

Outlook: more spatial statistics

Spatial Statistics

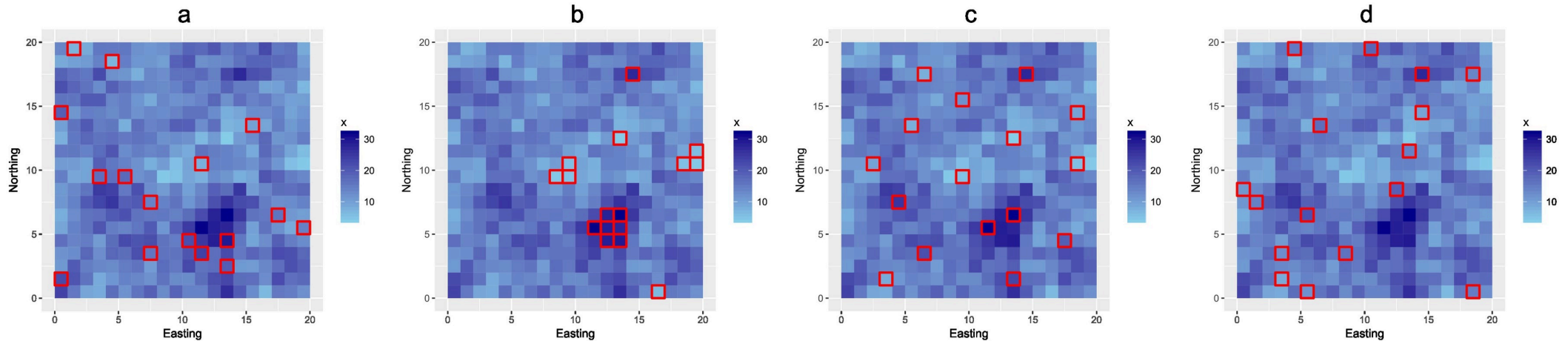
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1 Spatial sampling designs

Large number of different sampling designs for various end goals with their estimators.

