Digital Photogrammetric System

PHOTOMOD

Version 6.4

USER MANUAL

LIDAR Data processing

RACURS

Table of Contents

1. About

The current User Manual is intended to review the import of LIDAR data and point clouds for use in the *PHOTOMOD* system. It contains the description of the loading, viewing and processing of LIDAR data modes.

2. Import of LIDAR data

Import of LIDAR data is provided to enable using LIDAR data in the system. This feature allows to convert the LIDAR data to DEM which is saved into the file of active profile.

Lidar (also written LIDAR or LiDAR) is a remote sensing technology that measures distance by illuminating a target with a laser and analyzing the reflected light.

Lidar data are delivered in LAS formats files. LAS format files include the XYZ coordinates of the laser reflection points and their attributes (serial number of the reflected pulse, total number of reflections in a point, object classification data).

The system supports the use of LAS files regardless of the way the data was received.

The system supports the use of LAS files with points storage format from 0 to 2. When trying to import files in the format larger than 2, an error message will be displayed.

The LAS format supports point classification based on specifications developed by the *American Society for Photogrammetry and Remote Sensing (ASPRS)*. The table below shows the classification for LAS files 1.4:

Table 1. Classification

Classification Value	Meaning
0	**Created, never classified**
1	**Unclassified**
2	**Ground**
3	Low Vegetation
4	Medium Vegetation
5	High Vegetation
6	Building
7	Low Point (noise)
8	Reserved
9	Water
10	Rail
11	Road Surface
12	Reserved
13	Wire – Guard (Shield)
14	Wire – Conductor (Phase)

Classification Value	Meaning
15	Transmission Tower
16	Wire-structure Connector (e.g. Insulator)
17	Bridge Deck
18	High Noise
19-63	Reserved

Points of the laser reflection from the earth's surface, which coordinates and attributes are contained in the LAS format files, is called the *LIDAR points* in this documentation.

To use lidar data within the system, the data should be converted into DEM.

Also, when creating a DEM using the SGM method, the *PHOTOMOD* system provides possibility to create a file of point cloud in the LAS format similar to lidar data (see "Dense DEM generation using SGM method" chapter of the "DTM Generation" User Manual).

To work with lidar data and point clouds, use **Terrain › LAS** menu.

Table 2. Brief description of the "LAS" menu

Menu items	Function
Loas LAS...	opens **Load LAS** window allowing to load LIDAR data, split LIDAR data into sheets and transform the LIDAR data to DEM
Filter LAS...	allows to filter LIDAR data
Transform LAS coordinates	allows to change coordinate system of LAS
Cutting LAS by poligons	allows to edit the area of point cloud coverage

3. Load LIDAR data window

Load LAS window is used to transform the LIDAR data to DEM.

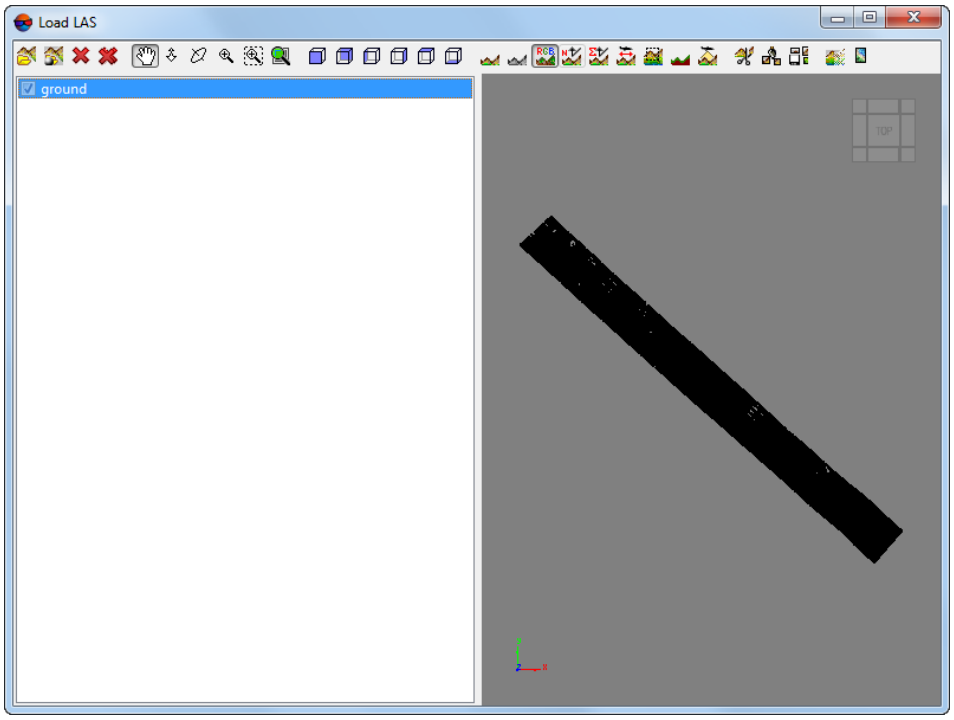

Fig. 1. Load LIDAR data window

Load LIDAR data window contains the following GUI elements:

- tool bar for loading, viewing and LIDAR data preparing for transforming to DEM;
- the workspace with the list of all open files
- working area for *LIDAR points* viewing, which contains in lower left corner the direction axes of the coordinate system of laded LIDAR data.

