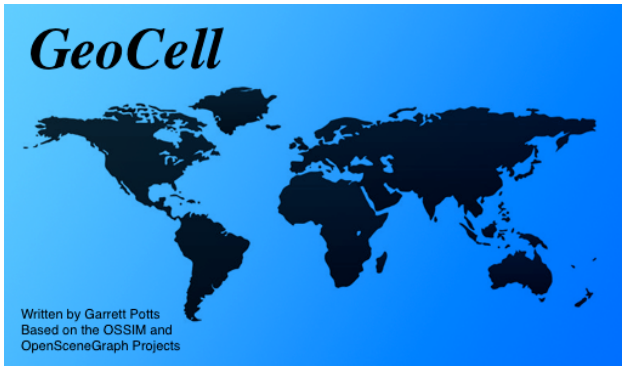
GeoCell Metric Exploitation

Version 1.8.16

March 2013

ABSTRACT

GeoCell provides a cross-platform GUI that exposes OSSIM library functionality. This document describes the photogrammetric capabilities available in GeoCell.



RadiantBlue TECHNOLOGIES

Table of Contents

1 Basic Operations

This section describes the basic operations required for all components of metric exploitation.

1.1 Load Images

Images can be loaded either individually or as members of a project file. A project file defines file paths and other parameters associated with a group of related images. OMAR has the capability to select images and export (download) a project file, along with associated image files (including geometry, overview, and histogram), for use in GeoCell.

1.1.1 GUI

To load an image or project via the GUI, select File->Open Image or File->Open Project and choose the desired file using the Open dialog box, as shown in **Figure 1**.

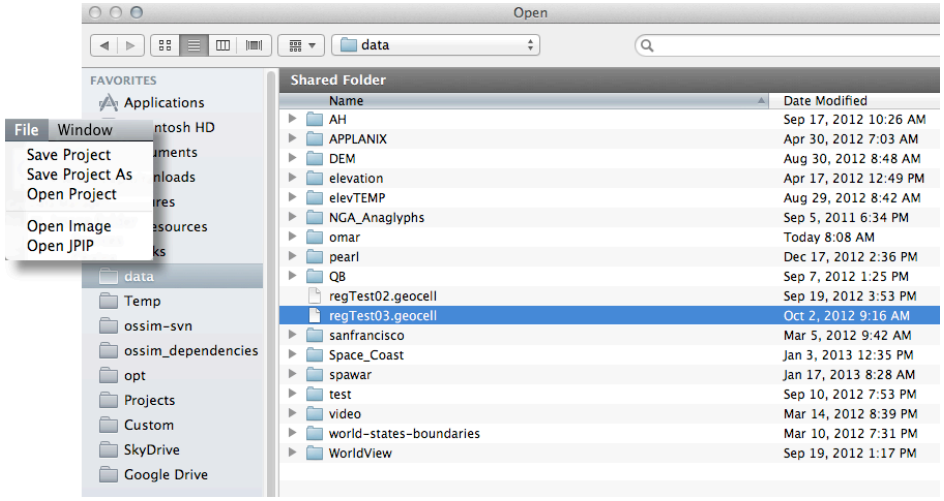


Figure 1. Image/Project File Selection

1.1.2 Command Line

Project files may be opened via command line in the following manner:

```
geocell –project /path/to/project/file
                    or
geocell /path/to/project/file.gcl   (with gcl extension)
```

Using the example from paragraph 1.1.1:

```
geocell –project /data/regTest03.geocell
                    or
```

```
geocell /data/regTest03.gcl
```

1.2 Open Display Windows

After loading, image chains must be selected to create the corresponding image display windows. With reference to **Figure 2**, follow these steps to create displays:

1. Expand the source entry list by clicking on the small triangle next to "Source"
2. Select desired sources and right-click to reveal pop-up menu
3. Select "Chains", then "Affine" for raw images or "Default" (or "Map Projection") for orthorectified images

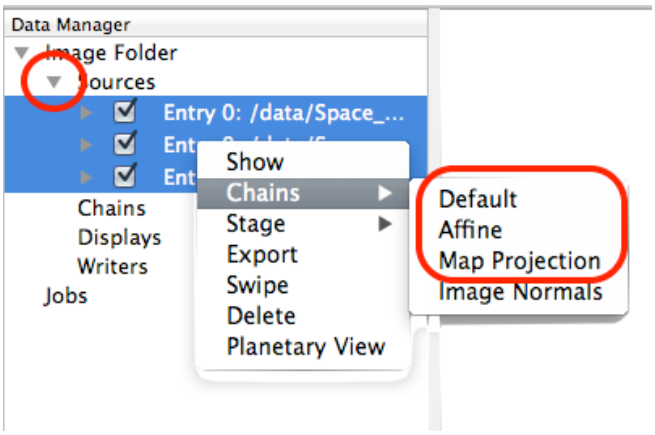


Figure 2. Chain Selection

1.3 Select Images

The metric exploitation processes are controlled by the tabbed Metric Exploitation window, which is initiated from the Exploitation Mode menu, as shown in **Figure 3**.