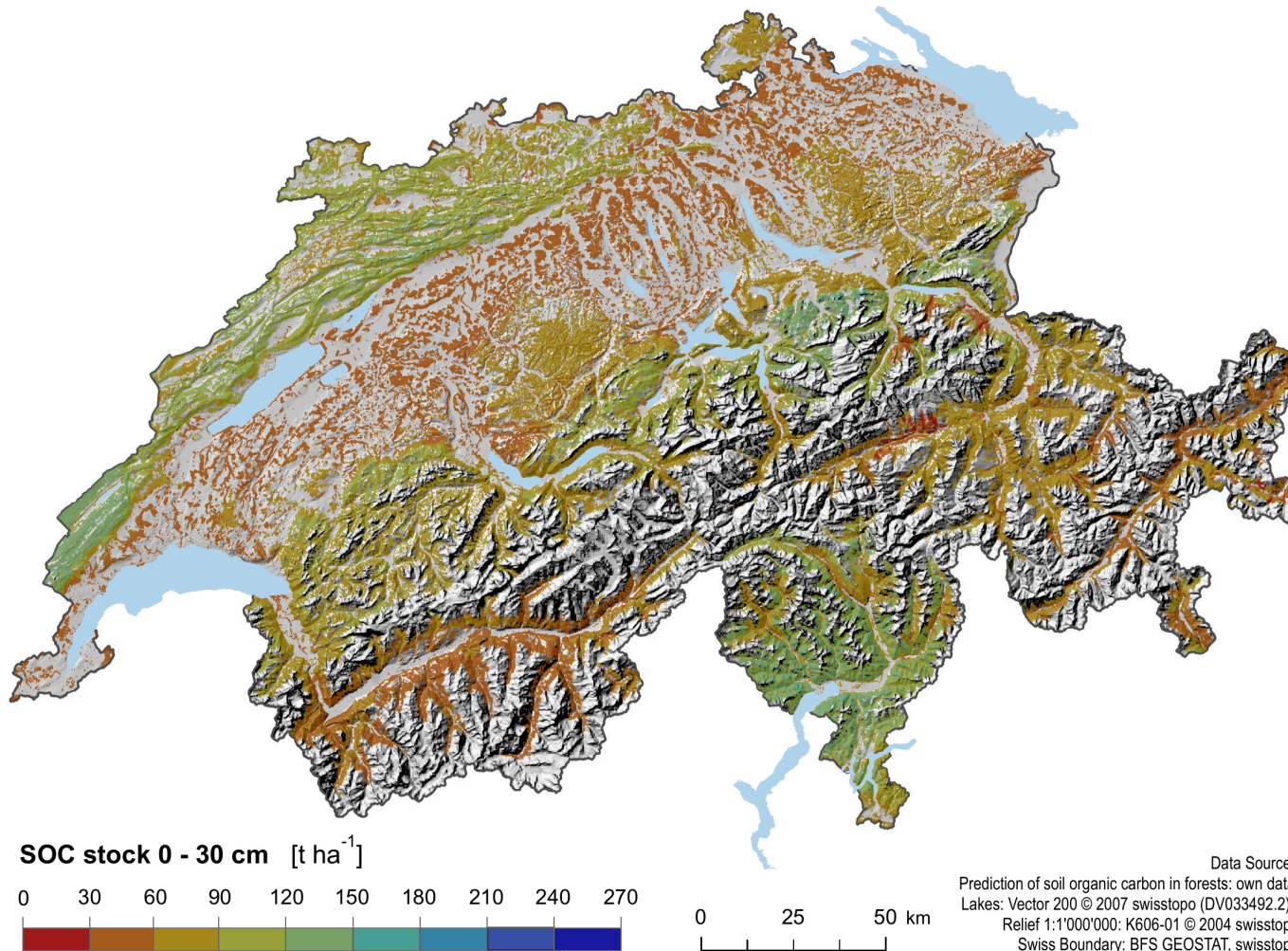


From left to right: simple random sample (a), optimized sample for mapping with linear regression model (b), optimized sample for kriging with an external drift (c), and stratified sample using sixteen equal-sized covariate strata (d). All samples are plotted in a map of the covariate (Brus, 2018).