Table 3. Toolbar of Load LIDAR data window

Buttons	Functions
	allows to open the LAS format files with LIDAR data
	allows to open the LAS format files with LIDAR data locating in the resources of active profile
	allows to close selected LAS format files with LIDAR data
	allows to close all opened LAS format files with LIDAR data
	allows to move working area for *LIDAR points* viewing in any direction
	allows to move working area for *LIDAR points* viewing perpendicular to the screen plane
	allows to enable rotation mode and rotate *LIDAR points*

Buttons	Functions
	allows to zoom in/zoom out working area
	allows to zoom in of working area selected by rectangle
	allos to display data in full scale and center it in the window
	allows to rotate *LIDAR points*
	allows to display LIDAR points in coloring mode to accordance with its Z-coordinate values
	allows to display *LIDAR points* in gray scale mode (if source LAS file contains such data)
	allows to display *LIDAR points* in RGB mode (if source LAS file contains such data)
	allows to display *LIDAR points* in coloring mode to accordance with serial number of reflected pulse per one point (if source LAS file contains such data)
	allows to display *LIDAR points* in coloring mode to accordance with number of reflected pulse per one point (if source LAS file contains such data)
	allows to display *LIDAR points* in coloring mode to accordance with aircraft scan direction when sounding the earth surface (if source LAS file contains such data)
	allows to display *LIDAR points* in coloring mode to accordance with edges (if source LAS file contains such data)
	allows to display *LIDAR points* in coloring mode to accordance with scan angle (if source LAS file contains such data)
	allows to display *LIDAR points* in coloring mode to accordance with objects classification (if source LAS file contains such data)
	allows to split the loaded LIDAR data
	allows to eneble/disable displaying of splitting grid
	allows to save parts of LIDAR data corresponding to created splitting into separate LAS files
	allows to transform all opened files with LIDAR data into one DEM file
	allows to save LIDAR data as a colour image

4. LIDAR data loading and displaying

The system allows to import lidar data as a vector layer (in the form of points, see the “Import from LAS” chapter of the “Vectorization” User Manual).

In order to load and display LIDAR data perform the following actions:

1. Choose **Terrain › LAS › Load LAS...**. The **Load LIDAR data window** opens.

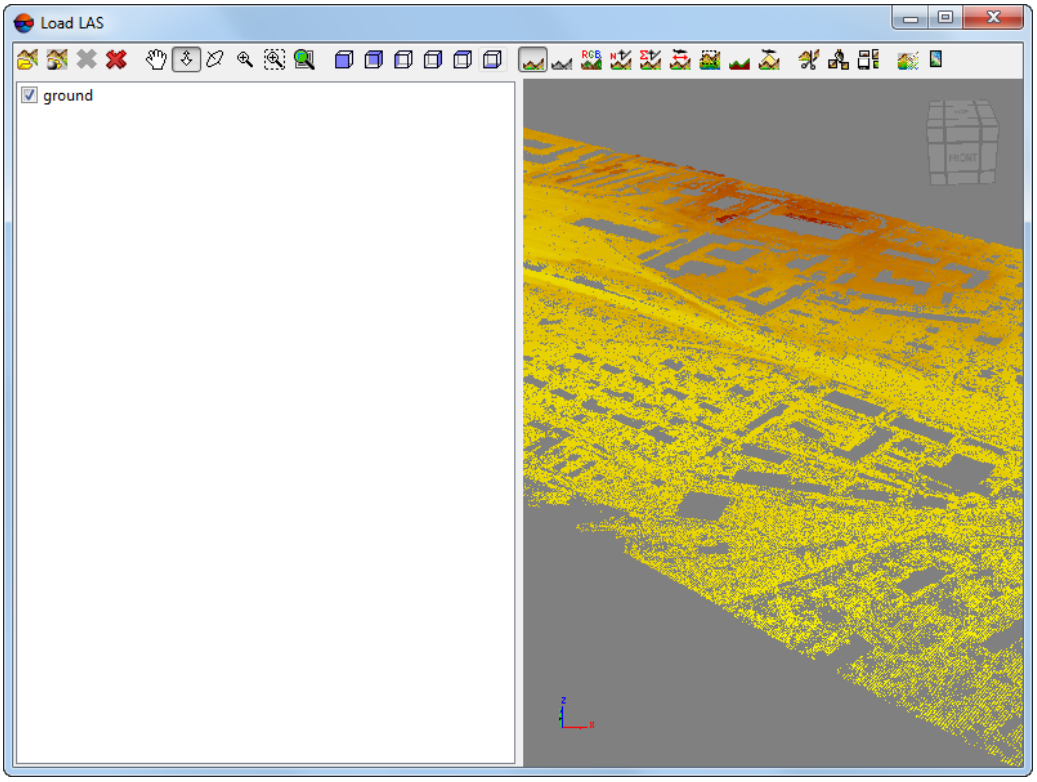

Fig. 2. Load LIDAR data window

2. Click the or button to load files. Choose one or more files in LAS format and click OK.

System provides the following features to control the display of loaded *LIDAR points*:

- use the mouse wheel for scaling points or use , , and buttons;
- click the button and move cursor in the working area with the pressed left mouse button to rotate or use , , , , and buttons;

System provides the following modes for coloring *LIDAR points*:

- – height coloring mode;
- – gray scale coloring mode;
- – RGB coloring mode;
- – coloring mode to accordance with serial number of reflected pulse per one point;
- – coloring mode to accordance with number of reflected pulse per one point;

- – coloring mode to accordance with aircraft scan direction when sounding the earth surface;
- – coloring mode to accordance with edges;
- – coloring mode to accordance with objects classification;
- – coloring mode to accordance with scan angle.

System provides the following features to save *LIDAR points*:

- click the to save LIDAR data as a colour image;
- click the button to save data according to splitting.

This cannot be performed until the data is split into sheets.

5. Splitting into sheets

The system provides the splitting into sheets of loaded LIDAR data to save data in the separate LAS format files or to select one or another parts of source LAS format file for DEM building.

To split the LIDAR data into sheets do the following actions:

1. Click the or button to load files. Choose one or more files in LAS format and click OK.
2. Choose one or more files in LAS format and click the button to specify splitting settings. **Splitting settings** window opens.

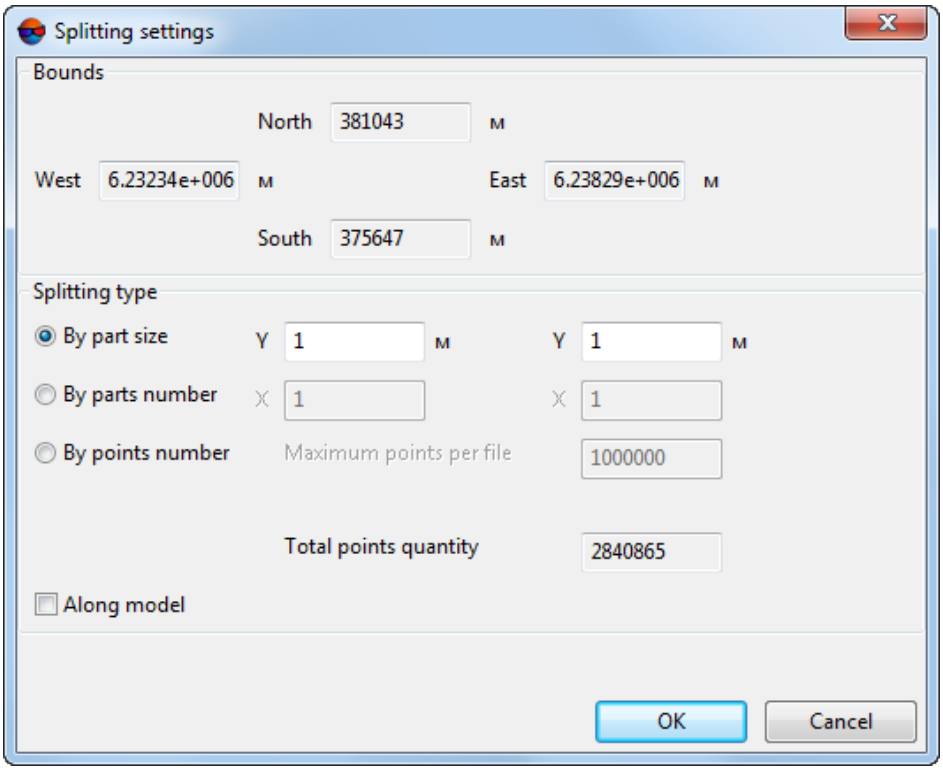

Fig. 3. “Splitting settings” window

The window displays the values of the lidar data area boundaries, in the **Bounds** section.

3. In the **Splitting type** panel select the splitting type by check box and specify the parameters:
   - **By part size** – splitting sheet’s size along X and Y axes in meters defines;
   - **By parts number** – number of splitting sheets along X and Y axes defines;
   - **By points number** – max number of *LIDAR points* per single splitting sheet in the **Max points per single file** entry field.
4. [optional] To split data along extended fringe of model, set the **Along model**.
5. Click OK. **Splitting settings** window closes. Sheet frames for selected file are displayed in **Load LIDAR data** window.

Use the button for turning on/off the sheet frames displaying mode.