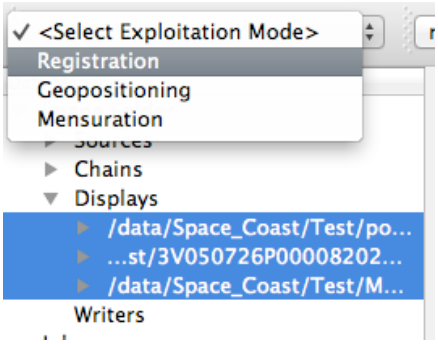


Figure 3. Registration Window Selection

Prior to selecting the desired operation, the applicable images must be selected after first expanding the displays list by clicking on the small triangle next to “Displays”. If no images (or too few) are selected, an error pop-up is displayed, as shown in **Figure 4**.

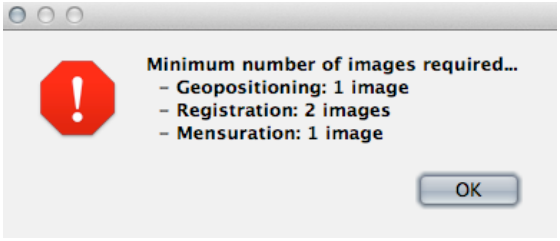


Figure 4. Error Pop-up for Too Few Images

All metric exploitation components are controlled via the Metric Exploitation window, as shown in **Figure 5**. Its tabs are active based on the selected mode, with the Image Summary tab always active. The ***Dismiss*** button hides the window, but maintains the mode. The window can be revealed again by reselecting the mode or by clicking in the Data Manager area and pressing the ‘s’ key. The Reset Mode button resets to the no mode state and removes all measured points.

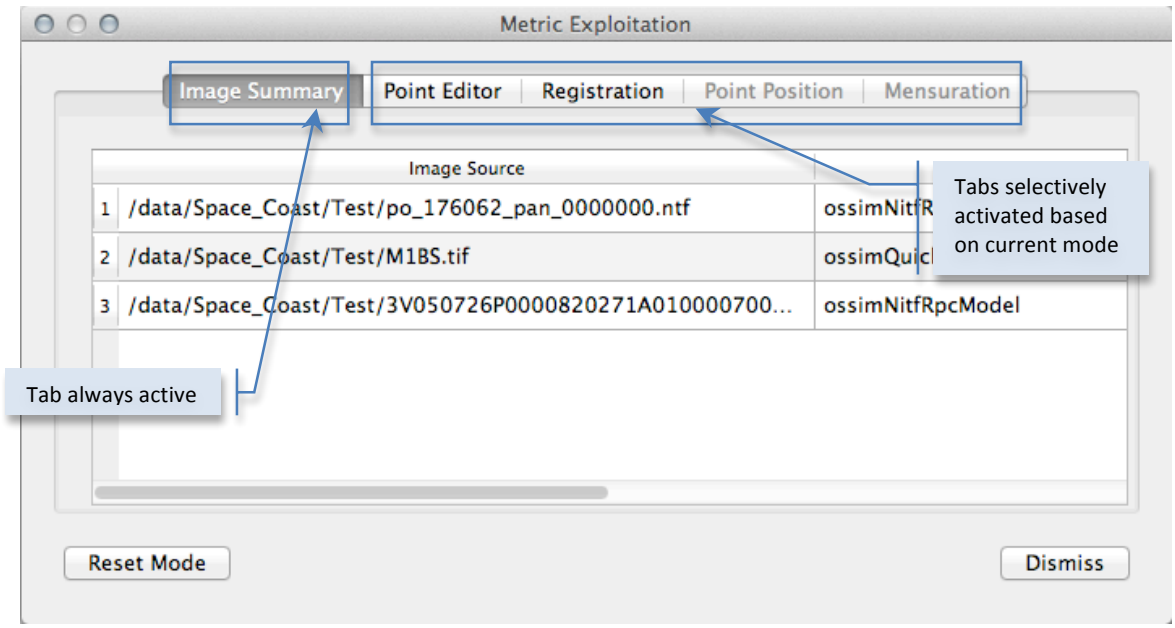


Figure 5. Metric Exploitation Window

2 Point Positioning

This section describes geopositioning component of metric exploitation. The point positioning function is NOT CERTIFIED FOR TARGETING.

