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Preliminary results of geostatistical methods utilization for processing of the BIAS data

Gasyukov P.S. and Kasatkina S.M.

Atlantic Scientific Research Institute of Marine Fisheries and Oceanography,
Kaliningrad, Russia

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The main questions the survey should answer:

- What is the abundance of a particular stock?
- How is it distributed?
- How good is the abundance estimates?
- What is the variance of the abundance estimates?

Current practice:

- Descriptive statistics methods used to calculate mean values (Sa) and frequency distributions (proportions);
- No uncertainty estimates;
- The mute agreement:

  the observations are independent random values.

The fields of fish density are coherent spatial formations

It is exhibited in correlation of field values in points closely located to each other.

Methods based on the hypothesis of independence causes errors in the estimated values.

The technique of processing the data of coherent fields is based on geostatistical theory.

Objectivities

- To show application of the geostatistical methods for processing the acoustic survey data;
- To start the discussion about geostatistical application in the Baltic international acoustic surveys.

Data used:

- Russian acoustic survey in 26 and 28 subdivision of the Baltic Sea in October 2004 (Sa values)

- Russian and Sweden data collected in overlapping rectangle 45G9 in autumn 2004 (Sa values)

Geostatistical application includes 3 steps:

- Determination of spatial structure;
- Recovery of distribution by area based on observed data and known model of spatial structure;
- Estimation of integrated values (mean values, variances, integrals and mapping of observations.

The spatial structure is studied by means of VARIOGRAMMS

- Two types of variogramms:
  - Experimental
  - Theoretical models

If *Z(x)* is field value, where *x* the spatial coordinate of a point, the experimental variogramm

$$\gamma(h) = 0.5 \frac{1}{N_h} \sum_{x_i - x_h \approx h} [Z(x_i) - Z(x_j)]^2$$

Examples

- Exponential variogramm

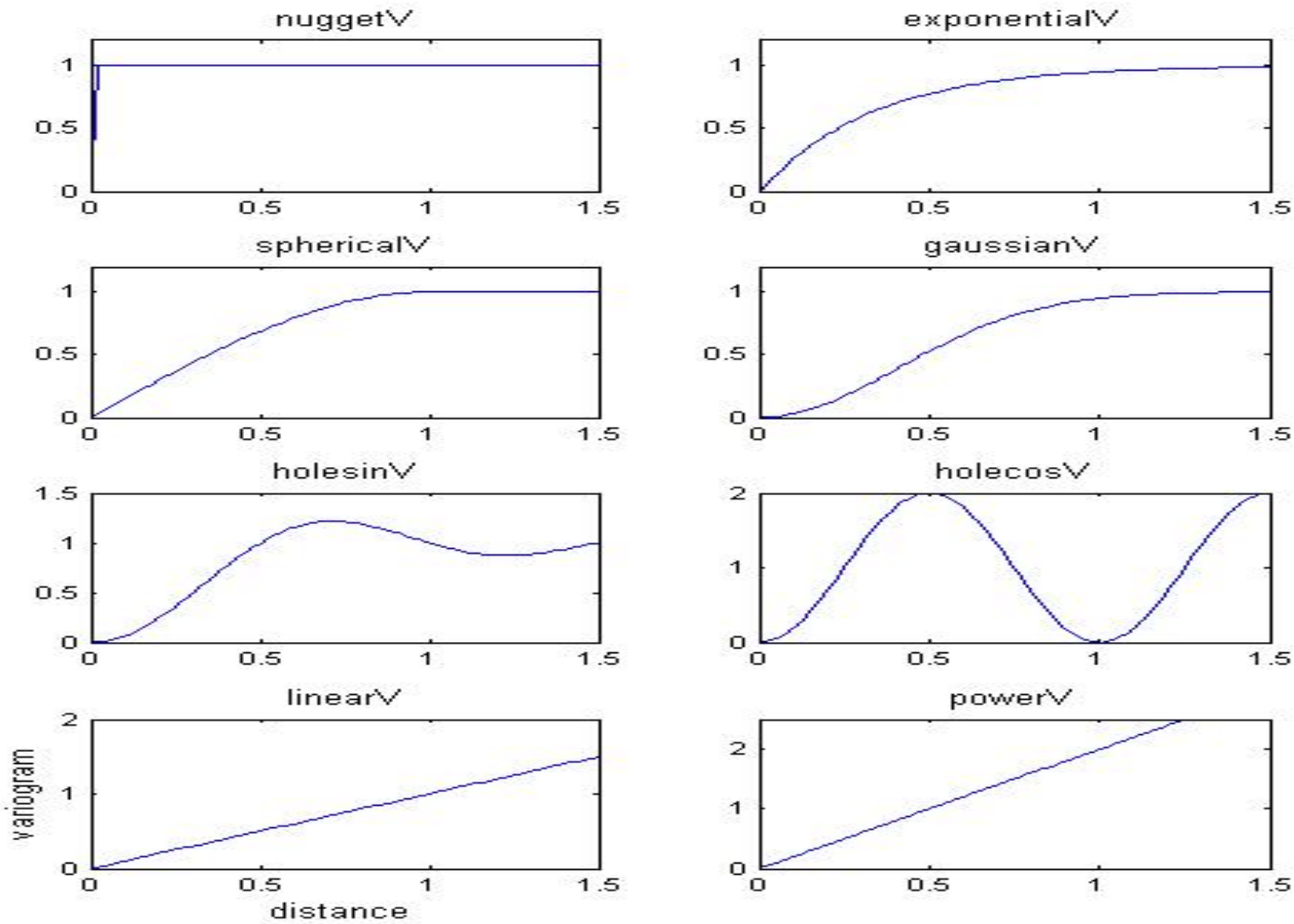
$$\gamma(h) = C \cdot [1 - \exp |h| / a]$$