2 Block kriging

Mean and standard error estimates for finite support targets, e.g. parcels, municipalities.

Example: Soil organic carbon stocks, mapped with robust external-drift kriging for Swiss forests.

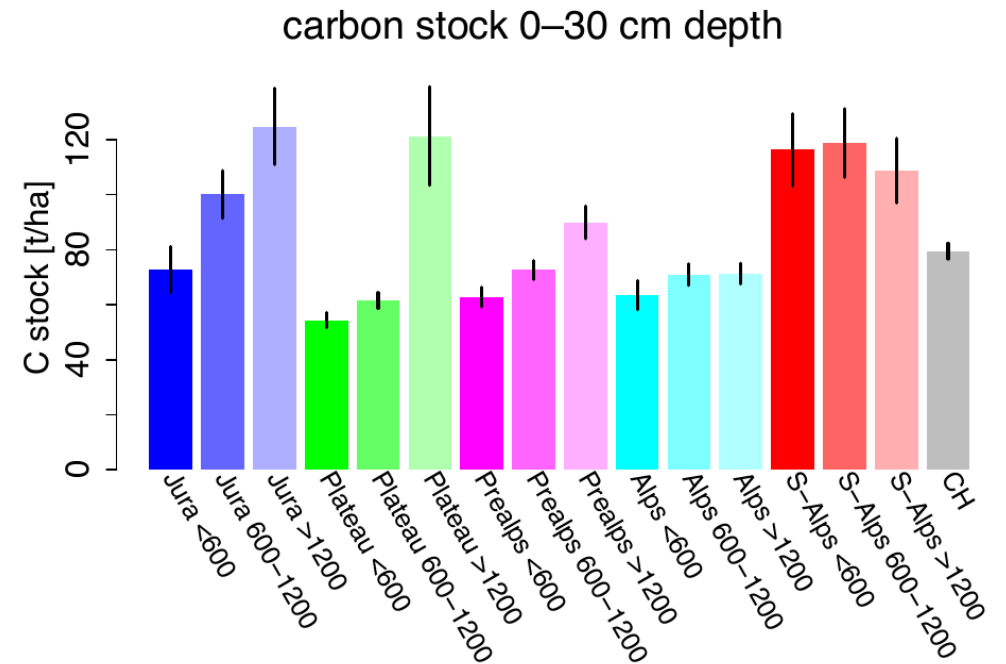
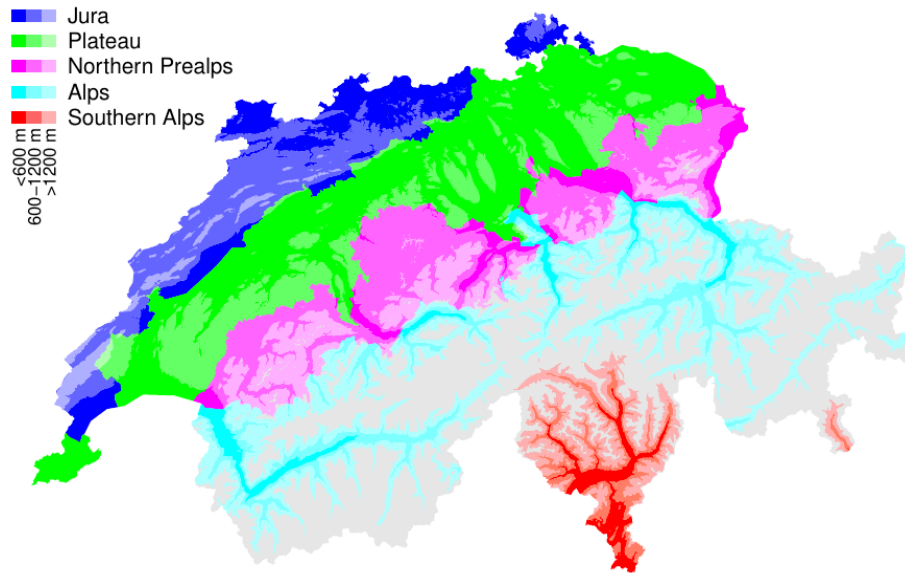