2.1 Point Position Tab

The Point Position tab is illustrated in **Figure 6**.

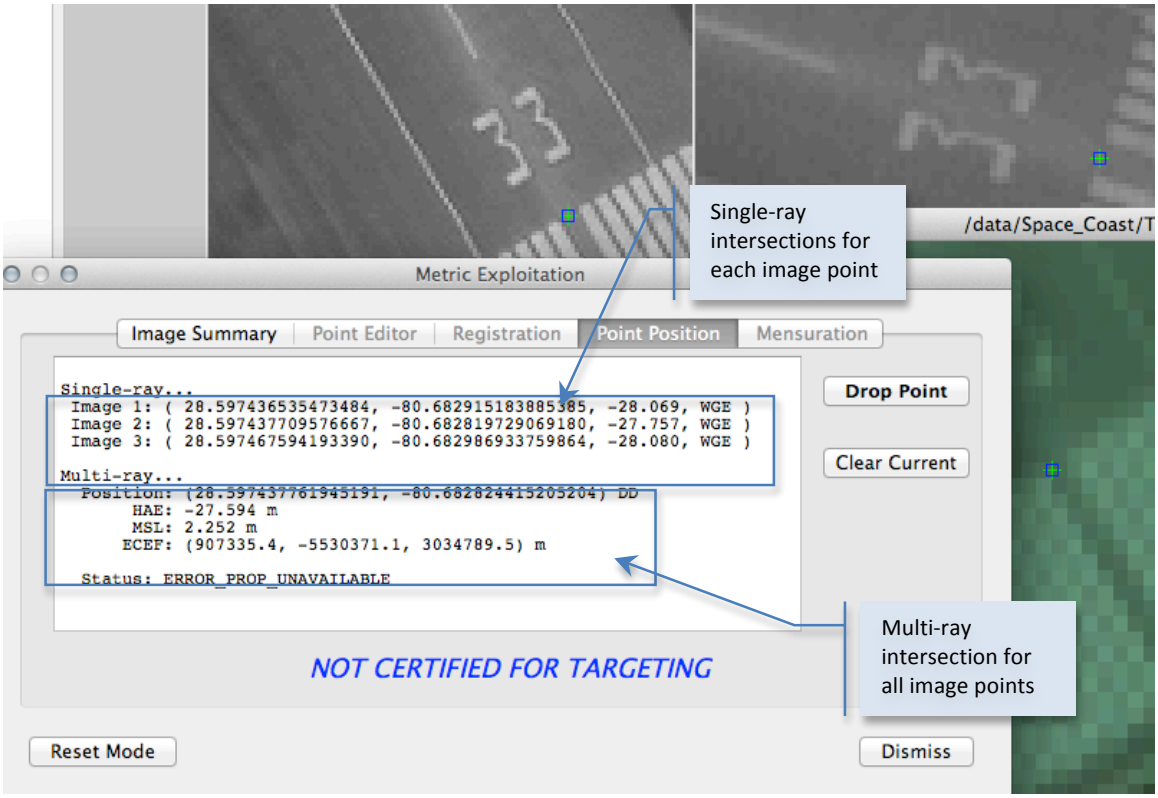


Figure 6. Point Position Tab

After measuring the corresponding point in each image, press the ***Drop Point*** button to execute the intersection ("point drop"). The results are written to the summary window. These results include individual single-ray intersections with the elevation surface and one multi-ray spatial intersection using all image rays. The display uses the following abbreviations:

1. DD: longitude, latitude in decimal degrees
2. HAE (also WGE): height above ellipsoid (WGS84)
3. MSL: height above mean sea level
4. ECEF: earth-centered earth-fixed Cartesian frame

3 Image Registration

Image registration requires the measurement of tie points common to the image overlap areas. Based on the differences between the measured and projected point positions, selected image parameters are adjusted through a mathematical process known as a *bundle adjustment*.

3.1 Register Images

The Metric Exploitation-Registration tabbed window is composed of three tabs that are described in the following paragraphs.

3.1.1 Image Summary Tab

The Image Summary tab is illustrated in **Figure 7**.

