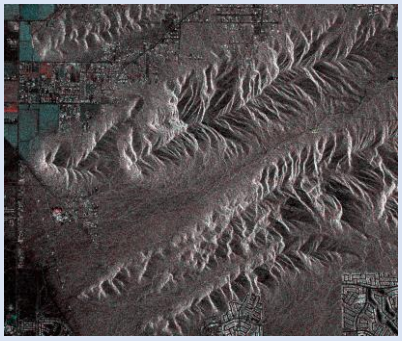
SAR Change Detection and Feature Extraction

Version: Geomatica 2012 and Up

Last modified: April 2015

SAR Change Detection and Feature Extraction

Please note: The imagery used in this demonstration can be substituted with freely available RADARSAT-2 imagery – a suitable image pair is the Phoenix imagery, which is a similar dataset (two repeat pass images over the same location).



Phoenix U12, May 04, 2008
Phoenix U12, May 28, 2008

Be sure to credit any work you produce as "RADARSAT-2 imagery courtesy of MDA" and to respect the End User License Agreement (EULA) of the demonstration license provided with the imagery.

Demonstration Overview

Abstract

This demonstration provides a complete end-to-end workflow for automating change detection information extraction from multi-temporal SAR imagery.

The primary demonstration shows the audience the basics of building a model in Geomatica's Modeler environment. Two repeat pass images collected over the same location, 24 days apart are analysed to determine the changes that have occurred on the ground.

Required Software

- PCI's Geomatica v2012 and up

Demo Levels

This demonstration includes two sections, a primary demonstration and an optional extended demonstration.

Primary Demonstration – Automated change detection model in Modeler

Extended Demonstration (Optional) – Further statistical analysis to classify changes identified in imagery.

Key Applications

- Change detection
- Monitoring
- Defence – feature identification
- Much more…

Pre-Demo Setup

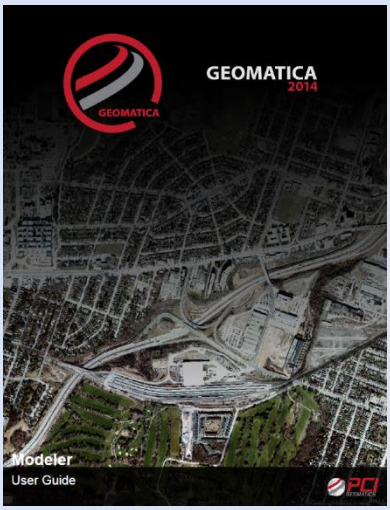
This section provides instructions regarding how to unpack the data for this demonstration. Generally, this only needs to be done once.

Due to the number of files that are created during this demonstration, it is recommended that you delete the entire **SAR_Change_Detection** folder when you have completed the demonstration and then follow the steps below to set this demonstration up for another customer.

1. Navigate to where you downloaded **SAR_Change_Detection.zip**
2. Right click on the zip file and select (**your zip utility**) → **Extract Here**

About the Modeler environment

The Modeler environment provides access to PCI's 550+ powerful processing algorithms in an easy to use, intuitive graphical workflow interface. To get familiar with the basics of Modeler, be sure to review the Geomatica II Coursebook, as well as the Modeler User Manual, which can be found in the C:\...\PCI Geomatics\Manuals folder of your Geomatica installation folder.



Primary Demonstration (SAR Change Detection and Feature Extraction)

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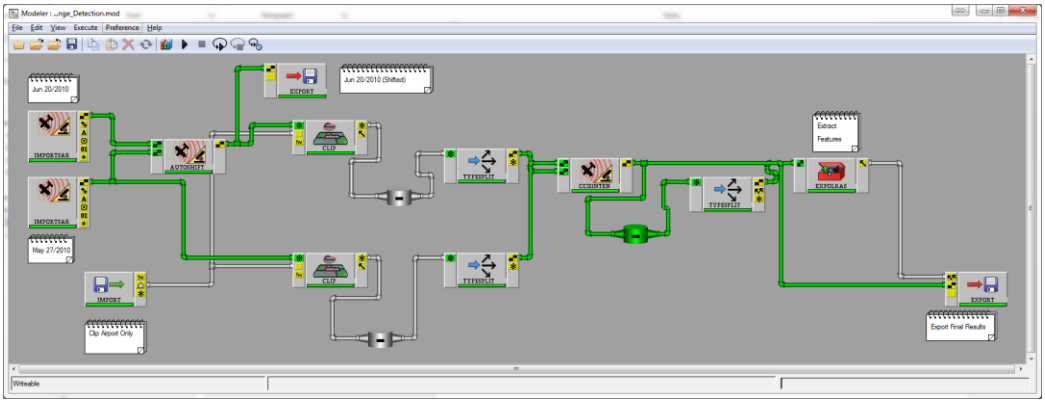
Open & Review Modeler Project

