Software

PHOTOMOD 4.4

Scanner Images Processing

USER MANUAL

Racurs, Moscow, 2009

1. Space imagery processing in PHOTOMOD software system 3

2. SPOT Monoblock processing workflow 3

2.1 Launch PHOTOMOD Montage Desktop 3

2.2 Create PHOTOMOD project 4
2.2.1 Set PHOTOMOD project parameters 4
2.2.2 Specify the PHOTOMOD project reference system 5
2.2.3 Finalize the PHOTOMOD project parameters setup process 6

2.3 Input images into Monoblock project 6
2.3.1 Create strip (or strips if needed) 6
2.3.2 Add images into the strip 7

2.4 Phototriangulation stage 11

2.5 Block adjustment 15

2.6 Orthomosaic creation 18

3. Processing of IKONOS stereopair 22

3.1 Project creation in PHOTOMOD 22

3.2 Input images into Stereoblock project 22
3.2.1 Images adjustment 24

3.3 Start of phototriangulation 30

3.4 Ground control, check and tie points measurement 31

3.5 Block adjustment and pass to processing stage 34

3.6 Creation of orthomosaic for IKONOS stereopair 38

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1. Space imagery processing in PHOTOMOD software system

Digital photogrammetric system **PHOTOMOD** allows to process images acquired by space scanners and to produce both cartographic and other output products.

PHOTOMOD system includes special type of projects intended for space imagery processing – **Scanner survey** projects. If initial images make up a valid stereopair you should select **Stereoblock** subtype of the project to be created. If there is no images overlap or the overlap is not good enough to perform stereo processing, select **Monoblock** subtype. Single space images are processed in **Monoblock** subtype projects either.

The Manual is aimed to demonstrate the workflow of both scanner survey projects subtypes in general: SPOT 5 set of images as **Monoblock** project (see the chapter 2 SPOT Monoblock processing workflow), and IKONOS stereopair as **Stereoblock** project (see the chapter 3 Processing of IKONOS stereopair).

Details of space images formats and their processing in **PHOTOMOD** are described also in **Overview** and **PHOTOMOD Montage Desktop** User manuals.

2. SPOT Monoblock processing workflow

Block of space images without stereo overlap (SPOT 5 set of images is shown as an example here) as well as single scanner image processing consists of several main stages:

- project creation (which includes reference system specification and images addition);
- points measurement (ground control and check points coordinates specification and points measurement on the images);
- block adjustment;
- orthomosaic creation.

The step-by-step instructions are given below.

2.1 Launch PHOTOMOD Montage Desktop

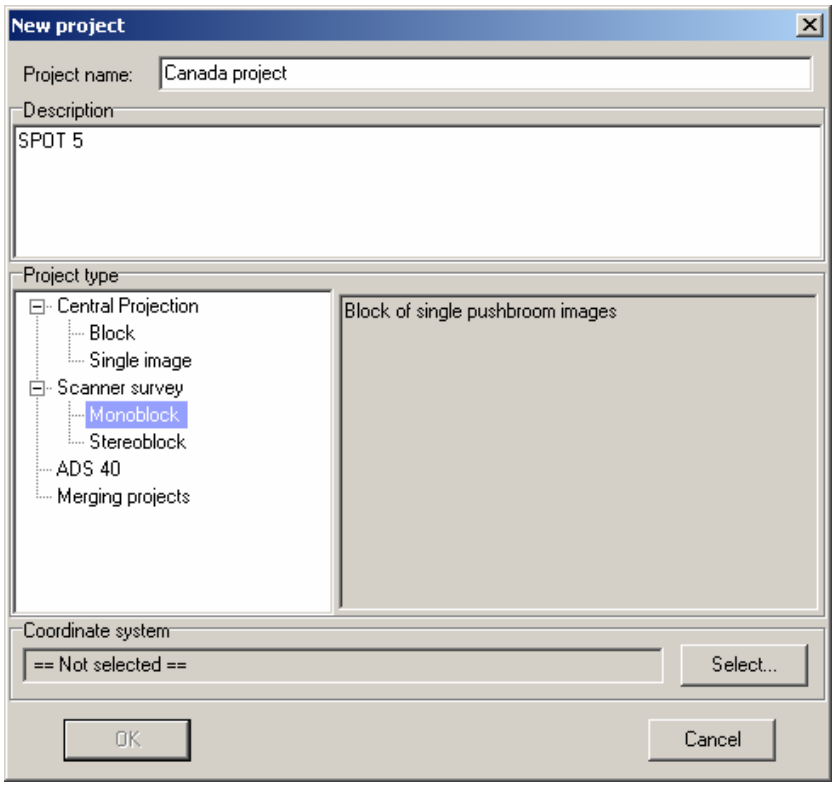
Start **PHOTOMOD System Monitor** first (from standard **Start** menu of OS Windows using command **Programs | PHOTOMOD | Utility | PHOTOMOD System Monitor**). Then launch **PHOTOMOD Montage Desktop** using either double click on **PHOTOMOD System Monitor** icon in Windows system tray or standard Windows **Start** menu.

2.2 Create PHOTOMOD project

Push the **Create** button in the window appeared to start new **PHOTOMOD** project creation.

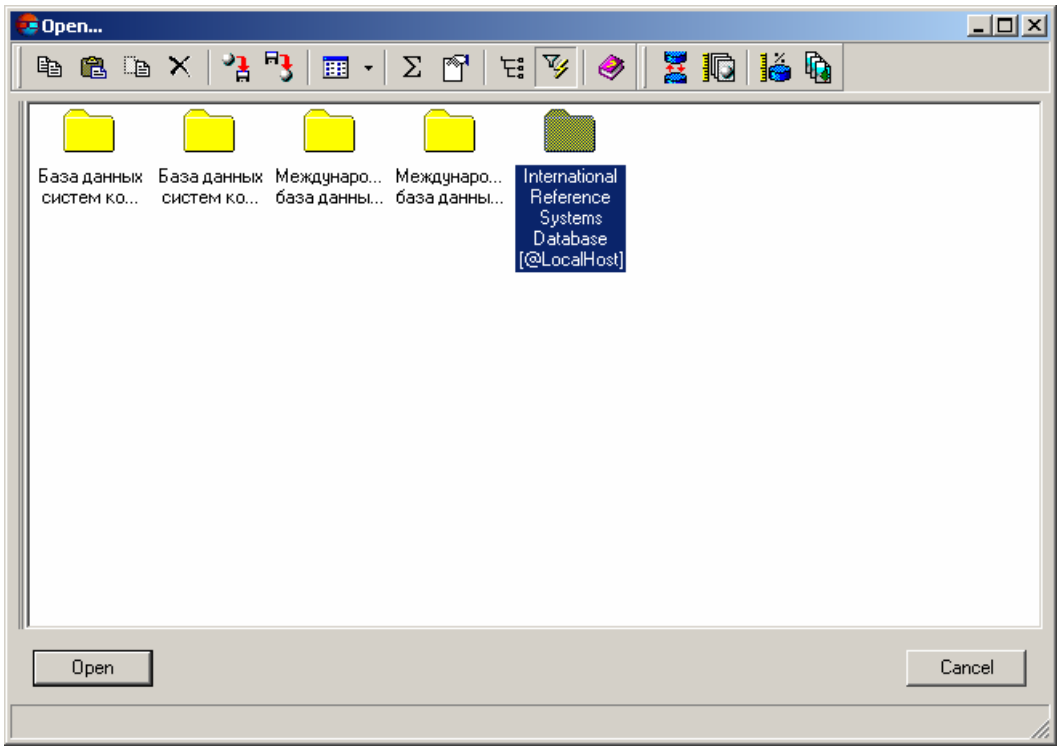
2.2.1 Set PHOTOMOD project parameters

In the **New project** window specify some project name (mandatory) and project description (optionally). Select the project type. It should be **Scanner survey | Monoblock** in this case. The word “Monoblock” means that the images overlaps do not constitute stereopairs. Select this project type both for single SPOT image or several ones without stereo overlap.

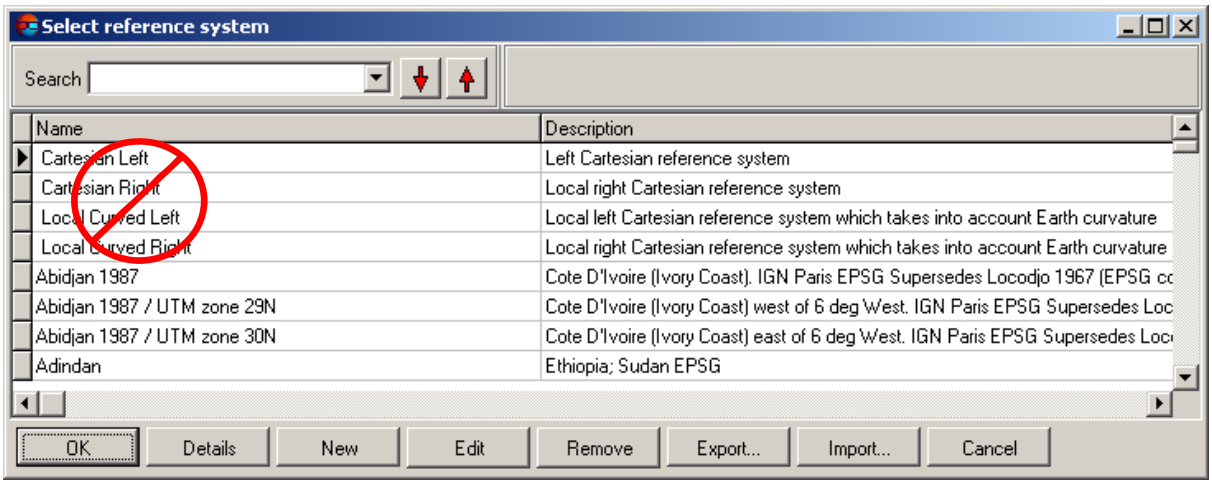


2.2.2 Specify the PHOTOMOD project reference system

To complete the project creation, select coordinate system by pushing the **Select** button. The reference systems are stored in databases. You can install several databases into each of PHOTOMOD data storages; moreover, you can use several storages simultaneously. So you should select the reference systems database first (select the database and push the **Open** button).



Then select the appropriate reference system from the list. Use search operation to find the reference system by its name.

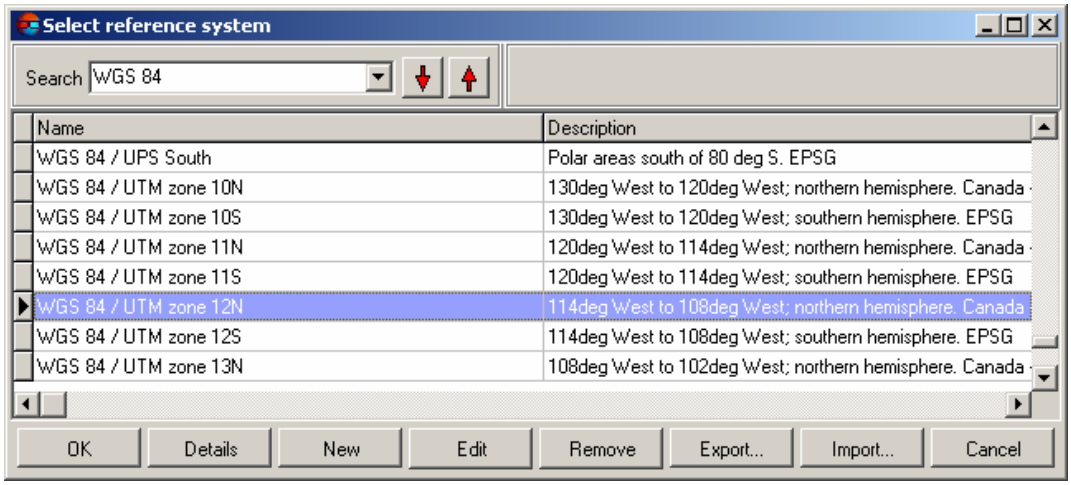


It should be noted that currently **PHOTOMOD** project cannot use latitude-longitude reference systems for the workflow. So, if necessary, convert the source data (GCP coordinates and DEM) into some projected reference system (using PHOTOMOD), then implement the workflow, and finally create the output orthoimagery with respect to the latitude-longitude system.

Please remember also that the “Cartesian Left”, “Cartesian Right”, “Local Left”, “Local Right” systems cannot be used with the pushbroom imagery, because the relation between the

systems and global frames is unknown (but it is necessary for involving the imagery metadata into adjustment process). See **PHOTOMOD Mosaic** User Manual.

When the appropriate reference system is selected (or created), push **OK** to finalize the reference system specification.

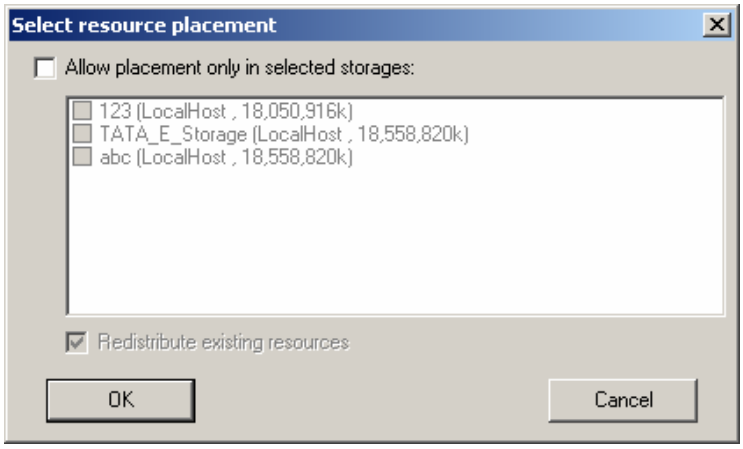


Refer to **PHOTOMOD Montage Desktop** User Manual for more details on coordinate systems creation or selection.

2.2.3 Finalize the PHOTOMOD project parameters setup process

When project name, project type and project reference system are specified in the **New project** window, push **OK** to proceed.

In the dialog appeared select the **PHOTOMOD** storage for your project if you work with several PHOTOMOD storages.



2.3 Input images into Monoblock project

2.3.1 Create strip (or strips if needed)

Any image of PHOTOMOD project should be placed into some strip. The meaning of the term “strip” is not proper for pushbroom block (contrary to aerial block). In the case of pushbroom monoblock project the only way of using strips is that PHOTOMOD supposes that strip is oriented “horizontally”, so it is reasonable to place into the same strip images which have side (but not top and bottom) overlaps.

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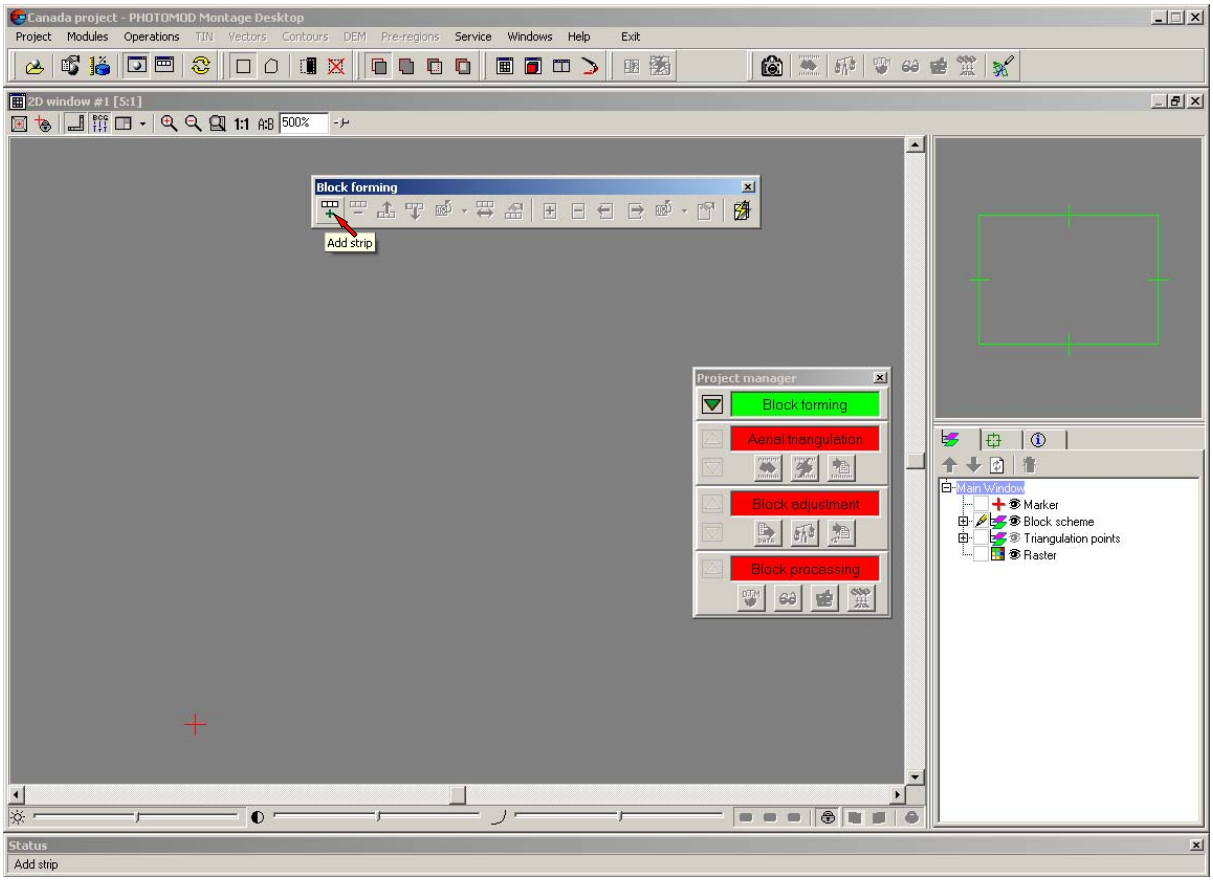
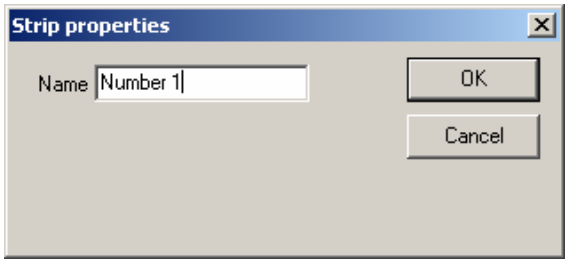
So before an image addition you should create or select strip and then place the image into it. To create the strip, push the button (**Add strip**) on the **Block forming** toolbar. If the toolbar is not visible, turn it on using **PHOTOMOD Montage Desktop** main menu (**Windows | Toolbars | Block forming**).

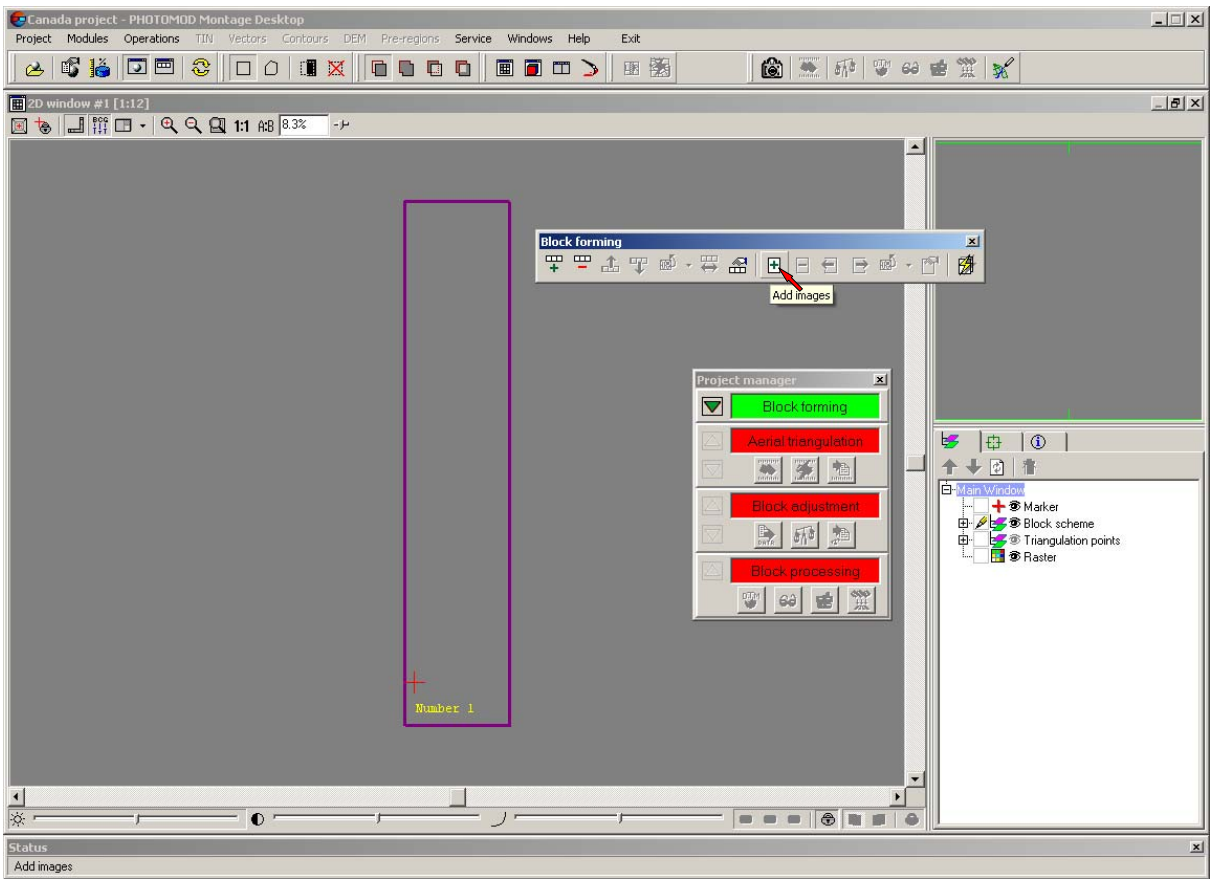


Then specify the strip properties: input the strip name. There is no need to change the strip orientation.