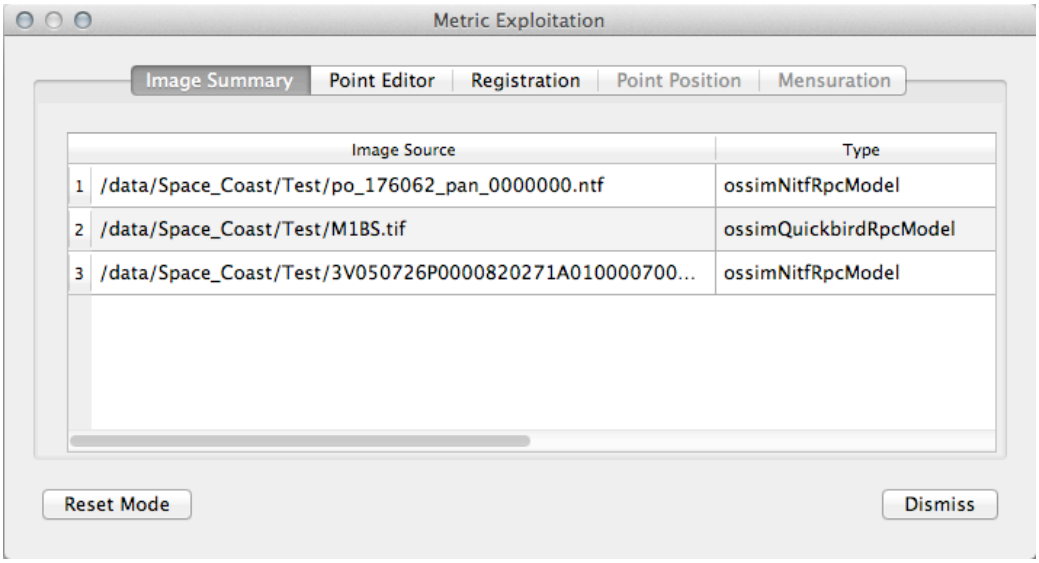


Figure 7. Image Summary Tab

This tab, which is primarily informational, provides a convenient view of the images and their associated types. A right-click context menu is available off the row header for each image, as shown in **Figure 8**. The context menu can be used to toggle the control status of the image (indicated by appending a "C" to the image number) and to display its Parameter Adjustments summary window.

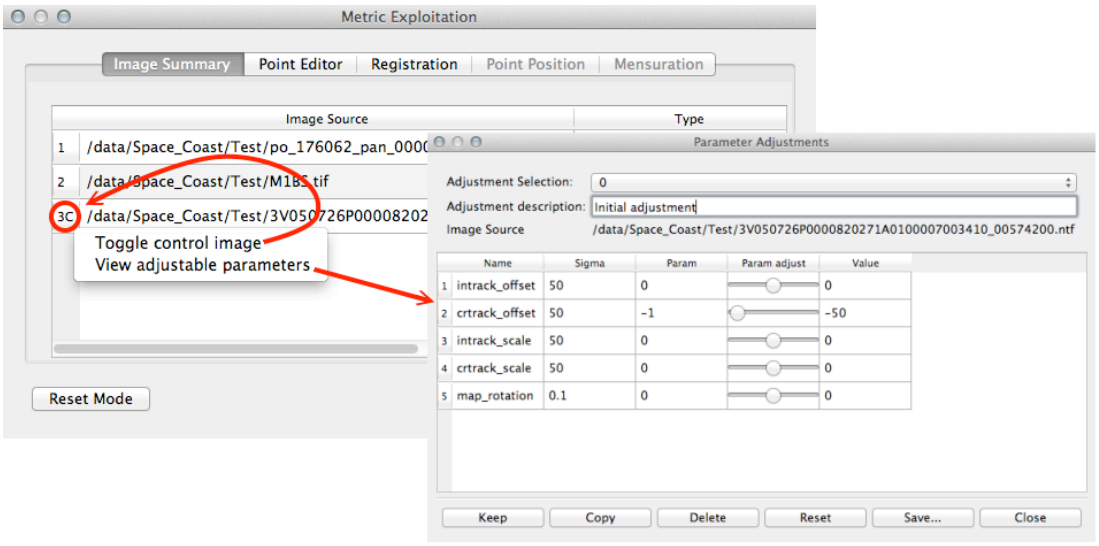


Figure 8. Image Context Menu

3.1.2 Point Editor Tab

The Point Editor tab is illustrated in **Figure 9**. Follow these steps to add tie points:

1. Press the ***New Point*** button to create a new table column and increment the current point indicator (below the ***New Point*** button).
2. Measure the current tie point in each image. The corresponding table cell will turn yellow.
3. For any point, after the first image has been measured, clicking on the point header will preposition all images to the corresponding position.
4. Any individual image point measurement can be toggled to inactive (indicated by red) by clicking on the cell. The point's symbol will also turn red and it will not be included in the solution.
5. Clicking on its column header revisits any tie point.

