

Observations about Behavioural and Spatial Distance

Thesis – “Ein computerbasiertes Cultural Evolution Modell zur Ausbreitungsdynamik europäisch-bronzezeitlicher Bestattungssitten”

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- Introduction (Data)
- Simulation (Theory and Method)
- Behavioural Distance
- Behavioural and Spatial Distance

Introduction

Data

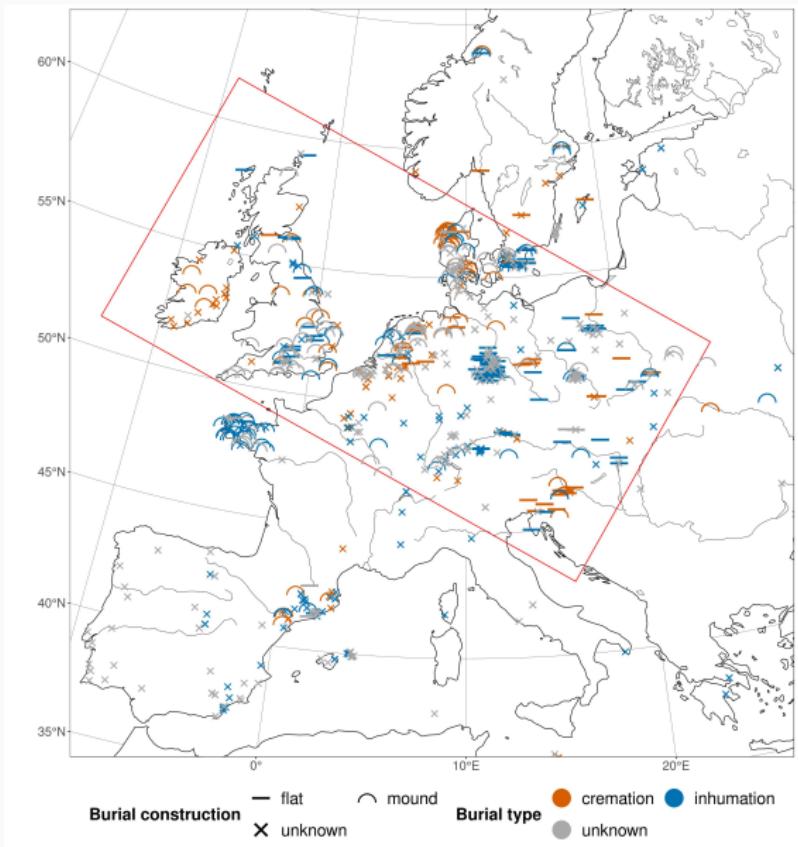


Figure 1: Radon-B ^{14}C dates of graves 2200-800 calBC (Albers Equal Area Conic)