- Spheric variogramm

$$\gamma(h) = C[\frac{3}{2}\frac{|h|}{a} - \frac{1}{2}\frac{|h|^3}{a^3}] \qquad |h| < a$$

$$\gamma(h) = C \qquad |h| \geq a$$

Theoretical models



Tasks which can be solved with variogramms

- Determine field value in the point where no observations were made;
- Calculate mean value of the field in some local place;
- Calculate mean value or integral from measured values for the entire rectangle, stratum, Subarea

All these tasks can be solved by kriging

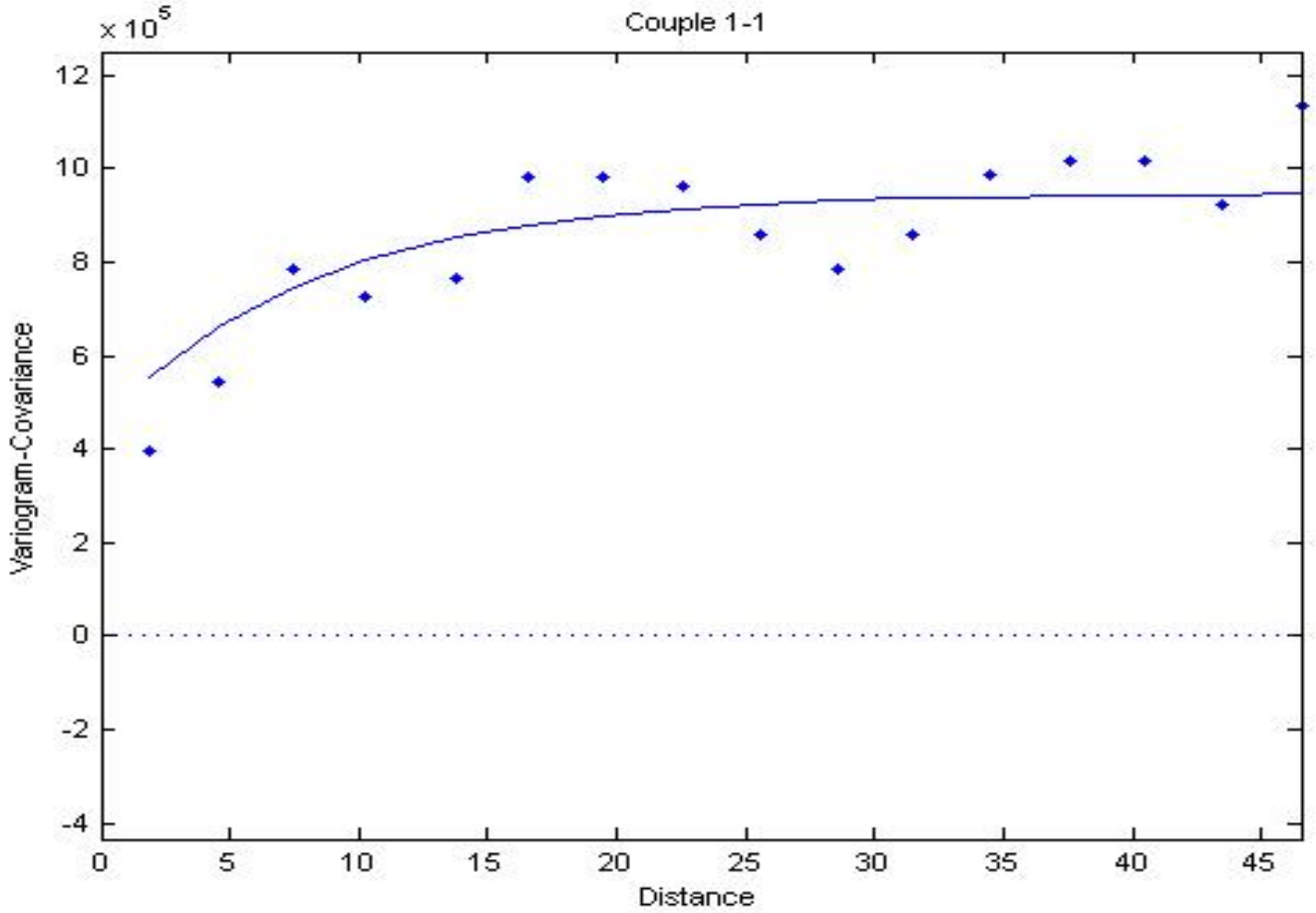
- The field value in point X_0 where no observations are available

