Geostatistics in the SPRING
Exercise 5

Course: Master of Science on Geospatial Technologies
Professor: Carlos A. Felgueiras

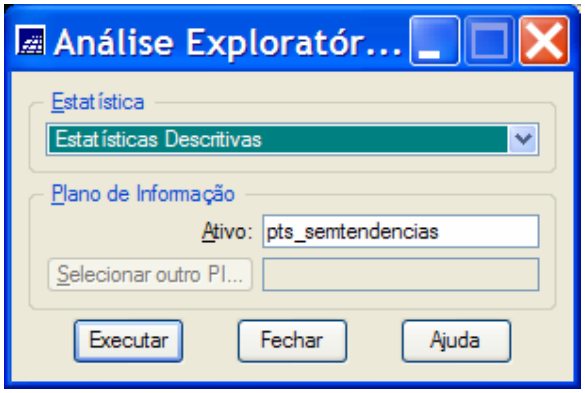
Contents

5. Modeling spatial variables with indicator geostatistics

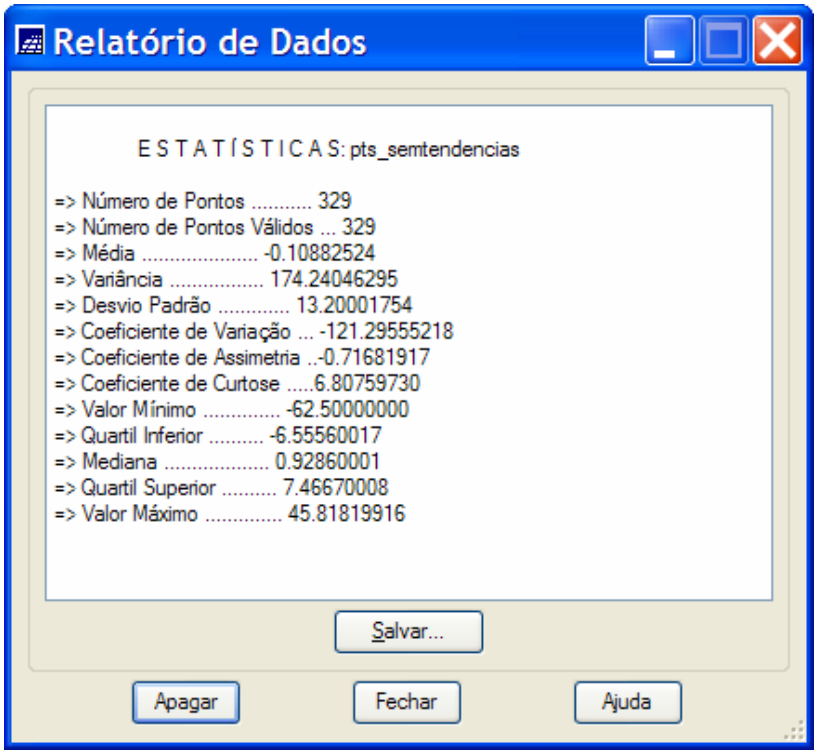
5.1 Performing exploratory analysis in the points without tendency

- Select, in the Control Panel, the IL *pts_semtendencias* of the *Altimetria* category.
- In the SPRING **Analysis** menu, select the **Geostatistics** option and, then, select the **Exploratory Analysis** option to open its window.

.



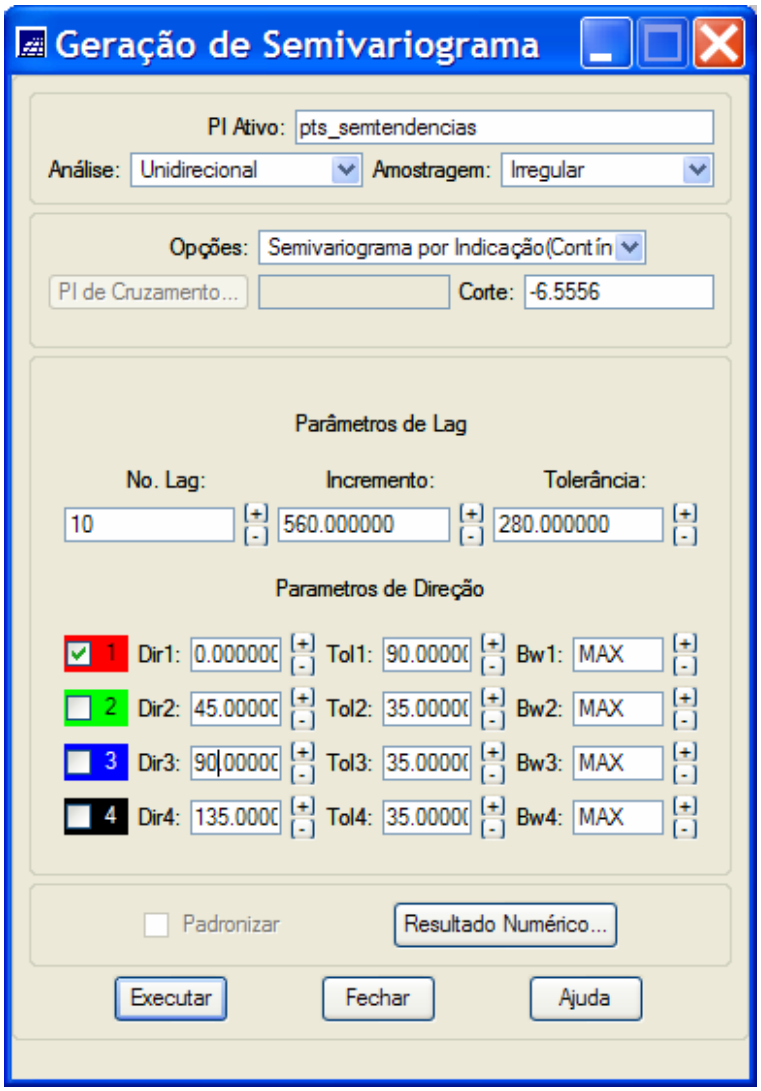
- Obtaining a report of summary statistics of the IL data
  - Select the option: *Descriptive Statistics*.
  - Click on the *Apply* button.
  - The figure below shows the report of summary statistics obtained from the data belonging to the *pts_semtendencias* InfoLayer.



- **Important: The quartis 1, 2 and 3 will be used in this lab as the cutoff values.**

5.2 Generating the experimental semivariogram for the first quartile (Cutoff = -6.5556)

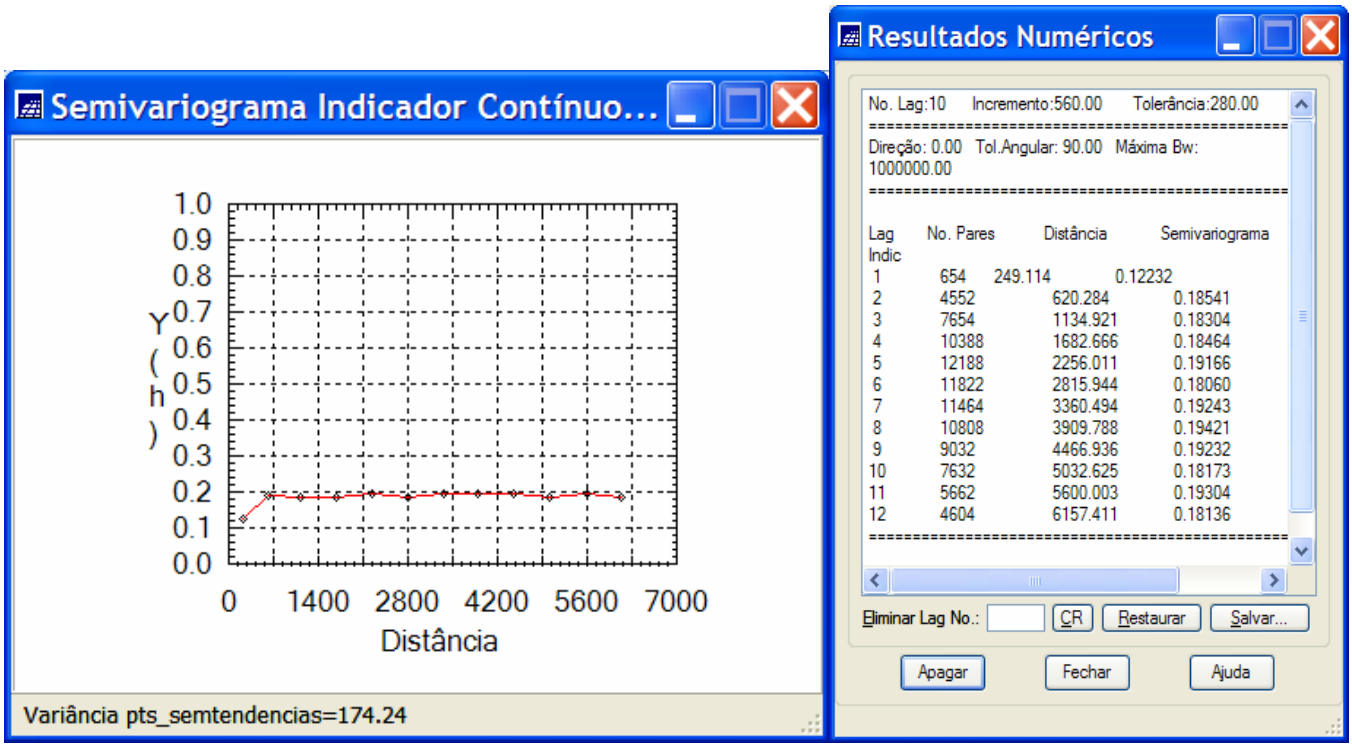
- Select, in the Control Panel, the IL *pts_semtendencias* of the *Altimetria* category.
- In the SPRING **Analysis** menu, select the **Geostatistics** option and, then, select the **Semivariogram Generation** option to open its window.
- To show Experimental Semivariograms of the *pts_semtendencias* InfoLayer
  - Select the option *Unidirectional* as for Analysis: and the option *Irregular* as for the Sampling:
  - Select as Options: Indicator *Semivariogram (Continuous)* and set the cutoff value as *-6.5556* (value of the first quartile).
  - Fill out the text fields of the Lag Parameters and of the Direction Parameters with the values presented in the figure below.