Research Area and Regions

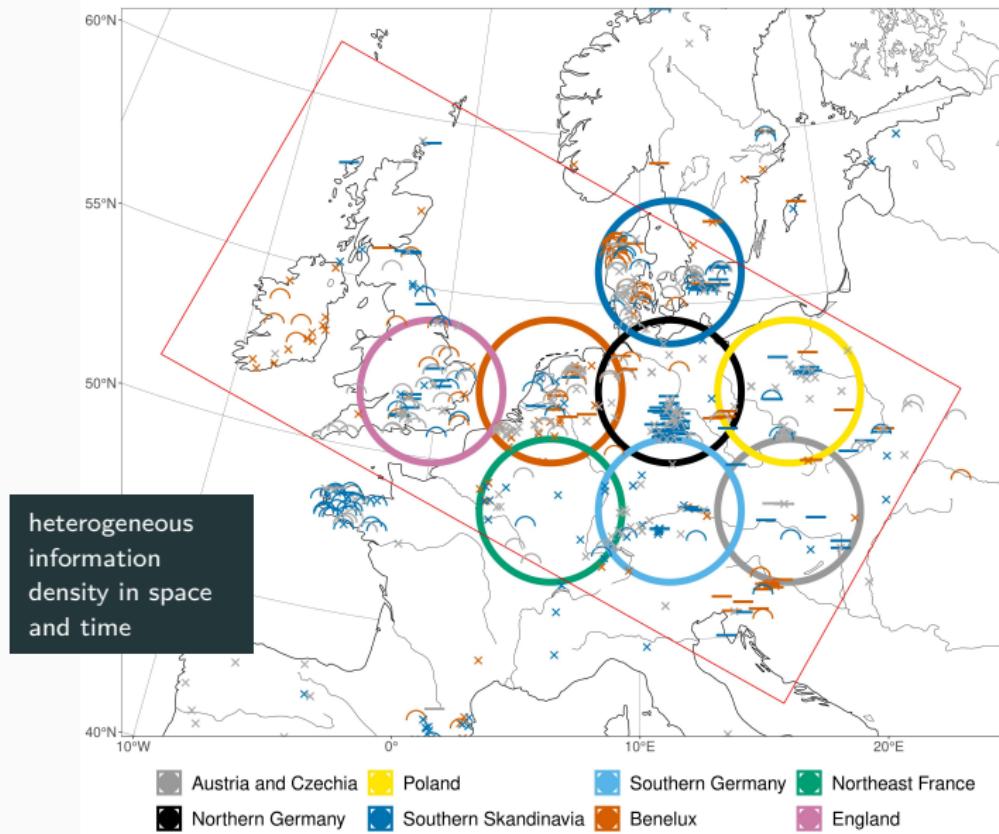


Figure 2: Artificial Regions: 400km distance, 240km radius, ≥ 70 dates

Development

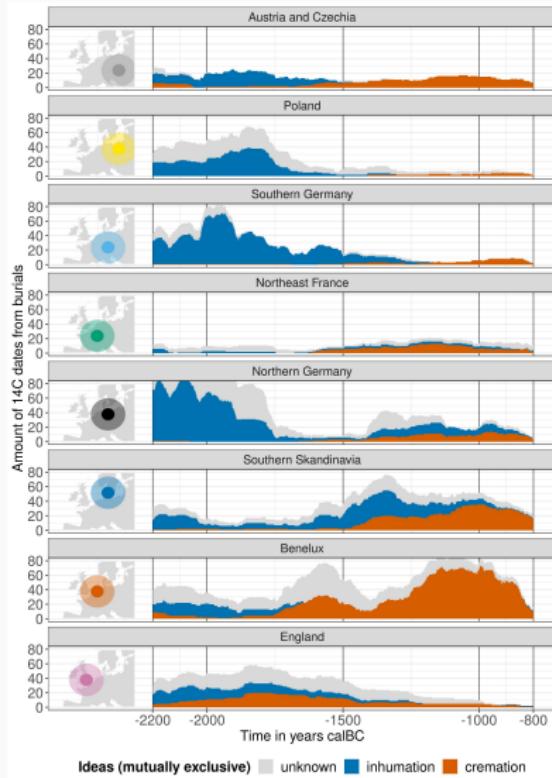


Figure 3: Burial type development absolute numbers

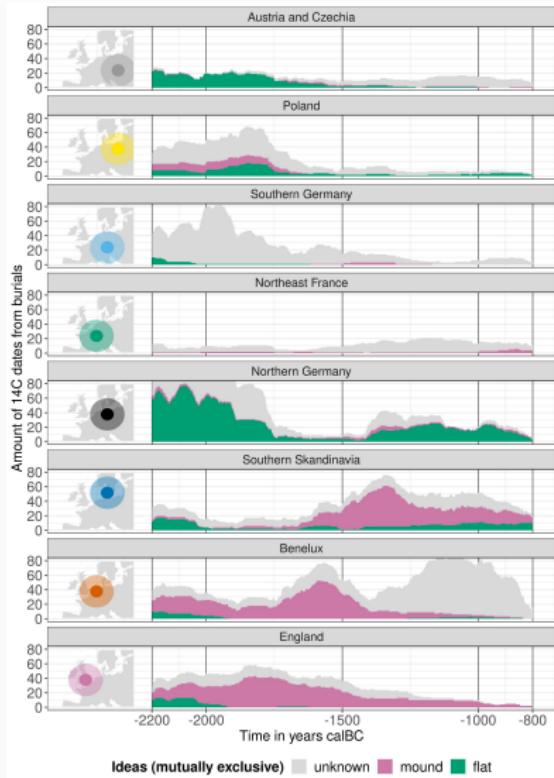


Figure 4: Burial construction development absolute numbers

Development

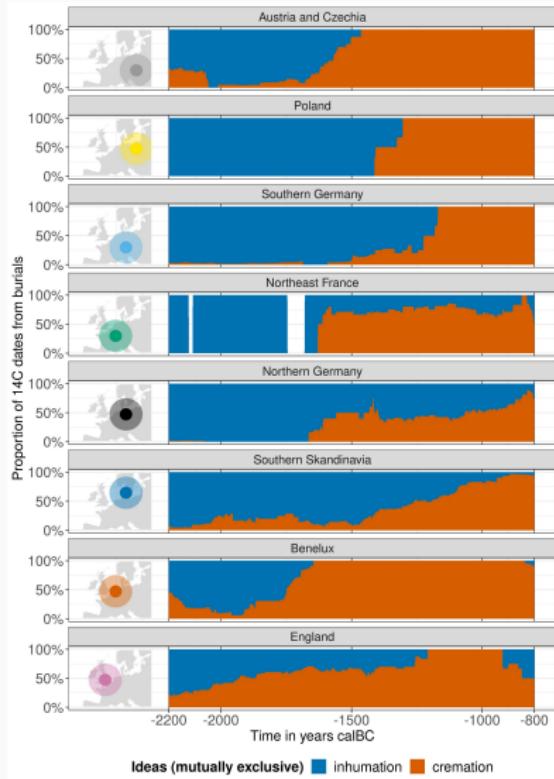


Figure 5: Burial type development proportions

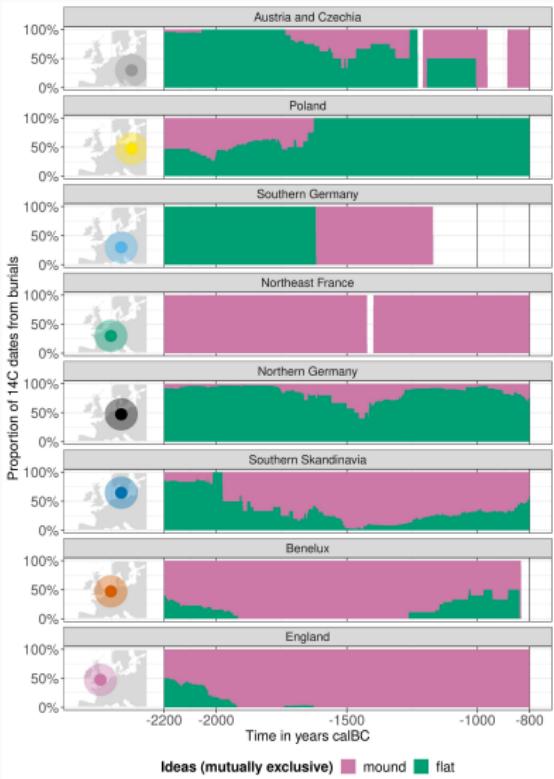


Figure 6: Burial construction development proportions

Simulation

Concept

- Funeral rituals are **behaviour/ideas/cultural traits** and spread in space and time. They live in **social space** and their spread depends on social relationships.
- Funeral rituals are a special category of ideas: They have a relatively low interaction with the human-environment system and can be treated as **selectively neutral**.
- The main mechanisms of diffusion of neutral variants are **innovation, drift** and **flow**.

