# Spatial pattern of Eurasian woolly mammoth extinctions during the Late Pleistocene based on statistical inference from fossil records

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**Title**

Spatial pattern of Eurasian woolly mammoth extinctions during the Late Pleistocene based on statistical inference from fossil records

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**Abstract:**

Late Pleistocene extinctions affected most large and low-fecundity mammals such as the woolly mammoth (*Mammuthus primigenius*) in Eurasia. Despite recent advances in both genetic and modelling approaches and increasing fossil data, assessing the relative importance of climate variations and human hunting on the spatial pattern of mammoth extinction remains a challenge. This is because estimating incomplete fossil time series biases the true dates of extinction and appearance, potentially leading to incorrect conclusion of the relative importance of individual and synergistic drivers. We compared outputs of two statistical models that (i) spatially infer mammoth final extinction dates and first human occurrence from sighting records based on the recently developed Gaussian-resampled inverse-weighted McInerny (GRIWM) and (ii) predict the date when mammoths should have gone extinct based on climate change only (climate anomaly and velocity). GRIWM generates a confidence interval of the true extinction time, which suggests a pattern of mammoths extinctions starting in central Europe and spreading toward both western Europe and north-eastern Siberia. Climate change had a minor impact on mammoth extinctions, mainly in the northeastern part of Eurasia where the synergistic hypothesis is mainly supported by our results whereas the human hunting hypothesis is more likely to have caused mammoth extinctions elsewhere in Eurasia.