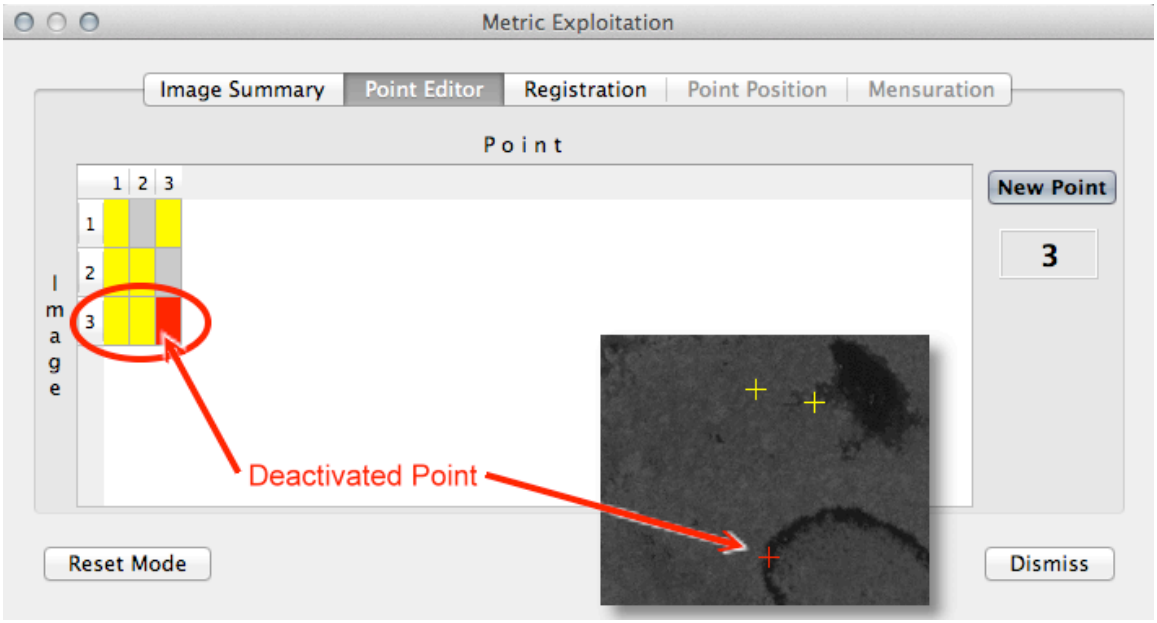


Figure 9. Point Editor Tab

3.1.3 Registration Tab

The Registration tab is illustrated in **Figure 10**. Upon completion of tie point measurement, press the ***Register*** button to execute the registration solution. A detailed solution report is written to the summary window. See paragraph 3.2 for a description of the report content. If the results are satisfactory, press the ***Accept*** button to save the parameter adjustments. Press ***Clear*** to remove the report, ignore the solution, and perform additional tie point editing.

