Section 21: Understanding Spatial Models

Section Objective

This section will introduce students to the ERDAS IMAGINE Spatial Modeler. To better understand and improve upon your capabilities of producing your own spatial models, this section will provide a solid starting point.

A Spatial Model is a collection of operators, and is presented as a page containing a set of interconnected operators. The main use of a model is it allows you to create a self-contained functional piece that can be re-used in other solutions. It is similar to a function in a programming language. Spatial Models are saved in files with a .gmdx extension.

Tools Used

- Customize the Ribbon Tool — Add a model to a configurable ribbon interface
- Model Execute Options — Preview or Run model directly from the Editor Window
- Operator Properties Dialog — Define variables or values in Operators without ports
- Processing Properties — Define display name and model icon
- Spatial Model Editor — Core Spatial Model Editing Window

Model Operators Used

- Band Selection — Define band/s to be used in a model
- Command Line — Utilize external .exe executables in your model
- Expression — Expression Editor Syntax for advanced modeling
- Port Input — Used to force a User Input Value/s
- Preview — Creates a Dynamic Preview Window of model output
- Principal Components — Principal Components calculation that can be modified
- Raster Input — Utilize a Raster within your model using this Operator
- Raster Output — Define a Output Dataset using this Operator

Class Notes

Understanding Spatial Models

Objective:

This section will introduce students to the ERDAS IMAGINE Spatial Modeler. To better understand and improve upon your capabilities of producing your own spatial models, this section will provide a solid starting point.

Task 1: Spatial Model Basics

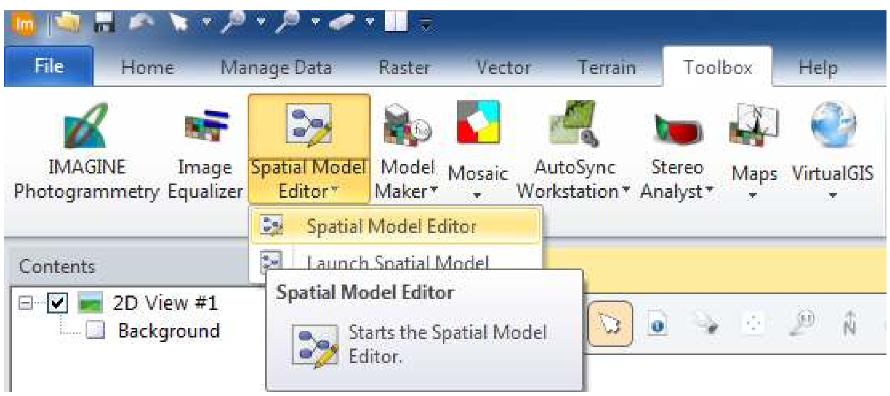
Please revise the following content in your own time and during class, follow the instructor's presentation for further understanding. A better understanding of the concepts behind the Spatial Modeler will help allow you to create Spatial Models with ease.

Models A Spatial Model is a collection of operators, and is presented as a page containing a set of interconnected operators. The main use of a model is it allows you to create a self-contained functional piece that can be re-used in other solutions. It is similar to a function in a programming language. Spatial Models are saved in files with a .gmdx extension.

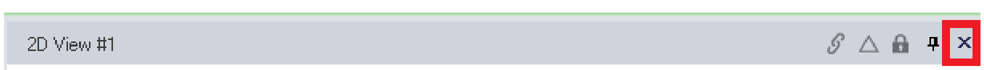
Operators The main building block of a Spatial Model is an operator.

1. From the Toolbox Tab click on **Spatial Model Editor**

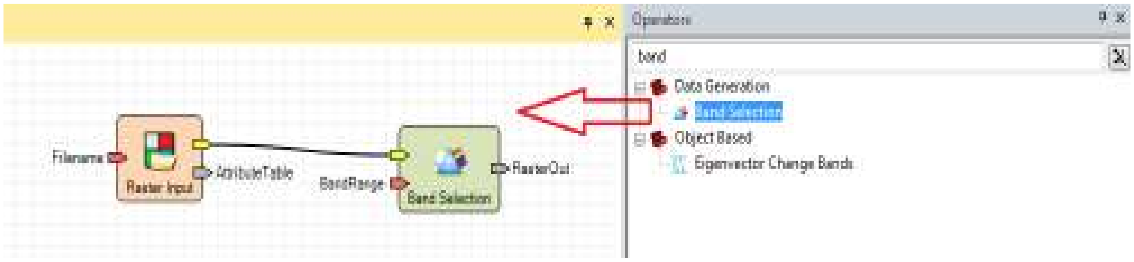
   This will launch a new Spatial Model Editor Page



2. **Close** the **2D View #1**

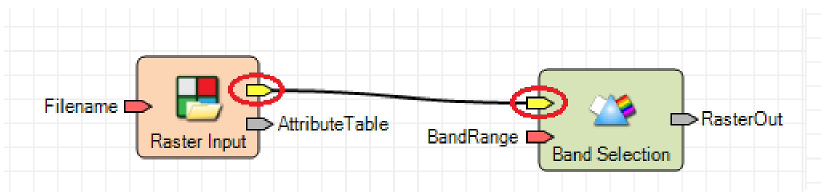


3. Drag into a new Spatial Model Editor; **Raster Input** and **Band Selection** from the Operators List. Remember the Key Word Search!



Operators are presented as rounded rectangles with input ports on the left, and output ports on the right. Each operator will have an icon plus a title below it.

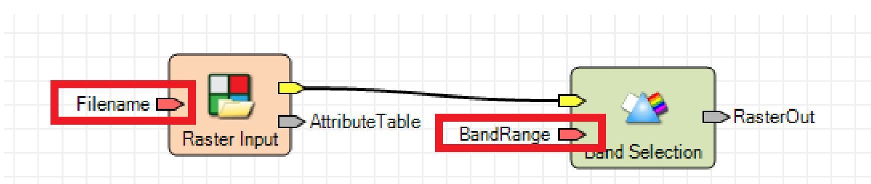
Most operators will have a pale green background, but operators that represent data input or output operations have a pale peach background. Connect the Raster Input, "RasterOut" Port to the "RasterIn" Port of the Band Selection Operator as shown



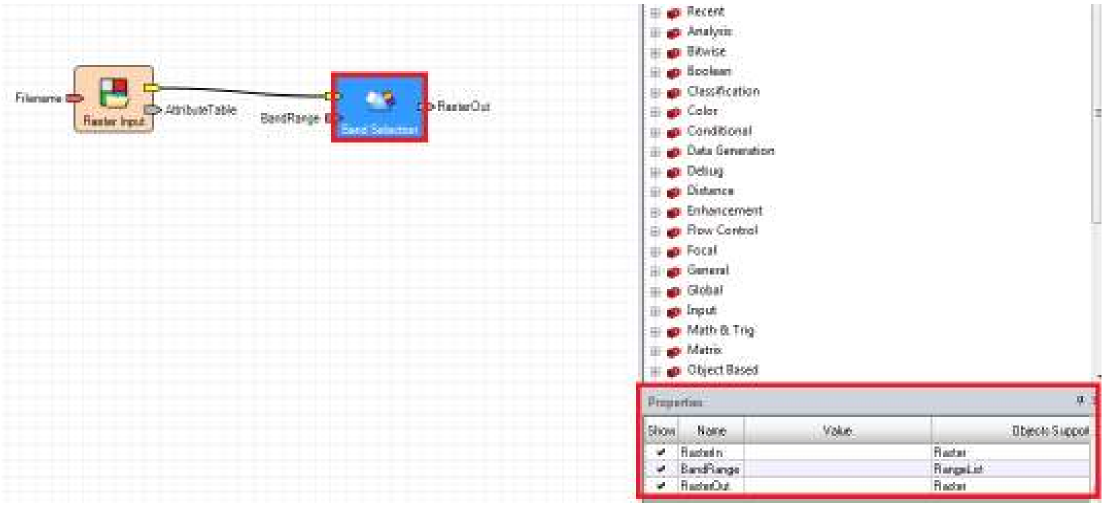
An operator is a self-describing object that performs a task, usually done on some data. It contains input or output points which are called ports. These ports allow data to flow through an operator. Operators are grouped by a category, for example, Data Generation. The Band Selection Operator is listed in the Data Generation category.

This example performs a Band Selection operation on the Raster Input. Operators also contain information about their connections with other operators. In a connection, the operator that runs first is called the parent operator, and the operator that runs second is the child operator. This is usually in a left to right flow as shown in image.

Currently this basic model has two empty ports waiting for an input; 1. A filename for the Raster Input and 2. The Band Range for the Band Selection



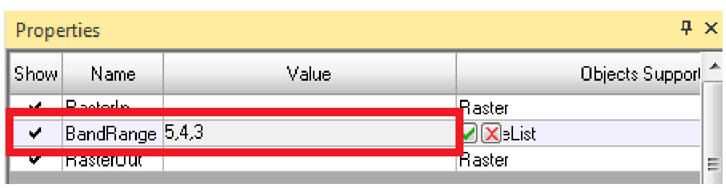
4. You can define an input directly in the model by either double clicking on the operator or by defining the input using the Properties Dialog Box. Highlight the Band Selection Operator so the Properties details appear



By defining the values directly in the properties dialog box, without a Port Input operator, the model will run with this setting without asking user for an input value when running the model. Useful for predefined settings or values that don't change or require a different user input when launching model.

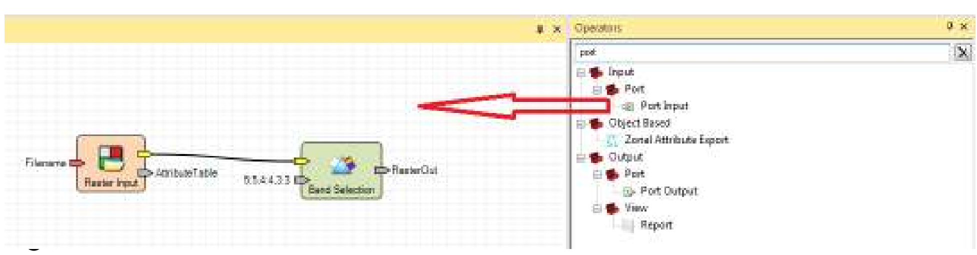
5. In the Band Selection Properties Dialog, Enter the **Band Selection 5, 4, 3**

This will in turn create a 543 Raster from the Input



For values in a model you want to ask the user an input, use a Port Input

6. Fr

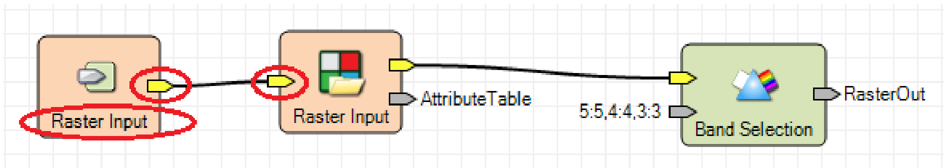


perators List, drag and drop Input Port into the editor

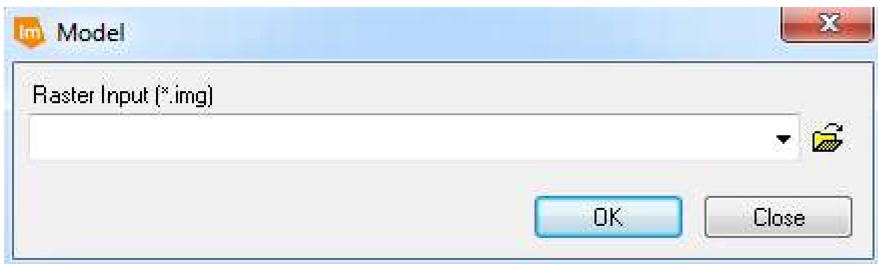
7. Rearrange the Port Input to the Left of Raster Input

8. Right Click on the Port Input and **rename to Raster Input**

9. Connect the Raster Input Port to the Filename port of Raster Input



The Input (and Output) Ports you define, is what will display in your Model Interface



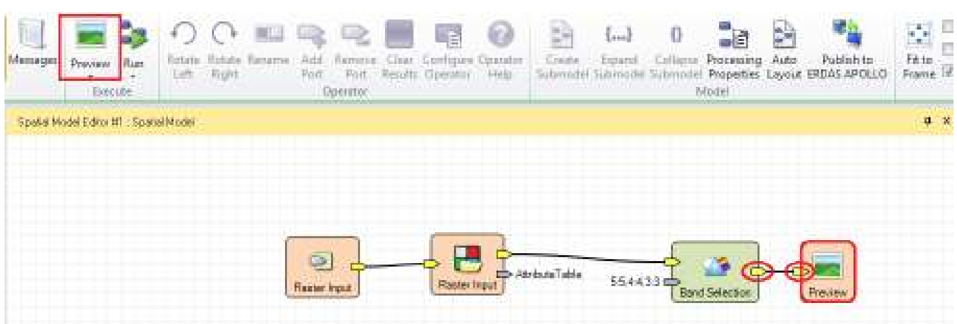
One important reference is to include notes about any restrictions. For example a model requiring a Digital Elevation Model, will best suit a name such as DEM Input, not a simple Raster Input.