- Click on the *Apply* button to display the semivariogram graph generated for the entered parameters. Change these parameters up till find out a semivariogram that represents the attribute variation in the study area.

- Observation: Click on the *Numerical Results* button to open the window of Numerical Results that contains a numerical report related to the semivariogram generation. In this window, check, mainly, the presence of semivariogram values obtained from too small number of pairs. Consider change the increment value for a larger one when the number of pairs of the first lag is small.

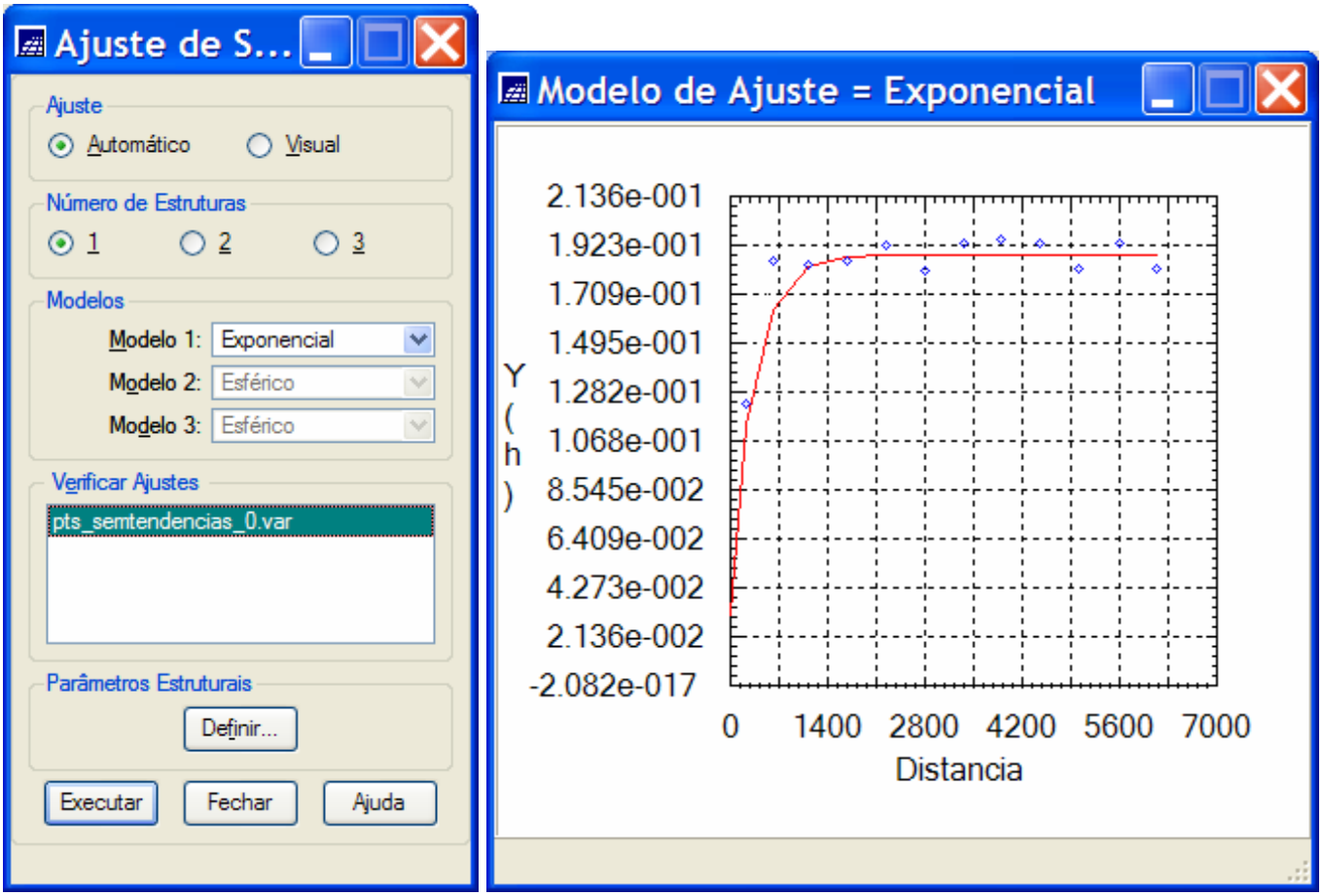
o The figure below shows the semivariogram graph along with the numerical results obtained with the user defined lag and direction parameters.



5.3 Fitting the theoretical semivariogram to the experimental one (Cutoff = -6.5556)

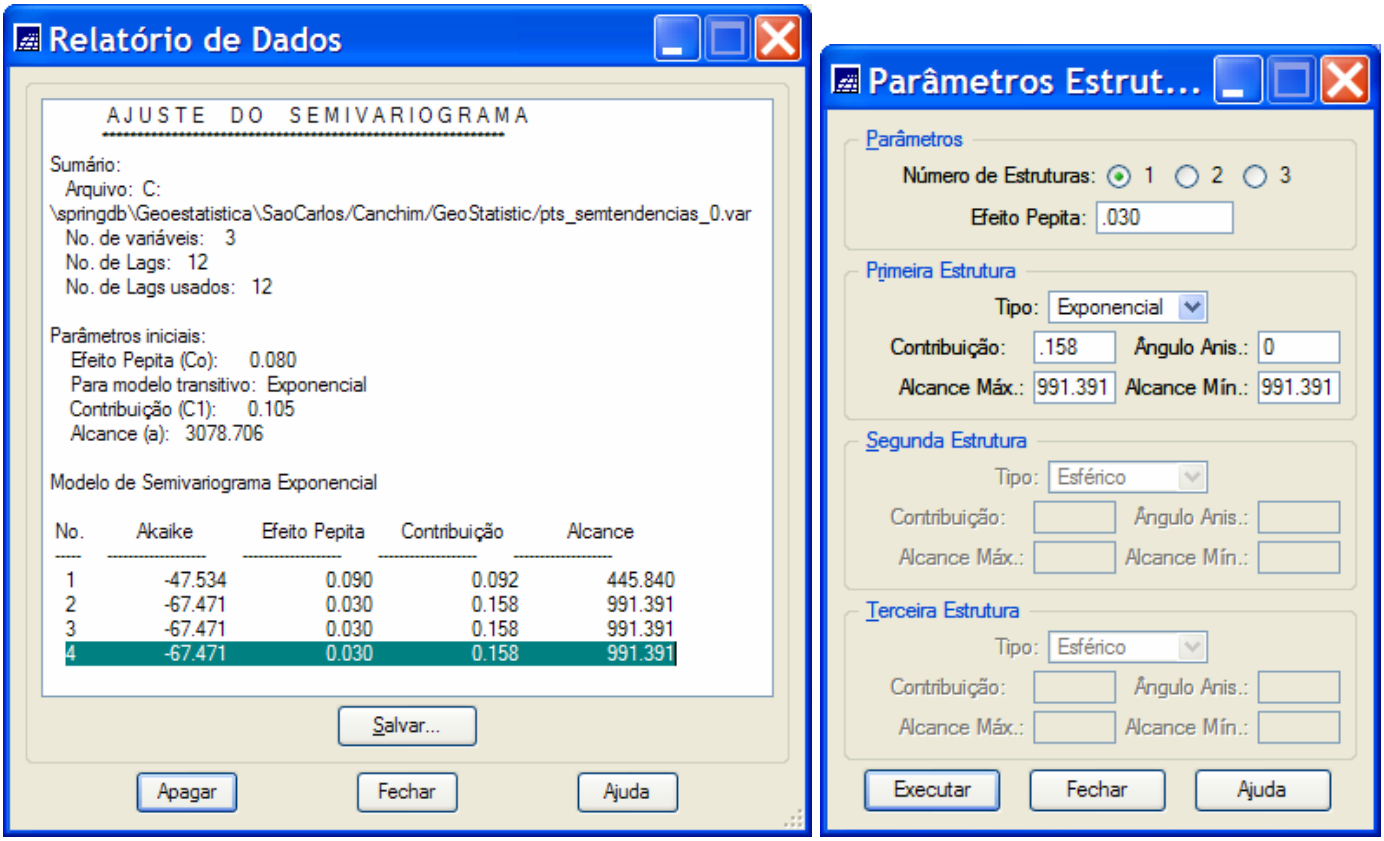
- Select, in the Control Panel, the IL *pts_semtendencias* of the *Altimetria* category.
- In the SPRING **Analysis** menu, select the **Geostatistics** option and, then, select the **Semivariogram Modeling** option to open its window.

