0 and observe the effect
- Change the window_size and the filter type between Median and Mean, and note the effect on the image



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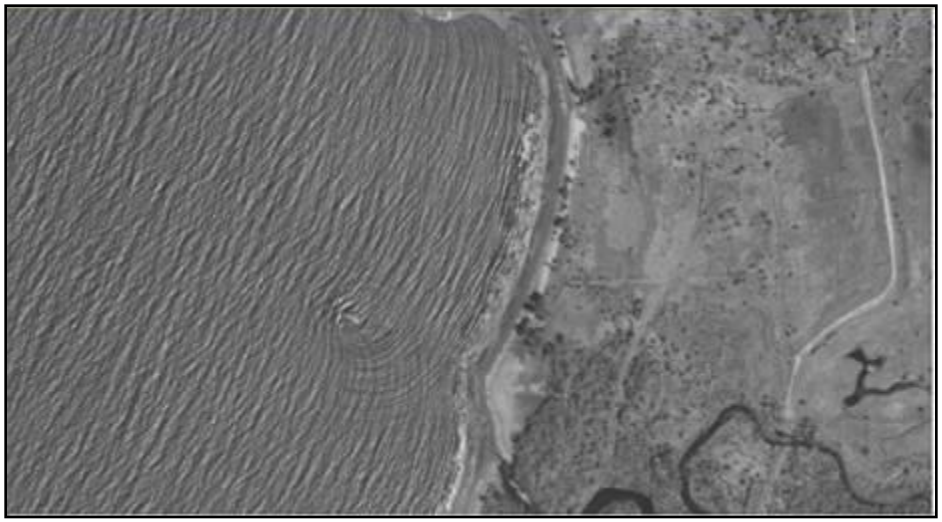
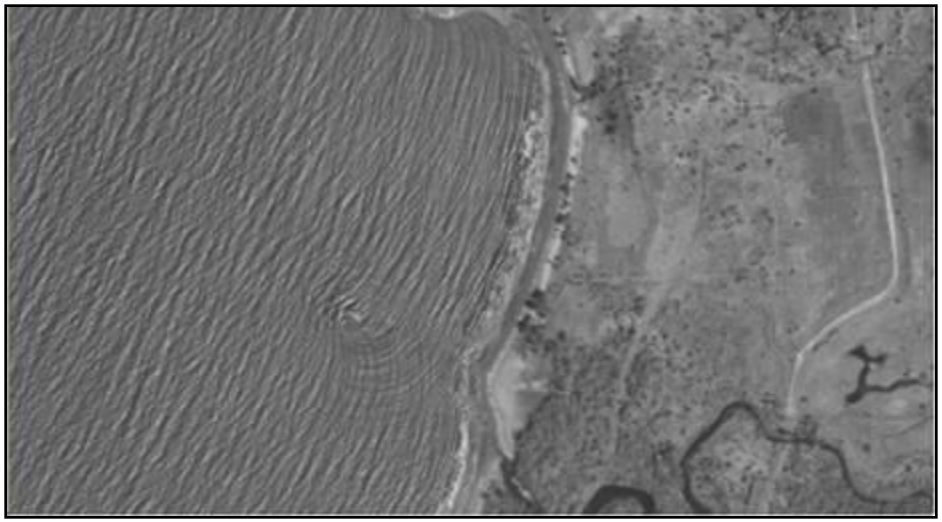
Comparison of Various Smoothing Methods

3x3 Mean



Gaussian Filter std 1.5



3x3 Median

Gaussian Filter std 1.5

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Image Sharpening

Image Sharpening Techniques

Step 1: Convolve the Laplacian kernel with the image.

Original Image

$$*$$

-1	-1	-1
-1	8	-1
-1	-1	-1

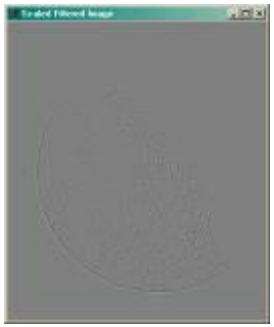
Laplacian Kernel

$$=$$

Filtered Image

Image Sharpening Techniques (cont.)

Step 2: Rescale the filtered image to be between 0 and 255 (for an 8 bit image).



Step 3: Add the rescale filtered image to the original image, and rescale results again.

Original Image

Sharpened Image

Image Sharpening Example

- Open the image ..\02_ImageLinker\images\ILexample\L71189056_05620021230_HRF.fst

- Image Sharpening Filters are used to enhance the edges of blurry images.

- Often times used in low resolution imagery to visualize details.

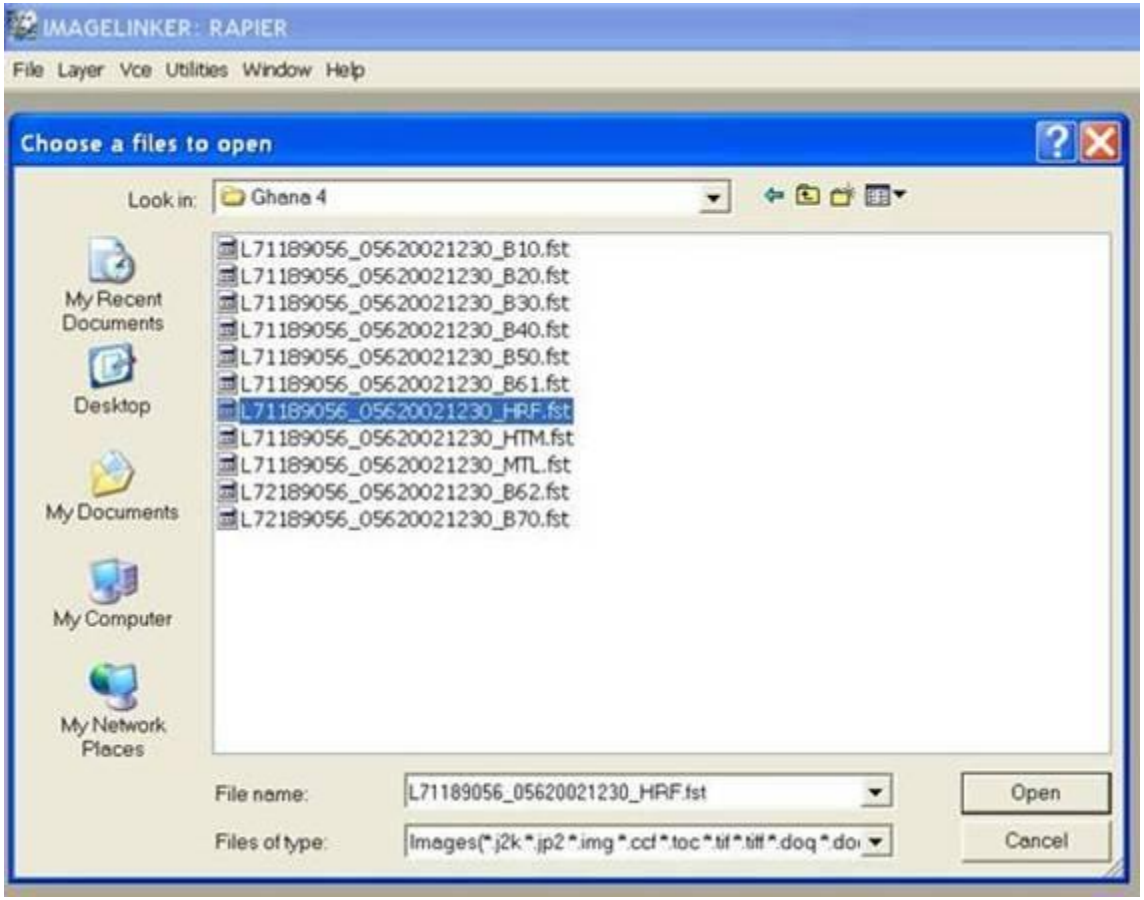


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Image Sharpening Example

- Choose Enhancements->Band selection

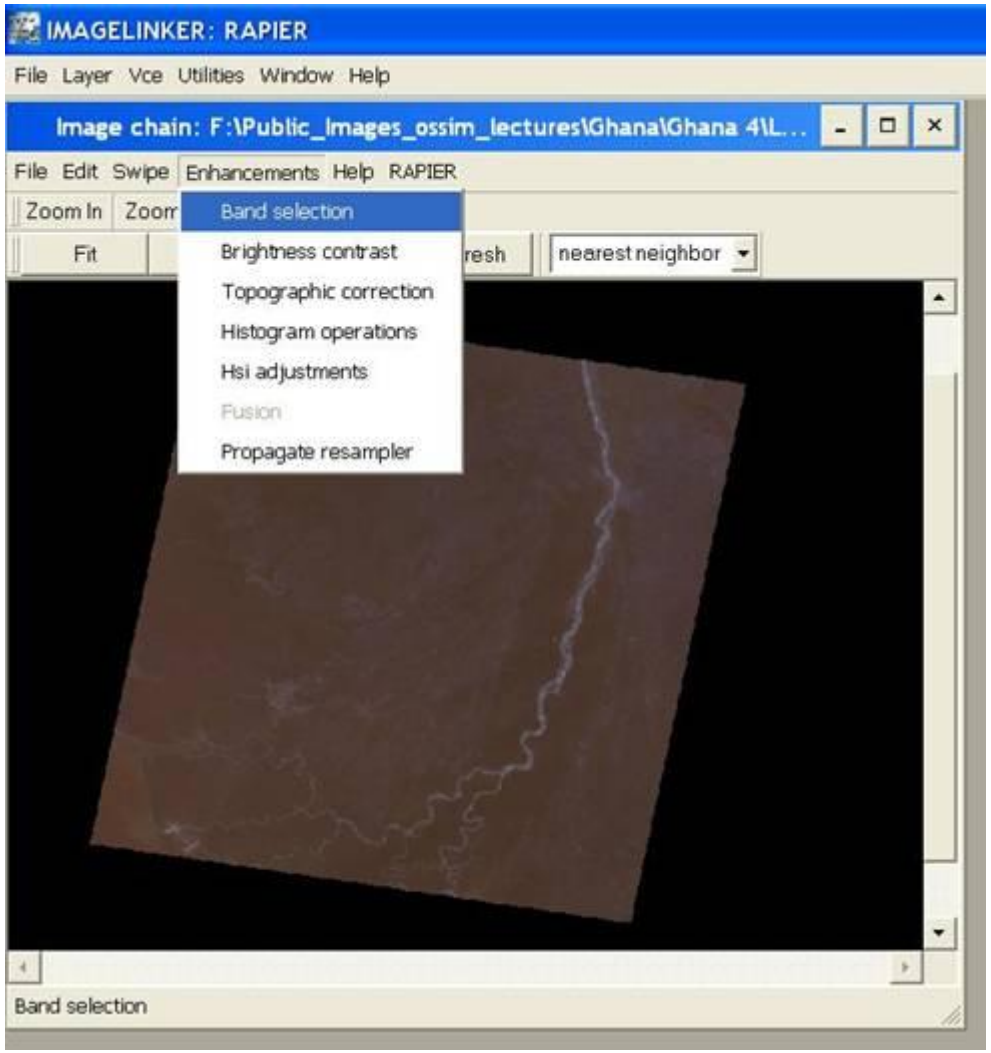

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Image Sharpening Example

- Click the True bubble.
- Select bands 6, 5, 4 and hit apply.

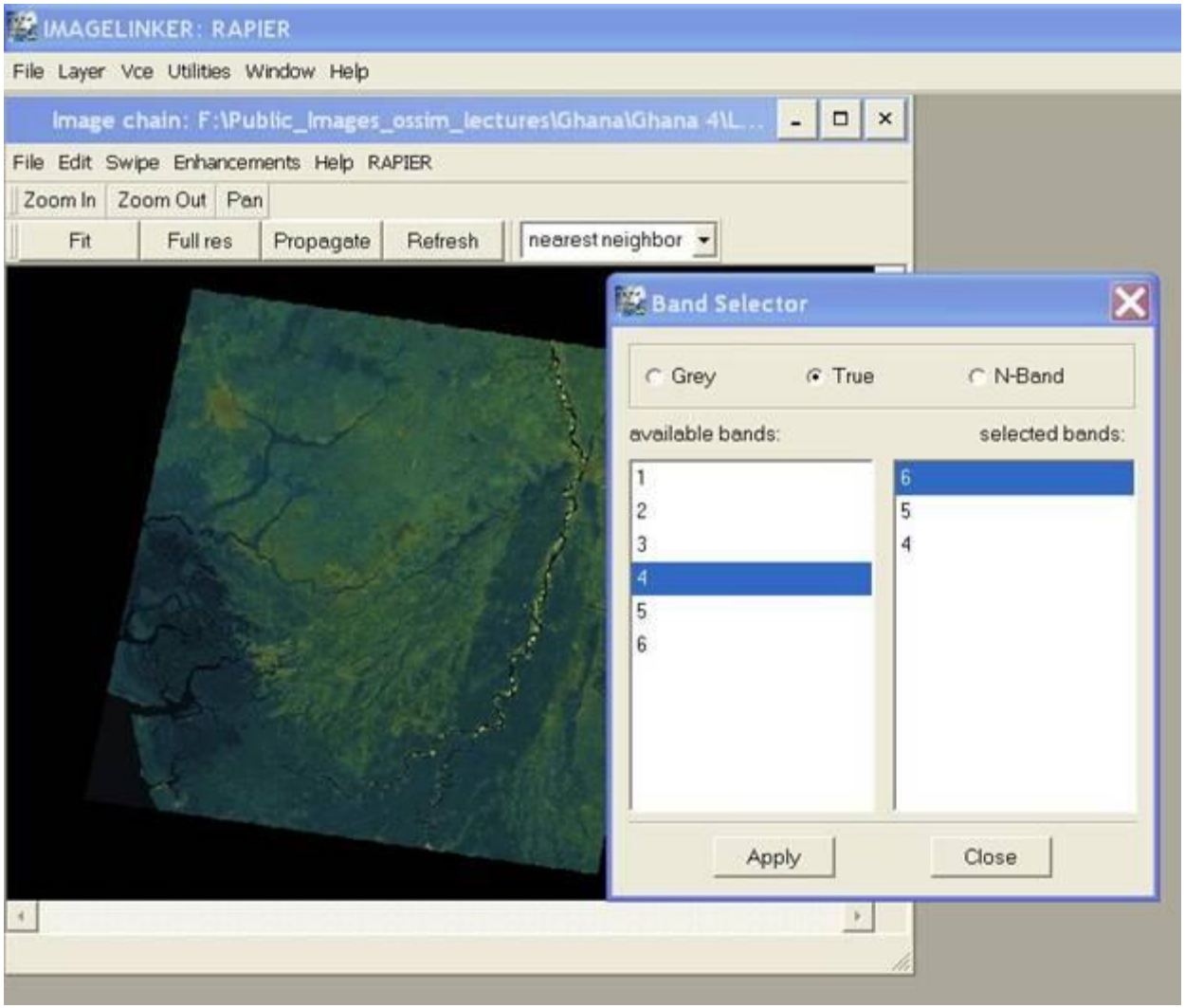

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Image Sharpening Example

- Open the image chain.
- On the left, scroll down to ImageSharpenFilter.
- On the right, select Landsat.
- Click Insert After to insert the sharpen filter.

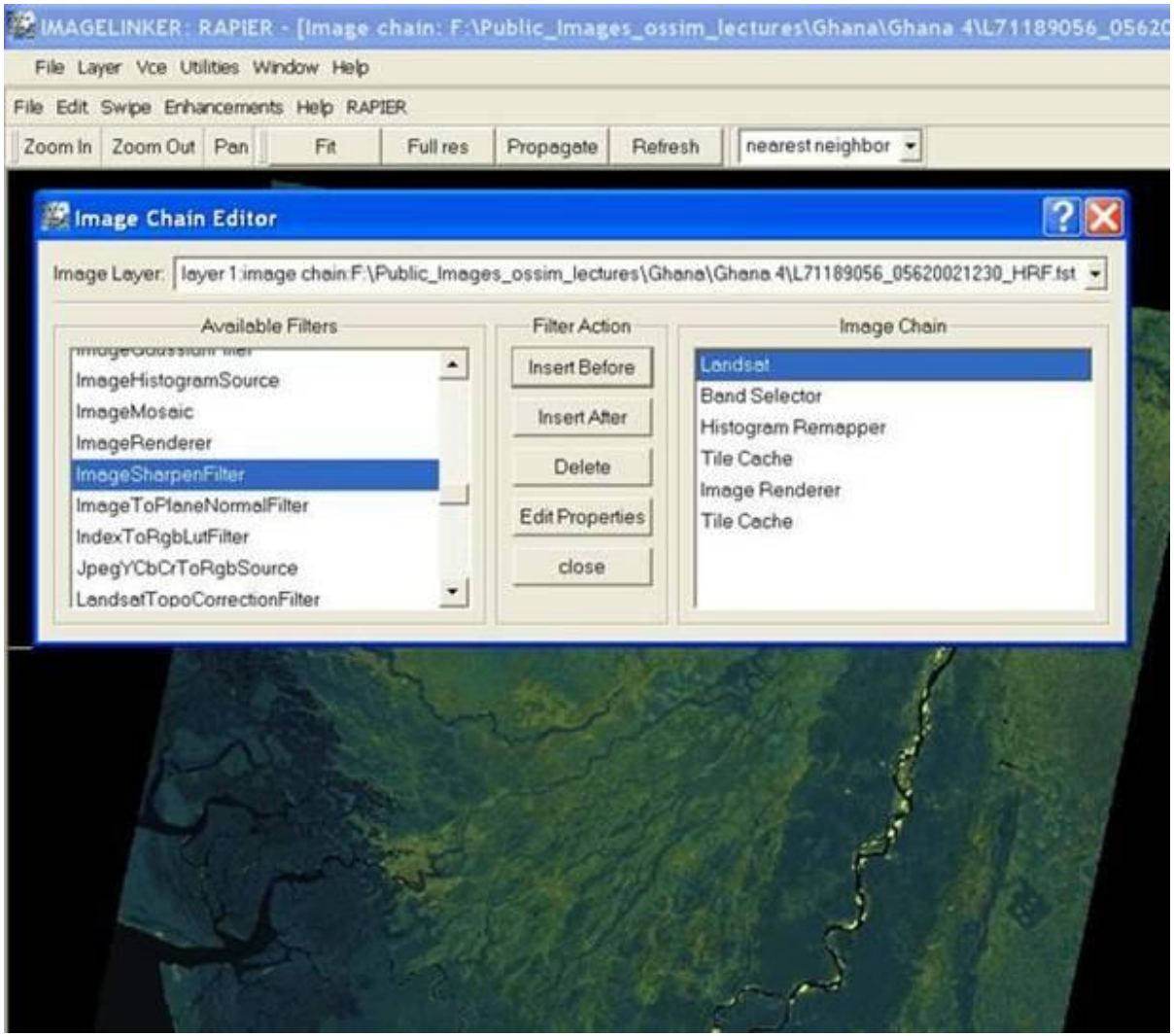

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Image Sharpening Example

- The image should appear sharper.
- Click on the Edit Properties button for the Sharpen filter.
- Close the image chain editor.
- Zoom in and pan around. Enable and disable the sharpen filter and observe the result