So be careful and clever! with naming your ports

10. Drag and Drop a Preview Operator into the Editor

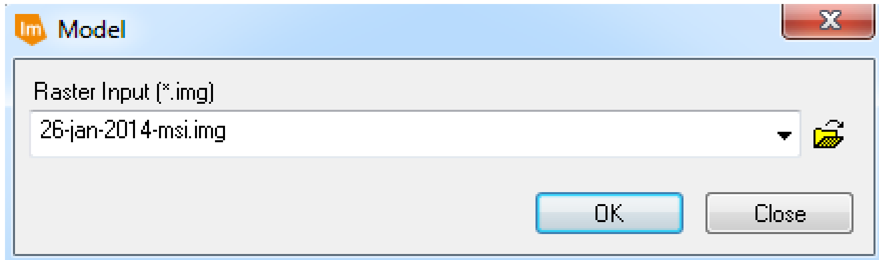
11. Connect the Band Selection Output to the Preview Port.

12. Then Click **Preview** from the Execute Group



The GUI of your Spatial Model will appear

13. From your TrainingData Folder, Load **26-jan-2014-msi.img** and Click **OK**



14. A preview will display of the Landsat8 Image of Perth as a RGB 543 image

15. **Close** the Preview Window
16. **Clear** the Spatial Model Editor

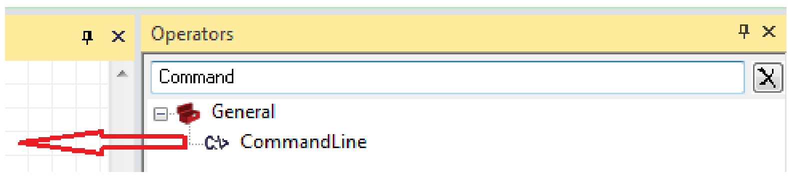
Task 2: Command Line Operator

A new capability in IMAGINE Spatial Modeler (from version 2014) is the Command Line Operator. Use this operator in your models to incorporate external executables. There are many available ER Mapper executables that IMAGINE can pull into and utilize in custom spatial models

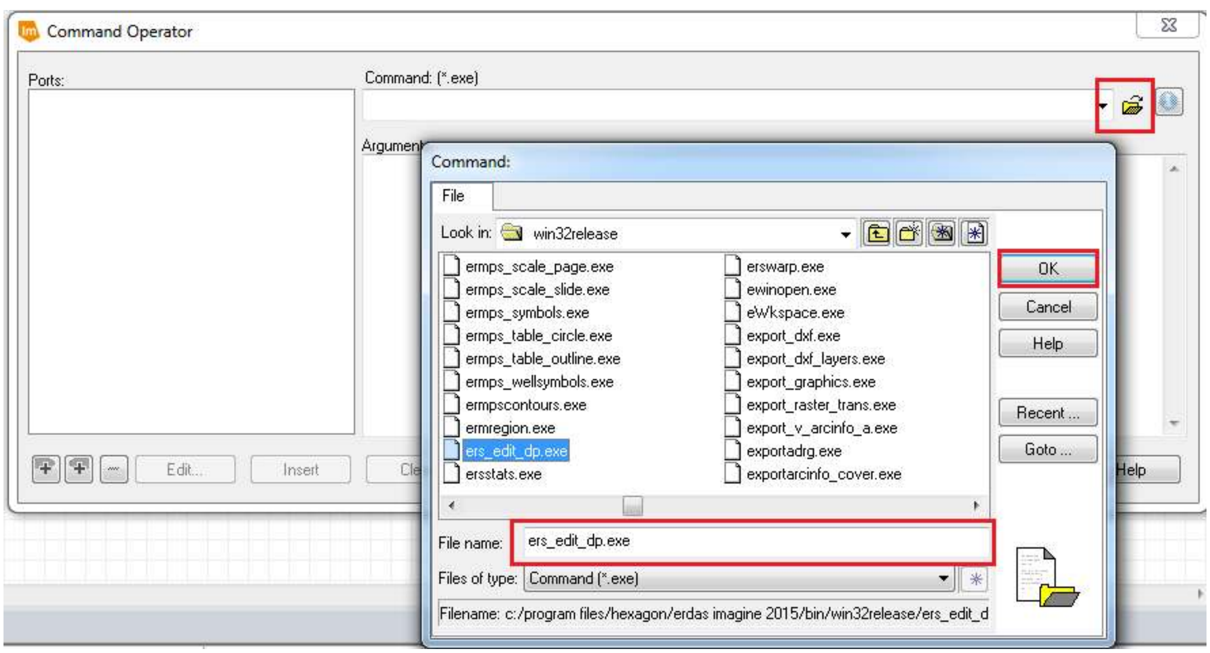
This operator extends IMAGINE's capabilities by allowing you to utilize external programs into the spatial model

This example will create a very simple ERS Header File for any associated input image using the ER Mapper executable from within IMAGINE

1. Open a new Spatial Model Editor
2. Drag and Drop the **Command Line** operator into the Spatial Model Editor



3. **Double Click** on the **Command** Line Operator in the Spatial Model Editor. The Command line settings will appear

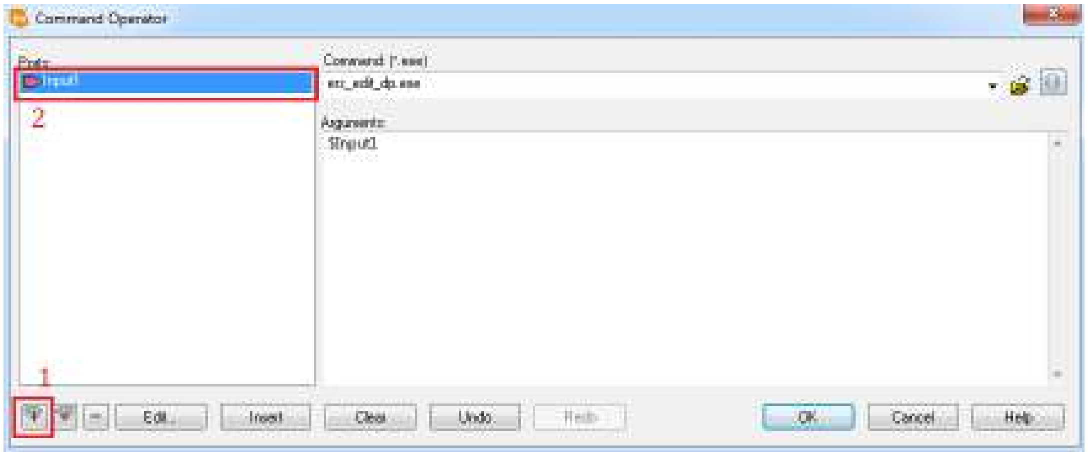


4. **Load ers_edit_dp.exe** and Click **OK**

The ers_edit_dp.exe is available from:

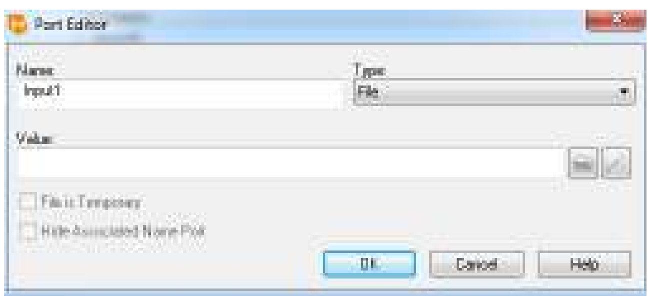
C:\Program Files\Hexagon\ERDAS IMAGINE 2015\bin\win32release

5. **Add an Input** and then **Double Click** on the Port to **add $Input1** to the Command

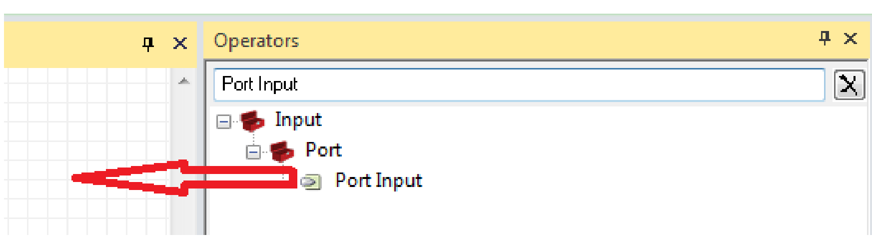


Line Argument

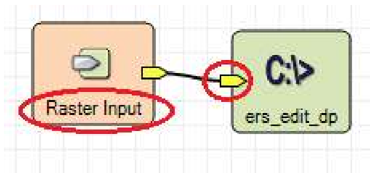
6. Select the Input1 and Click **Edit**
7. Check the Type is set as File and click **OK** to Close



8. Click **OK** again on the Command Operator dialog to Close
9. Drag and Drop a **Port Input** operator into the Spatial Model



10. **Rename to Raster Input** and **Connect** as Shown

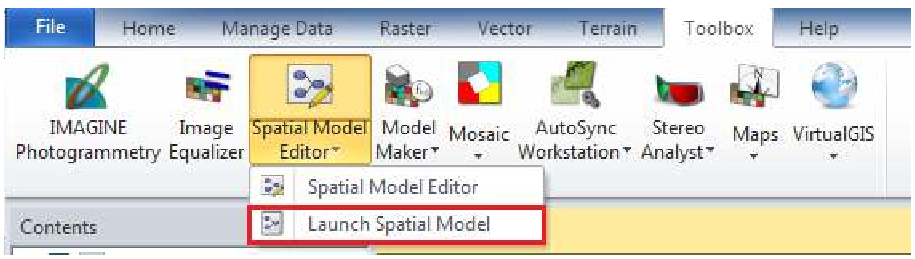


11. File | Save Model As: TrainingData\Output Folder **create_ers_headerfile.gmdx**

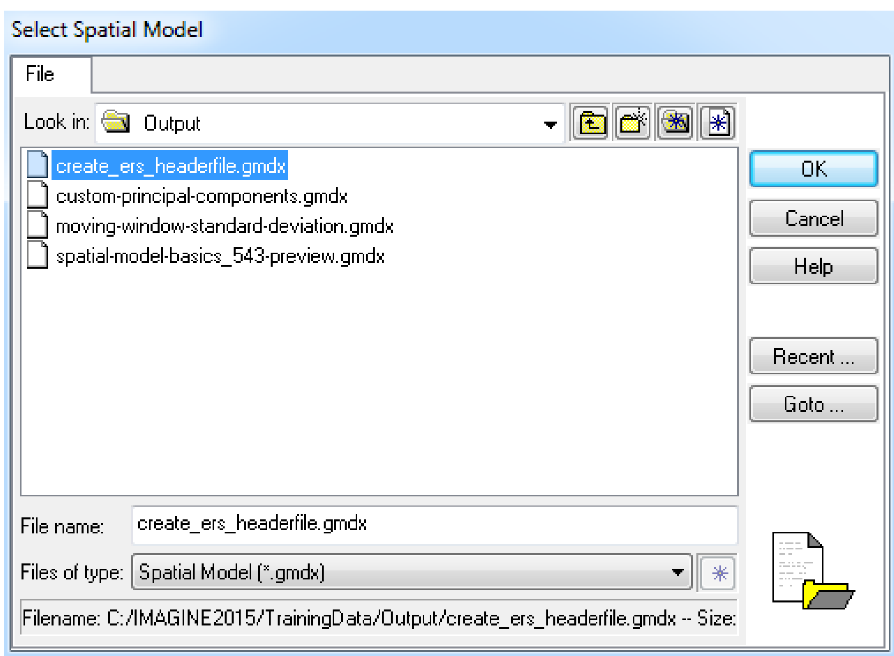
Task 3: Basic Model Batching

This task will briefly highlight how you can further expand your Spatial Model capabilities by easily running in batch mode.