Block kriging SOC stocks

Basis: Punctual kriging and fitted (residual) variogram.

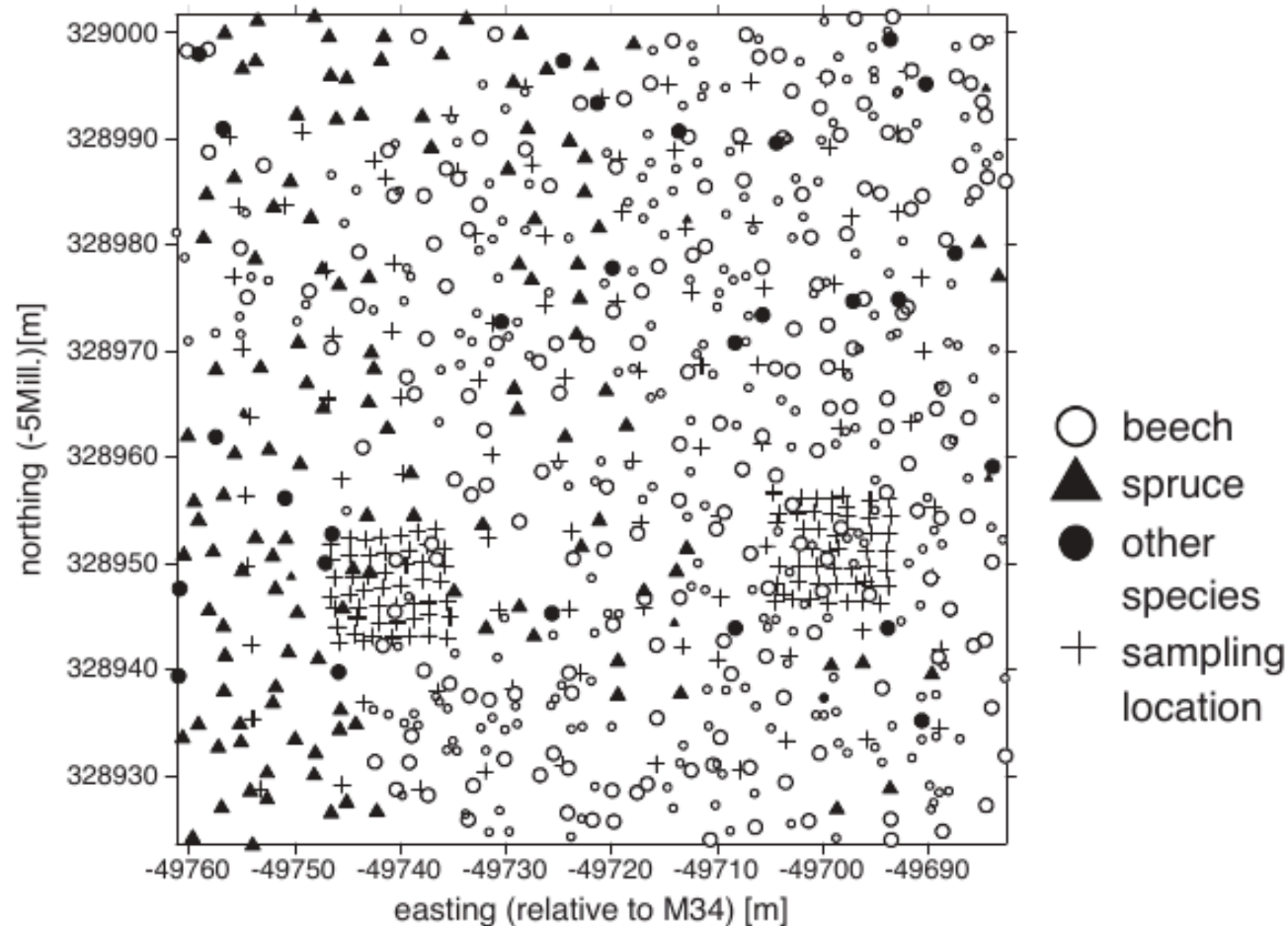
Mean per unit: approximated by mean of punctual kriging predictions.