1. Navigate to **C:\...\SAR_Change_Detection**
2. Double click on **SAR_Change_Detection.mod**

The file opens in **Modeler**

3. Maximize the window to bring all elements into view



4. Click on the **Run** button to execute the complete model.

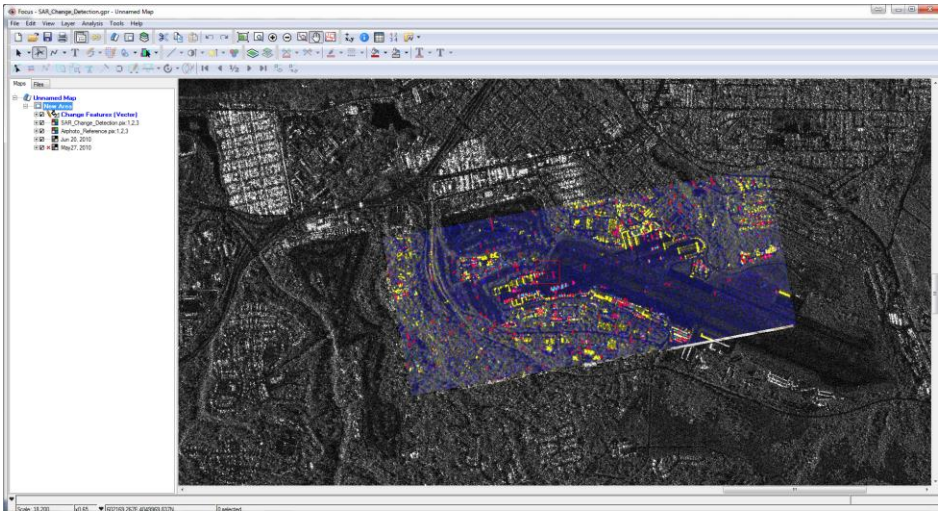
The complete workflow will execute, in 2-3 minutes or less. The final results can then be viewed in Focus.

RADARSAT-2 imagery used in this demonstration is located over Monterey, California – site of many world renowned golf courses including Cypress Point, and Pebble Beach. The second image in this series was collected on June 20, 2010 02:10 UTC, in an Ascending pass (south to north). The local time was 18:10 on Saturday, June 19th. As it turns out, the US Open (one of five major international golf tournaments) was held at Pebble Beach during this time – the new features that appear in the imagery are likely related to the increased traffic (private planes, vehicles, etc).

Load and inspect the results of the model in Focus.

Inspect results

1. Open **SAR_Change_Detection.gpr** from the C:\..\Precomputed folder

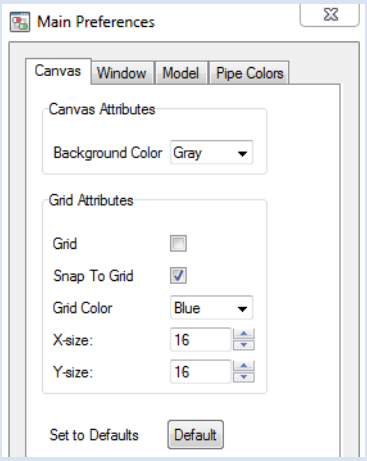


The following layers are automatically loaded (from top):

Layer	Description
Change Features	Automatically extracted changes
SAR Change Detection	CCDINTEN analysis results (Intensity from test, intensity from reference, and change metric)
Airphoto Reference	Reference imagery (roughly 50 cm resolution)
Jun 20, 2010	Ultrafine 14 RADARSAT-2 image
May 27, 2010	Ultrafine 14 RADARSAT-2 image

Tips to layout the model in a fast, efficient manner:

Under the Preferences menu of the Modeler window, select **Snap to Grid**. Be sure to save your preferences once you've made this change.