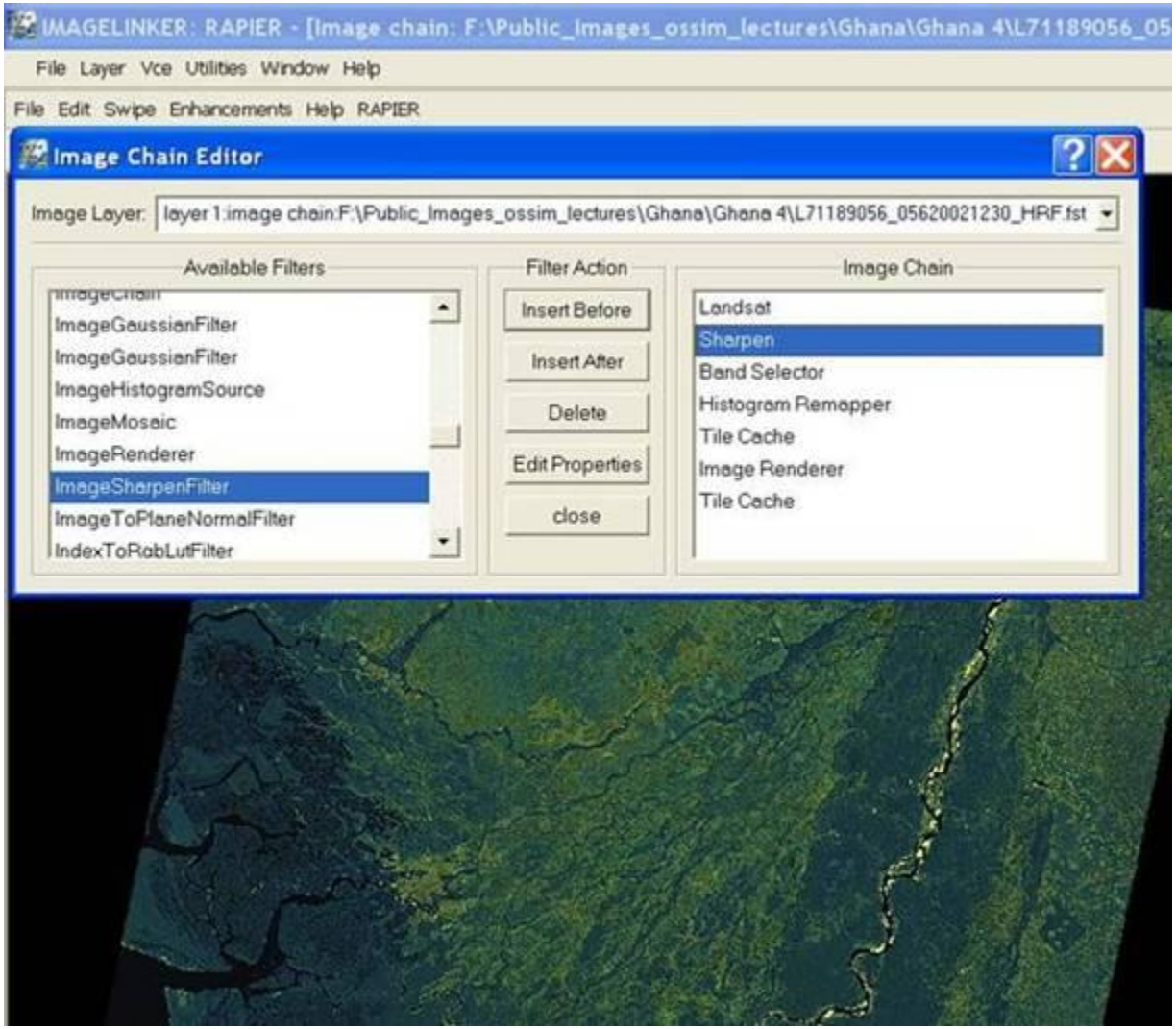

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Image Sharpening Example

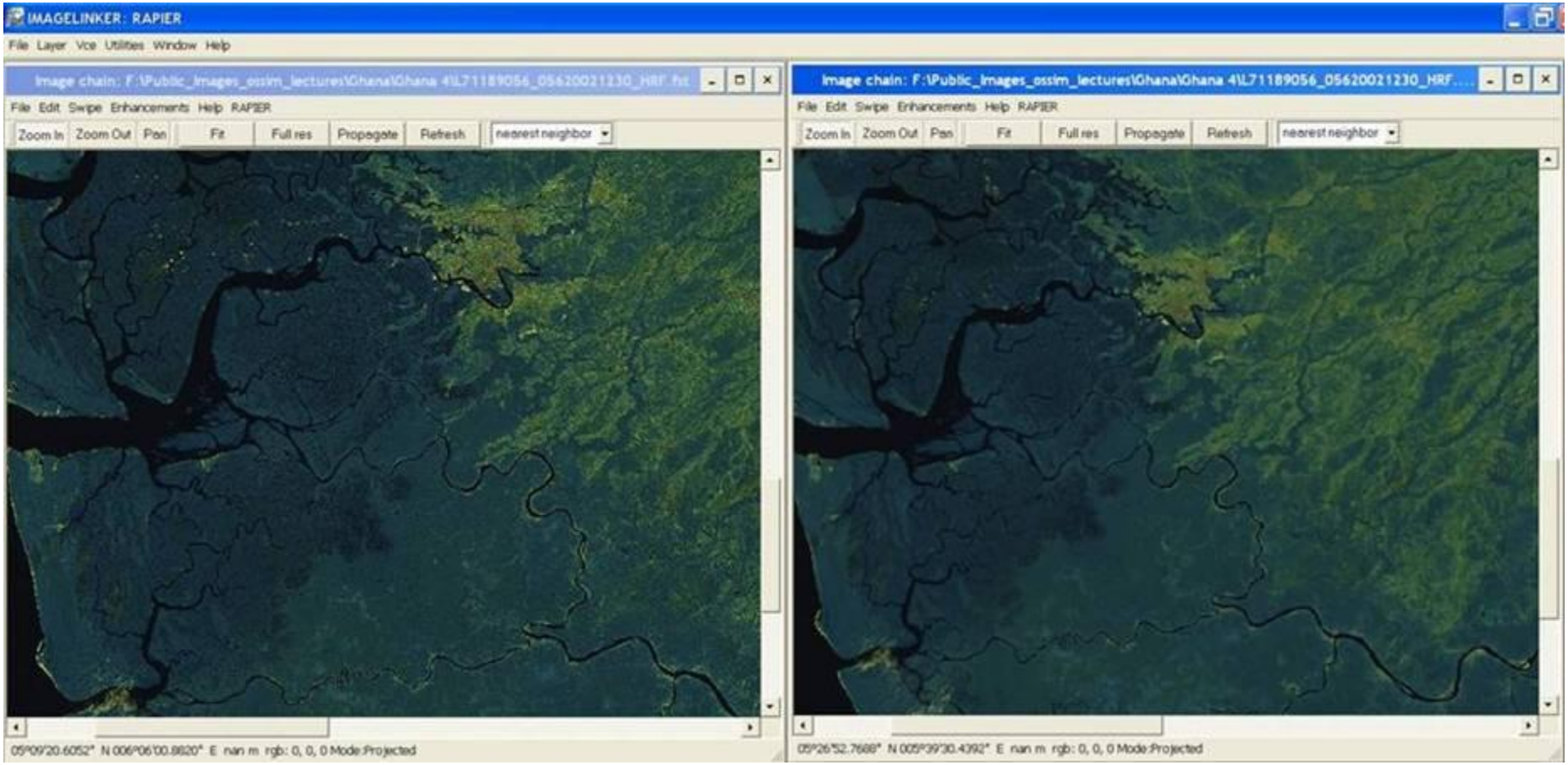

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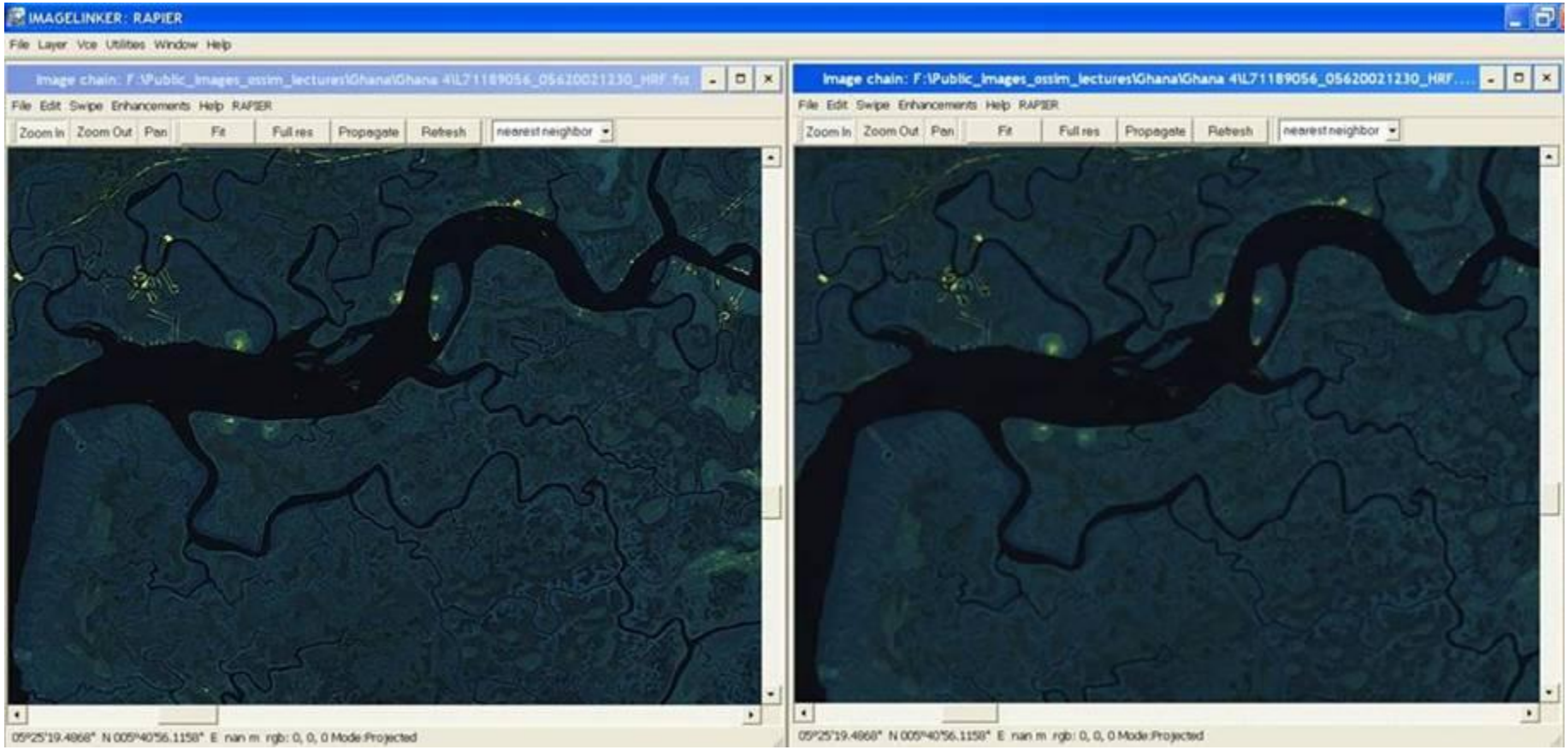
Image Sharpening Example



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Edge Detection

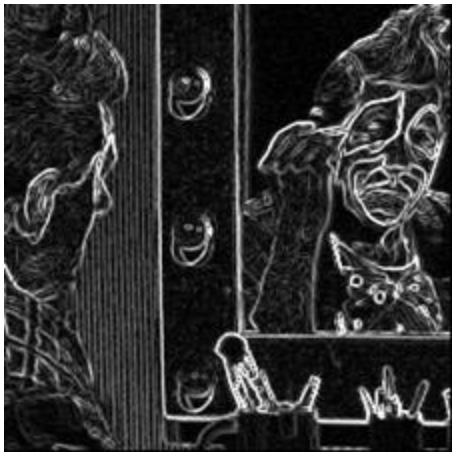
Edge Detection Overview

- Identifies sharp changes in image brightness
- Gradient operators are used to compute the brightness discontinuity in the image
- Thresholding the gradient image will produce an edge image
- Examples: Canny, Sobel, Roberts Cross

Original Image

Canny

Sobel



Roberts Cross

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Canny Edge Detection

Step 1: Smooth Image

Remove noise by smoothing the image using a Gaussian kernel.

$\frac{1}{115}$

2	4	5	4	2
4	9	12	9	4
5	12	15	12	5
4	9	12	9	4
2	4	5	4	2

Discrete approximation to Gaussian function with σ=1.4

$$h(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

Step 2: Compute Edge Strength

-1	0	+1
-2	0	+2
-1	0	+1

Gx

+1	+2	+1
0	0	0
-1	-2	-1

Gy

The magnitude (edge strength) of the gradient is computed using the formula:

$$|G| = |Gx| + |Gy|$$

Canny Edge Detection (continued)

Step 3: Compute the edge direction

$$\Theta = \tan^{-1}(Gy / Gx)$$

Step 4: Group the edge direction to one of the four angles

0 degree
45 degree
90 degree
135 degree

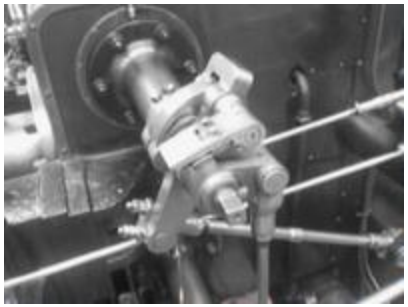
Step 5 : Apply Non-maximum suppression.

Trace along the edge and set pixel values to zero that is not considered an edge. The output edge image will appear as a thin line.

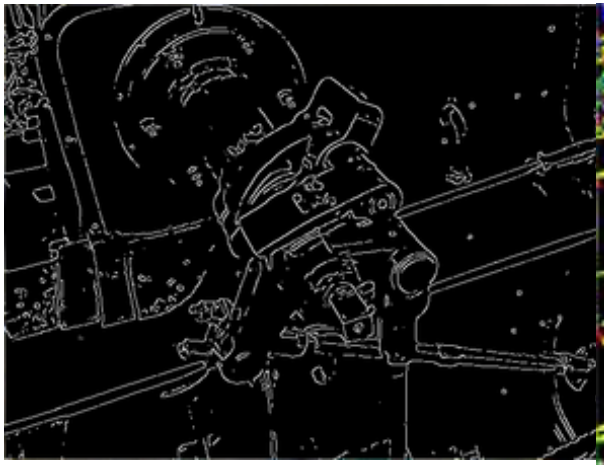
Step 6: Eliminate streaking using hysteresis thresholding.

Hysteresis uses two threshold values, T1 and T2. Any pixel greater than T1 is considered an edge pixel. Any pixels connected to the edge pixel and greater than T2 are set as final edge pixels.

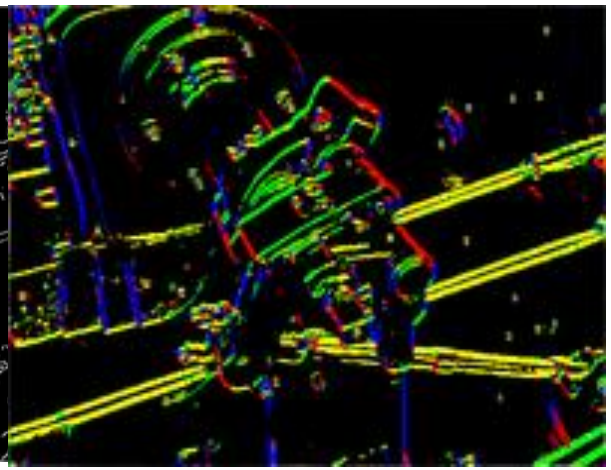
Canny Edge Detection: Edge Map



Original Image



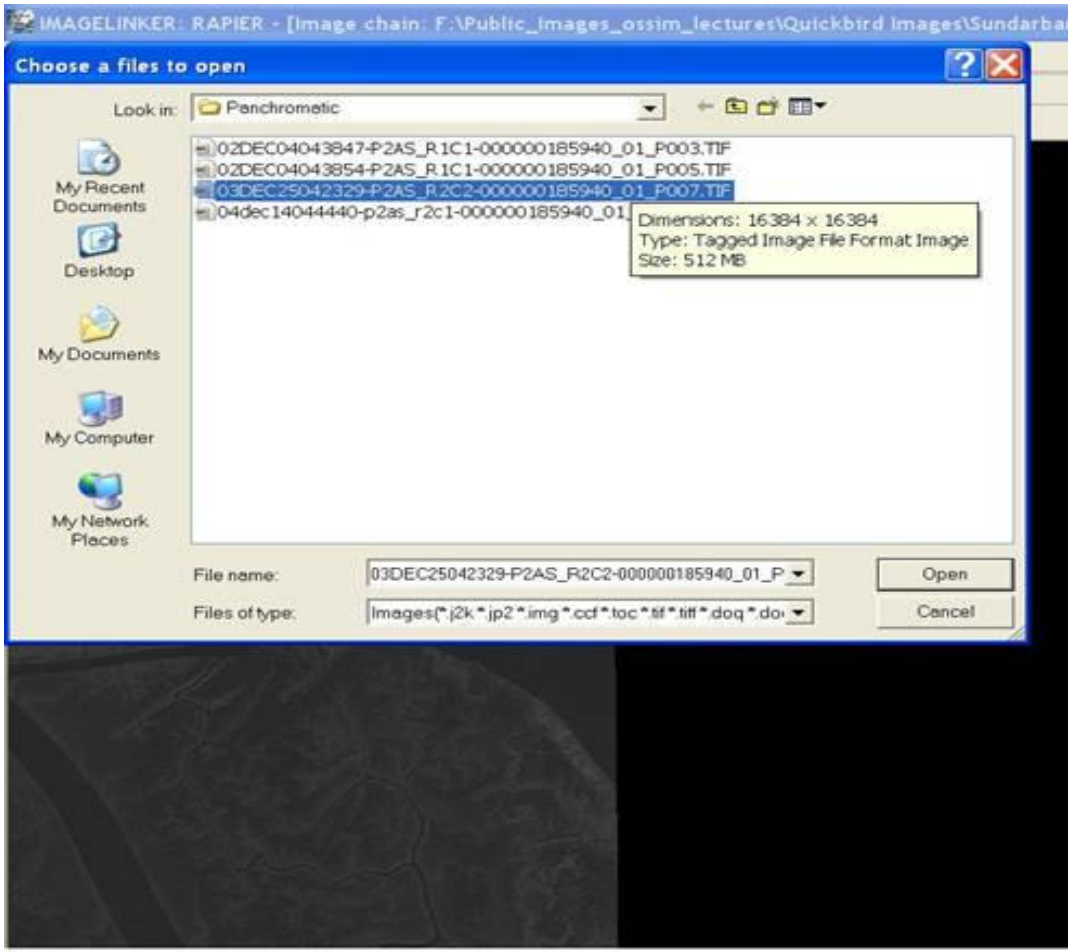
Edge Detected Image



Edge Map (Each Edge Direction is a Different Color)

Edge Detection for Mapping River Systems

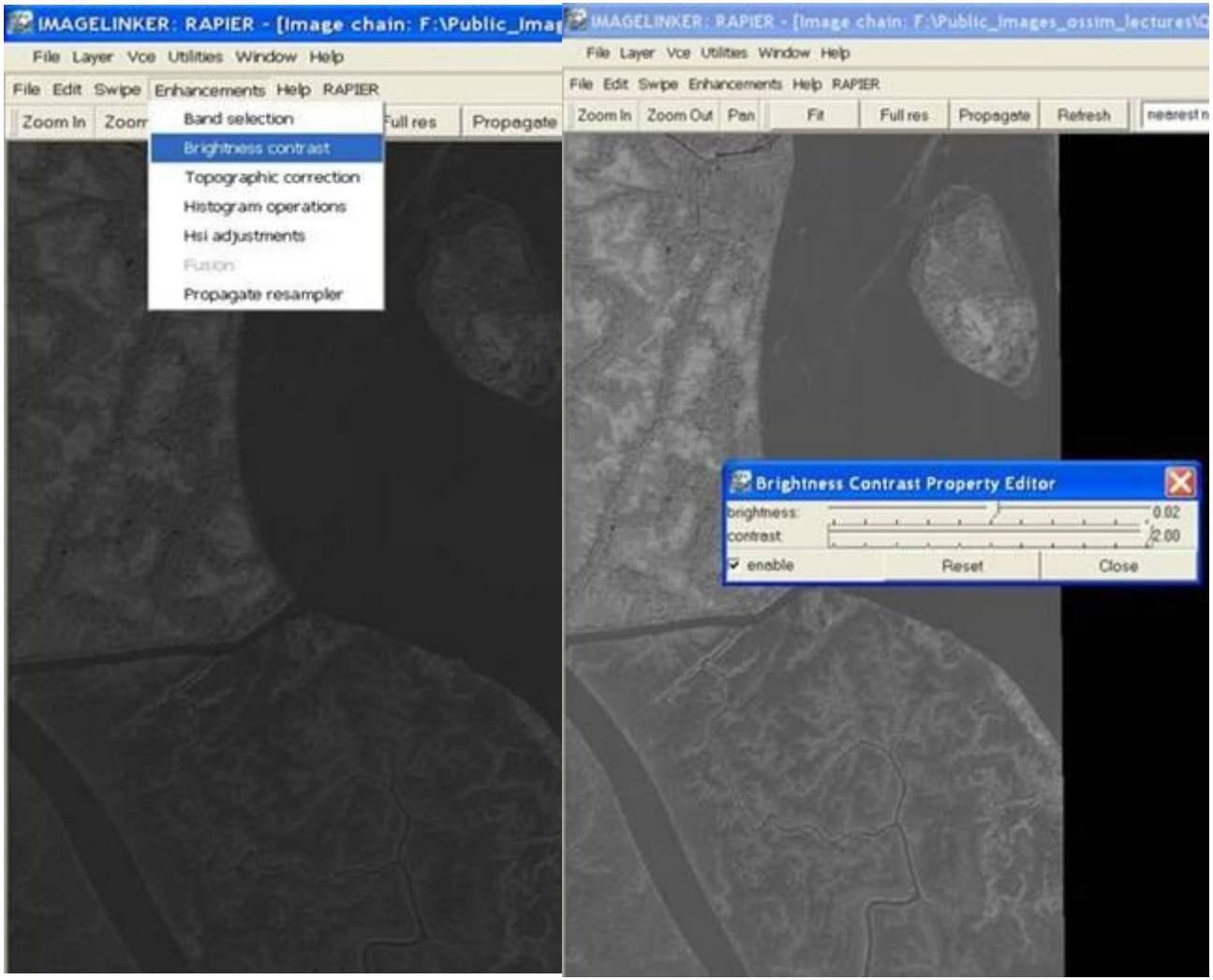
- Open the image 2.1.41_pan_imagen3.tif



Distribution Statement A: Unlimited Distribution

Edge Detection for Mapping River Systems

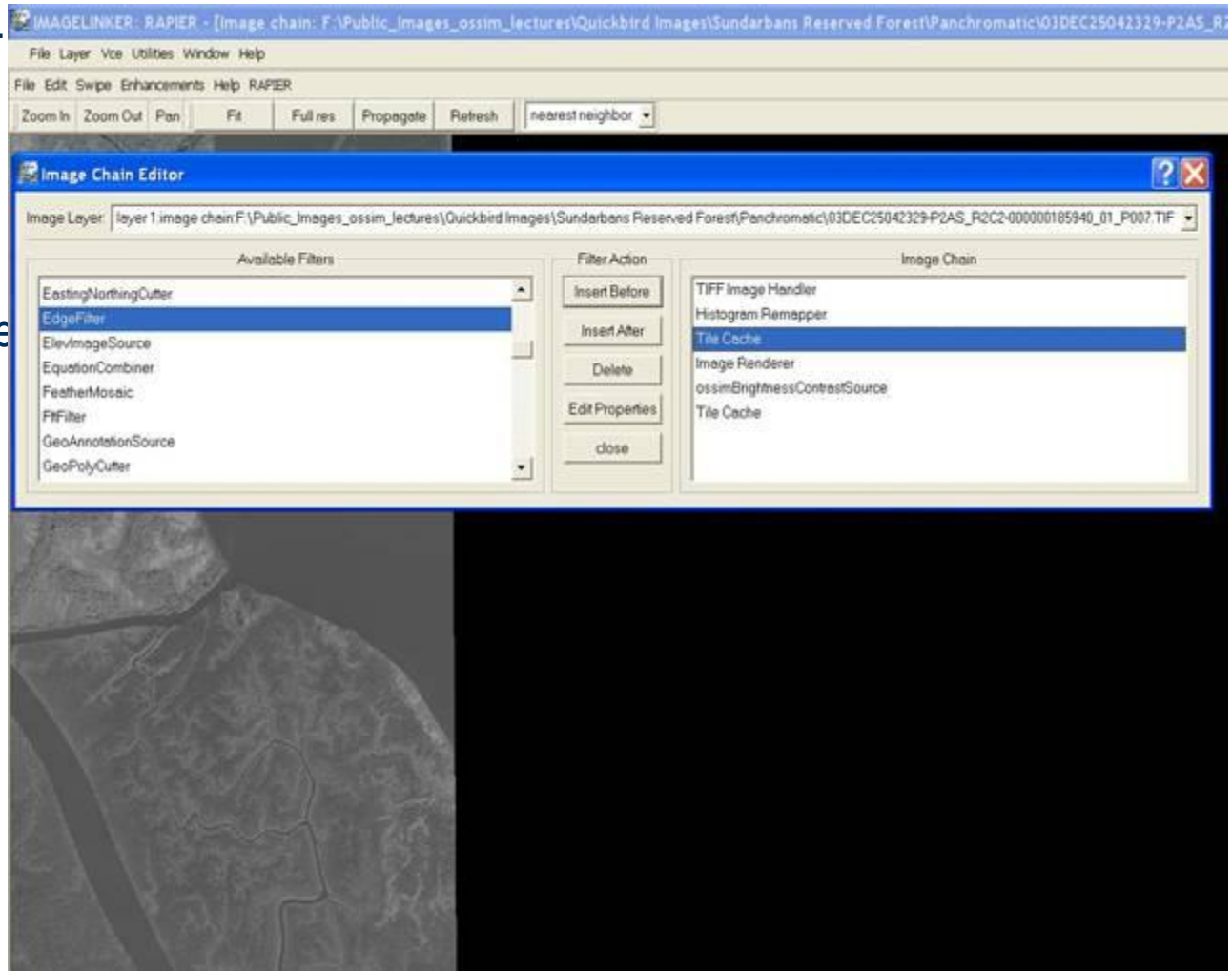
- On the image menu, select Enhancements -> Brightness contrast
- Adjust the contrast to 2.0 and the brightness to .04