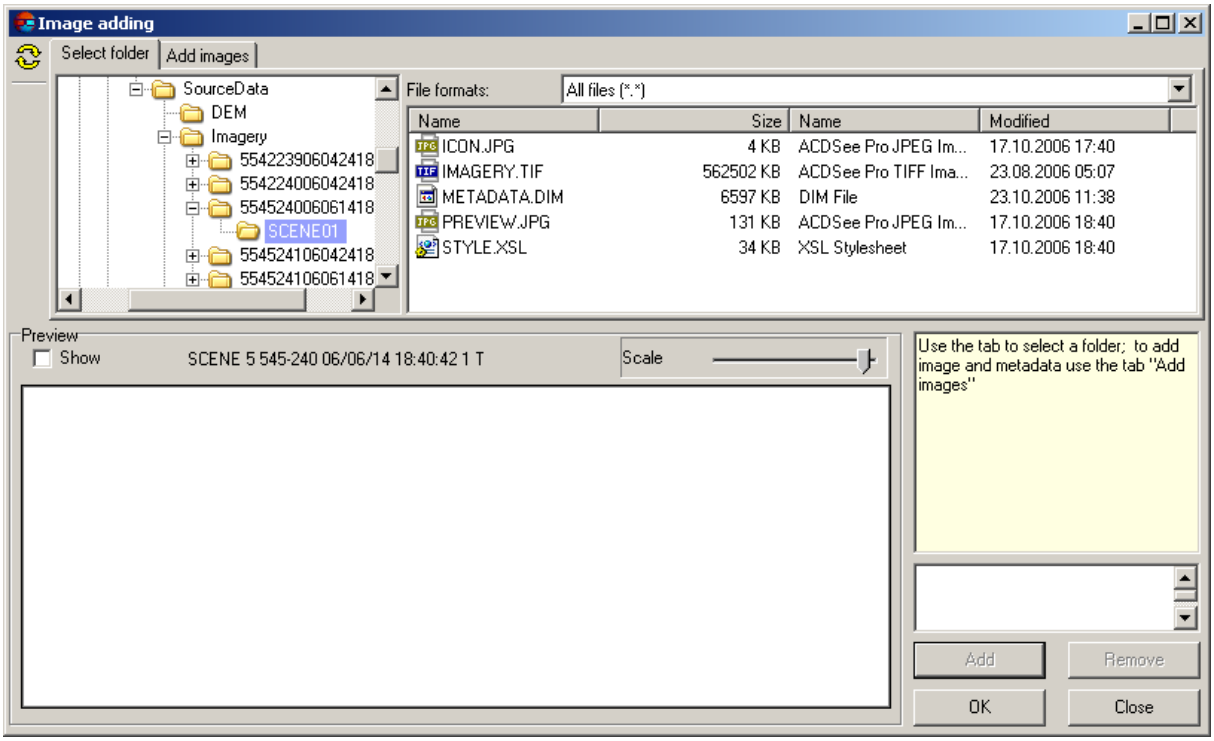
2.3.2 Add images into the strip

When a new strip has been created or selected (which can already contain some images), you can add one or several images into it.



Push the button (**Add images**) on **Block forming** toolbox to call the dialogue of images adding (make sure that the marker is inside the strip frame in 2D window).

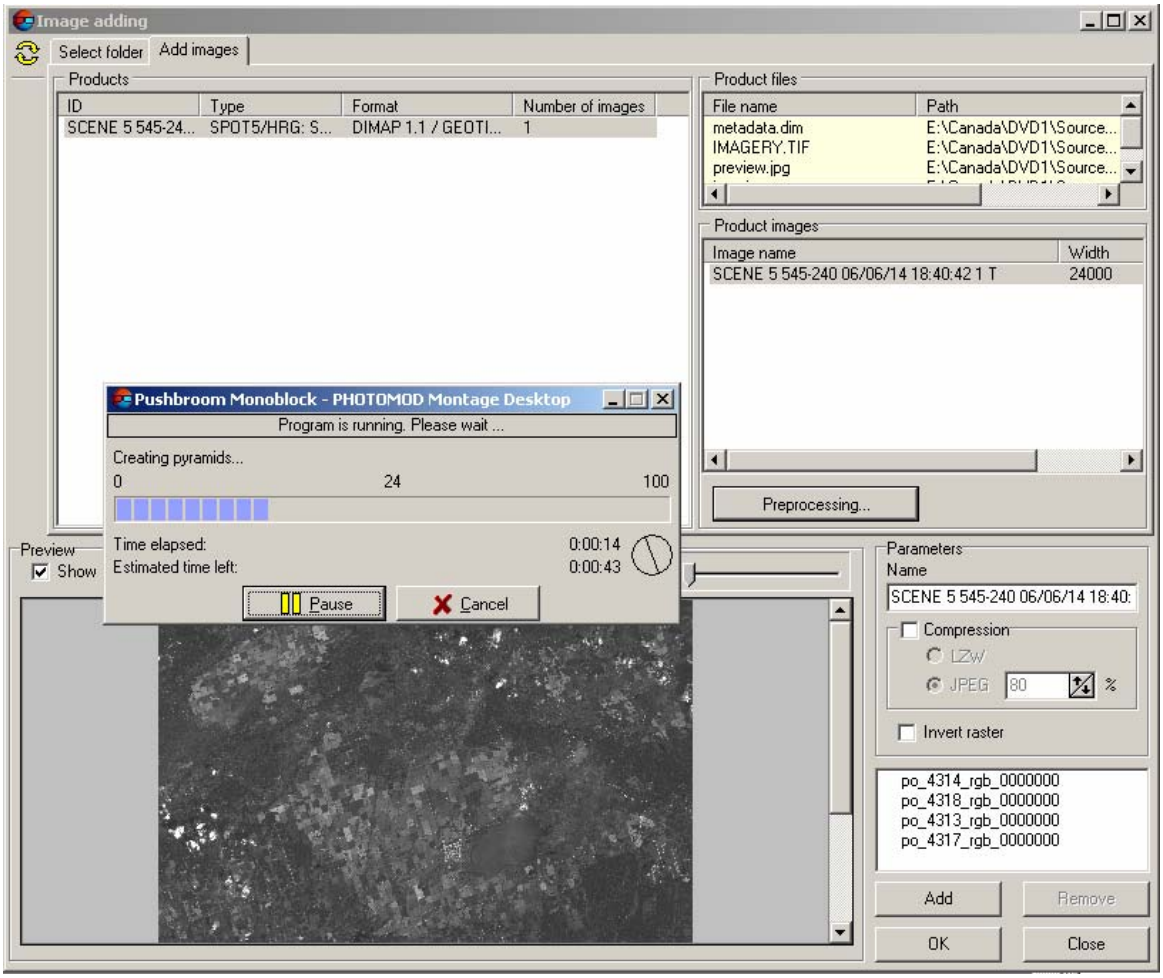
The dialog contains two tabs.



The left tab **Select folder** is used to select folder that contains the data while the right tab **Add images** are used to add imagery into the project.

The dialog conceptually based on automatic imagery recognition. When user changes from **Select folder** tab to **Add images** tab, the image recognition procedure is started. It searches for imagery metadata and reads it. So it is not allowed to rename or move files of the source imagery product.

The results of the analysis are shown on the picture below.

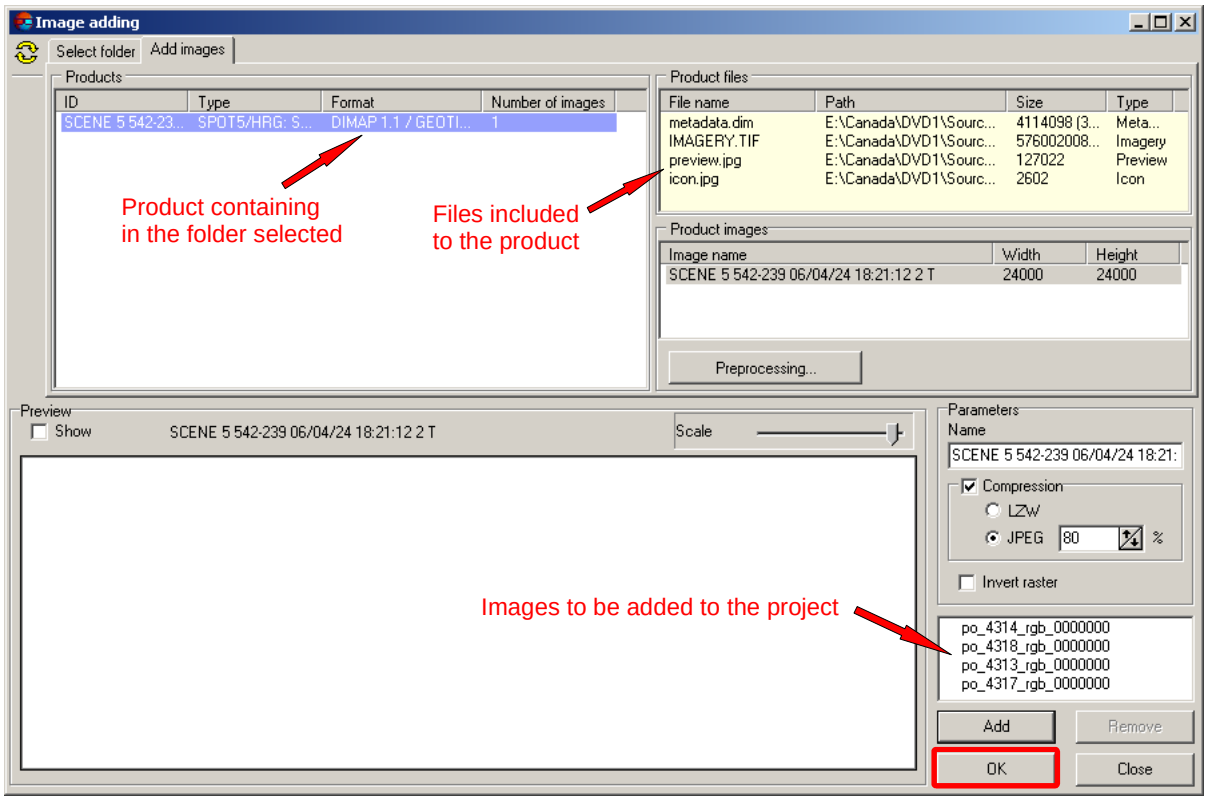


The window shows the imagery products recognized, the files, which comprise the product and the images the product includes.

The **Preprocessing** button opens a window intended for preliminary radiometric processing of the images; it is necessary if the input imagery have dynamic range more than eight bits per sample. More details on radiometric processing of the images see in the chapter 3.2.1 Images adjustment.

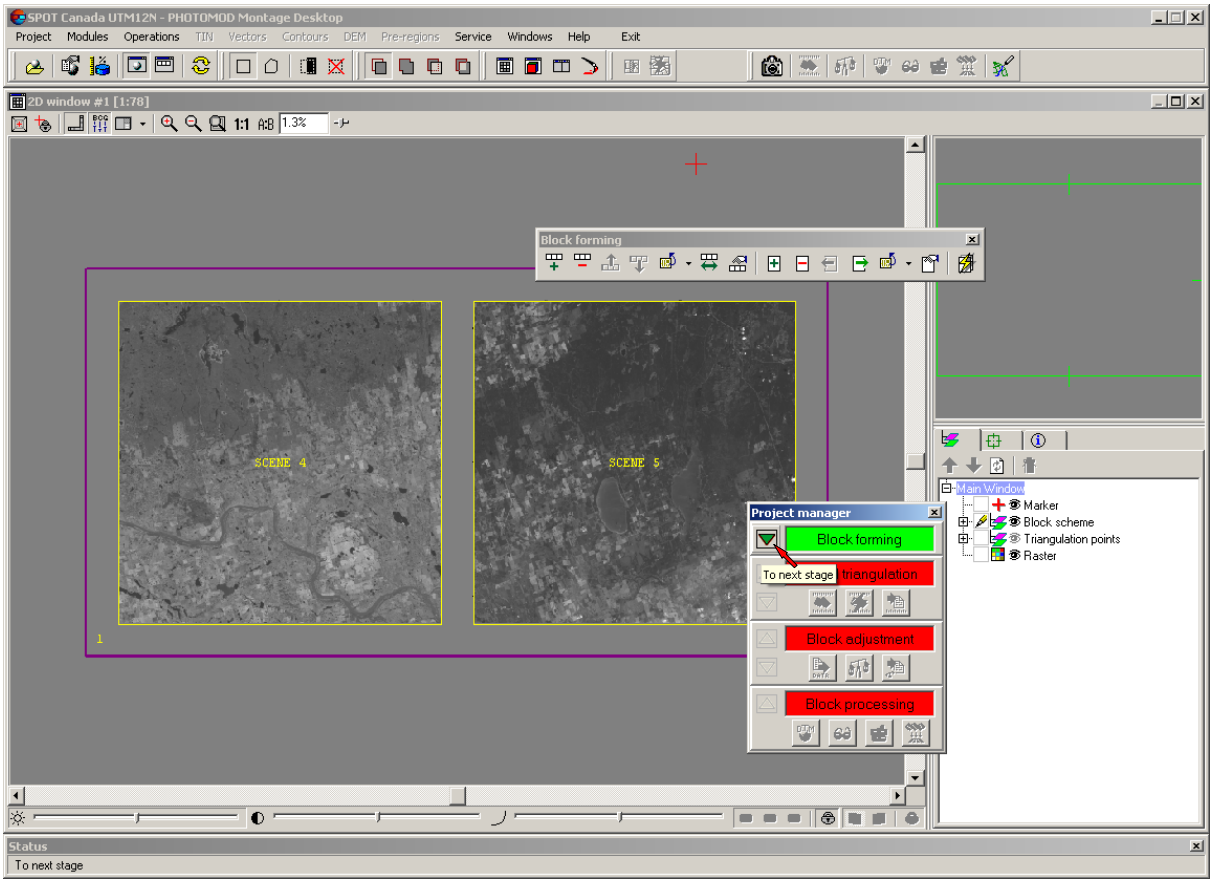
The field **Name** in **Parameters** panel specifies the image name in the project (it may differ from the image filename or product ID). The name must have length of 2-32 symbols. Push the button **Add** to add the image to project

You can return to the **Add images** tab, select new folder and to add images from it too.



Names of the images added previously are listed in the panel above the buttons.

Push the **OK** button to close the window saving changes.
You will return to the **PHOTOMOD Montage Desktop** window; the images will be written into PHOTOMOD Storage; the source imagery data will not be used anymore.

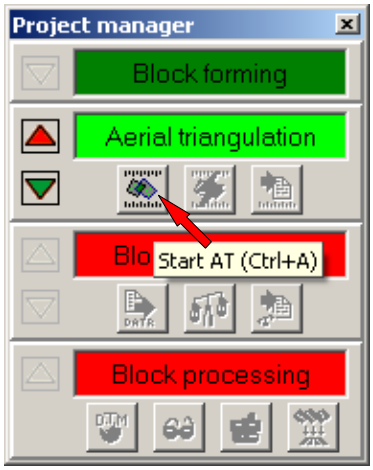


Then in **PHOTOMOD Montage Desktop** window add new strips here and add images into them.

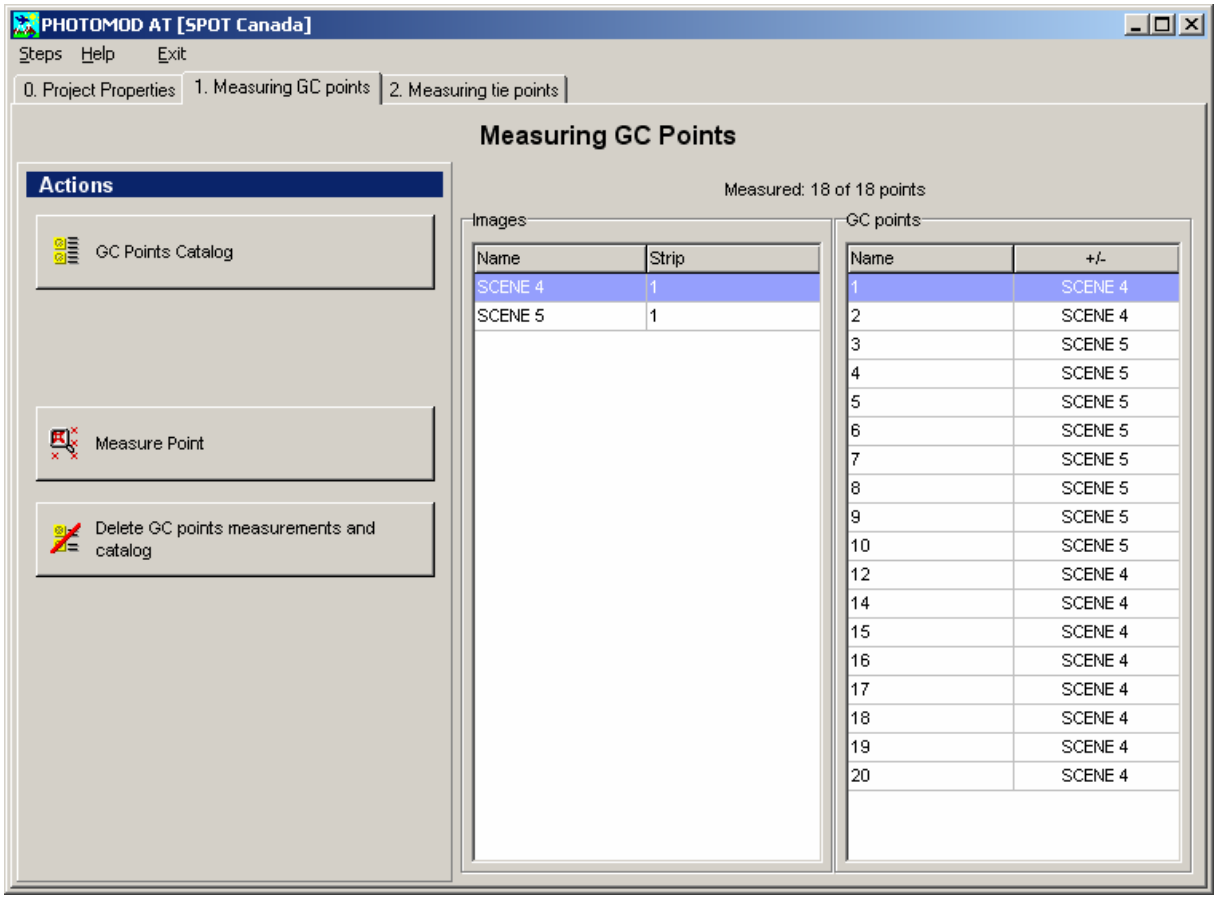
Then push the button in the **Project manager** window to get from **Block forming** to **Aerial triangulation** stage.

2.4 Phototriangulation stage

The stage is called **Aerial triangulation** but nevertheless it regards to space pushbroom imagery too. On the stage user should collect point's data: input geodetic coordinates of ground control and check points and measure on the images ground control as well as tie points. Run **PHOTOMOD AT** module to perform the operations.



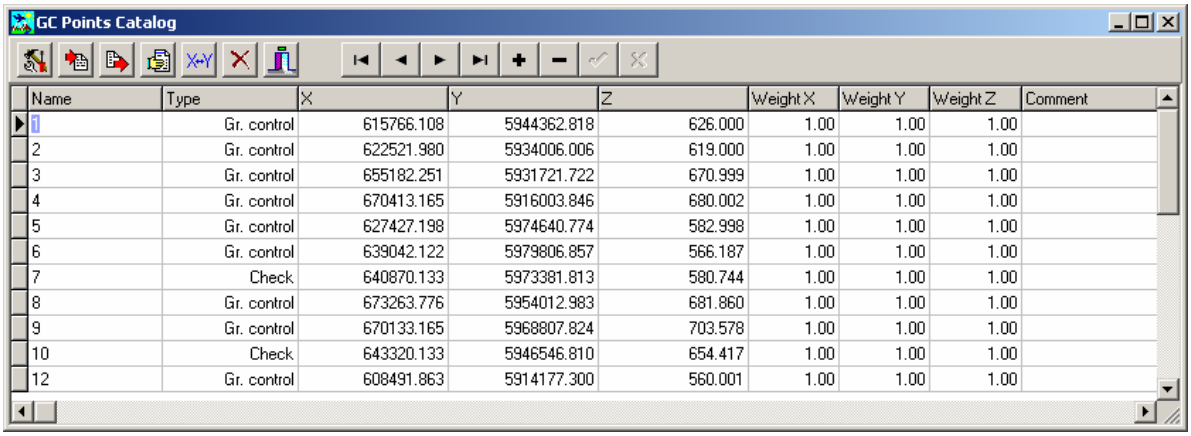
AT interface is based on the set of tabs, which are used in left-to-right order.



The tab **Measuring GC points** is used to specify the ground points geodetic coordinates and to measure the ground points on the images.

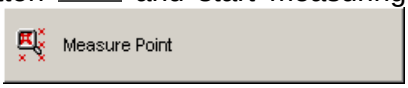
Use the button

to call the window for ground points geodetic coordinates input.



Name	Type	X	Y	Z	Weight X	Weight Y	Weight Z	Comment
1	Gr. control	615766.108	5944362.818	626.000	1.00	1.00	1.00	
2	Gr. control	622521.980	5934006.006	619.000	1.00	1.00	1.00	
3	Gr. control	655182.251	5931721.722	670.999	1.00	1.00	1.00	
4	Gr. control	670413.165	5916003.846	680.002	1.00	1.00	1.00	
5	Gr. control	627427.198	5974640.774	582.998	1.00	1.00	1.00	
6	Gr. control	639042.122	5979806.857	566.187	1.00	1.00	1.00	
7	Check	640870.133	5973381.813	580.744	1.00	1.00	1.00	
8	Gr. control	673263.776	5954012.983	681.860	1.00	1.00	1.00	
9	Gr. control	670133.165	5968807.824	703.578	1.00	1.00	1.00	
10	Check	643320.133	5946546.810	654.417	1.00	1.00	1.00	
12	Gr. control	608491.863	5914177.300	560.001	1.00	1.00	1.00	

You can load the ground points coordinates from the text file using the (**Import**) button or input it manually immediately in the table. The coordinates must be given with respect to the project reference system specified above (see the chapter 2.2.2 Specify the PHOTOMOD project reference system). If coordinates of all the points have the same accuracy, all the weights should be set to be unity.