Standard errors: “correct” for spatial covariance structure modeled by variogram. I.e. the larger the spatial auto-correlation, the smaller the standard errors for a finite target.

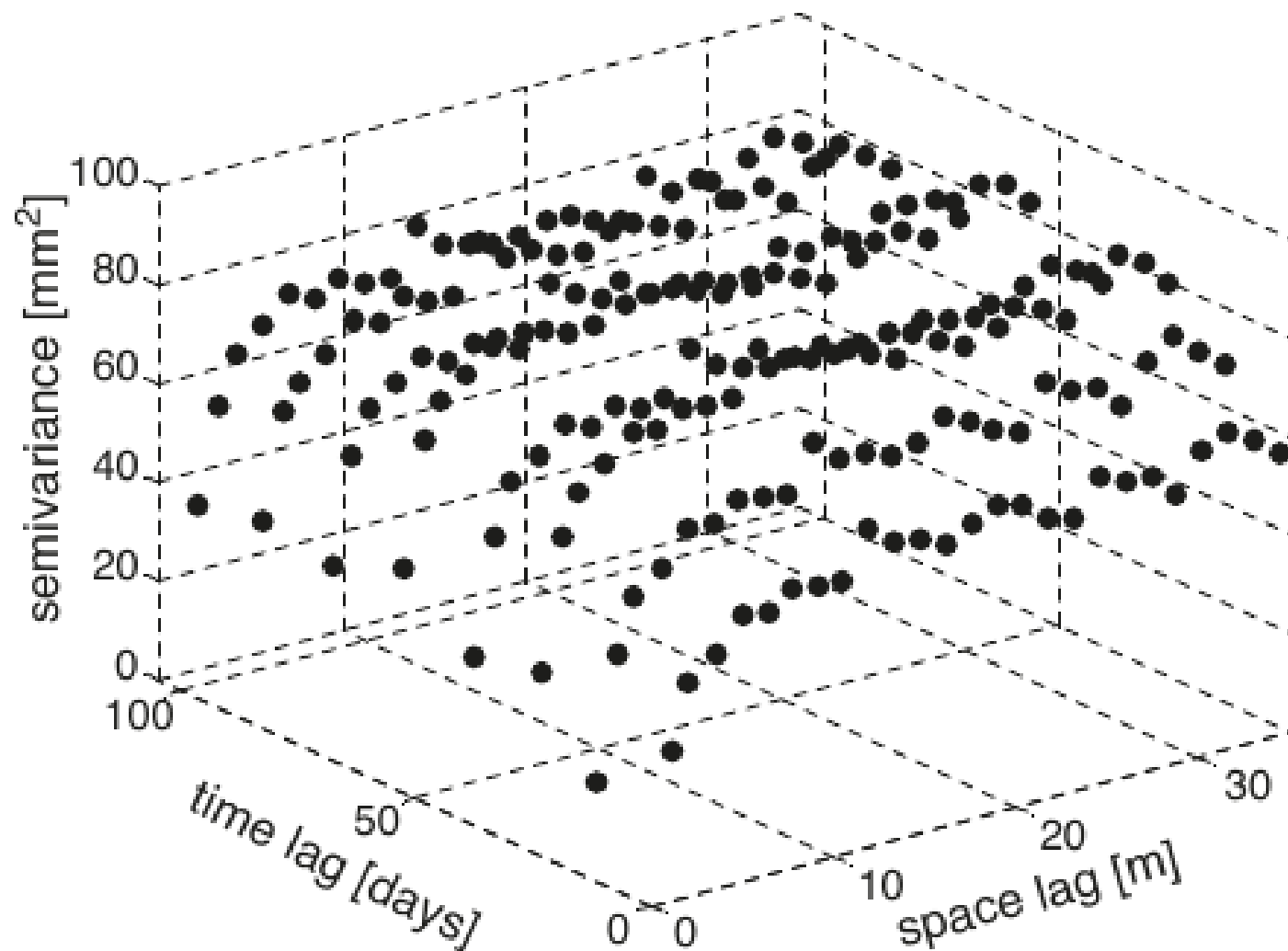


3 Space-time data

Temporal change of soil water storage in a forest. Measurement of soil water storage biweekly during growing season for 2 years (Jost et al., 2005)