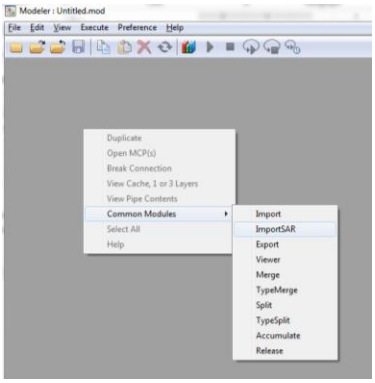
If you are using the same module more than once, you can right click on your first module, and select **Duplicate** to make a copy and drop it on the canvas.

To load the modules on your canvas, you can select **Add to Canvas** from the menu or you can left click on the module icon, and then drop it on the canvas.

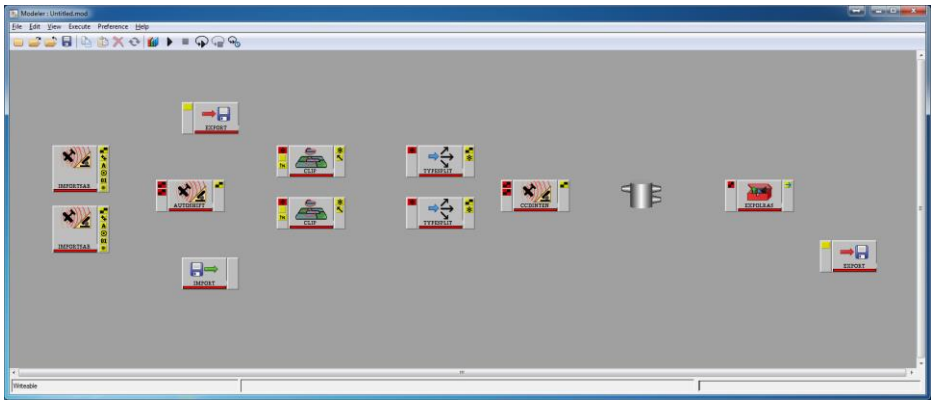
Build Model to perform automated change detection

Now, we will build the model to perform this analysis. The detailed steps are outlined below.

1. Open Modeler, starting with an empty canvas
2. Layout all of the required algorithms. To add the algorithms, click on the **Module Librarian** icon in the toolbar. For generic algorithms, such as **IMPORTSAR,** or **EXPORT** right click anywhere on the canvas and select them from the **Common Modules** menu.



3. You canvas should have all of the following elements prior to advancing to the next step.



4. Populate all parameters in the modules, starting from the left, working your way to the right.

   IMPORTSAR: Click on this module, and select the **product.xml** file from the June 20th image for the top SARINGEST module. For the bottom **IMPORTSAR** module, navigate to the May 27 **product.xml** file and select it.

   File names/selection for the two RADARSAT-2 images:
   Top IMPORTSAR Module:
   C:\..\Data\U14-HH-2010-06-20-SLC\product.xml

   Bottom SARIMPORT Module:
   C:\..\Data\U14-HH-2010-05-27-SLC\product.xml

   AUTOSHIFT: All parameters can be left on default values.

   EXPORT (left side): Double click and specify a filename for the Autoshifted June 20th image:
   C:\..\Output\U14_June20_shifted.pix

   IMPORT: Double click the Import module on the left side of the canvas, and select the vector file for the airport area to clip the analysis. The file is: **C:\..\Data\Reference\airport_vec.pix**

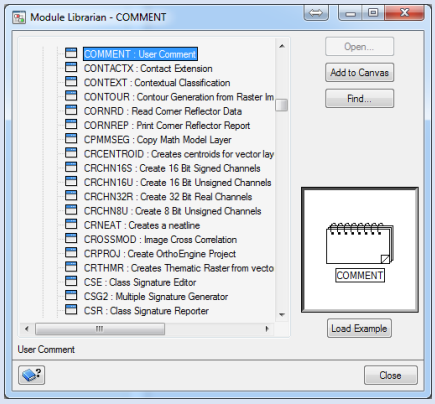
   CLIP (both CLIP modules): Double click the CLIP module and select **Use a Clip Layer** from the first drop down menu.

   TYPESPLIT: Double click the module and select **Rasters** as the Input Parameter. This will separate the clip vector and the raster layer for the next step in the processing workflow.

   CCDINTEN: Leave the options on default.