Distribution Statement A: Unlimited Distribution

Edge Detection for Mapping River Systems

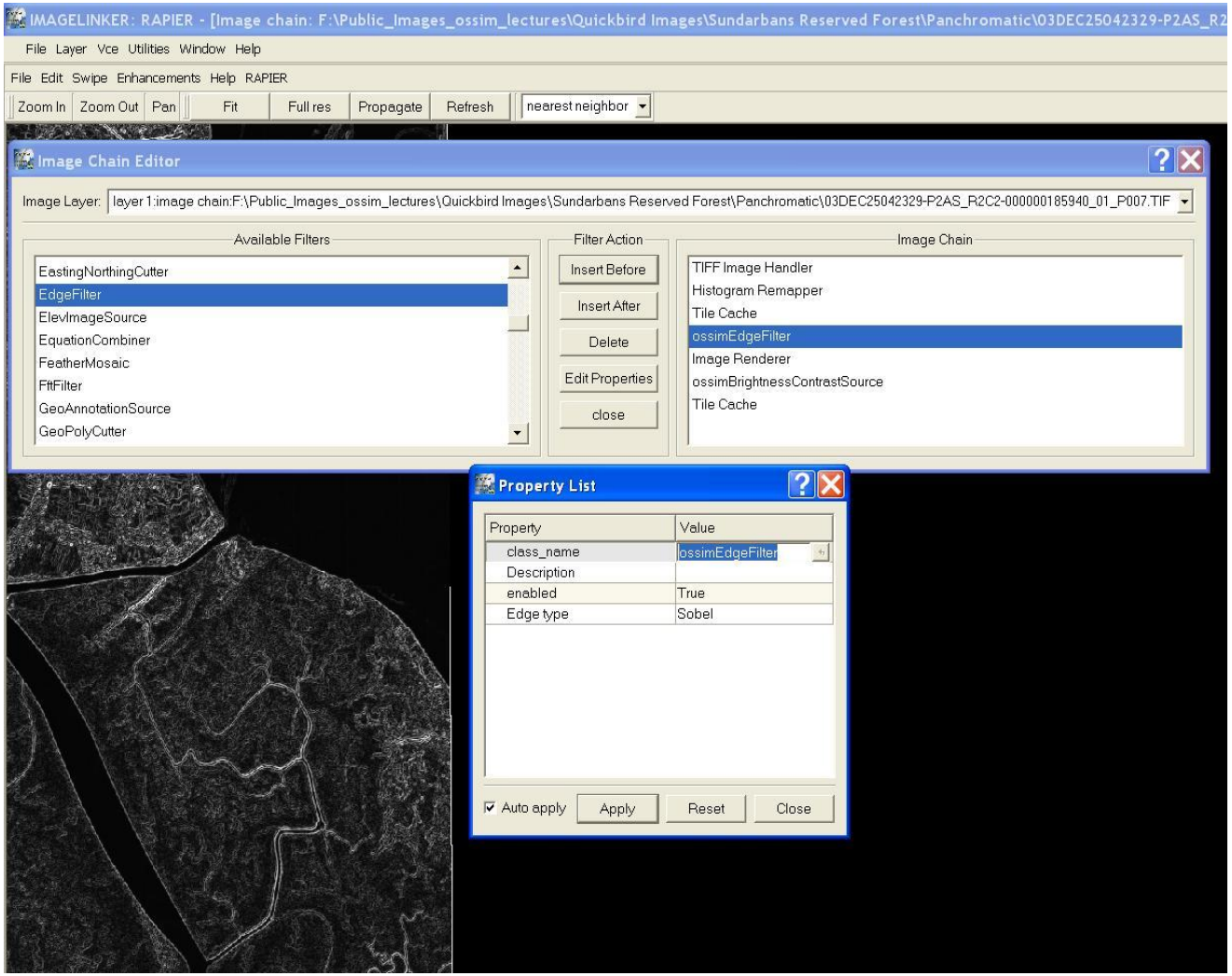
- Open the Image Chain Editor.
- On the left, scroll down to EdgeFilter and highlight it.
- On the right, select Tile Cache (top one).
- Select Insert After.



Distribution Statement A: Unlimited Distribution

Edge Detection for Mapping River Systems

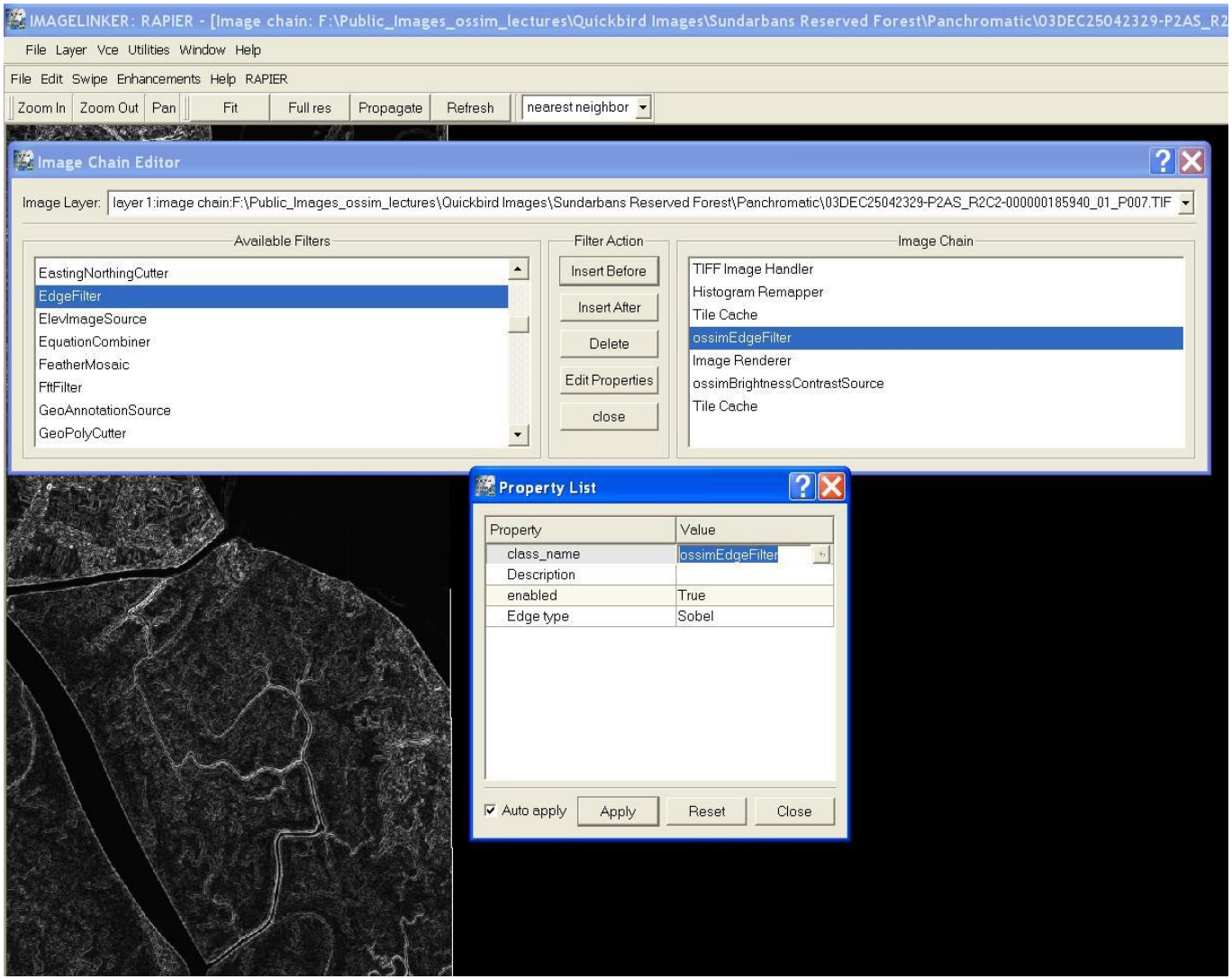
- With the ossimEdgeFilter highlighted on the right, select the Edit Properties button.
- You should see an entry called Edge type which is set to Sobel
- Close the Image Chain Editor so you can view the image easier



Distribution Statement A: Unlimited Distribution

Edge Detection for Mapping River Systems

- Change the edge detector type, noting the differences.
- Zoom in and pan around.
  - Is the output of the edge filter here binary or gray scale?
  - To make an “edge map”, what would be the next step?\
- Often a lack of strong edges provides useful information.
  - What features lack strong edges?

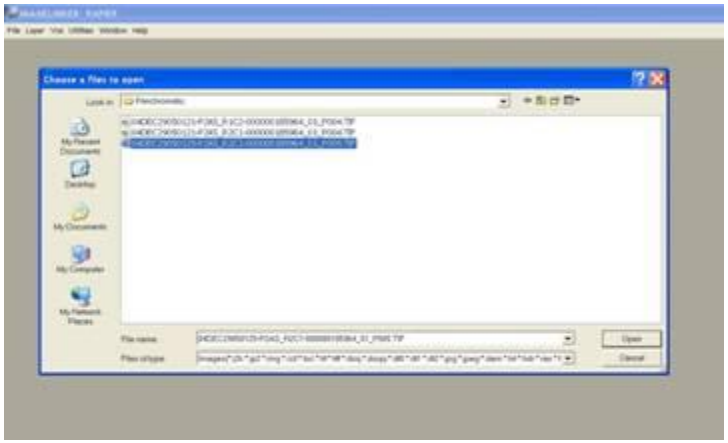


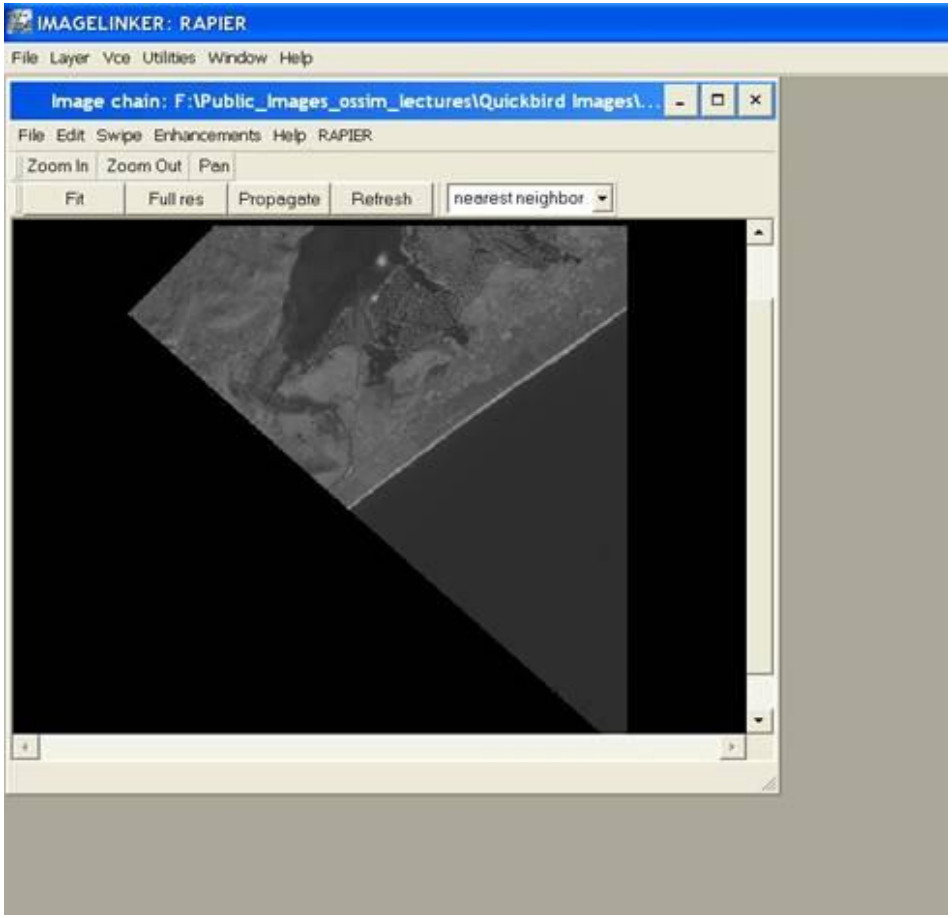
Distribution Statement A: Unlimited Distribution

Pansharpening Example

Pansharpening Multi-spectral Imagery

- Open the image 2.1.50_pan_imagen5.tif
- Select Enhancements->Brightness contrast
- Move contrast to 2.0, and brightness to .05
- Your display should appear similar to that shown to the right

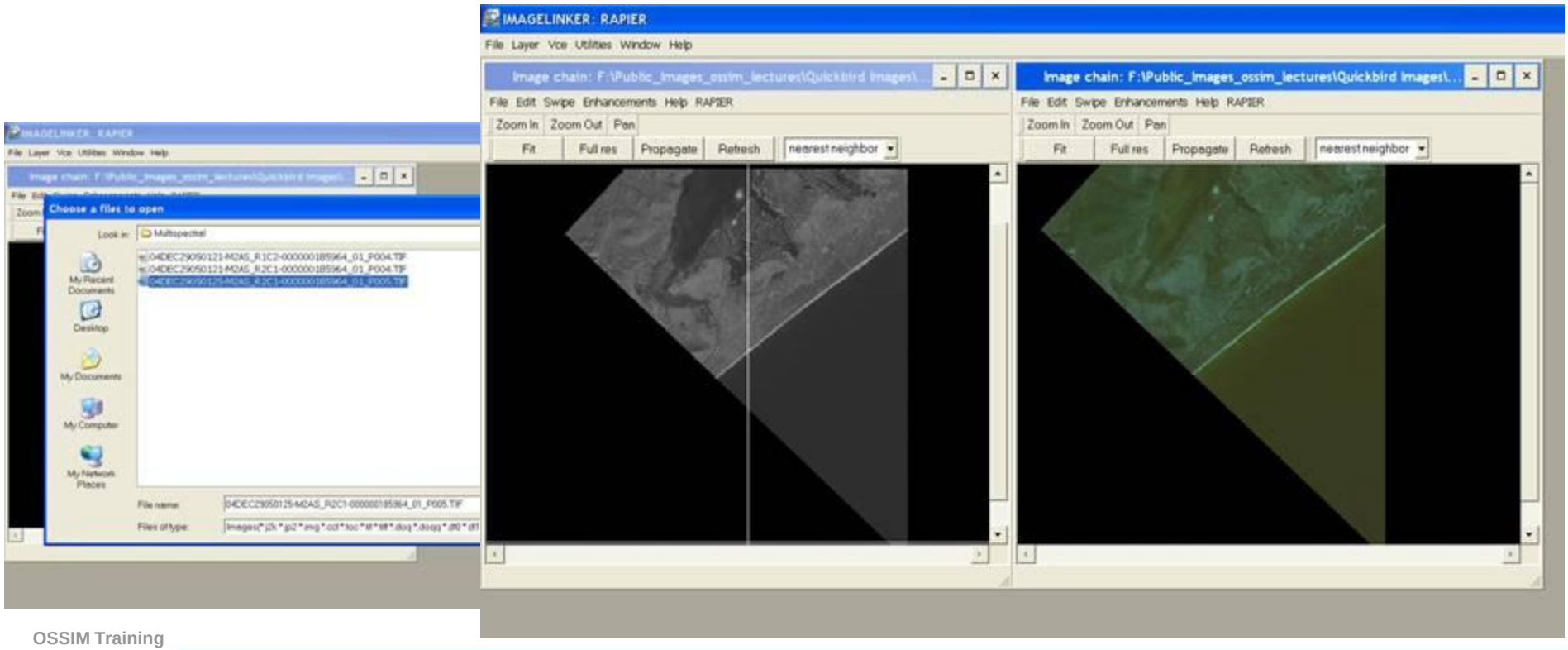




Distribution Statement A: Unlimited Distribution

Pansharpening Multi-spectral Imagery

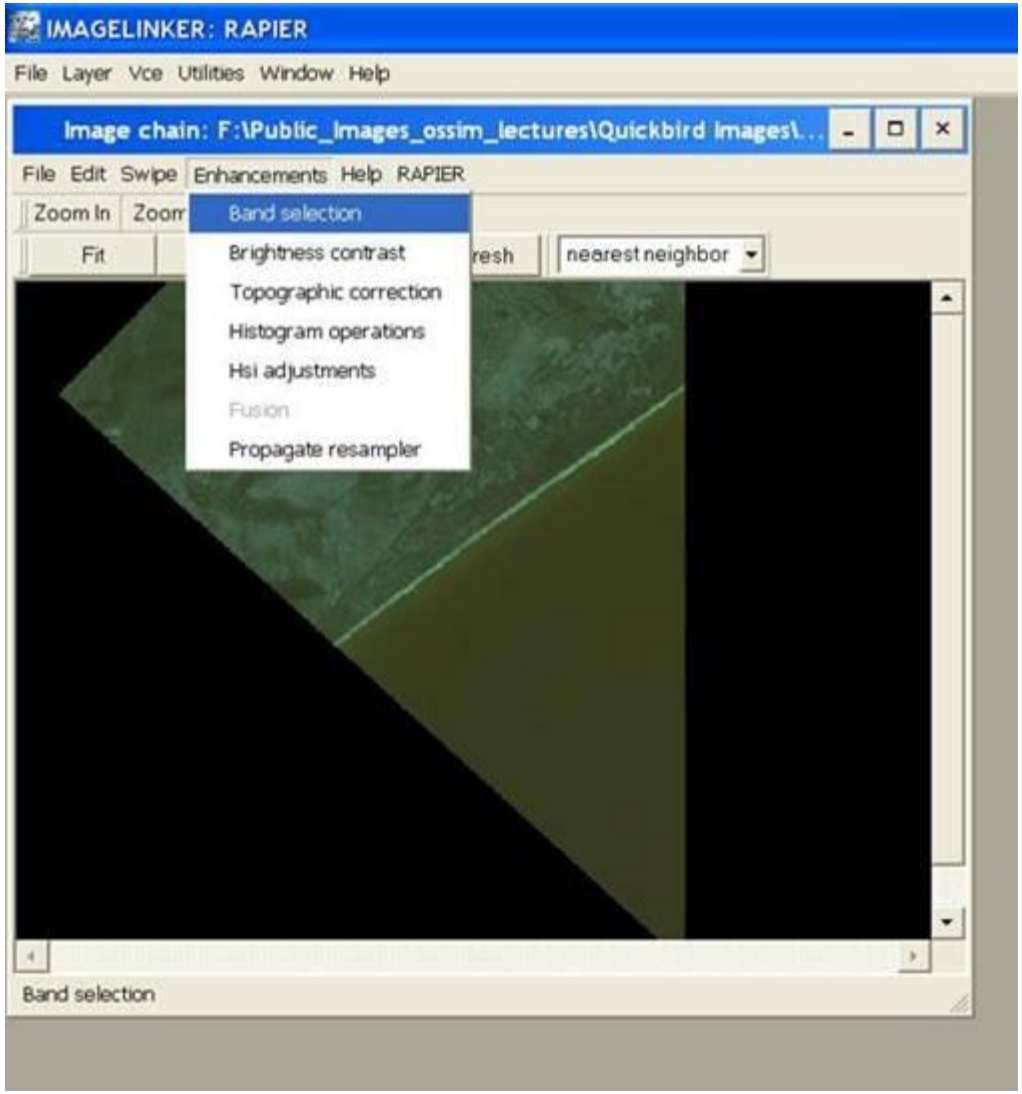
- Open the image 2.1.51_ms_imagen6.tif
- Select Enhancements->Brightness contrast
- Move contrast to 2.0, and brightness to .05



