GARP

Genetic Algorithm for Rule-Set Prediction:

- machine-learning algorithm that creates ecological niche models for a species (Chen and Peterson 2000; Peterson 2001; Stockwell 1999).
- ecological niche of a species, defined as the range of environmental conditions within which it can persist without immigrational subsidy
- predicts species' range expansion or contraction in response to real or simulated climatic changes

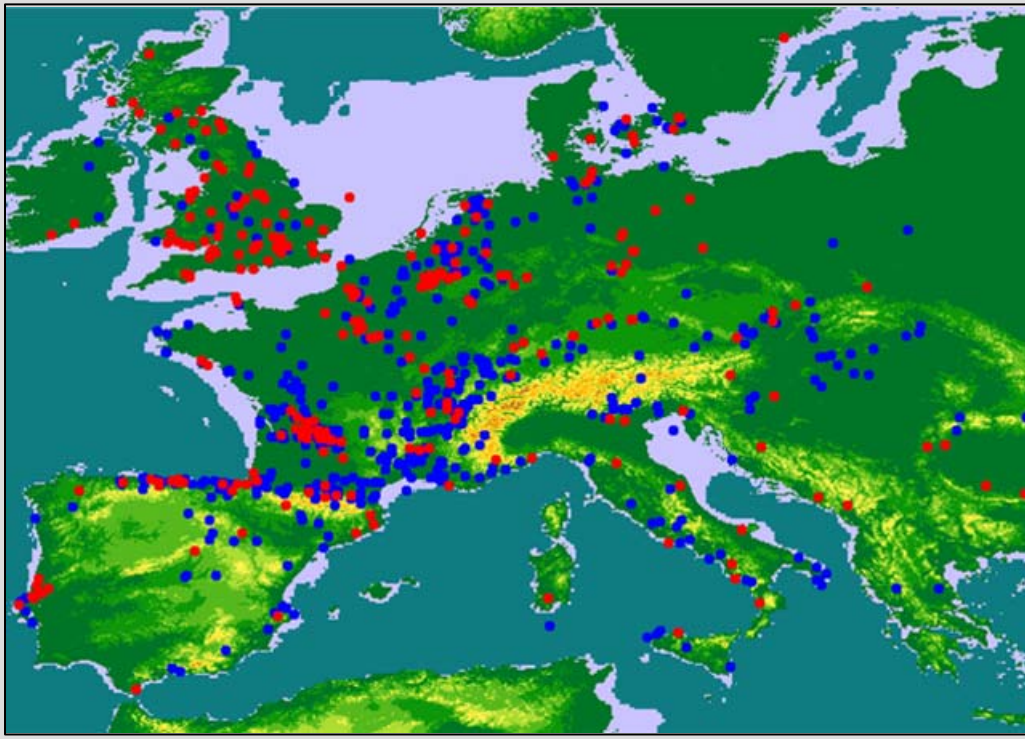
- **Desktop GARP**
  http://www.lifemapper.org/desktopgarp/

GARP Input Data

- the geographic coordinates of radiometrically dated and culturally attributed archaeological sites

- 6200 C_{14} ages for 1112 sites
  - Type of date and dated material
  - Arch. level and cultural attribution
  - Geographic coordinates

- Faunal Data for over 2000 archaeological components from ca. 500 sites



● – AMS
● – Conventional

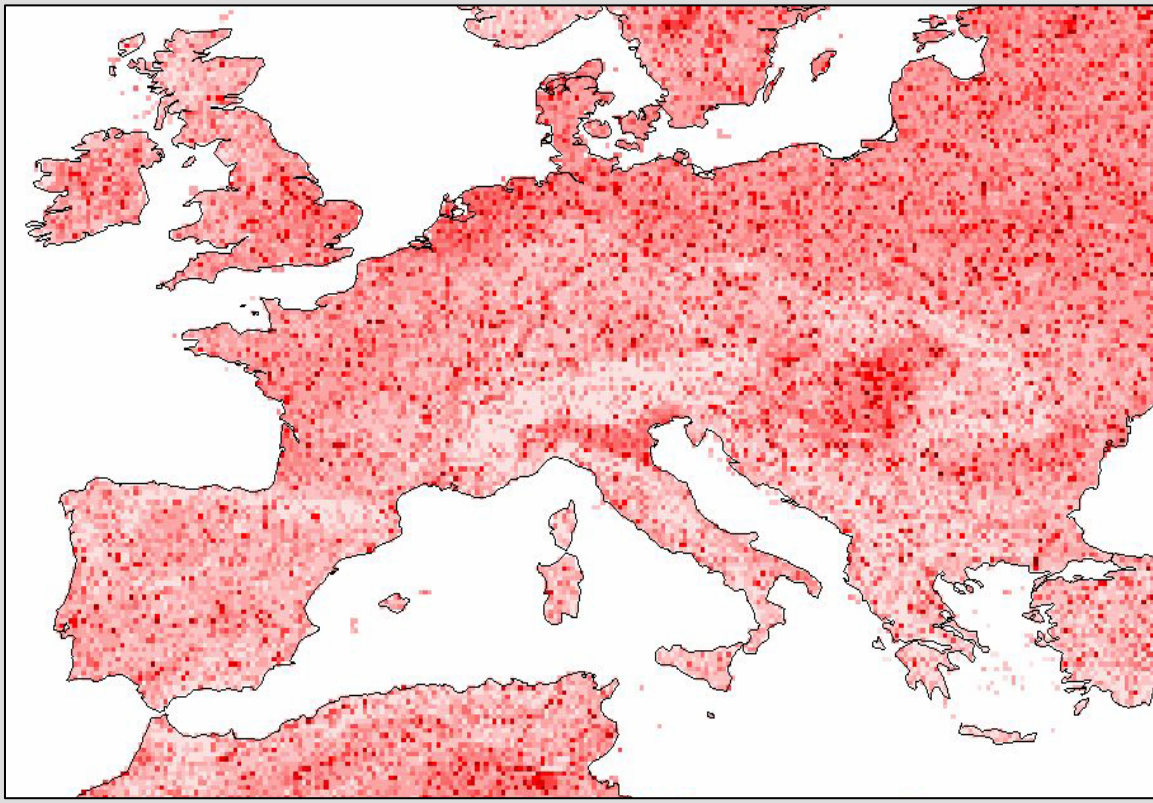
d'Errico and Sanchez Goni 2003 QSR
d'Errico et al. in Bard 2006

GARP Input Data

- Raster GIS data layers

Landscape attributes

- slope
- aspect
- elevation
- drainage Index



Drainage Index

Banks, d'Errico et al. 2007. JAS

GARP input data

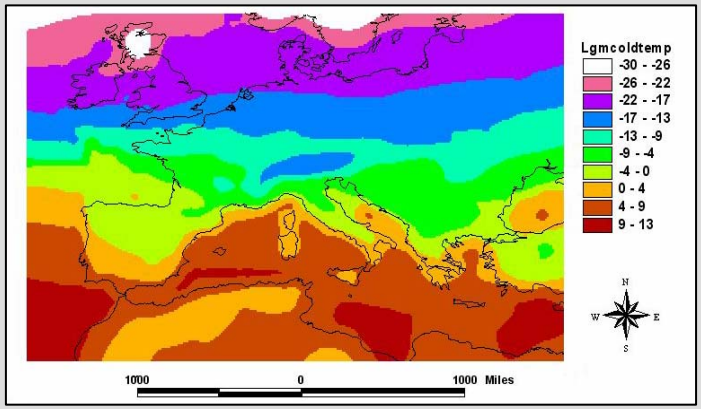
Raster GIS data layers

High- Resolution Climate Simulations :

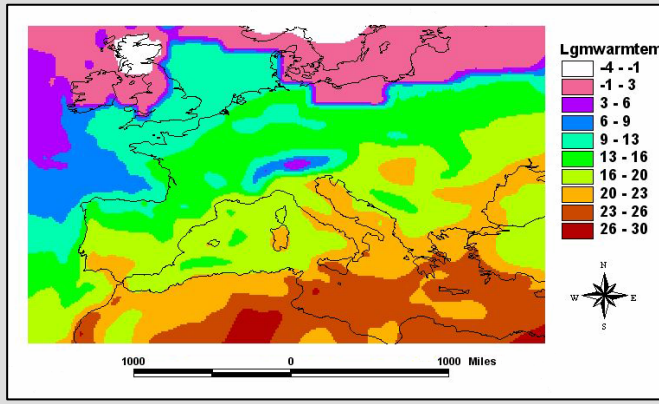
by forcing a

GCMs following the PMIP 1 protocol

- Sst temperatures
- Sea ice cover
- Ice-sheets volume
- CO2 concentration
- insolation



LGM Cold Month Temp.

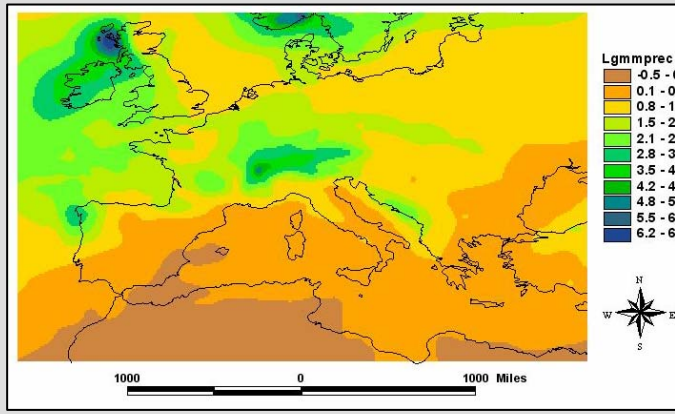


LGM Warm Month Temp.

output:

- Temperature
- Mean Annual
- Coldest Month
- Warmest Month
- Precipitation

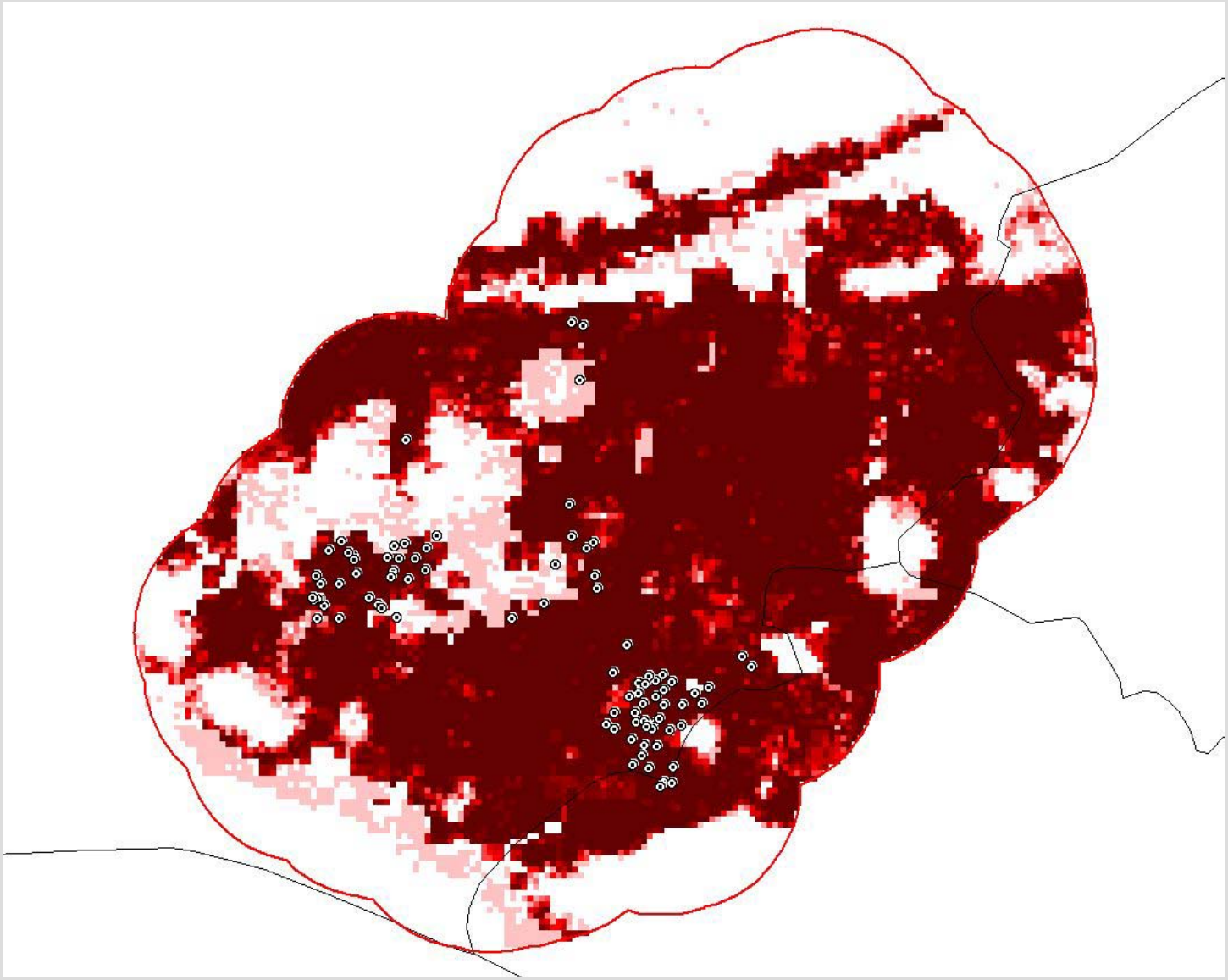
grid box size over Europe of ~ 60 km



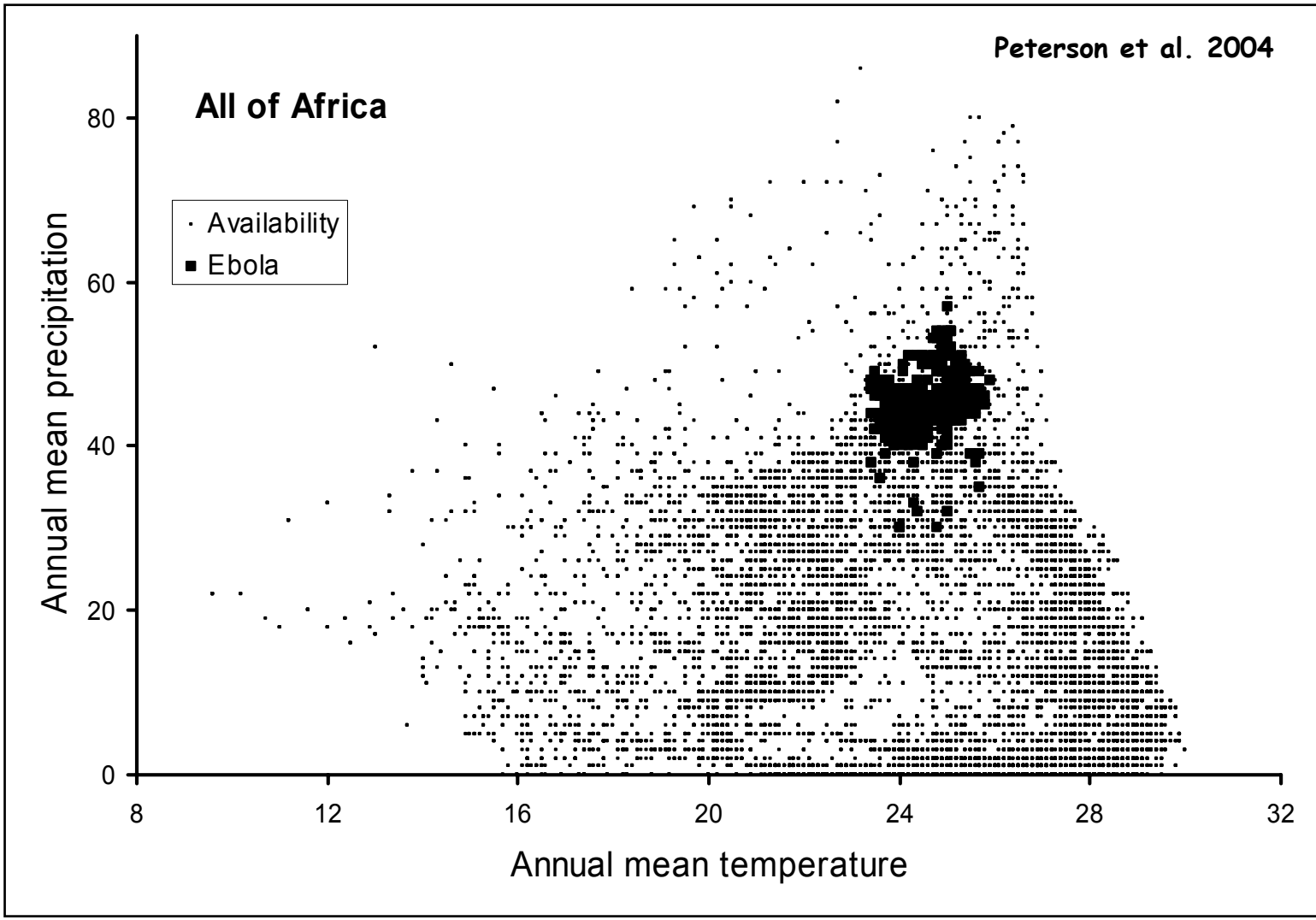
LGM Mean Annuel Precip.

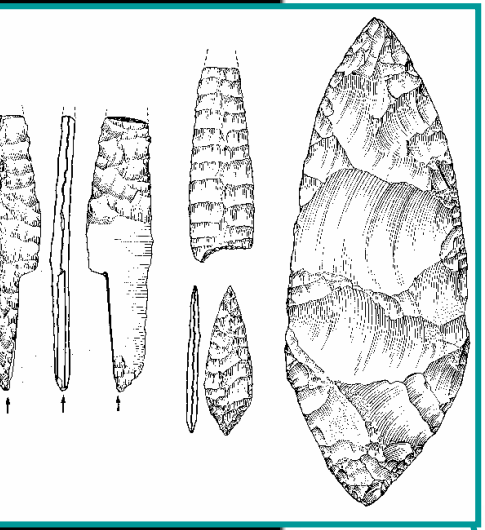
Banks, d'Errico et al. 2007 JAS

GARP Modeling Process



An example: the Ebola





Solutrean

Epigravettian

Glaciated

Tundra

Fores

Parktundra

Stepp

Banks, d'Errico et al., 2007, JAS

Application of GARP to the LGM

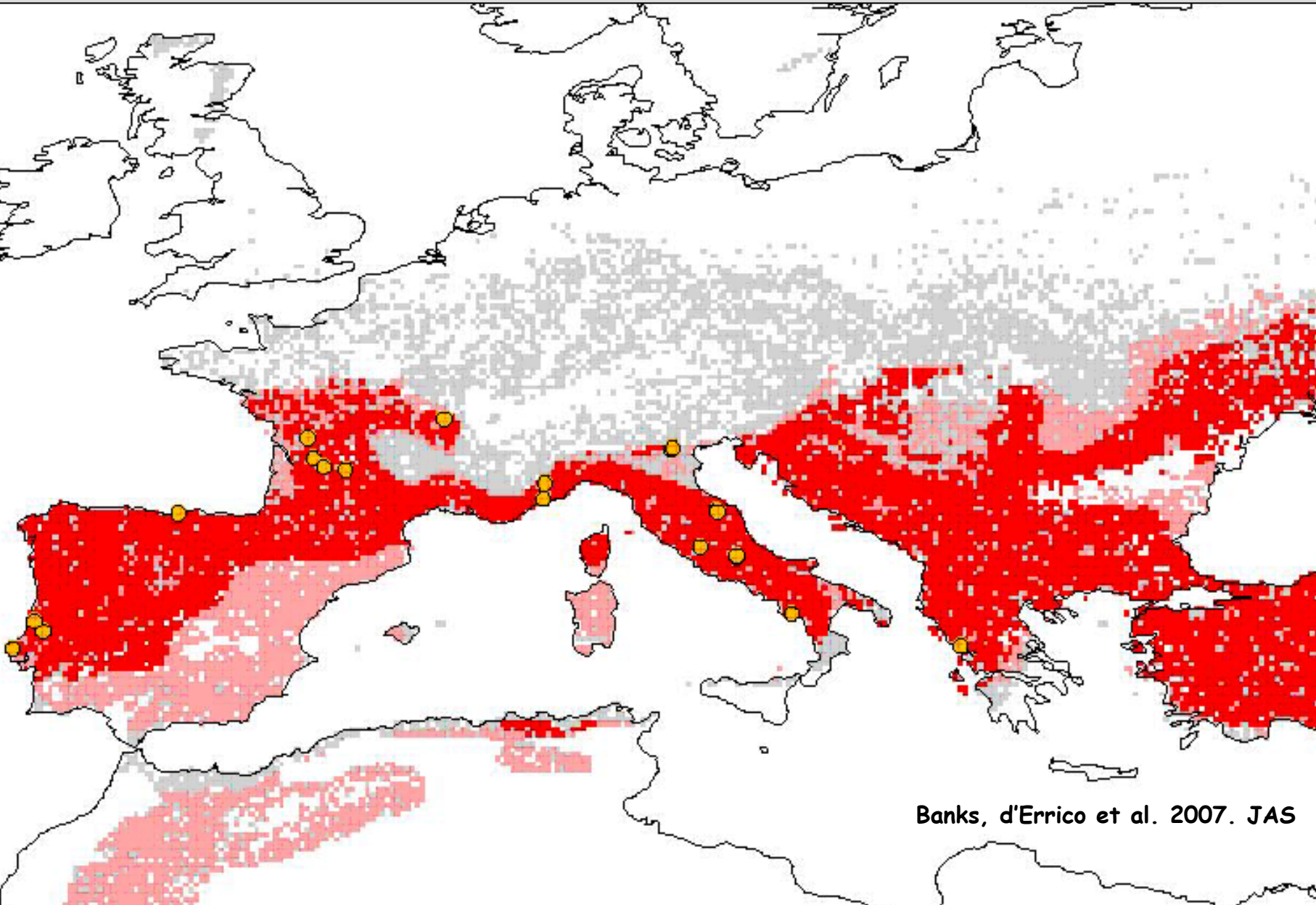
- determine the limits of the potential human range during the LGM (22 – 20 ka cal BP)