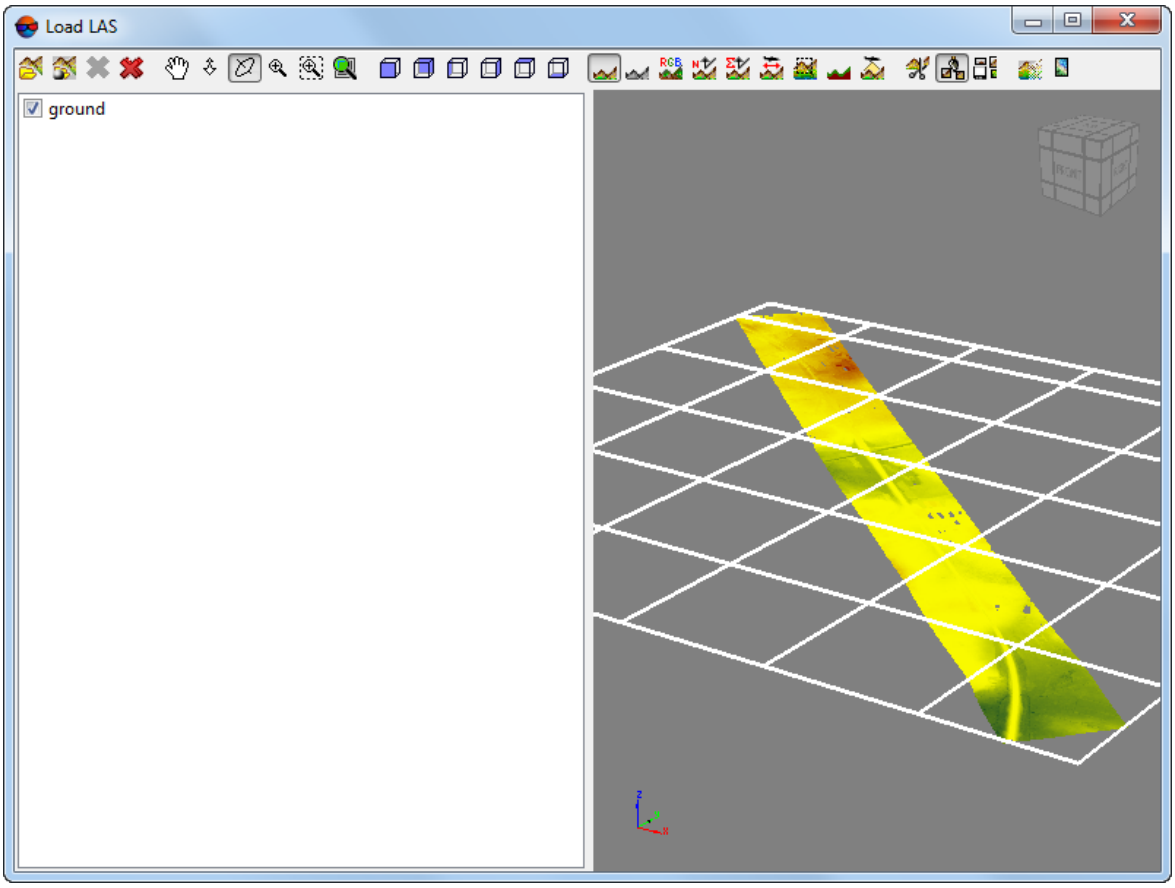

Fig. 4. Splitting sheets displaying

6. Click the button to save the LIDAR data from splitting sheets in the separate LAS format files. **Save** window opens.

7. Specify the folder of active profile and *left part* of the name for creating the LAS format files.

8. Click OK. The file is created for each sheet. The name of this file is created from the specified initial part, the filename of splitting of LIDAR data and the serial number in accordance with the number of the splitting sheets.

6. DEM creation

LIDAR data should be processing and converting to DEF for using in in the system.

For DEM building perform the following actions:

1. Load Lidar data.

2. Click the button. The **Save** window opens. Define folder in the active profile and filename of output DEM in the **Save** window. Click **Save**.

3. The **DEM parameters** window opens. Estimate boundaries, size and calculated number of cells for output DEM in the **DEM parameters** window.