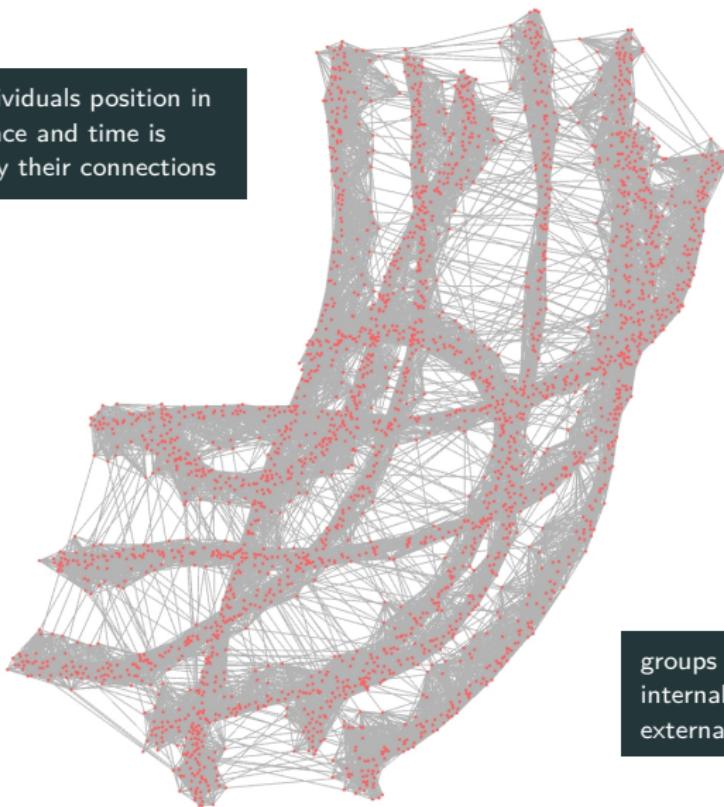
Drift: Dominanz of individual traits due to stochastic processes

Flow: Information transfer and synchronization across group boundaries

Concept: Ideas are **entities** that expand competitively in a **population graph**.

Population Graph

every individuals position in social space and time is defined by their connections



groups have a high degree of internal and a low degree of external interaction

Figure 7: Example Population Graph (Fruchterman Reingold)

