



Web-based Geostatistics using WPS

Jorge de Jesus

Institute for Environment and Sustainability
Joint Research Centre of the European Commission
jorge.de-jesus@jrc.it

Gregoire Dubois

Institute for Environment and Sustainability
Joint Research Centre of the European Commission
gregoire.dubois@jrc.it

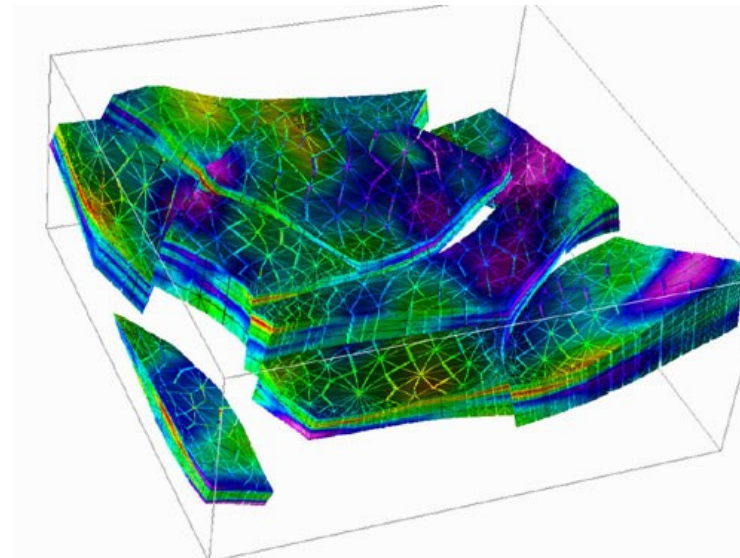
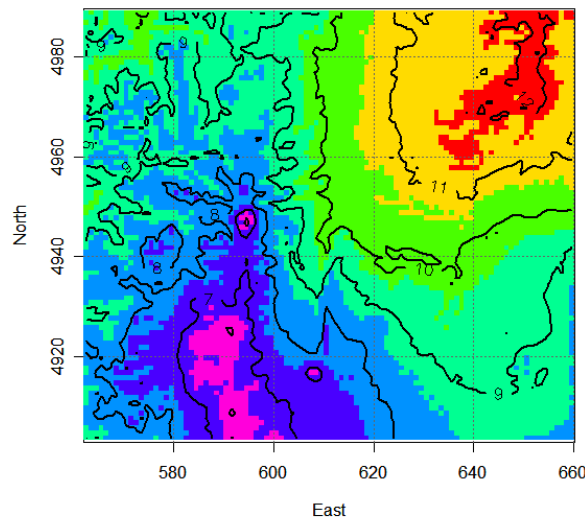
Paul Hiemstra

Department of Physical Geography
University of Utrecht
p.hiemstra@geo.uu.nl



Web-based Geostatistics using WPS

- Geostatistics is frequently used to map environmental variables for risk management