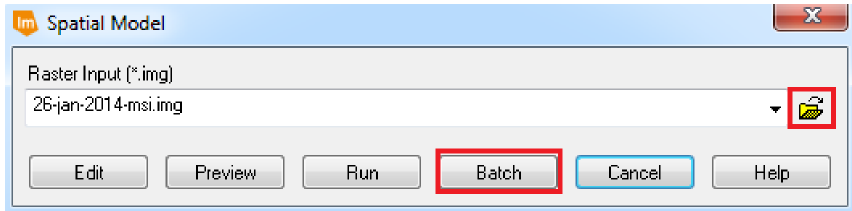
1. Navigate to Toolbox Tab | Common Group | Spatial Model Editor Pull-down list and select **Launch Spatial Model**



2. From TrainingData\Output Folder open **create_ers_headerfile.gmdx**



3. Specify the File Input: TrainingData**26-jan-2014-msi.img** and Click on **Batch**



4. From the Batch Command Editor, Select **Add Files**

5. Ctrl + Shift and add the remaining 5 Landsat Images from the TrainingData Folder:

26-jan-2014-pan.img

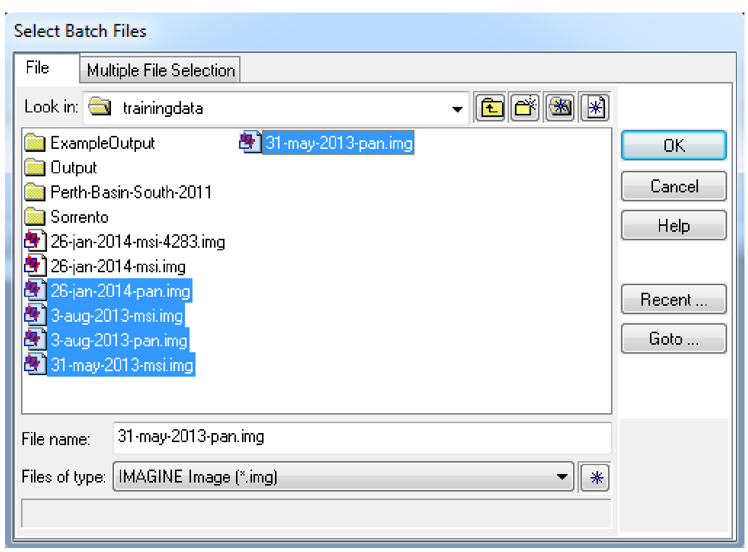
3-aug-2013-msi.img

3-aug-2013-pan.img

31-may-2013-msi.img

31-may-2013-pan.img

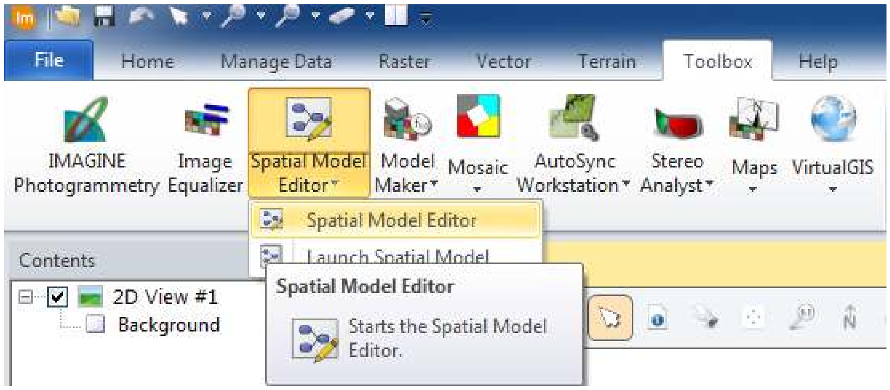
and then click **OK** on the Select Batch Files Window



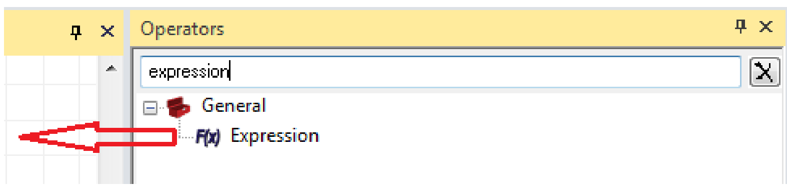
6. On the main Batch Command Editor, Click **Run Now**
7. The Process List will appear to display the status of your Batch Process. The end result will be associated ERS Header Files being created

Task 4: Moving Window Statistics

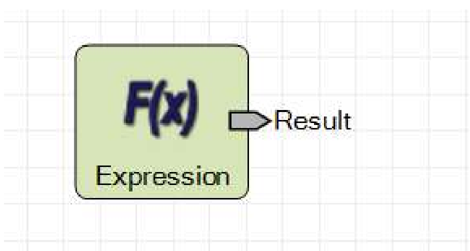
1. Open a new Spatial Model Editor



2. Drag and Drop a **Expression** Operator into the Spatial Model Editor

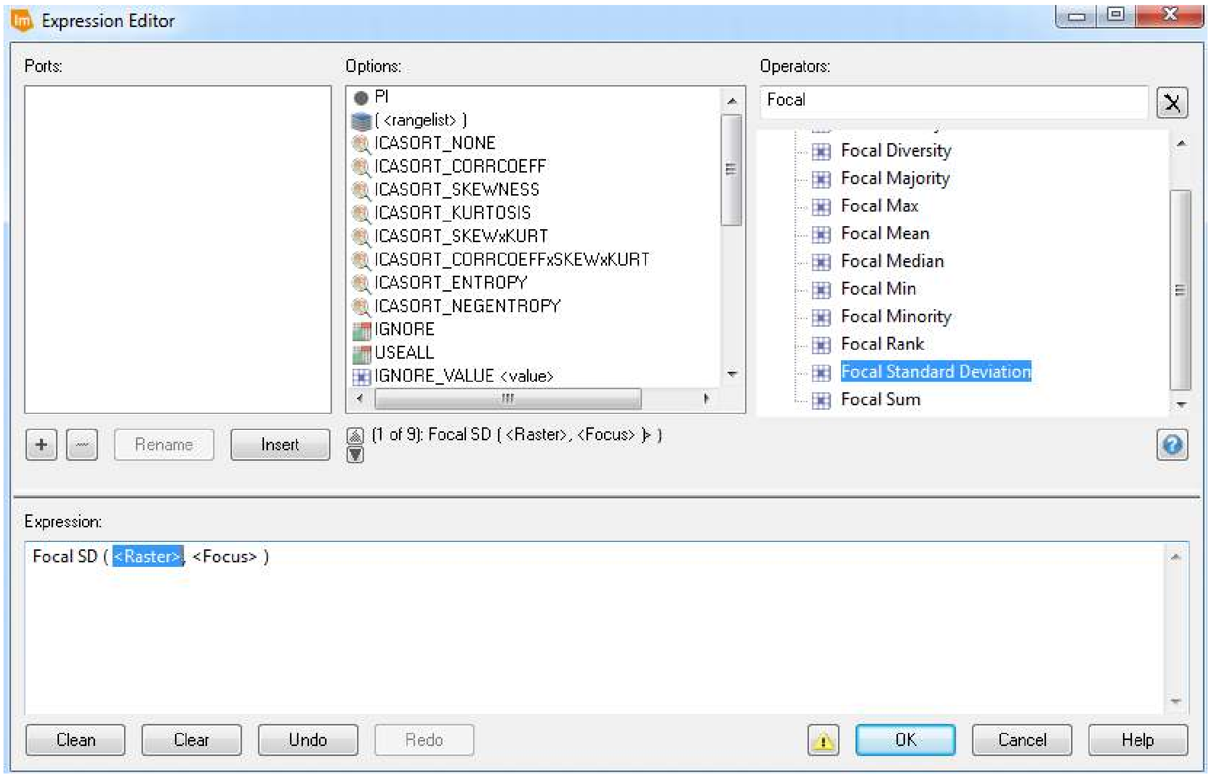


3. **Double Click** on the Expression Operator (in the Editor)

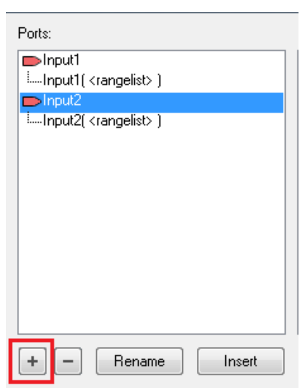


4. This will open the Expression Editor. Enter the key word Focal and double click on **Focal Standard Deviation** to enter its expression into the editor

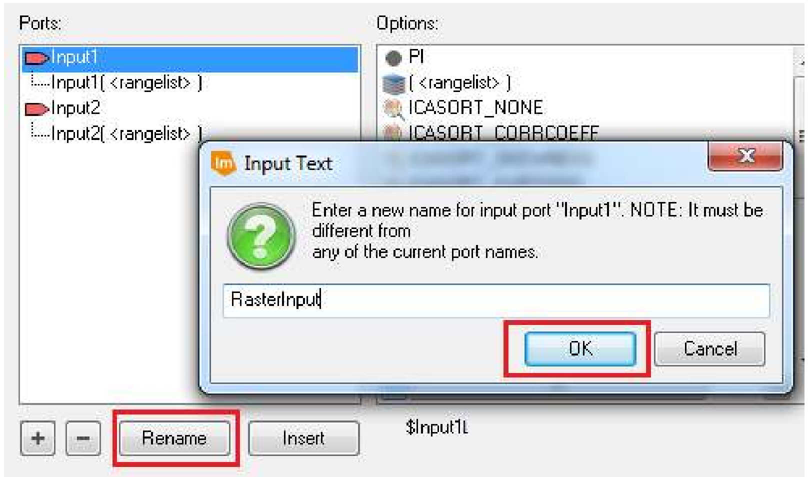
Note – this model can easily be adapted by selecting another Focal Statistics Function such as Min, Max and Rank etc.