So, you should fill the catalog of ground control and check points geodetic coordinates. Then close the window using the button and start measuring points on images. Run the procedure by pushing the button 

(**Measure point**).

In the window opened select a point from the list in the window bottom, select the appropriate image using the button (**Select image**) and find the point on the image (referring to overview image on the left and lens image on the right). Then push the button (**Measure**) to place the point in the current marker position.

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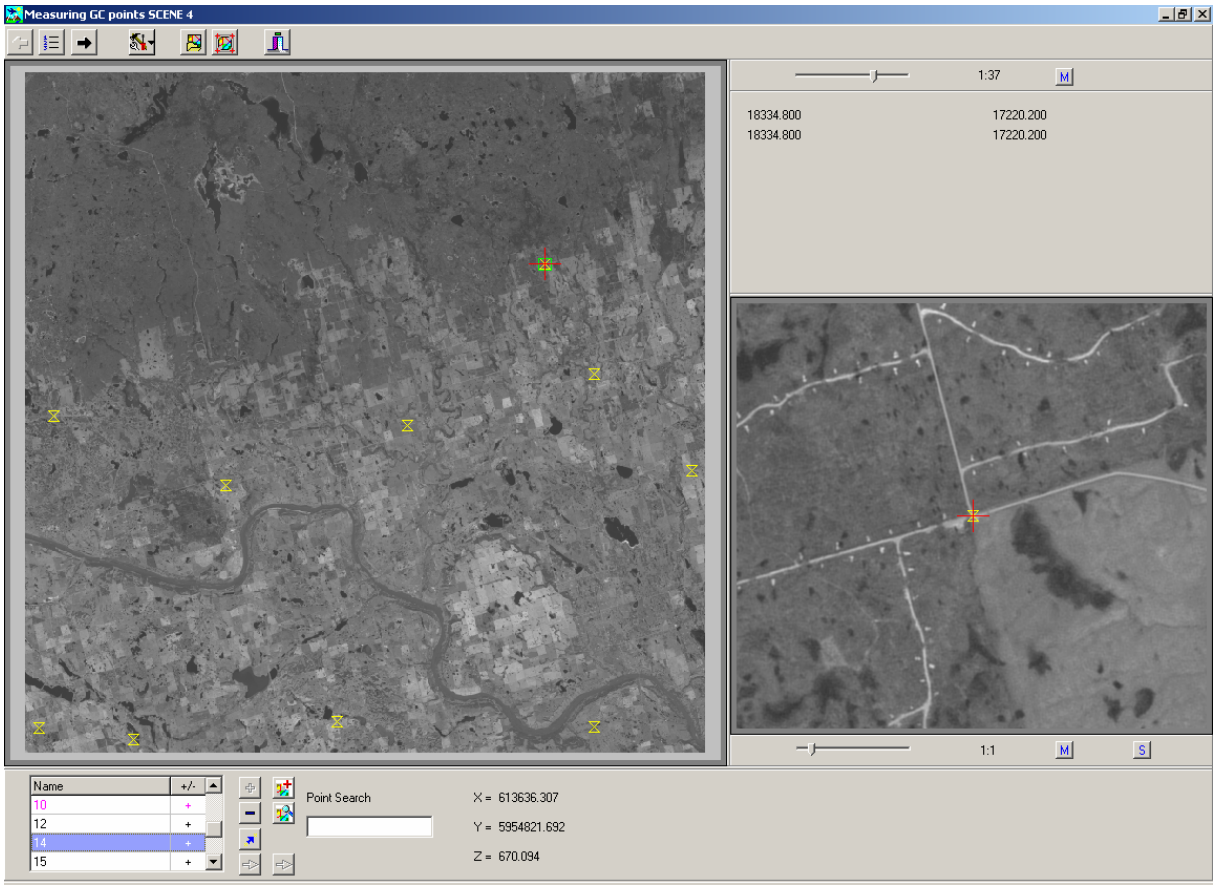
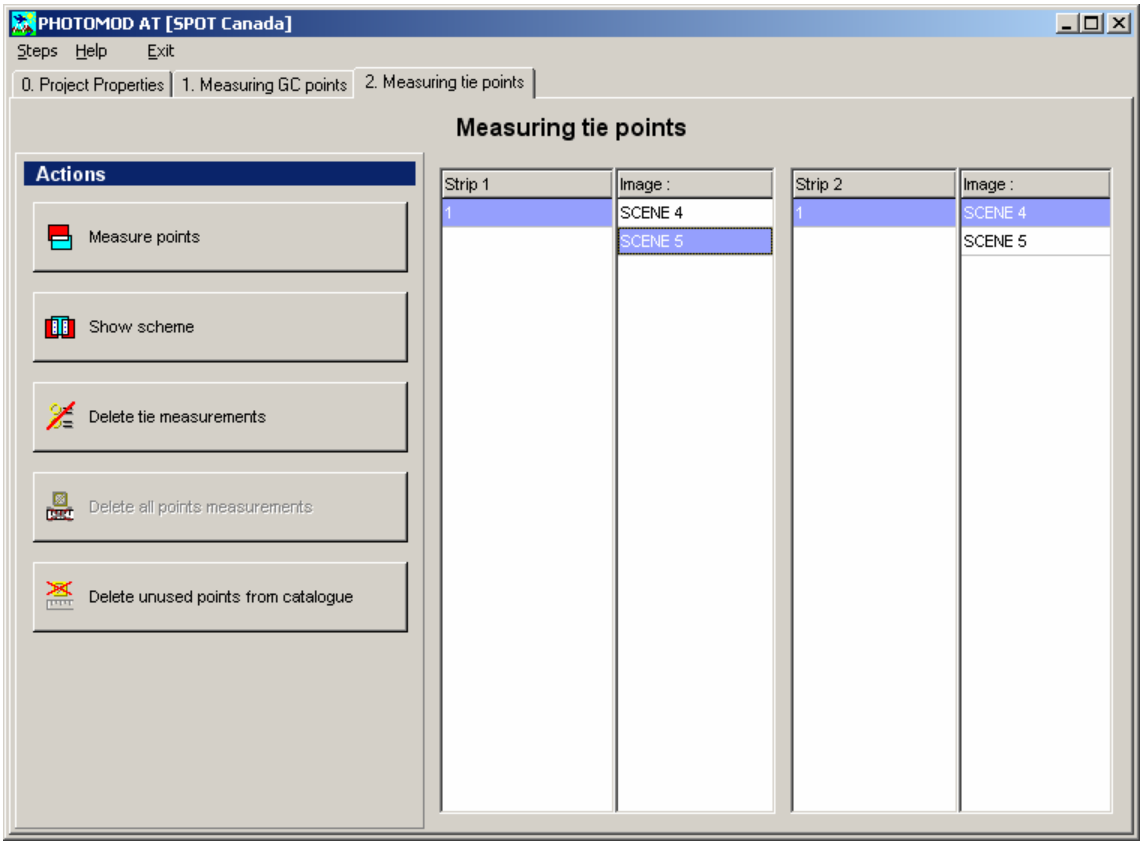
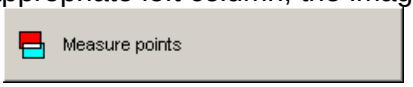
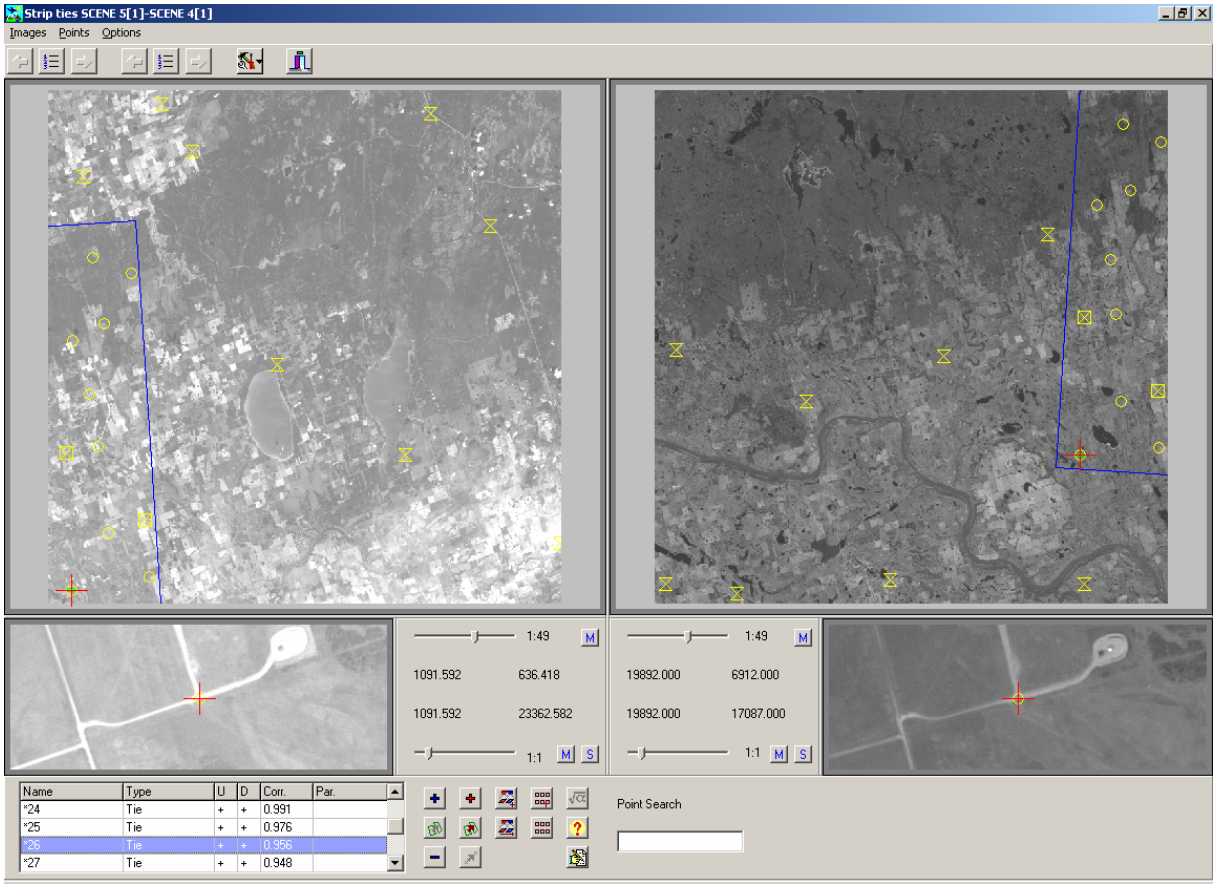


You should measure each point on the appropriate single image in the window.
To measure tie points and to transmit already measured ground points to other images use the tab **Measuring tie points**.



You should select two images for the ties measurement procedure. When a strip is selected in the appropriate left column, the images of the strip are shown in the right column. Push the button 

(**Measure points**) to measure points that ties the selected images.



If the images selected belong to the same strip (side-to-side overlap), the window is arranged horizontally; if they belong to different strips (bottom-to-top overlap), the window is arranged vertically.

You can add tie point or transmit already measured ground control, check or tie point with correlation (using the icon (**Add with correlation**)) or manually without correlation algorithm (using the icon (**Add without correlation**)).

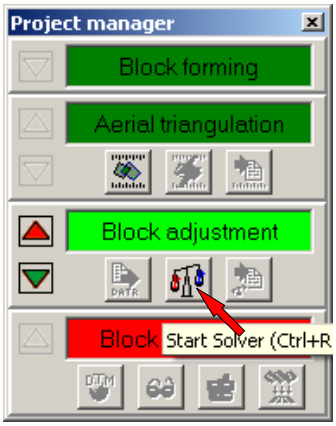
You should measure several tie points in each overlap and transmit ground points to all the images the point belongs. You can change the images using buttons on the top of the window , (next/previous image of the strip).

Refer to the **PHOTOMOD AT** User Manual to see more about ground control and tie points measurement in PHOTOMOD.

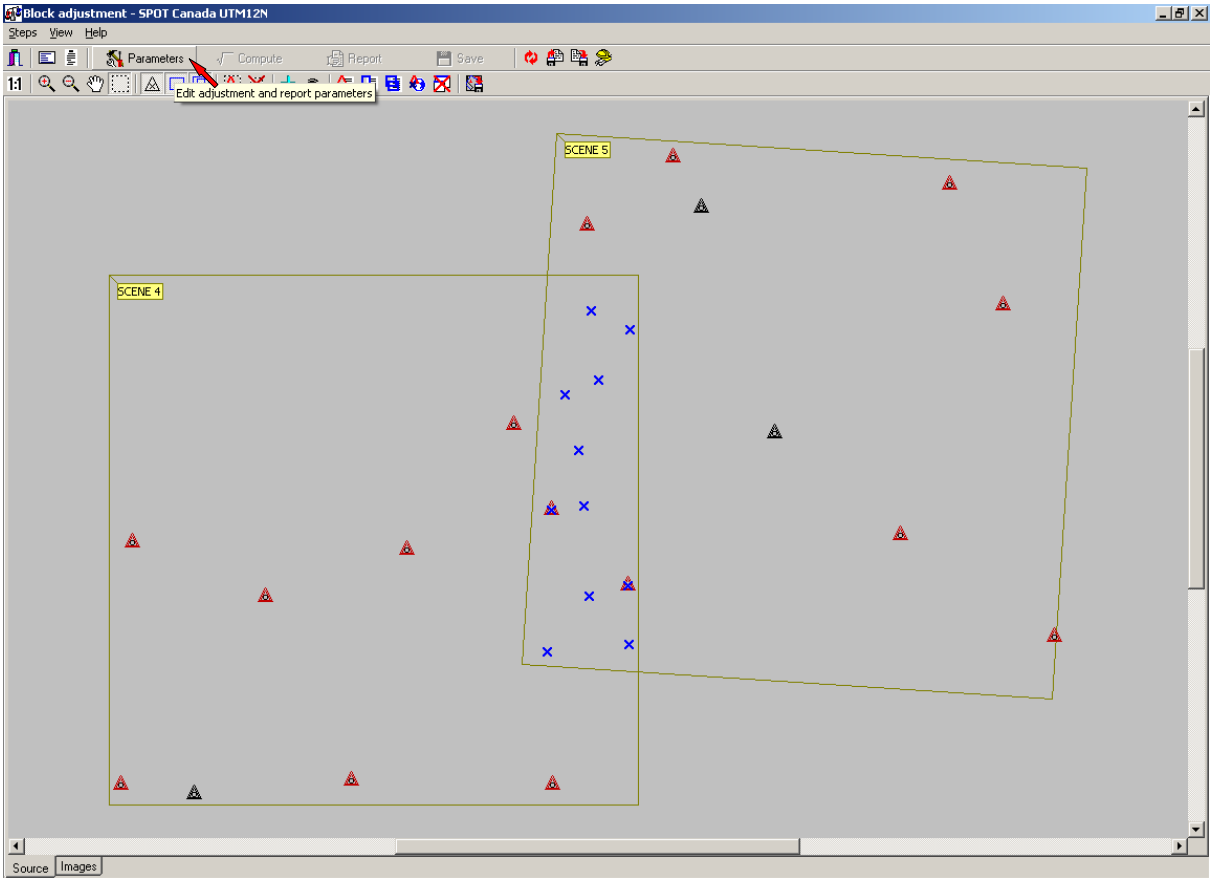
When all the points are measured, close the window and leave **PHOTOMOD AT** module. You will return to **PHOTOMOD Montage Desktop**. Get to the next stage **Block adjustment** using the button in the **Project Manager** window.

2.5 Block adjustment

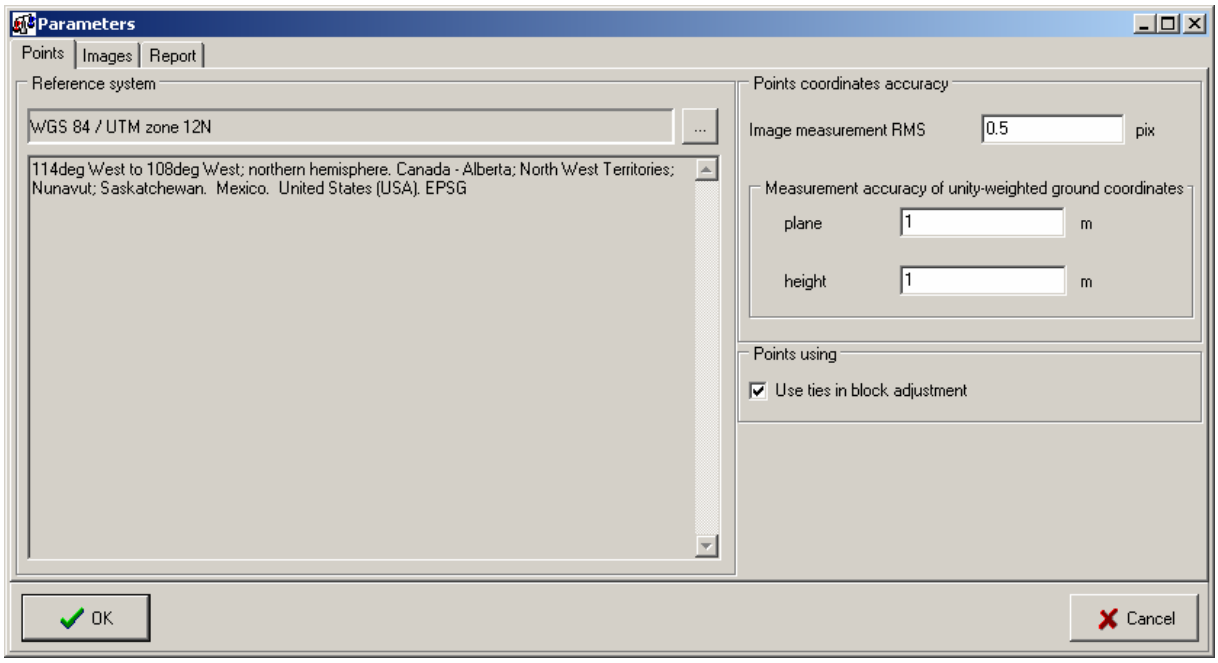
Launch **PHOTOMOD Solver** module from **Project manager** used for images block adjustment.



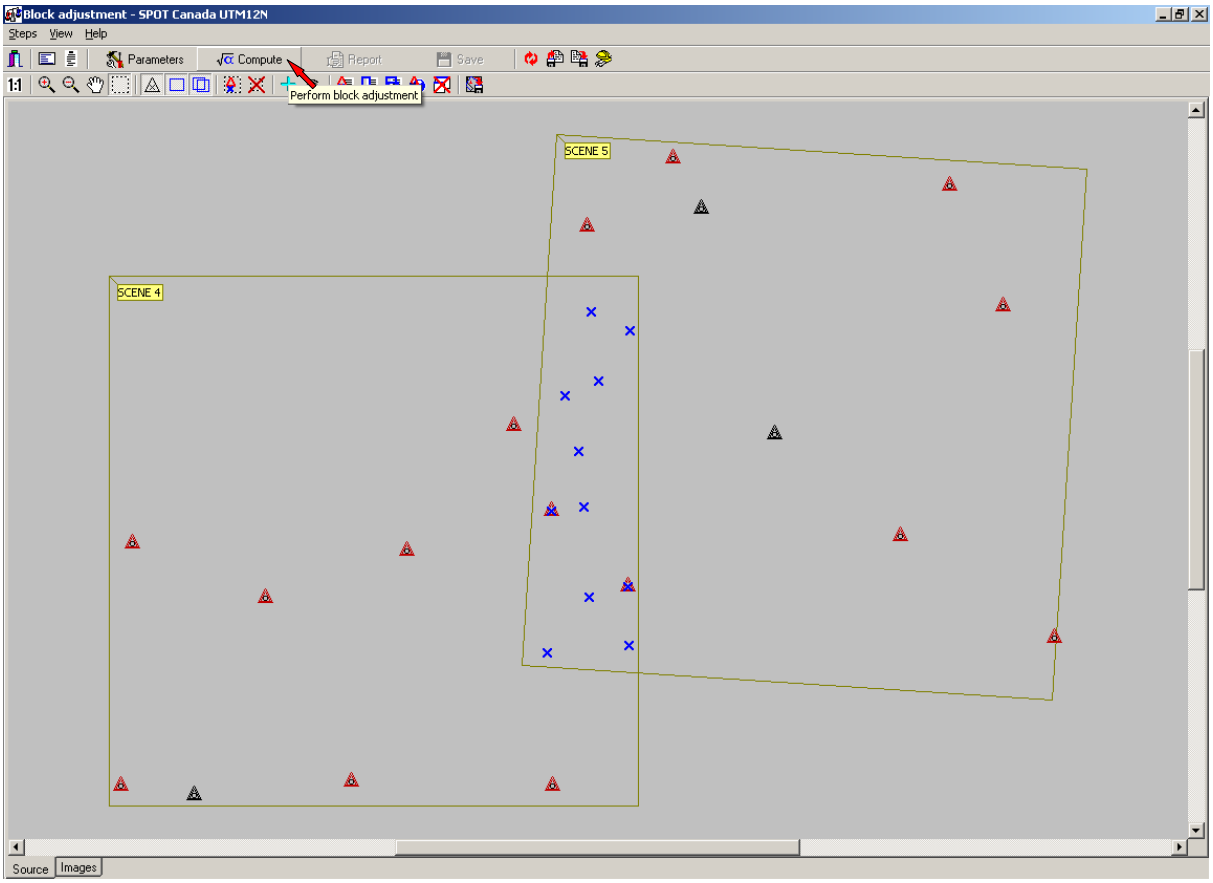
After starting **PHOTOMOD Solver**, push the button to specify the parameters of the block adjustment procedure.