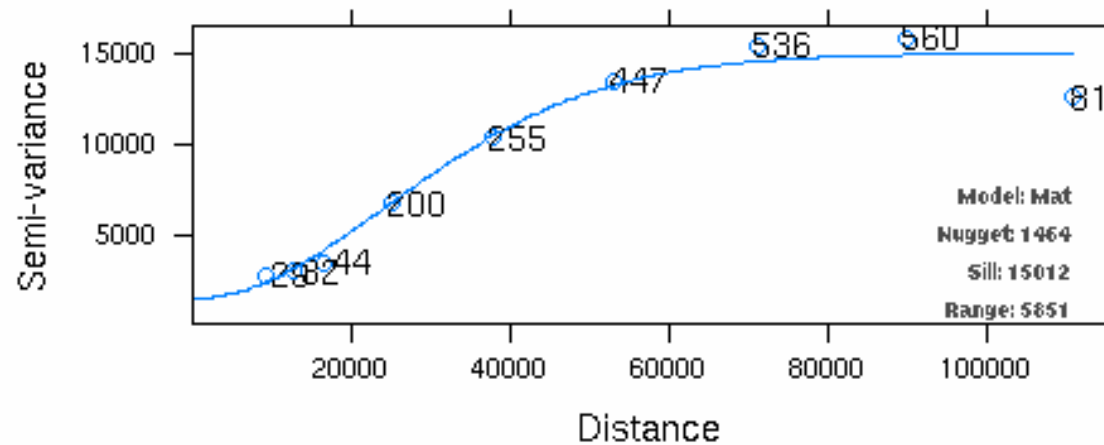




Web-based Geostatistics using WPS

- The Kriging interpolator requires a model of the spatial correlation (Semivariogram, SV)

Experimental variogram and fitted variogram model





Web-based Geostatistics using WPS

- The fitting of the SV is usually done manually

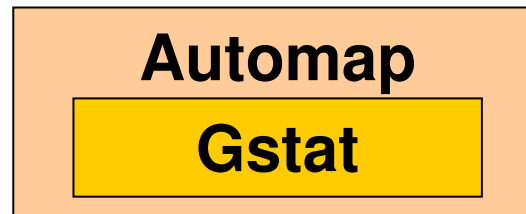


Generating maps in real-time using geostatistics requires many choices of parameters (i.e. choice of SV model) to be computed automatically



Web-based Geostatistics using WPS

- *automap* was developed to define automatically the semi-variogram
- *automap* is written in R and depends on *gstat* (geostatistical package also written in the R)





Web-based Geostatistics using WPS

Case studies

- *automap* applied to 2 data sets from two Spatial Interpolation Comparison (SIC) exercises organized in 1997 (SIC97) and 2004 (SIC2004).

See <http://www.ai-geostats.org/>

- Participants in SIC had to estimate values of a variable at given locations using subset of the total number of measurements of the variable



Web-based Geostatistics using WPS

Case studies

- SIC97 → Daily Rainfall measurements in Switzerland



- SIC2004 → Radiation values in normal conditions and in emergency situation (simulated local extreme values)



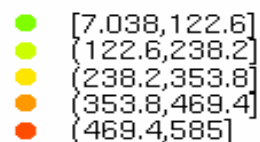
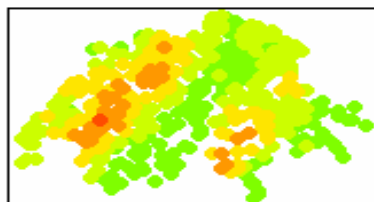
3 case studies



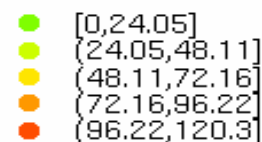
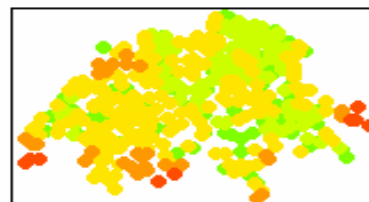
Web-based Geostatistics using WPS

SIC 97:

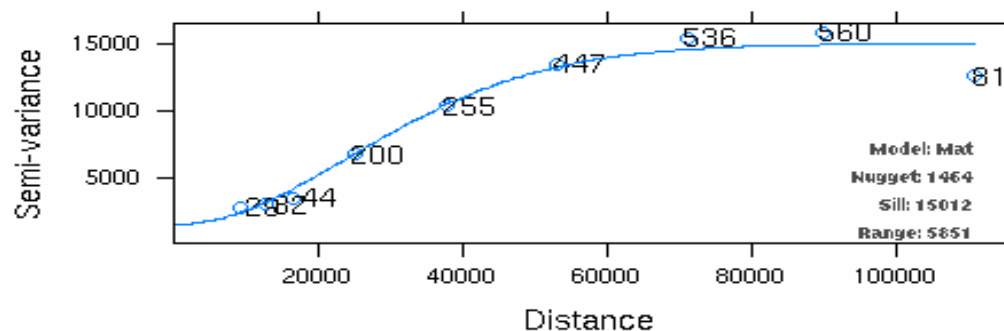
Kriging prediction



Kriging standard error



Experimental variogram and fitted variogram model

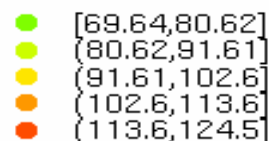
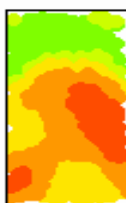