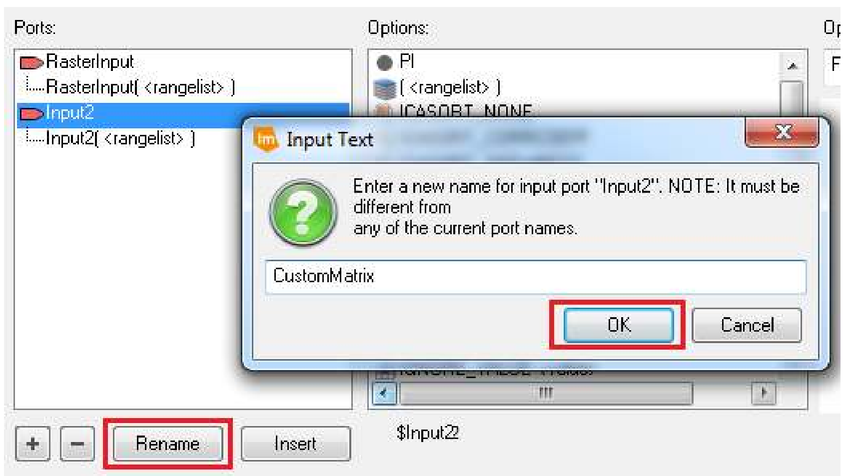
5. **Add Two Input Ports**



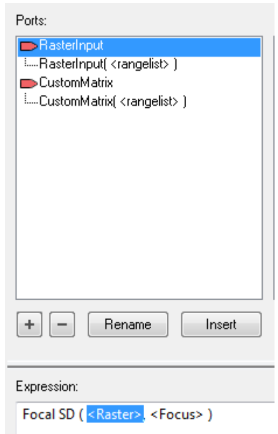
6. Highlight Input1 and **Rename** to **RasterInput** and Click **OK**



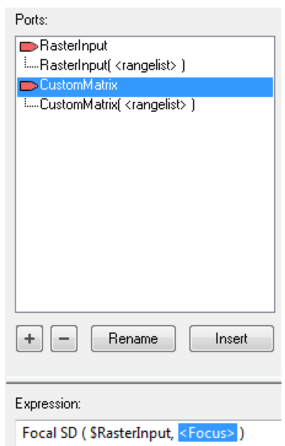
7. Highlight Input2, **Rename** to **CustomMatrix** and Click **OK**



8. Highlight <Raster> in the Expression Editor then Double Click RasterInput from the list of Inputs. This will automatically 'insert' the selected input and replace the highlighted text within the Expression Editor



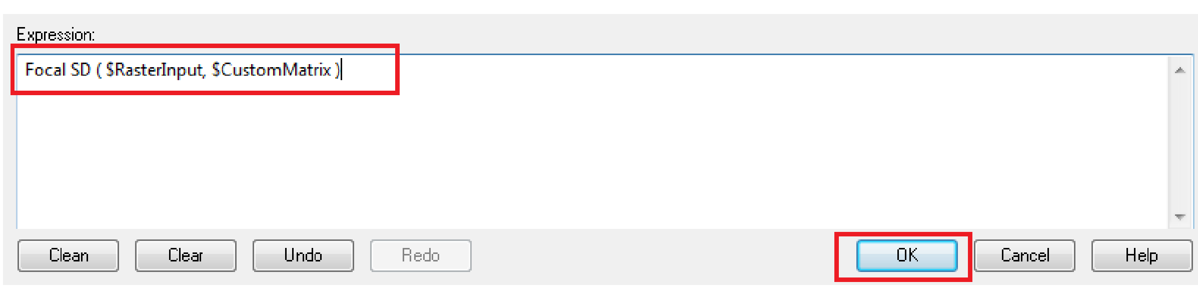
9. Highlight <Focus> in the Expression Editor then Double Click CustomMatrix from the list of Inputs



10. Your Expression Syntax should now read:

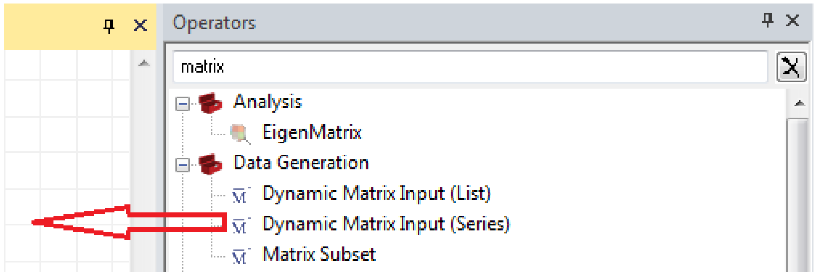
Focal SD ($RasterInput, $CustomMatrix)

11. Click **OK** to Close Expression Editor

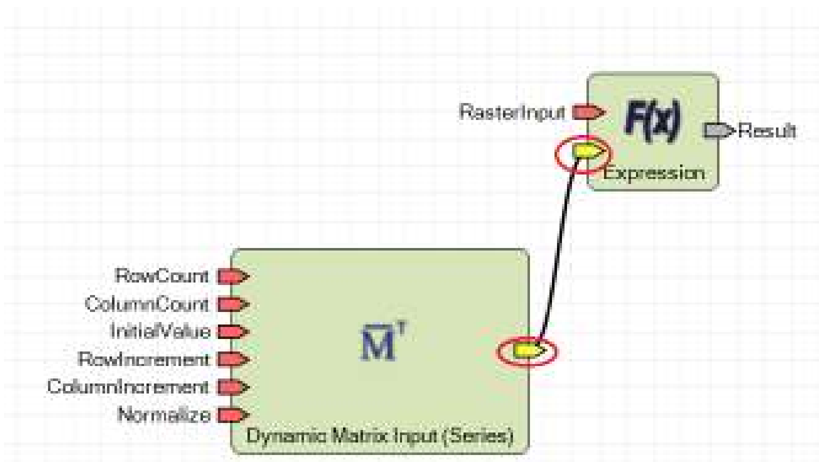


12. Drag and Drop a **Dynamic Matrix Input (Series)** Operator into the Spatial Model Editor

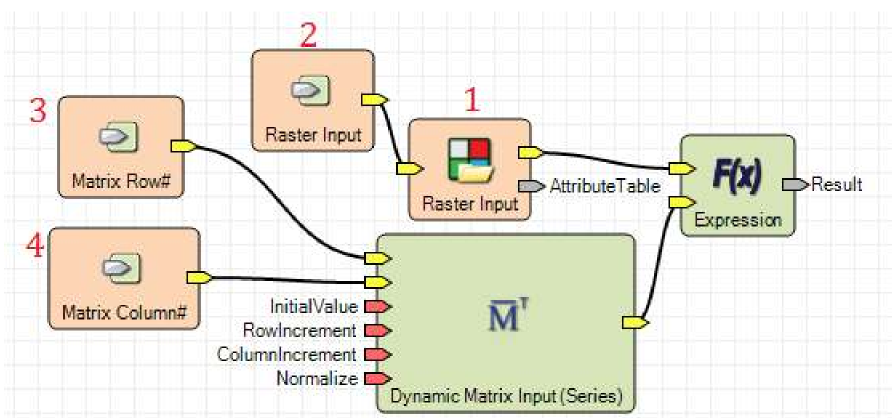
    There are several Matrix Input Options. The Dynamic Matrix Input (Series) Operator will allow the user to specify the Row & Column Sizes



13. Connect the Dynamic Matrix Input Output to the Input of the Expression Operator



14. Drag and Drop a **Raster Input** into the Spatial Model Editor
15. Drag and Drop **3x Port Inputs** into the Spatial Model Editor
16. Connect and Rename as shown



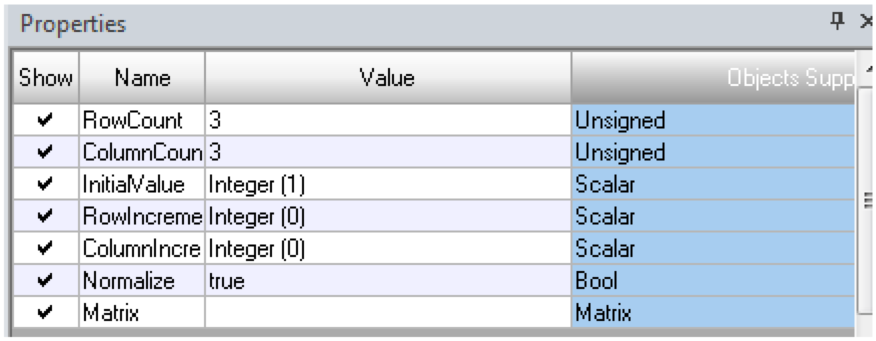
17. Highlight the Dynamic Matrix Input Operator so the Properties Dialog appears and enter the following settings:

    Initial Value: **1**

    Row Increment: **0**

    Column Increment: **0**

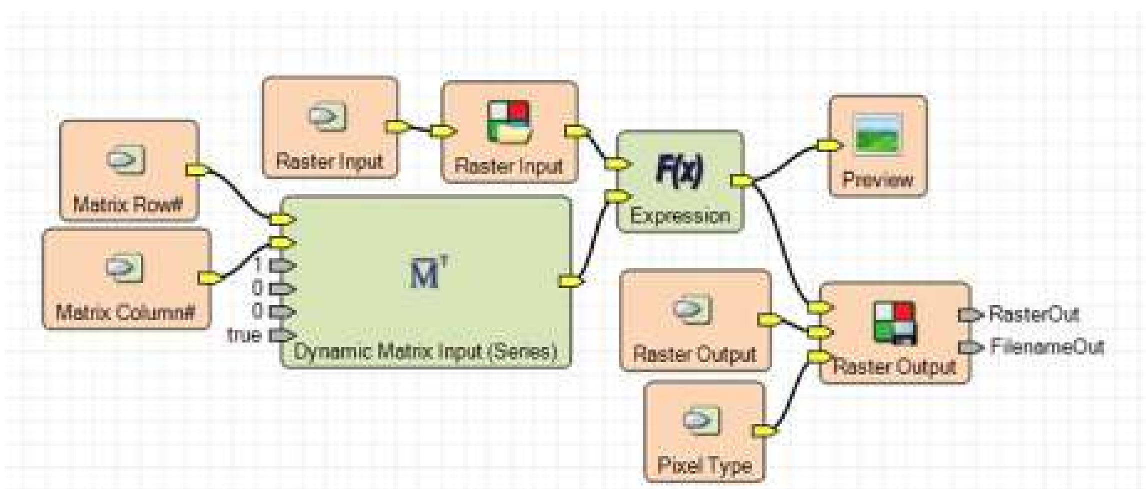
    Normalize: **true**



Properties

Show	Name	Value	Objects Supp
✔	RowCount	3	Unsigned
✔	ColumnCoun	3	Unsigned
✔	InitialValue	Integer (1)	Scalar
✔	RowIncreme	Integer (0)	Scalar
✔	ColumnIncre	Integer (0)	Scalar
✔	Normalize	true	Bool
✔	Matrix		Matrix

18. Connect a **Preview, Raster Output** to the Expression Result as shown:



19. File | Save As | Spatial Model As | **moving-window-standard-deviation.gmdx**

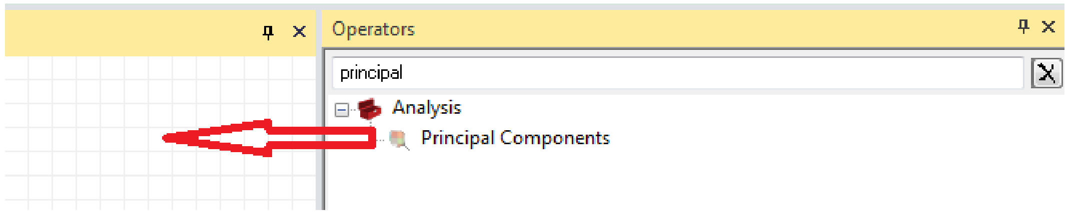
For the statistics output, generally Unsigned 16bit or Float 32 are the best options for Pixel Type. To understand the strengths of the model you have just created, we will open an existing tool within IMAGINE. Navigate to Raster Tab | Resolution Group | Spatial Pull down List and select **Focal Analysis**

Note the existing Focal Definition Size is limited to; 3x3, 5x5 or 7x7. The spatial model just created allows for any user defined matrix input. This means you have just extended the capability of a standard tool found within IMAGINE.

On the Focal Analysis tool, select Help button to learn more.