Generic Results

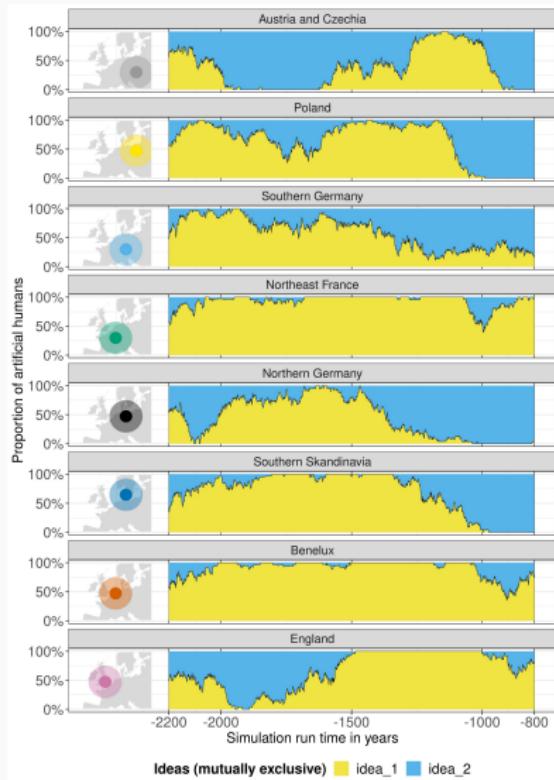


Figure 8: Proportions development of one simulation example run

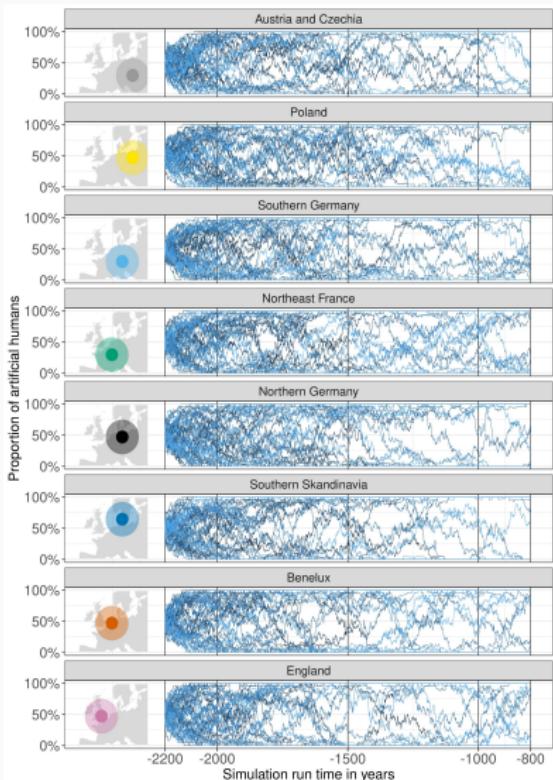


Figure 9: Proportions development of many simulation runs

Generic Results

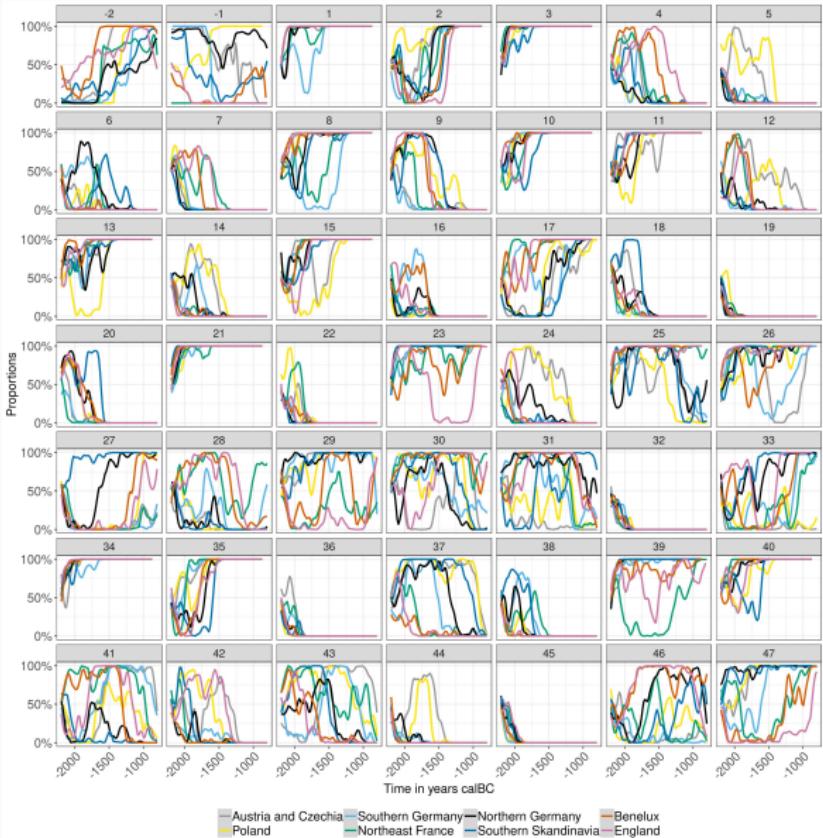


Figure 10: Many simulation runs compared to the real world data

Behavioural Distance

Squared Euclidian Distance (SED)

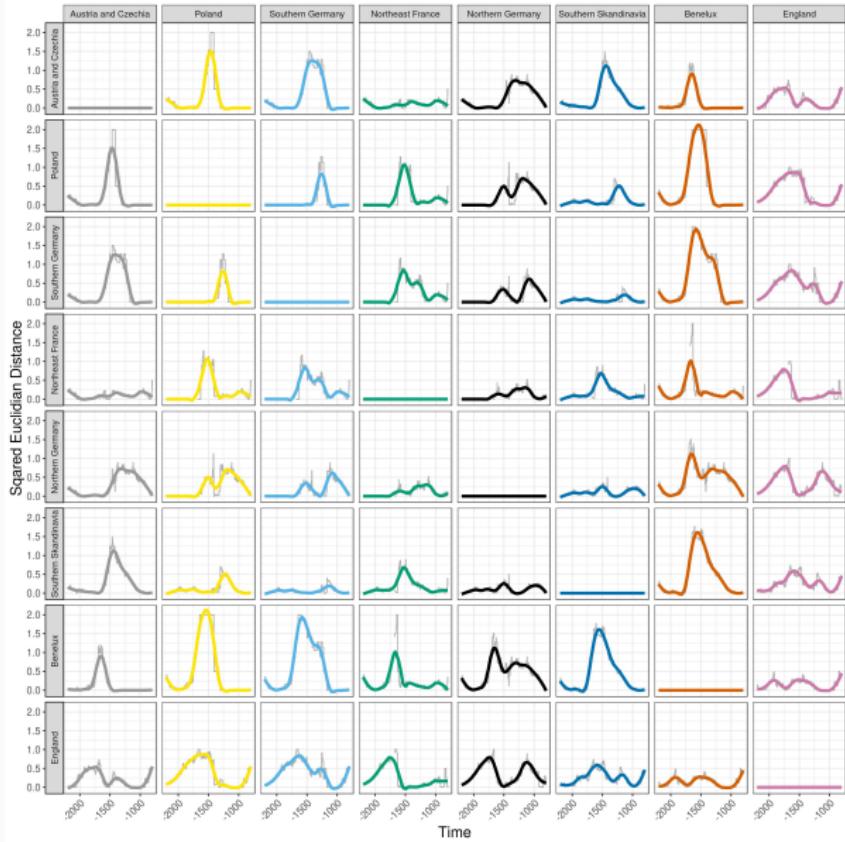
The Squared Euclidian Distance is a simple **measure of between-group similarity**.

$$d_{ij}^2 = \sum_{k=1}^n (p_{ik} - p_{jk})^2$$

- d_{ij}^2 : Squared Euclidean distance between two groups i and j
- k : Variant counter
- n : Total amount of variants in a population
- p_{ik} : Relative frequency of the k 'th variant in population i
- p_{jk} : Relative frequency of the k 'th variant in population j

Region Distance Matrix

low distance at the start and end due to universal shift from inhumation to cremation



the different adoption rates are visible as peaks of cultural distance

the gradual change from one tradition to the other in England and Southern Scandinavia evens out the distances

Figure 11: Development of burial type SED for all regions relations

Region Distance Matrix

Central
European
Cluster?