- To show Fitted (Modeled) Semivariograms of the *pts_semtendencias* InfoLayer
  - Select the option *Automatic* as the Adjusting in the Semivariogram Modeling window
  - Select Number of Structures equal 1 and Model 1: Exponential.
  - Click on the button *Apply*.
  - Click on a variogram name, in the list of names of the Adjust Verification list, to display the fitted semivariogram defined by the chosen parameters.
  - Change the adjusting parameters to obtain different modeled semivariograms up till find the one that better represents the attribute spatial variation. Use qualitative (visual) and quantitative information, that appears in the data report window, as criteria to accept the final modeled semivariogram.



- Click on the button Define..., to open the Structural Parameters window where the parameters of the fitted semivariogram will be stored.

- Use the fitted semivariogram parameters (nugget effect, contribution and range) that appear in the last line of the data report (see marked line below).

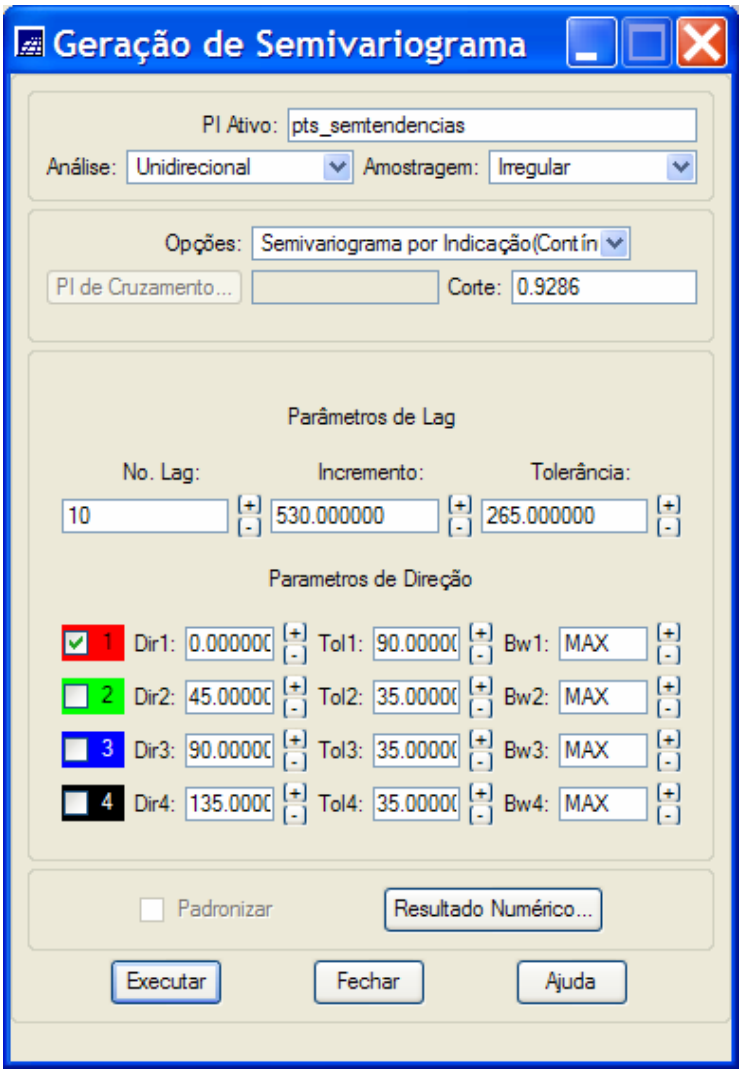


- Fill out the fields of the Structural Parameters window with the values presented in the figure above (right).
- Click on the Apply button to store the entered parameters.

IMPORTANT: In order to use the same fitted semivariogram for the InfloLayer pts_originais, select, in the Control Panel, the InfoLayer pts_originais and repeat the above steps of semivariogram generation, using the first quartile value of the pts_originais data, and of semivariogram modeling. In the semivariogram definition step, fill out the fields of the Structural Parameters window with the same parameters defined for the IL pts_semtendencias.

5.4 Generating the experimental semivariogram for the second quartile (Cutoff = 0.9286)

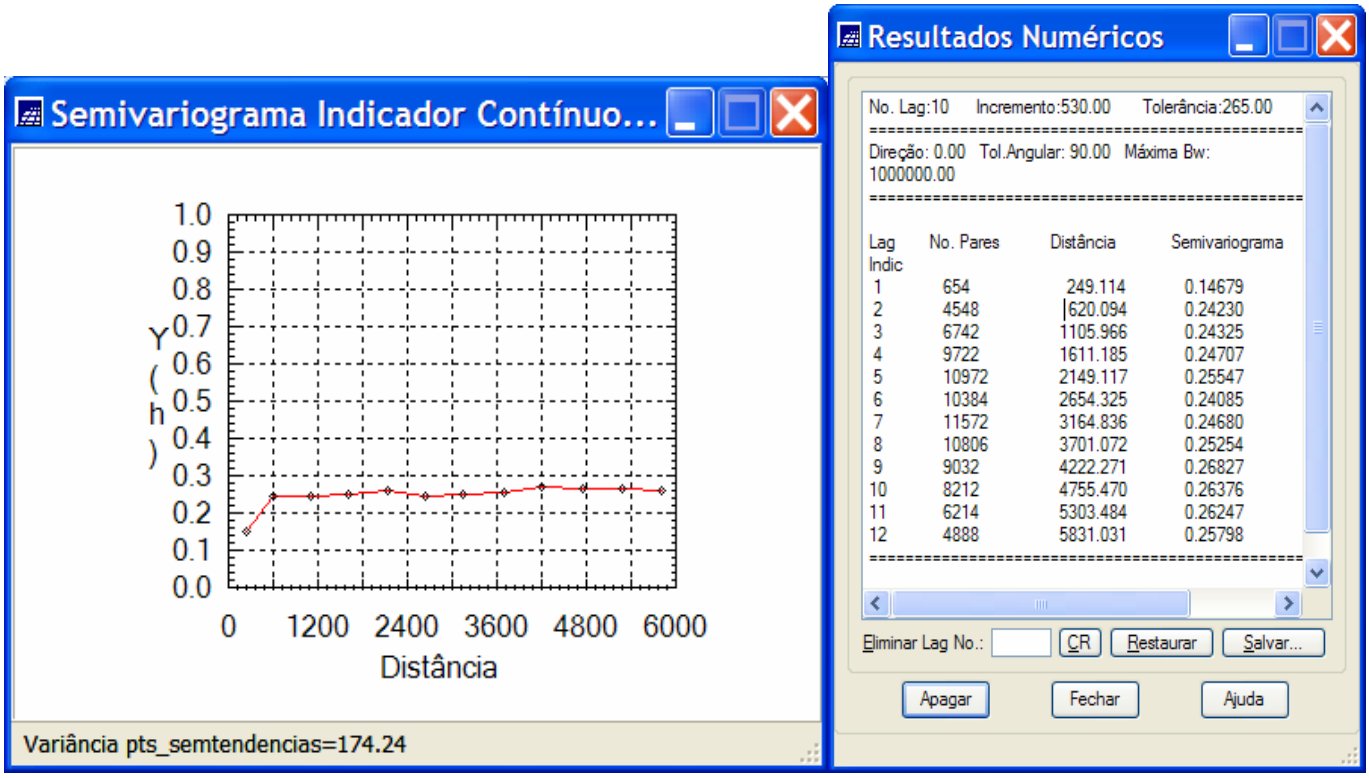
- Select, in the Control Panel, the IL *pts_semtendencias* of the *Altimetria* category.
- In the SPRING **Analysis** menu, select the **Geostatistics** option and, then, select the **Semivariogram Generation** option to open its window.
- To show Experimental Semivariograms of the *pts_semtendencias* InfoLayer
  - Select the option *Unidirectional* as for Analysis: and the option *Irregular* as for the Sampling:
  - Select as Options: Indicator *Semivariogram (Continuous)* and set the cutoff value as *0.9286* (value of the second quartile).
  - Fill out the text fields of the Lag Parameters and of the Direction Parameters with the values presented in the figure below.



- Click on the *Apply* button to display the semivariogram graph generated for the entered parameters. Change these parameters up till find out a semivariogram that represents the attribute variation in the study area.

- Observation: Click on the *Numerical Results* button to open the window of Numerical Results that contains a numerical report related to the semivariogram generation. In this window, check, mainly, the presence of semivariogram values obtained from too small number of pairs. Consider change the increment value for a greater one when the number of pairs of the first lag is small.