Task 5: Custom Principal Components

1. Open a New Spatial Model Editor
2. From the Operators list, Drag the **Principal Components** operator into the editor



3. Highlight the Principal Components Operator in the Editor

   This is to ensure its Properties Dialog appears

4. From the Properties Dialog, **Untick "Ignore"** port and enter **Count Value of 3**

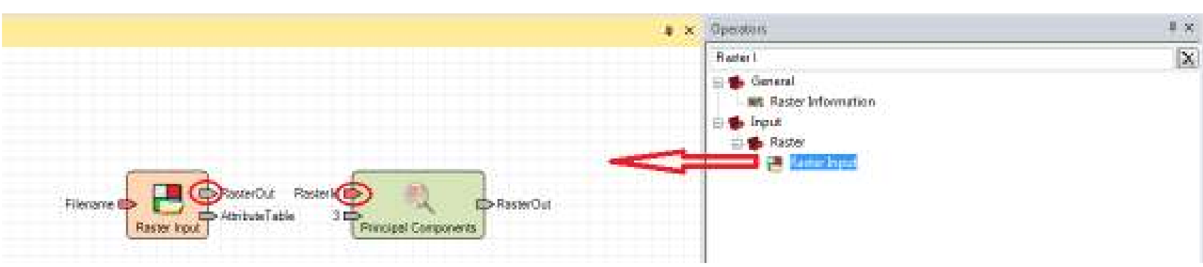
Properties

Show	Name	Value	Objects Supported
✔	RasterIn		Raster
	Ignore		Table, Scalar
✔	Count	3	Unsigned
✔	RasterOut		Raster

   Unselecting the 'show' option for ignore option will hide this option in the model. We will not need this option for this model.

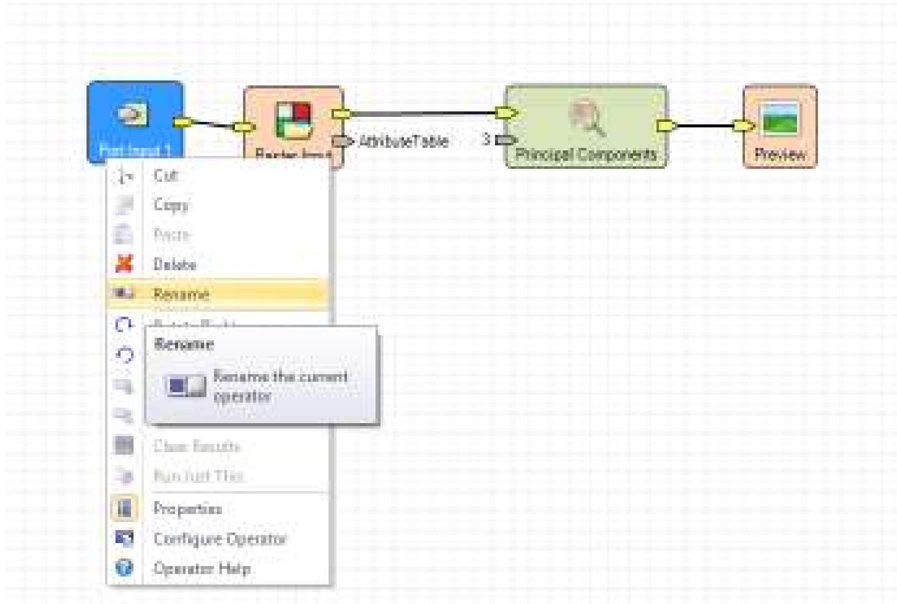
   By defining count value as 3, this defines the Maximum Principal Components Value to be calculated. Right Click on the Principal Components Operator and click on Help for further information

5. From the Operators list, Drag the **Raster Input** operator into the editor and **connect** the output port to the Principle Components operator

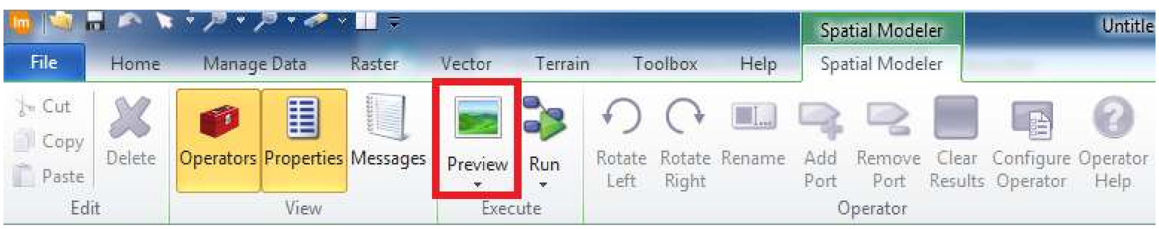


6. Drag and drop in to the Editor: **Port Input** and **Preview**

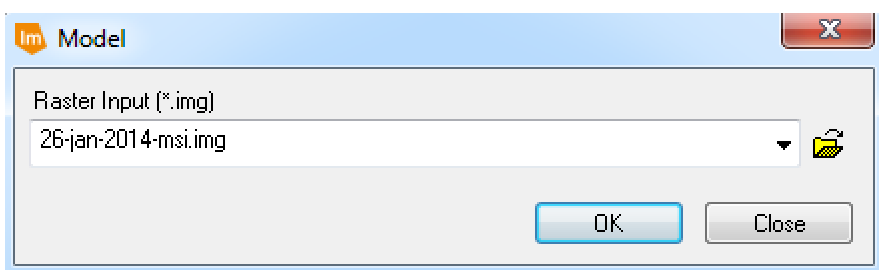
7. **Rename** the Port Input to **Raster Input** and connect operators as shown:



8. Click **Preview** from the Spatial Modeler Tab, Execute Group



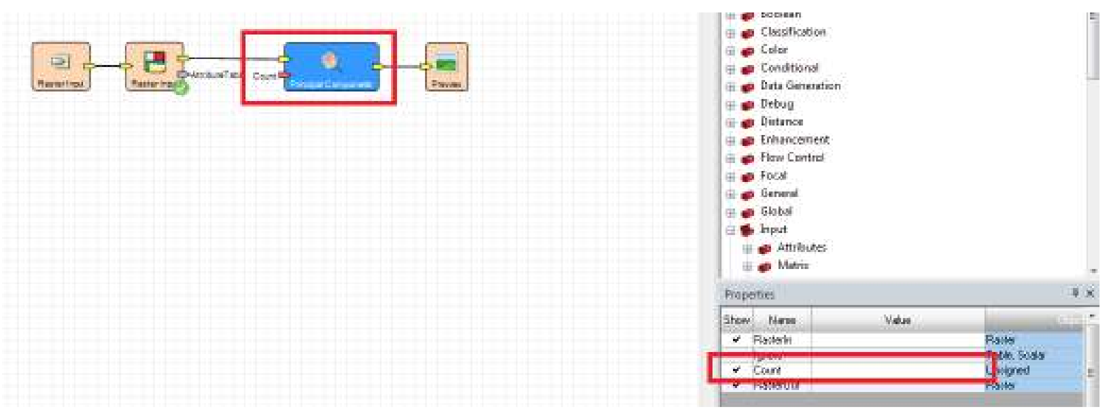
9. The GUI for your model will appear, Load **26-jan-2014-msi.img** from your TrainingData Folder and click **OK**



A Principal Components RGB 123 Image will appear. Note the Principal Components Operator creates PC up until the maximum number you have entered. In this example PC1 is shown in Band 1, PC2 shown in Band 2 etc.

10. **Close** the Preview.Input1 Window

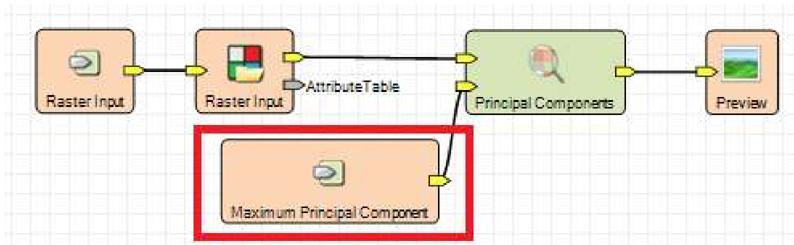
11. Highlight the Principal Components Operator in the Editor, ensure the Properties Dialog appears and then remove the Count Value you entered earlier of 3



12. A new Count Input Port is visible in the model. Drag and Drop a **Port Input** into the Spatial Model Editor

13.

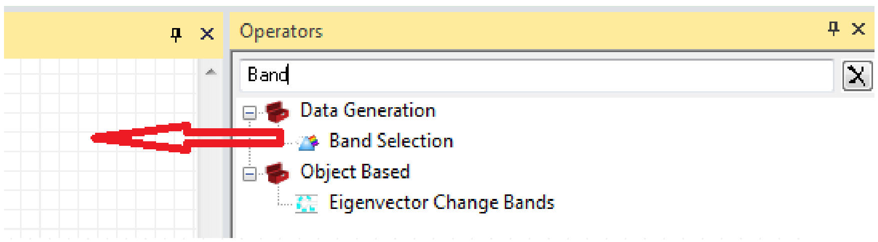
14. **Rename** to **Maximum Principal Component** and **Connect Port** as shown



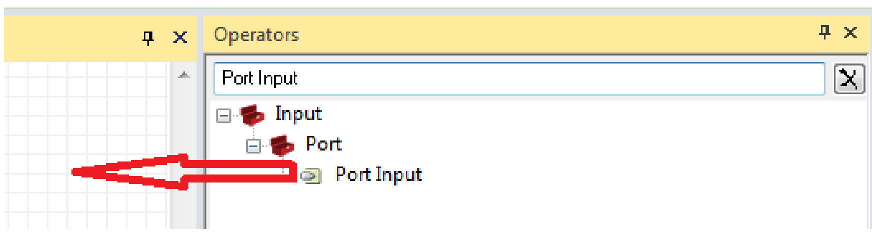
This will force the model to request a Maximum Principal Components Value each time, instead of a default of 3 as previously used

Now we want to create a custom band selection in this model. For many principal components, only a select range of bands are required

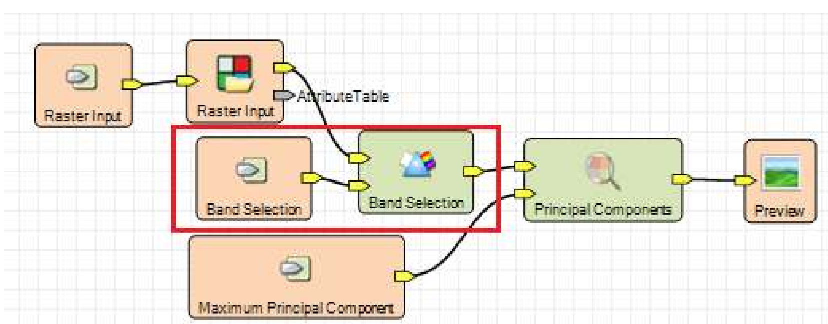
15. Drag and Drop **Band Selection** into the Spatial Model Editor



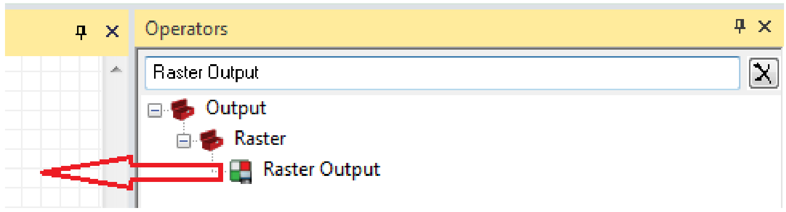
16. Drag and Drop **Port Input** into the Spatial Model Editor