- define the eco-cultural niches of the two main archeological cultures present in Europe at that time (the Solutrean and Epigravettian technocomplexes)

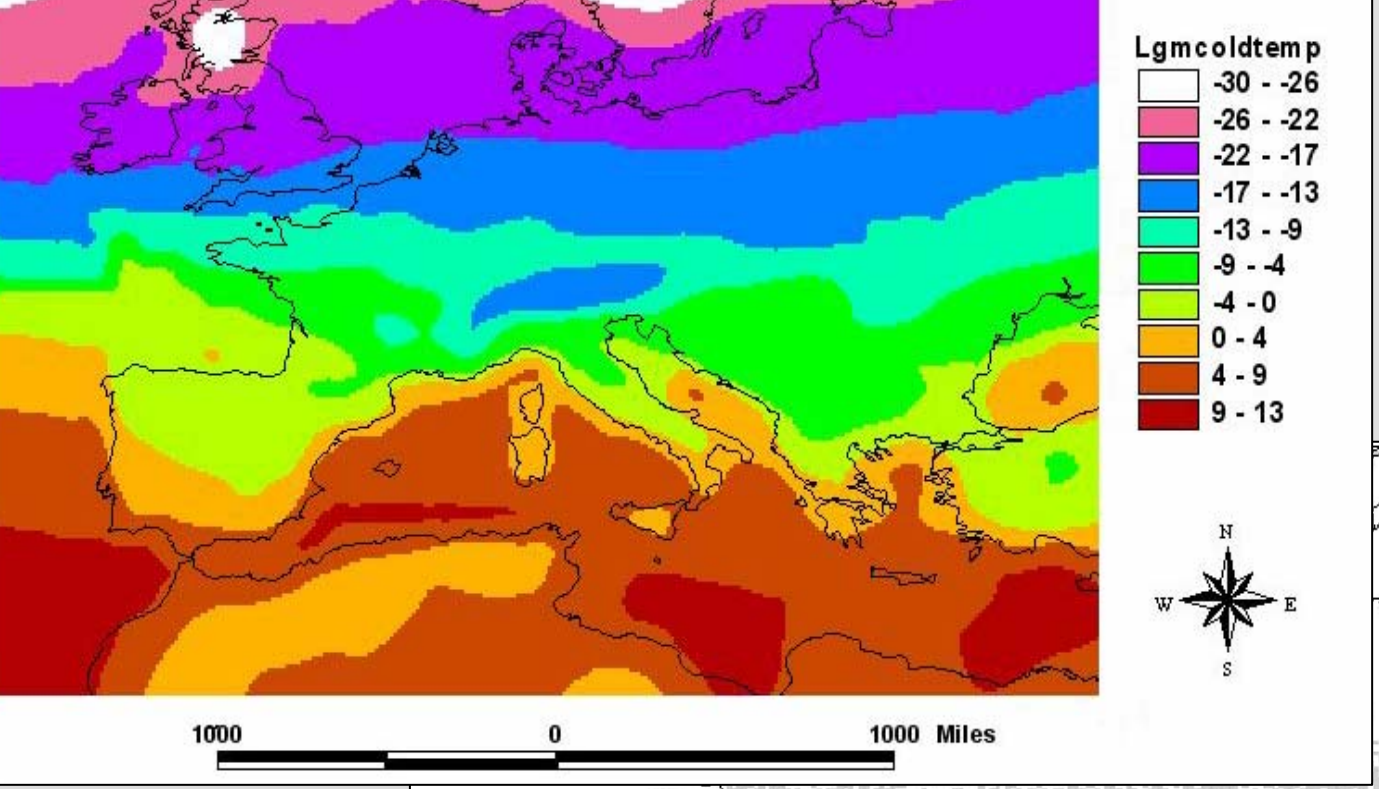
- identify environmental and cultural factors that shaped their geographic ranges

Banks, d'Errico et al. 2007. JAS

Results (Solutrean + Gravettian)



Banks, d'Errico et al. 2007. JAS

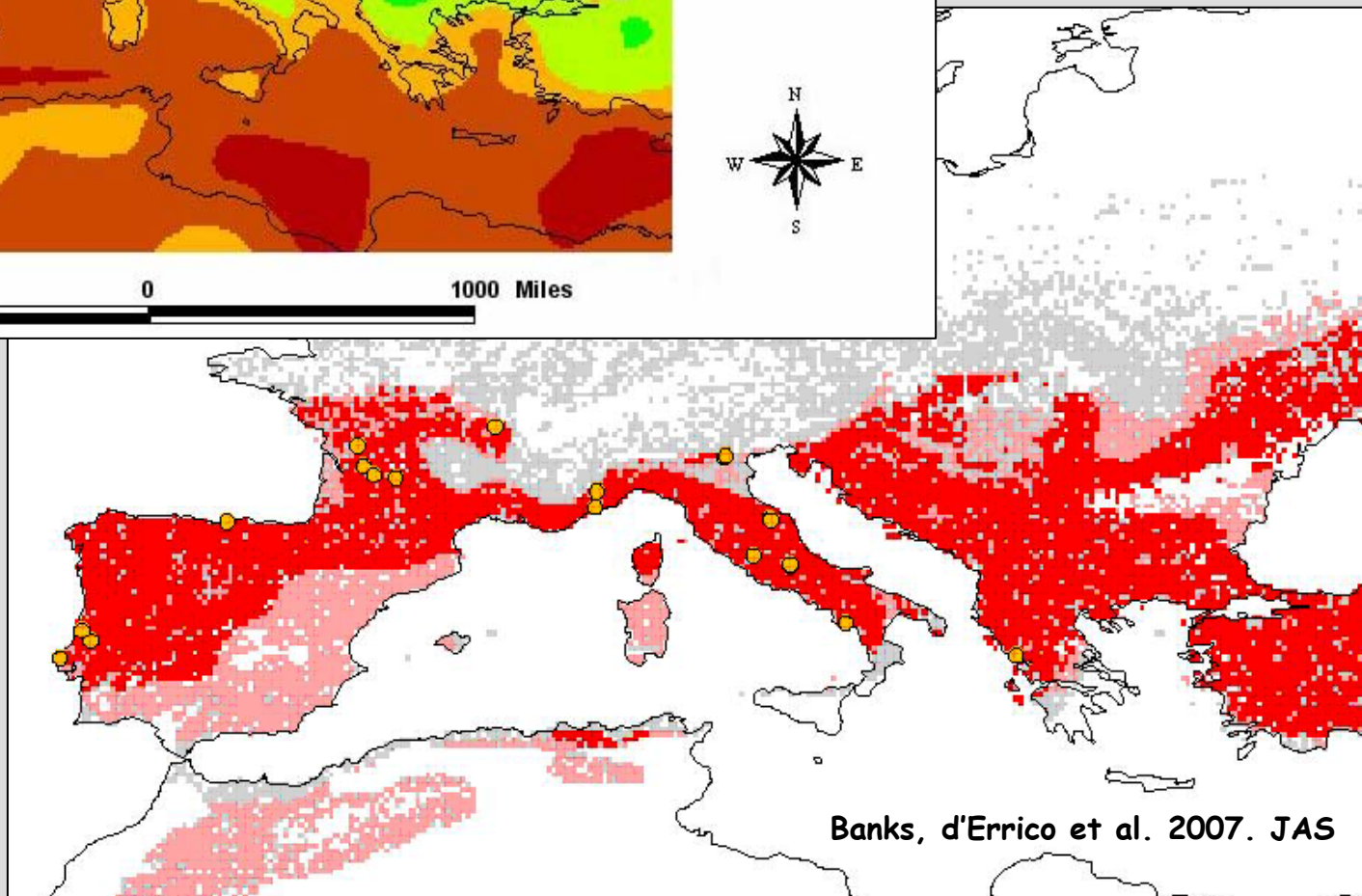


LGM Cold Month Temp.

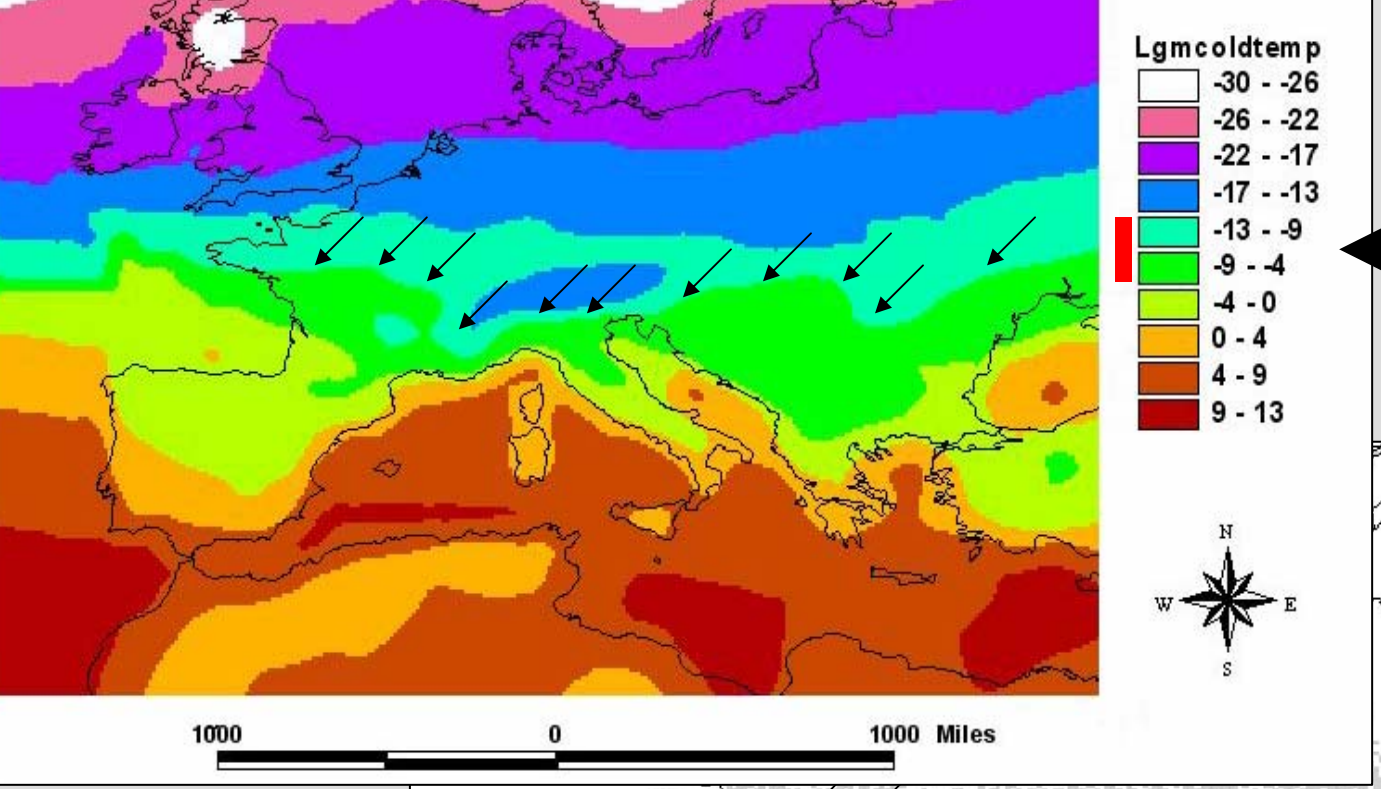
PCA = 85% variability

↓

First two components (temperatures)