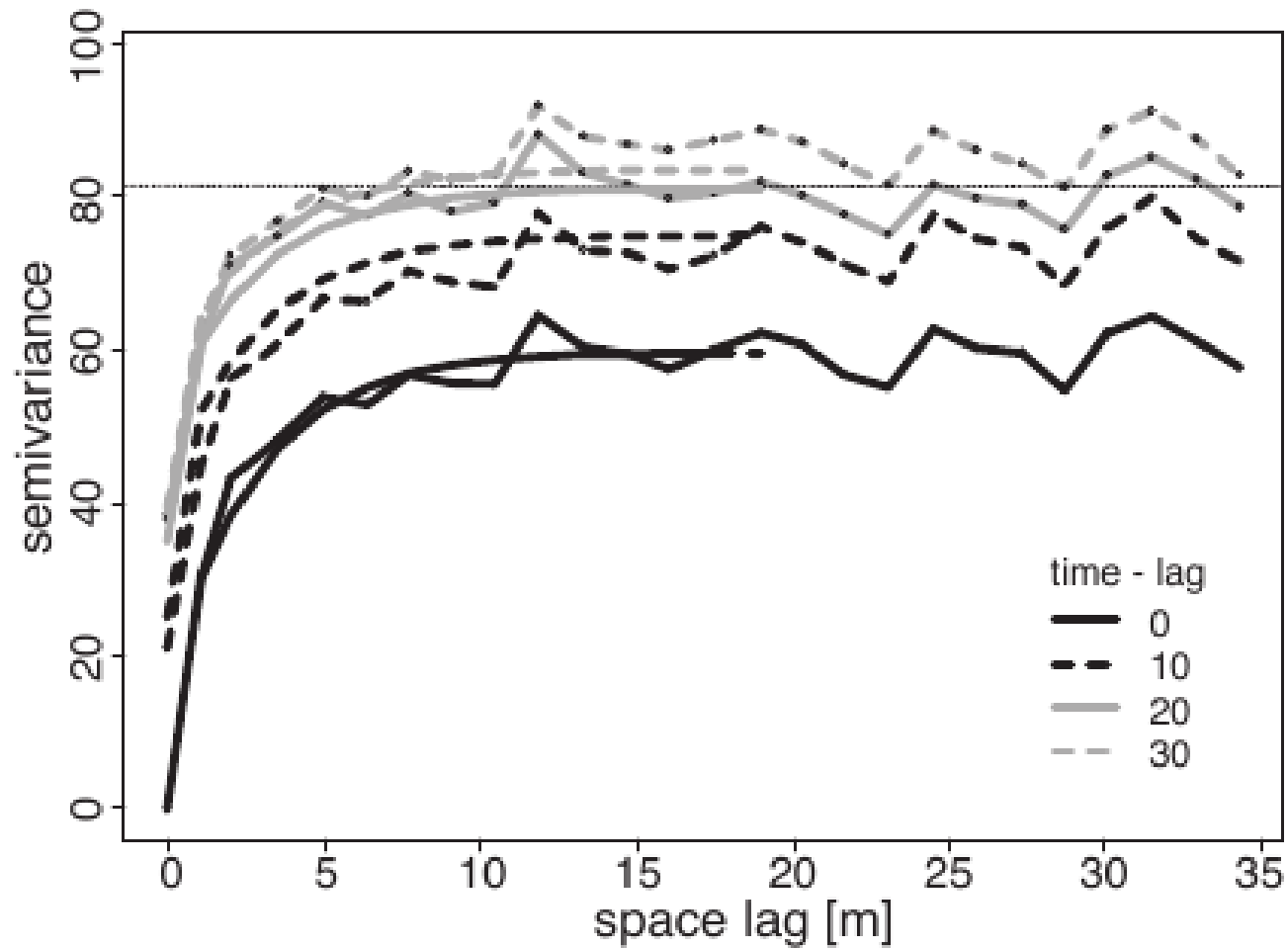


Space-time sample variogram



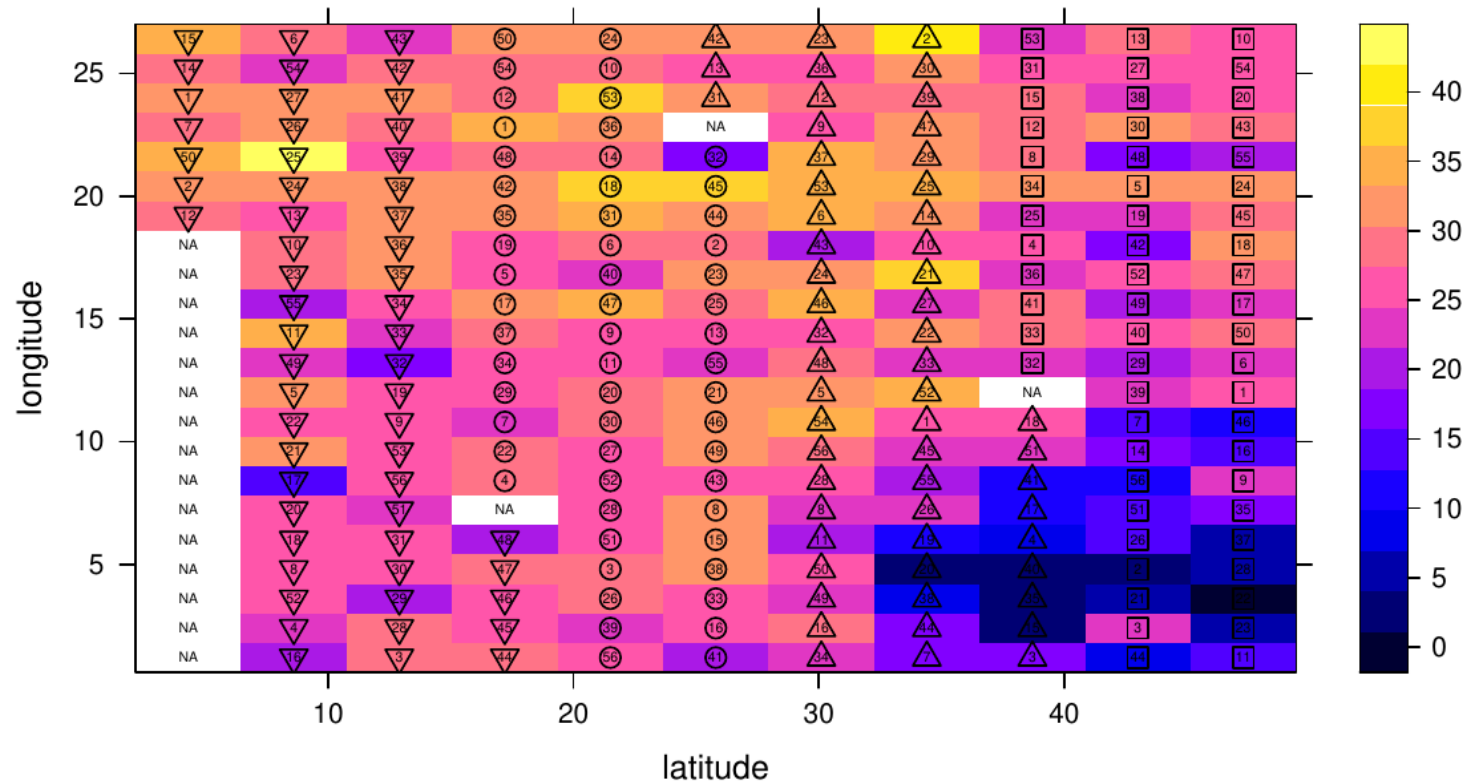
Space-time sample variogram

Product-sum covariance model fitted to space-time sample variogram.