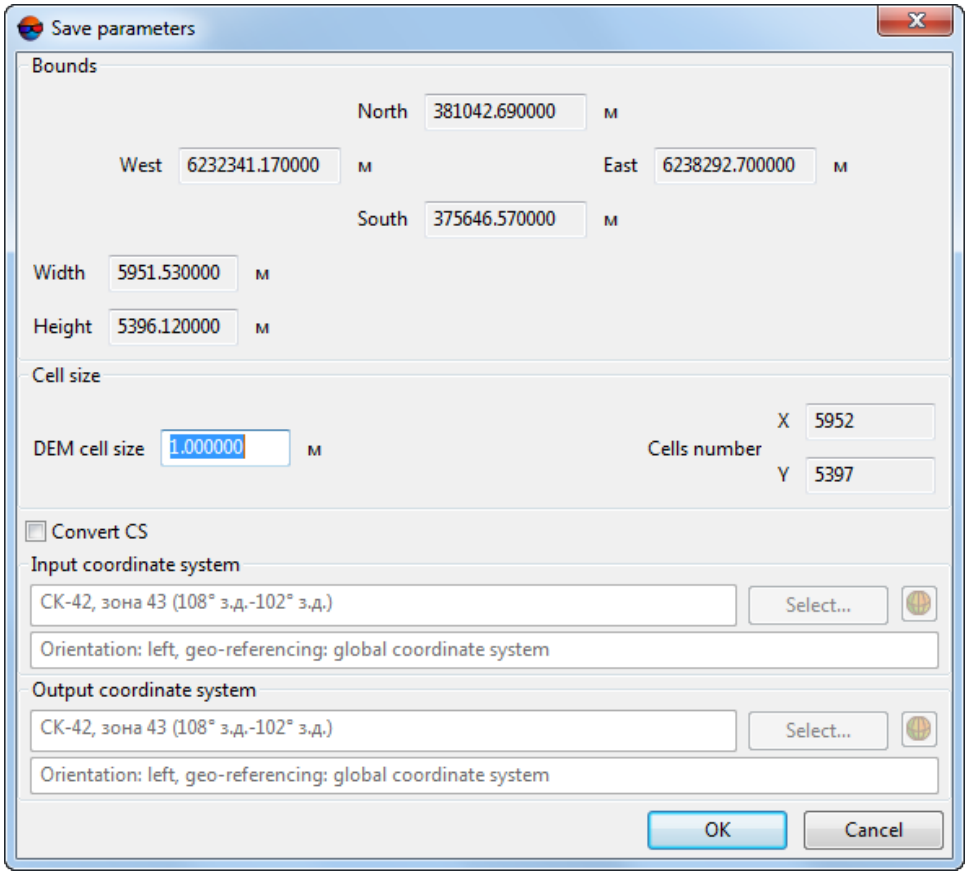

Fig. 5. “DEM parameters” window

4. Specify the **DEM cell size** of output DEM in meters. Automatic recalculation the number of cells is performed while change the **DEM cell size**.

5. [optional] If the project’s coordinate system differ to the LIDAR data’s CS, set the **Convert CS** check box check box. Define input CS of LIDAR data and output CS of DEM.

6. Click OK. The process of DEM building starts. The created DEM is saved in the specified file when the process completes.

7. LIDAR data filtering

The system provides possibility to filter lidar data and point clouds (obtained as a result of DEM creation using the SGM method), by elevations and numbers of reflected pulses in each point, to remove accident surges.

When filtering accident surges, the system provides possibility to use the reference surface of DEM (created together with the LAS cloud of points, or covering the same territory – see the “Dense DEM generation using SGM method” chapter of the “DTM Generation” User Manual).

In order to filter LIDAR data perform the following actions:

1. Choose **Terrain › LAS › Filter LAS...**. The **LAS filtering** window opens;

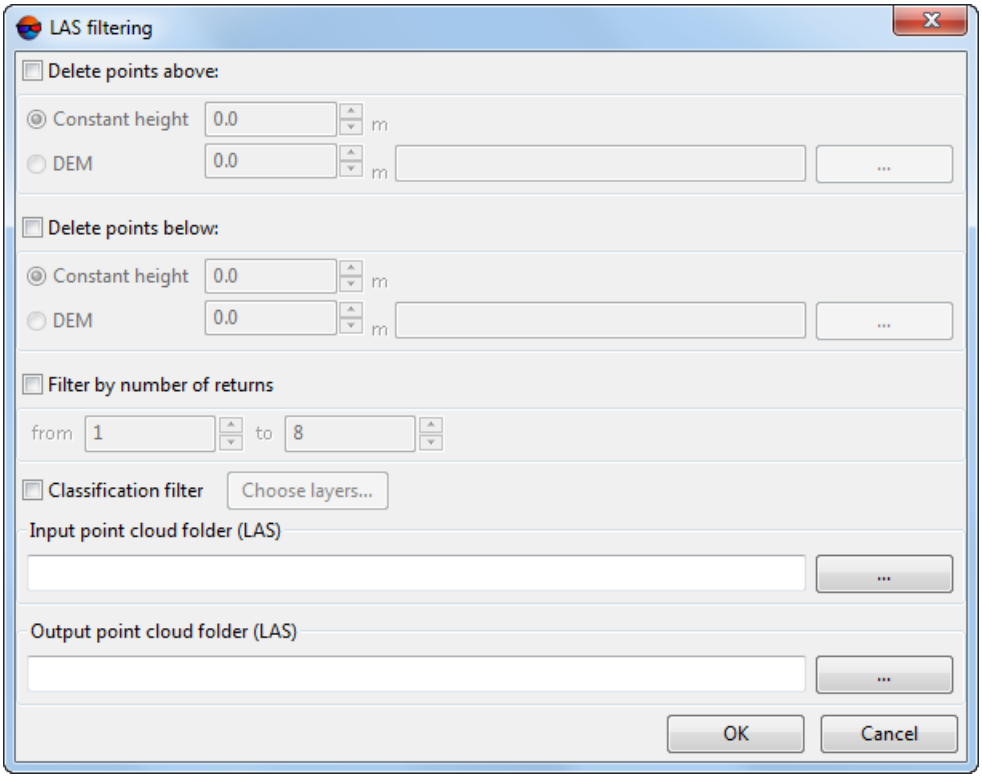

Fig. 6. The “LAS filtering” window

2. Click the ... button in the **Input point cloud folder (LAS)** field and select the folder with lidar data or point cloud in active profile resources;

   The filtering process will be started for every LAS file in the selected folder (e.g. for the point cloud, divided into tiles).

3. Click the ... button in the **Output point cloud folder (LAS)** field and select a folder for output data in active profile resources;

   Source folder and **Destination folder** must not coincide, otherwise the appropriate message is displayed.

4. [optional] set the **Delete points above** checkbox and adjust LAS filtering settings by the elevation:

   - **Constant height** – set the height in meters (all points above the preselected height will be removed);
   - **DEM** – click the ... button to select DEM as a reference surface in the active profile resources. Enter the value of permissible elevation above the DEM surface, in meters (all points above the DEM surface will be removed, except for those not exceeding the given permissible elevation).

   Too low or zero values of the permissible elevation may cause removal of "good" points, and hence, "sparse" point cloud.

   Recommended value is no less than RMS by Z in stereopairs (see the "Brief residuals report" chapter of the "Block adjustment" User Manual).

5. [optional] set the **Delete points below** checkbox and adjust LAS filtering settings by the elevation:

   - **Constant height** – set the height in meters (all points below the preselected height will be removed);
   - **DEM** – click the ... button to select DEM as a reference surface in the active profile resources. Enter the value of permissible deviation from the DEM surface, in meters (all points below the DEM surface will be removed, except for those not exceeding the given permissible deviation).

   For correct filter operation, *in case of filtering points below the DEM surface*, the reference DEM should be the digital terrain model, i.e. *do not include data on buildings and vegetation*.

   To create such a reference DEM, it is recommended to use *Buildings and vegetation filter* or *Slope based filter* (see the "DEM filtering" chapter of the "DTM Generation" User Manual).

   Recommended permissible deviation value is no less than RMS by Z in stereopairs (see the "Brief residuals report" chapter of the "Block adjustment" User Manual).

6. [optional] set the **Filter by number of returns** checkbox to adjust LAS filtering settings according to the number of reflected pulses in every point (in case of available data of such type in the LAS format file);

   When filtering the cloud of points, created during the DEM creation using the SGM method, this parameter has somewhat different meaning.

   In this case, in the LAS file, the number of reflected pulses in the given point is the number of stereopairs on the basis of which a particular point was calculated: 1, 2, 3, 4, 5, 6, 7, or 8.

Limitation of the “number of reflected pulses” by 1 to 8 results from the limitations of the LAS format itself, accordingly, in the latter case, the number of stereopairs can be both “8” and “8 and more”.

It is recommended to filter points calculated on the base of two and less stereopairs. Too strict filtering settings in relation to used stereopair numbers can result in removing “good” points, and hence “sparse” cloud of points (and therefore it may not to display some objects).

7. [optional] set the **Classification filter** checkbox to set LAS filtering parameters according to the classification of points (see Section 2);

   Click **Choose layers**. The **LAS classification filter parameters** window opens:

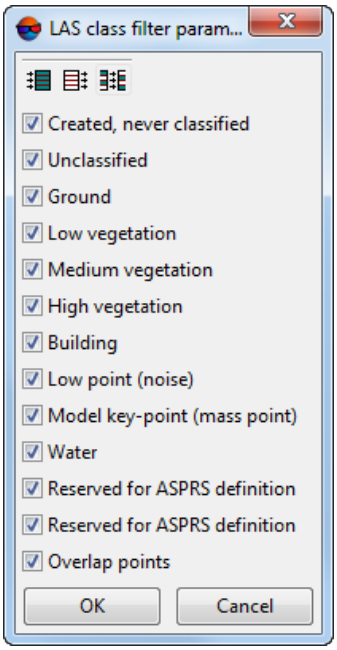

Fig. 7. The “LAS classification filter parameters” window

   To remove LAS points ranked in a certain way from the resulting file, clear the appropriate checkboxes. For group selection of point types, the following buttons are provided in the **LAS classification filter parameters** window:

   - – allows you to select types of lidar points;
   - – allows you to deselect all types of lidar points;
   - – allows you to invert selection of point types;

8. Click OK. As a result, processed LAS files will be created in the **Destination folder** having the names identical to the file names in the Initial folder.

