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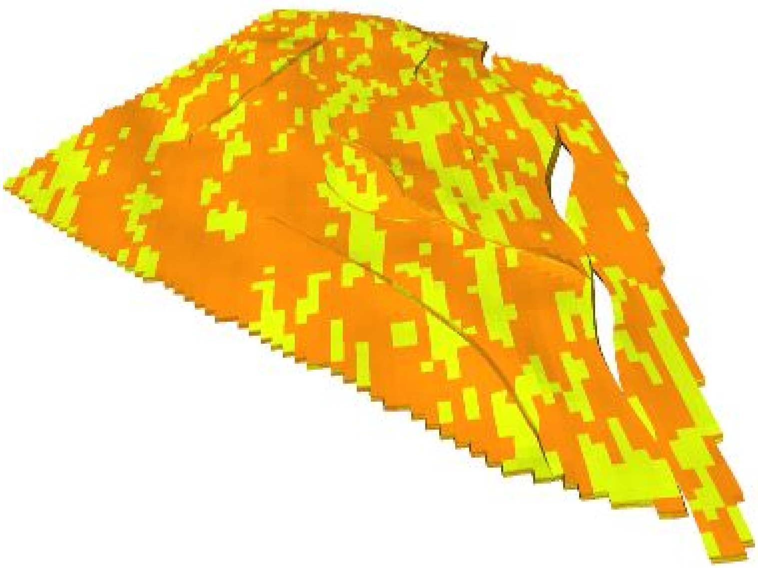
Note

Zonal Anisotropy

Different variogram in the lateral -and in the vertical direction



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Abstract

Variogram analysis often shows different behaviour vertically and laterally. This functionality has not yet been supported in RMS. We report on the new variogram type which has this functionality: The zonal anisotropy variogram in Iksim/Petrosim with focus on required input from the client program.

Keywords	Zonal anisotropy, variogram, Iksim, Petrosim
Target group	Roxar
Availability	Confidental
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1 Theory

The general form of covariance functions supported today is:

$$C(x1,y1,z1; x2,y2,z2) = \sigma(x1,y1,z1)\ \sigma(x2,y2,z2)\ \rho(d(x1-x2, y1-y2, z1-z2))$$

where σ is the standard deviation, ρ is the correlation function (variogram), and d is a distance function that captures variogram ranges and geometrical anisotropy. The covariance functions used in Petrosim and Iksim have been extended to include different variograms in the lateral and in the vertical directions. The new form is

$$C(x1,y1,z1; x2,y2,z2) = C(x1,y1; x2,y2)\ C(z1; z2)$$

$$= \sigma_{xy}(x1,y1)\ \sigma_{xy}(x2,y2)\ \rho_{xy}(d_{xy}(x1-x2, y1-y2))$$

$$\sigma_z(z1)\ \sigma_z(z2)\ \rho_z(d_z(z1-z2))$$

$$= \sigma(x1,y1,z1)\ \sigma(x2,y2,z2)\ \rho_{xy}(d_{xy}(x1-x2, y1-y2))\ \rho_z(d_z(z1-z2))$$

Here is $\sigma(x1,y1,z1) = \sigma_{xy}(x1,y1)\ \sigma_z(z1)$. So the total std.dev. is equal to the product of the lateral std.dev. and the vertical std.dev.

2 Interface

A new variogram class called ZonalAnisotropyVario has been implemented. This class is a child class of the Vario class:

```
class ZonalAnisotropyVario : public Vario
```

We create a new object by calling the constructor:

```
ZonalAnisotropyVario(const Vario* vxy, const Vario* vz, double
dip_angle = 0.0);
```

Requirements:

The lateral variogram should be stationary (constant std.dev.) and with dip angle and zero vertical range. The parameter dip_angle is currently a dummy and is not used.

The vertical variogram should be stationary (constant std.dev.) and with zero azimuth, dip and with zero lateral ranges.

The new ZonalAnisotropy class supports non-stationarity. Internally, every ZonalAnisotropy variogram is build up of 3 Vario objects:

1. Zonal Anisotropy: The total variogram.

2. The lateral variogram object (always stationary).

3. The vertical variogram object (always stationary).

The non-stationarity is connected only to the total variogram (and not the lateral –or vertical variogram object).

Use Vario::SetStd(FGrid * std) belonging to the zonal anisotropy variogram object to specify non-stationarity. Here is std the total std.dev.

Example:

```
double rx, ry, rz, std1, std2, dip, dummy;

SphVario vario_xy(rx, ry, 0.0, rot1, dip, std1); //2D
GauVario vario_z(0.0, 0.0, rz, 0.0 , 0.0, std2); //1D

ZonalAnisotropyVario vario_zonal(&vario_xy, &vario_z, dummy);

/*Now we have made a stationary ZonalAnisotropy variogram.

If we want an non-stationary ZonalAnisotropy variogram,we call the Vario::SetStd(FGrid * std) function:*/

FGrid* std;

vario_zonal.SetStd(std); // std is the lateral std.dev. multiplied with the vertical std.dev.
```

3 Testing of Iksim

Sequential indicator simulation has been implemented in the RMS framework in the Iksim program. Iksim is known as Indicators in RMS. Iksim communicates with RMS via interprocess socket communication (IPC).