Distribution Statement A: Unlimited Distribution

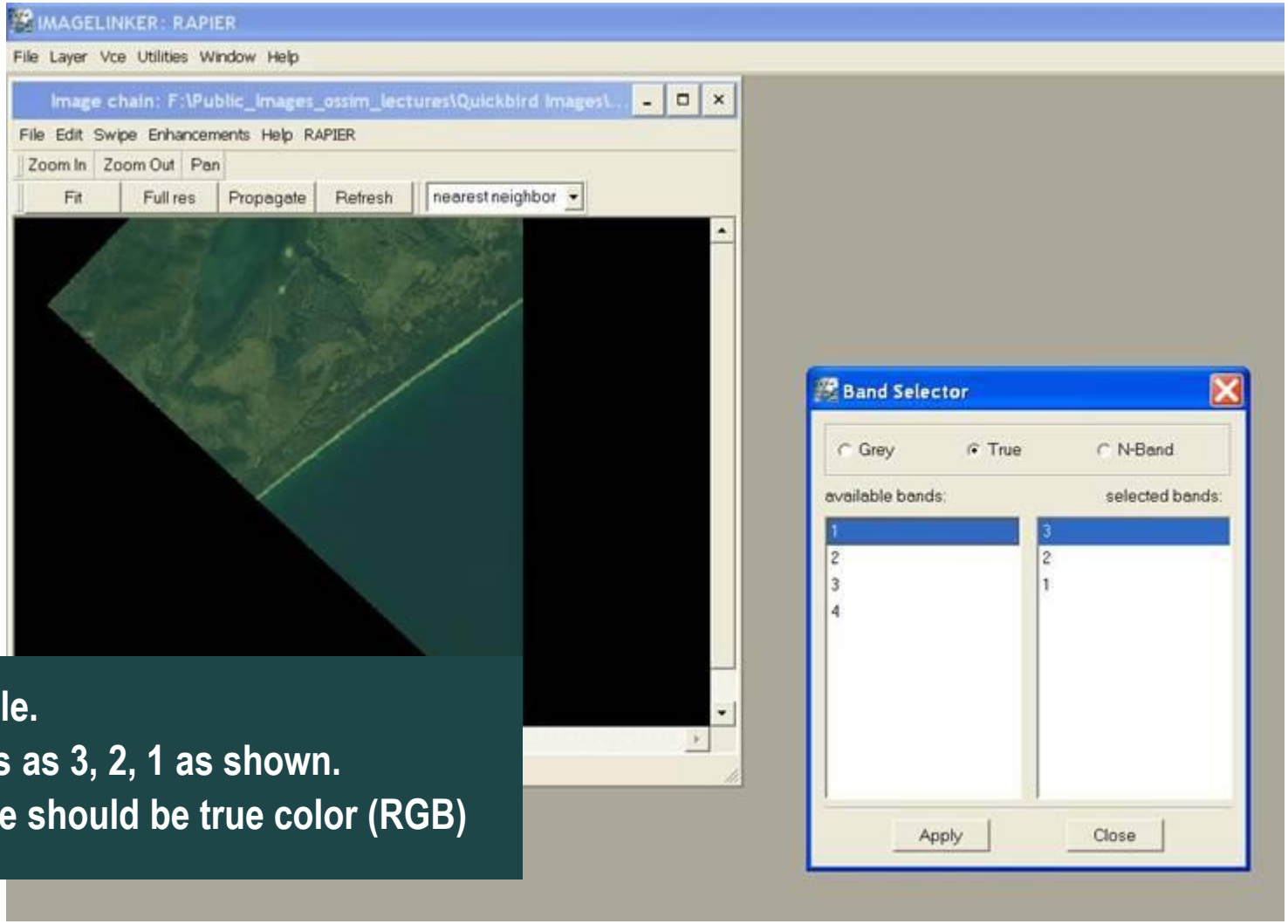
Pansharpening Multi-spectral Imagery

- On the Multispectral image menu, select Ehancements → Band Selection



Distribution Statement A: Unlimited Distribution

Pansharpening Multi-spectral Imagery



Select the True bubble.
Select the 3 channels as 3, 2, 1 as shown.
Hit apply. Your image should be true color (RGB)

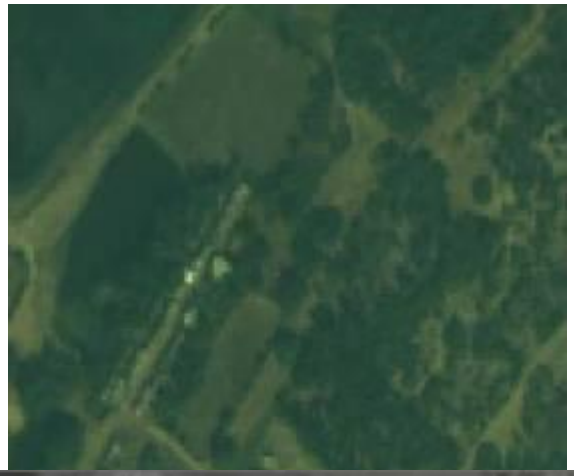
Distribution Statement A: Unlimited Distribution

Pansharpening Multi-spectral Imagery

- Zoom in on various areas of the two images.
  - What do you notice about the resolution of the two images? Are they the same, or different?

- Multispectral imagery in general has 1/n the resolution of panchromatic imagery collected using the same imaging system (*where n = the number of bands*). In this case, the resolution is ¼.

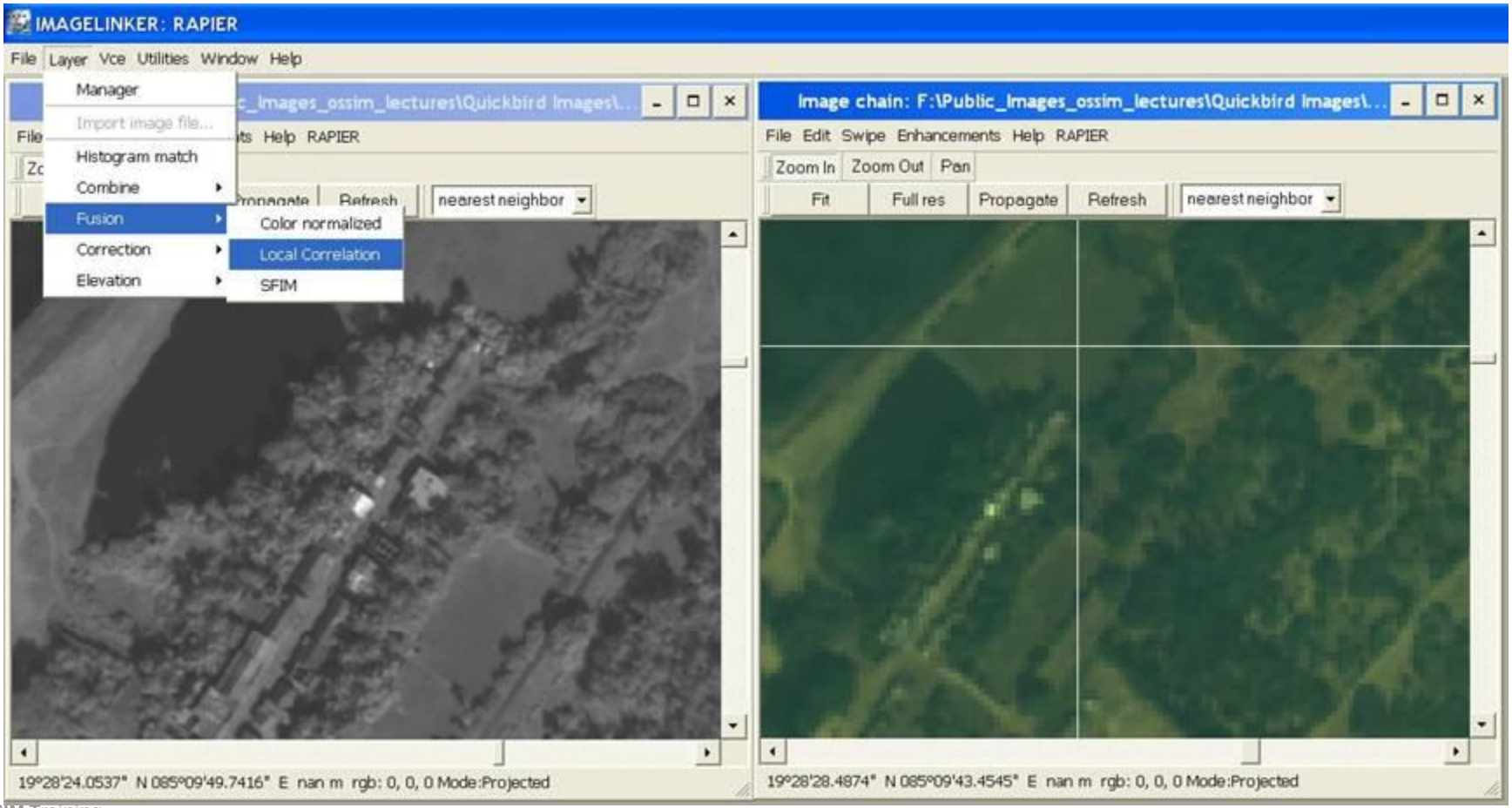
- Panchromatic sharpening is a vector-space signal processing based method for fusing high resolution pan imagery with lower resolution multispectral imagery



Distribution Statement A: Unlimited Distribution

Pansharpening Multi-spectral Imagery

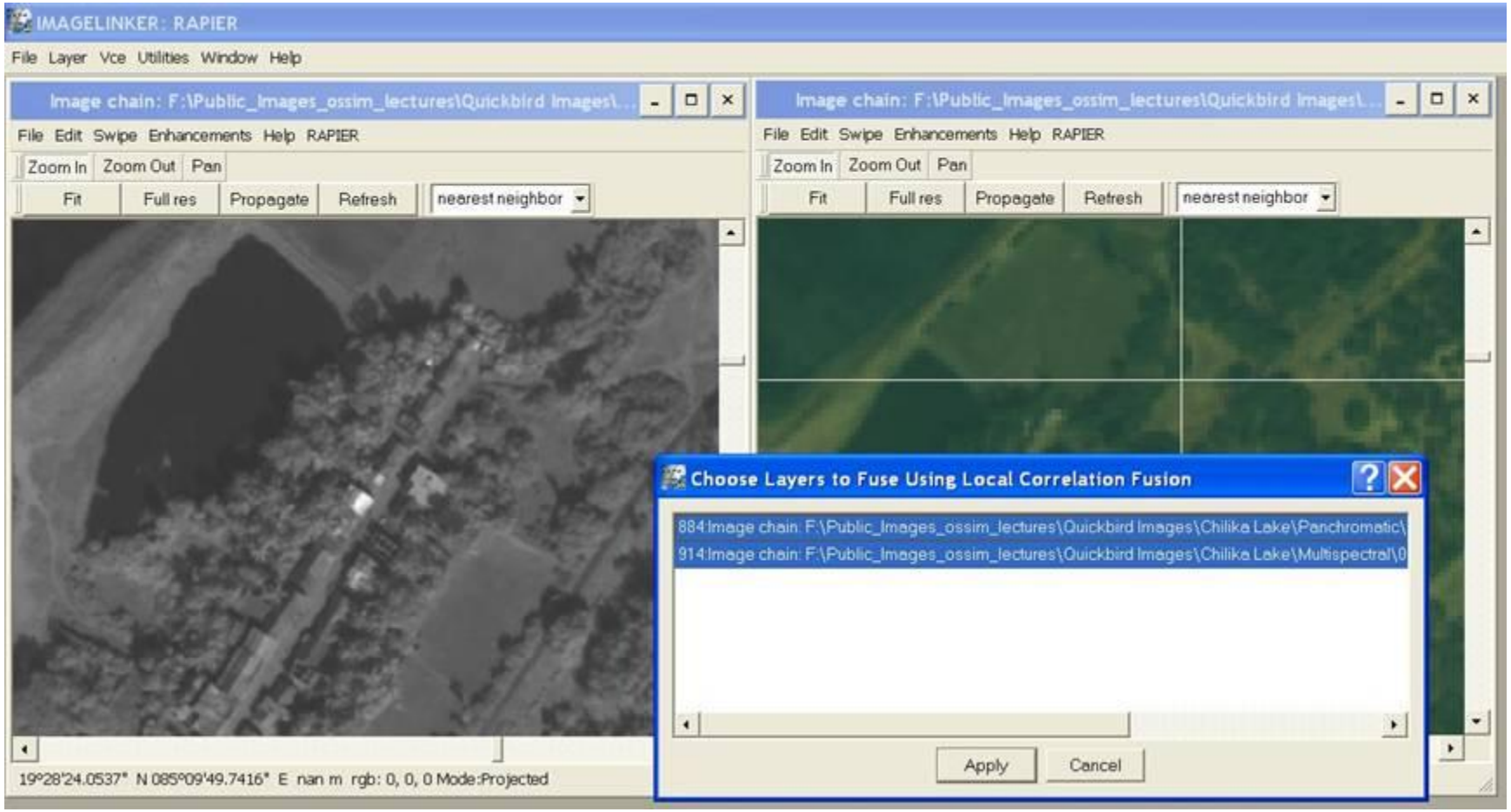
- Goto Layer → Fusion → Local Correlation



Distribution Statement A: Unlimited Distribution

Pansharpening Multi-spectral Imagery

- Select the two images you want to merge



Distribution Statement A: Unlimited Distribution

Pansharpening Results

- Zoom around and compare the original image to the new image

Original Image

Pan-Sharpened Image

Distribution Statement A: Unlimited Distribution

Pansharpening Results

- Try the other two methods of pan-sharpening and note the differences.
  - Color normalized
  - SFIM (Smoothing filter-based modulation)

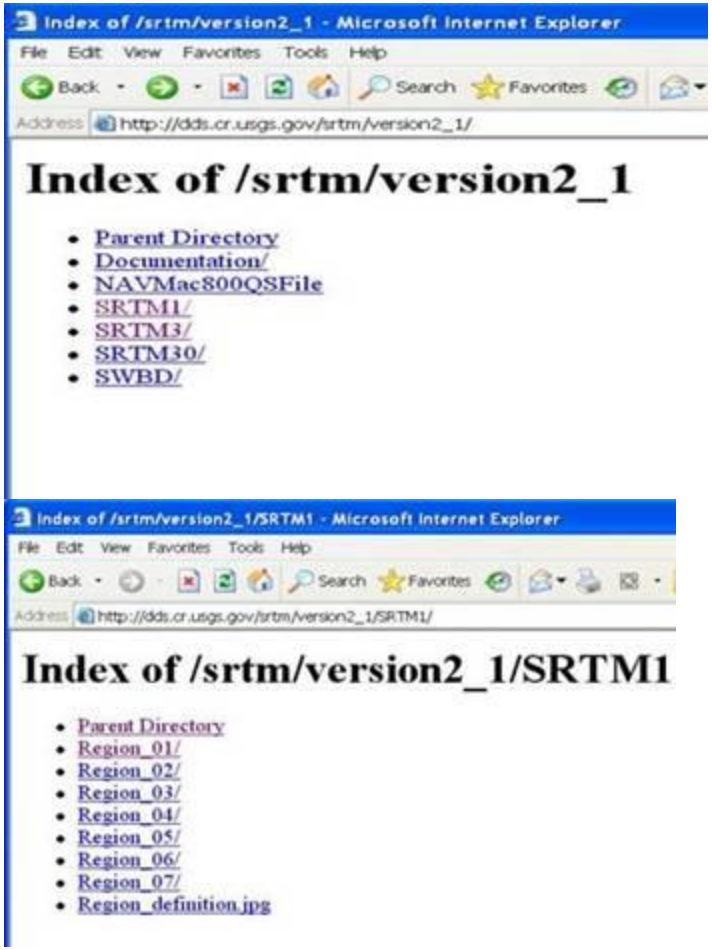
- Which method looks the best?

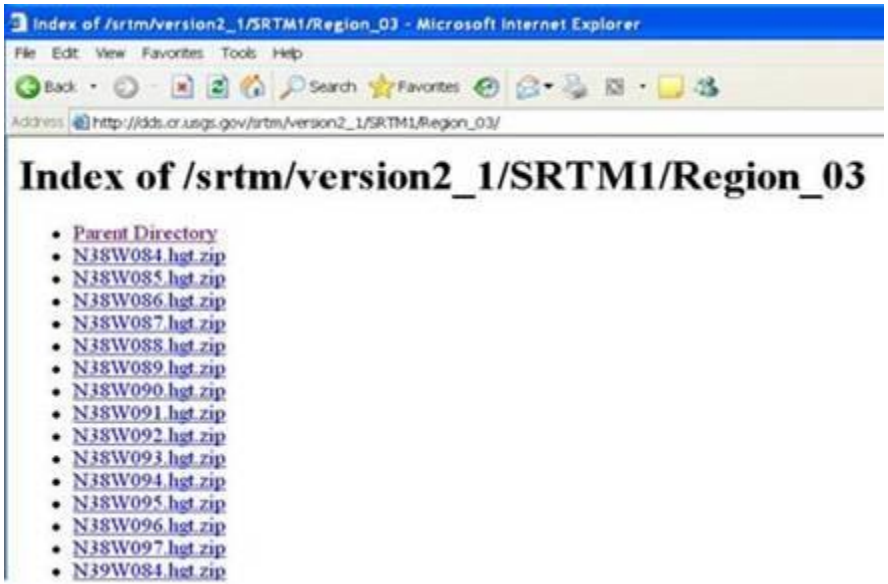
Distribution Statement A: Unlimited Distribution

Orthorectification

Where to Find DEM's for Orthorectification

- http://dds.cr.usgs.gov/srtm/version2_1/ - List of DEM's for specific grids.
- SRTM1 – spacing of 1"
- SRTM3 – spacing of 3"
- SRTM30 – spacing of 30"
- Separated into grids. Must find grid relevant for image





Distribution Statement A: Unlimited Distribution

How to generate DEM's

- Interferometric Synthetic Aperature Radar (two passes or single satellite equipped with two antennas (SRTM)).
  - Uses phase differences in returned signals to estimate height.
- Several methods of InSAR based DEM generation.
  - Tandem-X, follow on to TerraSAR-X will provide high resolution DEM's for the entire world.
- Stereoscopic image pairs using digital image correlation method – 2x optical images acquired different angles same pass (HRS instrument of SPOT5 satellite).

Distribution Statement A: Unlimited Distribution

CE90 and LE90 Errors

- CE90 is circular error at 90% probability, and is a measure of the horizontal geodetic accuracy in an image.

- Vertical accuracies are defined by the LE90 measure. The measured elevation of a point should lie within +/- LE90 of it's true elevation.

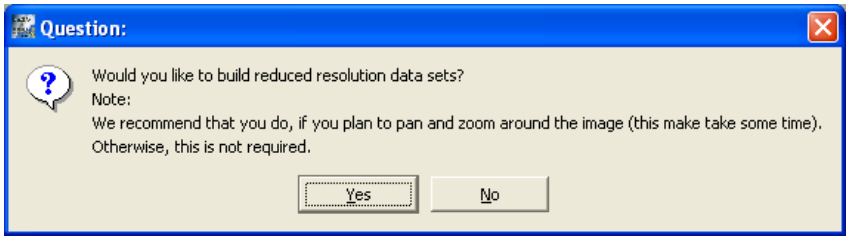
Distribution Statement A: Unlimited Distribution

SPAWAR Systems Center PACIFIC

ossimRlevel Filter Example

OSSIM RLevel Overview

- .OVR Files
  - When opening an image for the first time in Imagelinker, the following window pops up

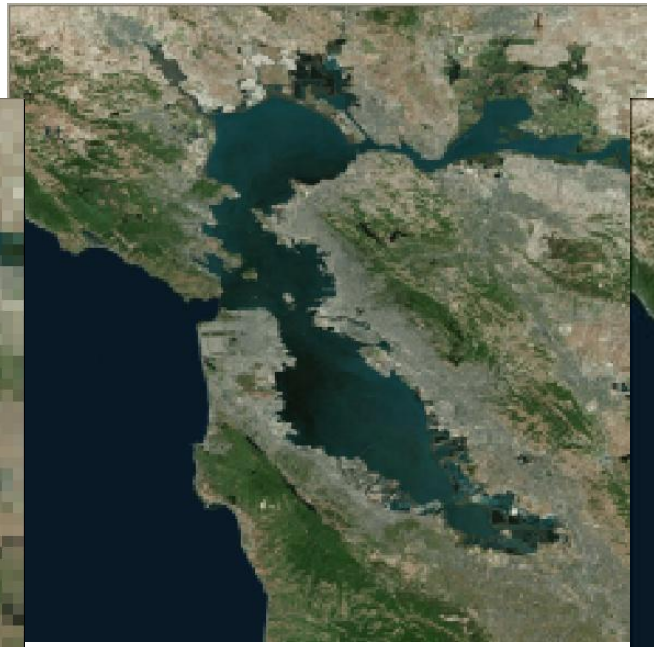


  - Two files are created when the user hits the yes button:
    - .OMD –metadata file
    - .OVR – multi resolution pyramid file
  - OSSIM creates resolution files to process image at different resolutions.

- What is a reduced resolution image?
  - A reduced pixel representation of an image computed by downsampling an image.