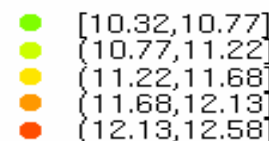
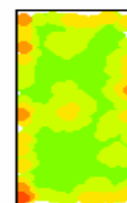
Web-based Geostatistics using WPS

SIC2004 (“normal scenario”):

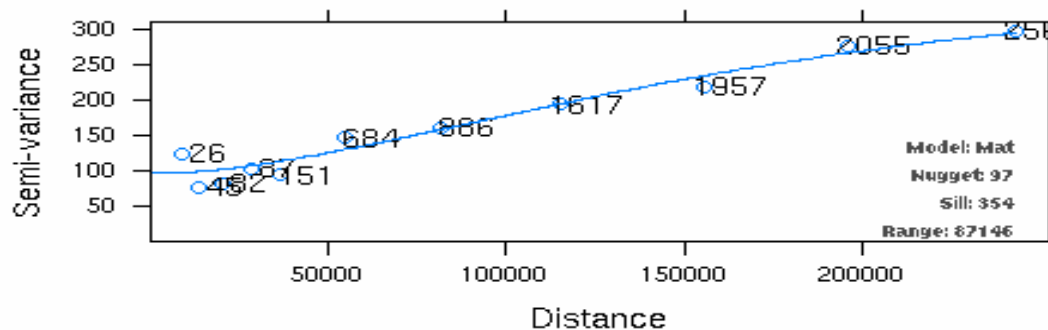
Kriging prediction



Kriging standard error



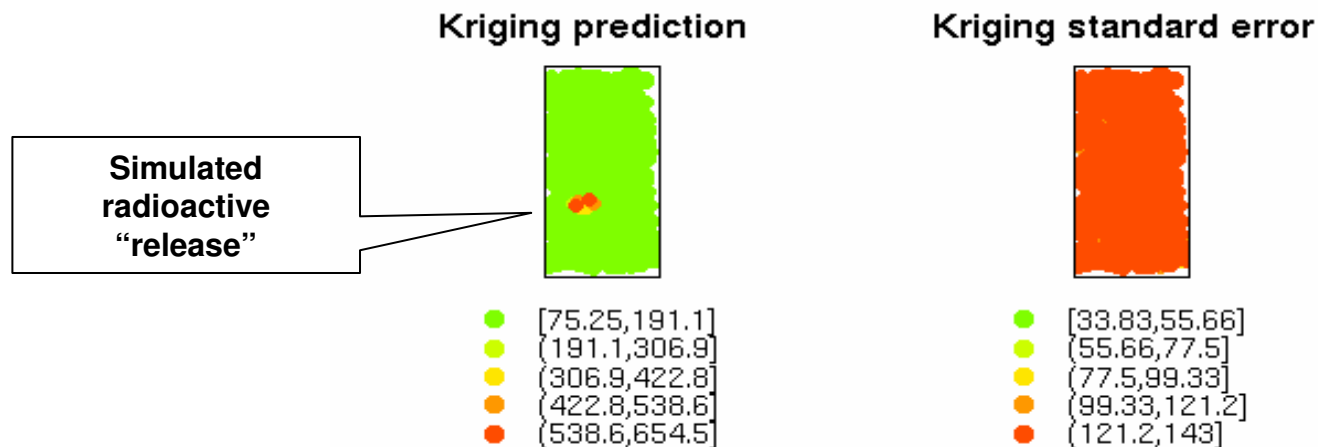
Experimental variogram and fitted variogram model



