Neolithic spread rates at different scales: Europe and the Near East versus the Mediterranean

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Two scales

- Scale 1 = LARGE: Europe and the Near East

  distance=? time=?

  Neolithic spread rate=?

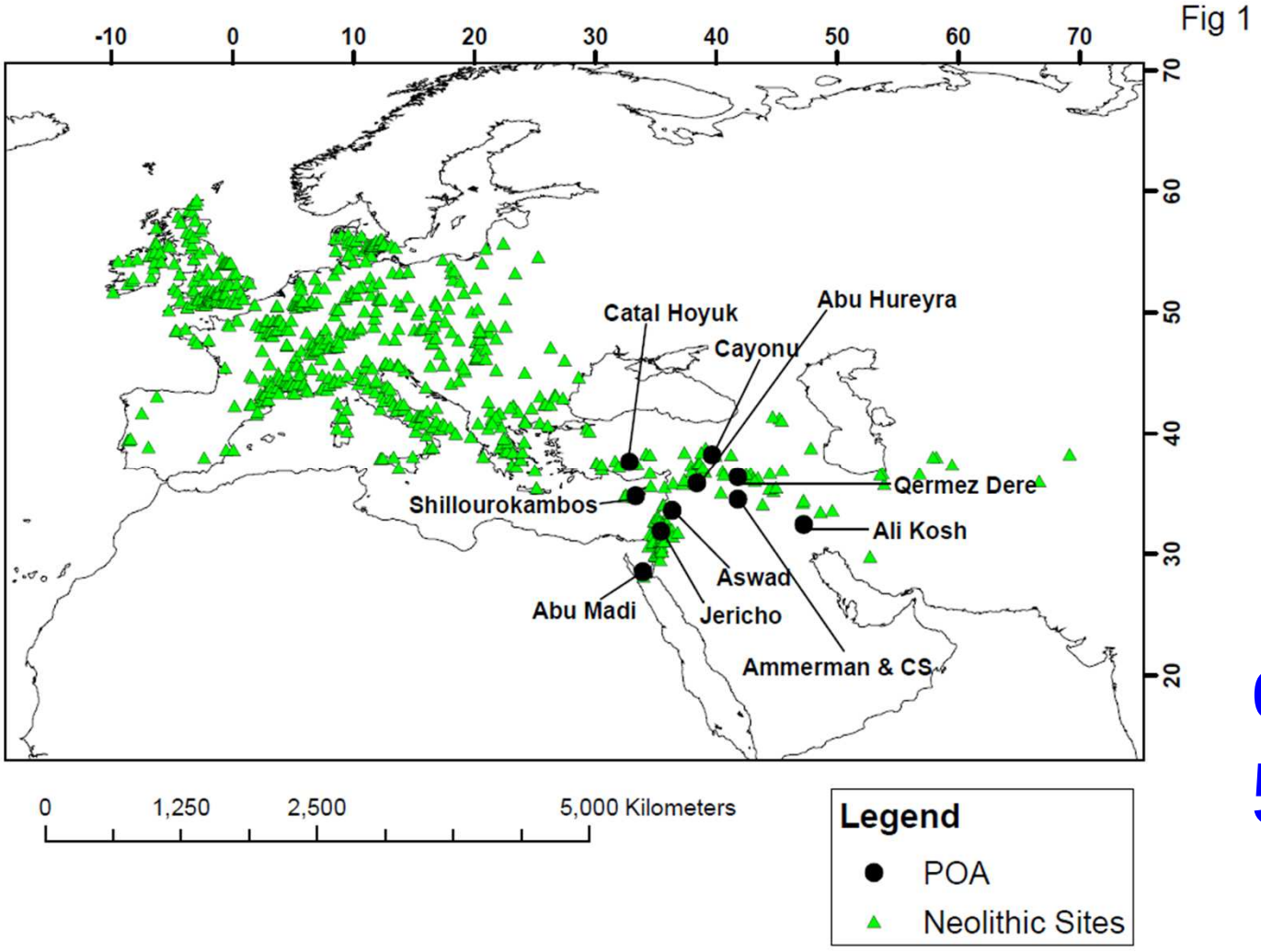
- Scale 2 = SMALL: The Western Mediterranean

  distance=? time=?

  Neolithic spread rate=?

- Are both spread rates different? Why?