Different Resolution Levels

Low Resolution



Medium Resolution

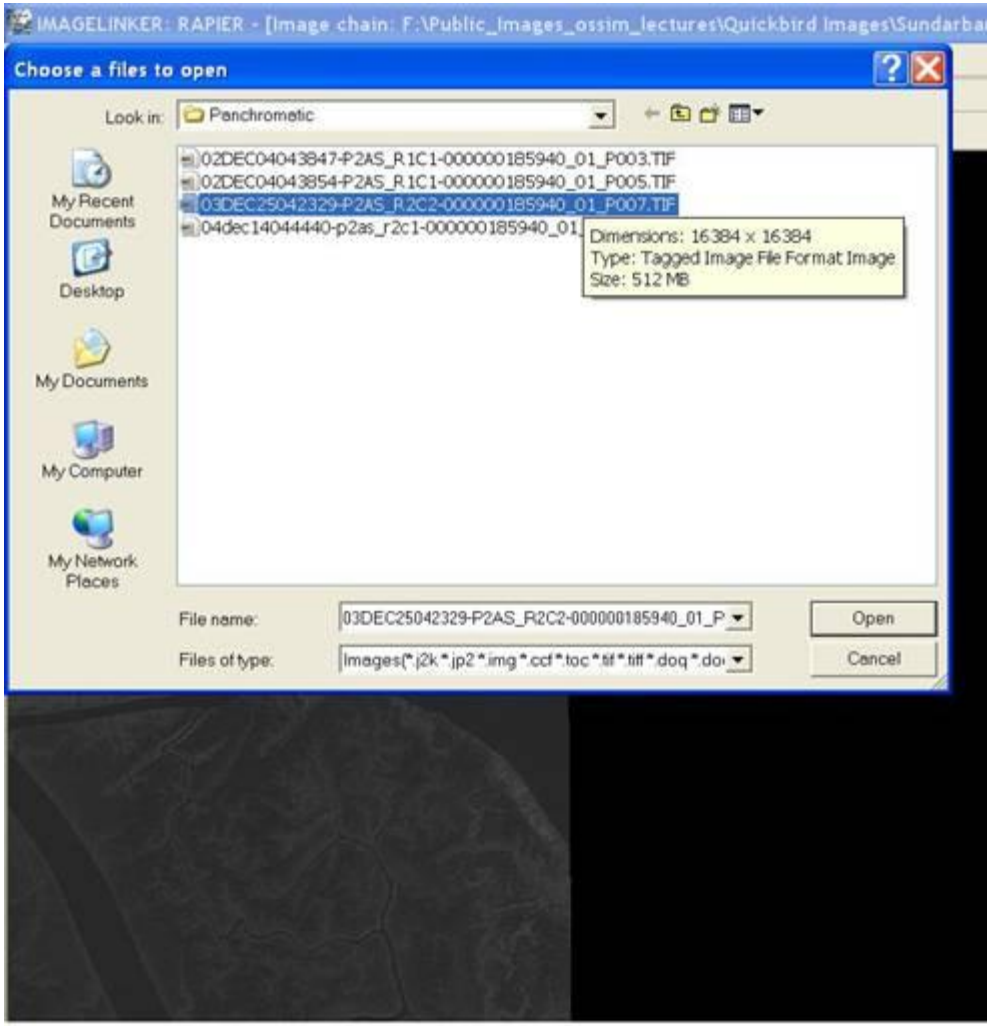
High Resolution

How Images are Downsampled

- Reason for downsampling?
  - Reduce memory
  - Speed up processing time
  - Image details are not important
- Number of Resolution Levels
  - Number of reduced resolution levels computed in Imagelinker is different for every image.
- Popular downsampling methods:
  - Nearest neighbor
  - Bilinear interpolation
  - Bicubic

OSSIM RLevel Filter

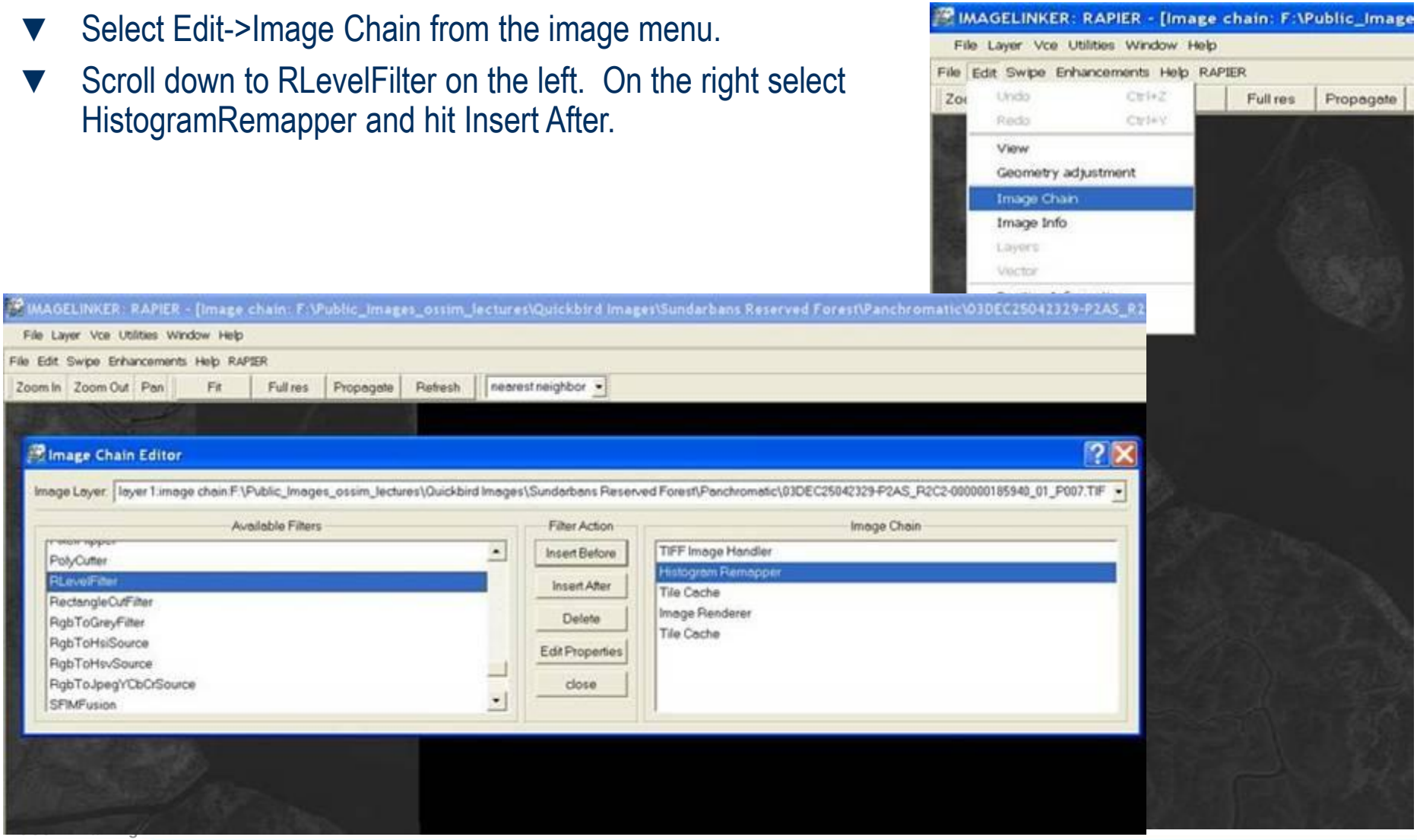
- Provides a convenient way to select resolution (from reduced resolution set)
- Open ..\02_ImageLinker\Images\ 2.1.71_pan_imagen8.tif



Distribution Statement A: Unlimited Distribution

OSSIM RLevel Filter

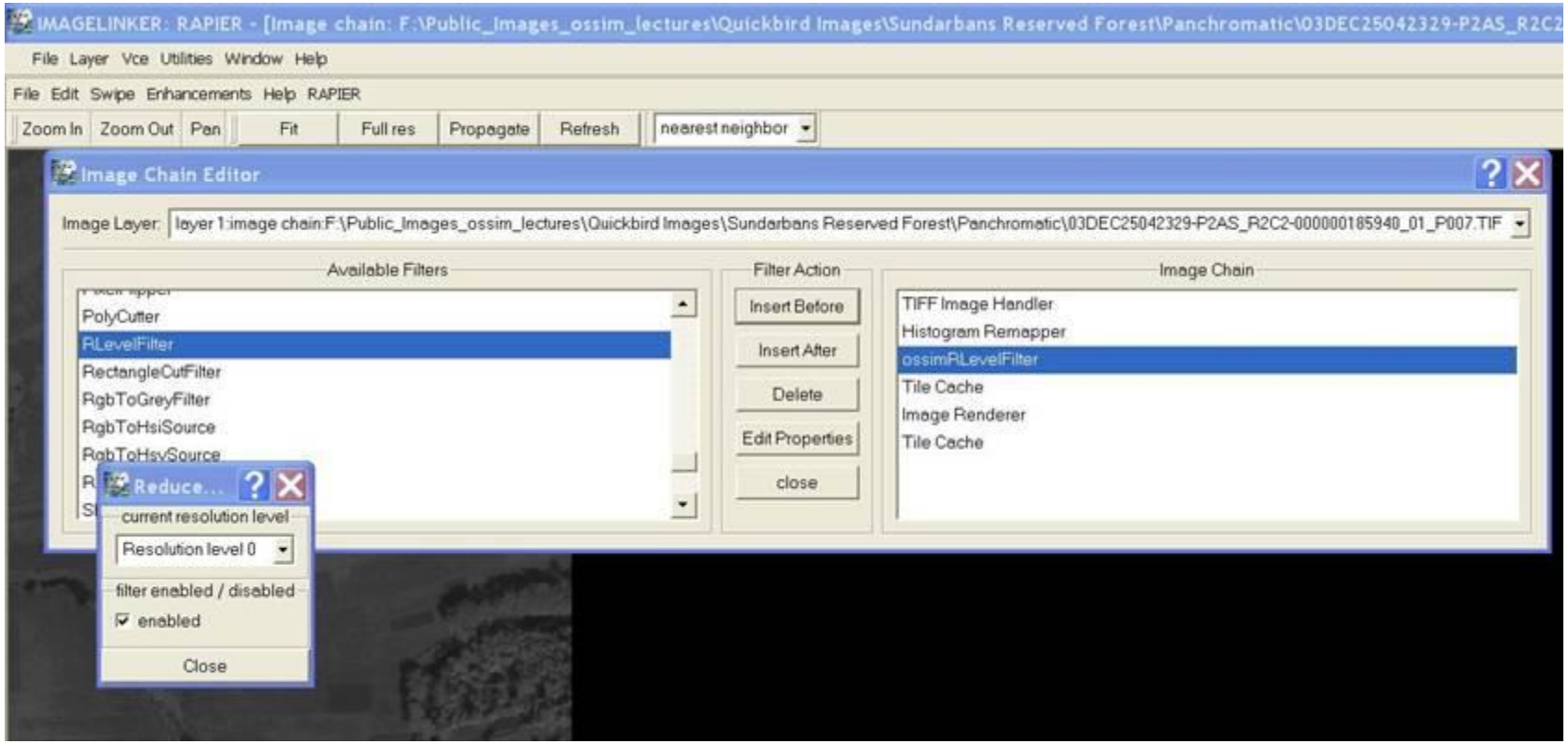
- Select Edit->Image Chain from the image menu.
- Scroll down to RLevelFilter on the left. On the right select HistogramRemapper and hit Insert After.



Distribution Statement A: Unlimited Distribution

OSSIM RLevel Filter

- Highlight ossimRLevelFilter on the right and select Edit Properties.
- Close the Image Chain Editor



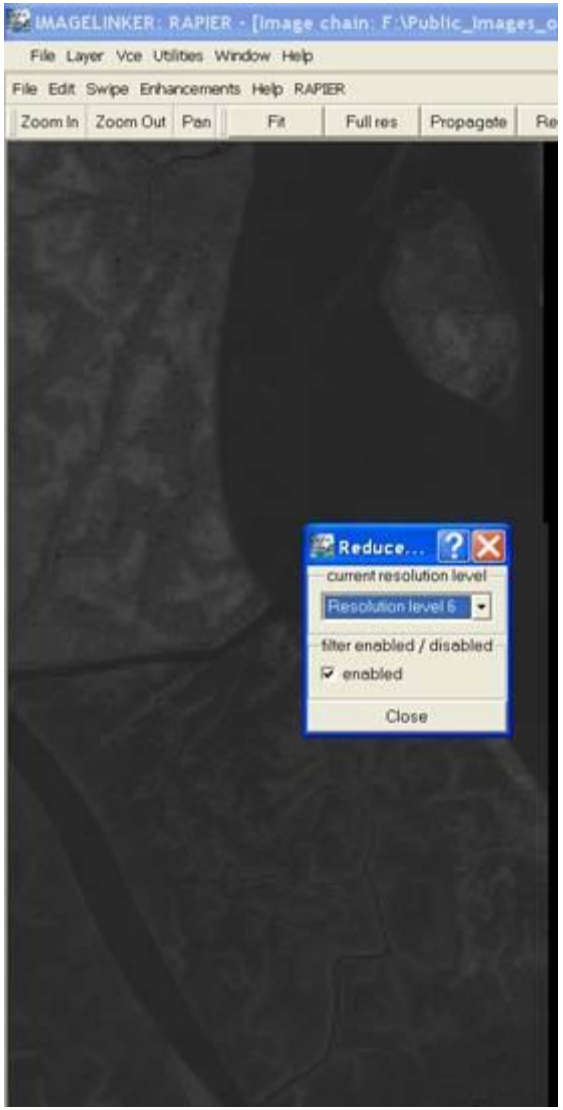
Distribution Statement A: Unlimited Distribution

OSSIM RLevel Filter

- On the drop-down menu, select Resolution level 8.
- On the image menu, hit Full Res, then Fit.
  - What do you notice about the resolution of this image?
  - What might the advantages be of processing a lower resolution version of the original image?

Distribution Statement A: Unlimited Distribution

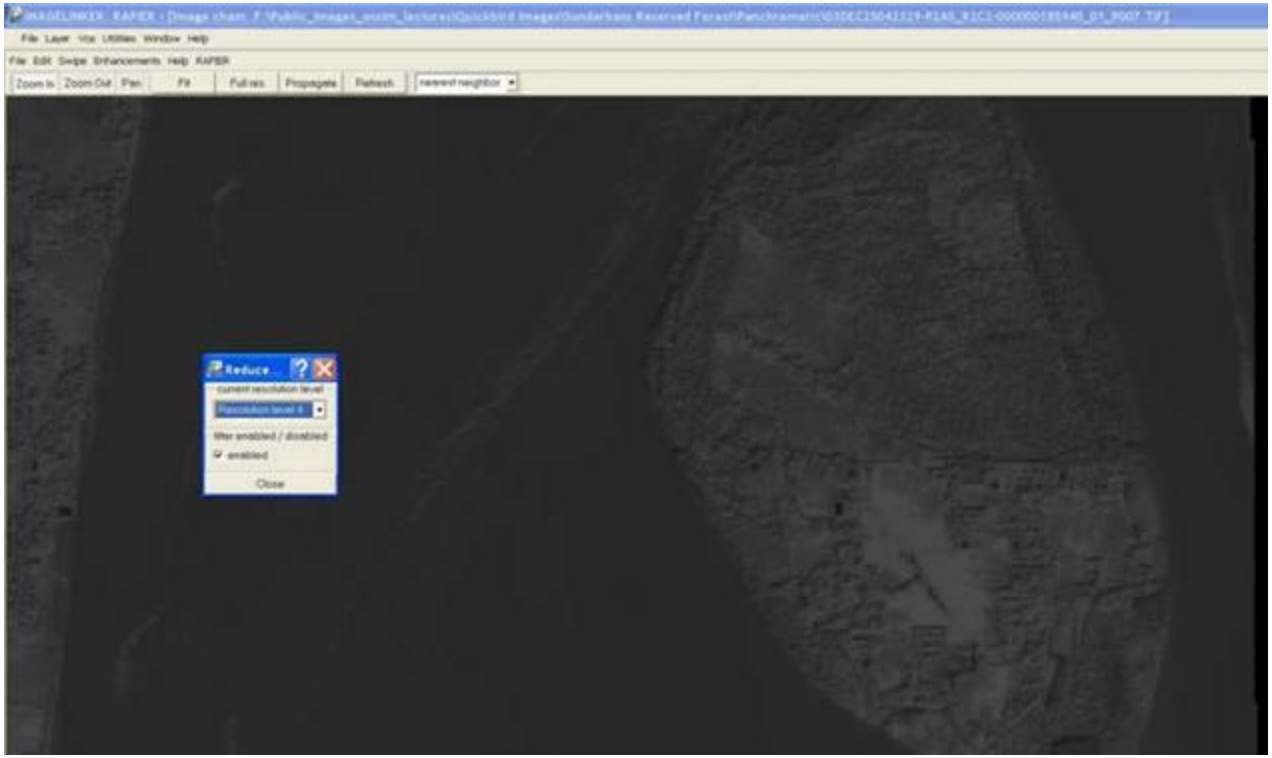
OSSIM RLevel Filter



Distribution Statement A: Unlimited Distribution

OSSIM RLevel Filter

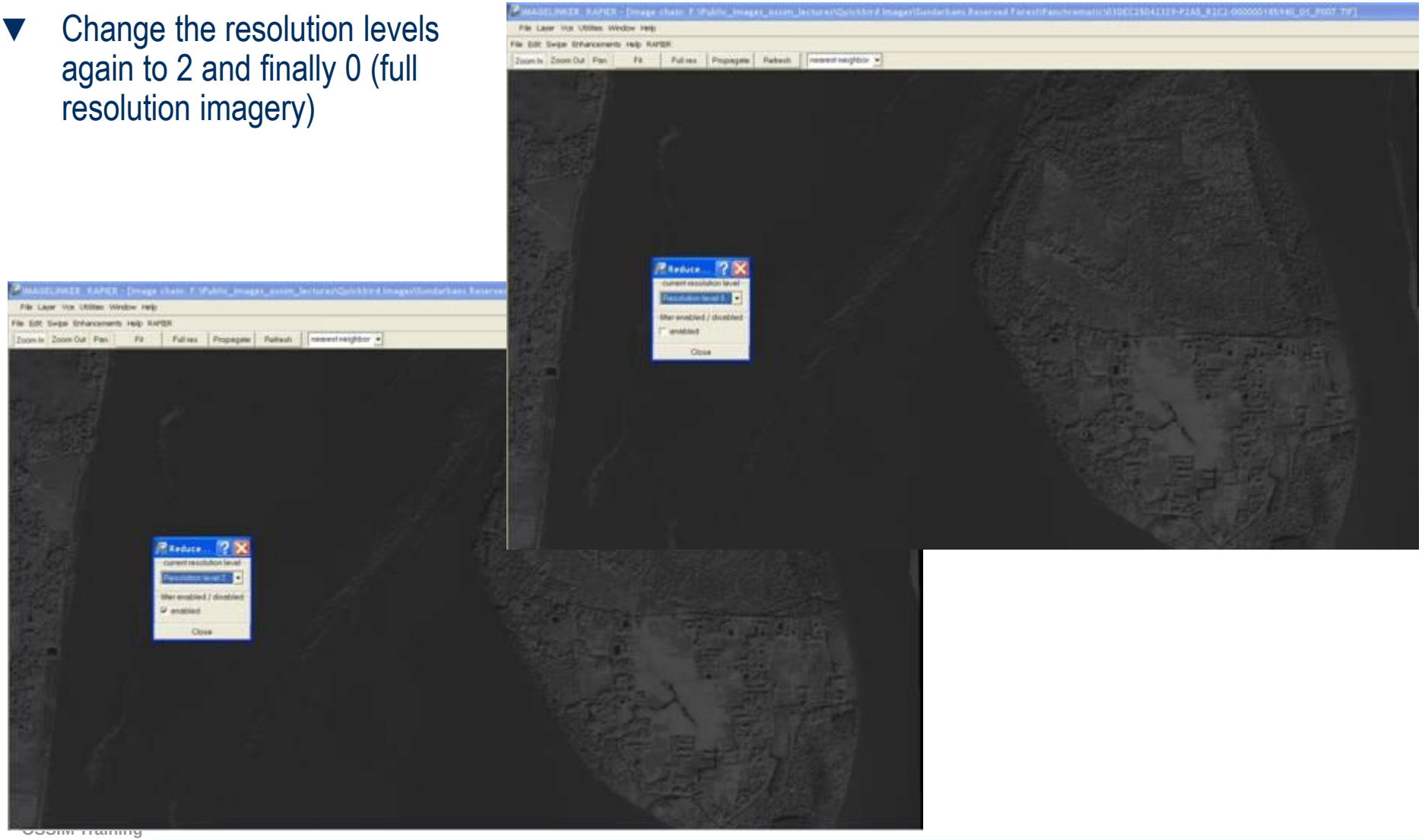
- Zoom into the island area on the right of the image.