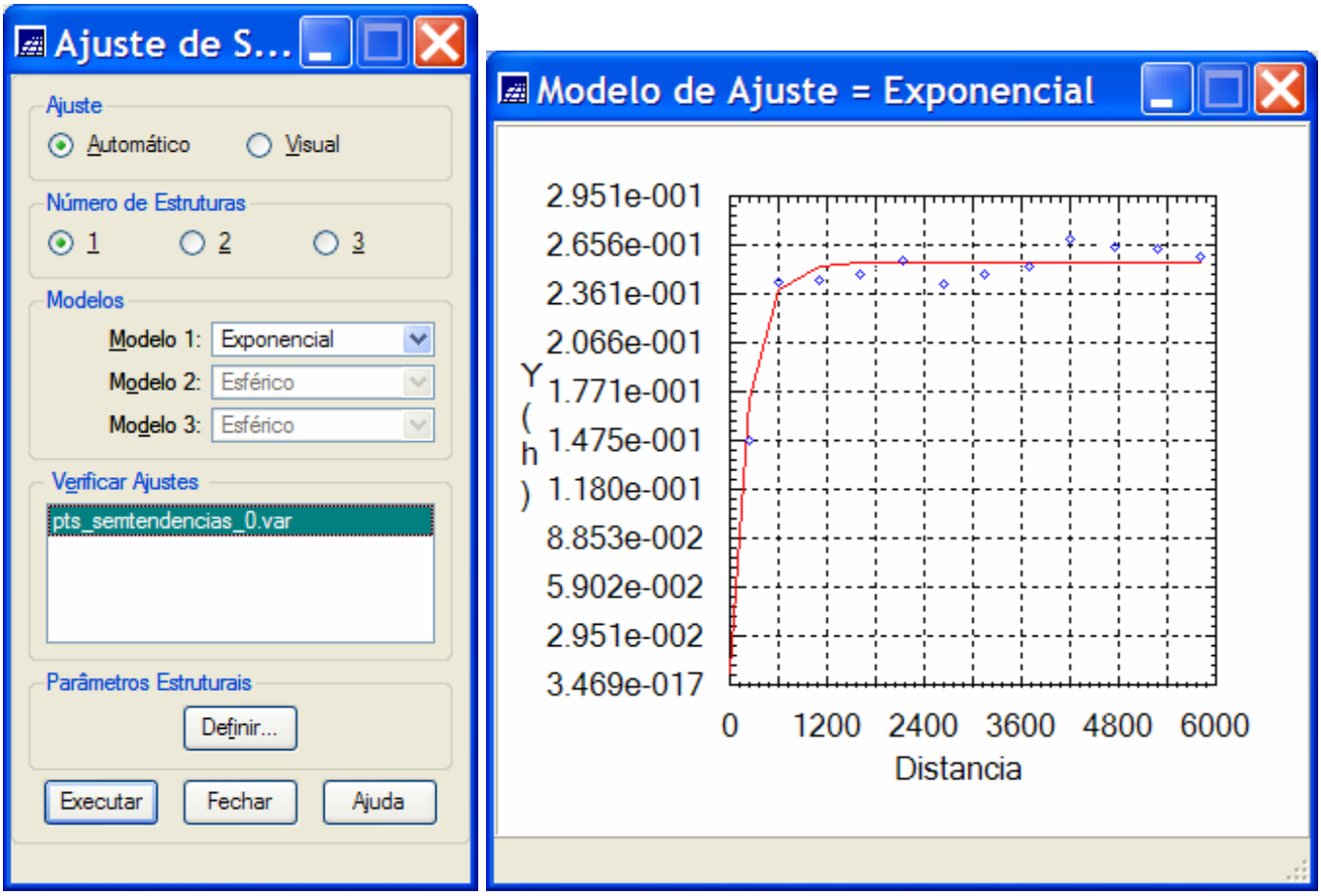
o The figure below shows the semivariogram graph along with the numerical results obtained with the user defined lag and direction parameters.



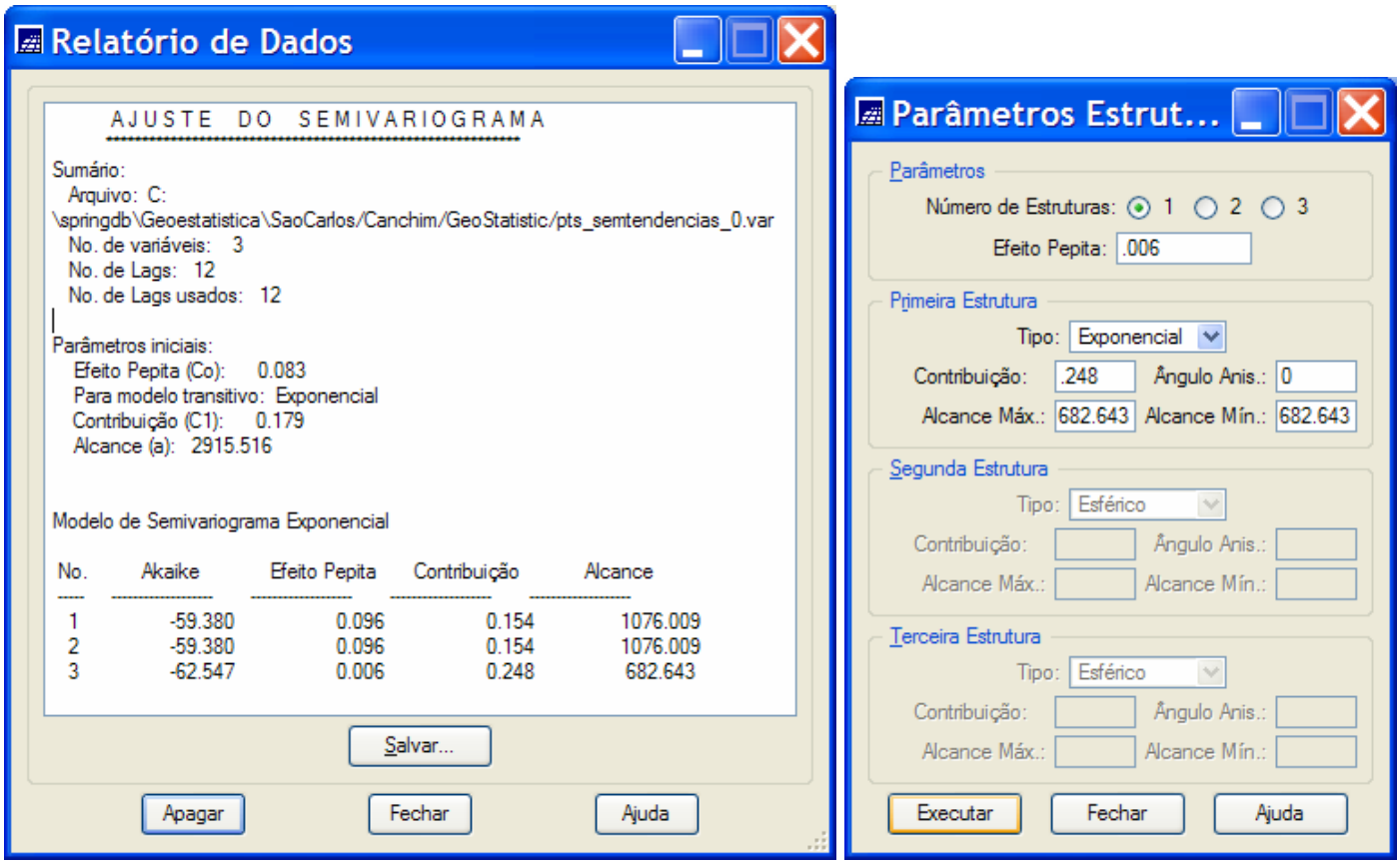
5.5 Fitting the theoretical semivariogram to the experimental one (Cutoff = 0.9286)

- Select, in the Control Panel, the IL *pts_semtendencias* of the *Altimetria* category.
- In the SPRING **Analysis** menu, select the **Geostatistics** option and, then, select the **Semivariogram Modeling** option to open its window.

- To show Fitted (Modeled) Semivariograms of the *pts_semtendencias* InfoLayer
  - Select the option *Automatic* as the Adjusting in the Semivariogram Modeling window
  - Select Number of Structures equal 1 and Model 1: Exponential.
  - Click on the button *Apply*.
  - Click on a variogram name, in the list of names of the Adjust Verification list, to display the fitted semivariogram defined by the chosen parameters.
  - Change the adjusting parameters to obtain different modeled semivariograms up till find the one that better represents the attribute spatial variation. Use qualitative (visual) and quantitative information, that appears in the data report window, as criteria to accept the final modeled semivariogram.



- Click on the button Define..., to open the Structural Parameters window where the parameters of the fitted semivariogram will be stored.
- Use the fitted semivariogram parameters (nugget effect, contribution and range) that appear in the last line of the data report (see marked line below).

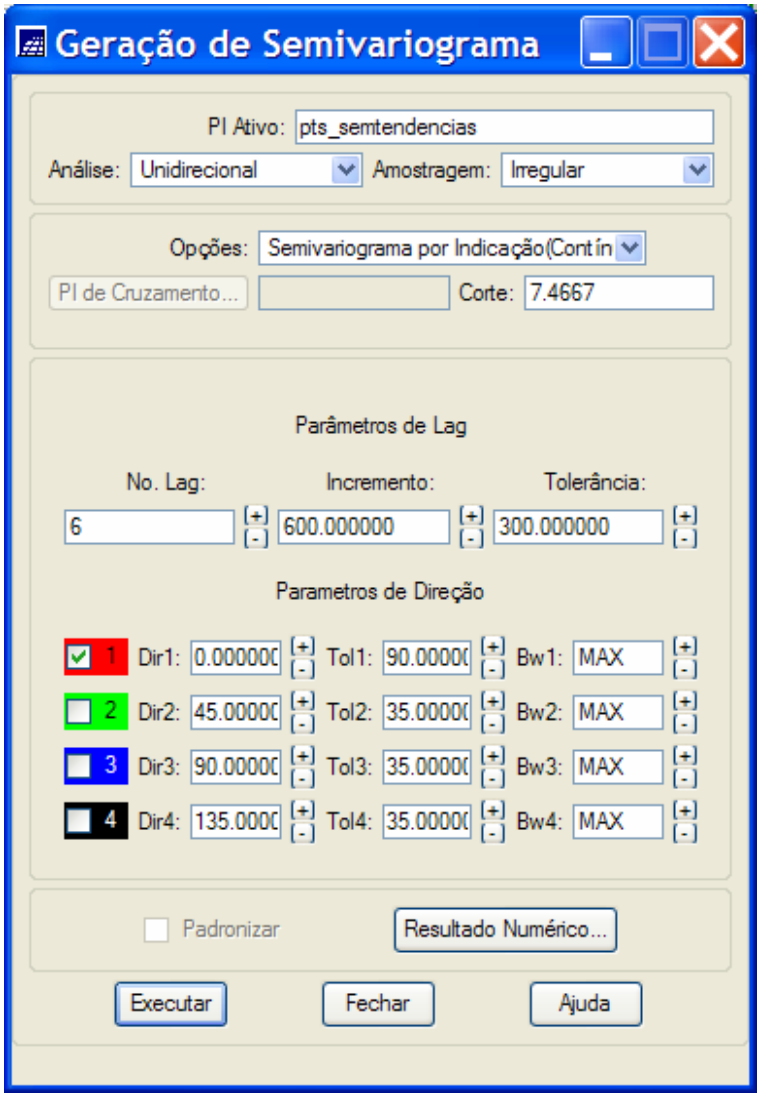


- Fill out the fields of the Structural Parameters window with the values presented in the figure above (right).
- Click on the Apply button to store the entered parameters.