Banks, d'Errico et al. 2007. JAS

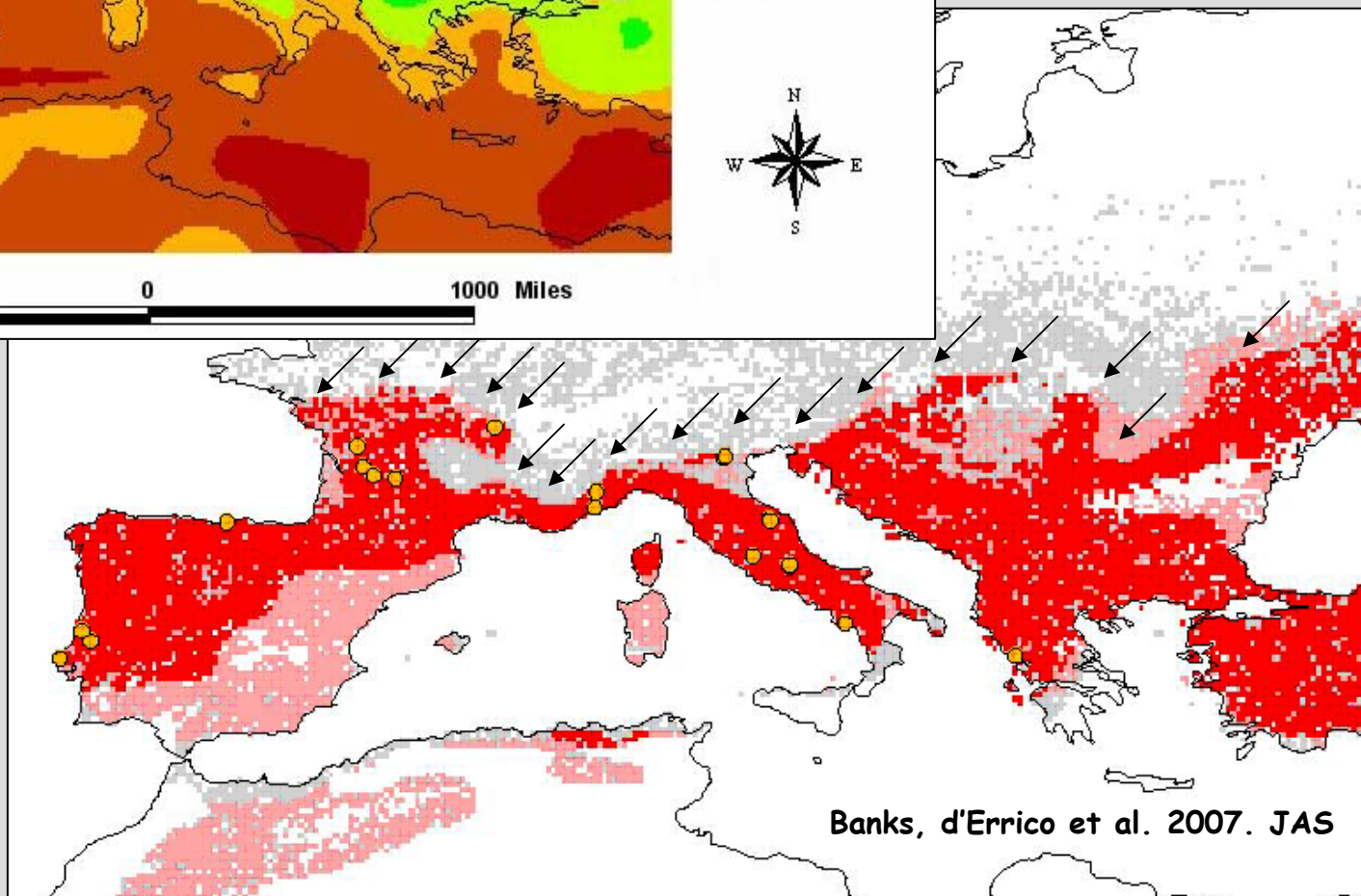


LGM Cold Month Temp.

PCA = 85% variability

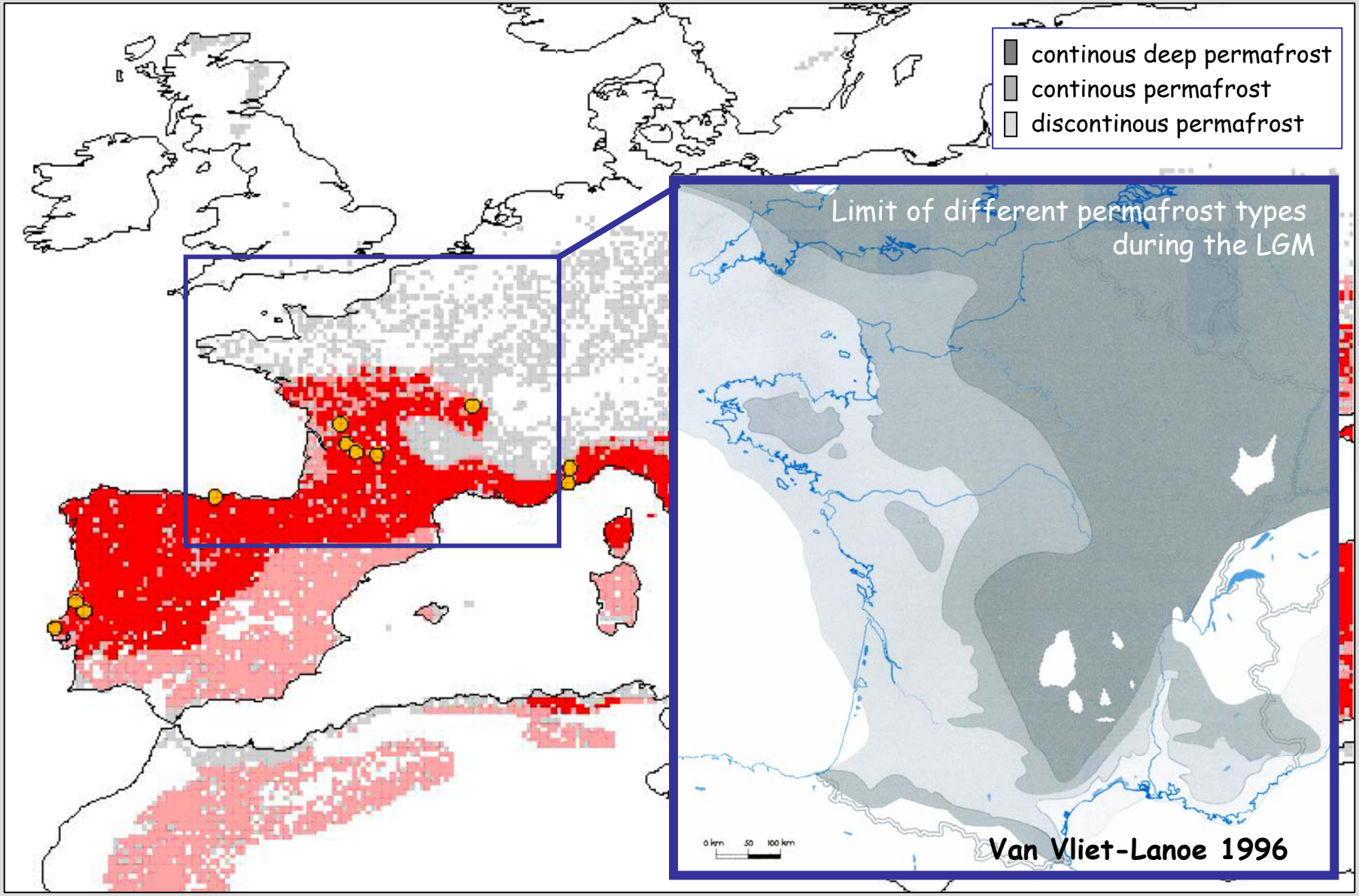
↓

First two components (temperatures)