4 Geostatistical analysis of experimental data

Example: Field experiment to compare the yield of 56 varieties of wheat in a randomized block experiment.



color scale: clay content

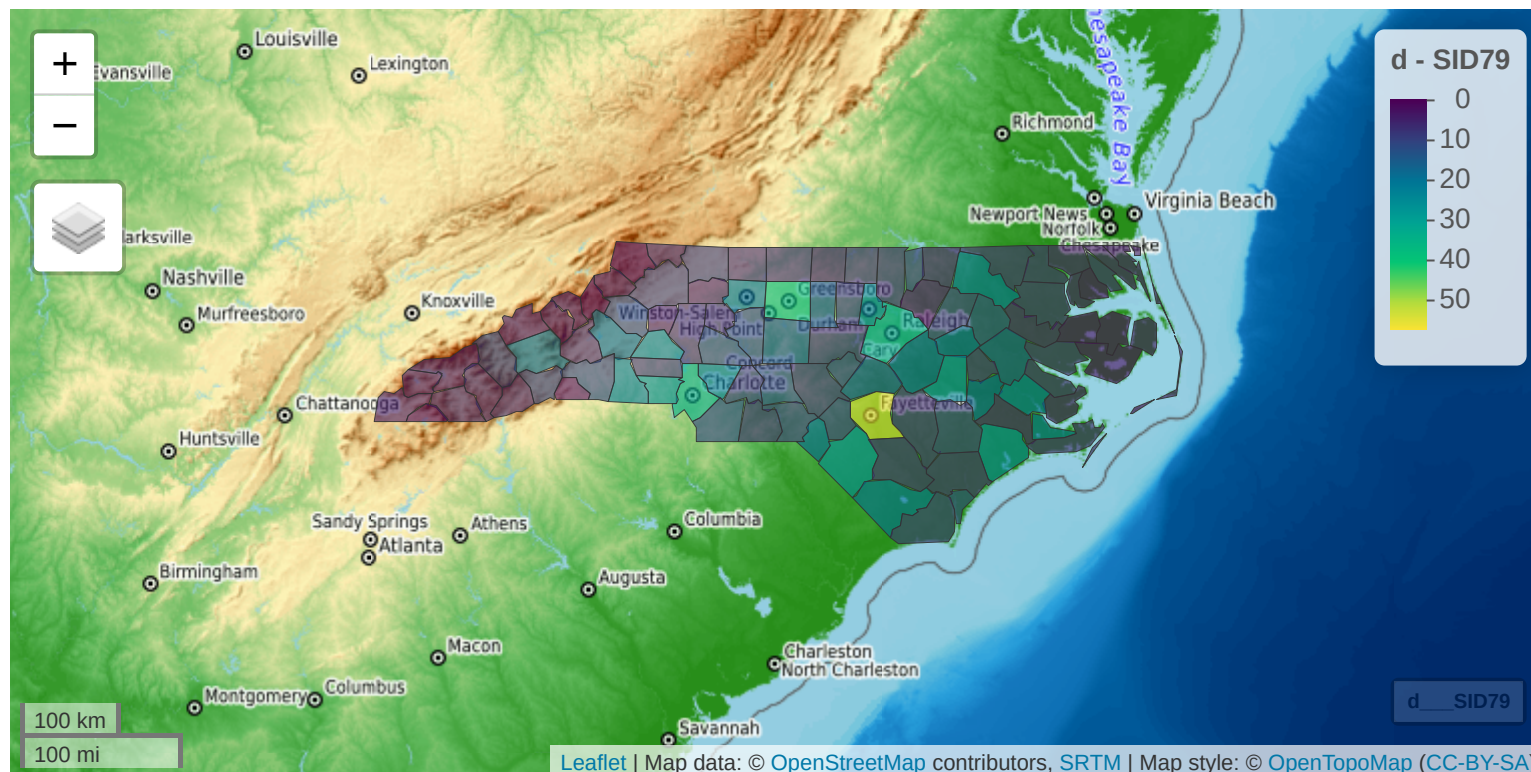
Geostatistical analysis of experimental data

- Field experiments in ecology, agriculture, forestry, often give rise to spatial data
- Classical analysis of variance of spatial experimental data ignores spatial structure of the data
- Blocking and randomisation sometimes not effective to account for natural heterogeneity within experimental site
- Residuals often violate independence assumption of classical analysis of variance methods
- Explicit consideration of auto-correlation by generalized least squares estimation.