$$Z(X_0) = \sum_{i=1}^{K} \lambda_i \cdot Z(x_i) \qquad \sum \lambda_i = 1$$

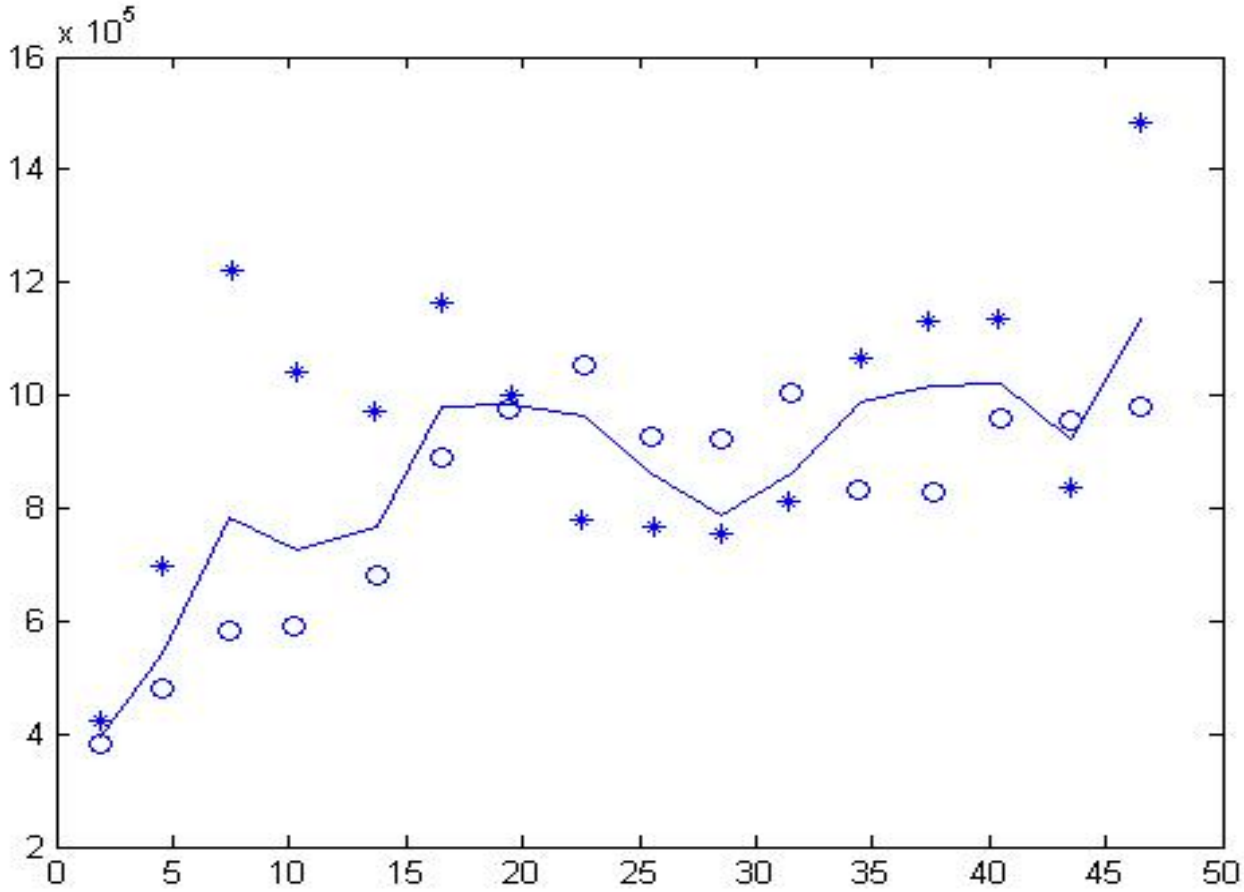
- K – number of adjacent points