Distribution Statement A: Unlimited Distribution

OSSIM RLevel Filter

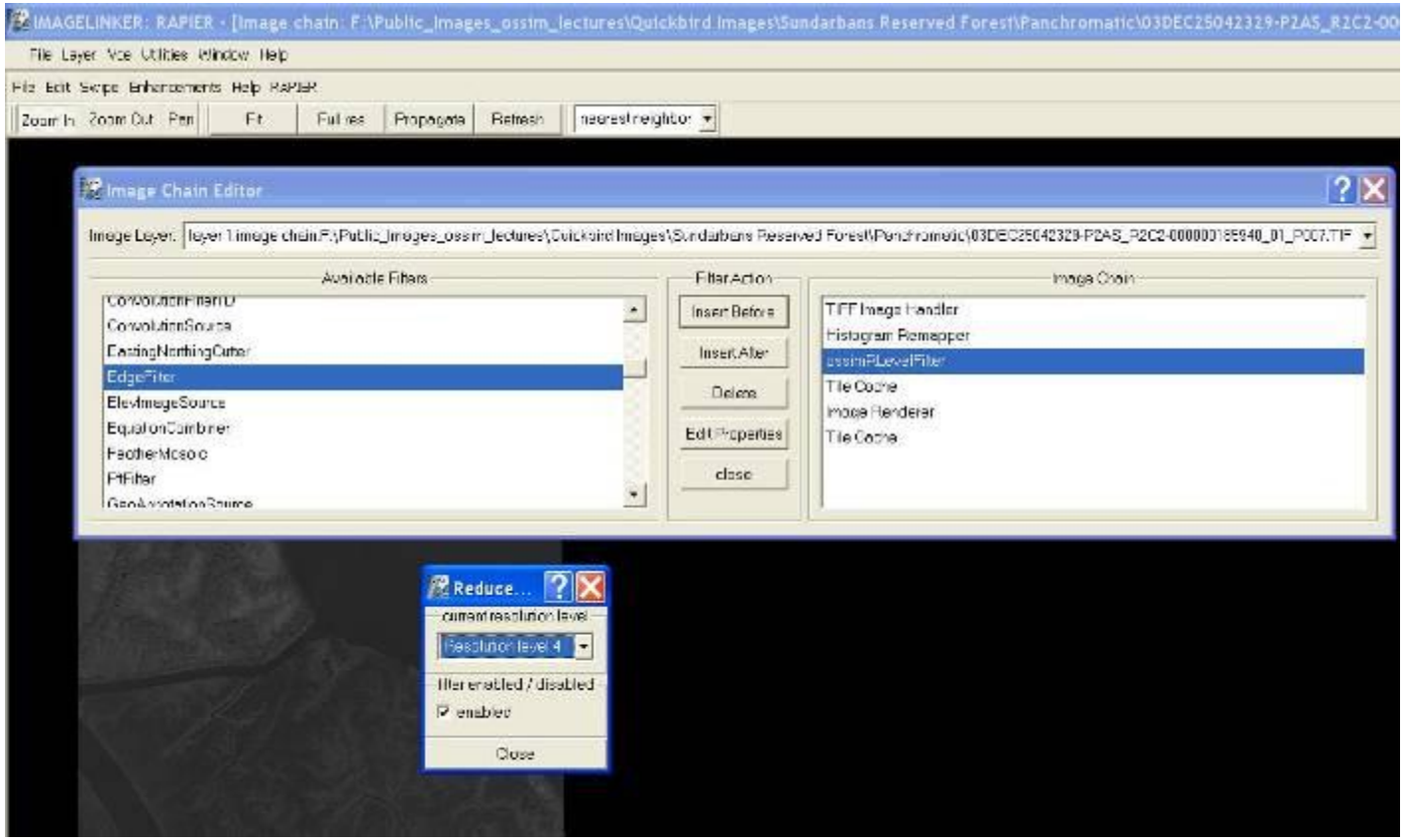
- Change the resolution levels again to 2 and finally 0 (full resolution imagery)



Distribution Statement A: Unlimited Distribution

OSSIM RLevel Filter

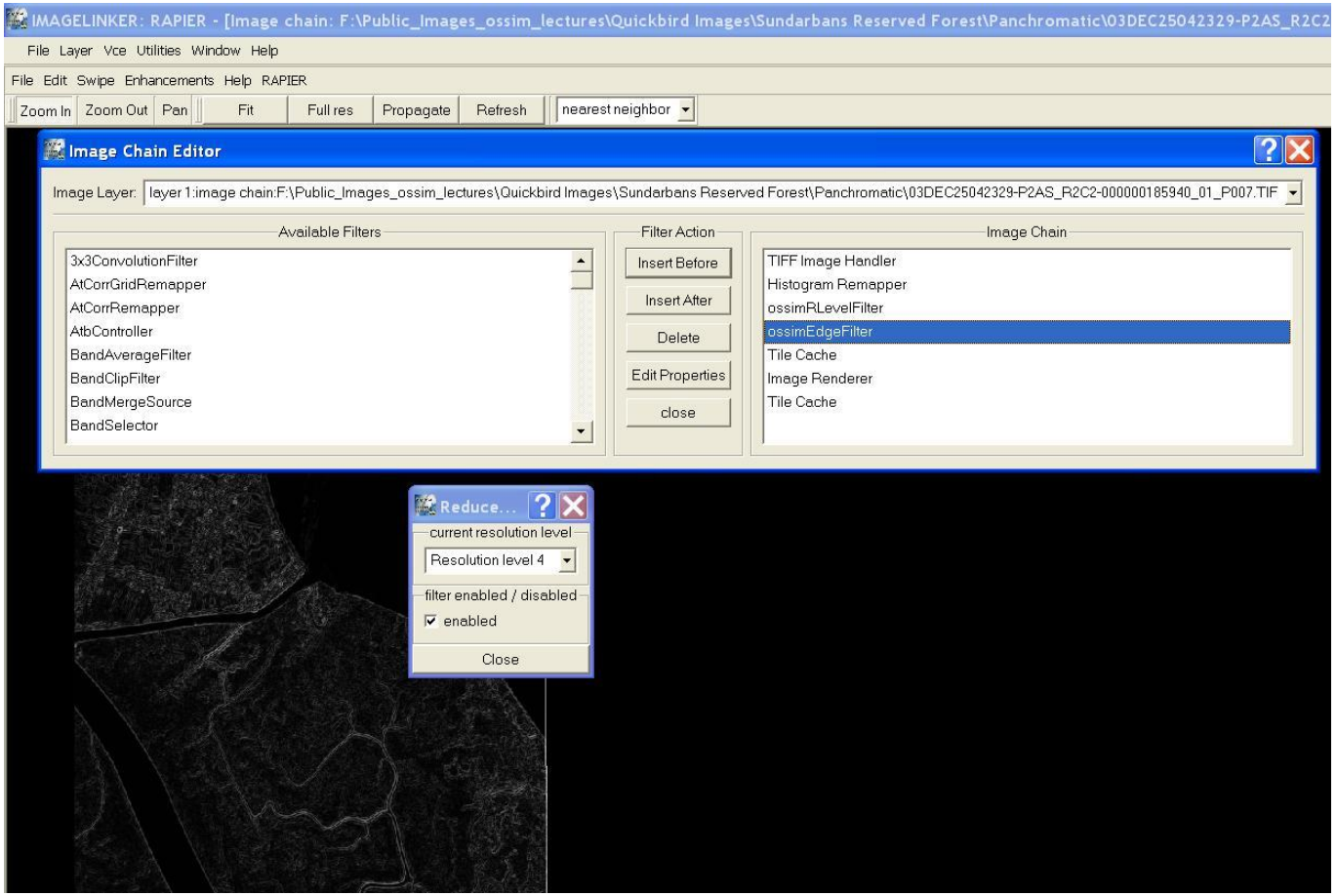
- Now, let's add an edge filter to the image chain and observe the effect of changing the Resolution level. **Set the resolution level to 4.**
- Open the Image Chain for the image again.
- Scroll down to EdgeFilter on the left
- Insert the Edge Filter after the ossimRLevelFilter



Distribution Statement A: Unlimited Distribution

OSSIM RLevel Filter

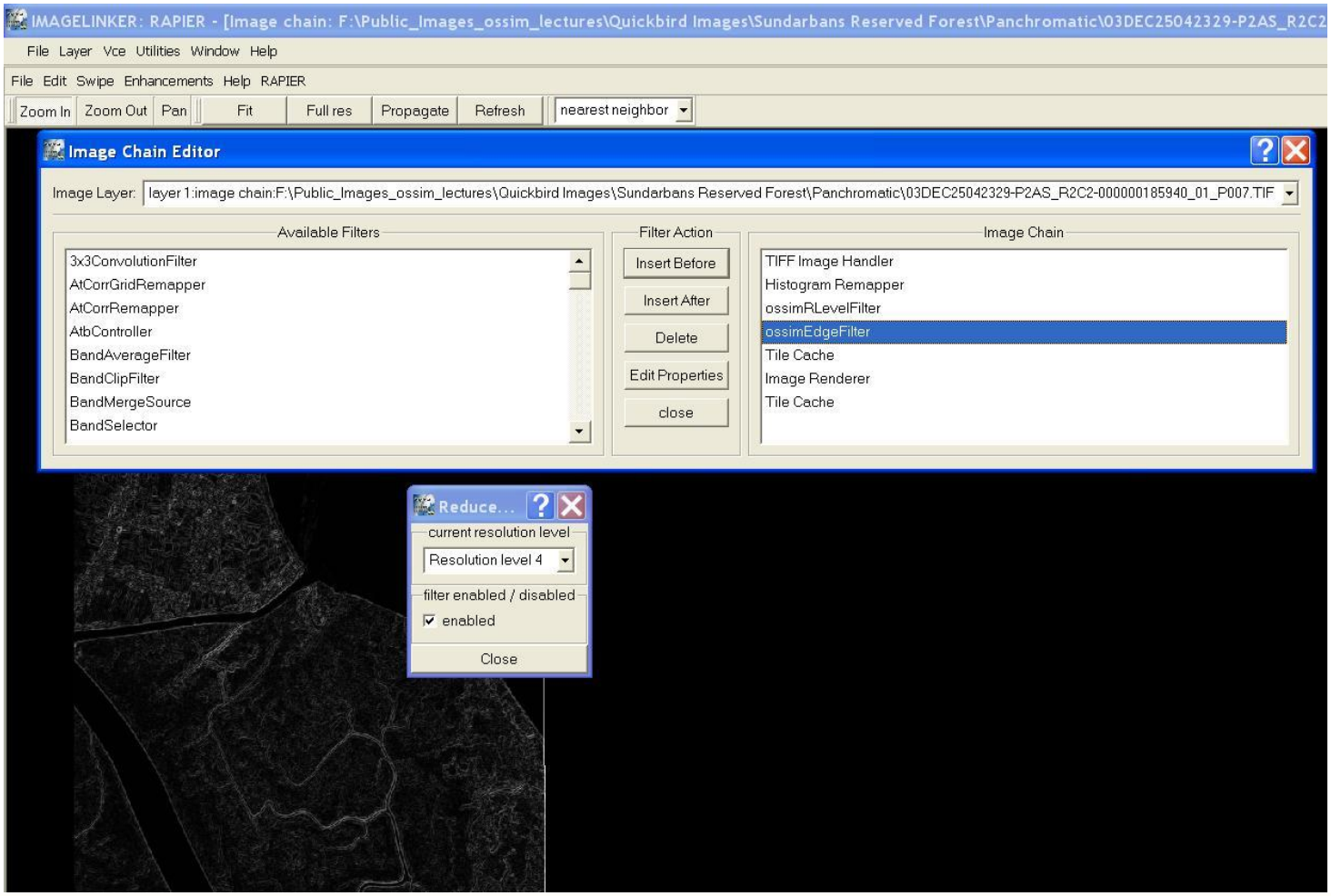
- You should see the edge map displayed. **Close the Image Chain Editor.**
- Notice the edge map, and level of details displayed.
- Now change the Resolution Level to 5.
  - What happens to the edge map?



Distribution Statement A: Unlimited Distribution

OSSIM RLevel Filter

- Zoom in to a small area of the image. Set the resolution level to various levels and observe the change in behavior of the Edge filter.



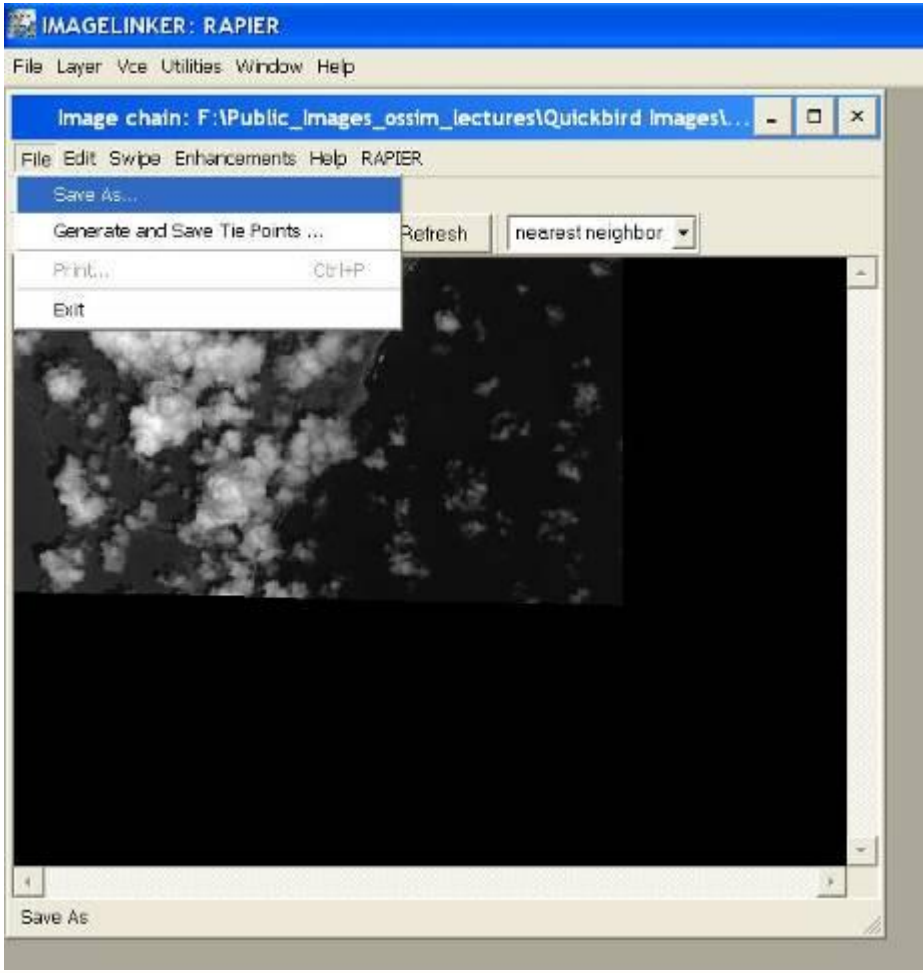
Distribution Statement A: Unlimited Distribution

Saving Images with Reduced Resolution

- Open the image

  ..\02_ImageLinker\Images\
  2.1.81_pan_imagen9.tif

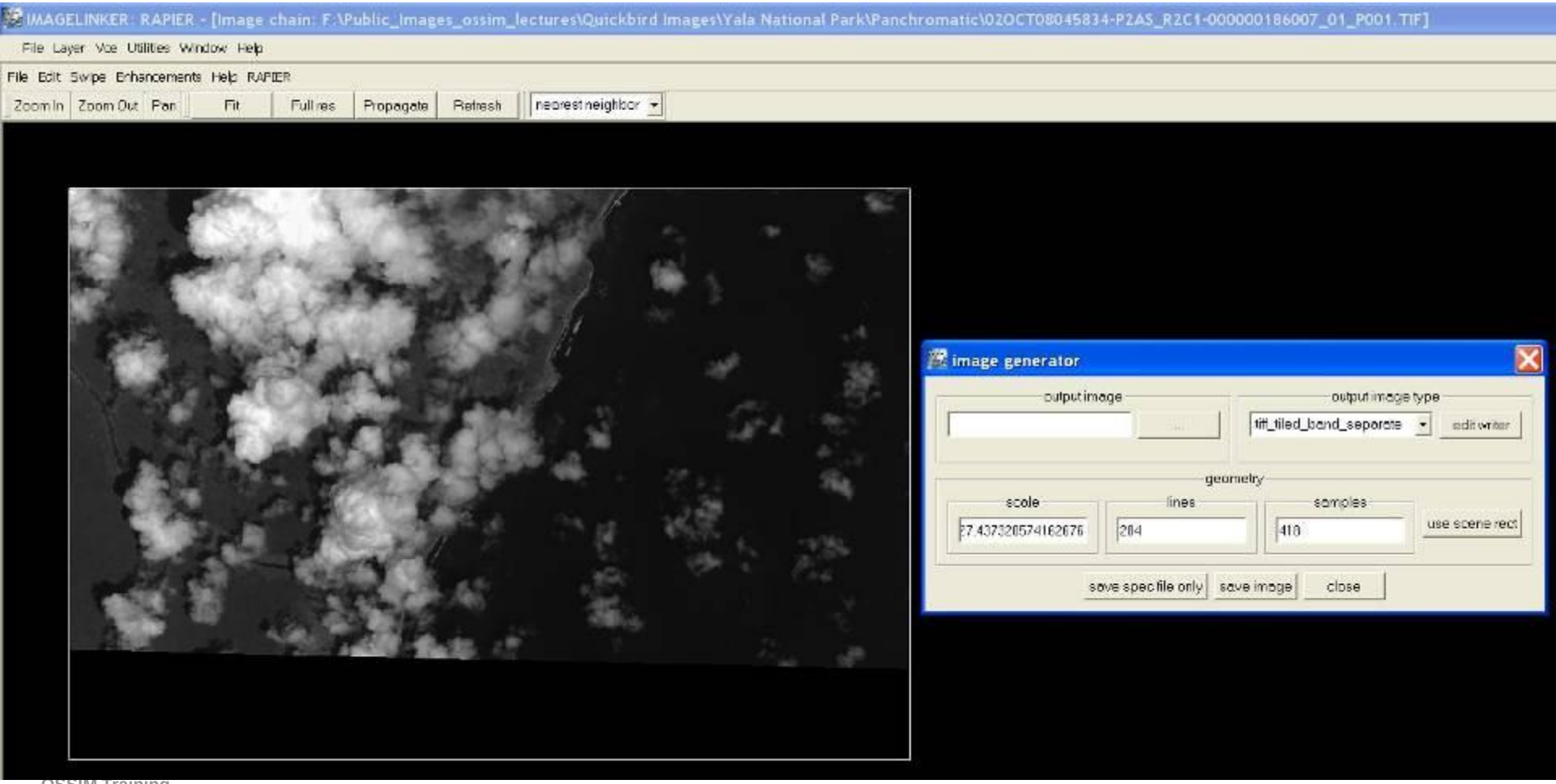
- In the Image menu, select File->Save As



Distribution Statement A: Unlimited Distribution

Saving Images with Reduced Resolution

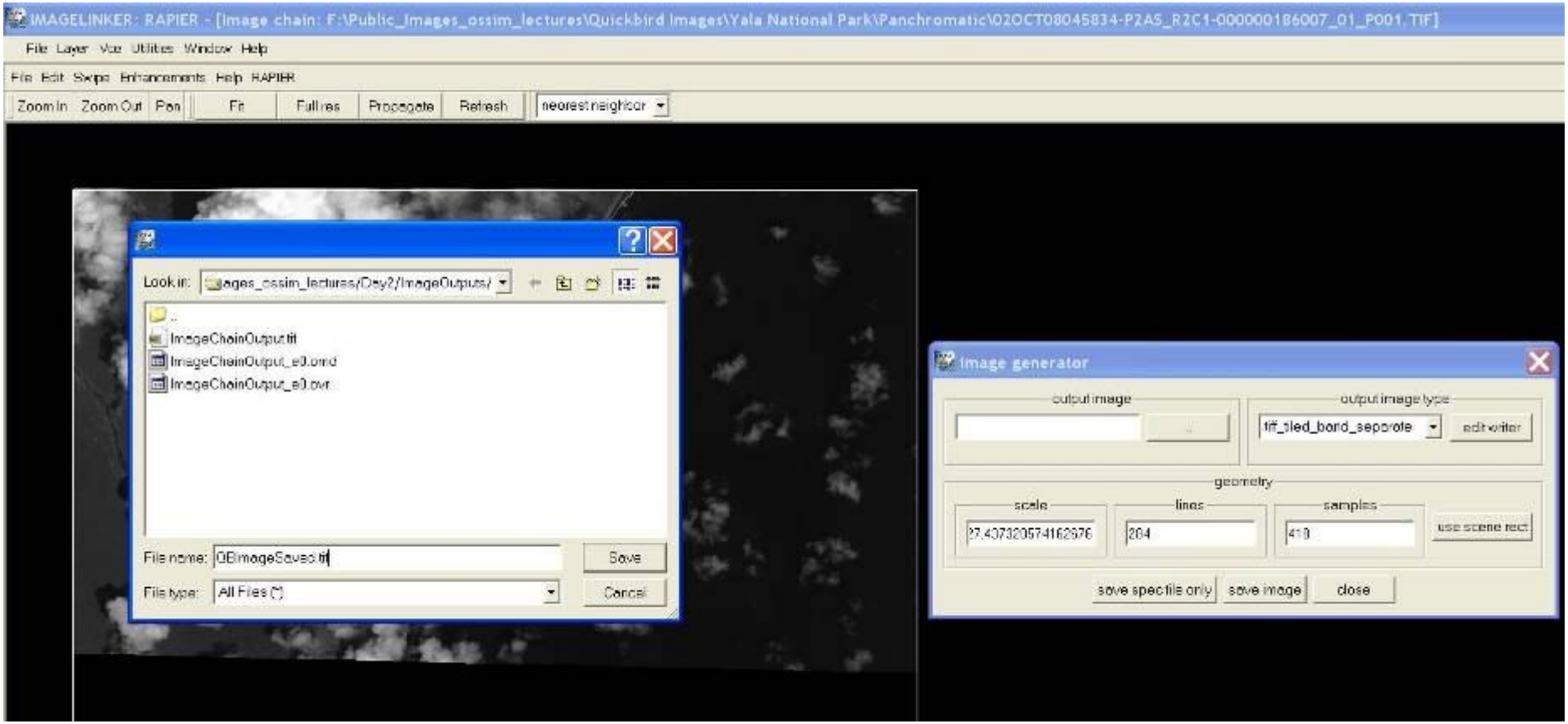
- Click on the … next to output image.