IMPORTANT: In order to use the same fitted semivariogram for the InfloLayer pts_originais, select, in the Control Panel, the InfoLayer pts_originais and repeat the above steps of semivariogram generation, using the second quartile value of the pts_originais data, and of semivariogram modeling. In the semivariogram definition step, fill out the fields of the Structural Parameters window with the same parameters defined for the IL pts_semtendencias.

5.6 Generating the experimental semivariogram for the third quartile (Cutoff = 7.4667)

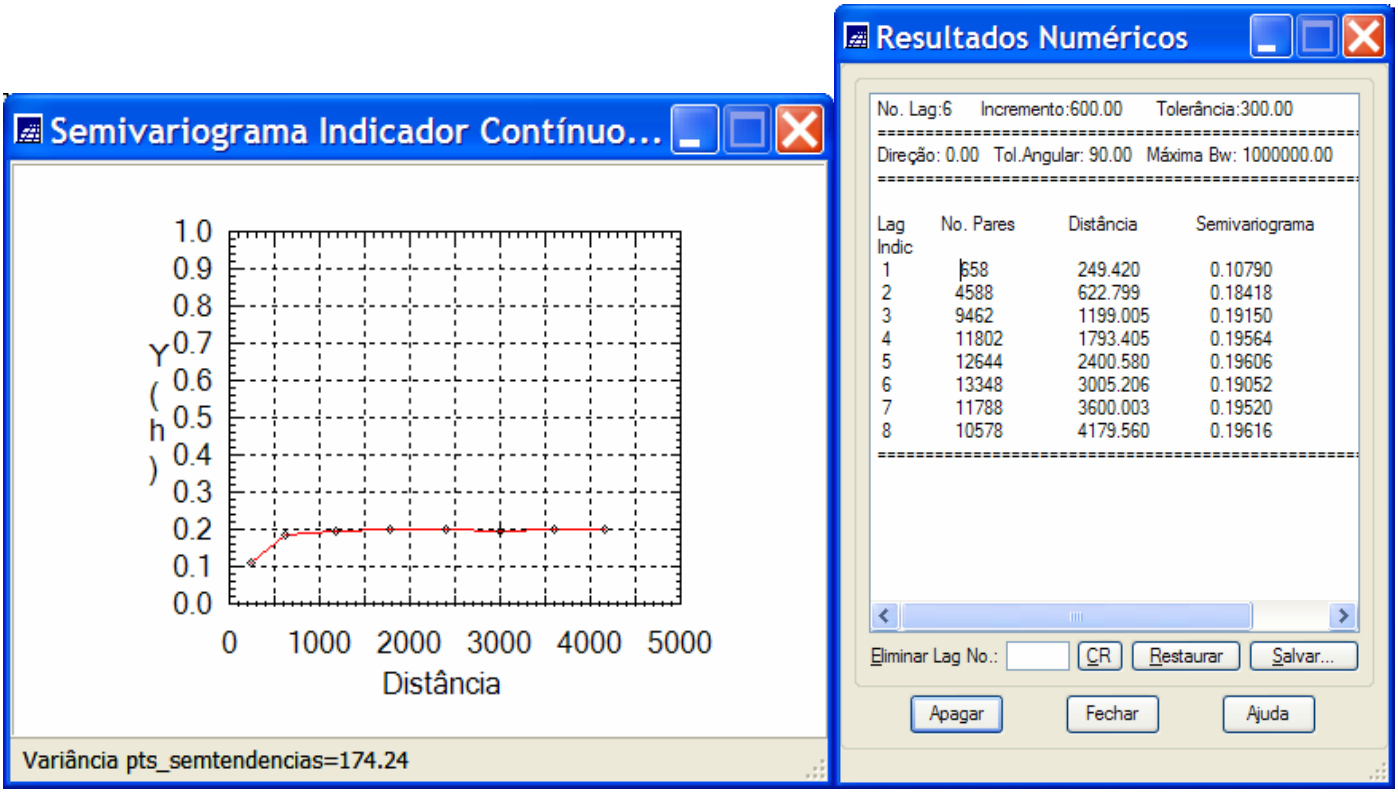
- Select, in the Control Panel, the IL *pts_semtendencias* of the *Altimetria* category.
- In the SPRING **Analysis** menu, select the **Geostatistics** option and, then, select the **Semivariogram Generation** option to open its window.
- To show Experimental Semivariograms of the *pts_semtendencias* InfoLayer
  - Select the option *Unidirectional* as for Analysis: and the option *Irregular* as for the Sampling:
  - Select as Options: Indicator *Semivariogram (Continuous)* and set the cutoff value as *7.4667* (value of the second quartile).
  - Fill out the text fields of the Lag Parameters and of the Direction Parameters with the values presented in the figure below.



- Click on the *Apply* button to display the semivariogram graph generated for the entered parameters. Change these parameters up till find out a semivariogram that represents the attribute variation in the study area.

- Observation: Click on the *Numerical Results* button to open the window of Numerical Results that contains a numerical report related to the semivariogram generation. In this window, check, mainly, the presence of semivariogram values obtained from too small number of pairs. Consider change the increment value for a greater one when the number of pairs of the first lag is small.

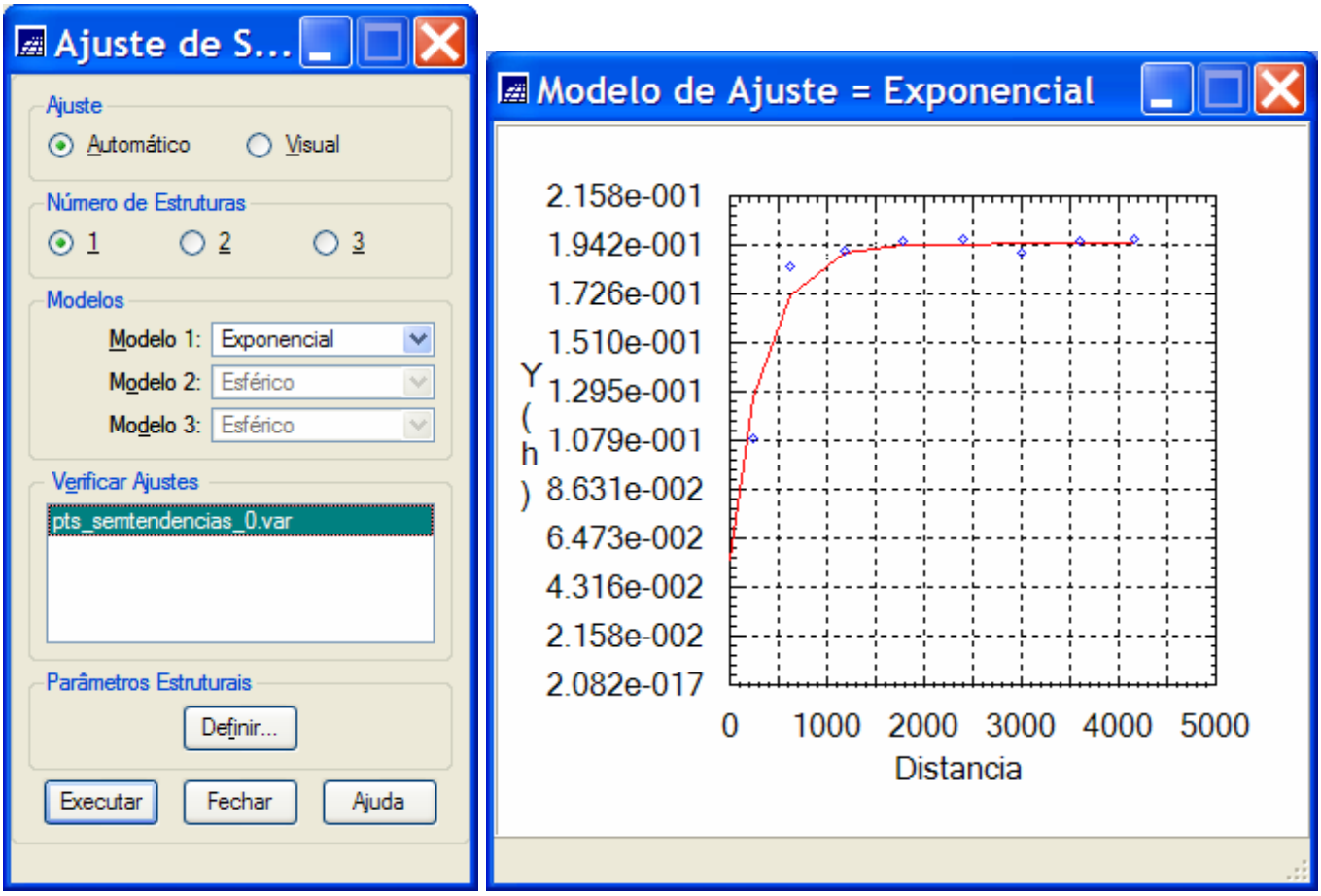
o The figure below shows the semivariogram graph along with the numerical results obtained with the user defined lag and direction parameters.