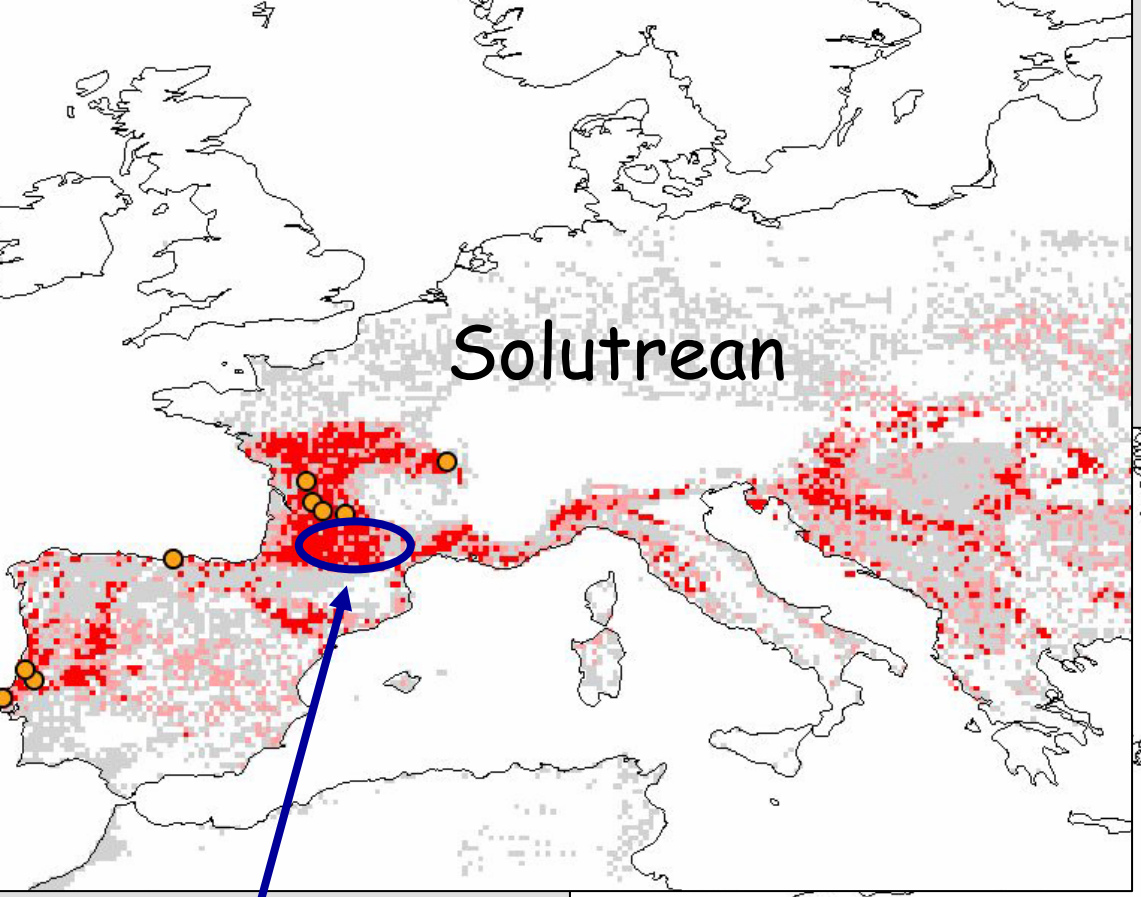


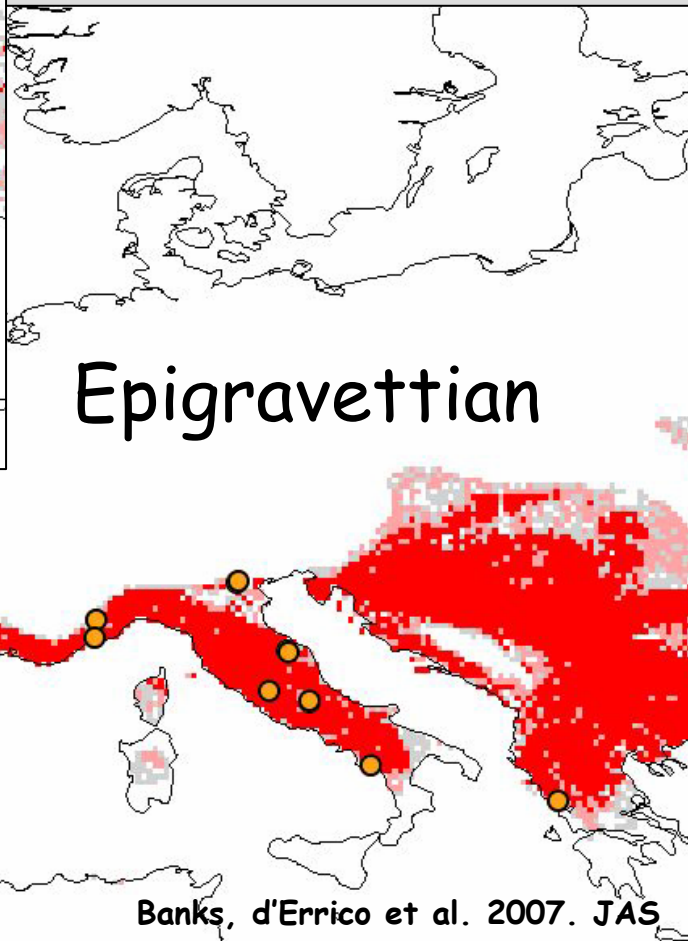
Banks, d'Errico et al. 2007. JAS

LGM Modeling Results



LGM RESULTS (cont.)