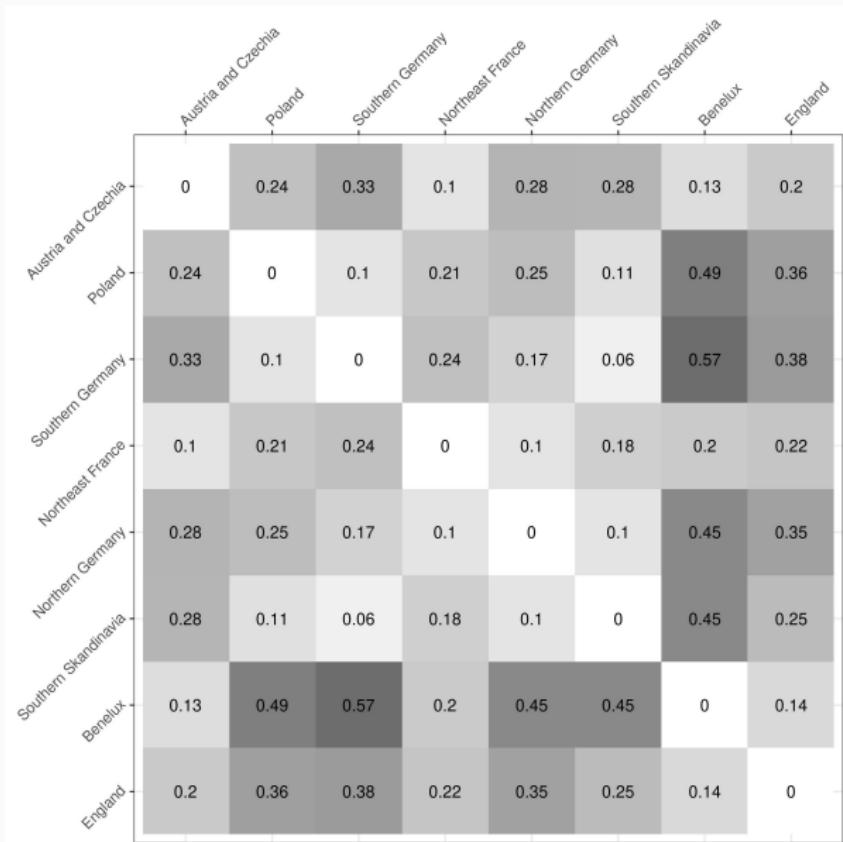
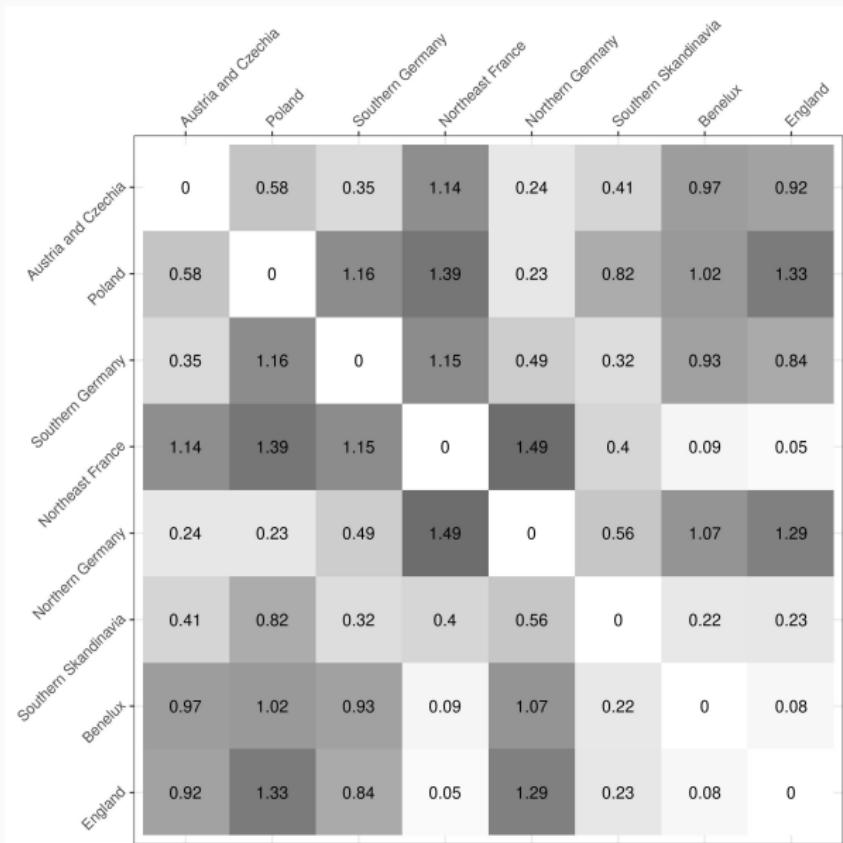


Figure 12: Mean burial type SED for all regions relations

Region Distance Matrix



Northwestern
European
Cluster?

