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Modelling past land use using archaeological and pollen data

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Accurate maps of past land use are necessary for studying the impact of anthropogenic land-cover changes on climate and biodiversity. We develop a Bayesian hierarchical model to reconstruct the land use using Gaussian Markov random fields. The model uses two observations sets: 1) archaeological data, representing human settlements, urbanization and agricultural findings; and 2) pollen-based land estimates of the three land-cover types Coniferous forest, Broadleaved forest and Unforested/Open land. The pollen based estimates are obtained from the REVEALS model, based on pollen counts from lakes and bogs. Our developed model uses the sparse pollen-based estimations to reconstruct the spatial continuous cover of three land cover types. Using the open-land component and the archaeological data, the extent of land-use is reconstructed. The model is applied on three time periods - centred around 1900 CE, 1000 and, 4000 BCE over Sweden for which both pollen-based estimates and archaeological data are available. To estimate the model parameters and land use, a block updated Markov chain Monte Carlo (MCMC) algorithm is applied. Using the MCMC posterior samples uncertainties in land-use predictions are computed. Due to lack of good historic land use data, model results are evaluated by cross-validation.

Keywords. Spatial reconstruction, Gaussian Markov random field, Fossil pollen records, Archaeological data, Human land-use, Prediction uncertainty