For the simplicity, you can perform the adjustment using default parameters values; so just push the **OK** button in the adjustment parameters dialog.

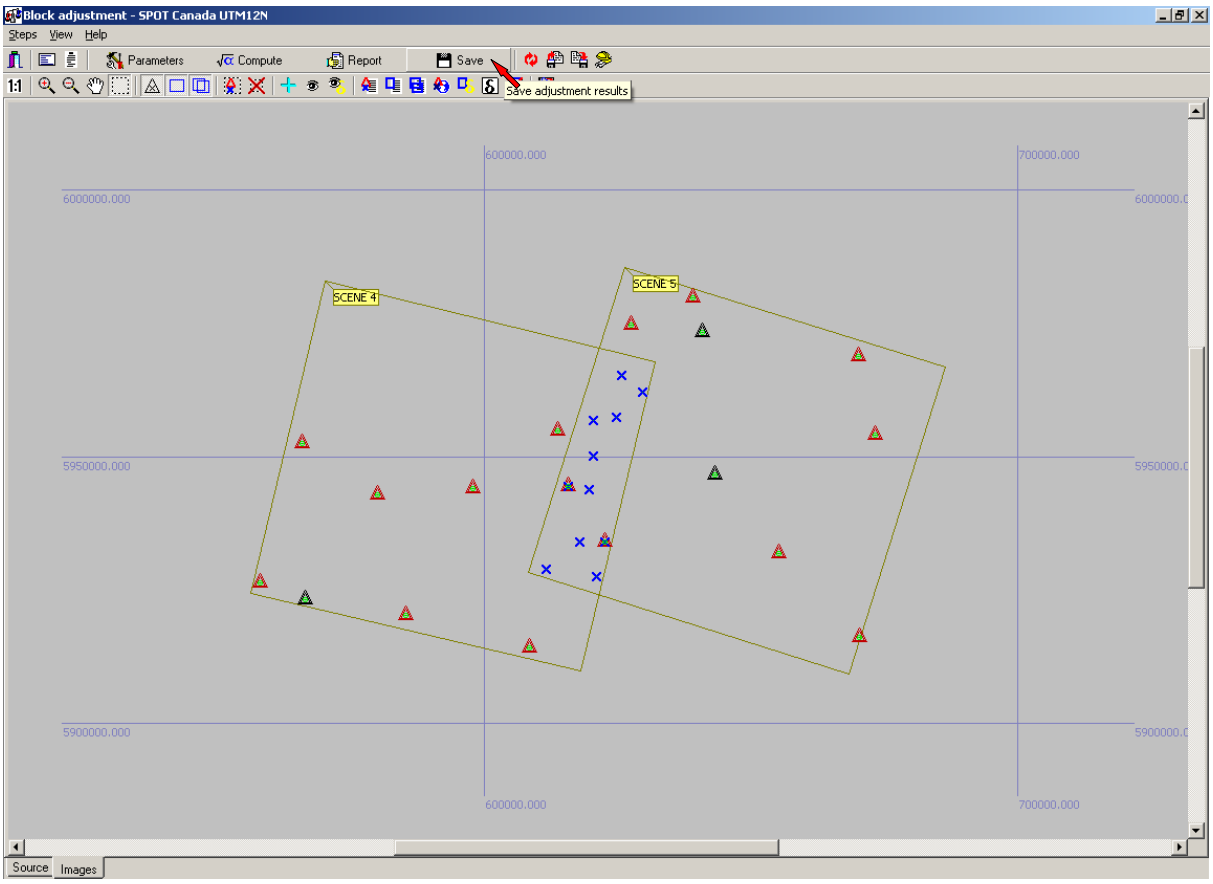


Then push the Compute button to start the adjustment process.



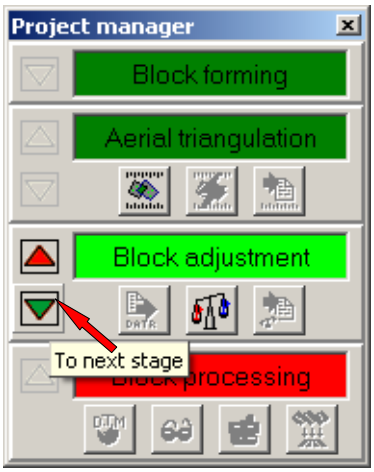
You should check the adjustment results: push the Report button to view the adjustment report.

Then save the adjustment results – push the button Save.



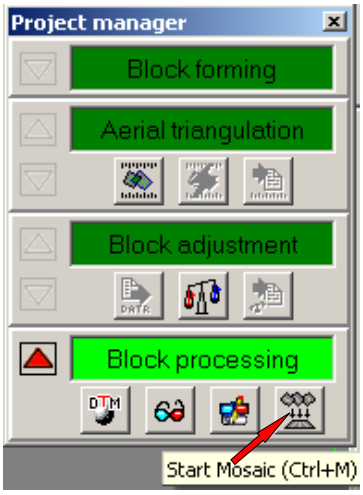
See more details on project adjustment in **PHOTOMOD Solver** User Manual.

When the adjustment is completed, close **PHOTOMOD Solver** and get to the next stage in **PHOTOMOD Montage Desktop**.

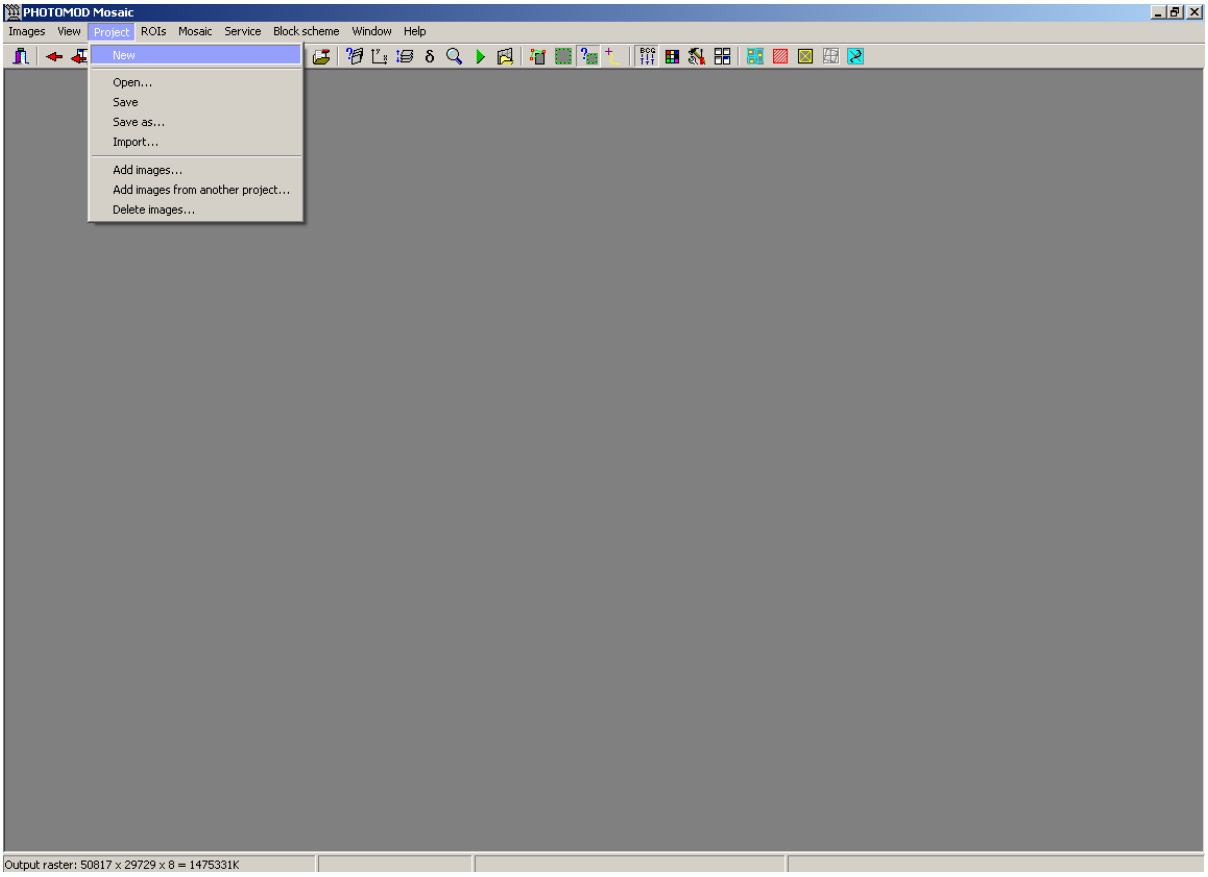


2.6 Orthomosaic creation

Start **PHOTOMOD Mosaic** to create orthoimagery.

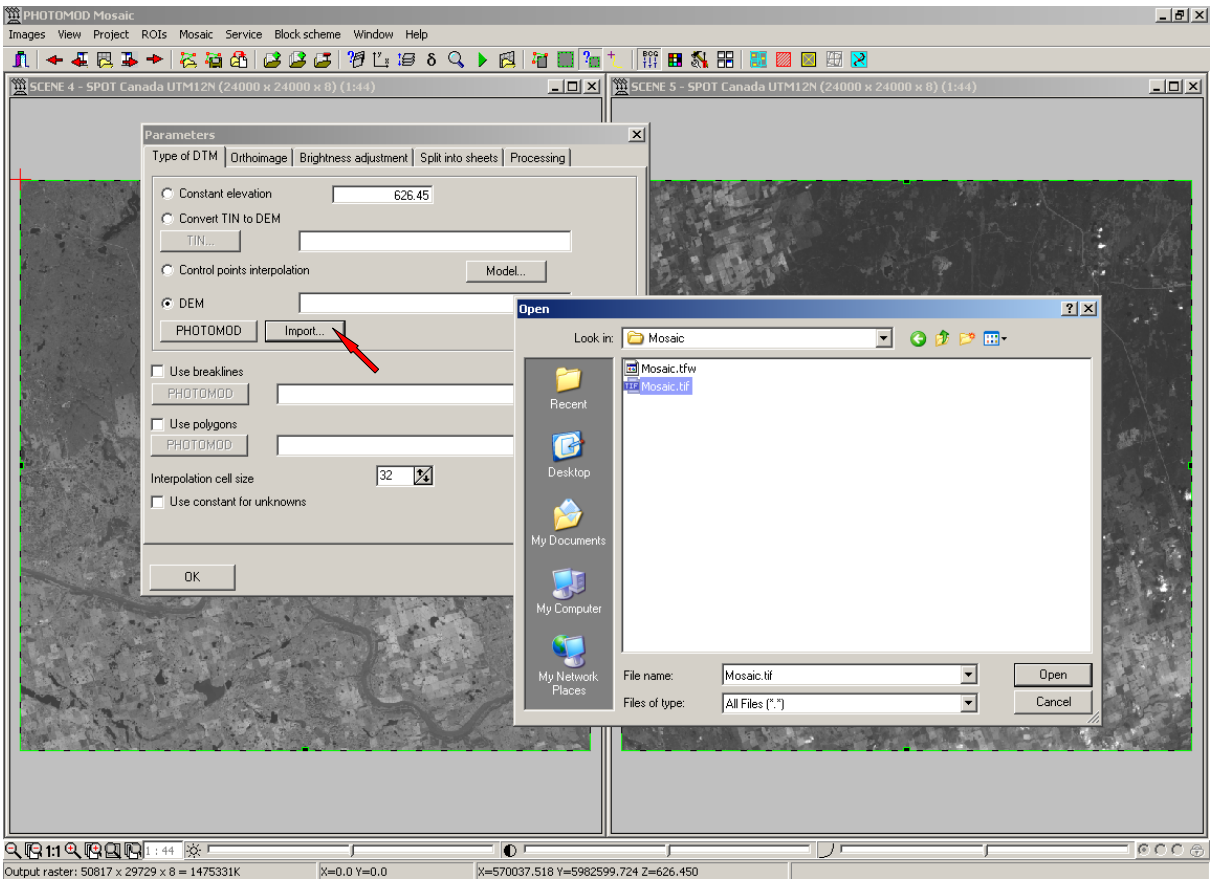


Create new **PHOTOMOD Mosaic** project (using menu command **Project | New**):

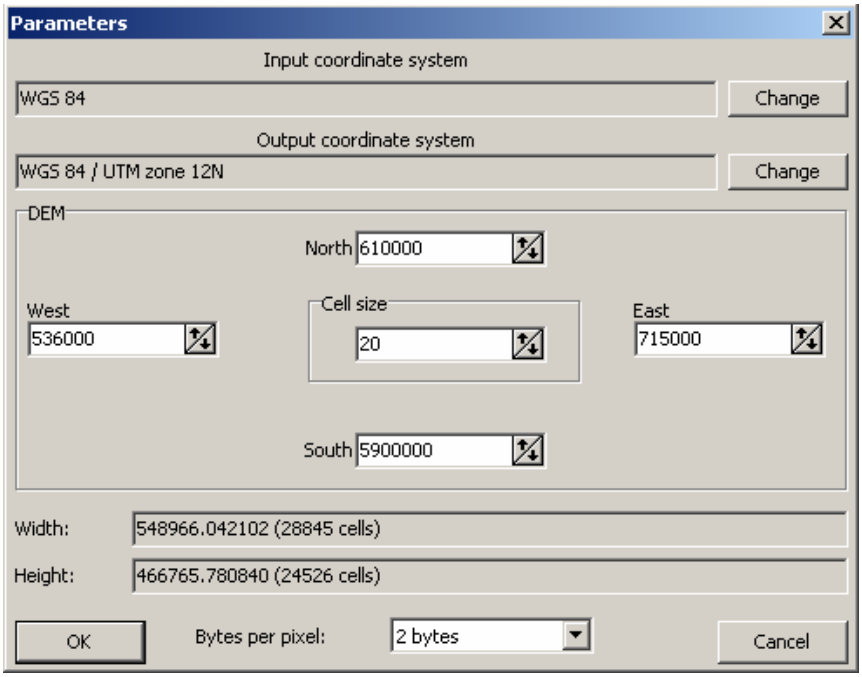


Specify the **PHOTOMOD Mosaic** project parameters in the **Parameters** window (use **Mosaic | Parameters** menu command to open it).

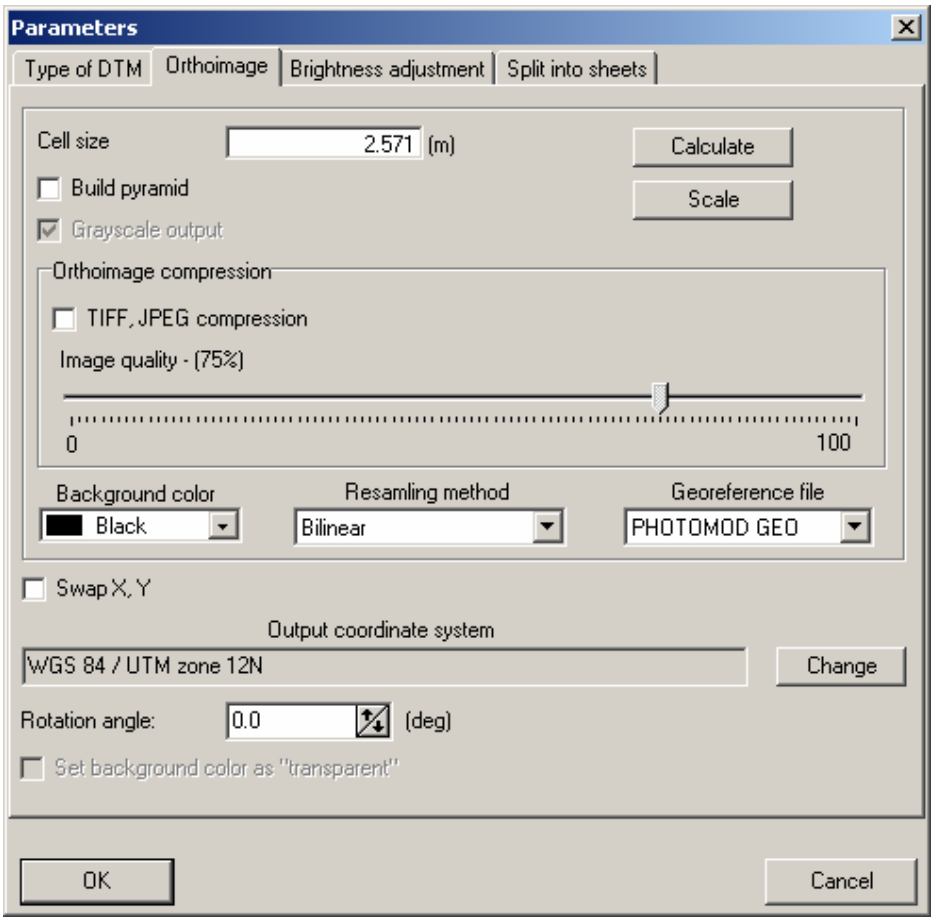
The first tab of the dialog is intended to specify the appropriate relief model to be used for orthomosaic creation. To import your DEM into PHOTOMOD project, select the **DEM** option and push the **Import** button.



Convert the DEM into the PHOTOMOD project reference system. Using the dialog you can cut the appropriate part of the DEM if your DEM is much larger than the imagery block; it will save space on your hard disks.



Then pass to the **Orthoimage** tab of the mosaic parameters dialog.



The most important settings are the **Cell size** (ground sample distance for the output orthoimage) and reference system for the output orthoimage (the reference system may differ from the PHOTOMOD project reference system).

You can also select the type of the georeference file here (MapInfo, Arc World, PHOTOMOD). Then push the **OK** button to close the mosaic parameters dialog.

To create the orthoimage push the button or use menu command **Mosaic | Build!**

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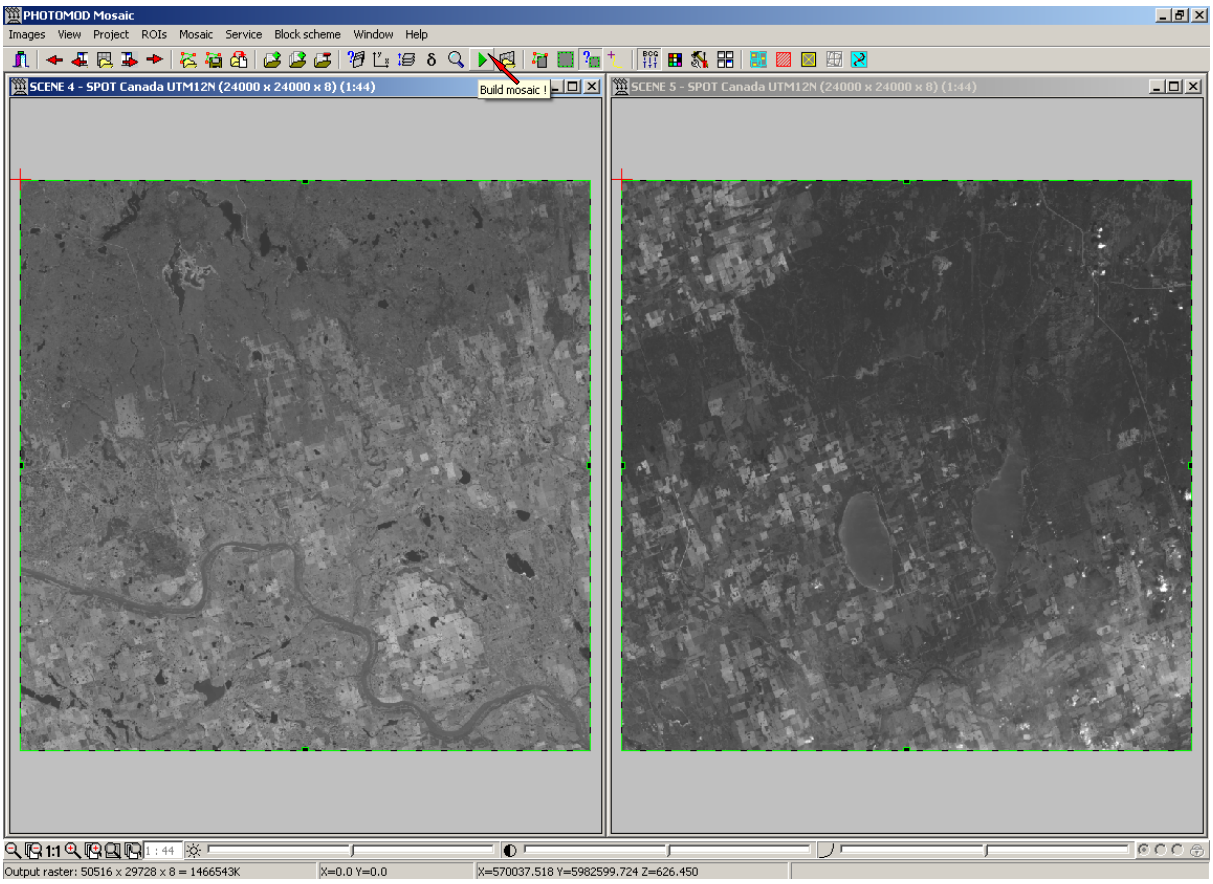
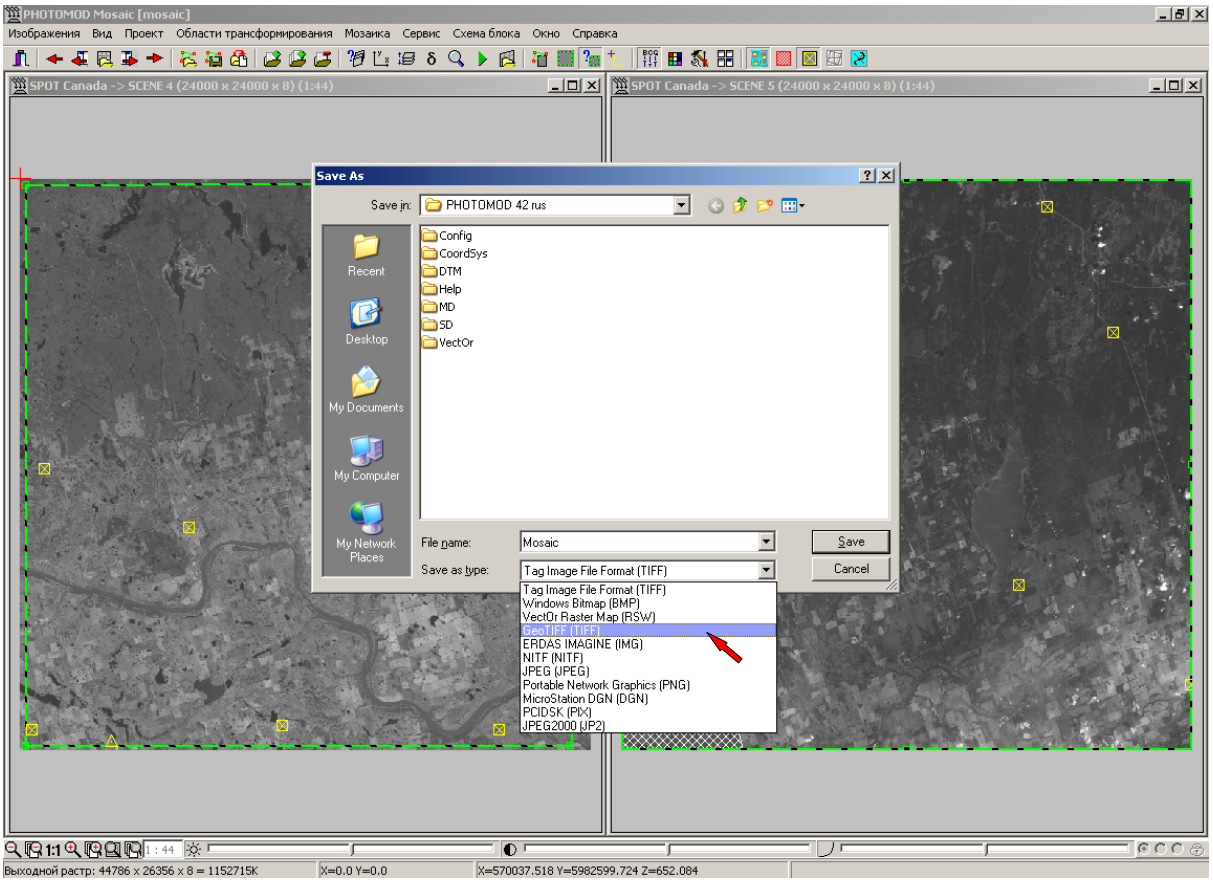


Select the appropriate type of the output orthoimage in the window of resulting mosaic file saving.