   EXPOLRAS: Set the **Threshold Minimum** to 95 – all changes detected which rank in the 95th percentile or higher will be kept. In addition, enter **25** for the **Minimum Area (pixels)**, to limit the size of objects that are detected. You can experiment with this to detect certain types of objects (cars vs planes, etc).

Tip: Annotate your model with the **COMMENT** module, which is accessible from the Module Librarian. Be sure to insert useful comments such as the acquisition dates of your images, or other relevant information.

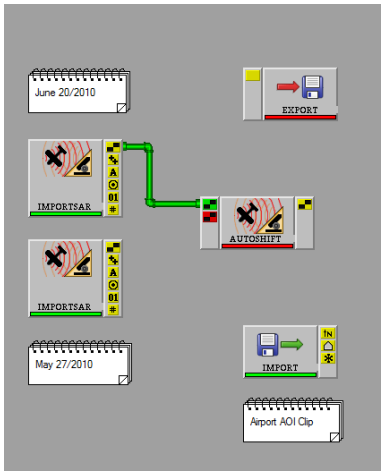


Tip: When connecting modules, you can either click on respective output / input ports, or you can select an already connected pipe and connect it either to an input or output port. If your canvas becomes cluttered, these options can be helpful. In addition, the modules can be repositioned, which can result in reduced clutter as the pipes will automatically redraw based on the module's new positions on the canvas.

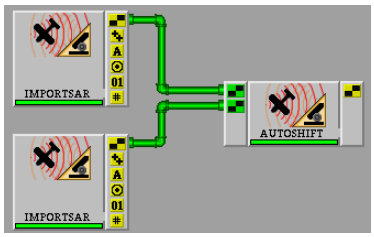
EXPORT (right side of canvas)**:** Specify an output filename:**C:\..\Output\SAR_Change_Detection.pix**

5. Now that you have properly configured the modules, you can connect them using the pipes within Modeler. Note as you connect the modules, there are different colors and thicknesses for pipes, which denote the type of data (raster, vector, bitmap, etc) they contain, the whether they contain single of multiple layers.

   Starting with the **AUTOSHIFT**, select the June 20th, 2010 image as the **Input Complex SAR image** (top port on the left of the module). Connect the two items together as shown below:



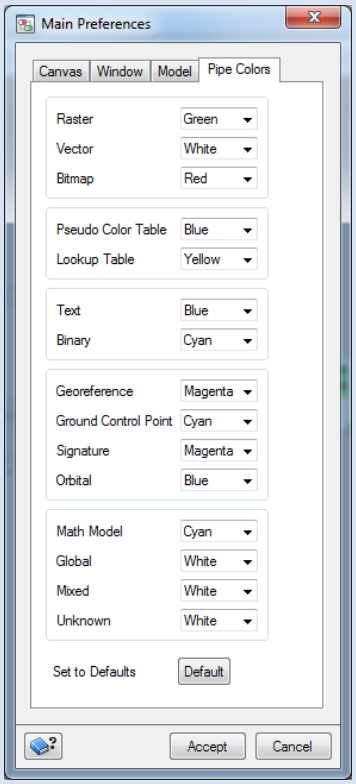
   Repeat the step, this time connecting the **Reference Complex SAR Image** port on the Autoshift module to the May 27th, 2010 image.



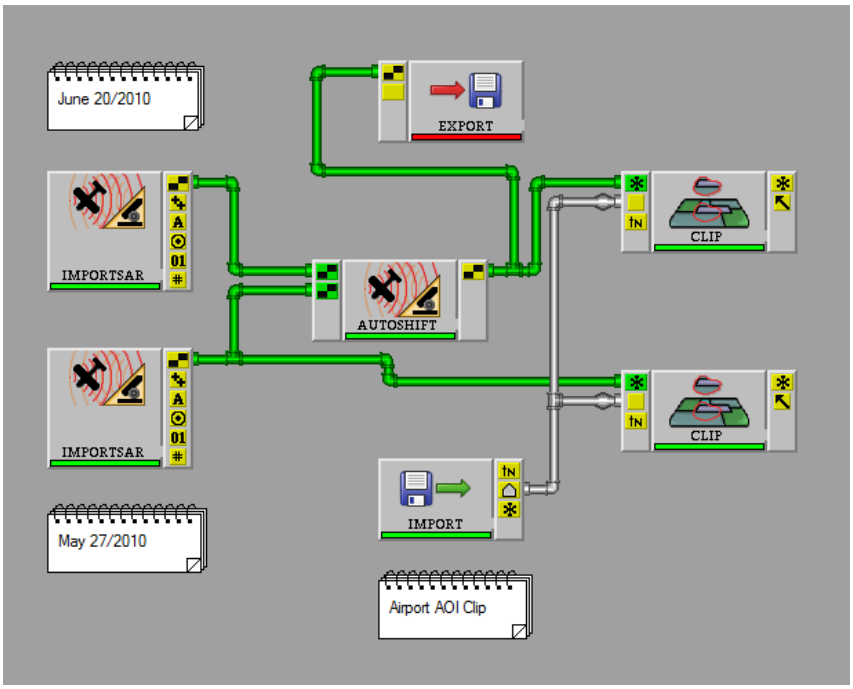
   Next, connect the **AUTOSHIFT** to the top most **CLIP** Module. **CLIP** also needs the input vector layer, which you must connect to the Vector port.