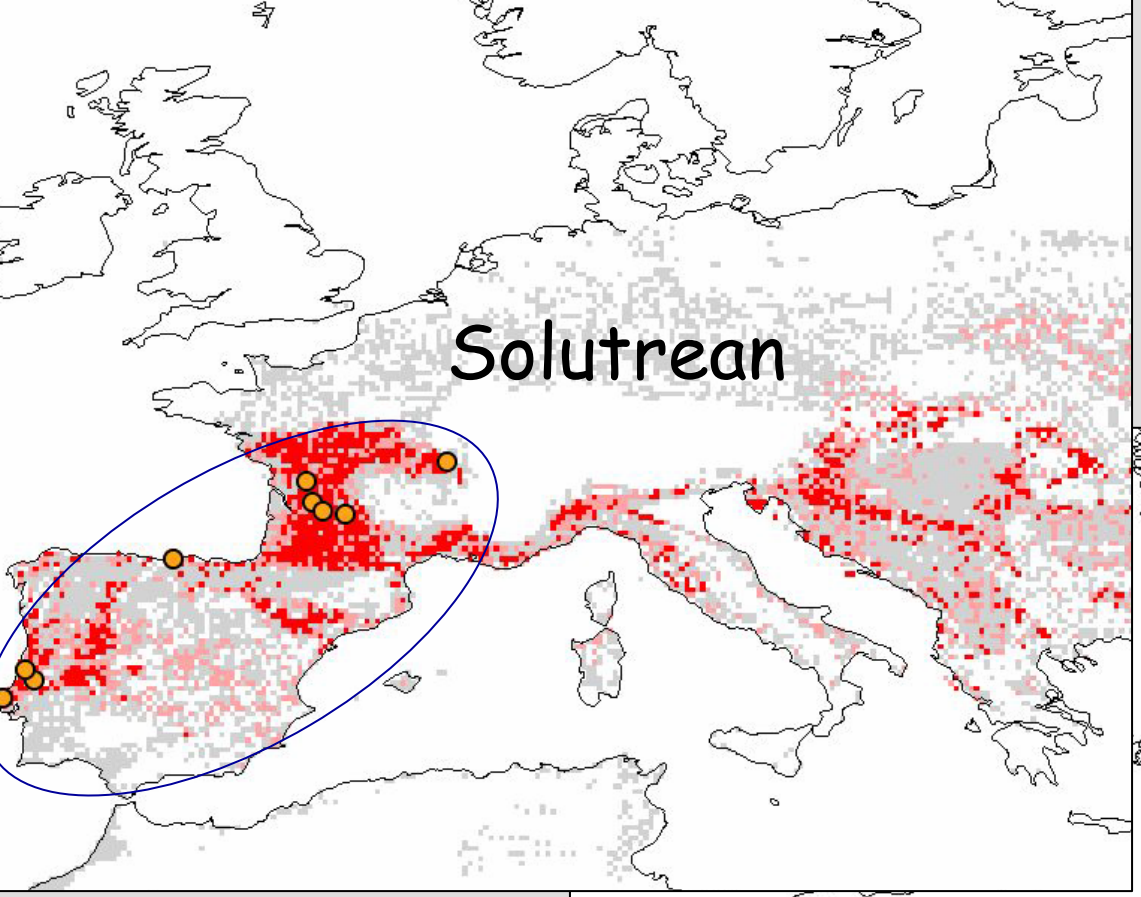


Little overlapping

↓

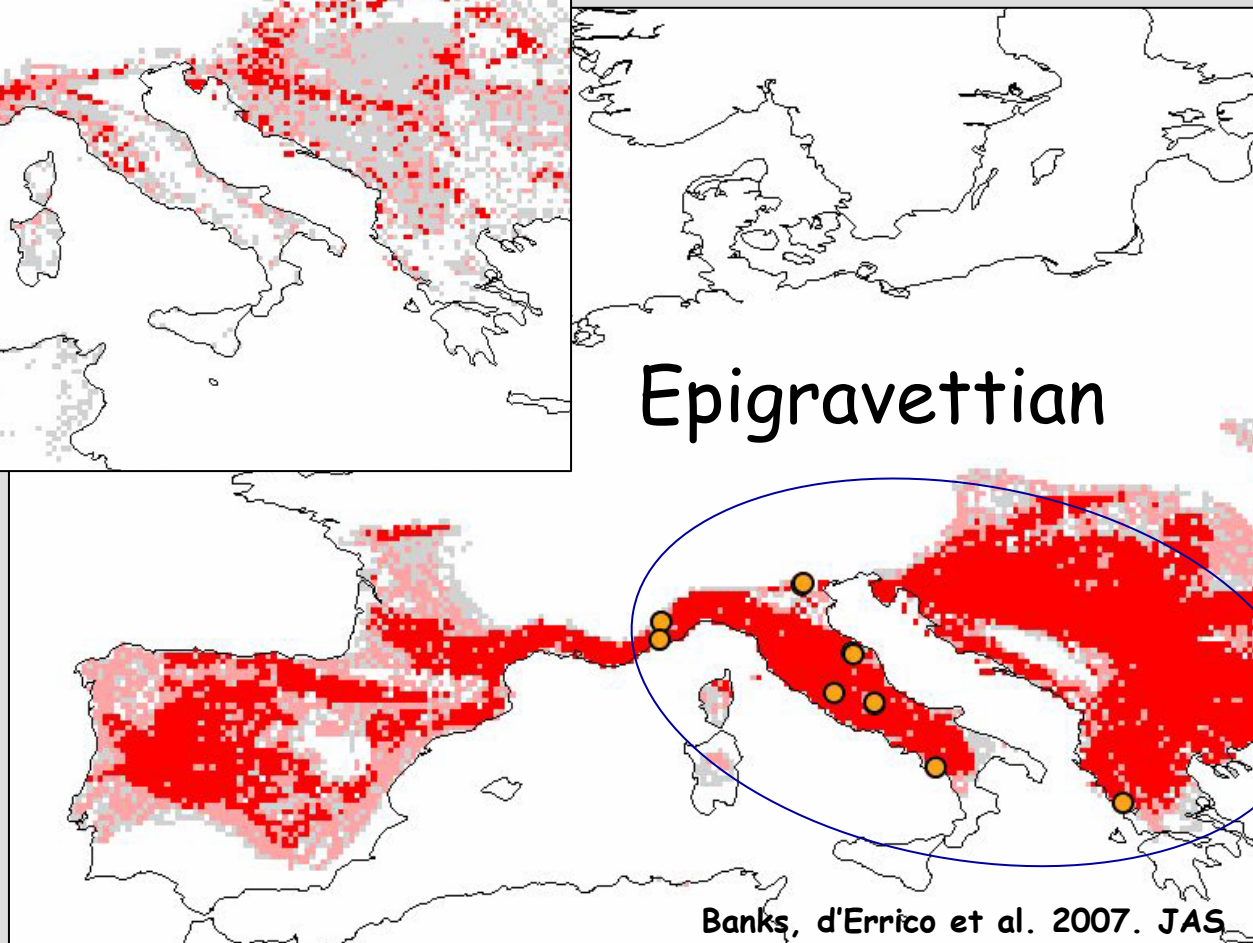
Adaptation to different environments

Banks, d'Errico et al. 2007. JAS

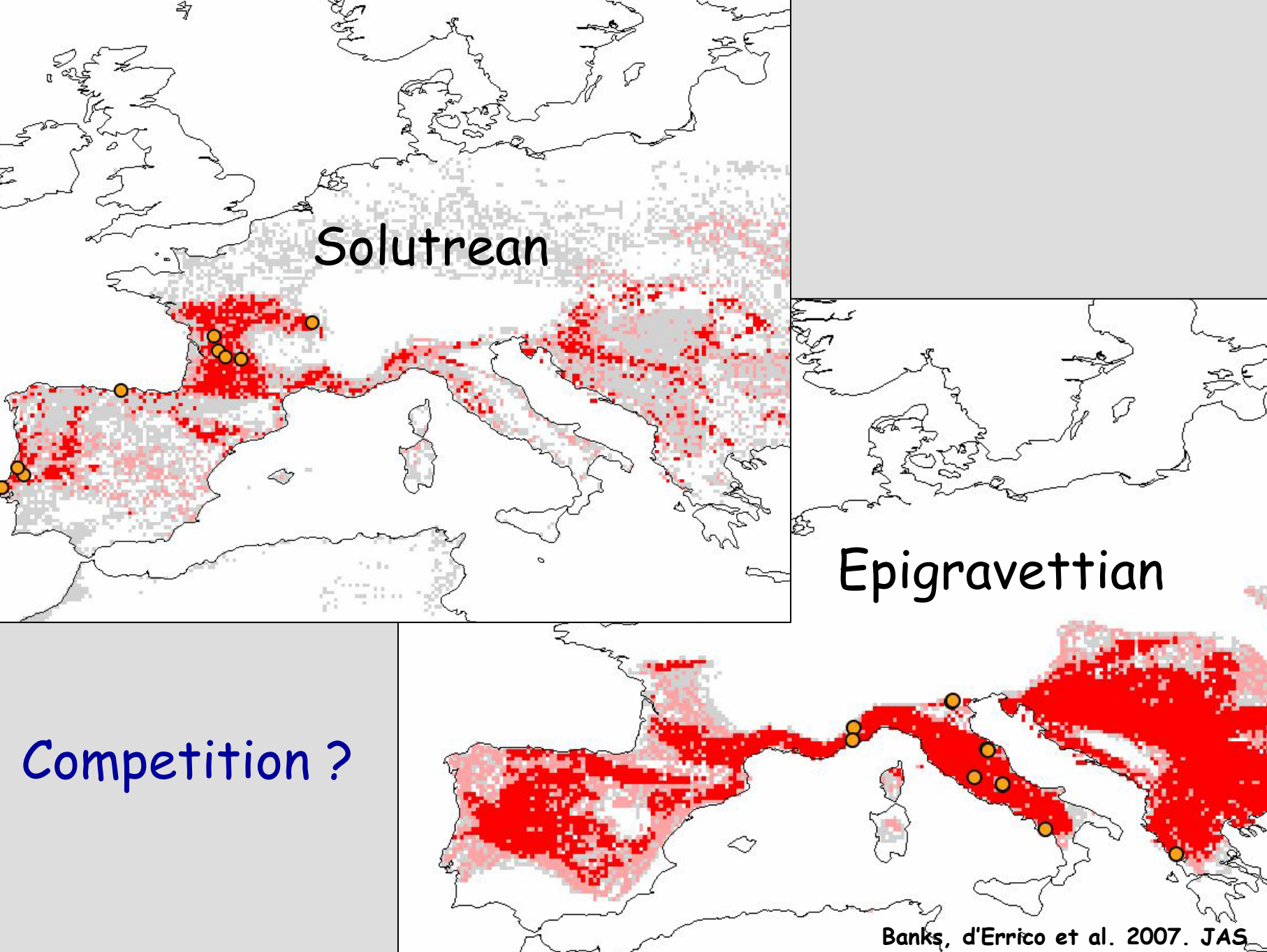


- Solutrean corresponds to known archaeological distribution

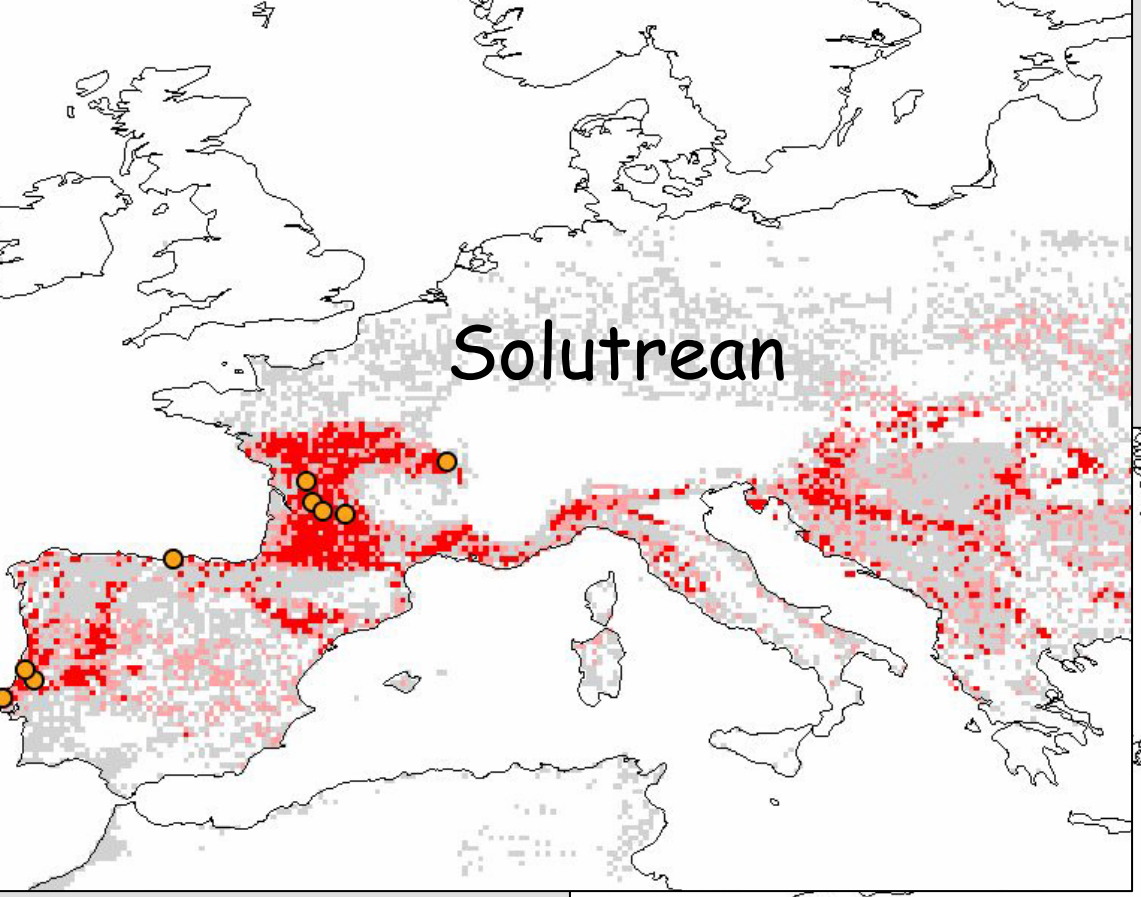
- Epigravettian is broader than its archaeological distribution