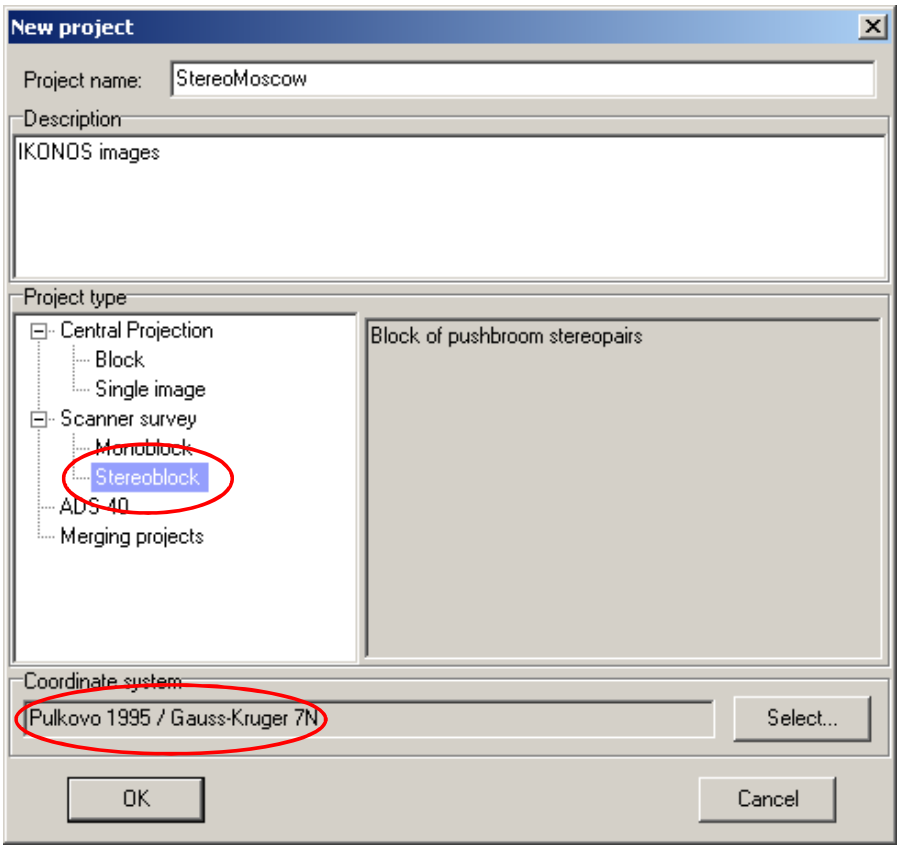


Refer to **PHOTOMOD Mosaic** User Manual for more details on orthophotos creation in **PHOTOMOD** system.

3. Processing of IKONOS stereopair

3.1 Project creation in PHOTOMOD

When creating a project for stereopair of scanner images (in this case, acquired by IKONOS satellite) select the project type – **Scanner survey | Stereoblock**. The rest of project creation procedure is the same as described in the chapter 2.2 Create PHOTOMOD project.



Coordinate system selection for the project to be created is described in the chapter 2.2.2 Specify the PHOTOMOD project reference system.

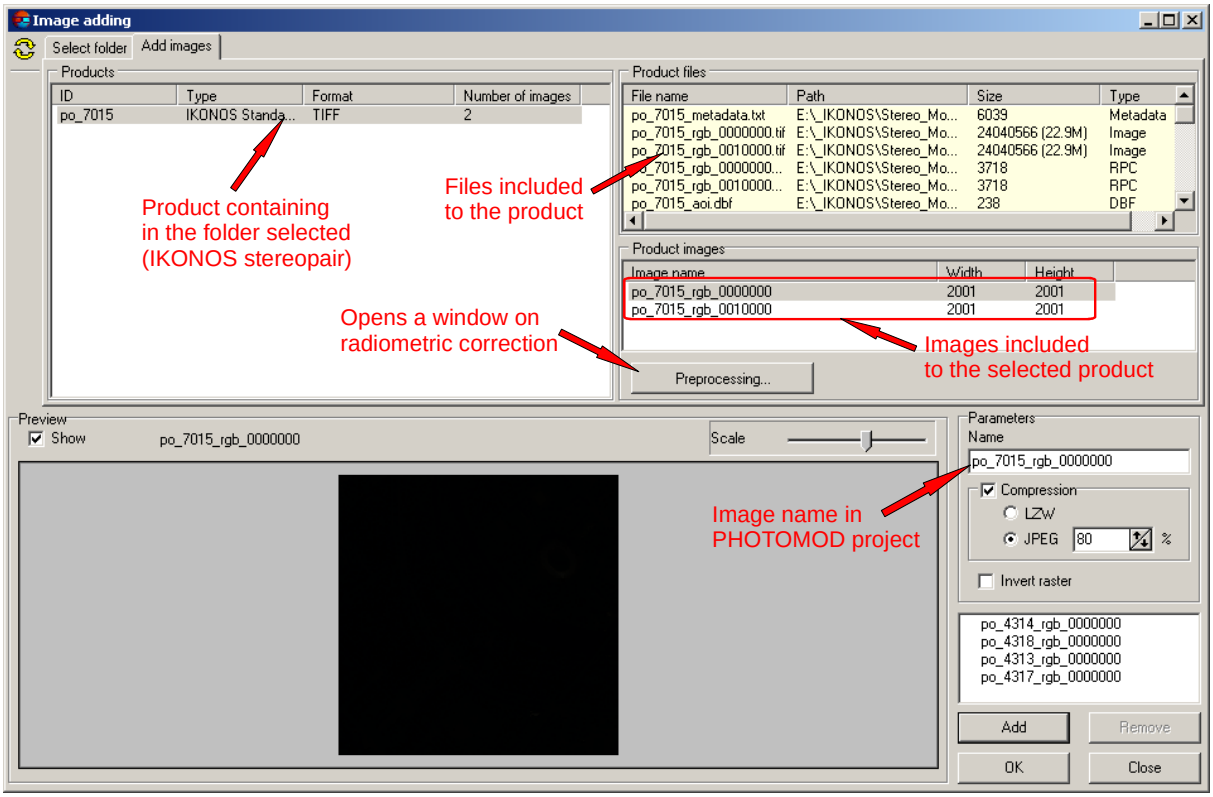
Note: Reference systems of the following types: "Cartesian" and "Local Curved" should not be used with IKONOS projects, because the systems are local (arbitrary positioned and oriented) while Rational Polynomial Coefficients (RPCs) the IKONOS imagery is supplied with are referenced with respect to global (WGS-84) reference system

Note: Current version of PHOTOMOD does not support geodetic (latitude-longitude) reference systems

3.2 Input images into Stereoblock project

After closing the dialogue of new project creation call the toolbar **Block forming** in **PHOTOMOD Montage Desktop** module using menu command **Windows | Toolbars | Block forming**, create new strip and add there initial images. See the chapter 2.3 Input images into project for more details on adding images to the project.

When IKONOS images are recognized by PHOTOMOD system automatically, they are listed in the panel **Product images**. The **Add images** window shows the following.

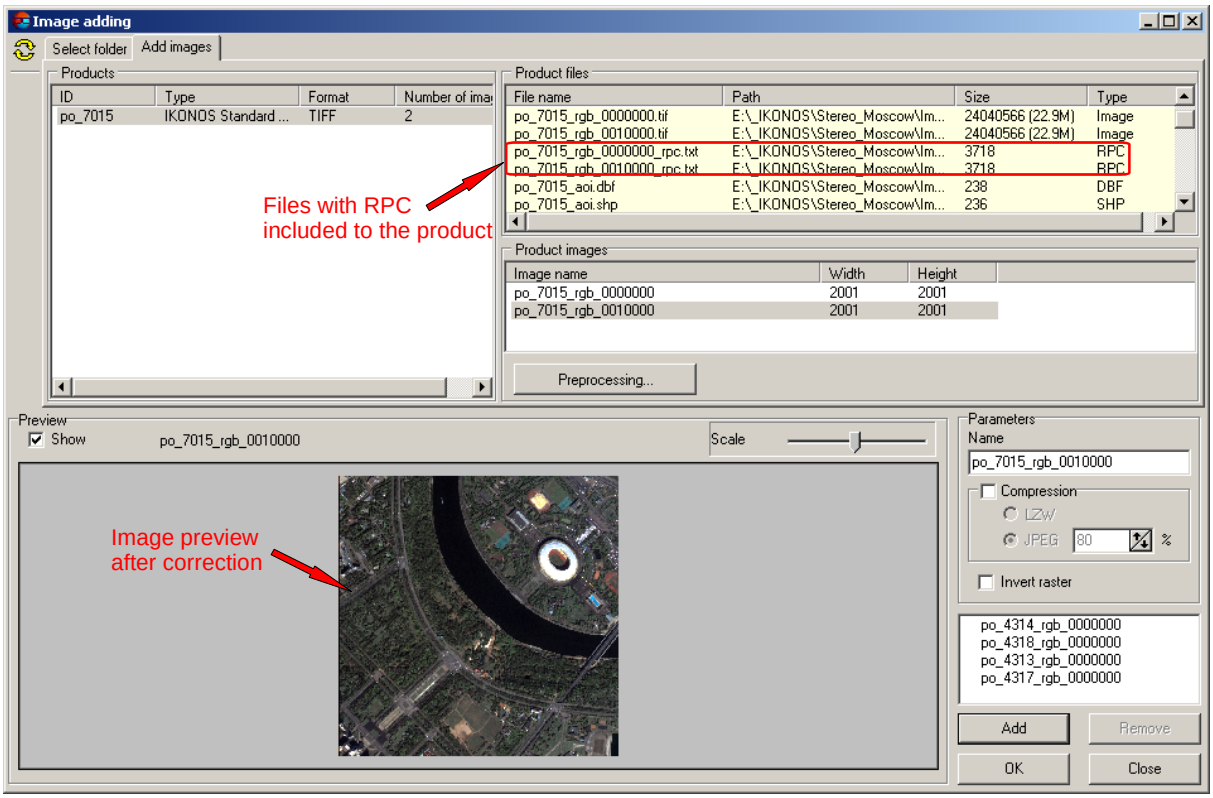


In **Products** panel imagery ***products*** containing in selected folder are displayed. The products are the sets of files obtained from space data supplier. The list of all files included to the product is shown (for reference only) in **Product files** panel to the left. List of images included to the product (shown in the **Product images** panel) is used for adding them to PHOTOMOD project.

All metadata included to the product is detected and added automatically. So the user should not know all the details of formats of the data, it is just necessary to remember that initial files of product should not be renamed (or moved), i.e. some of them are used for automatic search for other files included to the product.

In case of IKONOS imagery the process of recognition has two stages:

- searching for file with metadata and for files with images (and also for RPC files), which are specified in metadata file. If any of product files is absent you will see a warning
- reading RPC files and searching the appropriate images.



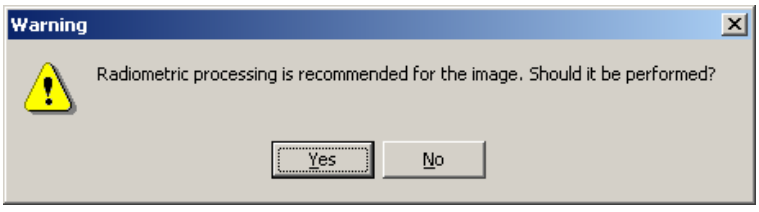
If the source raster has more than 8 bits per sample (acquired for instance, by IKONOS or QuickBird sensors), it is recommended to perform dynamic range adjustment procedure before image addition into PHOTOMOD project, see the chapter 3.2.1 Images adjustment.

3.2.1 Images adjustment

If the source raster has more than 8 bits per sample it is recommended to perform dynamic range adjustment procedure before image addition into PHOTOMOD project.

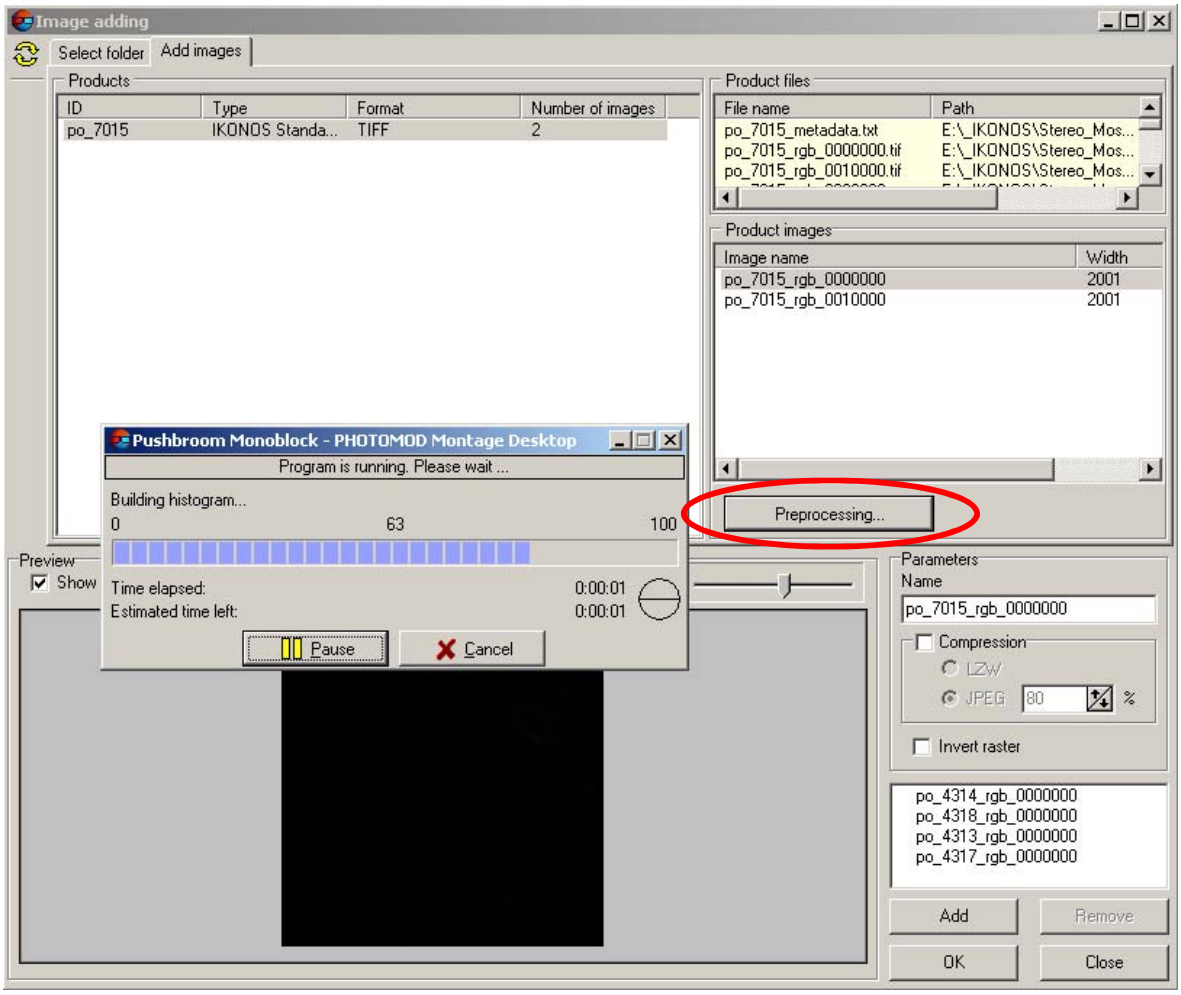
After you select an image, push the **Add** button and the system prompt you to perform such conversion automatically.

If you would not like to correct images radiometrically push the **No** button in the dialogue shown below:

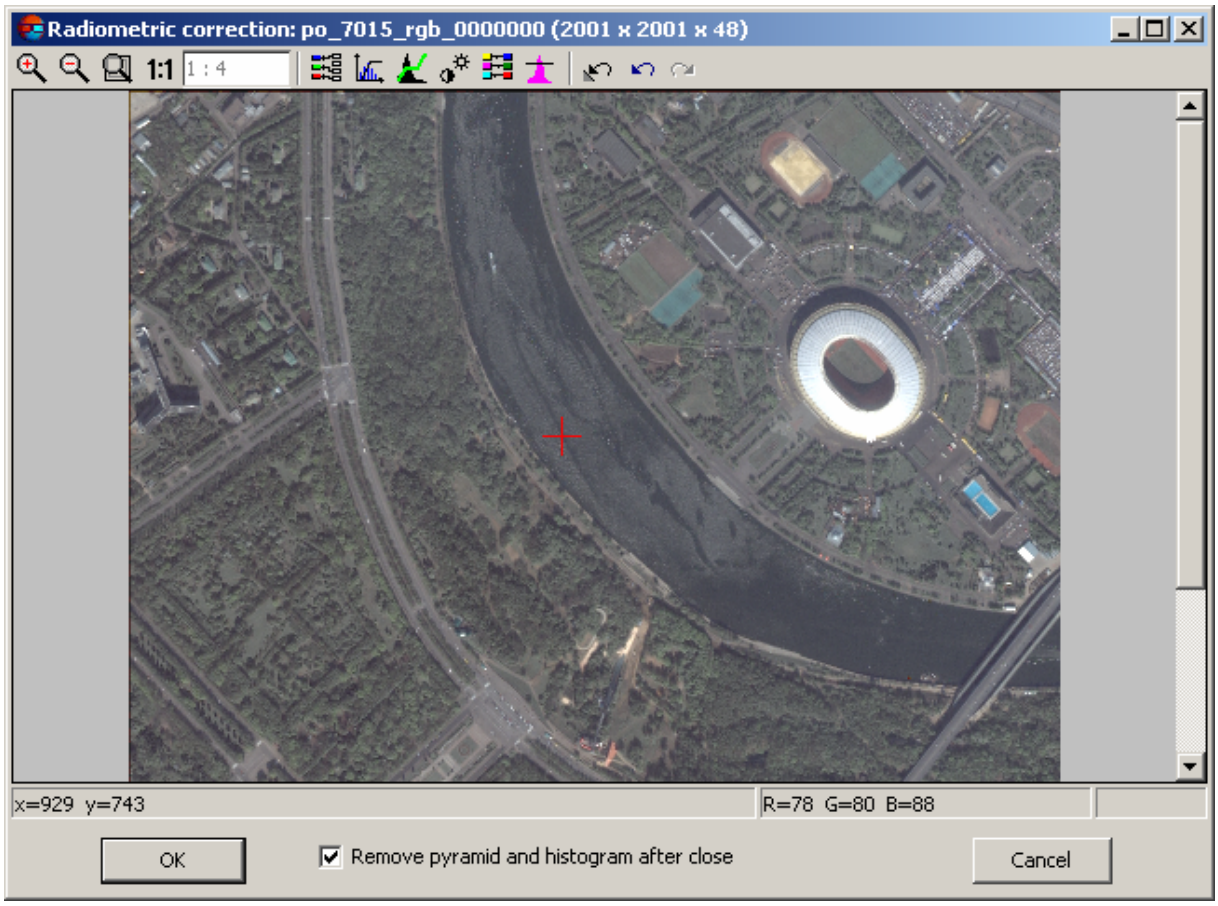


and the image will be added to the project without histogram correction.