Distribution Statement A: Unlimited Distribution

Saving Images with Reduced Resolution

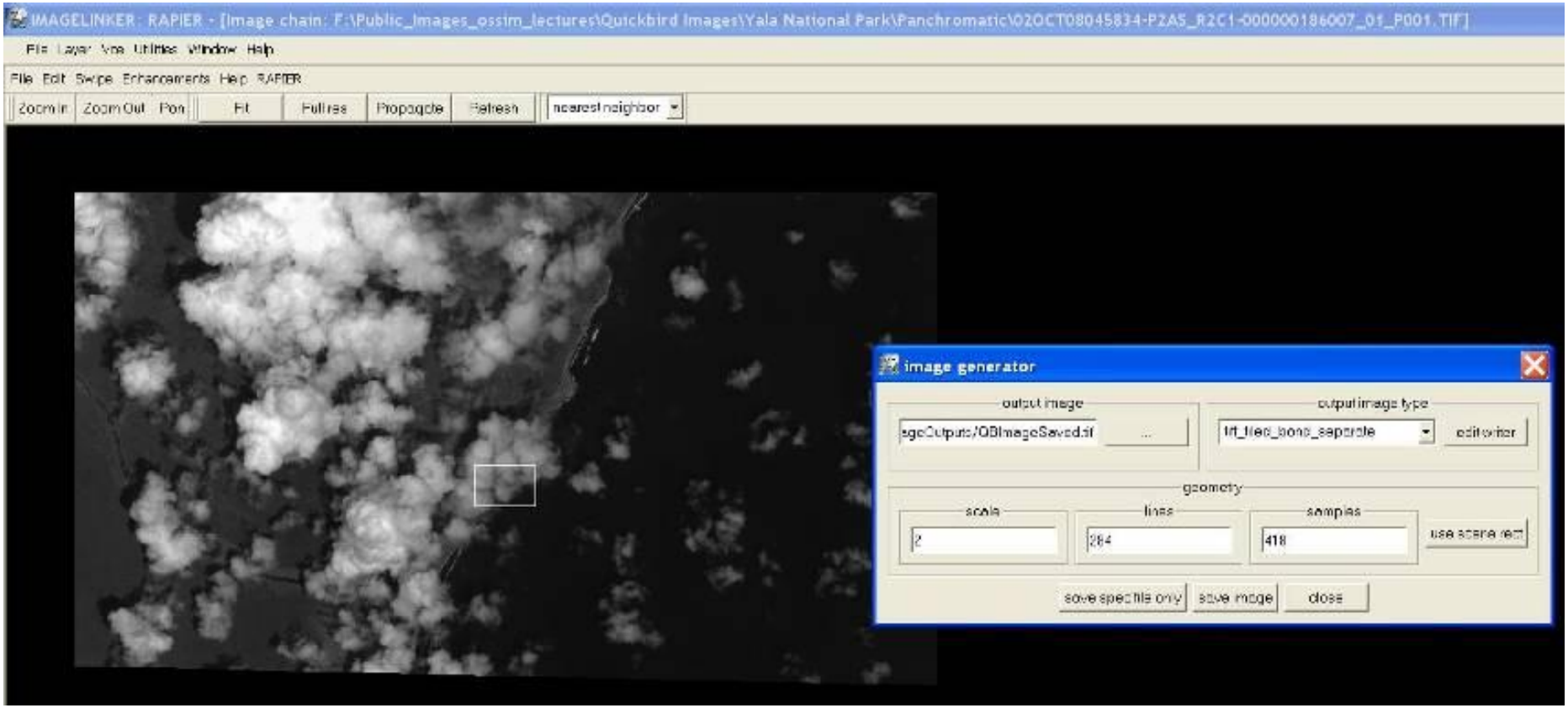
- Save the image anywhere as QBImageSaved.tif



Distribution Statement A: Unlimited Distribution

Saving Images with Reduced Resolution

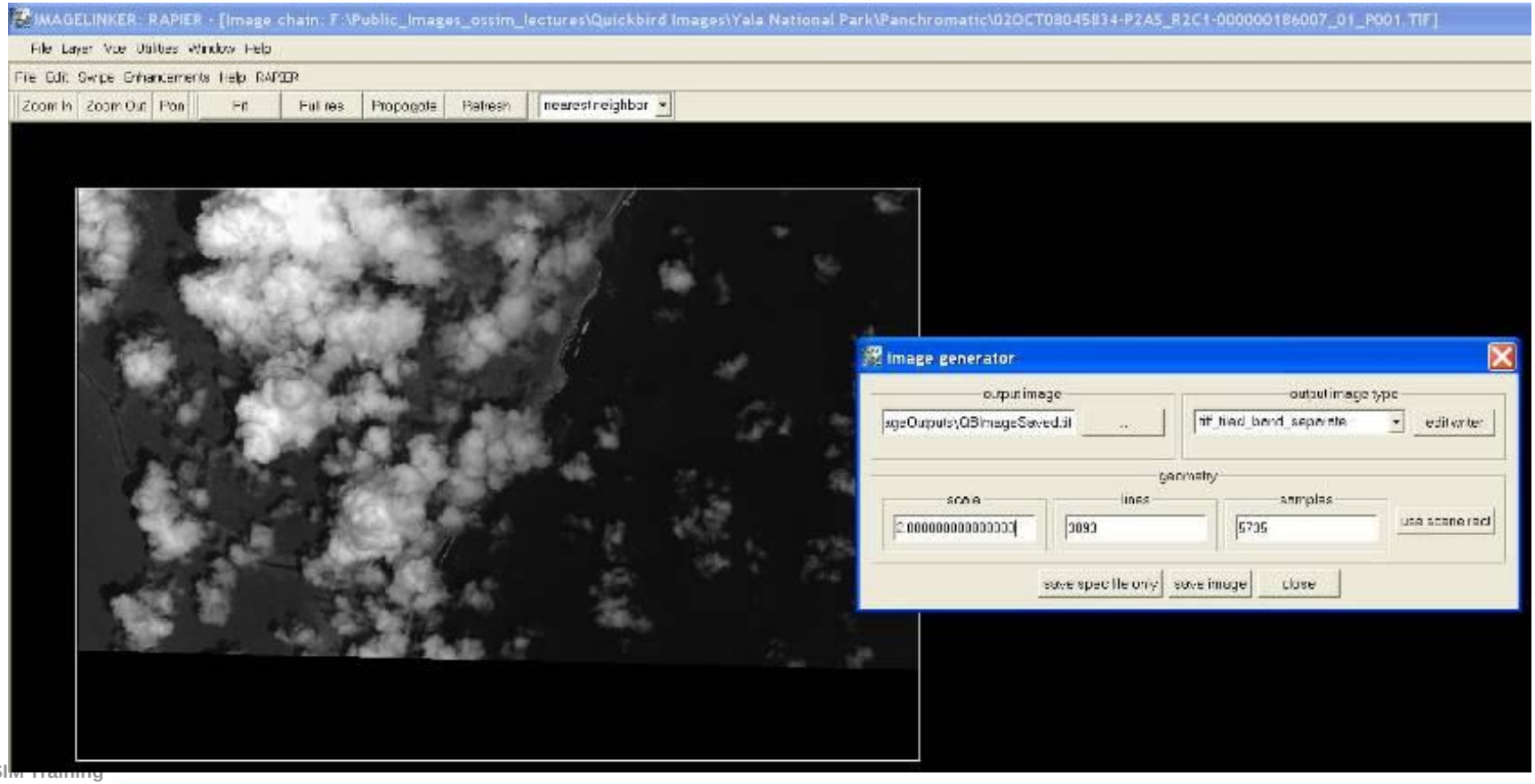
- Click on the space under scale, enter 2, and hit enter.
- You should see the white box (representing the image to be saved) shrink.
- Notice that the lines and samples are very low.



Distribution Statement A: Unlimited Distribution

Saving Images with Reduced Resolution

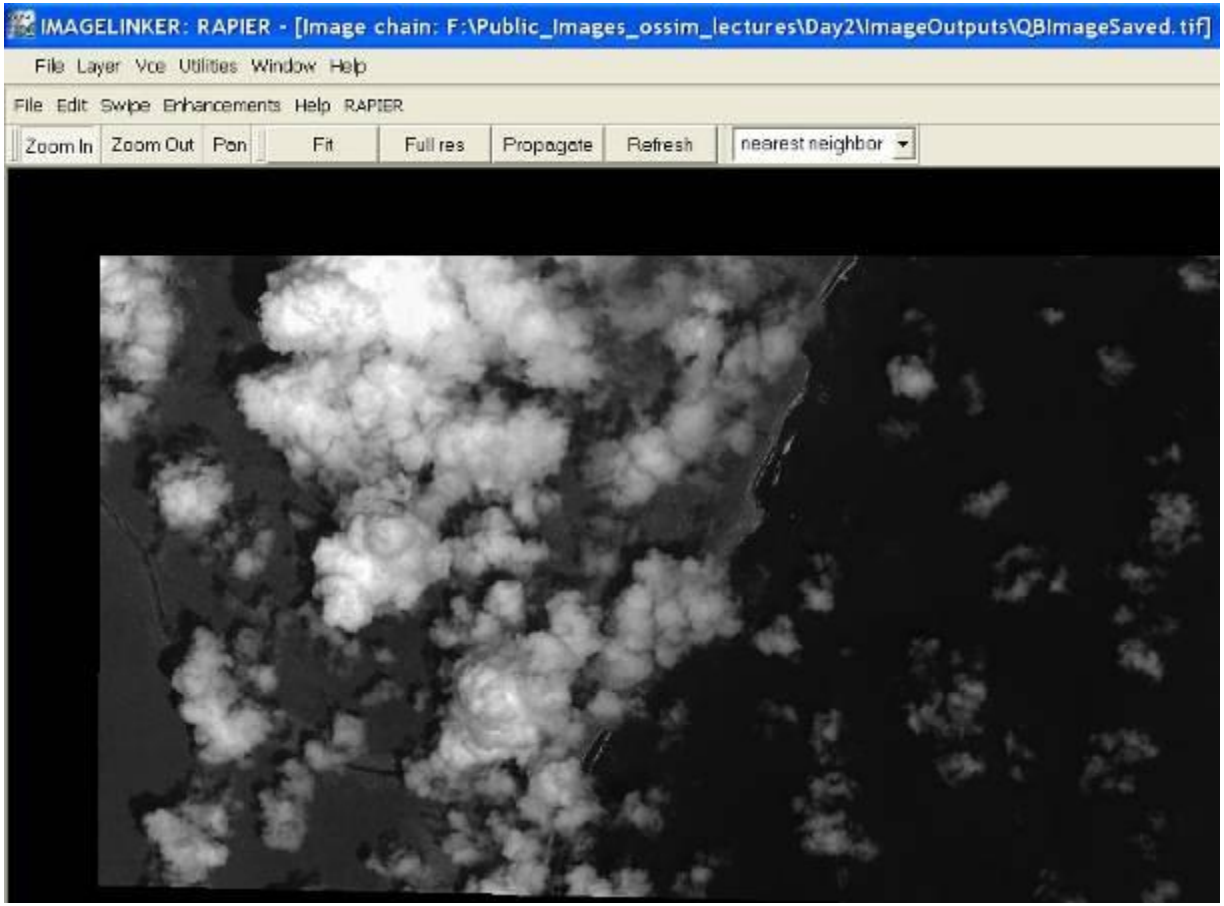
- Click on use scene rect. You should see the white rectangle cover the entire image.
- Now click save image.



Distribution Statement A: Unlimited Distribution

Saving Images with Reduced Resolution

- When the image is done saving, it will load in ImageLinker.
  - What do you notice about the image?



Distribution Statement A: Unlimited Distribution

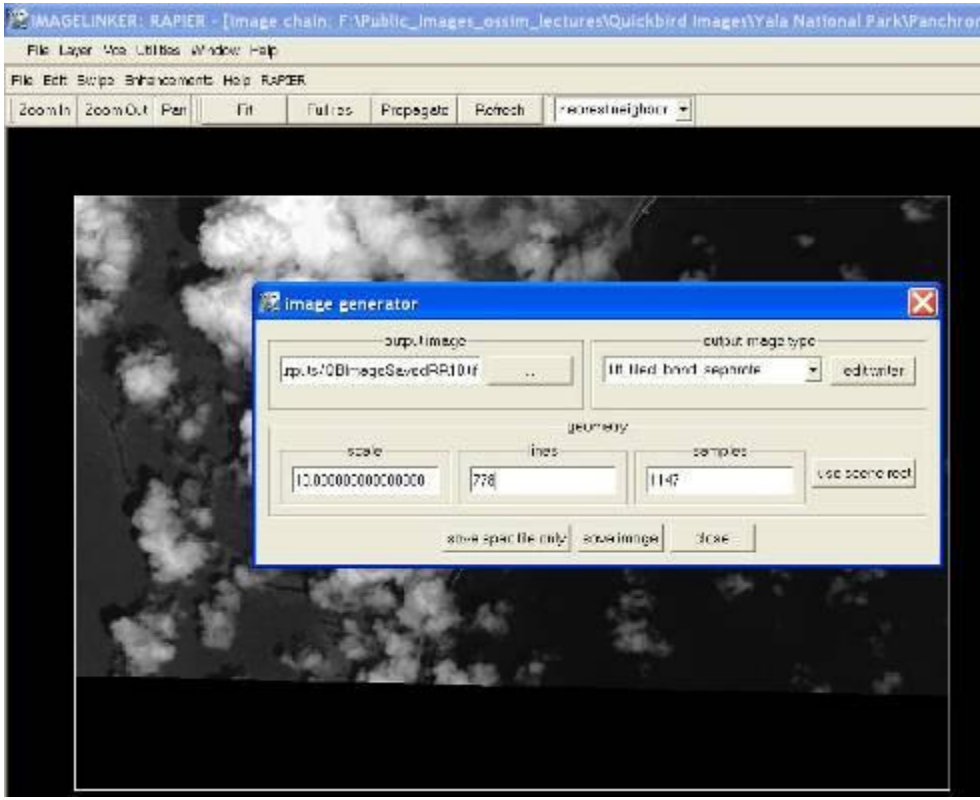
Saving Images with Reduced Resolution

- Now on the image generator menu, change scale to 10.0 and hit enter.
- Hit use scene rect.
  - What do you notice about the lines and samples?

▼Click the … on output image and change the output name to QBImageSavedRR10.tif

▼Click save image.

What do you notice about the amount of time it takes to save the image as compared to scale2?



Distribution Statement A: Unlimited Distribution

Saving Images with Reduced Resolution

- Zoom in and pan around QBImageSavedRR10.tif.
- Does the Image appear to be of a lower resolution?

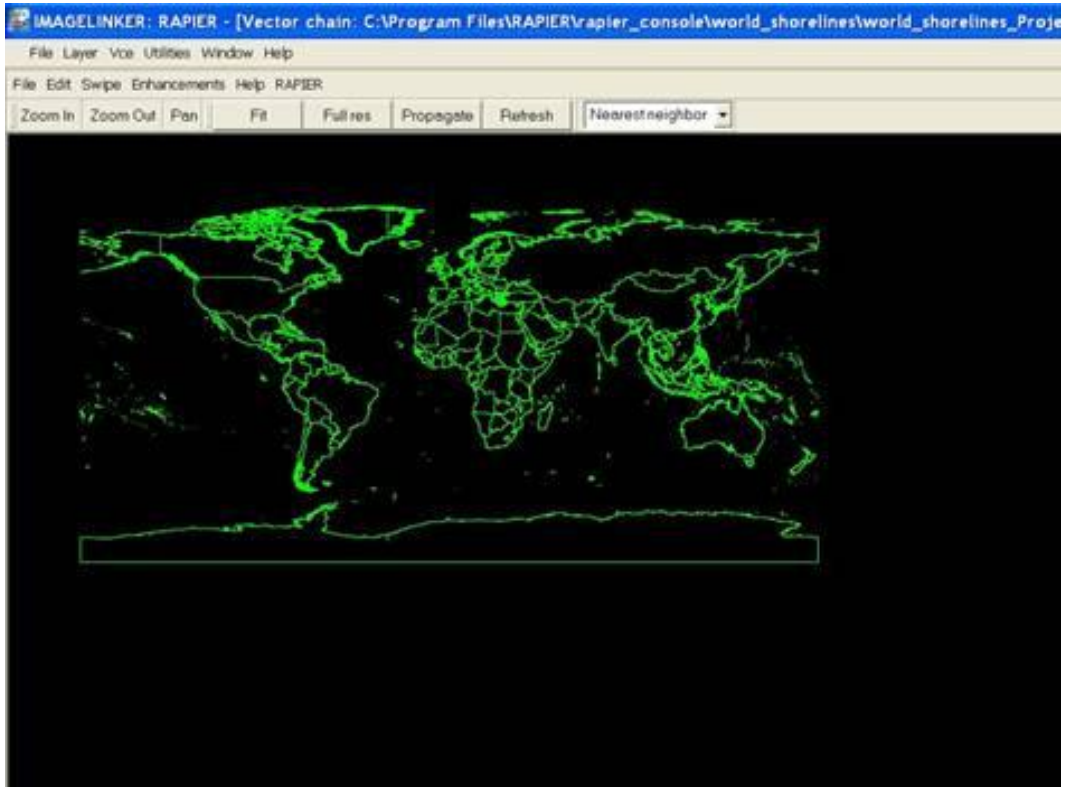
Distribution Statement A: Unlimited Distribution

Overlaying the World Vector Shoreline (WVS)

SPAWAR Systems Center PACIFIC

World Vector Shoreline

- Very large low resolution vector delineating all of the world's shorelines.
- Can be used to mask out land (if looking at water), or mask out water (if looking at land).



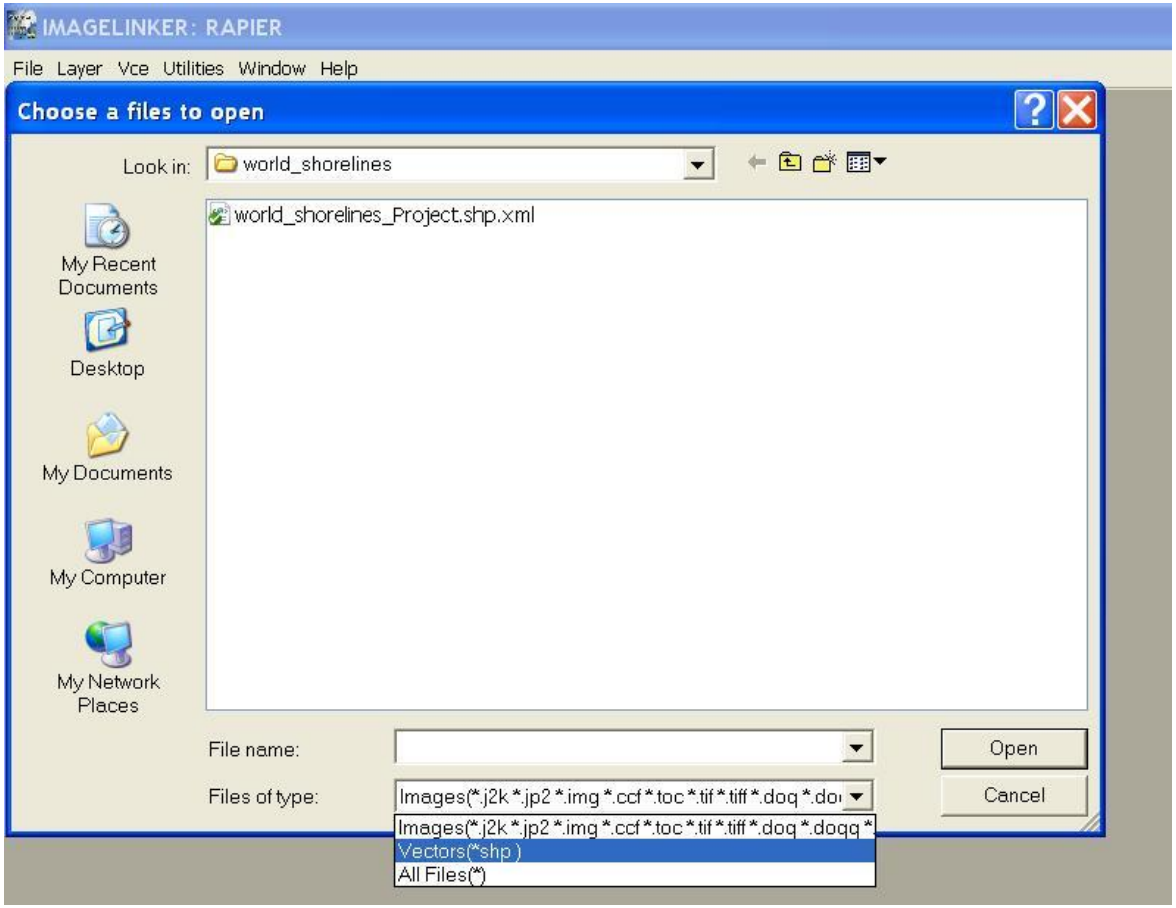
Distribution Statement A: Unlimited Distribution

Overlaying the World Vector Shoreline onto an Image

- To open the WVS, select File->Open Image. Change the Files of Type selection to Vectors (*shp)

- Open file

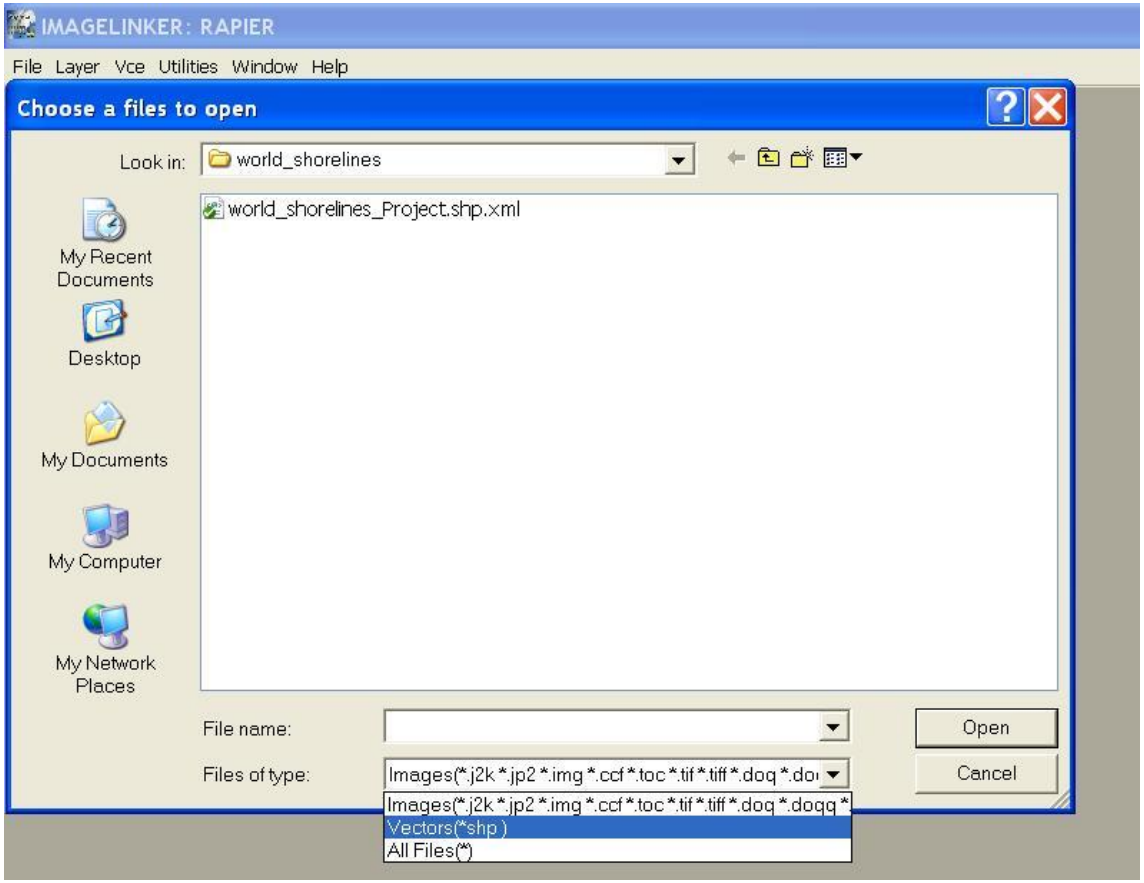
  ..\02_ImageLinker\Images\2.1.91_wvs.shp



Distribution Statement A: Unlimited Distribution

Overlaying the World Vector Shoreline onto an Image

- Select world_shorelines_Project.shp, and hit open.
- It may take some time to load the WVS for the entire globe.