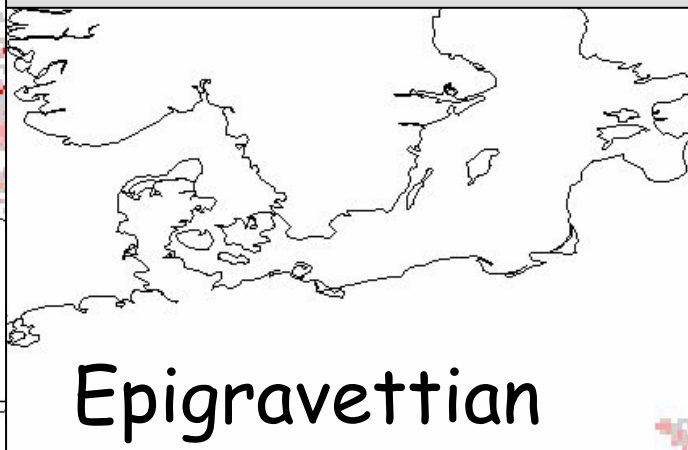


Banks, d'Errico et al. 2007. JAS

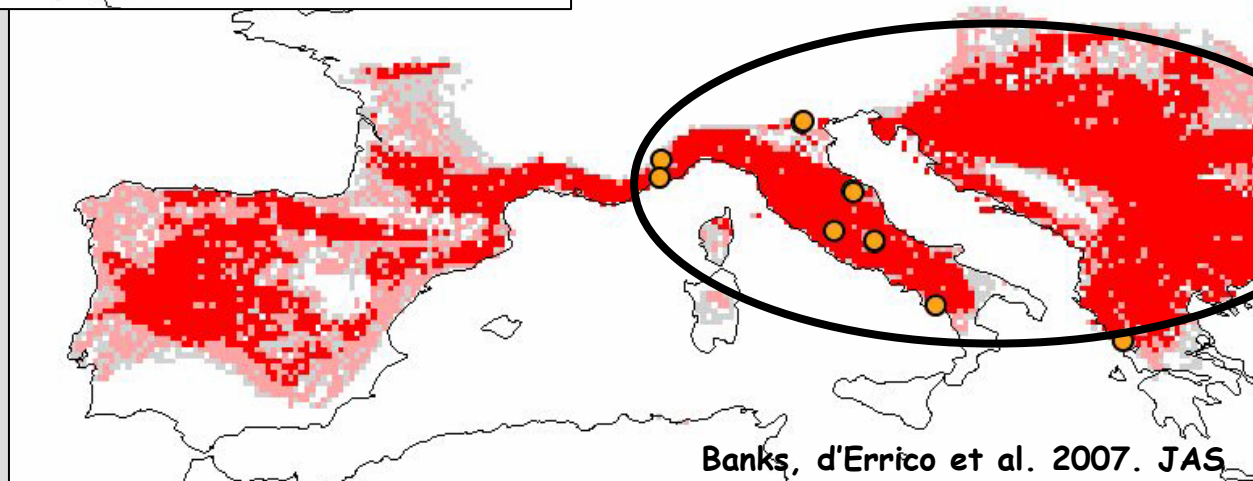

Solutrean
Epigravettian
Competition ?
Banks, d'Errico et al. 2007. JAS

Ecological risk





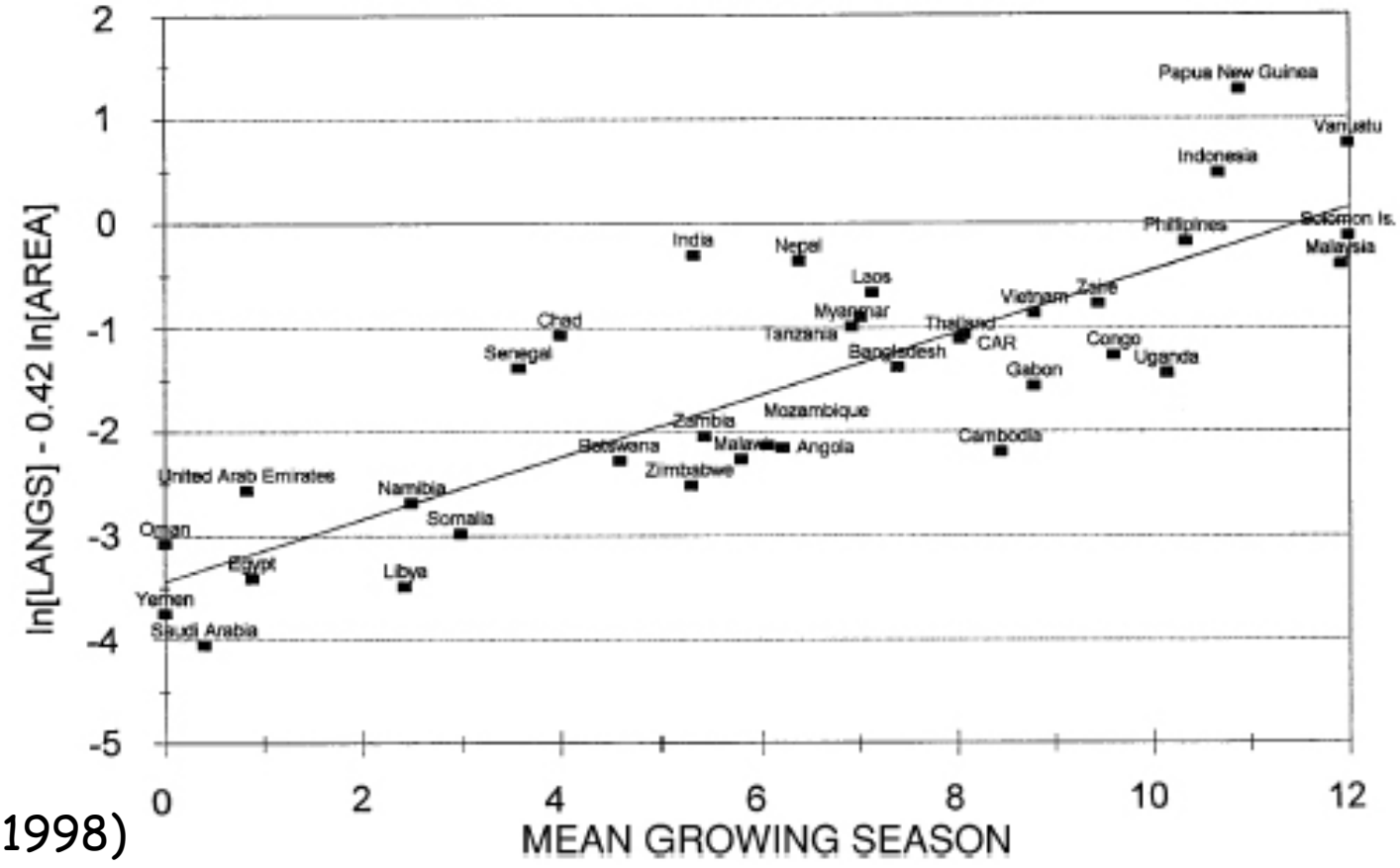
Competition ?



Banks, d'Errico et al. 2007. JAS

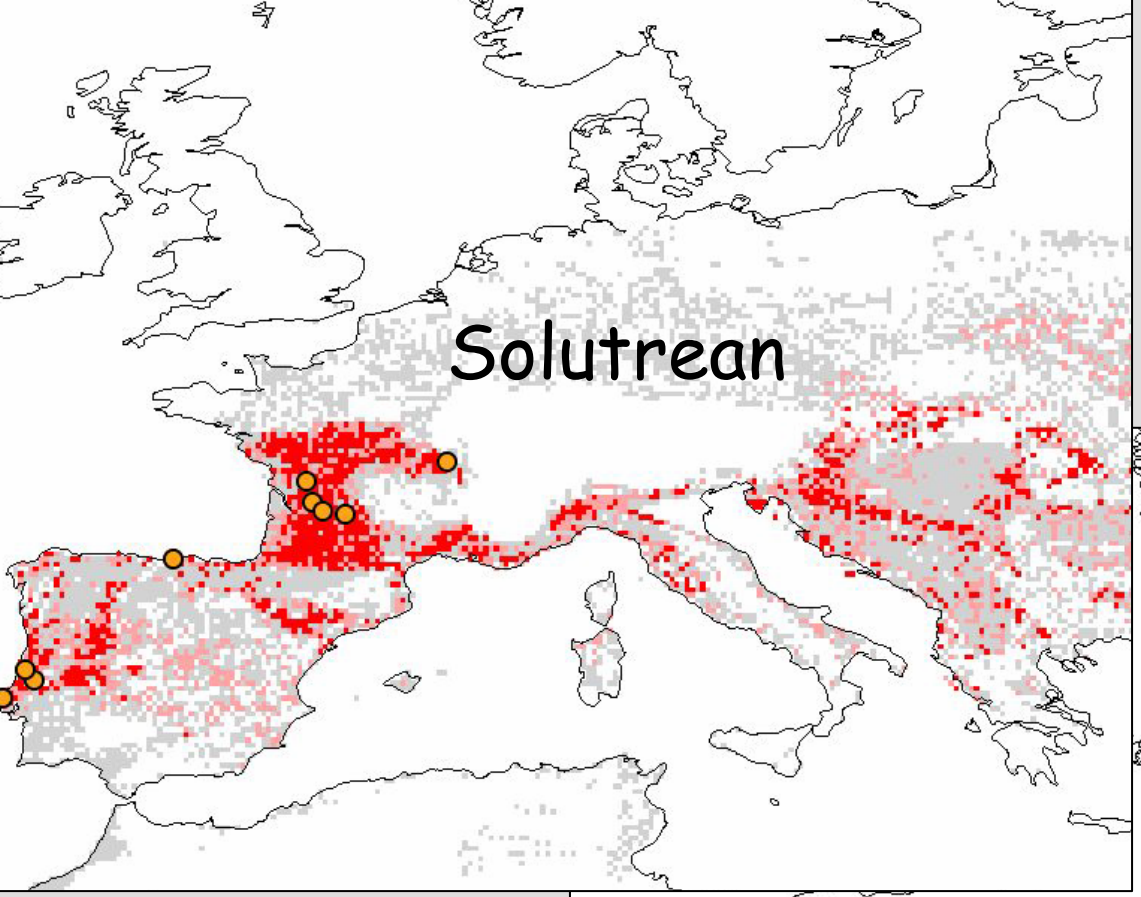
Nettle (1998), Mace & Pagel (1995)

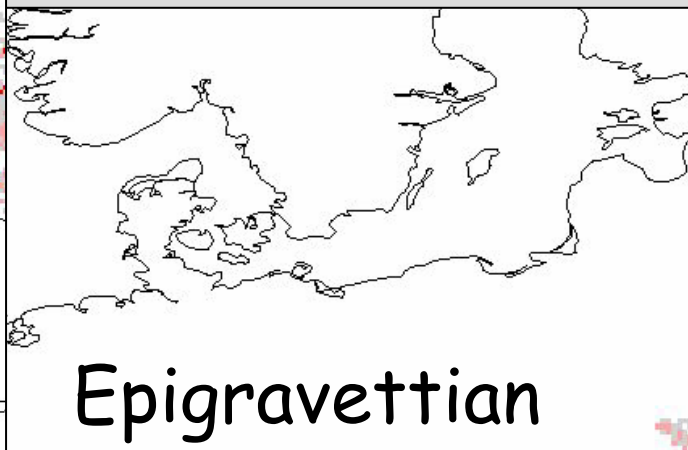
Linguistic diversity is linearly correlated with the ecological risk



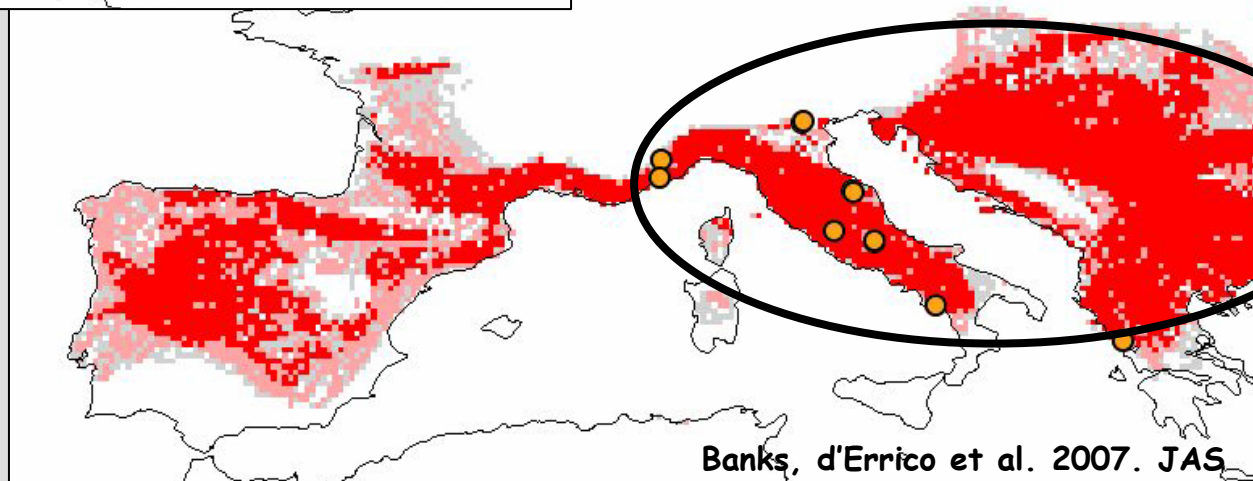
Nettle (1998)