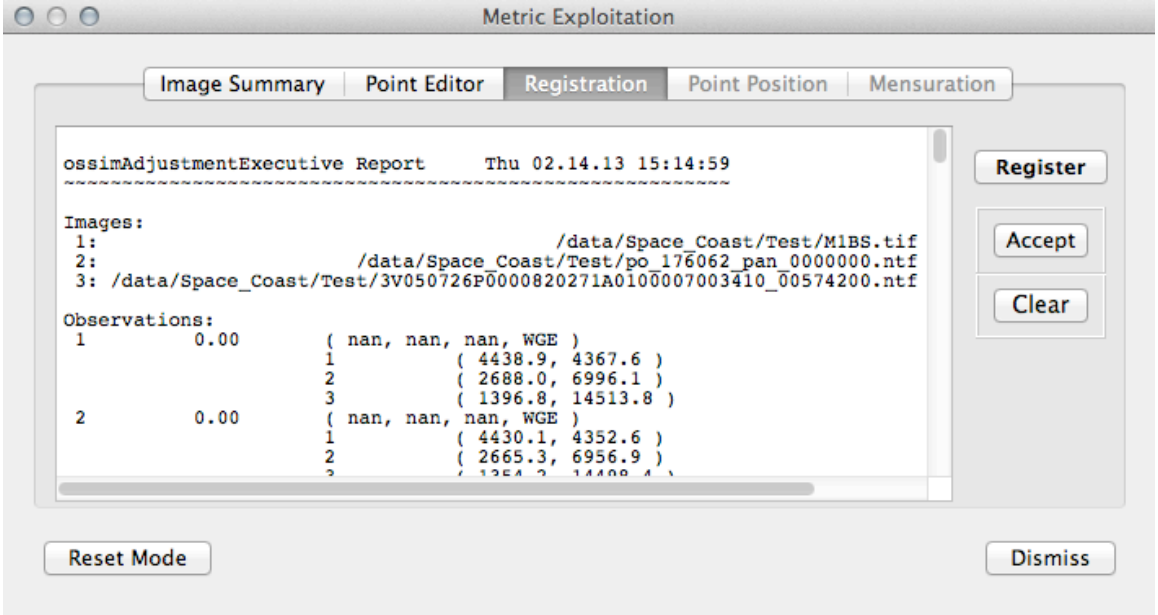


Figure 10. Registration Tab

3.2 Review Registration Report

The summary window shown in **Figure 10** contains a detailed solution report. The report content is described in the annotated example below.

```
ossimAdjustmentExecutive Report     Tue 02.19.13 10:18:55
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

Images:
 1:                      /data/Space_Coast/Test/po_176062_pan_0000000.ntf   nPar:  5
 2: /data/Space_Coast/Test/3V050726P0000820271A0100007003410_00574200.ntf   nPar:  5
 3:                                    /data/Space_Coast/Test/M1BS.tif      nPar:  5

Observations:
 1      0.00    ( nan, nan, nan, WGE )
                1       ( 2664.9, 6957.3 )
                2       ( 1353.9, 14498.8 )
                3       ( 4429.7, 4352.8 )
 2      0.00    ( nan, nan, nan, WGE )
                1       ( 2687.2, 6996.5 )
                2       ( 1396.7, 14513.9 )
                3       ( 4438.6, 4367.7 )
 3      0.00    ( nan, nan, nan, WGE )
                1       ( 2759.6, 6786.7 )
                2       ( 1309.9, 14306.7 )
                3       ( 4466.0, 4283.5 )

 Iteration 0...
Measurement Residuals...
 observation   image    samp    line    initial_meas
           1       1   -13.6    -8.9    ( 2664.9, 6957.3 )
           1       2    -9.4    -4.7    ( 1353.9, 14498.8 )
           1       3    -7.8    -5.1    ( 4429.7, 4352.8 )
```

Number of adjustable image parameters

Tie point ground coordinates
- "nan" indicates uninitialized
- actual coordinates indicate generated from control image

Tie point image coordinates (s,l)

Tie point summary list

Initial ("iteration 0") image space discrepancies (residuals)

```
           2       1   -13.7     -9.3     ( 2687.2, 6996.5 )
           2       2    -9.1     -4.1     ( 1396.7, 14513.9 )
           2       3    -7.7     -5.4     ( 4438.6, 4367.7 )

           3       1   -13.1     -8.7     ( 2759.6, 6786.7 )
           3       2    -9.0     -4.1     ( 1309.9, 14306.7 )
           3       3    -7.9     -5.5     ( 4466.0, 4283.5 )

_____________Mean:   -10.1     -6.2     RMS:    10.4     6.5
```

Data summary subgroups repeat for each iteration

```
 Iteration 1...
Parameter Corrections...
  n im        parameter    a_priori  total_corr   last_corr initial_std    prop_std
  1  1   intrack_offset     0.00000    -4.42692    -4.42692    50.00000    25.13001
  2  1   crtrack_offset     0.00000    -6.07293    -6.07293    50.00000    28.72990
  3  1    intrack_scale     0.00000    -2.06101    -2.06101    50.00000    49.55460
  4  1    crtrack_scale     0.00000     8.96572     8.96572    50.00000    42.26942
  5  1     map_rotation     0.00000     0.00600     0.00600     0.10000     0.09838
  6  2   intrack_offset     0.00000    -3.45761    -3.45761    50.00000    25.89186
  7  2   crtrack_offset     0.00000    -2.44296    -2.44296    50.00000    31.14816
  8  2    intrack_scale     0.00000    -3.20288    -3.20288    50.00000    48.28139
  9  2    crtrack_scale     0.00000     3.58490     3.58490    50.00000    40.63788
 10  2     map_rotation     0.00000    -0.00018    -0.00018     0.10000     0.09395
 11  3   intrack_offset     0.00000    -5.15540    -5.15540    50.00000    11.65369
 12  3   crtrack_offset     0.00000    -5.39114    -5.39114    50.00000    15.80003
 13  3    intrack_scale     0.00000     6.69311     6.69311    50.00000    38.37173
 14  3    crtrack_scale     0.00000    -4.60951    -4.60951    50.00000    45.34128
 15  3     map_rotation     0.00000    -0.00367    -0.00367     0.10000     0.09936
```