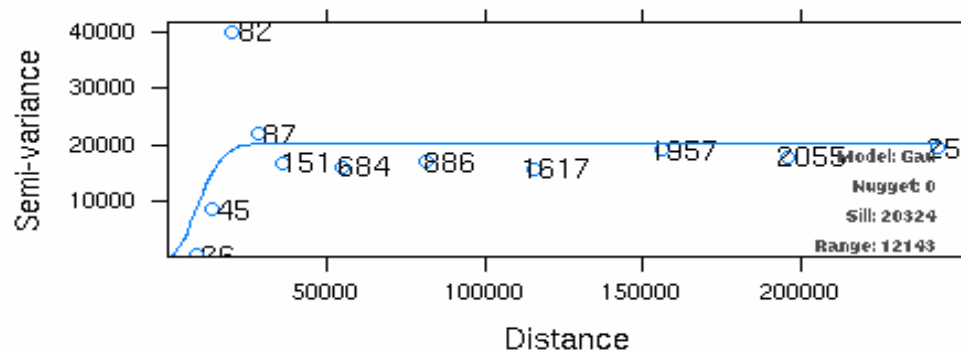


Web-based Geostatistics using WPS

SIC2004 (“emergency scenario”):



Experimental variogram and fitted variogram model





Web-based Geostatistics using WPS

Results:

	MAE	RMSE	<i>r</i>
SIC97 Rainfall	31.8	51.4	NA
SIC2004 Normal Scenario	9.2	12.5	0.78
SIC2004 Emergency Scenario	23.2	76.9	0.40



Web-based Geostatistics using WPS

Best user results:

	MAE	RMSE	<i>r</i>
SIC97 Rainfall	32.0	53.1	NA
SIC2004 Normal Scenario	9.1	12.4	0.74
SIC2004 Emergency Scenario	14.9	45.46	0.86

SIC2004: Best user results where obtained using:
Support Vector Regression algorithm



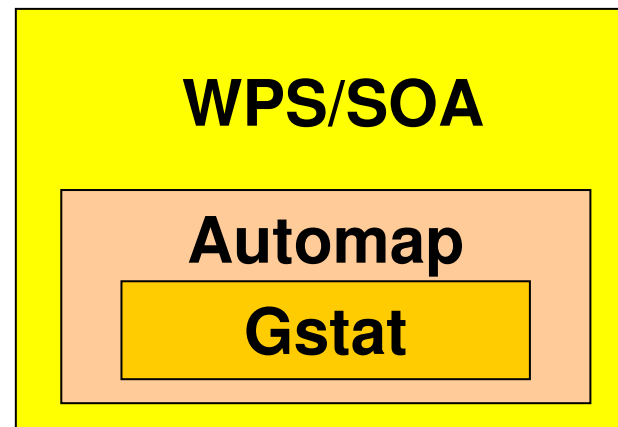
Web-based Geostatistics using WPS

- Automap produced best results for SIC97 and normal scenario of SIC2004 (*thanks to Matern variogram!*)
- Automap produced poor results for the extreme scenario of SIC 2004
- Cases with anomalies are obviously much more complex
- INTAMAP(.ORG) project deals with complex anomalies situations



Web-based Geostatistics using WPS Technical Issues

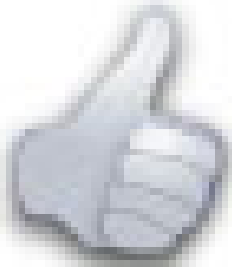
- An automatic interpolation system would need to be easy to integrate into a monitoring system.
- Web Processing Service (WPS) following Service Oriented Architecture (SOA)