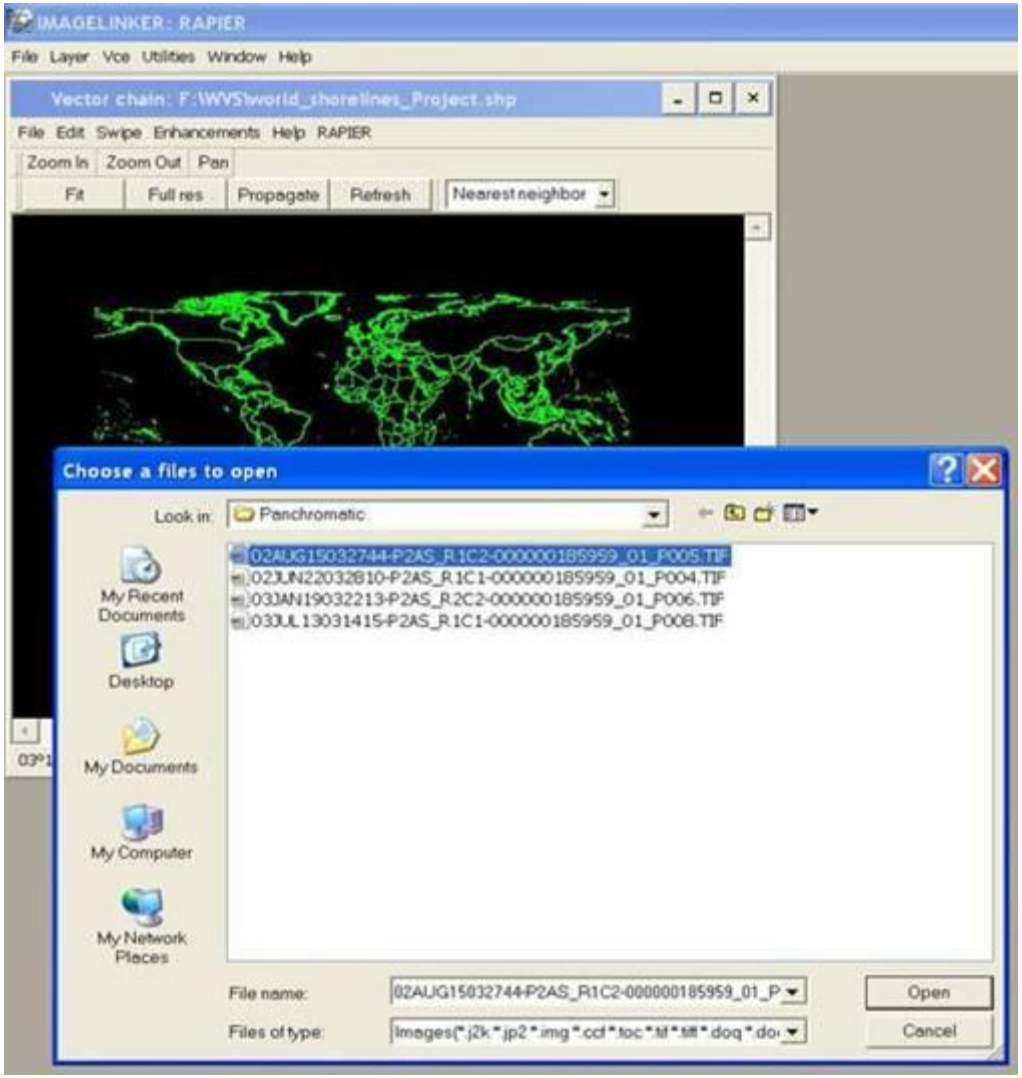


Distribution Statement A: Unlimited Distribution

Overlaying the World Vector Shoreline onto an Image

- Open the image

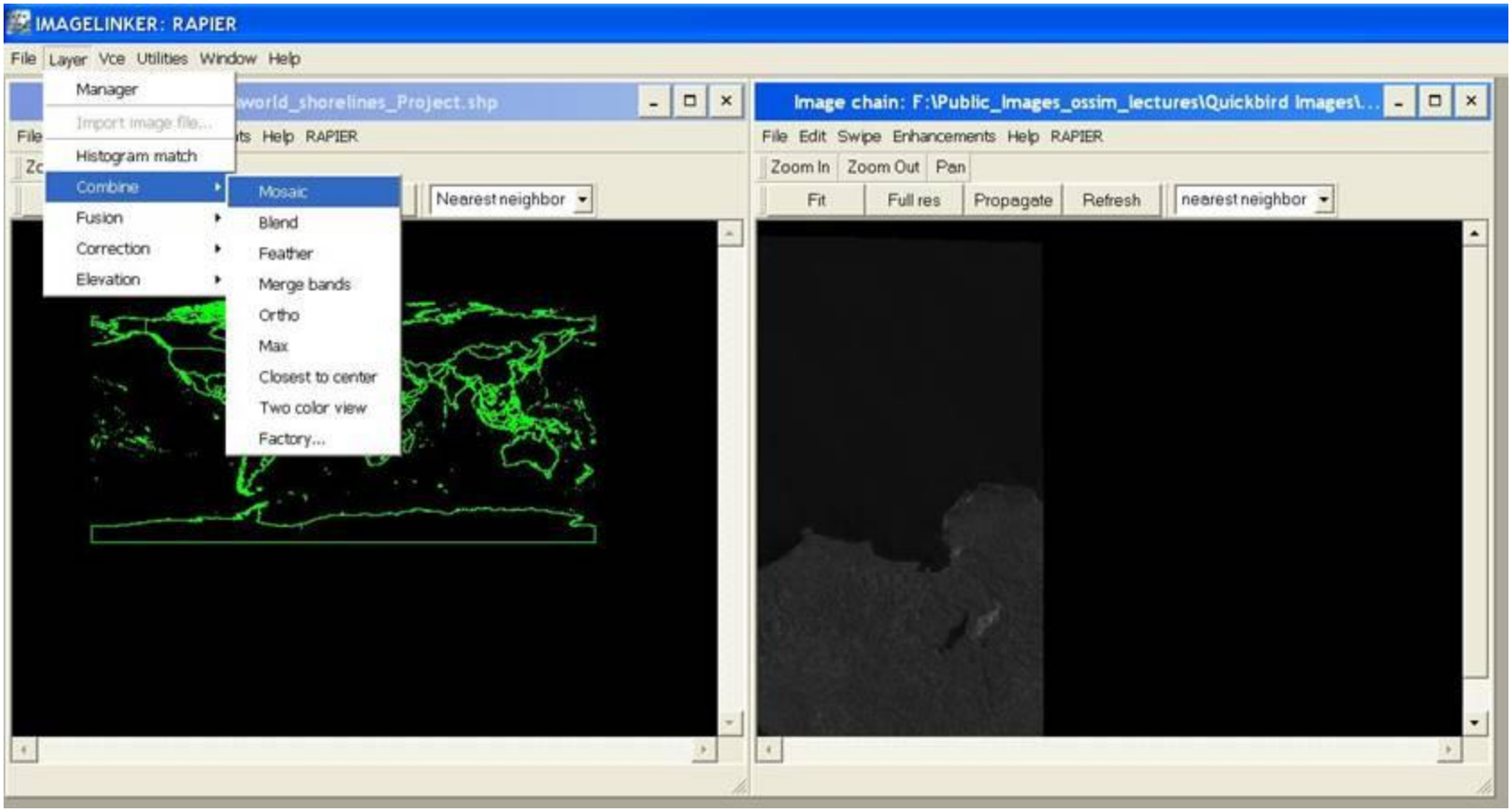
  ..\02_ImageLinker\Images\
  2.1.93_pan_imagen10.tif



Distribution Statement A: Unlimited Distribution

Overlaying the World Vector Shoreline onto an Image

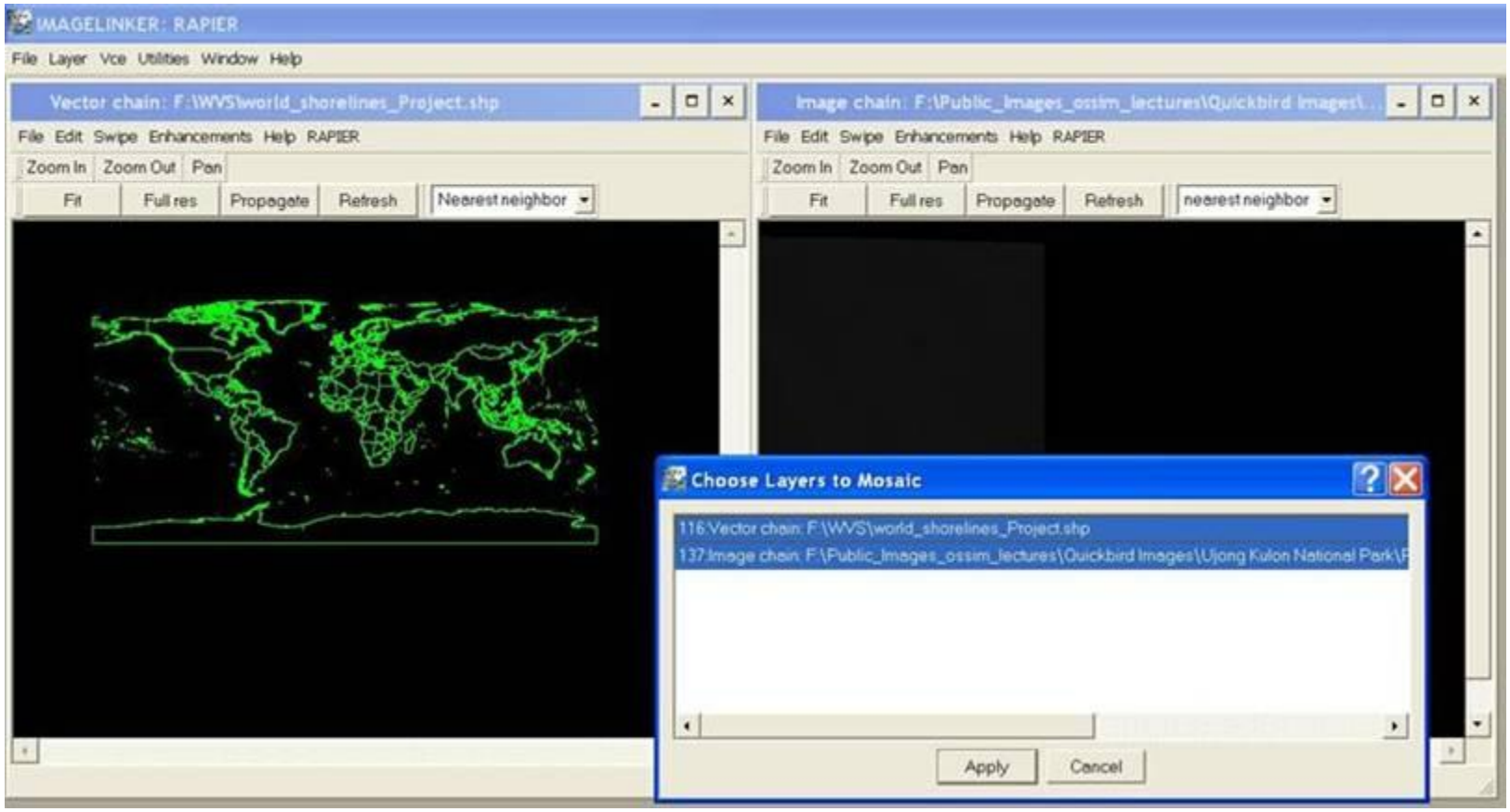
- Select Layer->Combine ->Mosaic



Distribution Statement A: Unlimited Distribution

Overlaying the World Vector Shoreline onto an Image

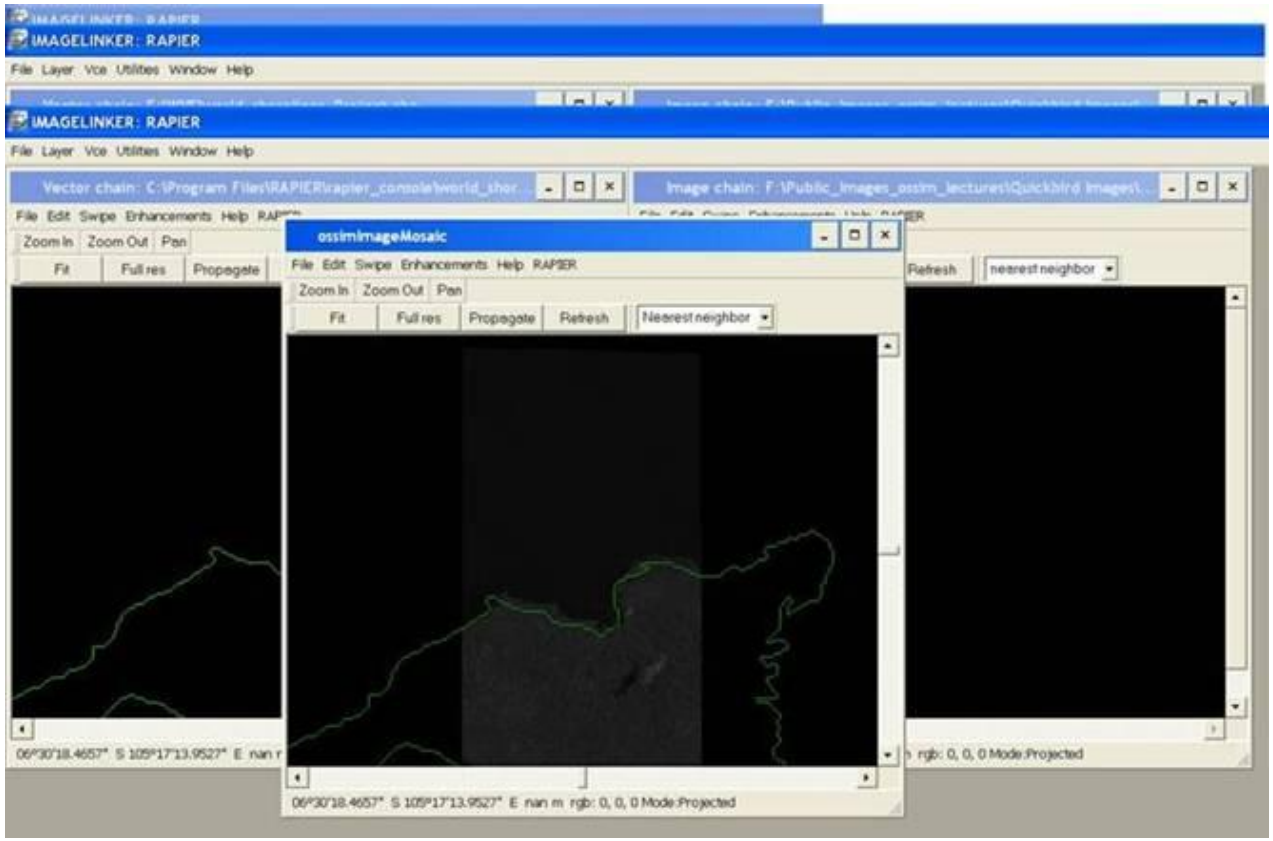
- Choose the Image and the WVS layer to mosaic.
- Hit apply
- There will now be 3 displays, two of which have the WVS



Distribution Statement A: Unlimited Distribution

Overlaying the World Vector Shoreline onto an Image

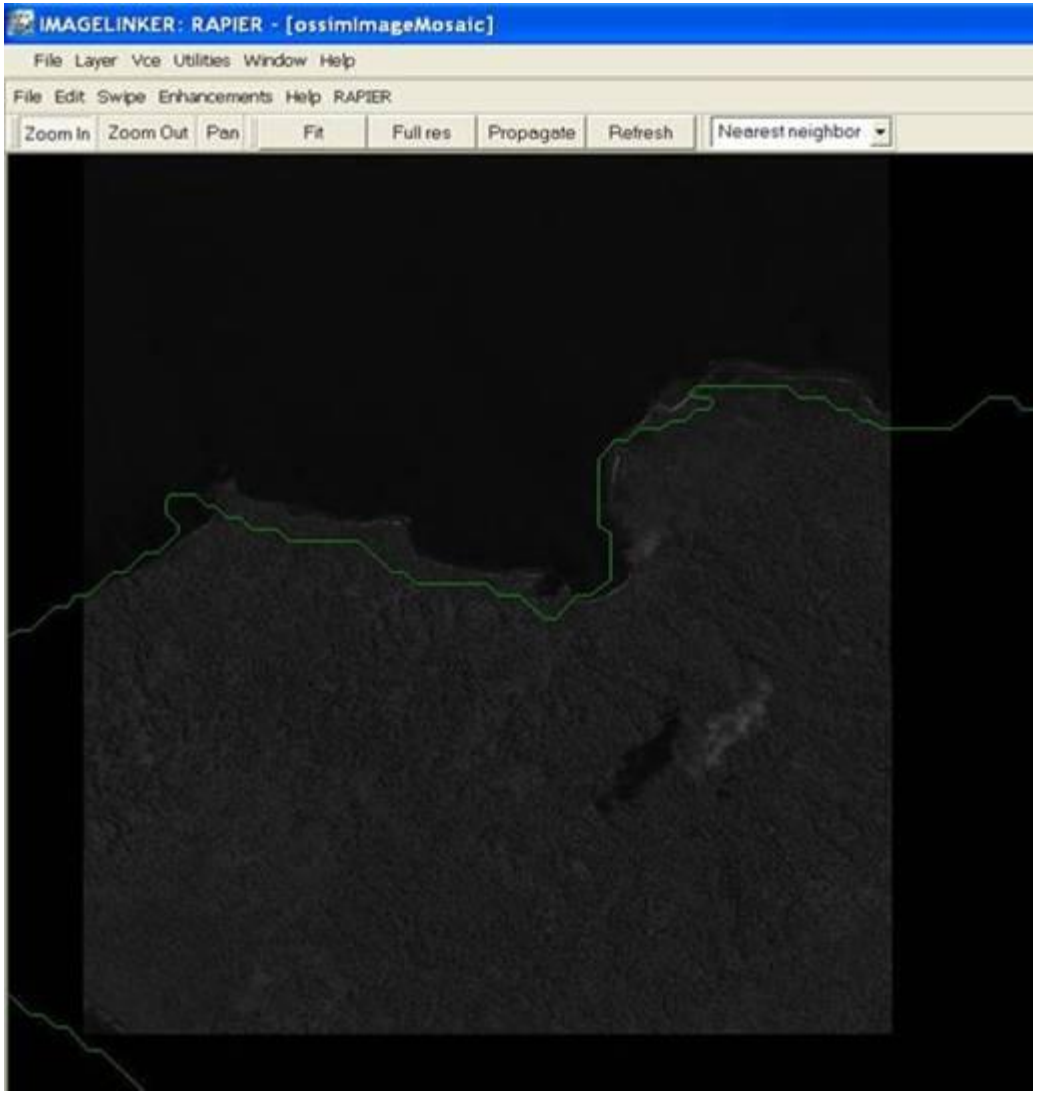
- On the Image Chain image (not the Vector Chain or ossimImageMosaic), hit Full Res, then Fit.
- Then hit Propagate (on Image Chain Image). This should cause the mosaic to display the WVS and the Image.



Distribution Statement A: Unlimited Distribution

Overlaying the World Vector Shoreline onto an Image

- Zoom in and examine the WVS overlay onto the image.
  - Does the resolution of the WVS appear to be high or low? Does it follow the coastline exactly?
  - What phenomena (natural and man-made) might cause errors in the WVS?



Distribution Statement A: Unlimited Distribution

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Conclusion

Distribution Statement A: Unlimited Distribution