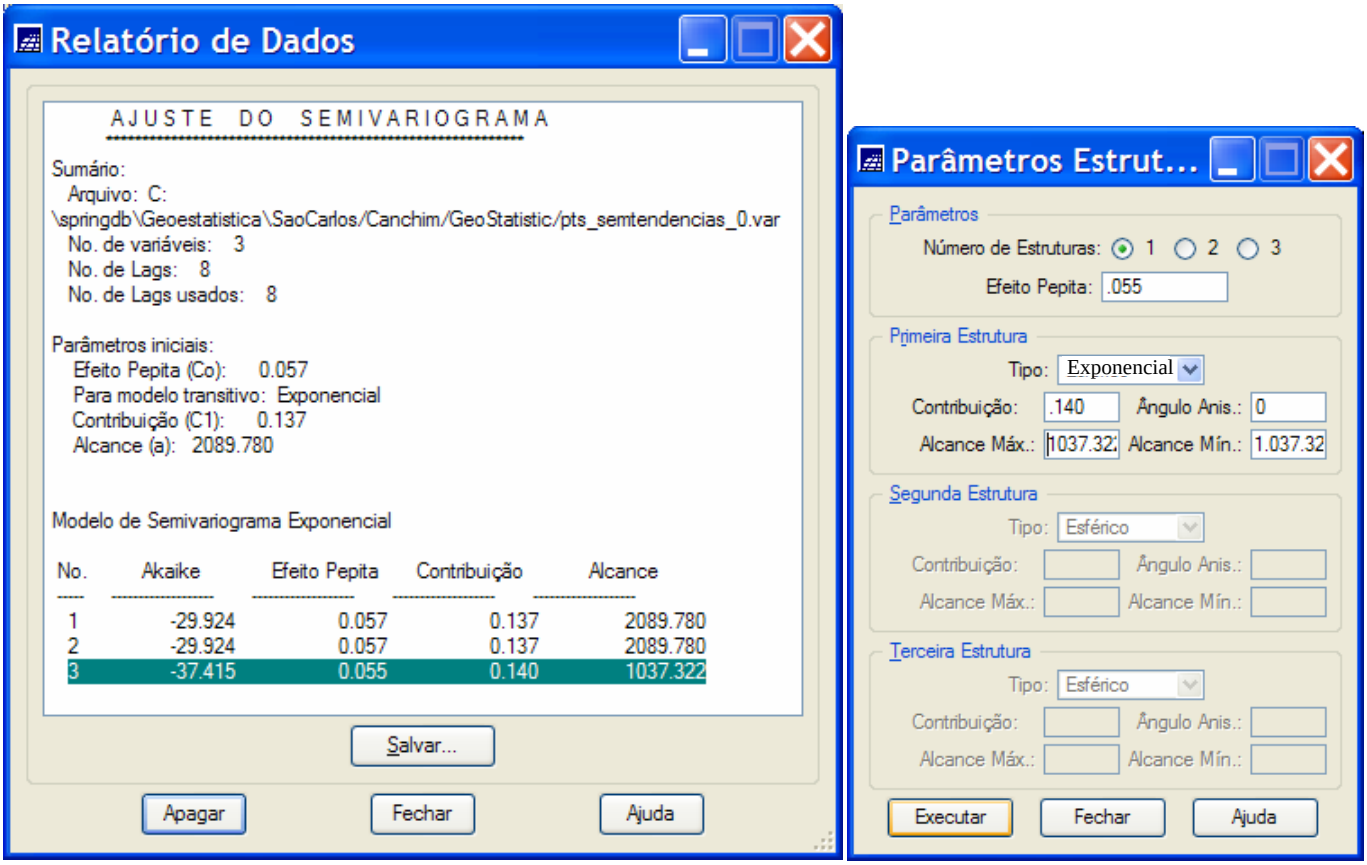
5.7 Fitting the theoretical semivariogram to the experimental one (Cutoff = 7.4667)

- Select, in the Control Panel, the IL *pts_semtendencias* of the *Altimetria* category.
- In the SPRING **Analysis** menu, select the **Geostatistics** option and, then, select the **Semivariogram Modeling** option to open its window.

- To show Fitted (Modeled) Semivariograms of the *pts_semtendencias* InfoLayer
  - Select the option *Automatic* as the Adjusting in the Semivariogram Modeling window
  - Select Number of Structures equal 1 and Model 1: Exponential.
  - Click on the button *Apply*.
  - Click on a variogram name, in the list of names of the Adjust Verification list, to display the fitted semivariogram defined by the chosen parameters.
  - Change the adjusting parameters to obtain different modeled semivariograms up till find the one that better represents the attribute spatial variation. Use qualitative (visual) and quantitative information, that appears in the data report window, as criteria to accept the final modeled semivariogram.



- Click on the button Define..., to open the Structural Parameters window where the parameters of the fitted semivariogram will be stored.
- Use the fitted semivariogram parameters (nugget effect, contribution and range) that appear in the last line of the data report (see marked line below).



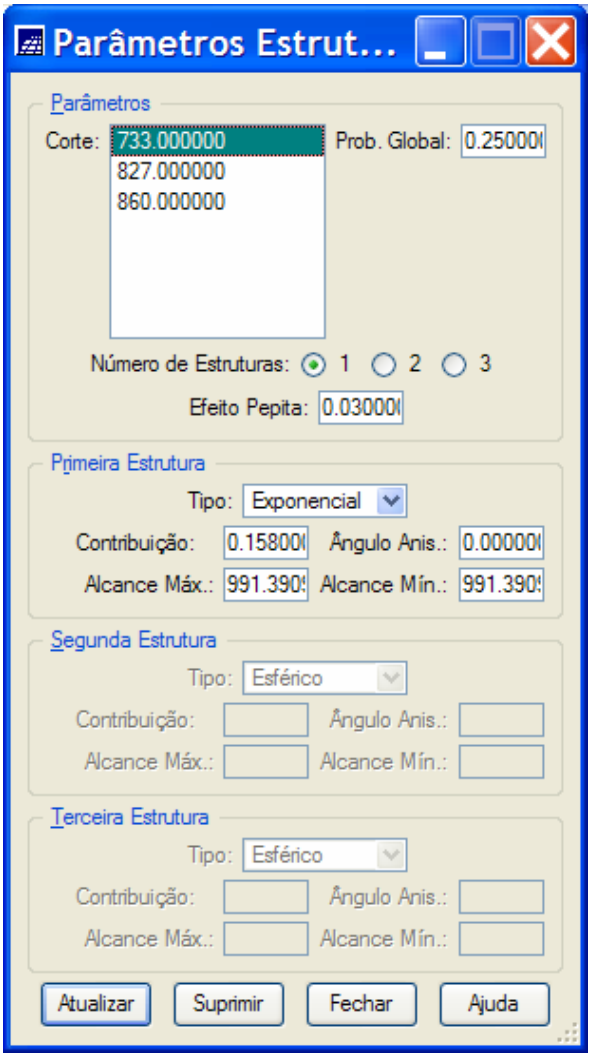
- Fill out the fields of the Structural Parameters window with the values presented in the figure above (right).
- Click on the Apply button to store the entered parameters.

IMPORTANT: In order to use the same fitted semivariogram for the InfloLayer pts_originais, select, in the Control Panel, the InfoLayer pts_originais and repeat the above steps of semivariogram generation, using the third quartile value of the pts_originais data, and of semivariogram modeling. In the semivariogram definition step, fill out the fields of the Structural Parameters window with the same parameters defined for the IL pts_semtendencias.

5.8 Generating numerical grids (means and standard deviations) with Indicator Kriging

- Select, in the Control Panel, the IL *pts_semtendencias* of the *Altimetria* category.
- In the SPRING **Analysis** menu, select the **Geostatistics** option and, then, select the **Indicator Kriging…** option to open its window.

- In the Indicator Kriging window:
  - Click on the **Model/Probabilities** button to open the window of variogram structural parameters.
  - In the window of Structural Parameters:
    - Fill out the field Global Prob: for each cutoff value. In this case use the values *.25, .5* and *.75* for the first, second and third cutoff values (quartiles). Click on the update button after a probability value is entered.
    - Use the window of Structural Parameters also to check and edit the entered values of variogram structural parameters.