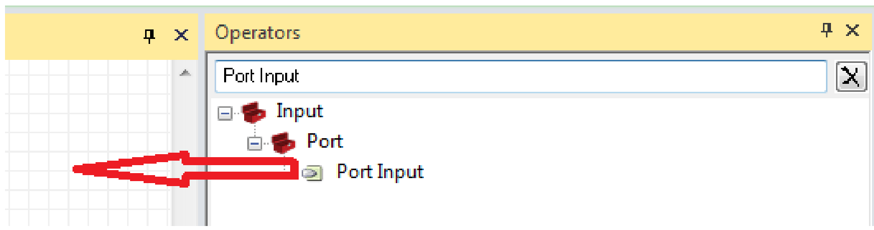
17. Rename and Connect as shown



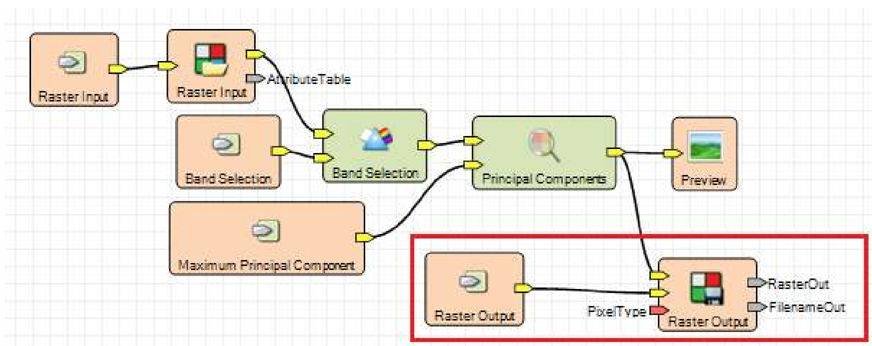
18. Drag and Drop **Raster Output** into the Spatial Model Editor



19. Drag and Drop **Port Input** into the Spatial Model Editor



20. Rename and Connect as shown



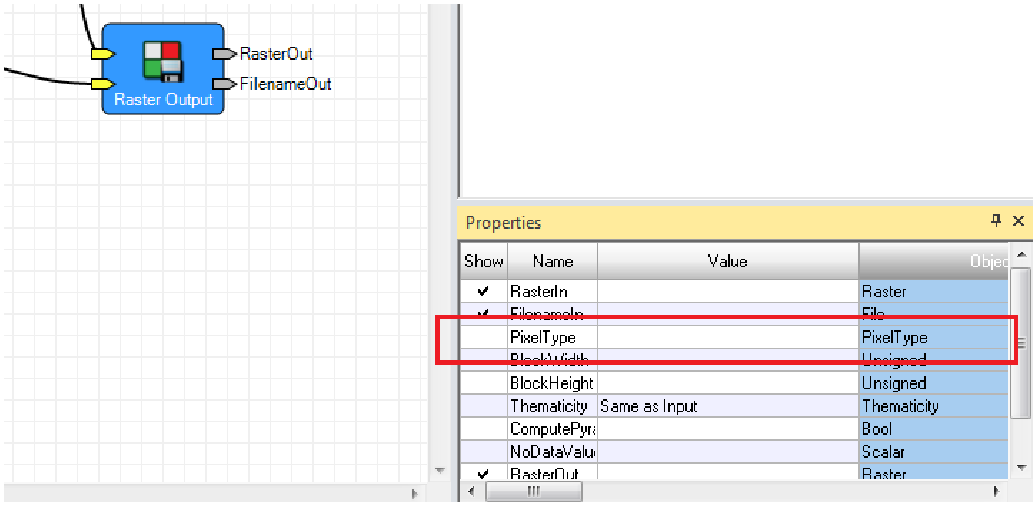
Note a PixelType input is available in the model. It is possible to connect to a Port to request user to specify PixelType. However for this model, we will set this as a default

21. **Double Click** on the **Raster Output** Operator

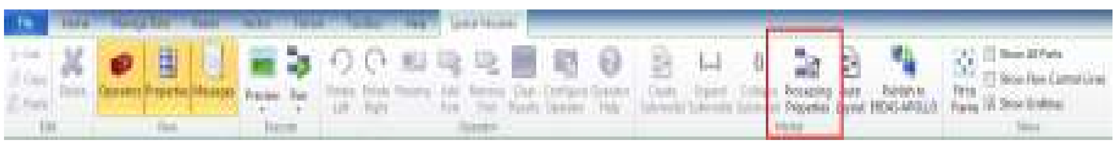
22. Ensure the Data Type is: **Same as Input**

23. Click **OK** to close Raster Output Dialog

24. In the Properties Dialog, **Untick PixelType**



25. From the Spatial Modeler Tab | Model Group select **Processing Properties**



The Processing Properties dialog will appear

26. Select the **Operator Info** tab in the Processing Properties dialog

These are general settings, dominantly used by APOLLO for geoprocessing however can allow you to change the display settings of your model

Here is a summary of what each define:

Namespace This field is used internally and can be left blank.

Name: A short unique name for the model.

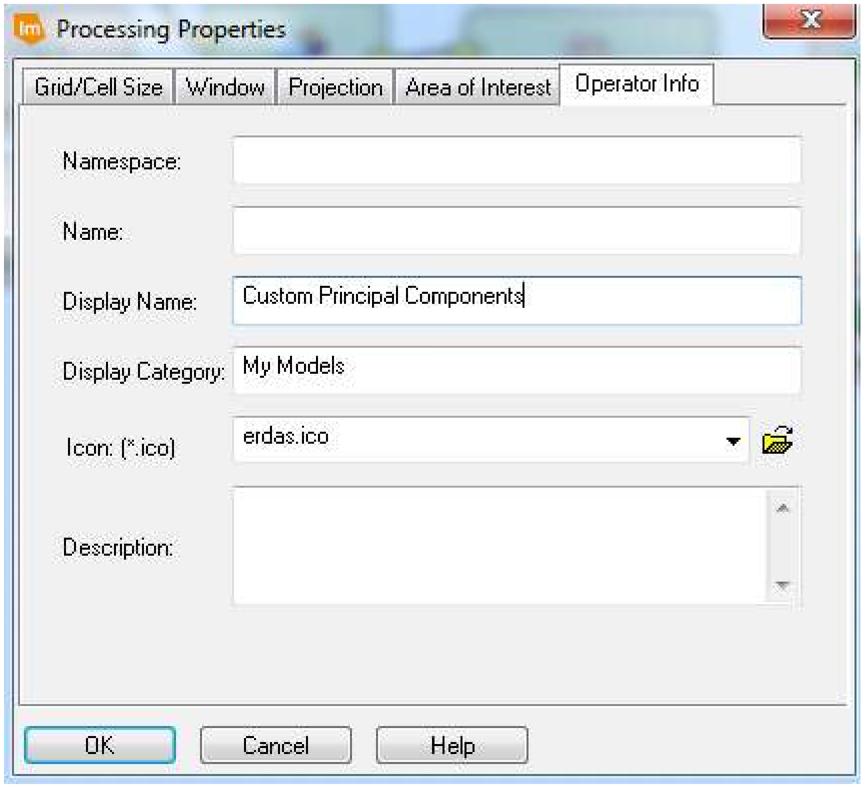
Display Name A "friendly" name identifying the model.

Display Category The category in which the model is to be sorted on the server.

Icon (*.ico) This field is used internally and can be left blank.

Description A description of the model's function and usage.

27. Define the following values:

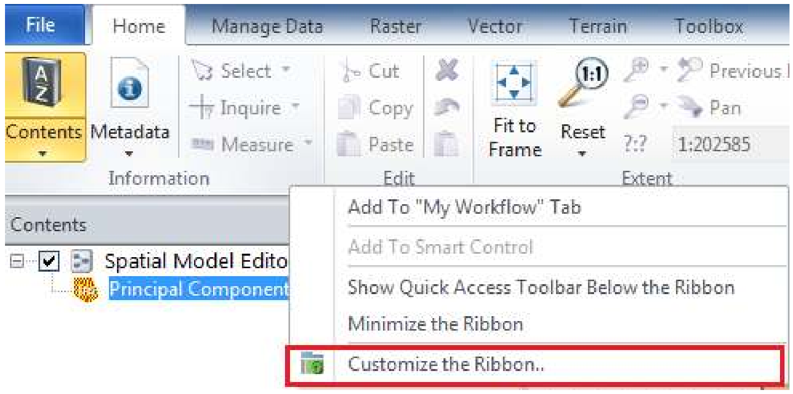


28. Click **OK** to close the Processing Properties dialog
29. File | Save As | **Save Spatial Model As**
30. Navigate to your TrainingData\Output Folder and save as

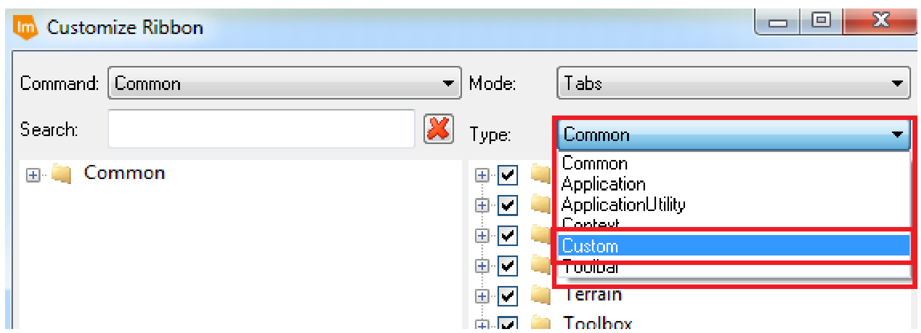
custom-principal-components.gmdx

Task 6: Adding a Custom Button to the Ribbon

1. **Right Click** within the Main Ribbon and select **Customize the Ribbon**



2. The Customize Ribbon dialog will appear. From the Type pull-down list select **Custom**

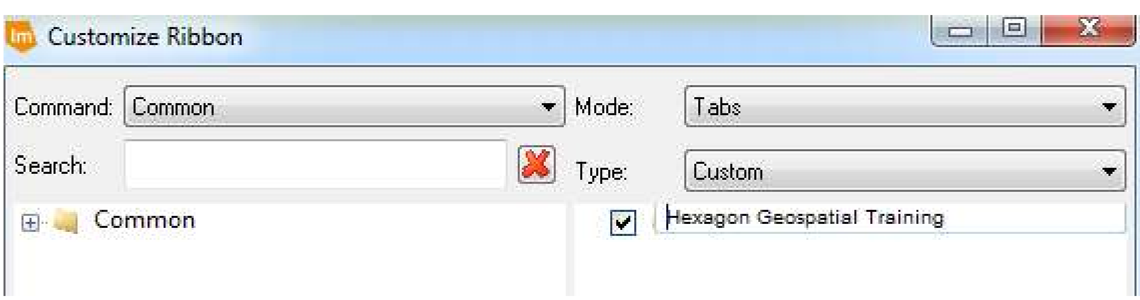


3. Click **New Tab**

   A new folder will appear called Custom

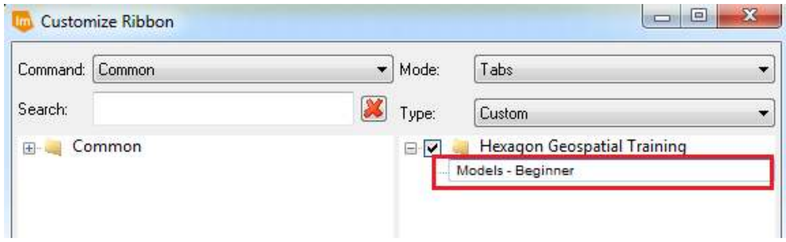
   You can rename this – by doing so, the display name of the tab will also change