Adjustable parameter corrections

```
Observation Corrections...
  n         observation    a_priori  total_corr   last_corr initial_std    prop_std
  1                   1    28.59735     3.92079     3.92079    50.00000    22.61567
                          -80.68278    -2.71886    -2.71886    50.00000    22.91156
                          -26.83644     0.17051     0.17051    50.00000    28.04424

  2                   2    28.59700     3.47060     3.47060    50.00000    22.56157
                          -80.68255    -2.52333    -2.52333    50.00000    22.85947
                          -28.33215     2.04273     2.04273    50.00000    28.06490

  3                   3    28.59890     3.31765     3.31765    50.00000    22.66972
                          -80.68181    -2.38507    -2.38507    50.00000    22.90460
                          -29.76113     1.41584     1.41584    50.00000    28.05215
```

Ground coordinate corrections

```
Measurement Residuals...
 observation   image    samp    line    initial_meas
           1       1    -0.1    -0.0    ( 2664.9, 6957.3 )
           1       2     0.0    -0.1    ( 1353.9, 14498.8 )
           1       3    -0.0     0.3    ( 4429.7, 4352.8 )

           2       1    -0.1    -0.0    ( 2687.2, 6996.5 )
           2       2     0.0     0.0    ( 1396.7, 14513.9 )
           2       3     0.2    -0.1    ( 4438.6, 4367.7 )

           3       1     0.2     0.0    ( 2759.6, 6786.7 )
           3       2    -0.0     0.1    ( 1309.9, 14306.7 )
           3       3    -0.2    -0.2    ( 4466.0, 4283.5 )

_____________Mean:     0.0    -0.0    RMS:     0.1     0.1
```

Image measurement residuals

```
 Iteration 2...
Parameter Corrections...
  n im        parameter    a_priori  total_corr   last_corr initial_std    prop_std
  1  1   intrack_offset     0.00000    -4.42816    -0.00124    50.00000    25.12279
  2  1   crtrack_offset     0.00000    -6.06469     0.00824    50.00000    28.75264
  3  1    intrack_scale     0.00000    -2.06194    -0.00092    50.00000    49.55560
  4  1    crtrack_scale     0.00000     8.97259     0.00687    50.00000    42.25599
  5  1     map_rotation     0.00000     0.00599    -0.00000     0.10000     0.09838
  6  2   intrack_offset     0.00000    -3.45382     0.00379    50.00000    25.89526
  7  2   crtrack_offset     0.00000    -2.44302    -0.00006    50.00000    31.17639
```

```
  8   2    intrack_scale     0.00000    -3.20447    -0.00158    50.00000    48.27970
  9   2    crtrack_scale     0.00000     3.57827    -0.00663    50.00000    40.63471
 10   2     map_rotation     0.00000    -0.00015     0.00003     0.10000     0.09394
 11   3   intrack_offset     0.00000    -5.15030     0.00510    50.00000    11.65931
 12   3   crtrack_offset     0.00000    -5.38992     0.00121    50.00000    15.78122
 13   3    intrack_scale     0.00000     6.67994    -0.01318    50.00000    38.39727
 14   3    crtrack_scale     0.00000    -4.61720    -0.00769    50.00000    45.33730
 15   3     map_rotation     0.00000    -0.00367     0.00000     0.10000     0.09936

Observation Corrections...
  n         observation    a_priori  total_corr   last_corr initial_std    prop_std
  1                   1    28.59735     3.92032    -0.00047    50.00000    22.61620
                          -80.68278    -2.71938    -0.00052    49.99998    22.90708
                          -26.83644     0.17089     0.00038    50.00000    28.04453

  2                   2    28.59700     3.47040    -0.00019    50.00000    22.56179
                          -80.68255    -2.52389    -0.00057    49.99999    22.85459
                          -28.33215     2.04298     0.00026    50.00000    28.06496

  3                   3    28.59890     3.31785     0.00020    50.00000    22.66964
                          -80.68181    -2.38592    -0.00085    49.99999    22.89936
                          -29.76113     1.41519    -0.00066    50.00000    28.05243


Measurement Residuals...
 observation    image    samp    line    initial_meas
           1        1    -0.1    -0.0    ( 2664.9, 6957.3 )
           1        2     0.0    -0.1    ( 1353.9, 14498.8 )
           1        3    -0.0     0.3    ( 4429.7, 4352.8 )

           2        1    -0.1     0.0    ( 2687.2, 6996.5 )
           2        2     0.0     0.0    ( 1396.7, 14513.9 )
           2        3     0.2    -0.1    ( 4438.6, 4367.7 )

           3        1     0.2     0.0    ( 2759.6, 6786.7 )
           3        2    -0.0     0.1    ( 1309.9, 14306.7 )
           3        3    -0.2    -0.2    ( 4466.0, 4283.5 )

               _____Mean:    -0.0    -0.0    RMS:     0.1     0.1

ossimAdjustmentExecutive Summary...
 Valid Exec:          true
 Nbr Ground Pts:      3
 Nbr Image Points:    9
 Nbr Images:          3
 Nbr Parameters:      15
 -------------------------
 Solution Converged: true
 Solution Diverged:  false
 Max Iter Exceeded:  false
 Max Iterations:     7
 Convergence Crit:   5.0%

 SEUW Trace...
   Iter       SEUW
      0     36.918
      1      0.622
      2      0.622

Tue 02.19.13 10:18:55
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
```