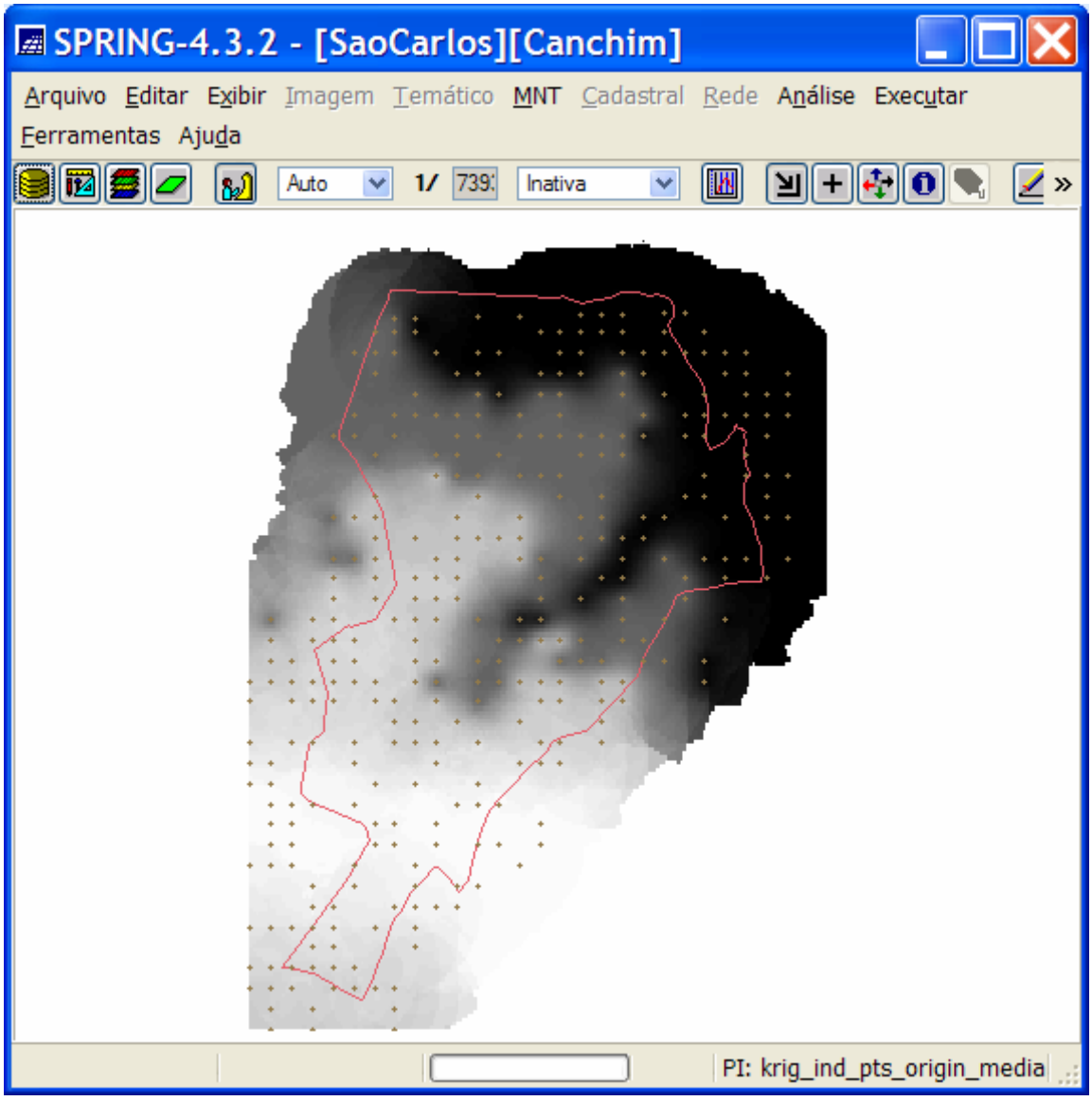
- Click on the Close button to exit the window of structural parameters.

- Select as **Variable:** the option *Continuous*
- Select as **Krig Type**: the option *Ordinary*.
- Select as **Option**: the option *Complete.*
- Define the grid parameters **ResX**: equal 35. and **ResY**: equal 50. This default values, along with the project bounding box, will generate a grid with 200 rows by 200 columns.
- Fill out the fields related to the interpolation parameters with the following values: **Minimum:** equal *4*, **Maximum:** equal *16*, **R.Min:** equal *1040*, **R.Max**: equal *1040* and **Angle: equal** *0.0*.
- Choose the output category clicking on the **Category…** button
- Fill out the field **IL Values:** with the name of the infolayer to be created, *pts_origin_media* in this case.
- Choose as **Value:** *Mean* and **Uncertainty:** *1 Standard Deviation*
- Click on the **Apply** button to run the indicator kriging procedure

5.9 Visualizing the results in the main graphical display of the SPRING

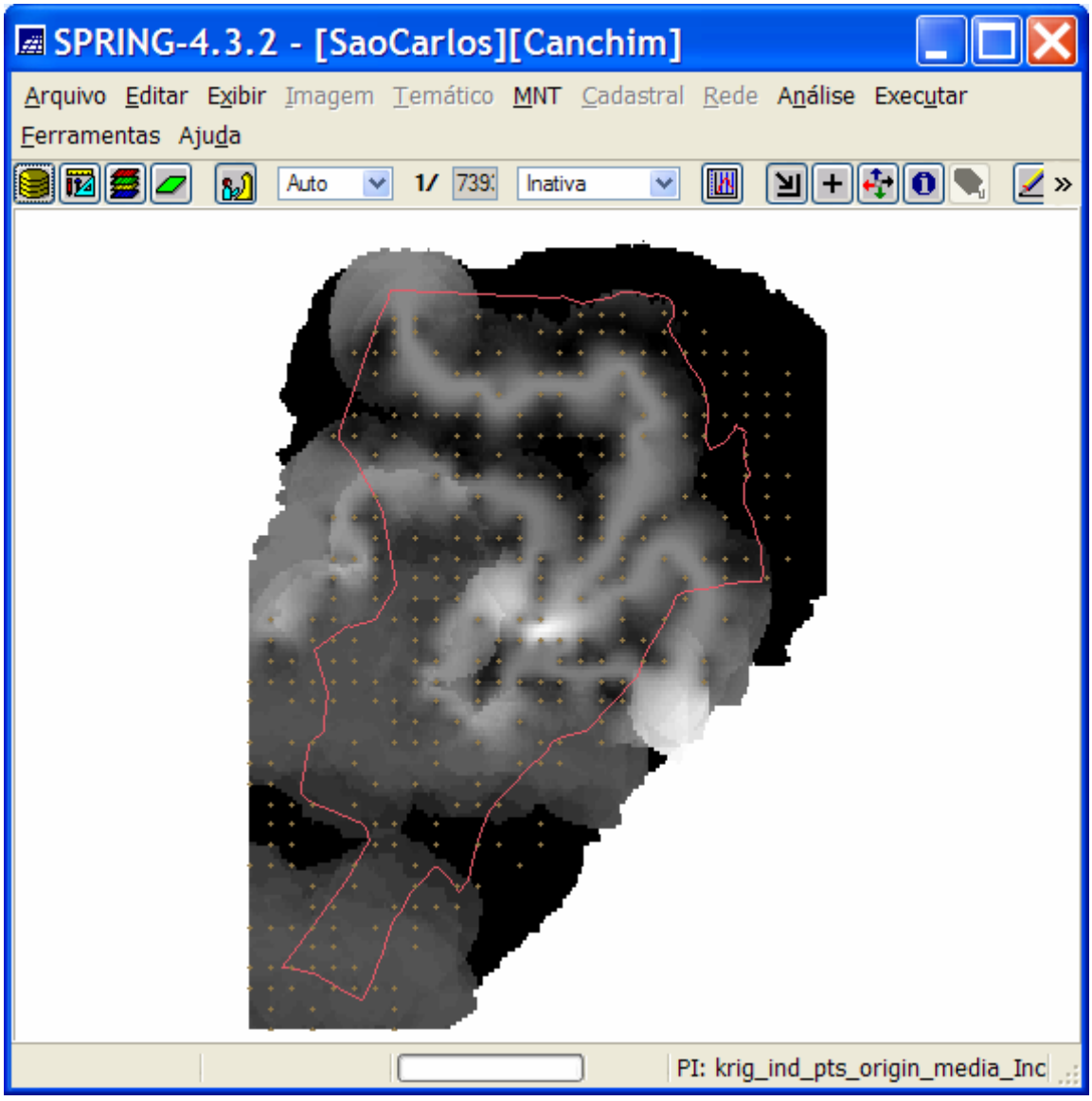
- Displaying the map of estimates of the indicator kriging
- In the Control Panel:
  - Enable the display control 1
  - Select in the list of Categories list: *Altimetria*
  - Select in the list of Infolayers : *krig_ind_pts_origin_media*
  - Select representation *Image*
  - Select also the *lines* of the *recorte* infolayer of the *Limites* Category and the samples of *pts_originais* infolayer of the *Altimetria* Category
  - Click on the button Draw 

- The figure below shows the map of mean estimates obtained from the uncertainty modeling by the indicator kriging for the *pts_originais* infolayer.



- Displaying the map of uncertainties (1 standard deviation) of the indicator kriging
- In the Control Panel:
  - Enable the display control 2
  - Select in the list of Categories list: *Altimetria*
  - Select in the list of Infolayers : *krig_ind_pts_origin_media_Inc*
  - Select representation *Image*
  - Select also the *lines* of the *recorte* infolayer of the *Limites* Category and the samples of *pts_originais* infolayer of the *Altimetria* Category
  - Click on the button Draw 

- The figure below shows the map of uncertainty values (1 standard deviation) obtained from the uncertainty modeling by indicator kriging for the *pts_originais* infolayer.