Ecological risk

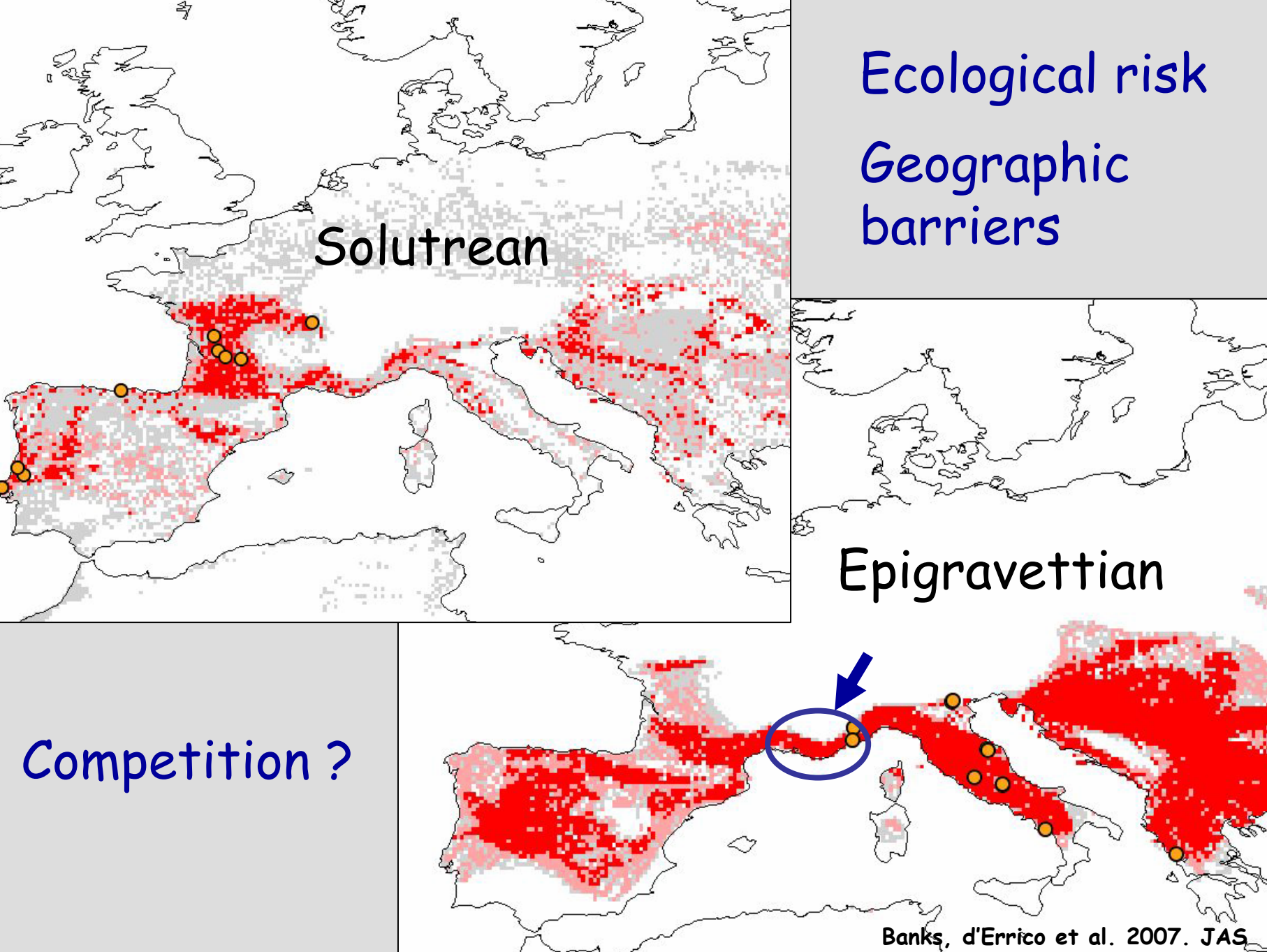




Competition ?

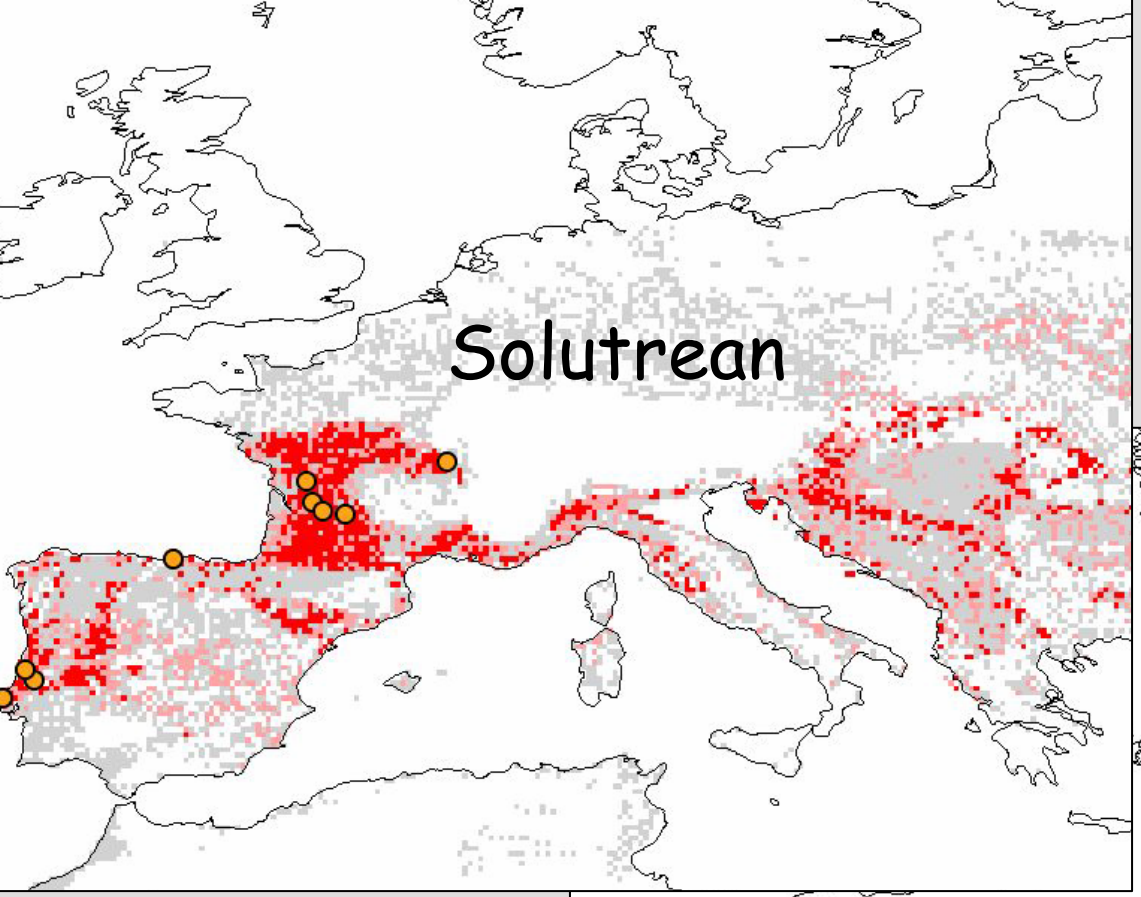


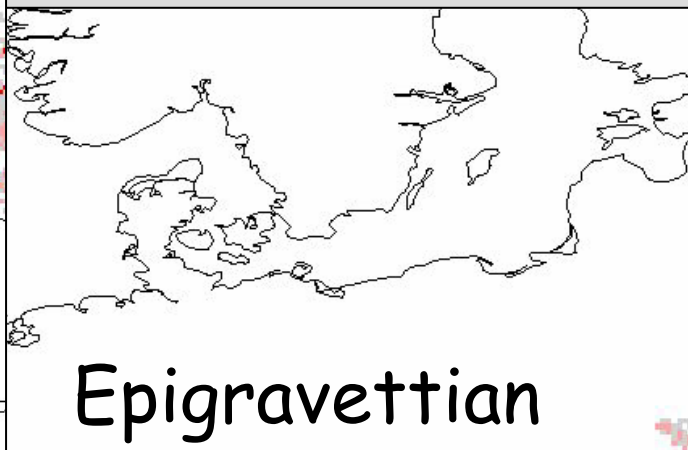
Banks, d'Errico et al. 2007. JAS


Ecological risk
Geographic barriers
Solutrean
Epigravettian
Competition ?
Banks, d'Errico et al. 2007. JAS

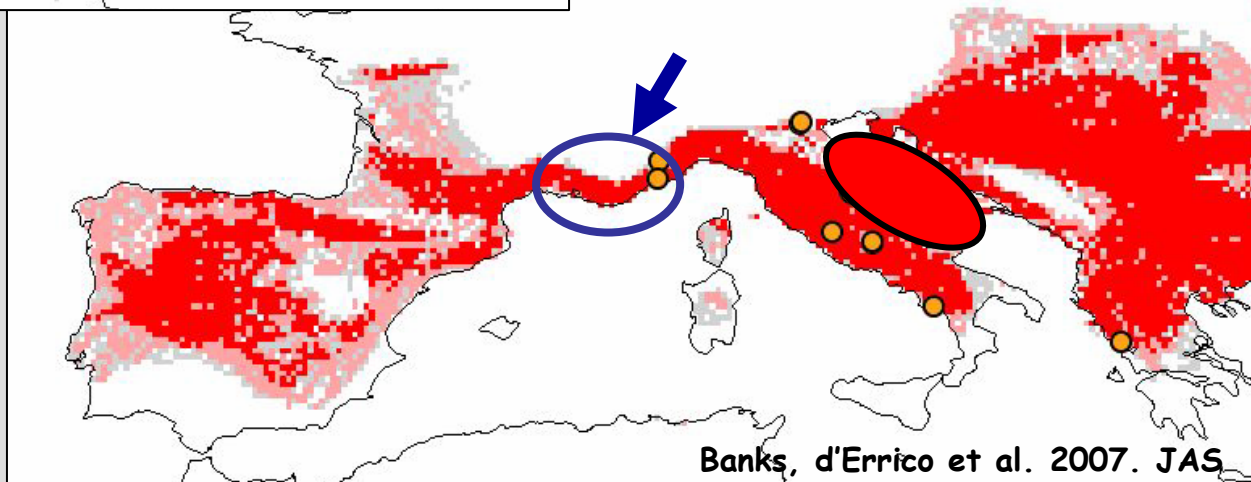
Ecological risk

Geographic barriers

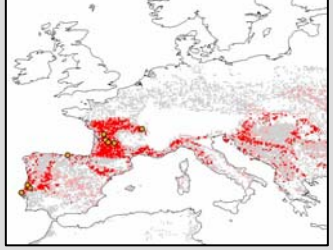




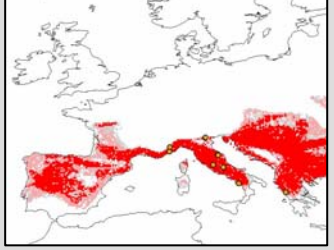
Competition ?



Banks, d'Errico et al. 2007. JAS



Conclusions



GARP consistently outline the northern boundary of human presence at 22,000–20,000 cal BP

This boundary is mainly determined by climatic constraints and corresponds well to known southern limits of periglacial environments and permafrost conditions during the LGM

Solutrean and Ancient Epigravettian are adapted to two different ecological regimes

Differences between predicted ecological niches and known ranges of the Solutrean and Epigravettian are interpreted as reflecting influences of ecological risk on geographic distributions of cultures

Banks, d'Errico et al. 2007. JAS