Note: Troubleshooting your model is made easier through the use of color coded pipes. Default colors include **Green** for Raster data, and **Grey** for vector data. Note below the vector file pipe that is connected to the **CLIP** module is grey, which the **IMPORTSAR** module pipes are green.

To access the pipe colors and modify them, click on Preferences / Pipe Colors within the Modeler menu.



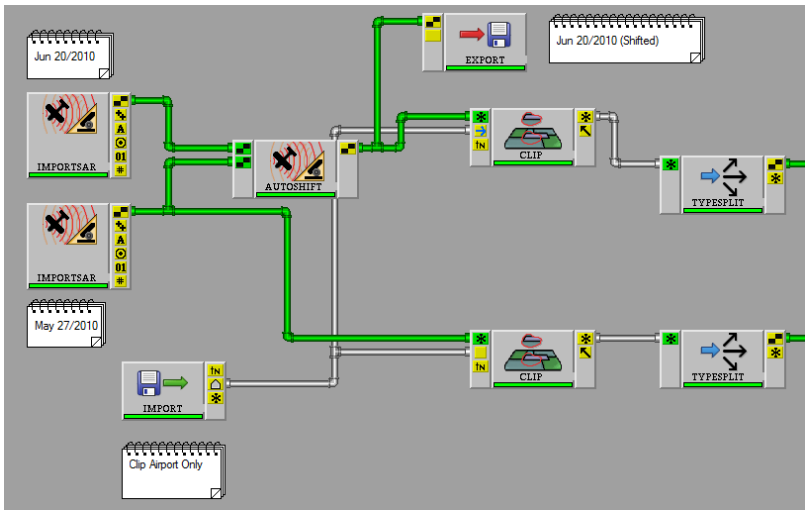
Next, connect the **IMPORTSAR** module for the May 27th image to the second **CLIP** module. You canvas should look as follows.



Note: For viewing purposes, you should connect the June 20th **AUTOSHIFT** results to the export module, which will allow you to see the original image, properly positioned and aligned with the other SAR image.

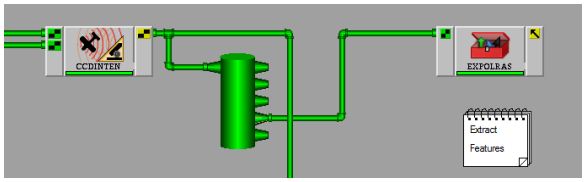
Note: The selection of the ports for CCDINTEN (top, bottom) will only affect the default coloring of the result image through the default loading in focus. In this demonstration, the results will show new objects (appearing on June 20th) as **BLUE** and objects which are no longer present as **MAGENTA**. This closely resembles typical change analysis displays, where "Blue is new, and Red has Fled".

The clipped files must be split to retain only the Complex SAR images to be used in the CCDINTEN analysis. Connect the two **CLIP** modules to the **TYPESPLIT** modules – this will pass the Raster data that **CCDINTEN** requires to perform the change detection between the two layers.