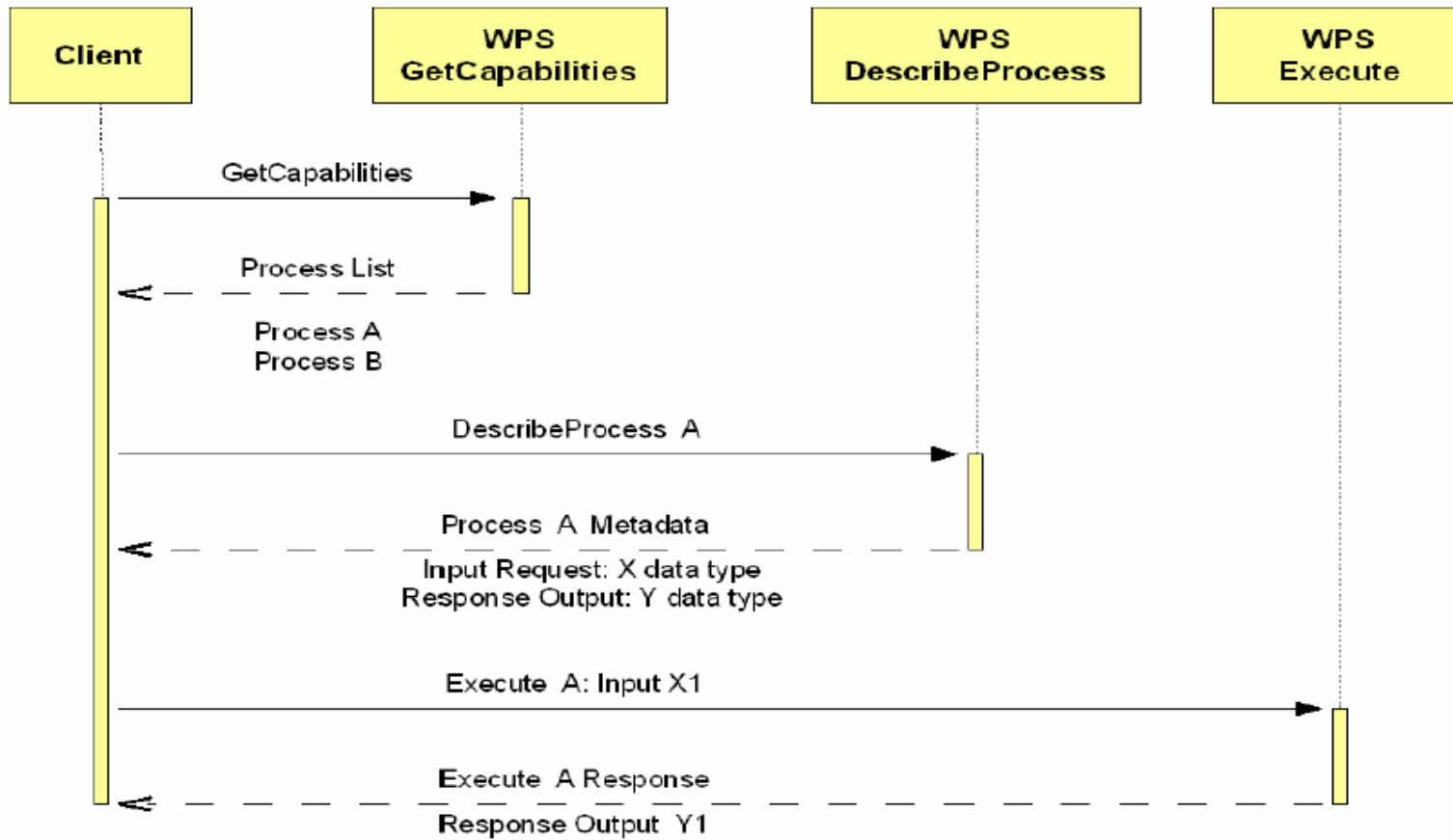
Web-based Geostatistics using WPS

- WPS is an OGC standard from the WMS/WCS/WFS family
- Process oriented, basic description and execution commands, very flexible