However it is recommended to perform radiometric correction (by pushing the **Yes** button). Advanced users could set up parameters of the procedure and start the process themselves using the button **Preprocessing** in the **Product images** field.



The procedure includes histogram creating which may appear to be rather time-consuming for large images. After completing of image histogram creation process the window **Radiometric correction** is opened. Window title bar contains image name, its width, height and number of bites per pixel.



Note. Temporal pyramidal image is created in Temp subfolder in PHOTOMOD configuration folder (usually in C:\PHOTOMOD.VAR\Temp). That is why you should have enough room on hard disk, otherwise the pyramid will be not created and image visualization at 2 and more zoom will be slow

Temporal pyramidal image and histogram used for preprocessing of the image to be added, could be deleted after closing the **Radiometric correction** window, if the option **Remove pyramid and histogram after close** is on.

In the **Radiometric correction** window you may change the results of automatic conversion manually using tools described below.

The following tools are used for image scale management:

- (duplicated by "***" key) - one step zoom in
- (duplicated by "***/***" key) - one step zoom out
- (duplicated by "**Alt-Enter**" keys) - fits image to window
- (duplicated by "**Alt-1**" keys) - 1:1 zoom (image cell corresponds to screen pixel)

Current ratio between image size and scale is shown in the window .

For zooming in by zoom box, press **Ctrl-Alt** keys and draw the box by the mouse. Use **Ctrl-Alt-Shift** keys for zooming out by zoom box. For "panning" over the image move a mouse cursor along with pressed **Alt** key.

If there is more than 8 bits per channel in the image, the histogram stretching operation is applied for the whole brightness range, for each channel independently.

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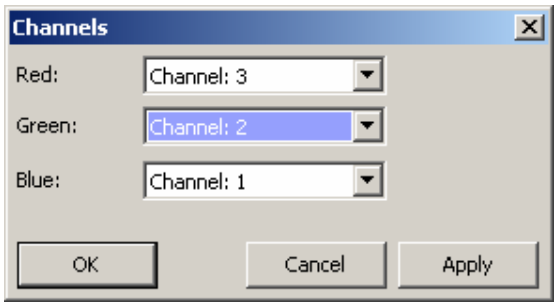
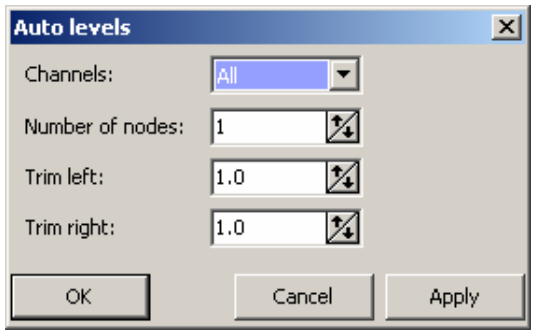
Operation of histogram stretching for the whole brightness range for each channel is started from the window opened by the button (**Channels**).



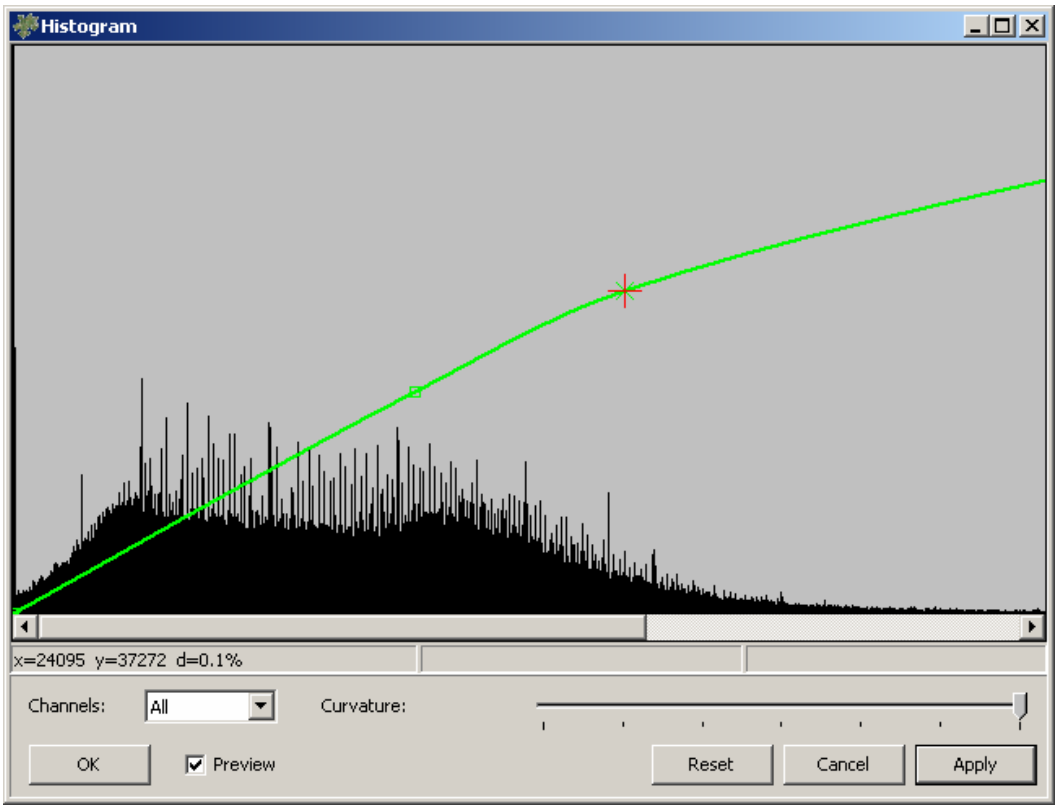
Note. The initial order of channels is setup depending on type of the image to be added

The button opens a window used for auto levels setup operation.



The operation includes stretching the histogram of the initial image on the whole brightness range. Select necessary channel of image (blue, green or red) in **Channels** field, and apply the next parameters of histogram stretching to them. The **Number of nodes** parameter specifies the number of intervals of intermediate feature, which is used for histogram stretching. Parameters **Trim left** and **Trim right** show a percent of histogram area to be cut off, and not be considered in the operation.

To view a histogram of the image to be added and to adjust a transfer function used to setup arbitrary brightness transformation, open a window by pushing the button (**Curves**).



Graphically the function is visualized as a green curve. In X axis there are values of image brightness before transformation, and in Y axis – after it. Transfer function is setup using node points (small green squares). Between nodes the function line is Bezier curve with curvature degree from 0% (leftmost position of the **Curvature** slider) to 100% (its rightmost position). When curvature degree is 0% the function is shown as a broken line segment.

To add node point place marker to needed point and press **Insert**.

To select node point just click somewhere close to it. You can move selected point by moving a mouse cursor along with pressed **Ctrl** key. Press **Delete** to delete selected point and **Esc** to cancel selection.

Use "**/**" and "*****" keys on numeric keyboard to zoom in/ zoom out the histogram. Use **Alt-Enter** shortcut to show the histogram in full and **Alt-1** to show it in 1:1 scale.

In case of color image the transfer function is setup either for all color channels simultaneously or for each one. Use **Channels** drop-down list to select color channel to be adjusted.

To apply all changes in image window immediately mark the **Preview** check box.

Marker X, Y coordinates and histogram value for the current brightness reading in percent are shown in **Status** line in the bottom of the window.

The button opens a window **Brightness-Contrast-Gamma** used for adjusting of the corresponding features for each image channel, or for all of them at once. If the option **Live preview** is on, the image changes are applied “on-the-fly”, without pushing the **Apply** button.

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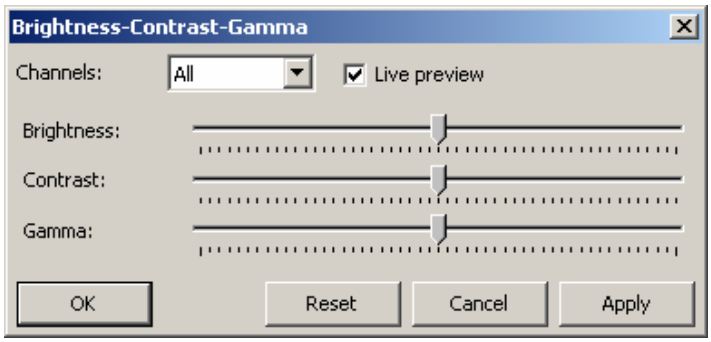
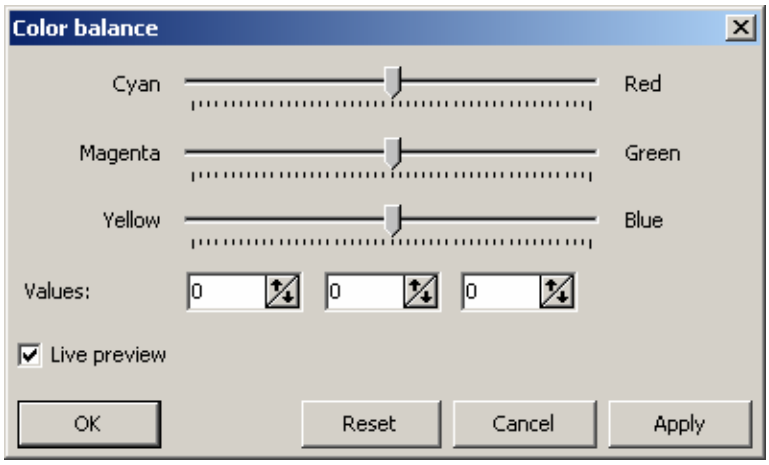
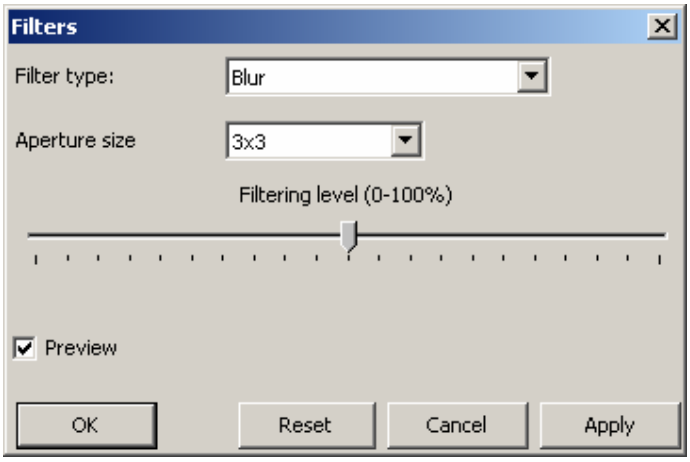


The button opens a window used for color balancing. You can shift the image balance to cyan, red, magenta, green, yellow or blue color. Resulting brightness is not changed at that. You can also shift balance of each color in numeric form –100 to 100 in the **Values** field.



The button (**Filters**) opens a window used for improving of visual quality of initial image using it's processing by different filters.



Select processing type in **Filter type** drop-down list from the following items:

- **Blur** – intended for dithering of initial image details
- **Gaussian blur** – kind of smoothing filter, where transfer value is not a linear function (as in **Blur** function), but a section of Gaussian function ("bell curve");

- **Sharpen** – allows to highlight and intensify a differences between image's details
- **Sharpen edges** – alike a **Sharpen** filter but performs filtering only when brightness differences between details are exceeding some threshold. Suits very well for identifying and highlighting of objects borders which are homogeneous insight (fields, for instance), at that inner part of objects remains unchanged
- **Median** – non-linear filter intended mainly for impulse noises filtration (single pixels with unnatural brightness)
- **Sobel** – non-linear differential filter, which is the first derivative of the initial raster. Used for acquisition of contour borders on raster image.

To apply all changes in image window immediately mark the **Preview** check box.

The button (undo) cancels the last action, (redo) – redoes the last cancelled action. The button cancels all actions performed, and undo-redo operations list depth is 10 actions.

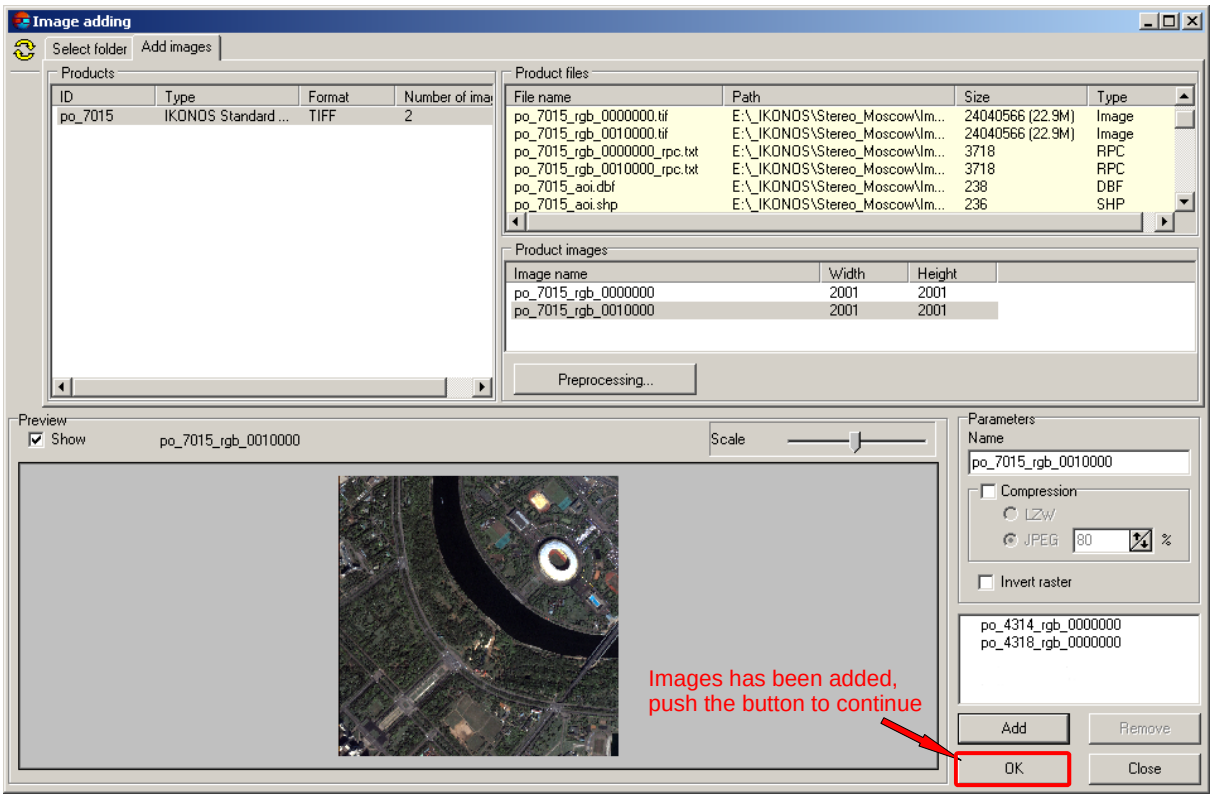
Note. All operations are applied to the current image state

When you get acceptable correction result in the preview window push the button **Close** and go back to **Adding images** dialogue – see the chapter 3.2 Input images into Stereoblock project.

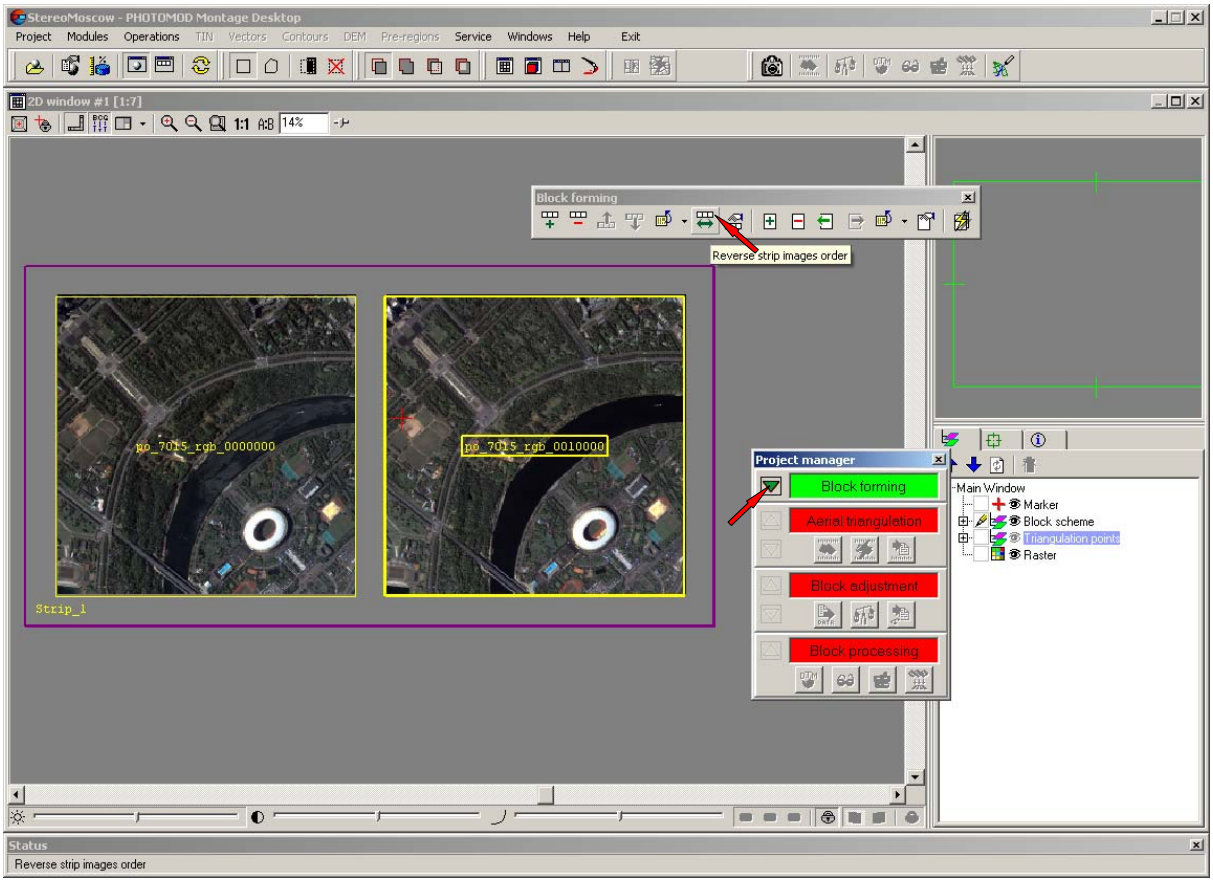
The procedure is not the only image enhancement/adjustment operation; other modules of **PHOTOMOD** system include brightness-contrast-gamma and color balancing procedures; the **Mosaic** module has advanced possibilities to adjust radiometry as well.

3.3 Start of phototriangulation

When all the necessary data contained in the current folder are added and specified in the lower window of the **Parameters** panel, go back to the **Select folder** tab to continue the image addition process or finish it by the button **OK**.



Images of the project are visualized then in the window of **PHOTOMOD Montage Desktop** module.



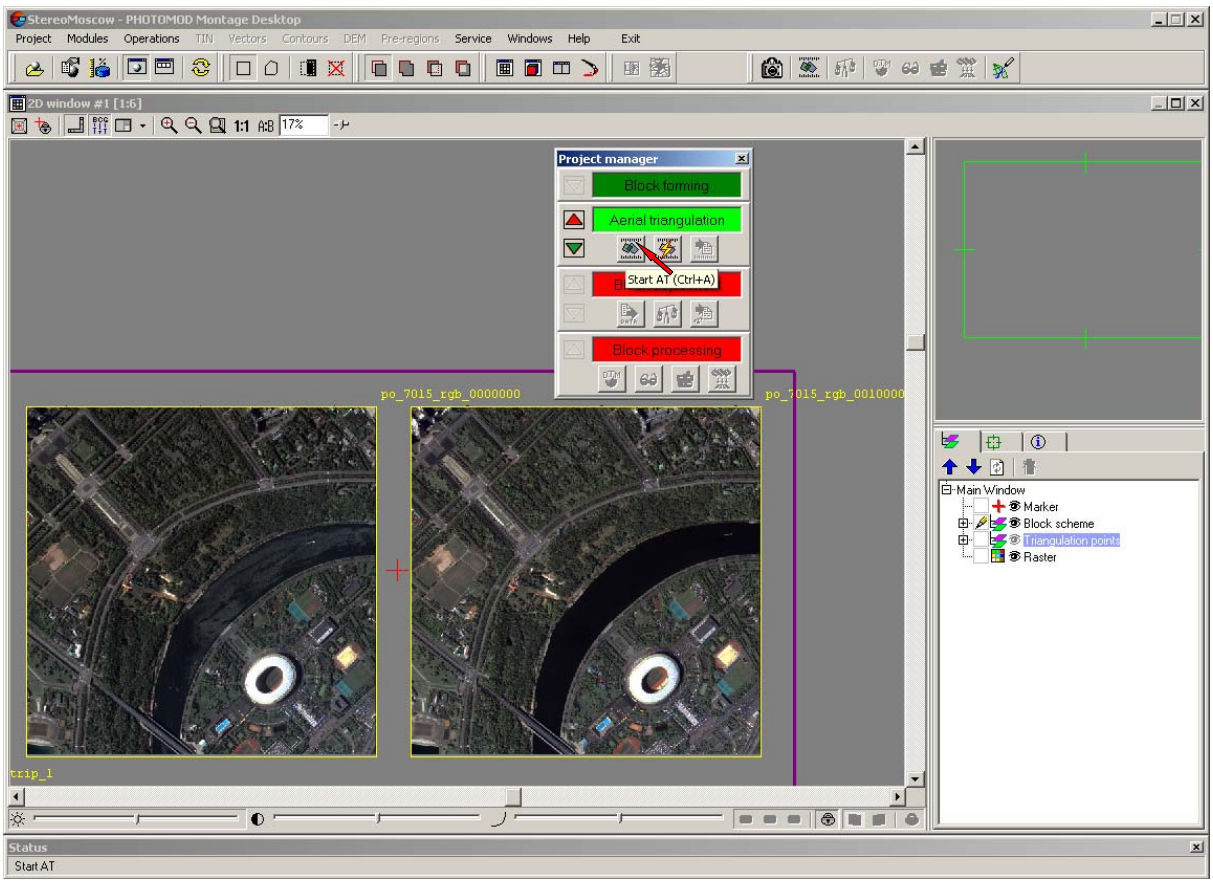
Due along-track stereopair acquisition mode, the IKONOS images are physically upper and lower to each other; so in case of IKONOS stereopair they are automatically rotated by 90 degrees to be left and right. But if something is wrong, you can rotate images “manually” using the button on **Block forming** toolbar.