Some initial testing with the new variogram class has been performed before and after the new RMS panels are finished. Before the new panels were ready, we used an internal procedure/hack to override the variograms streamed from RMS with zonal anisotropy variograms. We used the Emerald grid in these tests.

Figure 1 shows a realization created with a zonal anisotropy variogram with lateral spherical variogram and a vertical gaussian variogram.

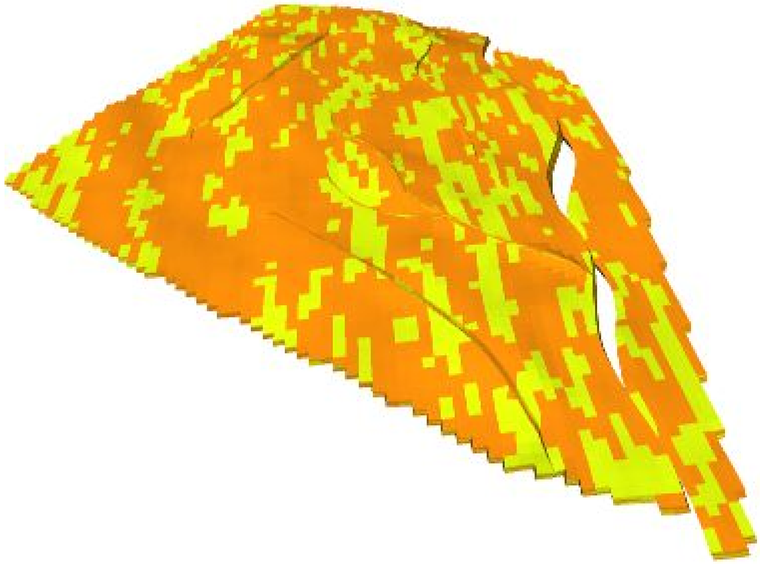

Figure 1. An Iksim realization with zonal anisotropy.

Tests done with the old variogram types give the same results as before.

4 Testing of Petrosim

Petrophysical modelling has been implemented in the RMS framework in the Petrosim program. Petrosim communicates with RMS via interprocess socket communication (IPC).

Some initial testing with the new variogram class has been performed before and after the new RMS panels are finished. Before the new panels were ready, we used an internal procedure/hack to override the variograms streamed from RMS with zonal anisotropy variograms. We used the Emerald grid in these tests.

Figure 2 shows a realization created with a zonal anisotropy variogram with lateral spherical variogram and a vertical gaussian variogram with a total std.dev. = 2.0. No transformations are added so we create a normal distributed field. The input model is specified without facies data.

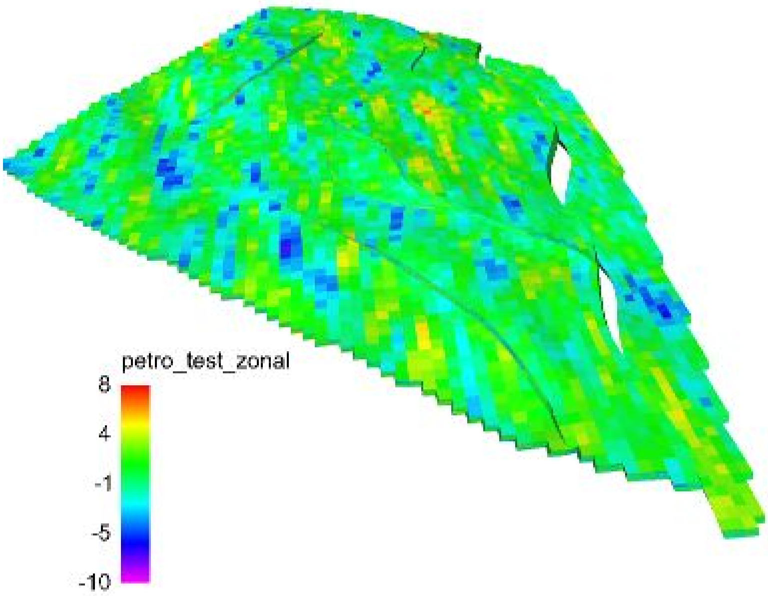

Figure 2. A Petrosim realization created with zonal anisotropy. Normal distributed field with expectation = 0 and std.dev = 2.

Tests done with the old variogram types give the same results as before.

5 Conclusion

Support for variograms with zonal anisotropy has been added to Iksim and Petrosim. Some preliminary tests of both programs have been done. The results look promising, but more testing is needed after the RMS panels have been implemented. Tests done with the old variogram types give the same results as before for both Iksim and Petrosim.