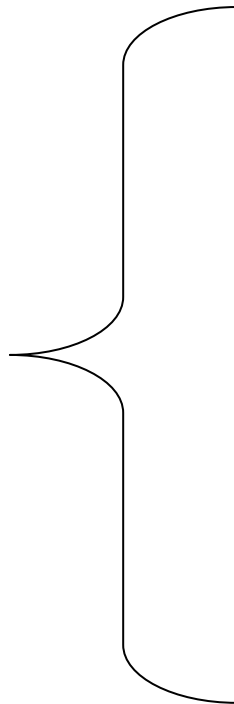
Web-based Geostatistics using WPS





Web-based Geostatistics using WPS

Operations



GetCapabilities

DescribeProcess

Execute



Web-based Geostatistics using WPS

Inputs

Key-Value-Pair (HTTP-GET)

XML (HTTP-POST)

Outputs

XML with simple values

**XML with Geotiff or other
XML doc**



Web-based Geostatistics using WPS

RAISIN:

- **REM's Automatic Interpolation Service for INTAMAP**
- **Provides AutoKrigingProcess and other auxiliary processes**

<http://remwps.jrc.it/wps.py>



Web-based Geostatistics using WPS

Raisin Components:

APACHE
HTTP SERVER



PyWPS



Web-based Geostatistics using WPS

Raisin Input:

- **GML (Geographic Markup Language) contained inside the XML request**

- **GML 2.1.2 , easily created using GDAL tools (ogr2ogr)**



Web-based Geostatistics using WPS

```
<ows:Identifier>autokrigeprocess</ows:Identifier> <DataInputs>
<Input>
<ows:Identifier>XYZPoints</ows:Identifier>
<ows:Title>XYZ SIC97 data points as GML</ows:Title>
<ComplexValue schema="http://ogr.maptools.org/sic97.xsd">
<ogr:FeatureCollection
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://ogr.maptools.org/sic97.xsd"
xmlns:ogr="http://ogr.maptools.org/"
xmlns:gml="http://www.opengis.net/gml">
<gml:featureMember>
<ogr:sic97 fid="F0">
<ogr:x>181072</ogr:x>
<ogr:y>33361</ogr:y>
<ogr:z>3.009</ogr:z>
</ogr:sic97>
</gml:featureMember>
</ComplexValue>
</Input>
</DataInputs>
</Execute>
```



Web-based Geostatistics using WPS

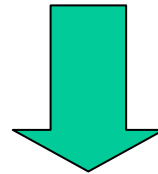
```
<ExecuteResponse version="0.4.0"
xmlns="http://www.opengespatial.net/wps"
xmlns:ows="http://www.opengespatial.net/ows"
xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.opengespatial.net/wps
http://www.ogcnetwork.net/schemas/wps/0.4.0/wpsExecute.xsd">
<ows:Identifier>autokrigeprocess</ows:Identifier>
<Status><ProcessSucceeded/></Status><ProcessOutputs> <Output>
<ows:Identifier>GeoTiff</ows:Identifier>
<ows:Title>Interpolated Output Map</ows:Title>
<ows:Abstract>Resulting interpolated Map. </ows:Abstract>
<ComplexValueReference encoding="utf-8" format="image/tif"
ows:reference="http://remwps.jrc.it/wpstmp/interpolation176304.tif"
schema=""/>
</Output>
</ProcessOutputs>
</ExecuteResponse>
```



Web-based Geostatistics using WPS

Discussion:

Real-time mapping of environmental data using AUTOMAP is currently limited to cases in which residuals of the input data can be described by a stationary random field



No trend or extreme values in data



Web-based Geostatistics using WPS

Discussion:

- Bottleneck on the XML parsing and file sizes
- Migration from WPS 0.4.0 to 1.0.0
- Implementation of parallel geostatistical calculations to decrease the time for response



Web-based Geostatistics using WPS

Discussion:

- **Automatic Mapping using SOA approach is feasible and could be integrated in other structures**
- **All tools/algorithms are open source**

More info on www.intamap.org !



Web-based Geostatistics using WPS

This work is funded by the European Commission under the Sixth Framework Programme, by the Contract N. 033811 with the DG INFSO, action Line IST-2005-2.5.12 ICT for Environmental Risk Management.

The views expressed herein are those of the authors and are not necessarily those of the European Commission.