Figure 13: Mean burial construction SED for all regions relations

Parallel Developments

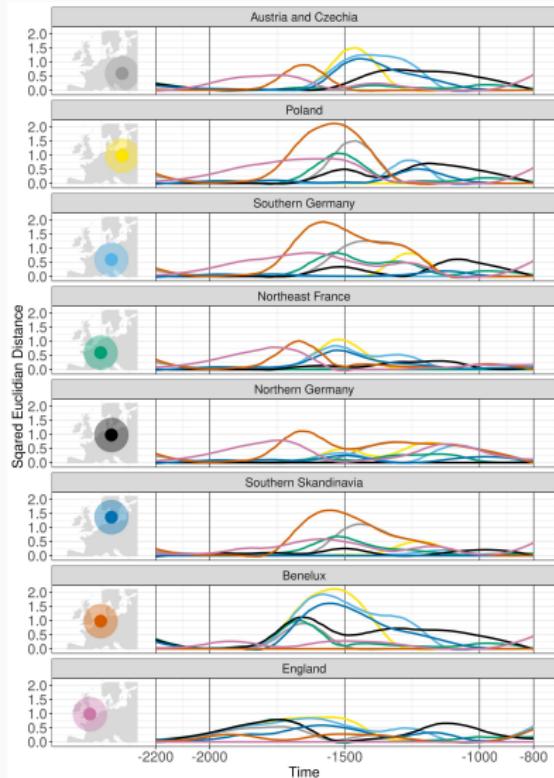


Figure 14: Development of **burial type** SED for each region

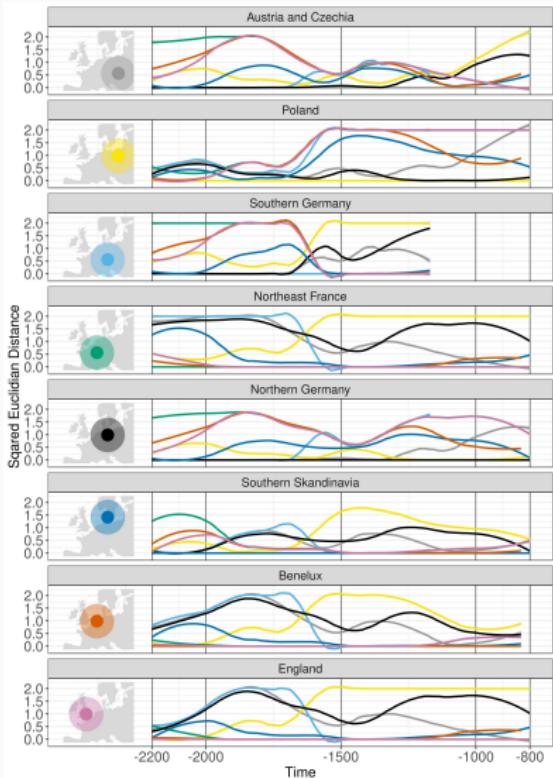
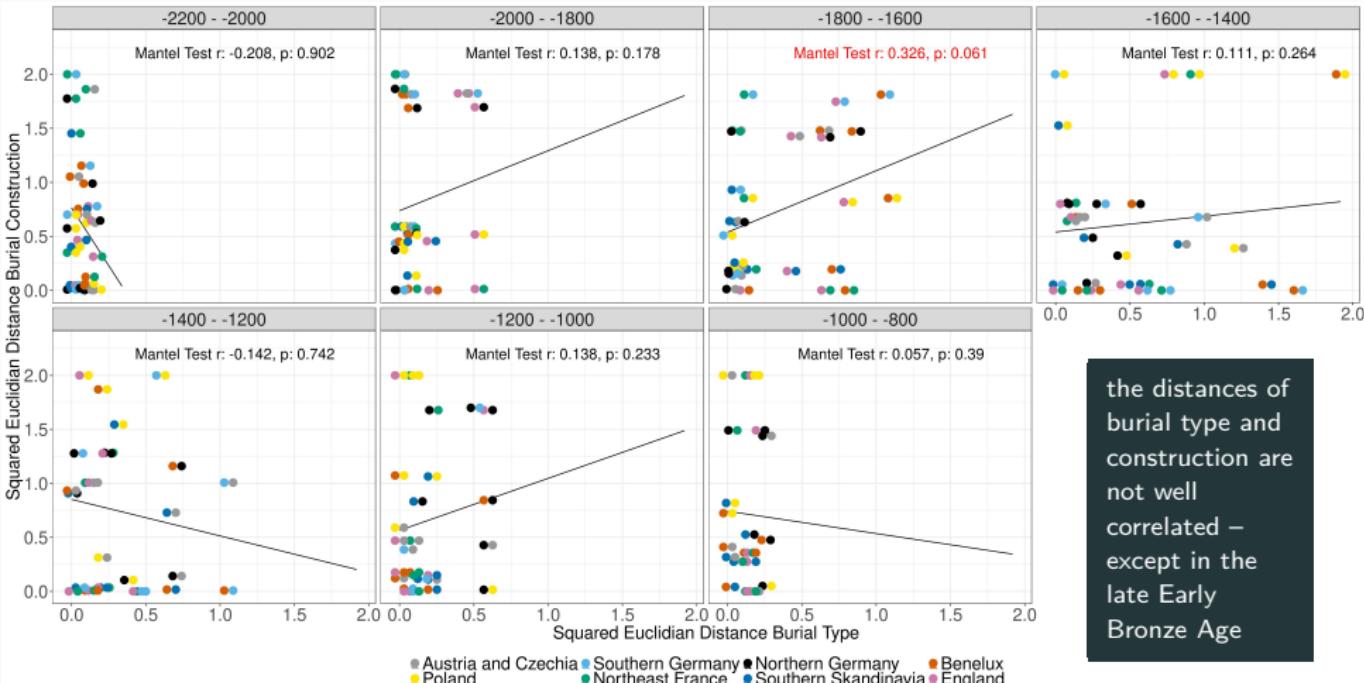


Figure 15: Development of **burial construction** SED for each region

Correlation



the distances of burial type and construction are not well correlated – except in the late Early Bronze Age