The first added image becomes left and the second image is right. User can invert the order by the button on **Block forming** toolbar.

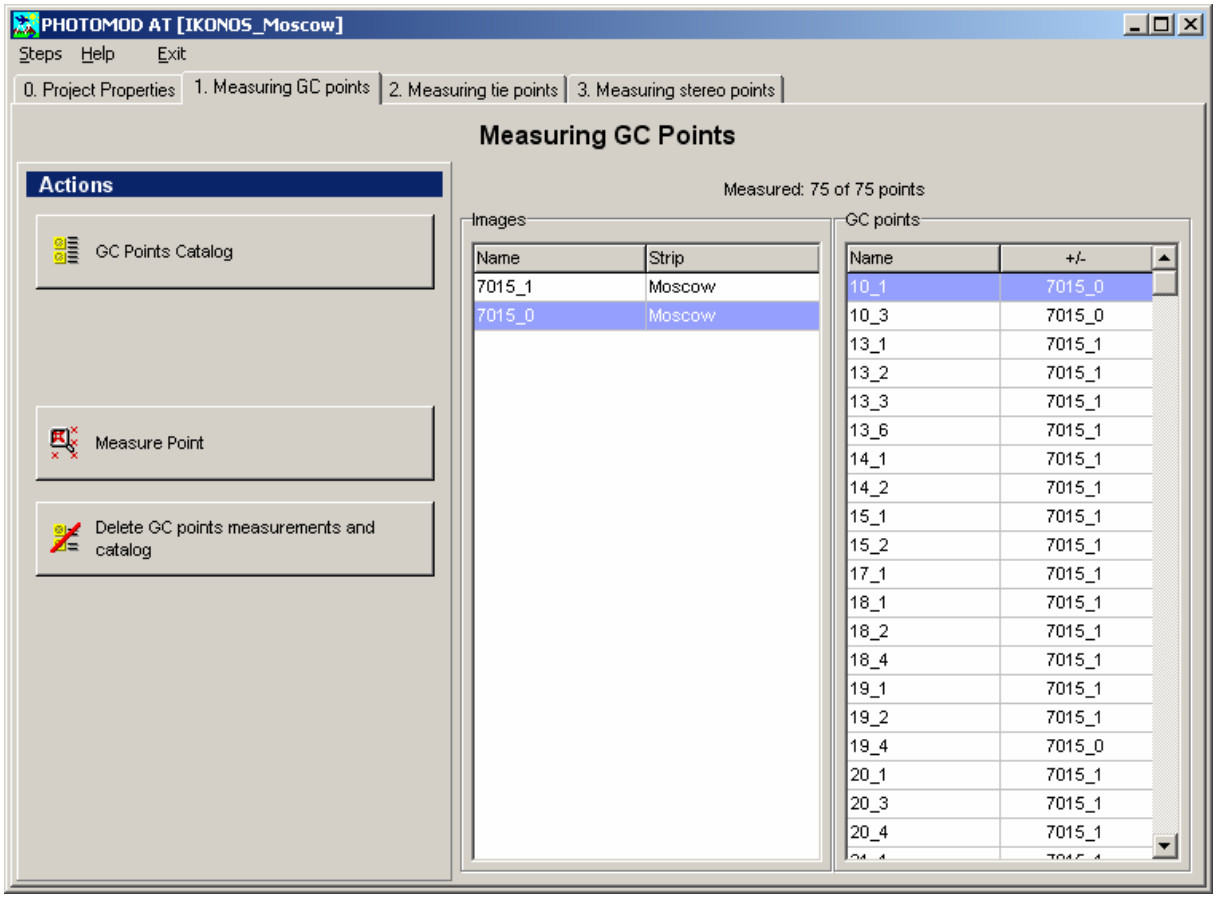
To pass to the next stage, push the button in **Project manager**.

3.4 Ground control, check and tie points measurement

The **PHOTOMOD AT** module (started from **Project manager** window) is used to perform point’s measurement on images.



In case of pushbroom imagery processing, use the following **PHOTOMOD AT** main window tabs. The tab **Measuring GC points** allows ground control and check points coordinates input and their measurement on the images.



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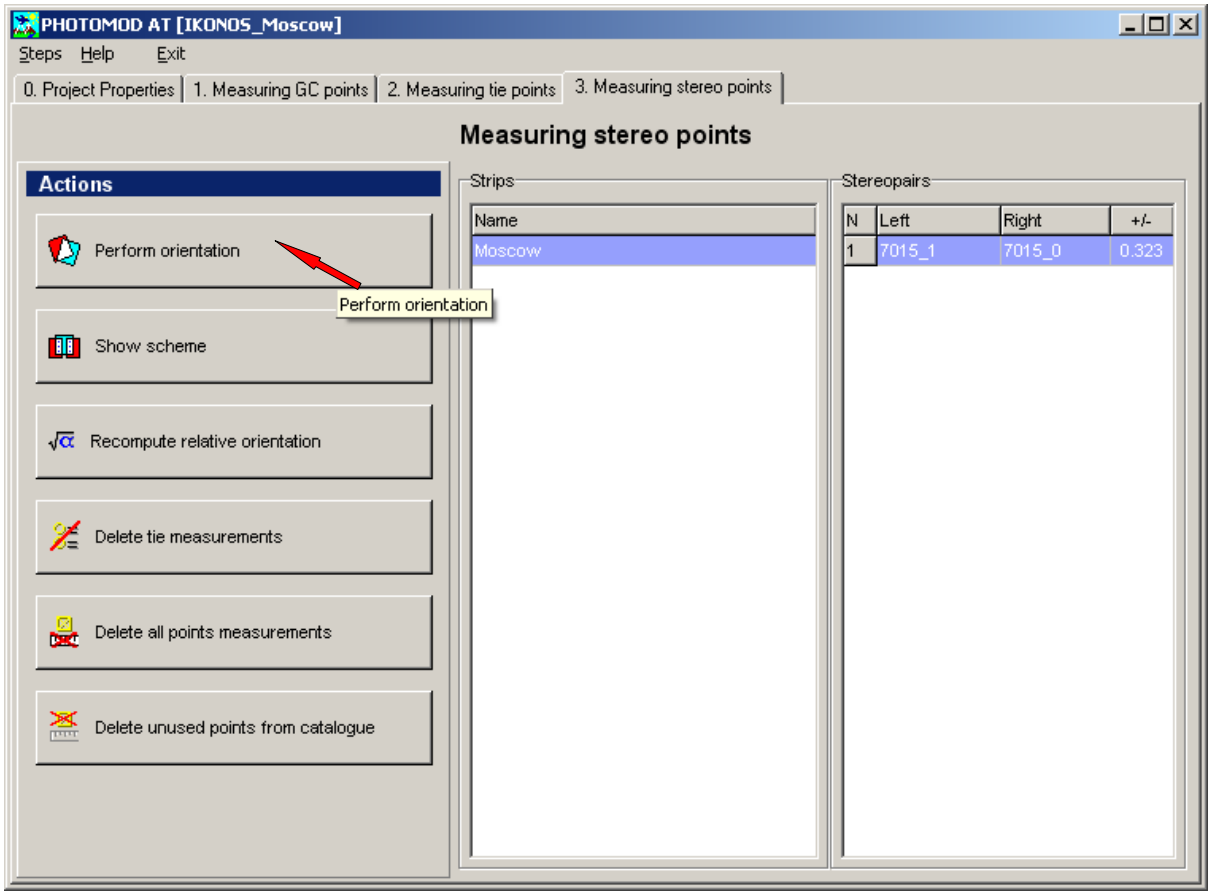
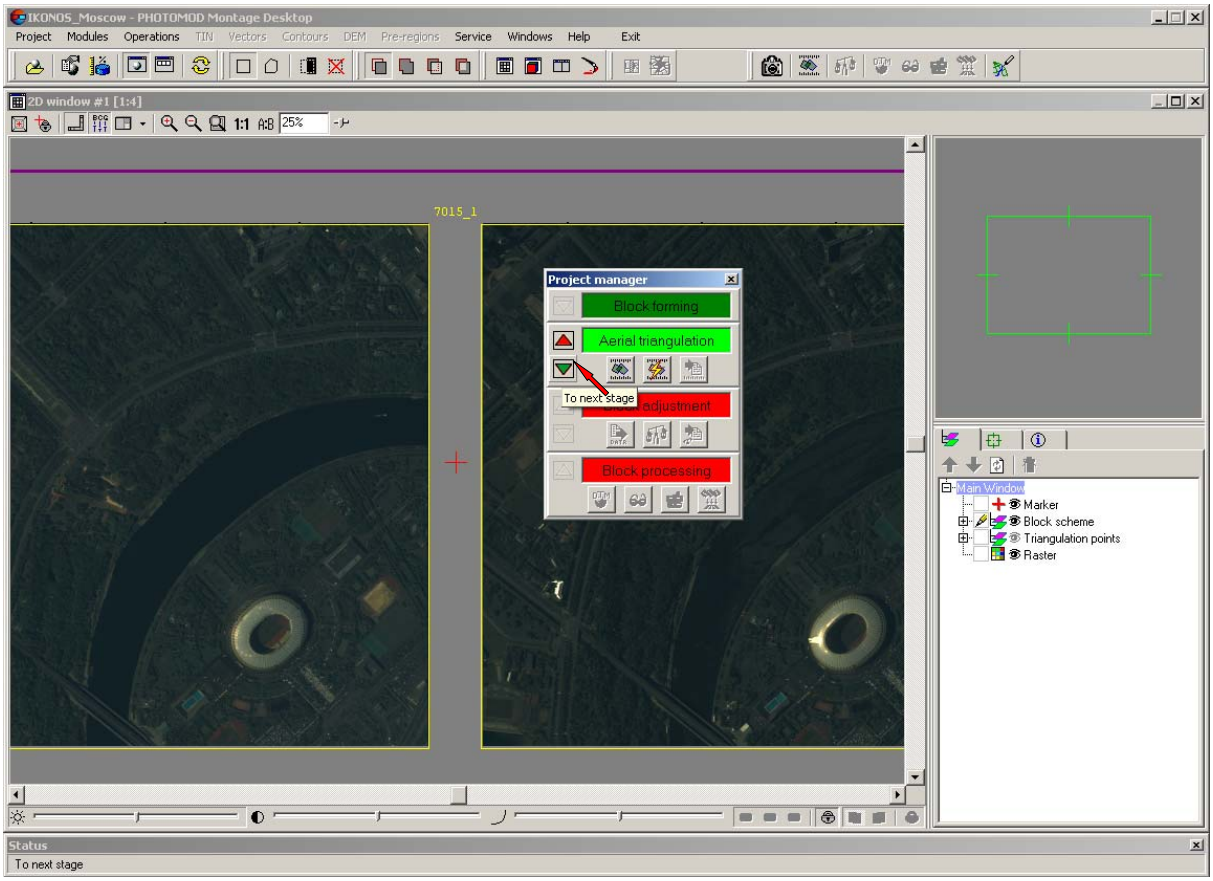
The tab **Measuring stereo points** is intended for GCPs/CPs and tie points measurement in stereoscopic mode.



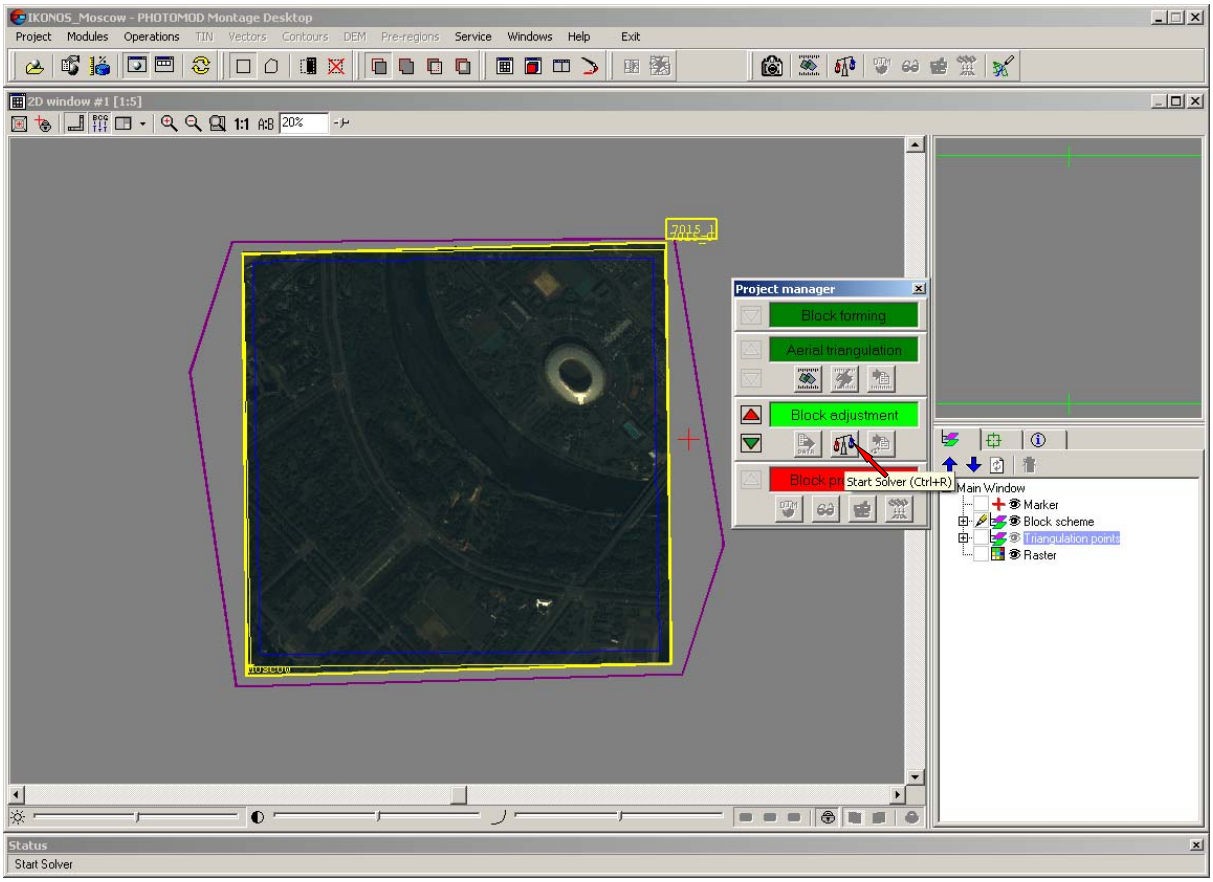
See the chapter 2.4 Phototriangulation stage and **PHOTOMOD AT** User manual for details on measurement of GCP and tie points on space images in PHOTOMOD.

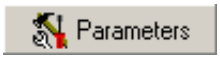
3.5 Block adjustment and pass to processing stage

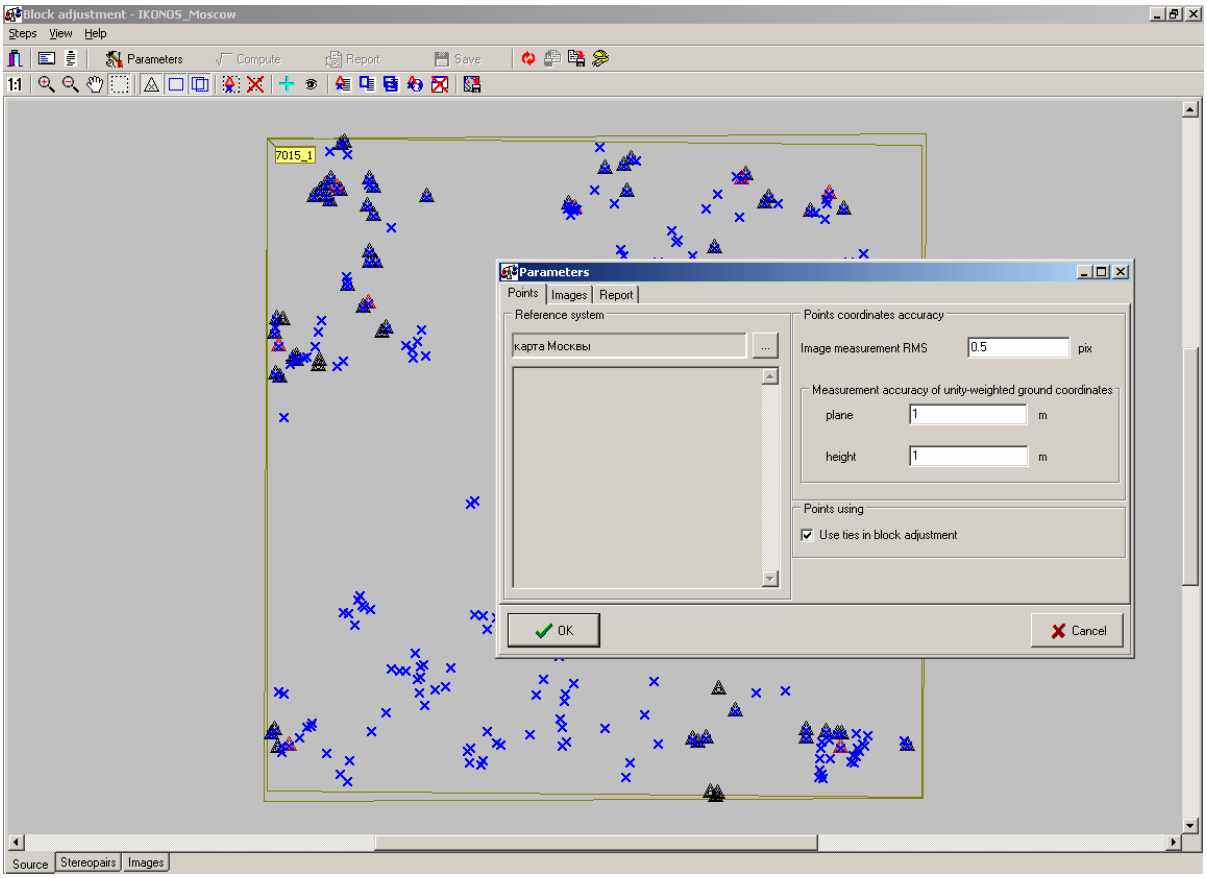
Push the next button to pass to block adjustment stage.



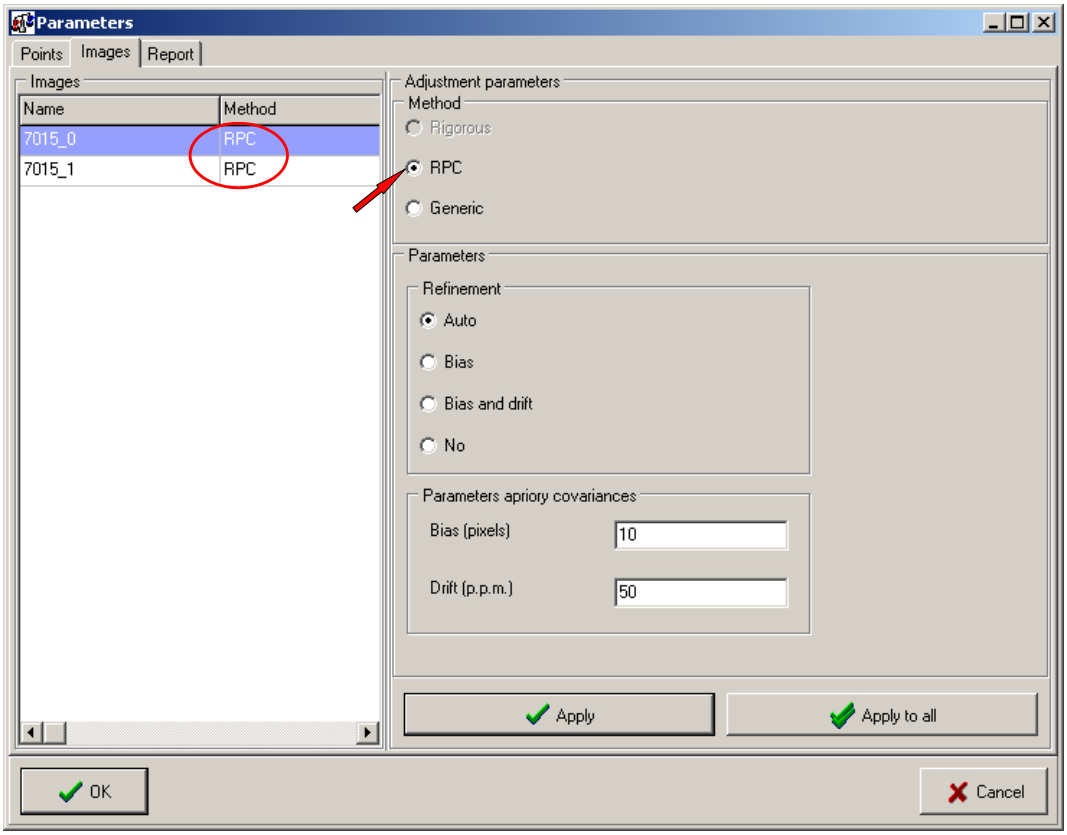
Start **PHOTOMOD Solver**.