λ_i -weights

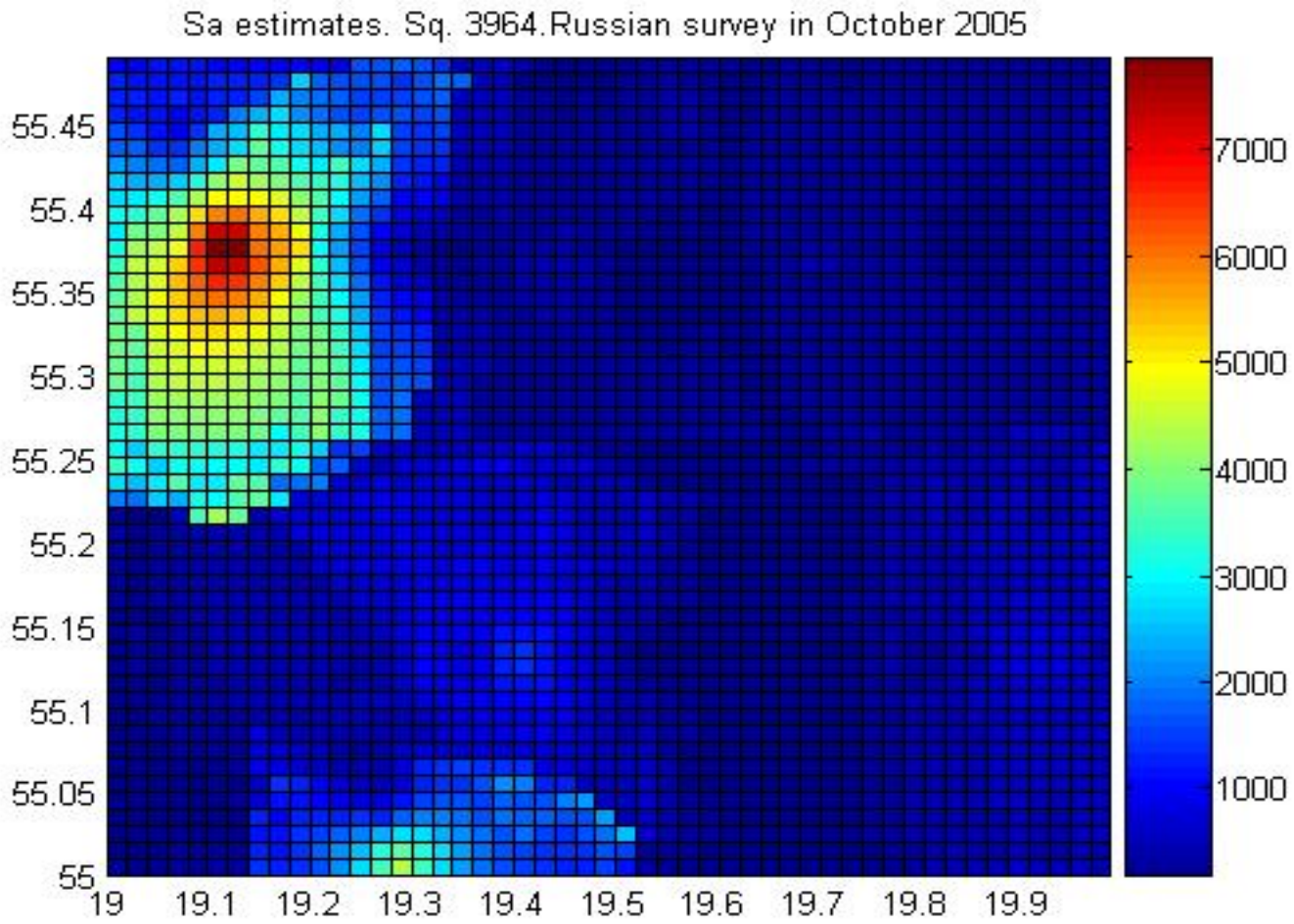
Omnidiractional variogramm



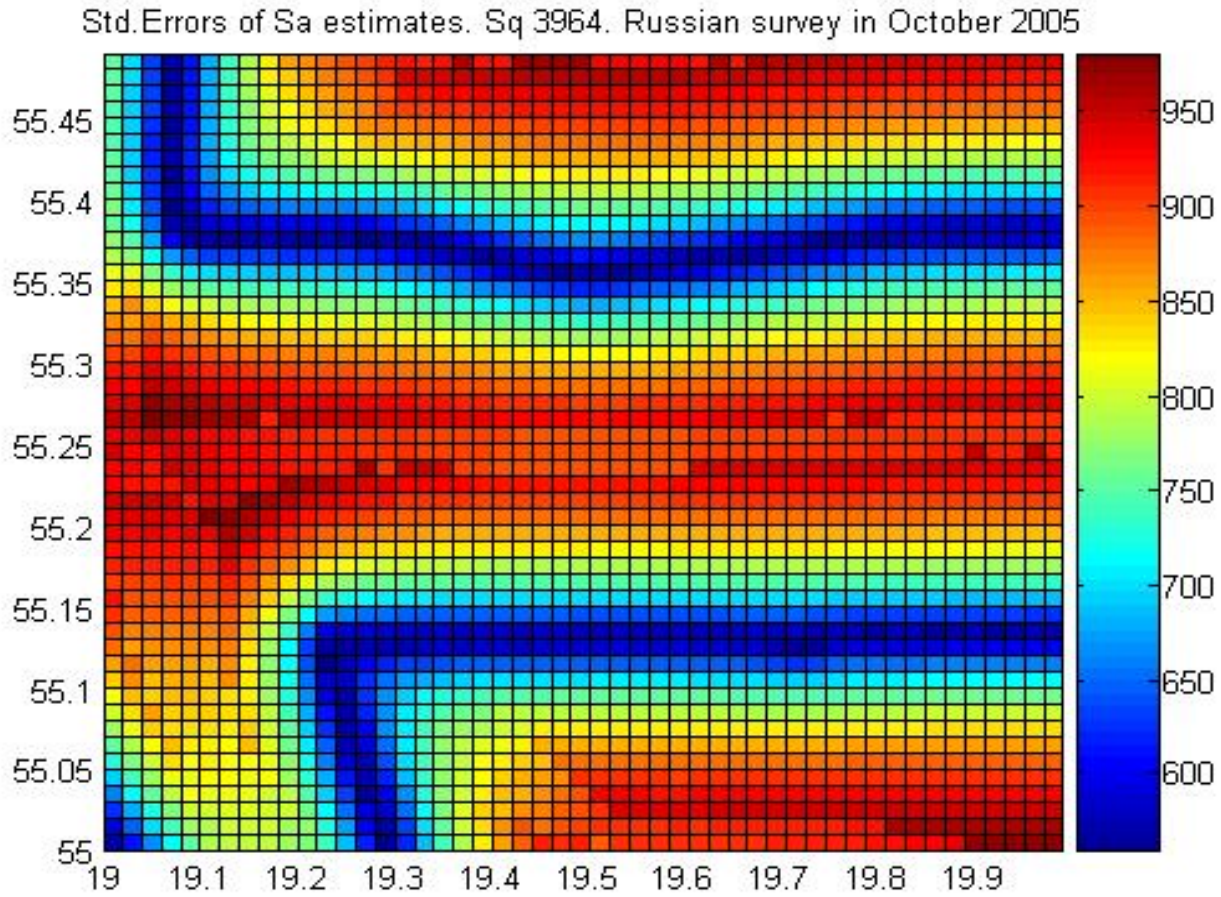
Directional variogramms