Figure 16: Correlation of burial type and burial construction Mean SED over time

Behavioural and Spatial Distance

Spatial Distance Classes

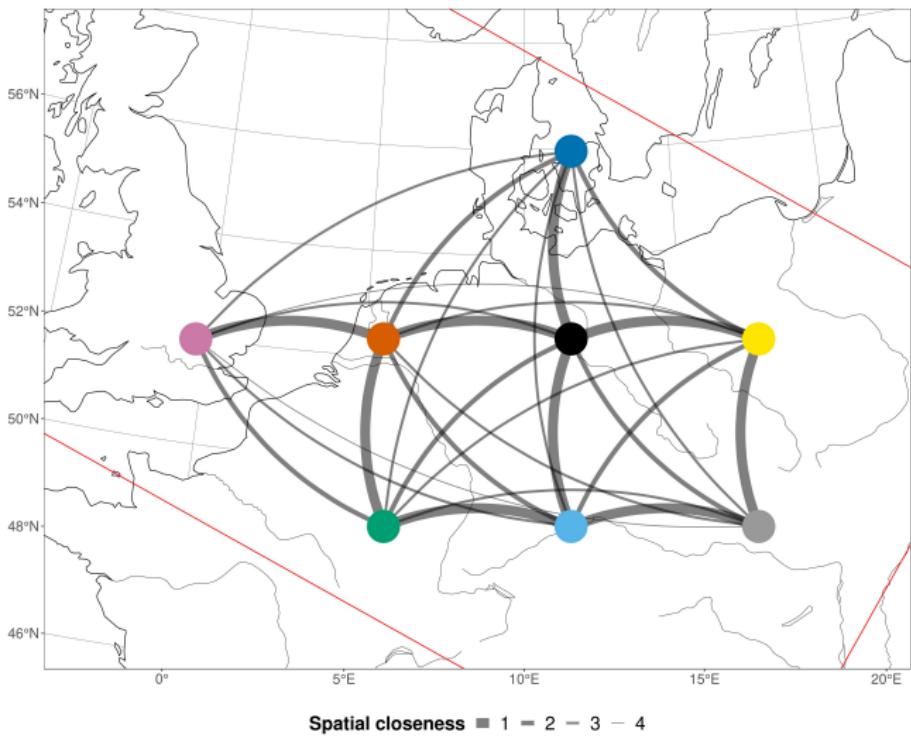


Figure 17: Spatial distance network and definition of distance classes

Correlation

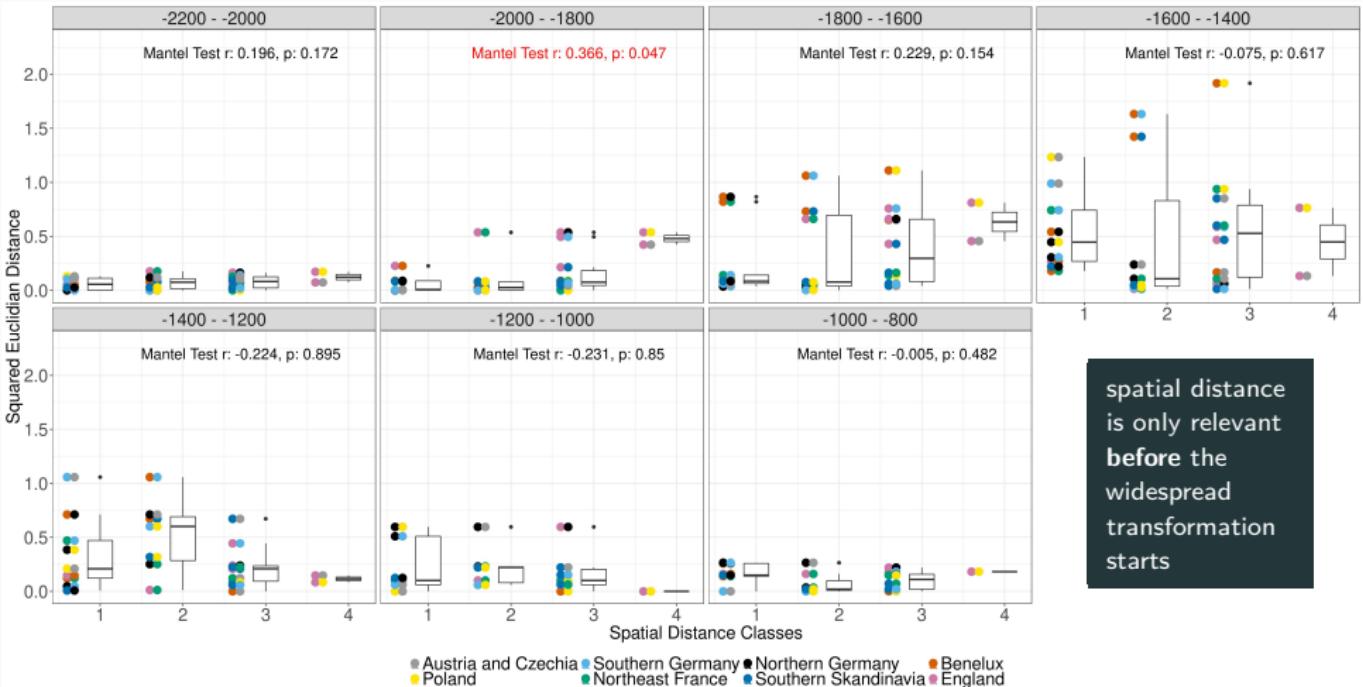


Figure 18: Burial type correlation of Mean SED and spatial distance

Correlation

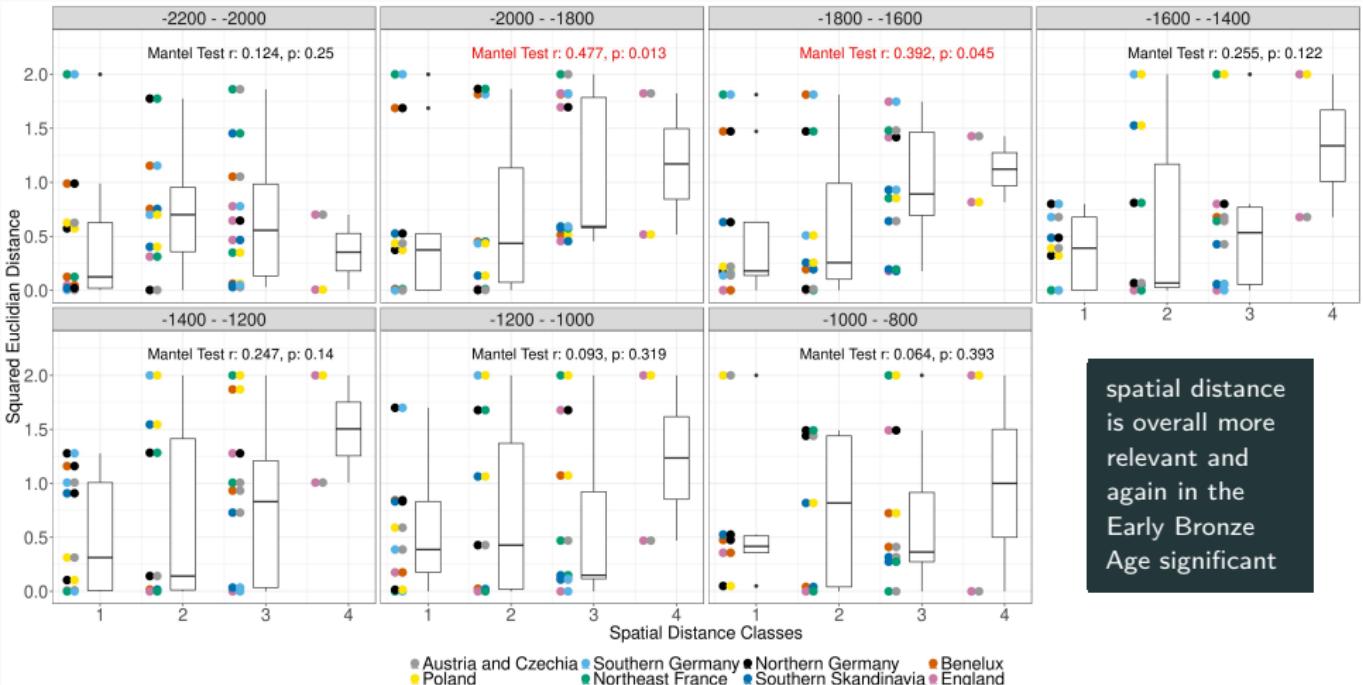
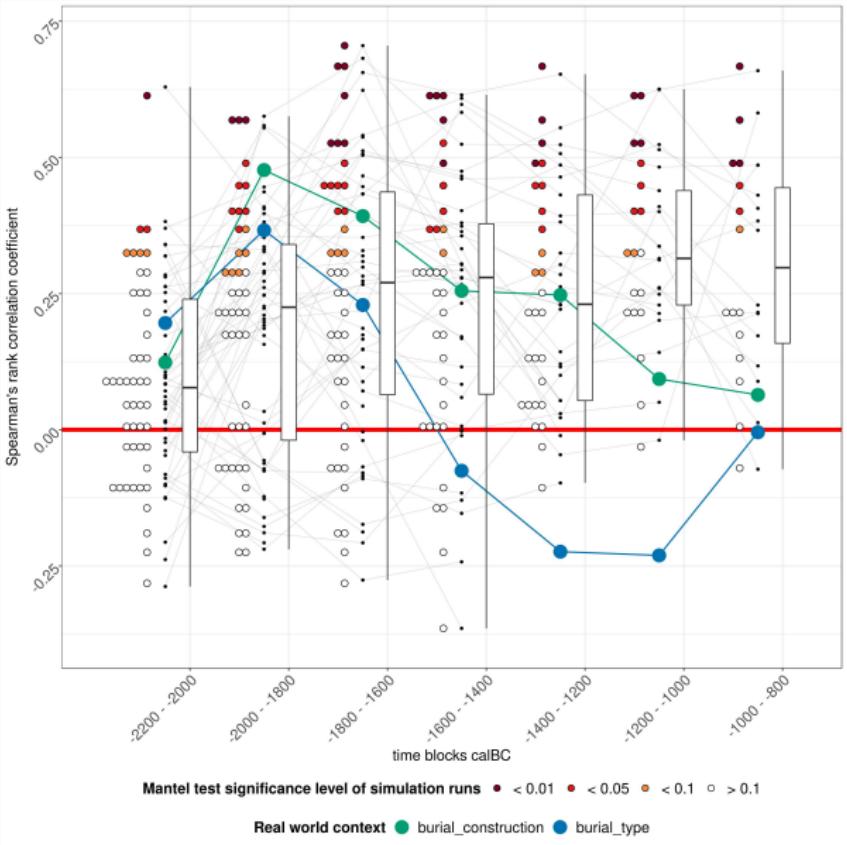


Figure 19: Burial construction correlation of Mean SED and spatial distance

Correlation



Compared to simulation results the expansion of cremation behaves highly atypical if we assume spatial correlation

Figure 20: Correlation coefficient over time for 50 simulation runs and the real world

Conclusion

Preliminary Observations and Hypotheses

- The diffusion of the cremation funeral tradition and traditions of flat vs. mound graves can both be explained by **neutral variant drift and flow** on a large scale. Local innovation might not have been necessary.
- Both contexts are mostly **independent**, except for a short period in the late Early Bronze Age.
- Both contexts are to a certain degree correlated to **spatial distance** in the Early Bronze Age, but become **increasingly unpredictable** in the Middle Bronze Age.
- The diffusion of cremation burials in the Middle and Late Bronze Age is **almost negatively correlated** with spatial distance.