5.10 Generating numerical grids (medians and interquartiles) with Indicator Kriging

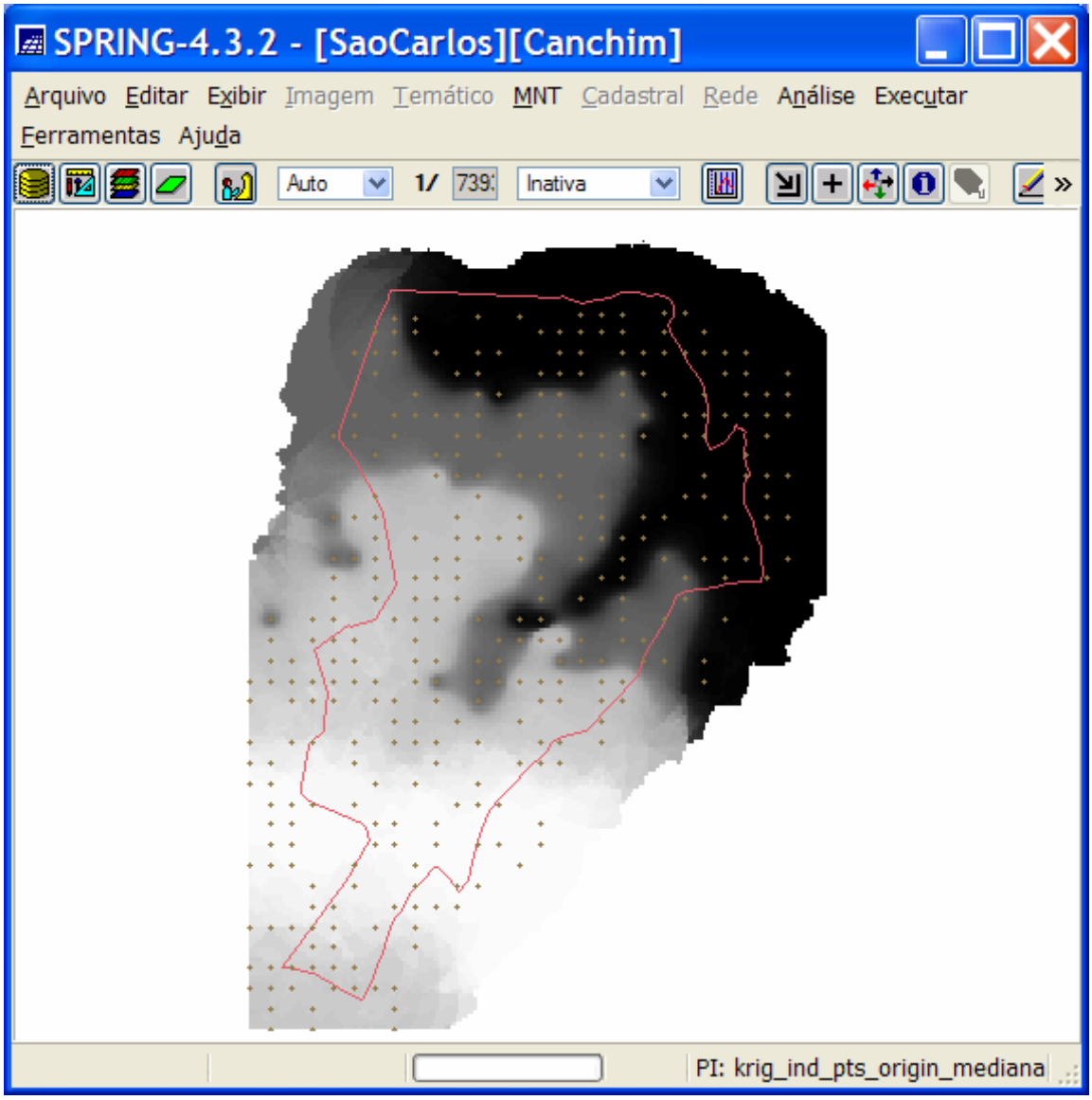
- Repeat the Indicator Kriging procedure, presented above, using *krig_ind_pts_origin_mediana* as the name to the **IL Values:** field and *median* and *Quantil .25* as the choices for the **Value:** and **Uncertainty:** fields respectively. (see figure below).

- Click on the Apply button to create the new maps of estimates and uncertainties.

- Visualizing more results in the main graphical display of the SPRING

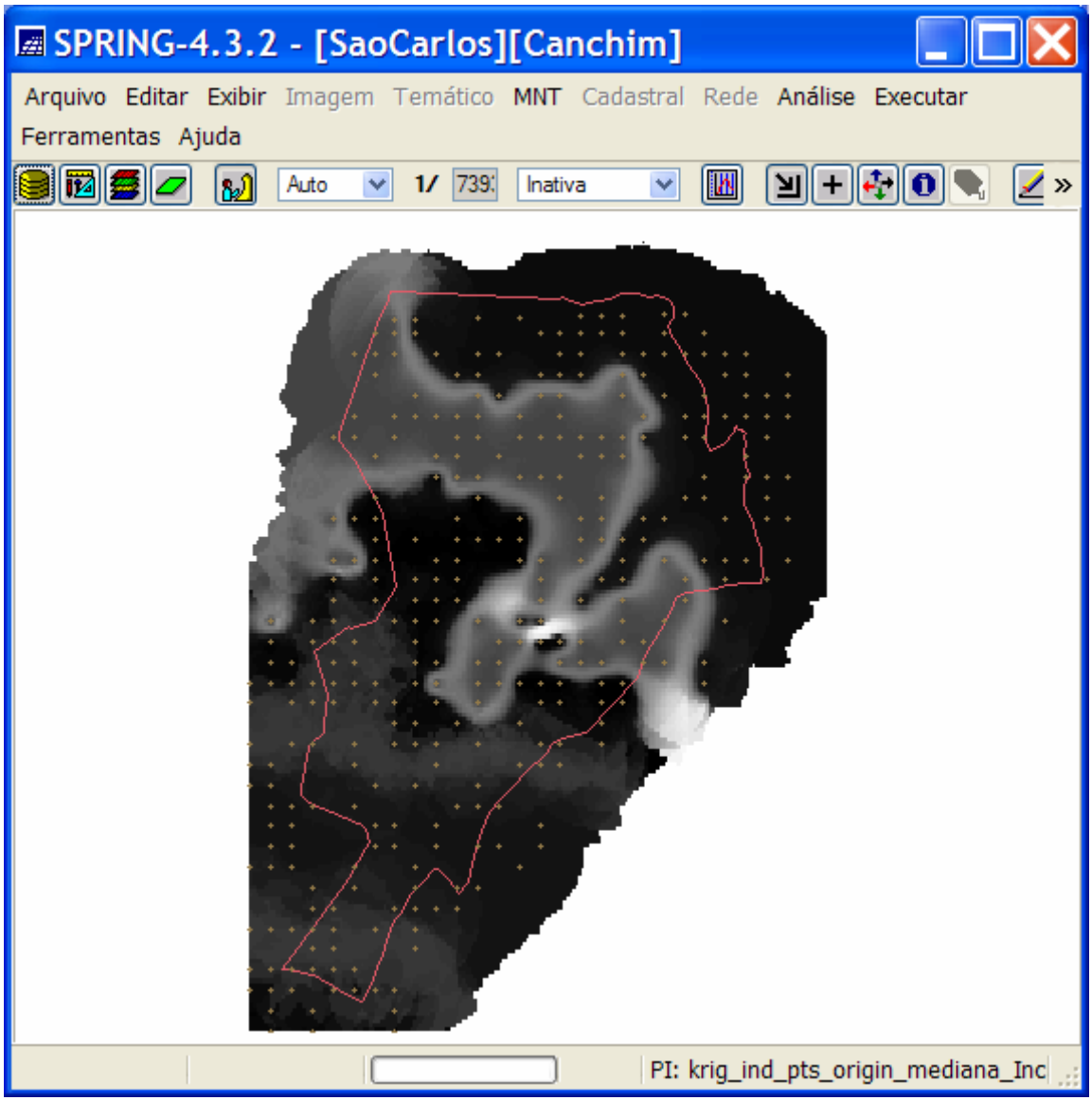
  - Displaying the map of estimates of the indicator kriging
  - In the Control Panel:
    - Enable the display control 1
    - Select in the list of Categories list: *Altimetria*
    - Select in the list of Infolayers : *krig_ind_pts_origin_mediana*
    - Select representation *Image*
    - Select also the *lines* of the *recorte* infolayer of the *Limites* Category and the samples of *pts_originais* infolayer of the *Altimetria* Category
    - Click on the button Draw 

  - The figure below shows the map of median estimates obtained from the uncertainty modeling by the indicator kriging for the *pts_originais* infolayer.



- Displaying the map of uncertainties (interquartil interval) of the indicator kriging
- In the Control Panel:
  - Enable the display control 2
  - Select in the list of Categories list: *Altimetria*
  - Select in the list of Infolayers : *krig_ind_pts_origin_mediana_Inc*
  - Select representation *Image*
  - Select also the *lines* of the *recorte* infolayer of the *Limites* Category and the samples of *pts_originais* infolayer of the *Altimetria* Category
  - Click on the button Draw 

- The figure below shows the map of uncertainty values (interquartil interval) obtained from the uncertainty modeling by indicator kriging for the *pts_originais* infolayer.



- **Comparative results between mean (top left) and median (top right) maps and between standard deviation (bottom left) and interquartil (bottom right) uncertainty maps.**