Next, connect the top image (June 20th, 2010) to the bottom port of the **CCDINTEN** module, and bottom image (May 27th, 2010) to the top port of **CCDINTEN.**

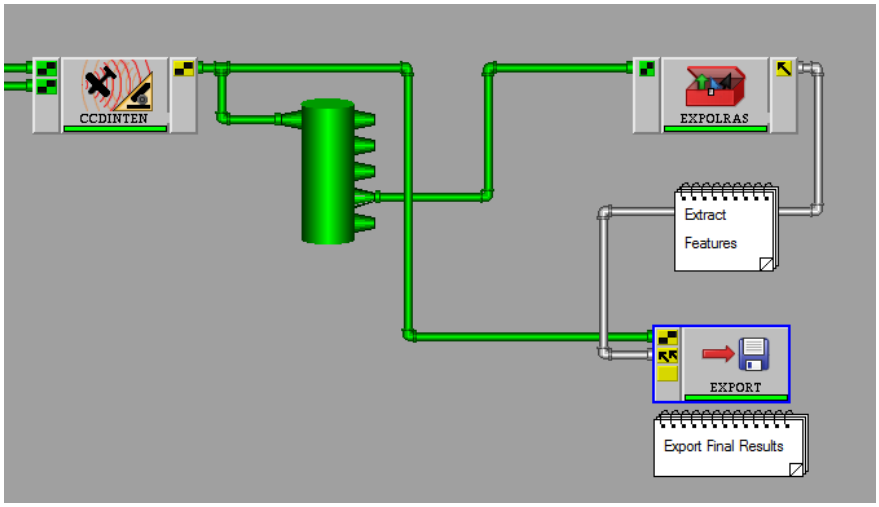
In order to pass the correct layer to **EXPOLRAS**, connect the output port of **CCDINTEN** to the port on the left of the **SPLIT** Module. To pass the 4th channel (which is what **EXPLORAS** requires) through, connect the second port of the **SPLIT** module on the right to the input port of the **EXPLORAS** module. This will create a third connection below the original two output ports of the SPLIT module. Now, duplicate **EXPLORAS** (right click on the module and duplicate it) and drop it on the canvas. Connect the third port on the right of the **SPLIT** module to the new copy of **EXPLORAS**. Create another copy of the **EXPLORAS** module, and connect the fourth port on the right of the **SPLIT** module to the new **EXPLORAS** module. Delete all other copies of the **EXPLORAS** modules on your canvas. Your connection should look as follows:



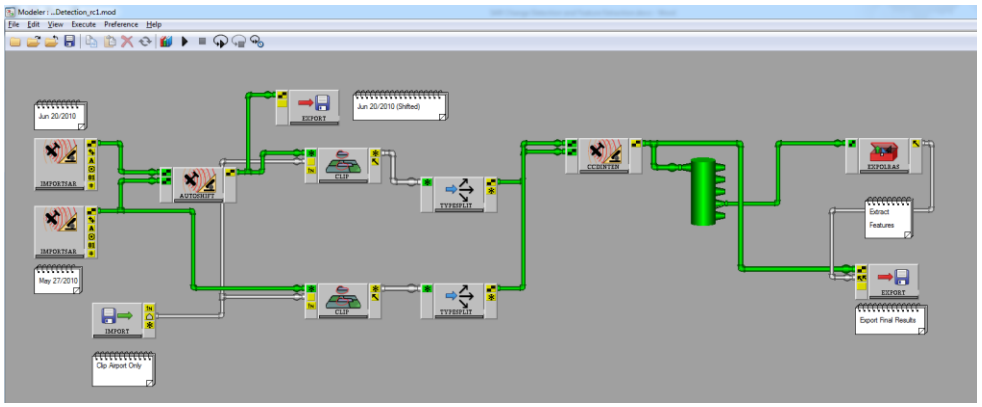
Tip: As you experiment with parameters and modify things in your model, you will likely want to quickly re-run the model. Be sure to select “Overwrite results” in modules such as **EXPORT** to ensure you are always looking at the latest results.

Note also that bulges in the pipes indicate the data has passed through. You can right click on the pipes to **View Pipe Contents** which can be a useful way to troubleshoot your models. If you wish to remove all temporary files off disk and start anew, click on **Edit / Clear all caches** from the main Modeler menu.

The final connections include the output port of **EXPLORAS** to the **EXPORT** module Vector input port, and the output port of the **CCDINTEN** module to the input port of the **EXPORT** module.



6. Once you’ve verified all steps above, click on **Run** icon in the Modeler interface.



The completed is shown above.

7. View your results in Focus by loading your layers. You can load the layers separately, or open the precomputed focus file under: **C:\..\Precomputed\SAR_Change_Detection.gpr**