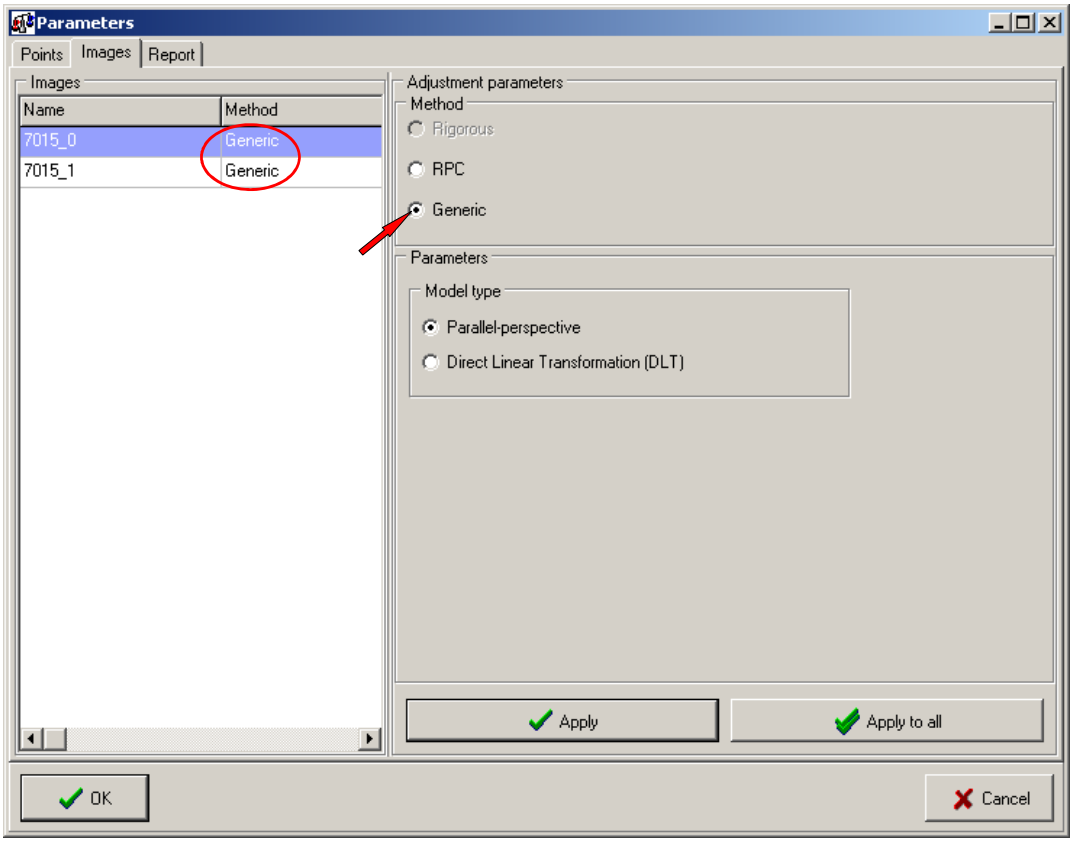
Push the button  in the opened window to set up adjustment parameters.



If IKONOS stereopair contains RPC coefficients supplied with the product, they are considered during adjustment that is shown in the **Parameters** window on **Images** tab.



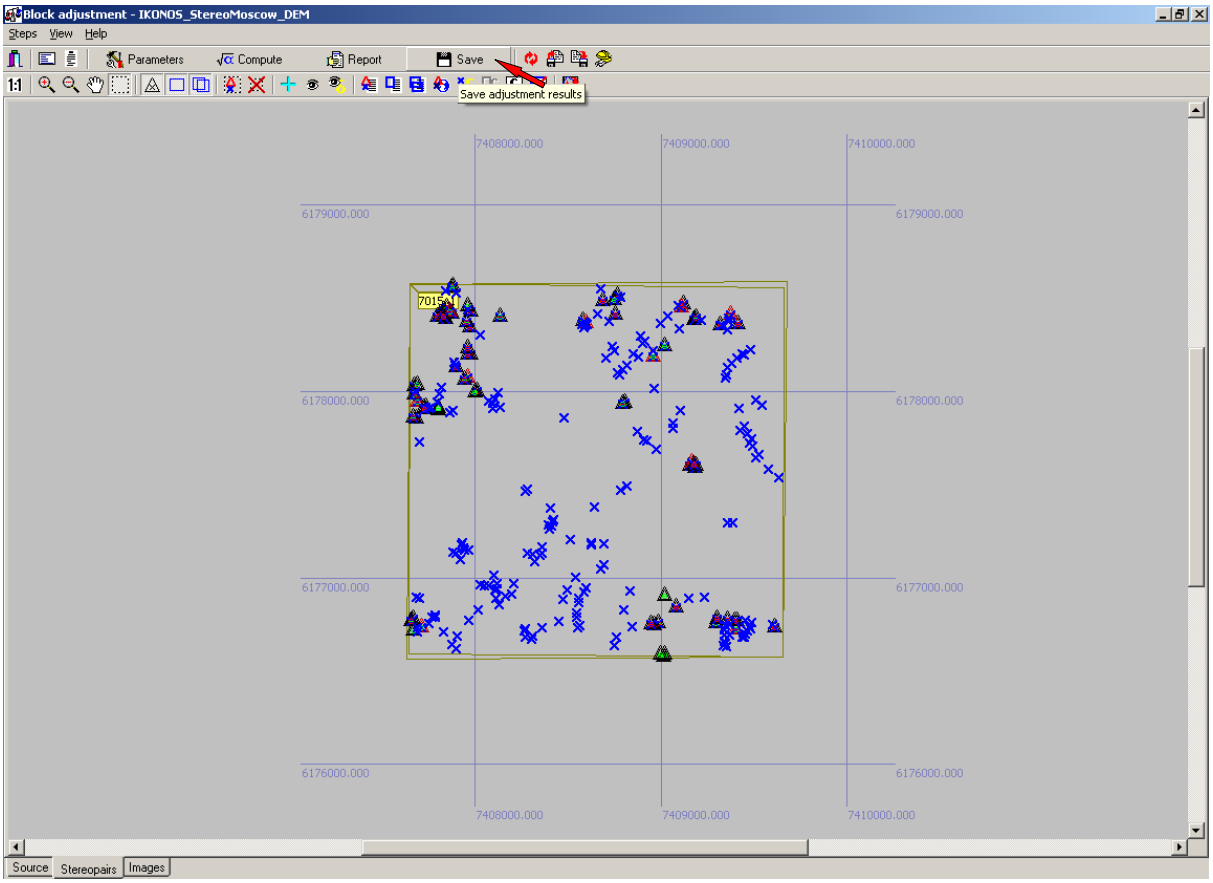
If RPC coefficients are not supplied with the product or the results of adjustment using the coefficients are poor, you may adjust the projects using **Generic** algorithm. Select the appropriate option in this case in the **Parameters** window on the **Images** tab:



After that in **Parameters** panel you can choose the model type: **Parallel-perspective** or **DLT** (direct linear transformation).

If the number of GCP is sufficient, leave the model selected by default – in that case the algorithms work similarly. If GCP amount is minimal, use default algorithm first and in case of improper results, use another one.

Then save the adjustment results (if they are acceptable) by pushing the button Save.

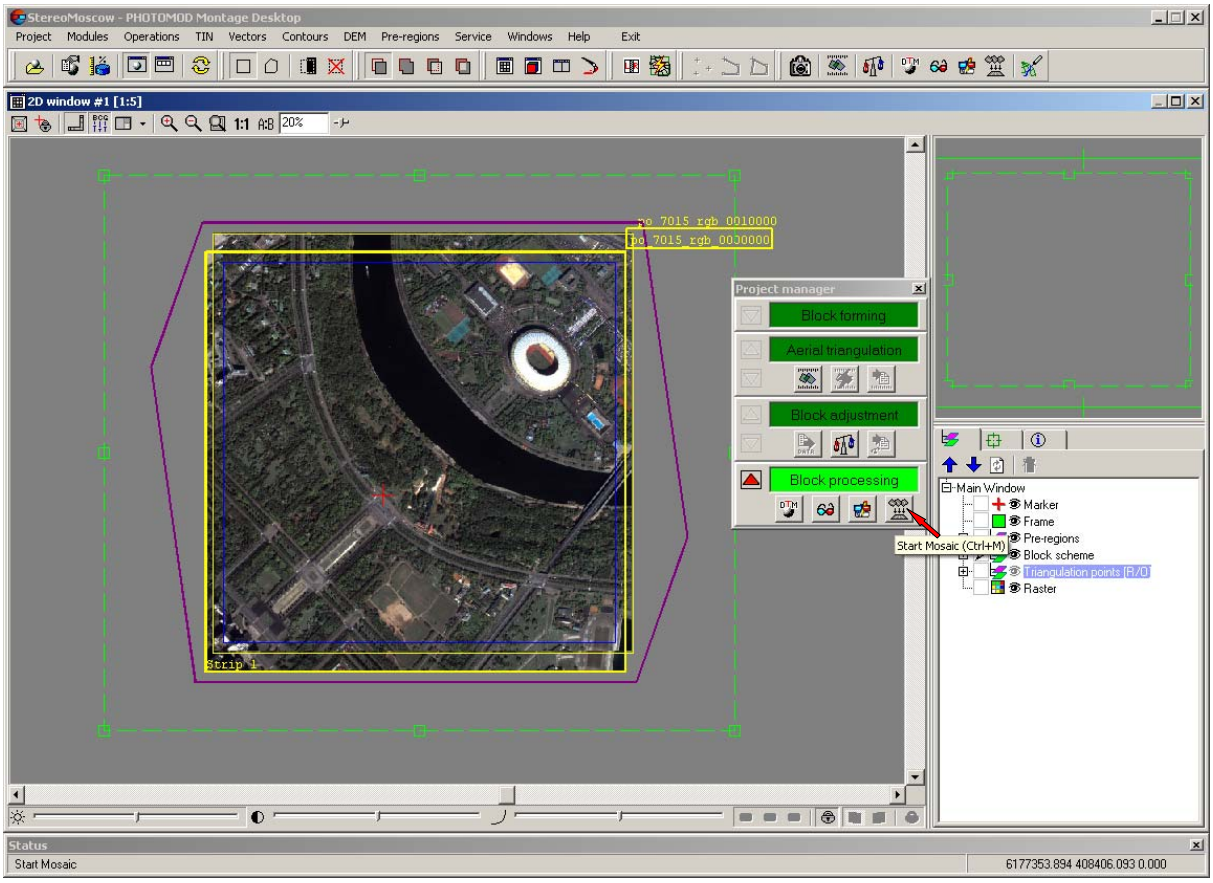


See more details about adjustment in **PHOTOMOD Solver** in the appropriate User Manual.

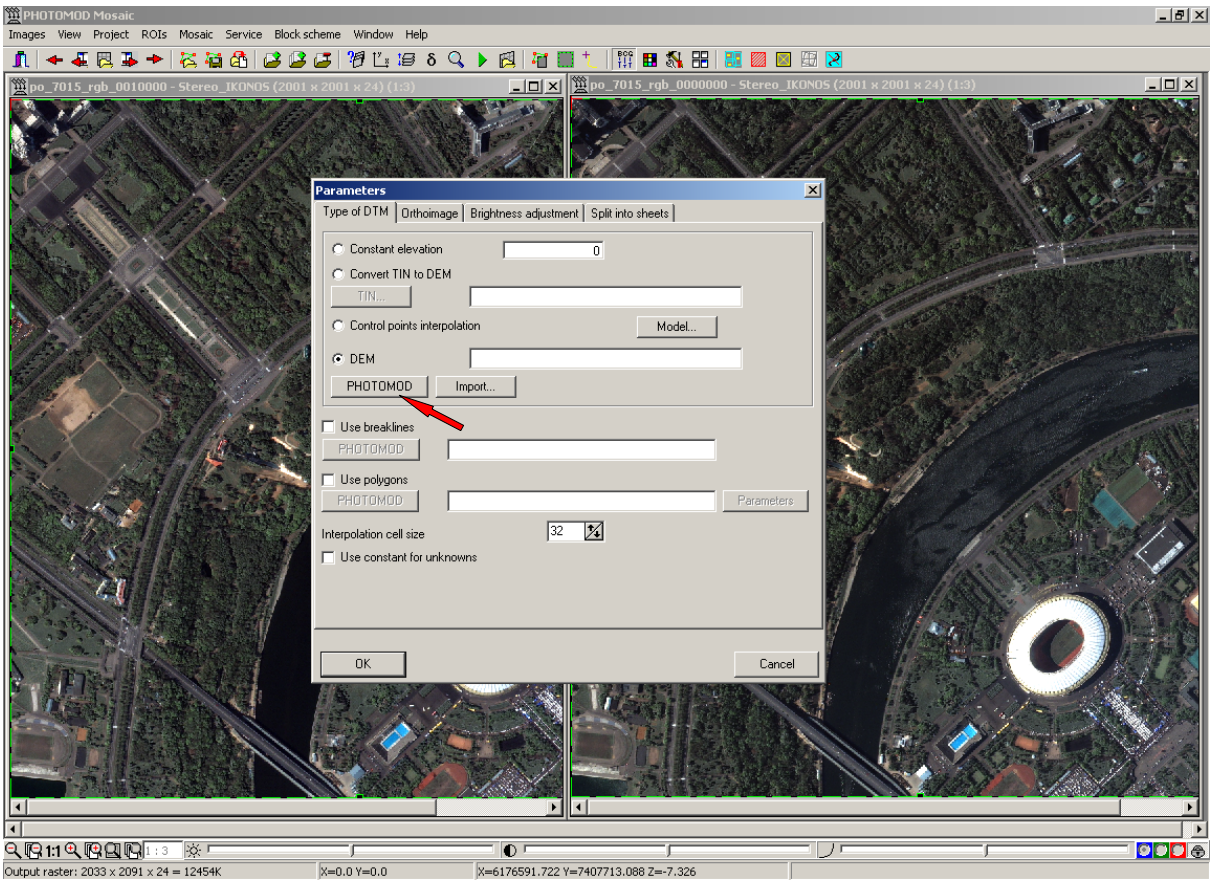
After completing the adjustment you, pass to orthomosaic creation in **PHOTOMOD Mosaic** module.

3.6 Creation of orthomosaic for IKONOS stereopair

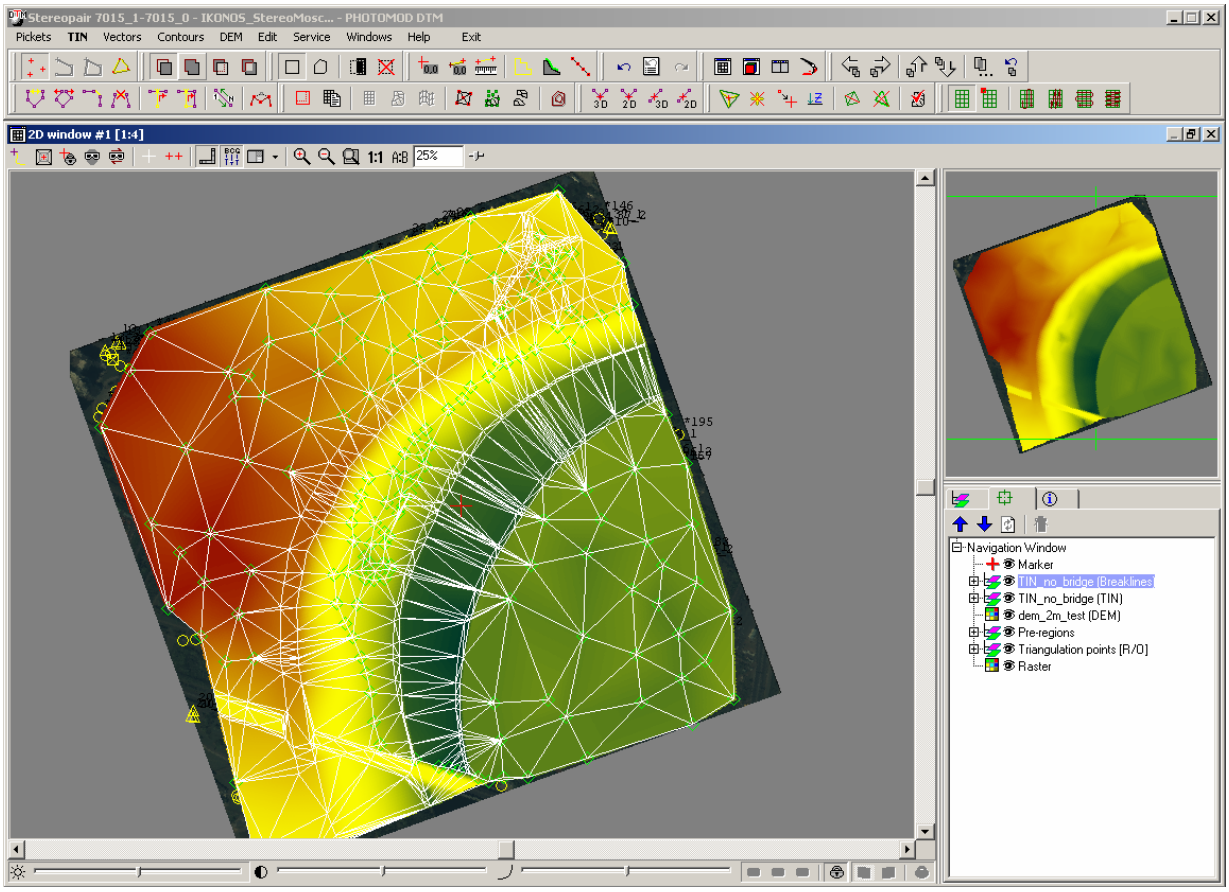
Start **PHOTOMOD Mosaic** using **Project Manager** in **PHOTOMOD Montage Desktop**.



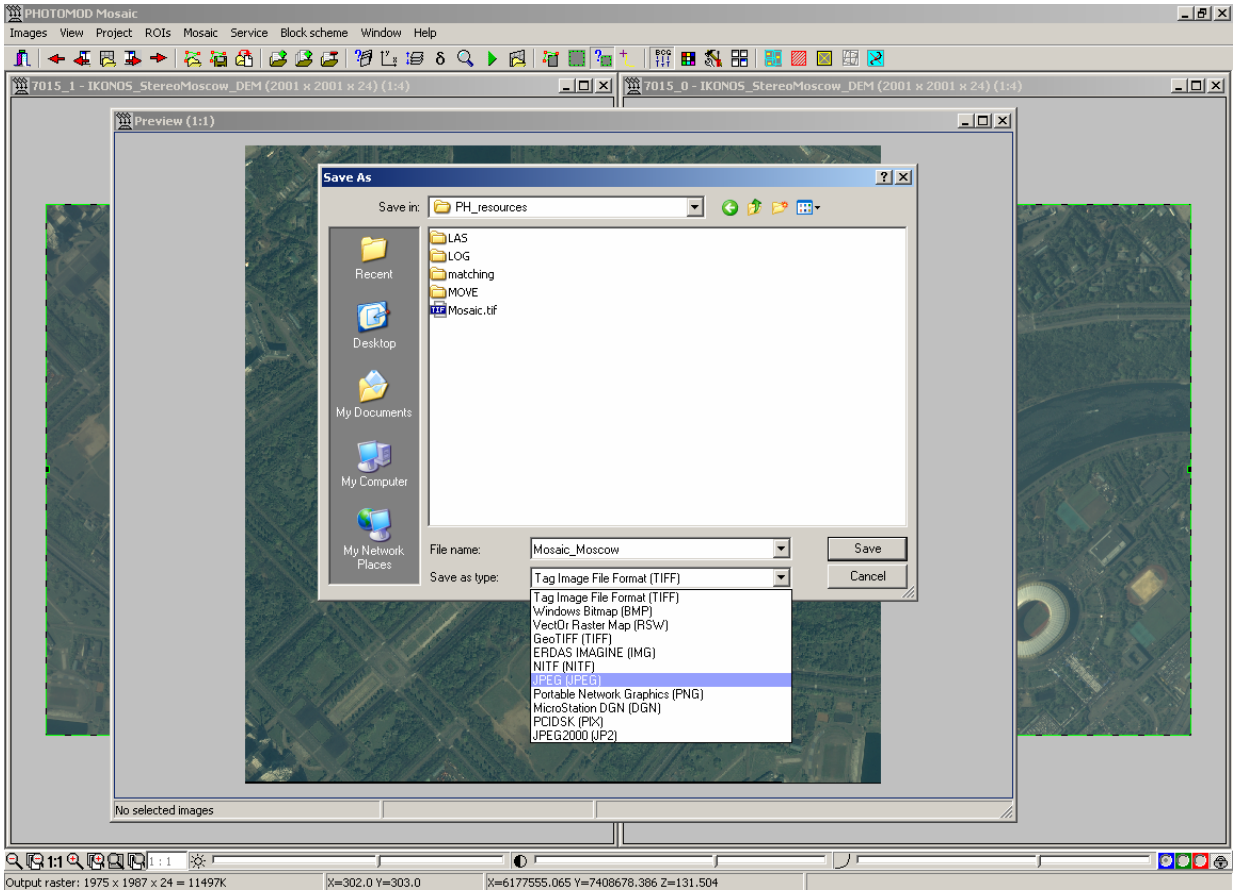
In **Parameters** window on **Type of DTM** tab select the option according to the relief model (DTM), which is used for orthophotos creation.



If the DTM was created in **PHOTOMOD DTM** module (automatically or in stereo mode), select it from project resources using the button PHOTOMOD in **Parameters** window.



After that set up other parameters needed (see the chapter 2.6 Orthomosaic creation) and start orthophoto mosaic creation using menu command **Mosaic | Build!**.



In the dialogue of resulting mosaic saving, select also file format in drop-down list and then push the **Save** button. Mosaic building process may take a long time for images blocks of big volume.

Refer to **PHOTOMOD Mosaic** User Manual for more details about orthomosaic building.