Discussion on the paper 'Bayesian analysis of Agricultural field trials' by Julian Besag and David Higdon

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We enjoyed reading this stimulating and elegant paper. Our comments pertain to the choice of the prior for fertility effects and to some computational aspects.

The choice of the Gaussian pairwise-difference prior (2.2) is advantageous mainly for computational reasons and we agree that a more appealing approach is to use a Gaussian process with a continuum index set. It is mentioned in section 2.3.3 that for moderately large data sets, such as the morning glory data, the computational task of inverting large non-sparse covariance matrices becomes very demanding for routine use. This is at least not the experience in Møller, Syversveen and Waagepetersen (1997, 1998) and Brix and Møller (1998), where the fast Fourier transform is used to diagonalize circulant embeddings of covariance matrices (see, e.g., Wood and Chan, 1994).

In Møller *et al.* (1997, 1998) and Brix and Møller (1998) a continuum Gaussian field is used to model the log intensity surface of spatial and spatio-temporal Cox point processes whereby so-called log Gaussian Cox processes (LGCPs) are obtained. It is shown that LGCPs satisfy many desirable theoretical properties and the models are applied to forest data and the development of weeds. The developed techniques can easily be adapted to the analysis of spatial count data sets (this is currently being investigated for counts of weed plants), and also for spatial continuous data sets. It is, for example, possible to develop diagnostics based on certain theoretical relationships in order to get an idea about an appropriate parametric class of covariance functions (rather than modelling the precision matrix as in section 2).

The empirical Bayesian prediction procedure in Møller *et al.* (1997, 1998) and Brix and Møller (1998) is based on conditional simulation of the intensity surface using a so-called Metropolis-adjusted Langevin Algorithm (MALA) (Besag, 1994; Roberts and Tweedie, 1997). For the applications we and some of our students (Segel, Sloth and Tøgersen, 1998) have considered, the MALA performs much better than usual Metropolis-Hastings

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algorithms with single variable updating schemes, and a slightly modified version further has the nice theoretical property of geometrical ergodicity. Using a fully Bayesian approach where a hyper-prior distribution is introduced for the mean and covariance parameters would only increase the computational burden with a factor of three.

When simulating from the posterior in Besag and Higdon's paper it would be interesting to see if there is any point in replacing the updating steps of τ and ψ by some MALA steps; particularly, for the morning glory data with the non-Gaussian likelihood we presume that it is advantageous to use the MALA. Incidentally, we believe that a MALA may also be appropriate for certain steps in the MCMC calculations in Diggle, Tawn and Moyeed (1998) as well as for many other applications in geostatistics and elsewhere.

References

[1] Besag, J. E. (1994). Discussion of the paper by Grenander and Miller. *J. R. Statist. Soc.*, **B**, **56**, 591–592.

[2] Brix, A. and Møller, J. (1998). Space-time multitype log Gaussian Cox processes with a view to modelling weed data. *Research Report R-98-2012*, Department of Mathematics, Aalborg University.

[3] Diggle, P. J., Tawn, J. A. and Moyeed, R. A. (1998). Model-based geostatistics (with discussion). *Appl. Statist.*, **47**, 299–350.

[4] Møller, J., Syversveen, A. R. and Waagepetersen, R. P. (1997). Log Gaussian Cox processes: A statistical model for analyzing stand structural heterogeneity in forestry. *Proc. First European Conference for Information Technology in Agriculture*, 339–342.

[5] Møller, J., Syversveen, A. R. and Waagepetersen, R. P. (1998). Log Gaussian Cox processes. *Scand. J. Statist.*, **25**, 451–482.

[6] Roberts, G. O. and Tweedie, R. L. (1997). Exponential convergence of Langevin diffusions and their discrete approximations. *Bernoulli*, **2**, 341–363.

[7] Segel, S., Sloth, N. and Tøgersen, F. A. (1998). Image analysis: A probabilistic approach using Markov chain Monte Carlo methods. *Diploma Thesis*, Department of Mathematics, Aalborg University.

[8] Wood, A. T. A. and Chan, G. (1994). Simulation of stationary Gaussian processes in $[0,1]^d$. *J. Comput. Graph. Statist.*, **3**, 409–432.