4. Slowly double click on the Custom Folder and **Rename** to **Hexagon Geospatial Training**

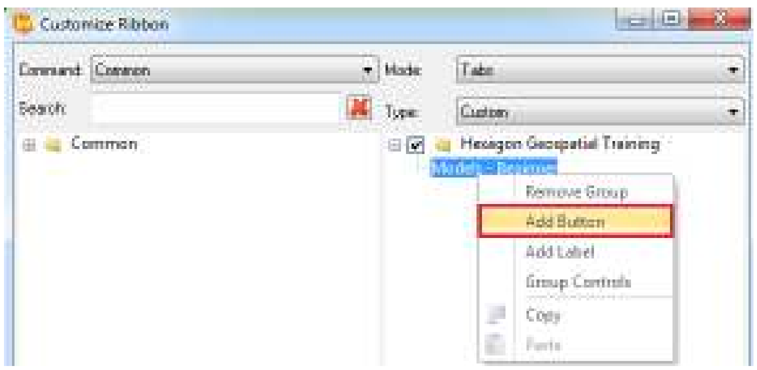


5. Highlight the Folder and Click **New Group**

6. **Rename** this new sub-folder to **Models – Beginner**



7. **Right Click** on the Models – Beginner Folder and **Add Button**

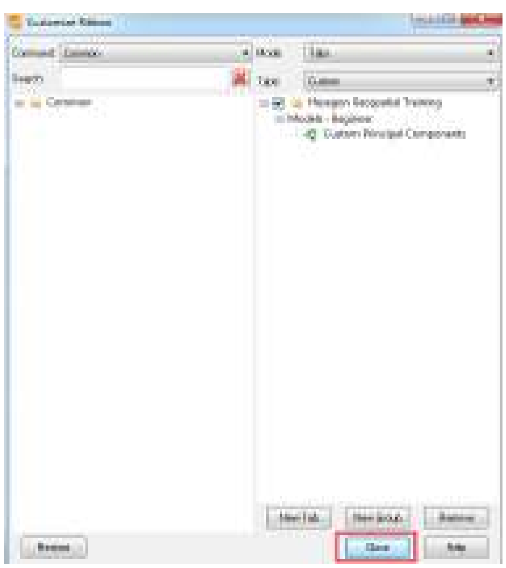


8. Navigate to your TrainingData\Output Folder and load your

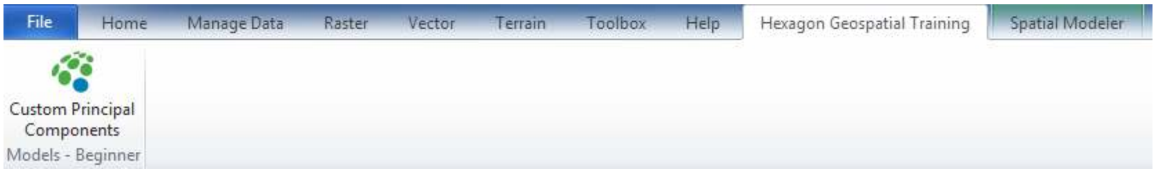
   custom-principal-components.gmdx model and click **OK**

   If you have not created this file earlier, use the model found in TrainingData\ExampleOutput folder

9. Once loaded, **Close** the Customize Ribbon Tool



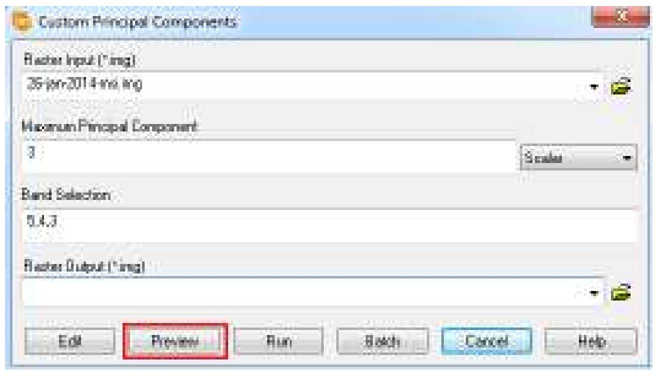
You now have your own tool and made it instantly accessible in the software



Note: The Icon. If you would like to get more advanced with your models, the option to easily load an .ico format provides you the capability to completely control the display of your Spatial Models. So be creative and imaginative.

10. **Launch** your model by clicking the **Custom Principal Components** icon from your Hexagon Geospatial Training Tab

11. Your GUI will appear, assign the following options and click **Preview**



12. An RGB Principal Components 123 Dynamic Preview will appear using only the bands 5, 4, 3 from the Landsat image as input.

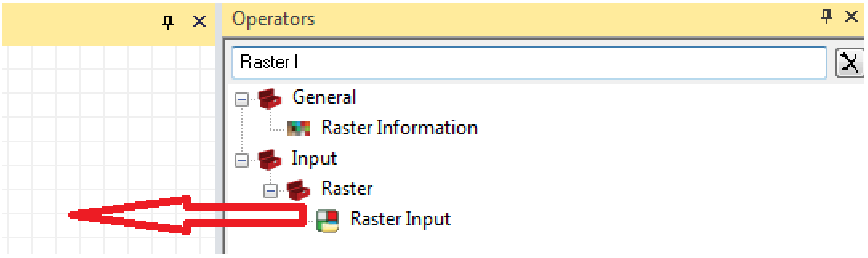
Refer to Customizing IMAGINE training to save custom layouts. This will save the custom toolbar and associated buttons you create

Task 7: Cell-Size Vector Buffer

Standard GIS Buffers are created using a set unit of distance, i.e. 20meters. However for advanced ECW users, a negative buffer is usually created using actual cell size of the input image. This involves a shapefile (of the image extent) being reduced by a distance relative to pixel size of the raster, instead of a set distance. The spatial modeler can achieve this by pulling the cell size of the input raster (later used in applying opacity) and creating a negative GIS Buffer of the vector. The end result is a more advanced GIS Buffer tool.

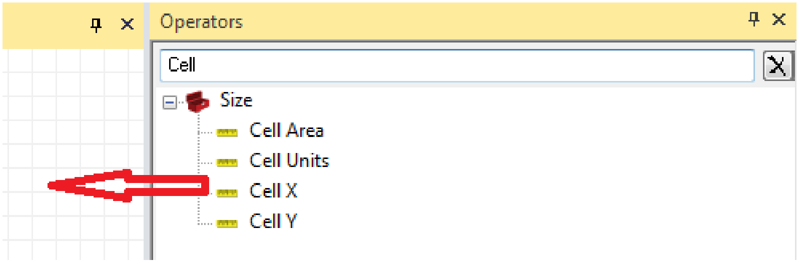
1. Open a New Spatial Model Editor
2. Drag and Drop **Raster Input** Operator into the Spatial Model Editor

This will be the Raster ECW Opacity is being applied to

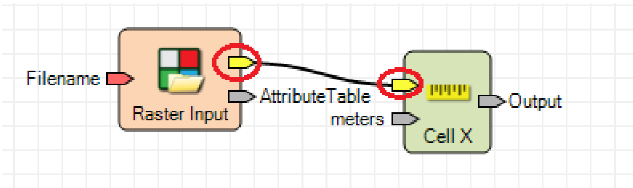


3. Drag and Drop **Cell X** Operator into the Spatial Model Editor

This operator returns the Cell Size (in X dimension) of the Raster Input

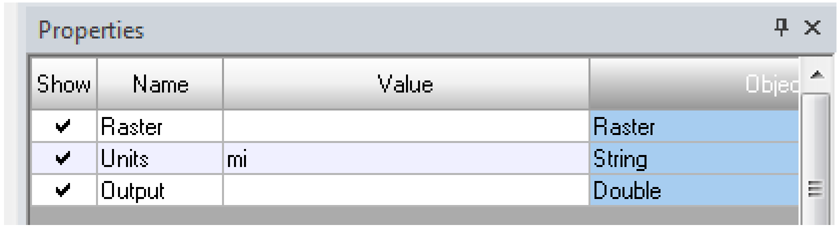


4. Connect the Raster Input "RasterOut" Port to the Cell X "Raster" Input Port



Note the default units for Cell X is *meters*, for the GeoMedia Buffer, the default unit is *miles.* This next step will illustrate how you can convert between units of measurement easily in the spatial modeler.

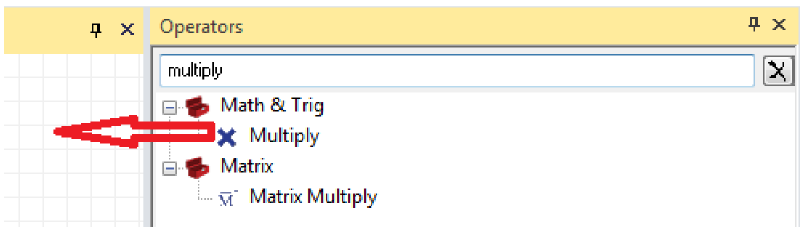
5. To convert the unit of measurement the Cell X Operator outputs, simply change the Unit Type from the Operators Properties Dialog to **mi**



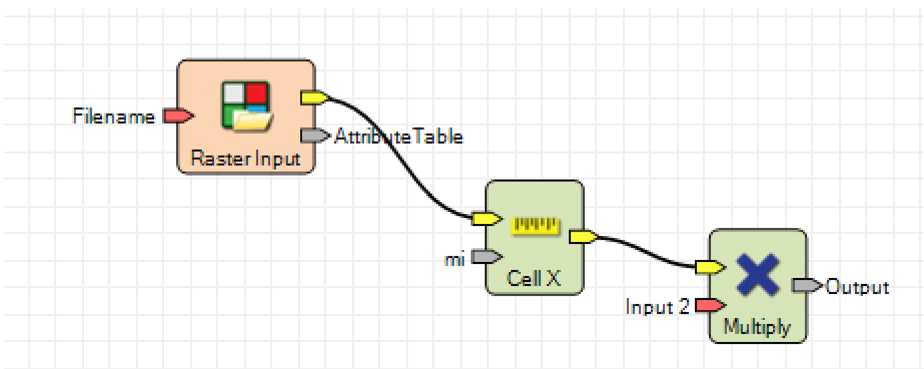
For more information regarding IMAGINE's Units of Measure just refer to: file:///C:/Program%20Files/Hexagon/ERDAS%20IMAGINE%202015/help/html/index.htm#UnitsofMeasure.htm

Now we have the Cell Size, we need to multiply it by a User Input. For example an input of 2 will create a buffer change 2 times the pixel cell size

6. Drag and Drop the **Multiply** operator into the Spatial Model Editor

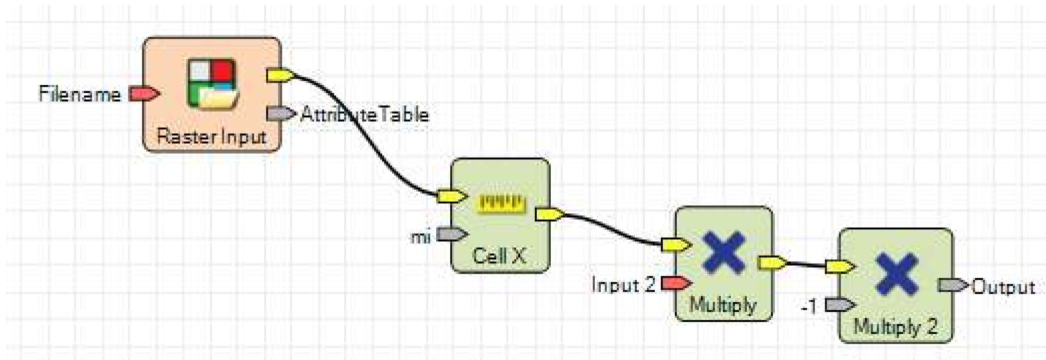


7. **Connect** the Cell X "Output" Port to the "Input 1" Port of the Multiply Operator

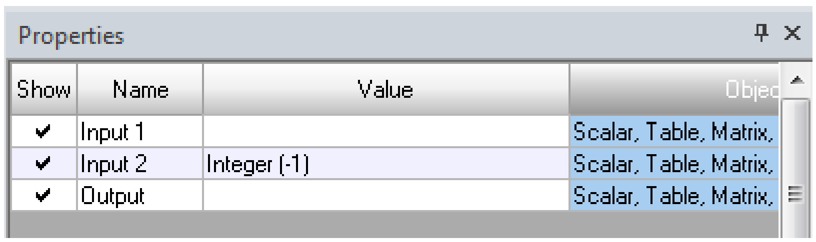


Now because for this example, only negative buffers will be used, we would like to add this into the model. This will prevent the need to enter a negative sign every time model is run.