Post-solution summary

Observation metrics

Iteration convergence information

Standard error of unit weight per iteration

Additionally, the following terminology is used in the summary report:

1. `a_priori`: provisional estimate of parameter/ground coordinate
2. `total_corr`: total correction for all iterations
3. `last_corr`: correction computed from last iteration

4. `initial_std`: standard deviation of provisional estimate
5. `prop_std`: propagated standard deviation
6. `SEUW`: standard error of unit weight

At a top level, the following factors generally indicate an acceptable solution:

1. Solution converged, as illustrated in the example above
2. Decreasing/stabilized SEUW
3. Reasonable corrections to adjustable parameters and ground points

3.3 Save Adjusted Parameters

The adjusted parameters may be saved in the standard OSSIM geometry file format (`.geom`) by using the Parameter Adjustments window referenced in paragraph 3.1.1. This action is selective, that is, each image parameter set must be saved independently using the ***Save…*** button, as shown in **Figure 11**. The adjustment is also labeled with the date and time.

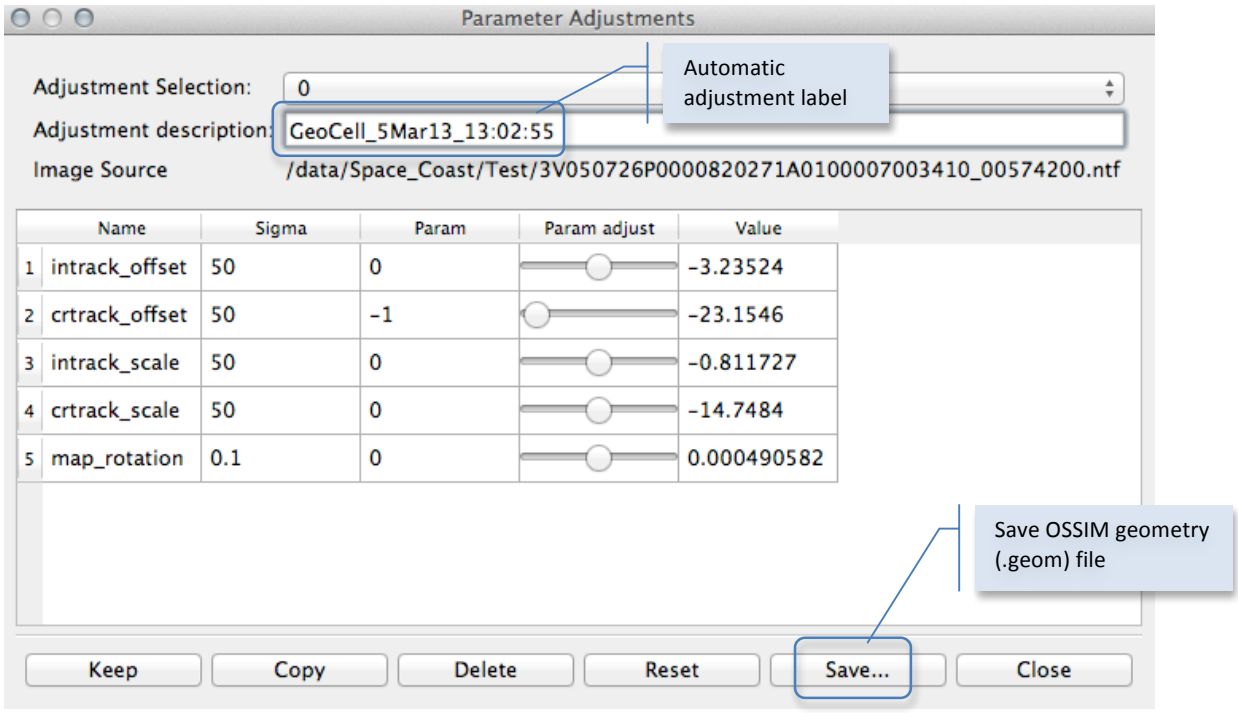


Figure 11. Parameter Adjustments Window - Saving Parameters

4 Mensuration

TBD