Calculated SA index in Rect. 39G9



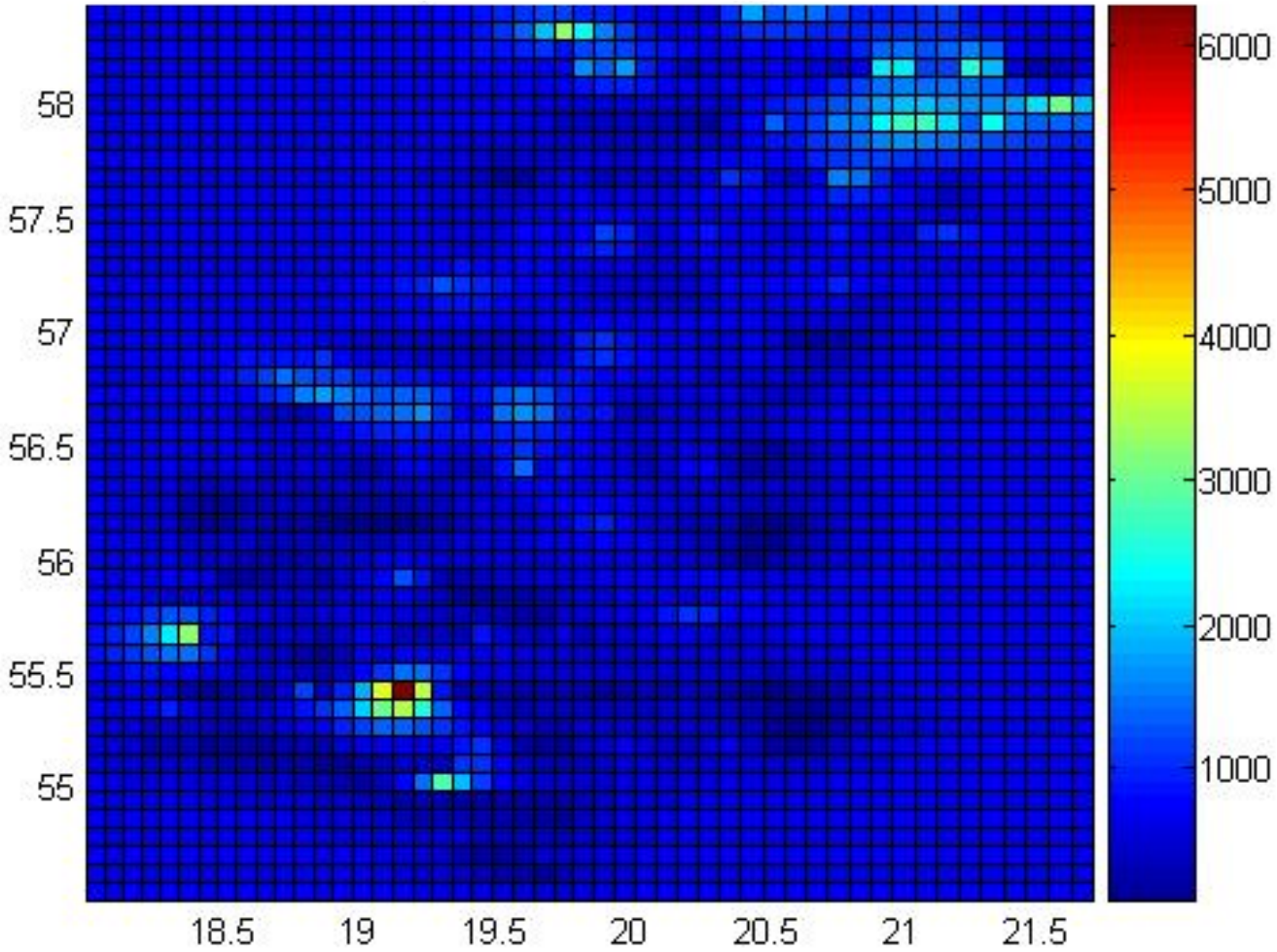
Std of SA index in Rect. 39G9



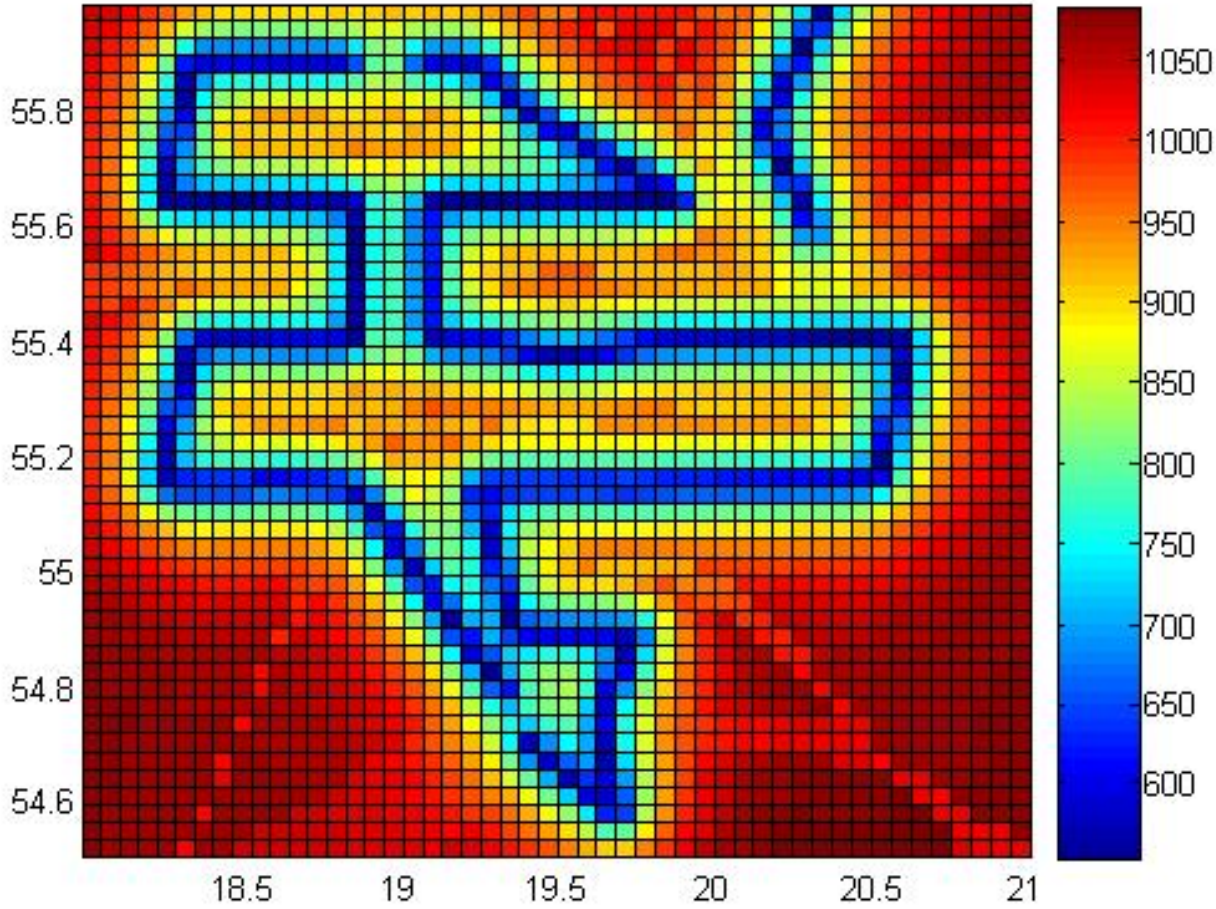
Statistics for Rect. 39G9

	Traditional method	Geostatistical method
Mean value	1041	855.7
Standard deviation	237.1	125.1
CV	0.223	0.146