8. Drag and drop a second **Multiply** operator and connect to the output of the first Multiply Operator



9. From the Properties Dialog, Enter **-1** as the Input2 Value for the Multiply 2 Operator

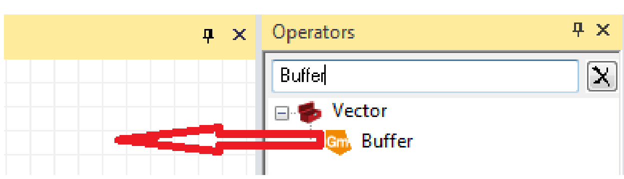


This model (so far)

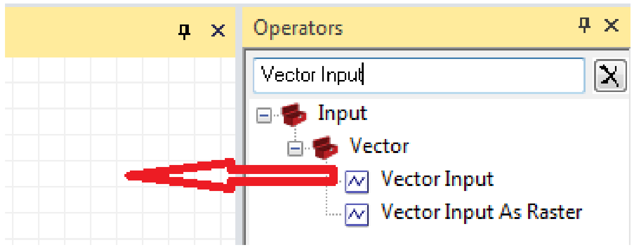
- takes a Raster Input
- gets it's Cell Size
- converts unit of measurement to Miles
- multiplies it by a user-input factor (such as 2 pixels)
- and then inverses this value to be used as a negative buffer

Complex! Yet a very simple logic to follow. This is one key benefit of the Spatial Model Editor. The left to right work flow is intuitive to many workflows and processes.

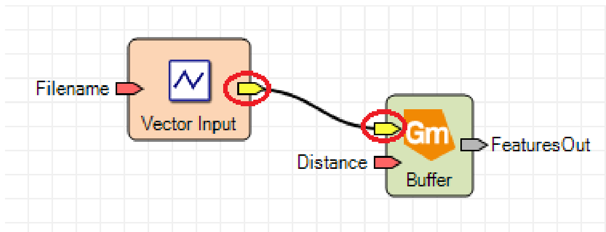
10. Drag and Drop **Buffer** Operator into a new Spatial Model Editor



11. Drag and Drop a **Vector Input** Operator into the Spatial Model Editor

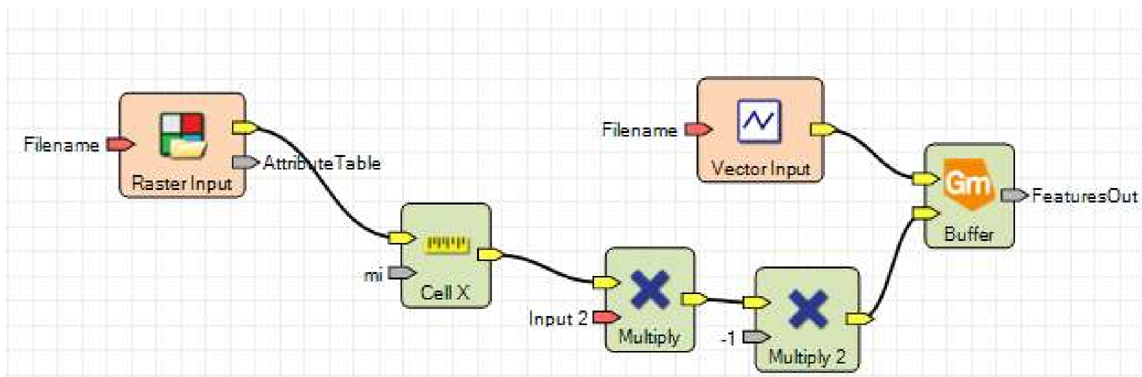


12. **Connect** the Vector Input “Features Out” Port to the Buffer “Features In” Port



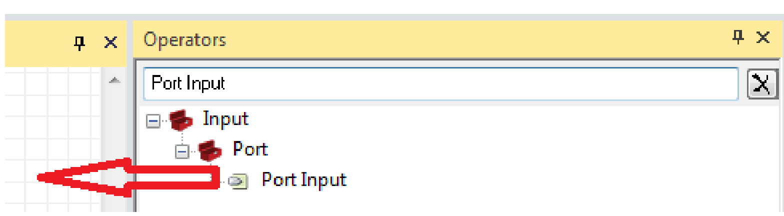
13. Connect the Multiply 2 “Output” to the “Distance” Port of the Buffer

Remember what our math calculated?



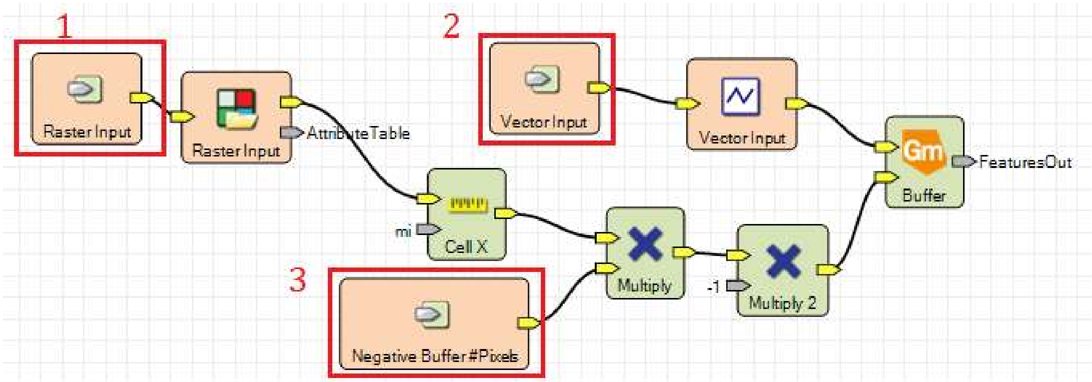
Note there are still Three Red Ports in need of an input in this model

14. Drag and Drop **3x Port Input** Operators into the Spatial Model Editor

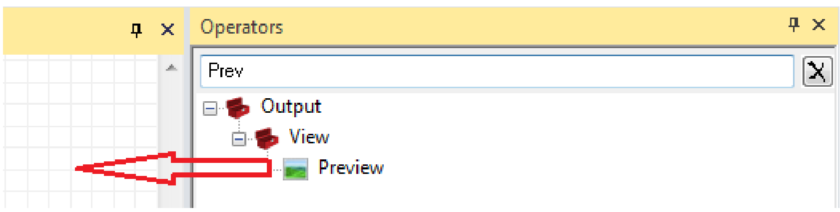


15. **Connect** and **Rename** the ports as shown

Note the order in which you create Port Inputs also determine the order the ports will display in your Model GUI



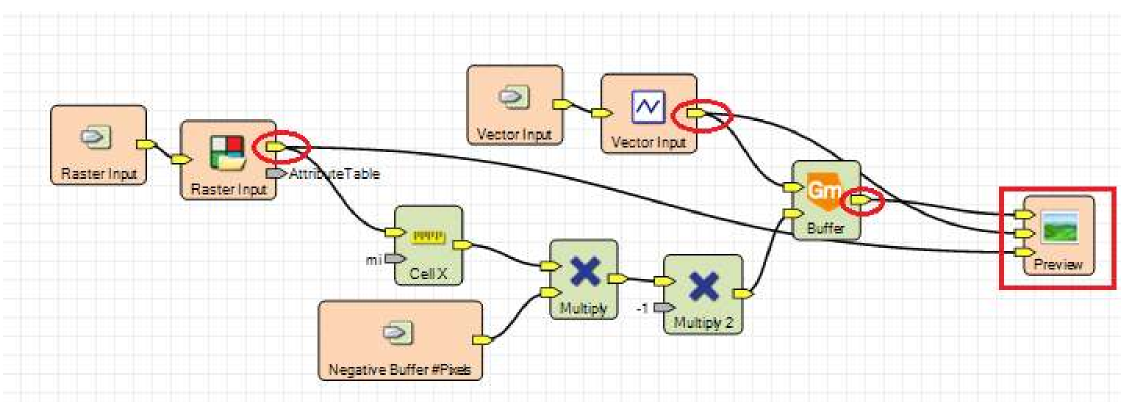
16. Drag and Drop a **Preview** Operator into the Spatial Model Editor



Generally, one Preview is sufficient with only one port. However for this model we would like to view 1, the Original Raster, 2, the Original Vector and 3, The Buffer Output to visually analyze the result.

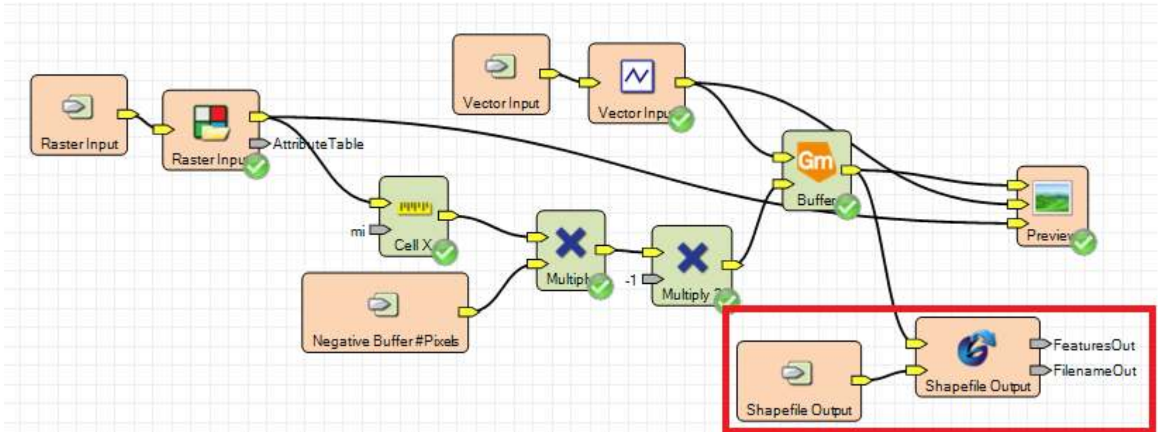
17. Right click on the Preview Operator and add 2 more Ports

18. Connect the Raster Input Output to Input 1, Vector Input Output to Input 2 and the Buffer Output to Input 3 of the Preview Operator

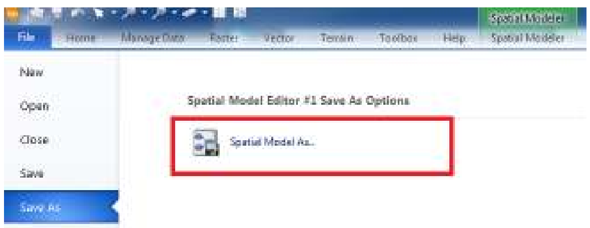


19. Drag and Drop a **Shapefile Output** Operator into the Spatial Model Editor

20. Add, connect and rename an **Input Port** to **Shapefile Output**



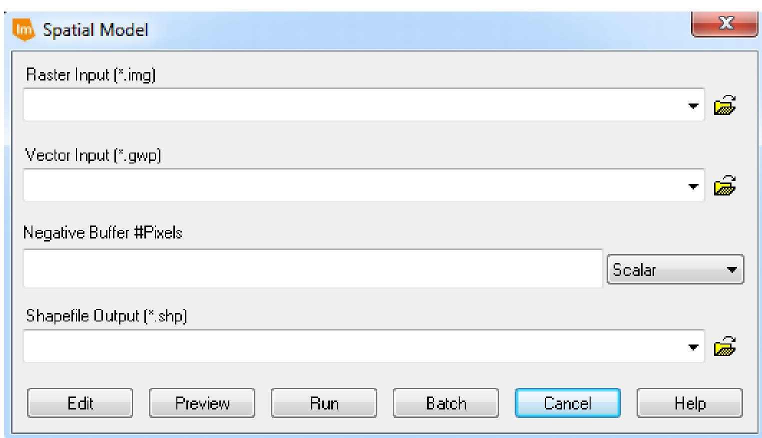
21. File | Save As | **Save Spatial Model As**



22. Navigate to your TrainingData\Output Folder and save as

negative-buffer-analysis.gmdx

23. You have now created your own Negative Pixel – Buffer Analysis Tool! Launch your model from Toolbox Tab | Spatial Model Editor Pull down list



Class Notes