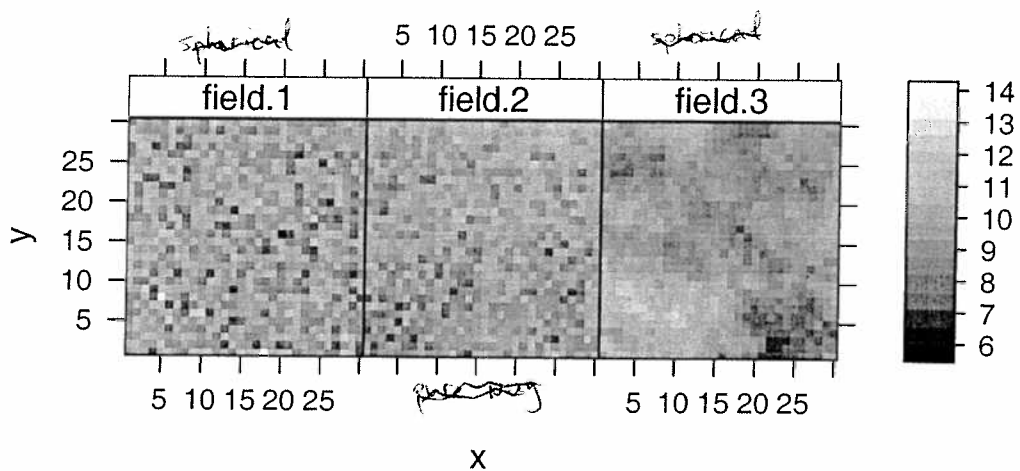Master Physical Geography, Spatial Analysis and GIS 2 (geo4-4412)
Final test
Mon Jan 31, 2004, 9:00-12:00

Please answer all questions.
Question 1.

a The three fields shown above (field.1, field.2 and field.3) were simulated
with three different variograms: (A) a spherical model with sill 1.0, a
range of 10, and zero nugget, (B) a pure nugget model with sill 1.0,
and (C) a spherical model with a range of 30, a (partial) sill of 0.5, and
a nugget of 0.5 (total sill is 1.0). Which of the three variograms (A,
B or C) were used to generate field.1, field.2 and field.3? *Explain your
answer briefly.*

b What are the main differences between a (conditional) simulated map
and a kriged map.

c Mention two potential situation for which you need to use (condition-
ally) simulated random fields, instead of kriged maps.

Question 2. Given is the following data set (x and y refer to spatial coordinates):

x	y	measurement
0	0	1
0	1	2
0	2	3
0	3	4

a. Calculate the semivariance for lag (h, or distance values) 1 and 2. Given is

$$\gamma(h) = \frac{1}{2N_h} \sum_{i=1}^{N_h}(Z(s_i) - Z(s_i + h))^2$$

b. Why do we, when calculating (sample) variograms, usually not consider spatial distances (lags, cutoff) larger than half or one third of the maximum distance spanned by the available data?

c. Why do we need to fit a function through the sample semivariogram before we can proceed with kriging or simulation?

d. Calculate the simple kriging predictor and prediction variance for location (0,4), given
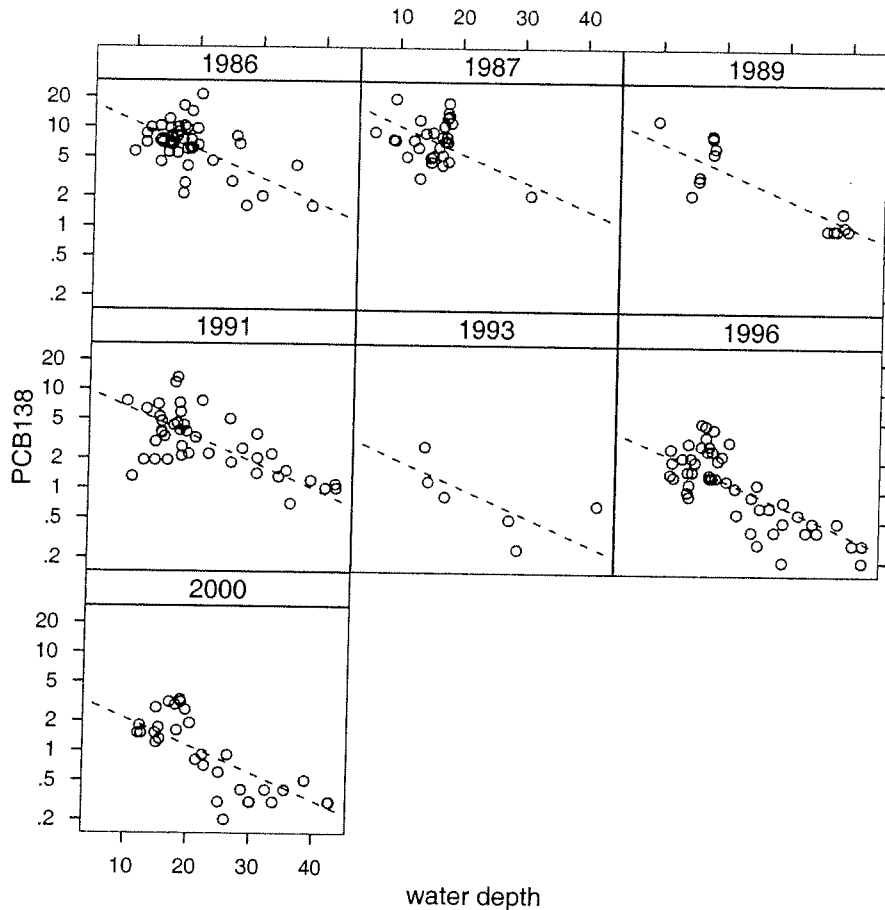
$$\hat{Z}(s_0) = \mu + v'V^{-1}(Z - \mu)$$

$$\sigma^2(s_0) = \sigma_0^2 - v'V^{-1}v$$

$$V^{-1} = \begin{bmatrix} 1.6 & -1.2 & 0.8 & -0.4 \\ -1.2 & 2.4 & -1.6 & 0.8 \\ 0.8 & -1.6 & 2.4 & -1.2 \\ -0.4 & 0.8 & -1.2 & 1.6 \end{bmatrix}, \quad \mu = 2, v = \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0.5 \end{bmatrix}, \quad \sigma_0^2 = 1$$

Question 3.

a. Given a data set and variogram, why does block kriging result in smaller prediction error variance than point kriging?

b. Why (and how) does the degree of this effect depend on the variogram model used?

Question 4.

Sea floor sediment PCB concentrations were measured over the last two decades on varying locations at the Dutch part of the North Sea. The figure above shows the (log) PCB-138 concentrations as a function of sea floor depth. Sea floor depth is known for each location of interest.

a. We want to map PCB concentrations over the North sea, for the year 2000, and we want estimates of the interpolation error variance. Explain how we can proceed given this data set. Which model do you choose, which method do you use, and what are the assumptions made.

b. We want to assess (estimate) spatial time trends: for each location we want to estimate the gradual change over time in PCB, and assess prediction error variances. Explain how we can proceed given this data set. Which model do you choose, which method(s) do you use, and what are the assumptions made.