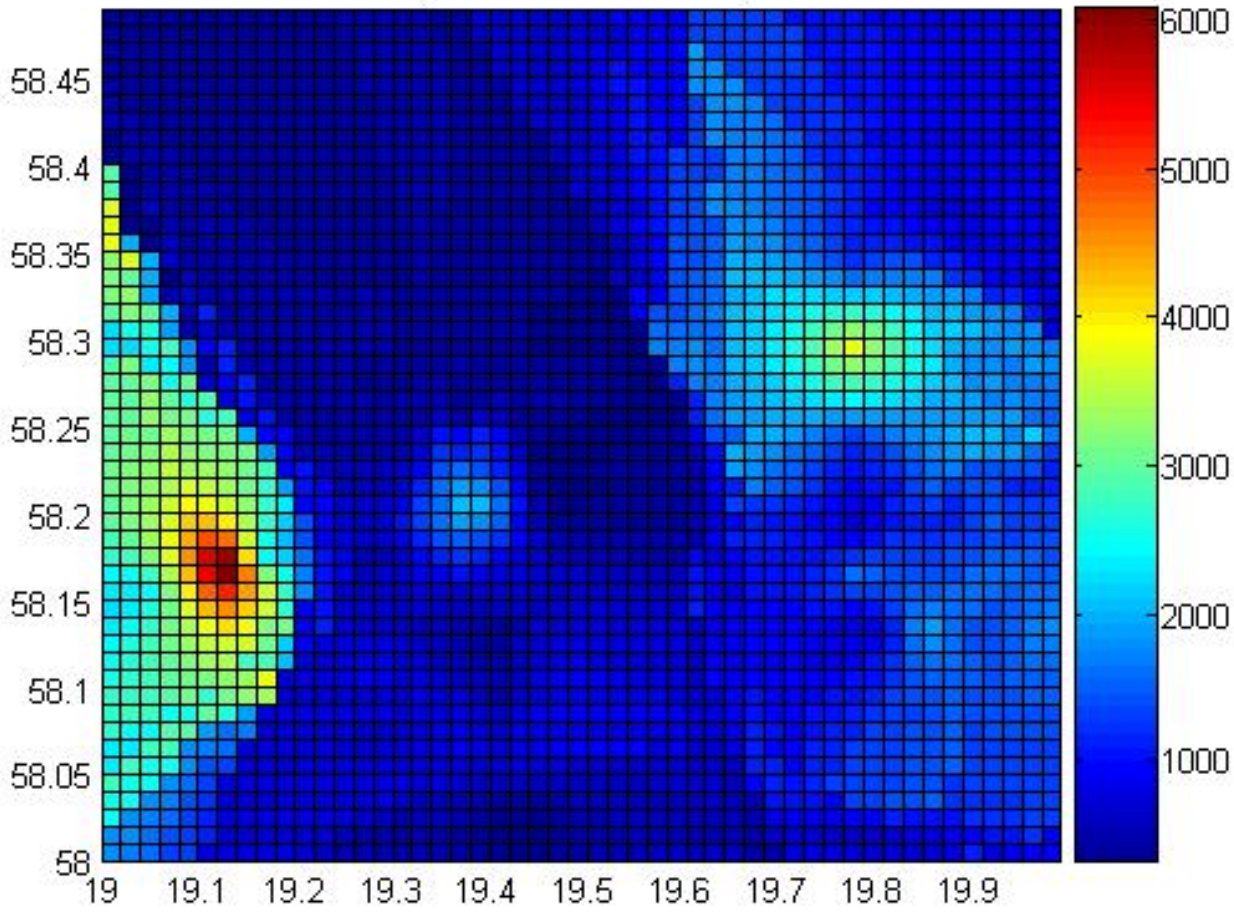
Calculated Sa index in 26,28 SD



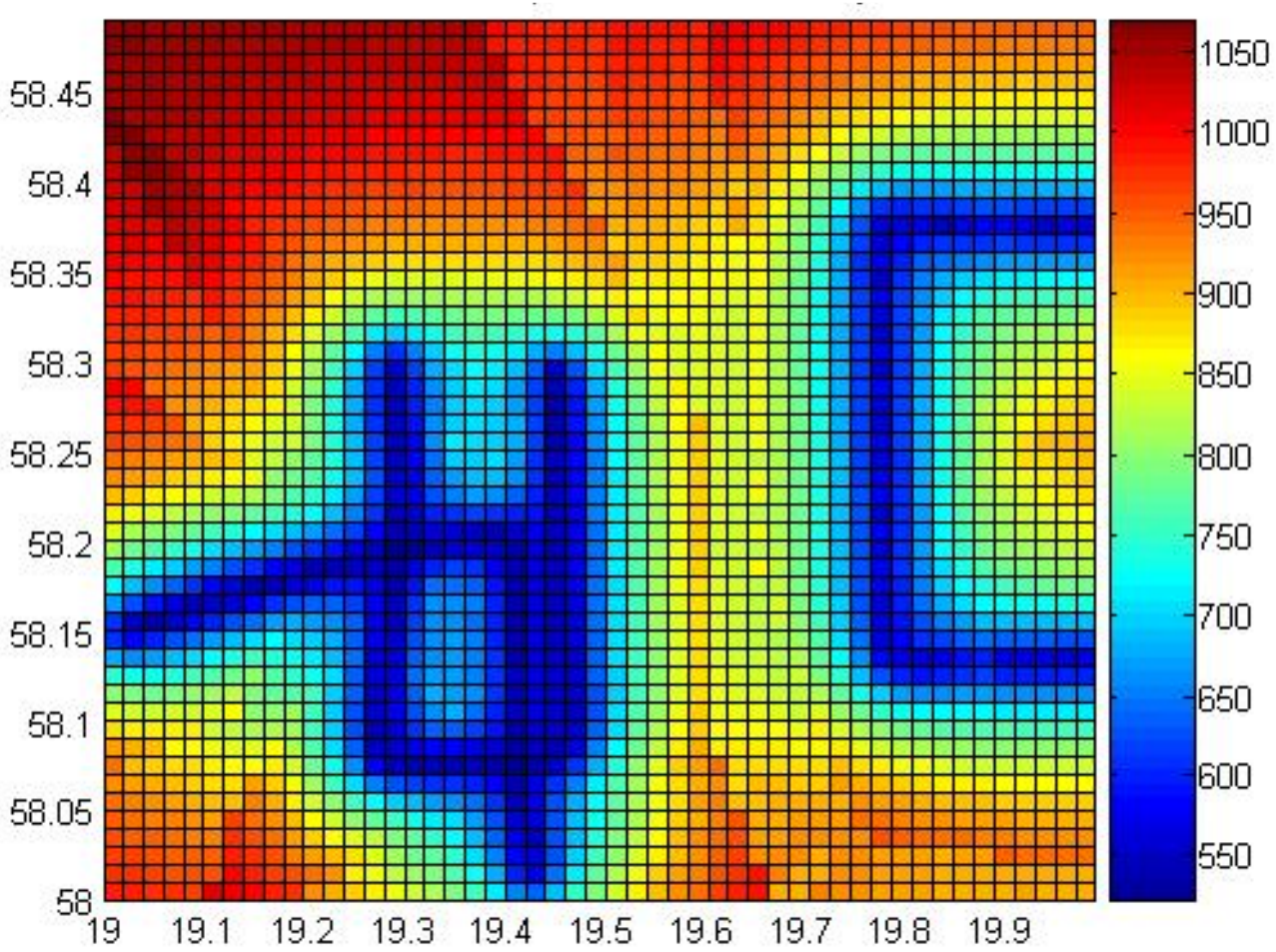
Std of Sa index in 26,28 SD



Calculated Sa index in Rect. 45G9



Std of Sa index in Rect. 45G9



Some properties of the traditional estimates

- They are based on the selected values in the rectangle;
- Do not reckon correlations in the closest points of the field;
- They very sensitive to the large values – anomalously high values in some points (skewed distribution)

Some properties of the geostatistical estimates

- The estimates are based on the knowledge of the field structure (allowing for correlation);
- Values near the boundary are calculated considering the values in neighboring rectangles (h is lesser the range);
- Large values used to locate high densities and do not influence on stability.

CONCLUSION

Geostatistics is the modern statistical method to process spatial data:

- **The methods are specially designed for objects with spatial distribution;**
- **Take into account spatial correlations;**
- **There is no problems with skewed distribution;**
- **Methods resulted in mean values and integral values estimates, give opportunity to map and estimate the uncertainty**