8. Transformation of point cloud coordinate system

The system provides opportunity to transform LAS-files from one coordinate system to another.

In order to transform LAS-files to another coordinate system perform the following actions:

1. Select **Terrain › LAS › Transform LAS coordinates**. The **Transform LAS coordinates** window opens.

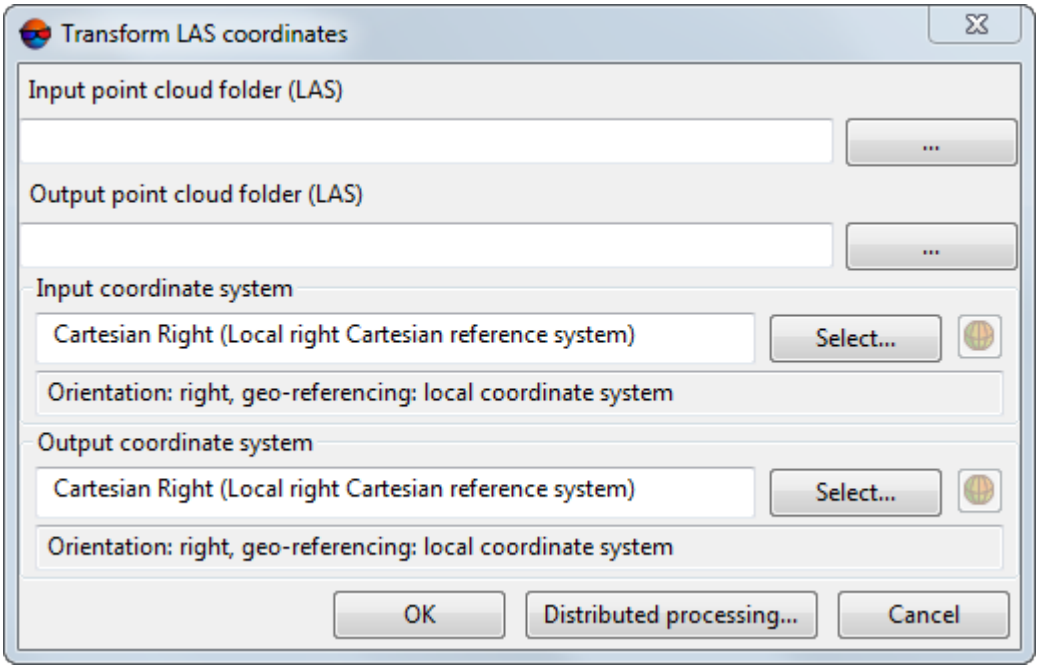

Fig. 8. Transform LAS to another coordinate system

2. Click the ... button in the **Input point cloud folder (LAS)** section and specify a source folder with point cloud in active profile resources.

3. Click the ... button in the **Output point cloud folder (LAS)** section and specify target folder for output LAS-files in active profile resources.

4. In the **Input coordinates system** section select actual Coordinate system of point cloud (if it is different from project coordinate system). Perform the following actions to do this:

    1. Click the **Select...** button to specify initial coordinate system.

        Coordinate system is specified using one of the following ways:

- **From DB** – from international or Russian coordinate system database (see*'Coordinate systems databases'* in the Project creation' User Manual);
- **From file** – allows to select coordinate system from files with `x-ref-system`, extension located out of active profile resources;
- **From resource** – from files with `x-ref-system` extension located in active profile resources, for example, to select coordinate system from another active profile project.

The system also allows to select coordinate system from a list of recently used coordinate systems.

2. [optional] When choosing coordinate system from database the **Coordinate system database** opens, which contains the list of coordinate systems.

To perform fast search for coordinate system, input the whole coordinate system name or its part to the **Find** input filed.

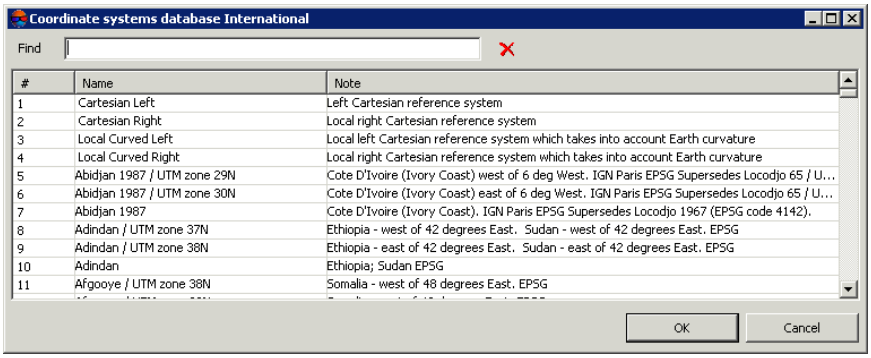

Fig. 9. Window used to select coordinate system from coordinate system database

3. [optional] To choose geoid to be used, click the button. Select proper type of geoid usage:
   - **No geoid**;
   - **EGM 96**.