5 Areal data: Lattice

In areal or lattice data, the domain D is a fixed countable collection of (regular or irregular) areal units at which variables are observed.

```
1 library(sf)
2 library(mapview)
3 d <- st_read(system.file("shape/nc.shp", package = "sf"), quiet = TRUE)
4 mapview(d, zcol = "SID79", map.types = "OpenTopoMap")
```



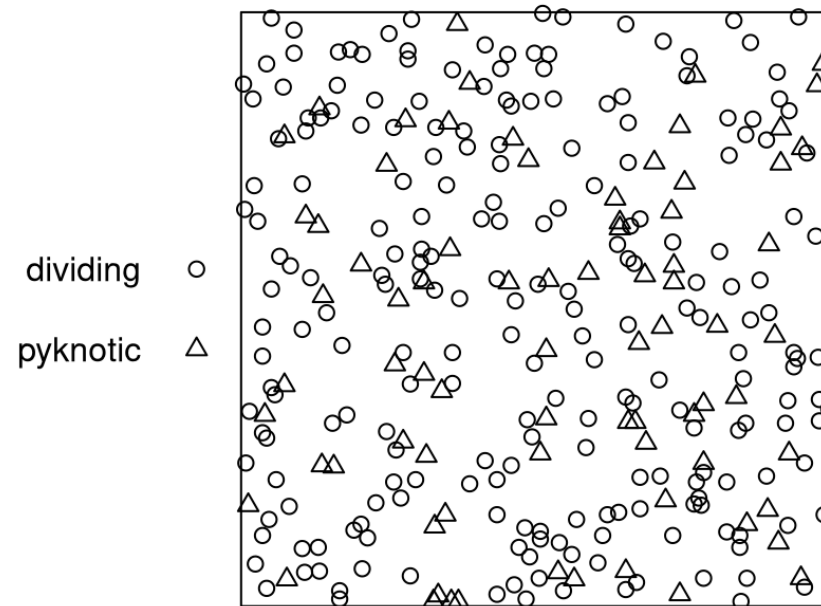
Number of sudden infant deaths per counties of North Carolina (USA) in 1979.

Cressie N.A.C.: Statistics for Spatial Data. Revised. New York: John Wiley & Sons; 1993.

6 Point pattern analysis

```
1 library(spatstat)
2 plot(hamster, main = "Pattern of cells in cancer tissue of a hamster")
```

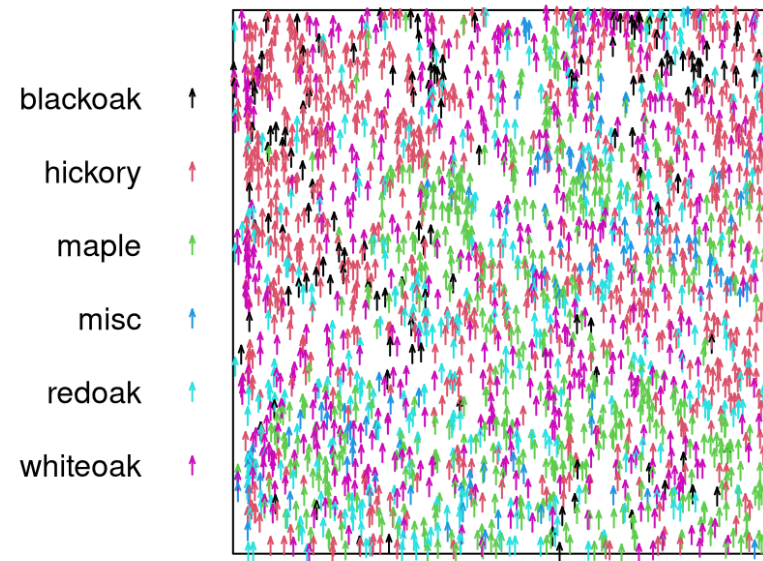
Pattern of cells in cancer tissue of a hamster



Point pattern

```
1 library(spatstat)
2 plot(lansing, shape="arrows", direction=90, cols=1:6, main = "Locations and botanical classification of trees in Lansing Woods (USA)")
```

Locations and botanical classification of trees in Lansing Woods (USA)



Diggle P.J.: Statistical Analysis of Spatial Point Patterns. 3rd ed. London: Arnold; 2014.



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shaping tomorrow