The system allows to use the EGM2008 geoid. See more details in the Installation EGM2008 Geoid User Manual. After installation the geoid is displayed in the list.

5. In the **Output coordinate system** define target coordinate system in which it is necessary to convert the point cloud. To do this perform actions from step **4**.
6. Click OK to start converting point cloud coordinate system.

To use distributed computing for changing of point cloud coordinate system, do the following:

1. Change settings and run the distributed processing server/client (see the 'Distributed processing' chapter in the 'General information about system' User Manual).

2. Click the **Distributed processing** button. Distributed processing tasks are created. Number of created tasks matches with number of LAS-files.

9. Point cloud cutting by polygons

The system allows to edit the area of point cloud coverage.

In order to correct point cloud area, perform the following actions:

1. Create vector layer and polygons in it, or open a layer with bordering polygons (see the 'Vectorization' User Manual).

If polygons used as boundaries have no attributes, create text attributes for them before point cloud cutting and save the vector layer (see the 'Vectorization' User Manual).

Names of output LAS-files (and also names of output folders containing these LAS-files) are to be set automatically from the object attribute values used as boundaries for cutting.

2. Select **Terrain › LAS › Cut LAS by polygons**. The **Cut LAS by polygons** window opens.

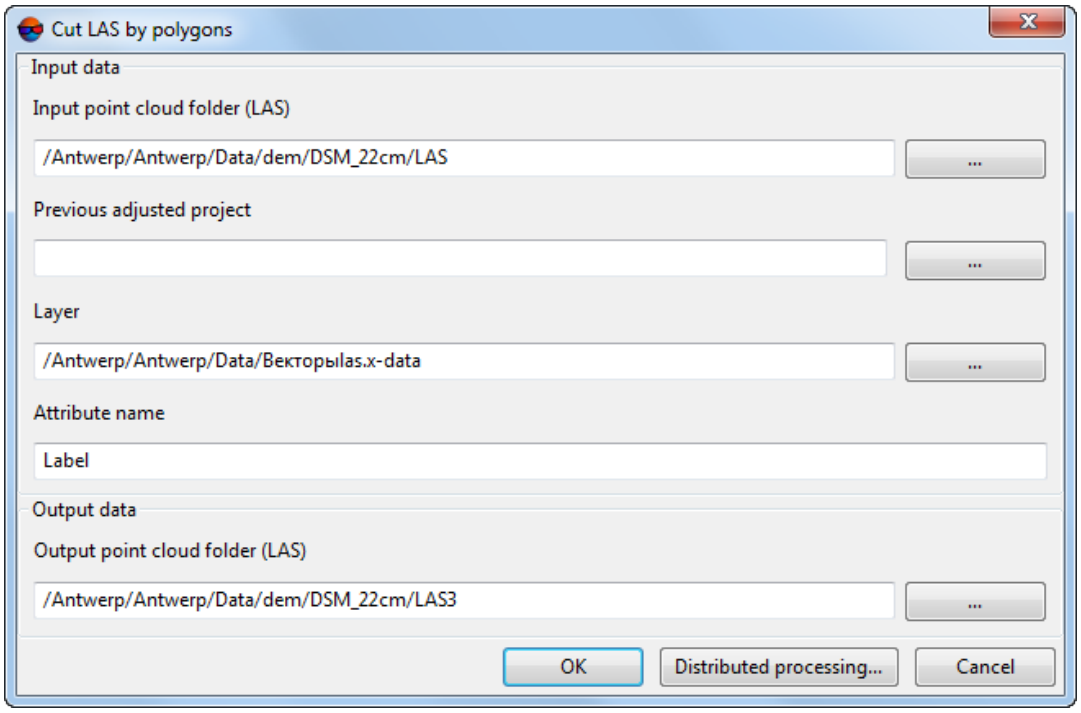

Fig. 10. Parameters of cutting by polygons

3. In the **Input data** section click the ... button in the **Input point cloud folder (LAS)** field to select input folder with LAS-files in active profile resources.

4. [optional] To define a **Previous adjusted project** in active profile resources, click the ... button in the **Previous adjusted project** field.

5. To define the vector **Layer** with polygons used as boundaries in active profile resources, click the ... button in the **Layer** field.

6. Input the **Attribute name** of polygons used as boundaries in **Attribute name** field;

7. In the **Output data** section click the ... button in the **Output point cloud folder (LAS)** field to specify output folder, containing folders with output LAS-files in active profile resources.

8. Click OK.

   To edit DEM in distributed processing mode, perform the following actions:

   1. Change settings and run the distributed processing server/client (see the “Distributed processing” chapter in the “General information” User Manual).

   2. Click the **Distributed processing** button. Distributed processing tasks are created. Number of created tasks matches with number of LAS-files.