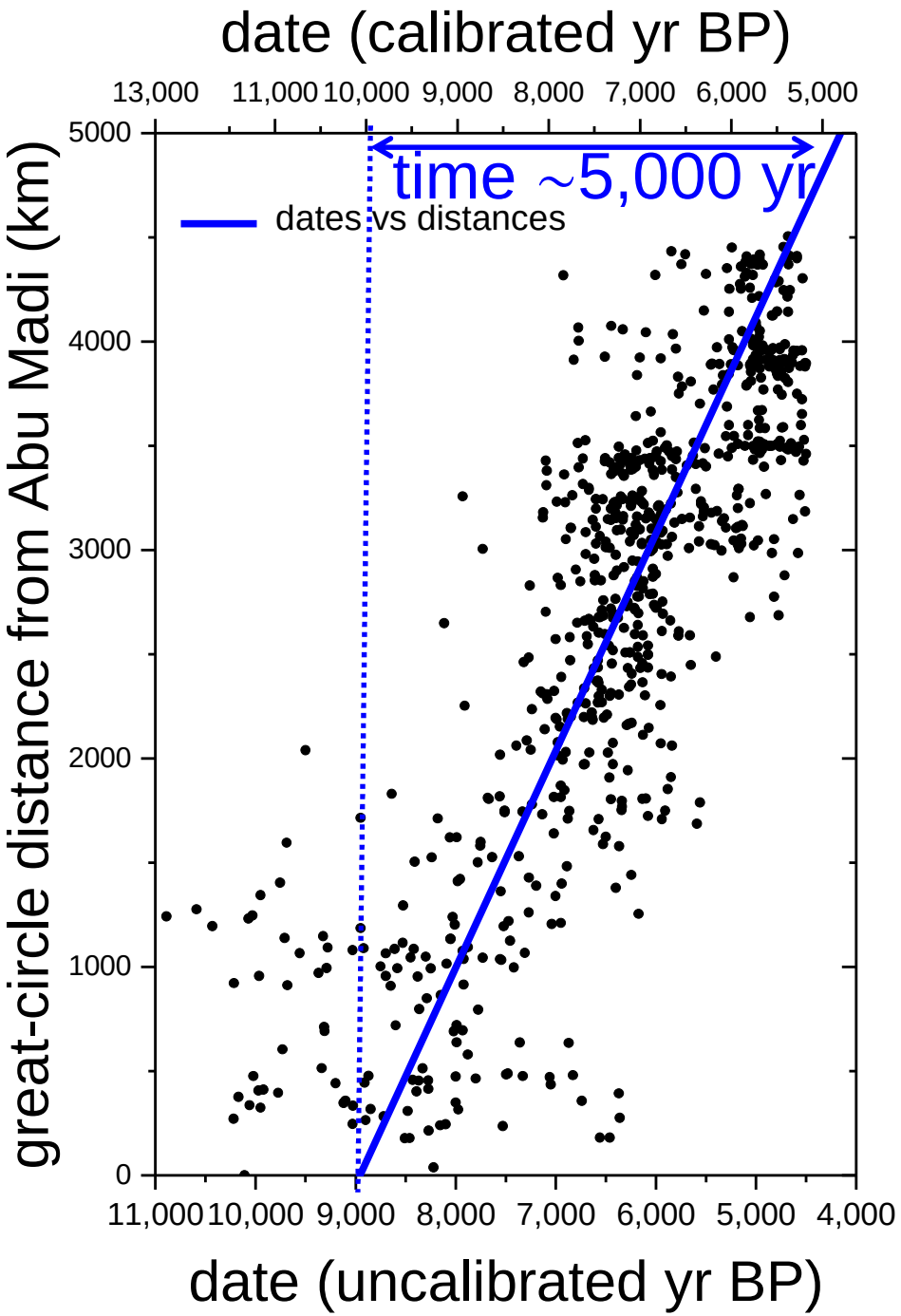
Scale 1 = LARGE:
Europe and the Near East



735 sites

Pinhasi, Fort & Ammerman, *PLoS Biol.* (2005)

distance~ 5,000 km



Scale 1 = LARGE: Europe and the Near East

time ~5,000 yr

rate= 0.9-1.1 km/yr

735 sites in Europe & Near East

r = 0.83: highest-*r* origin (Abu Madi):

slopes of dates vs distances:

uncalibrated: 1.0-1.1 km/yr;

calibrated: 0.9-1.0 km/yr

Pinhasi, Fort & Ammerman,

PLoS Biol. (2005)

Scale 1 = LARGE

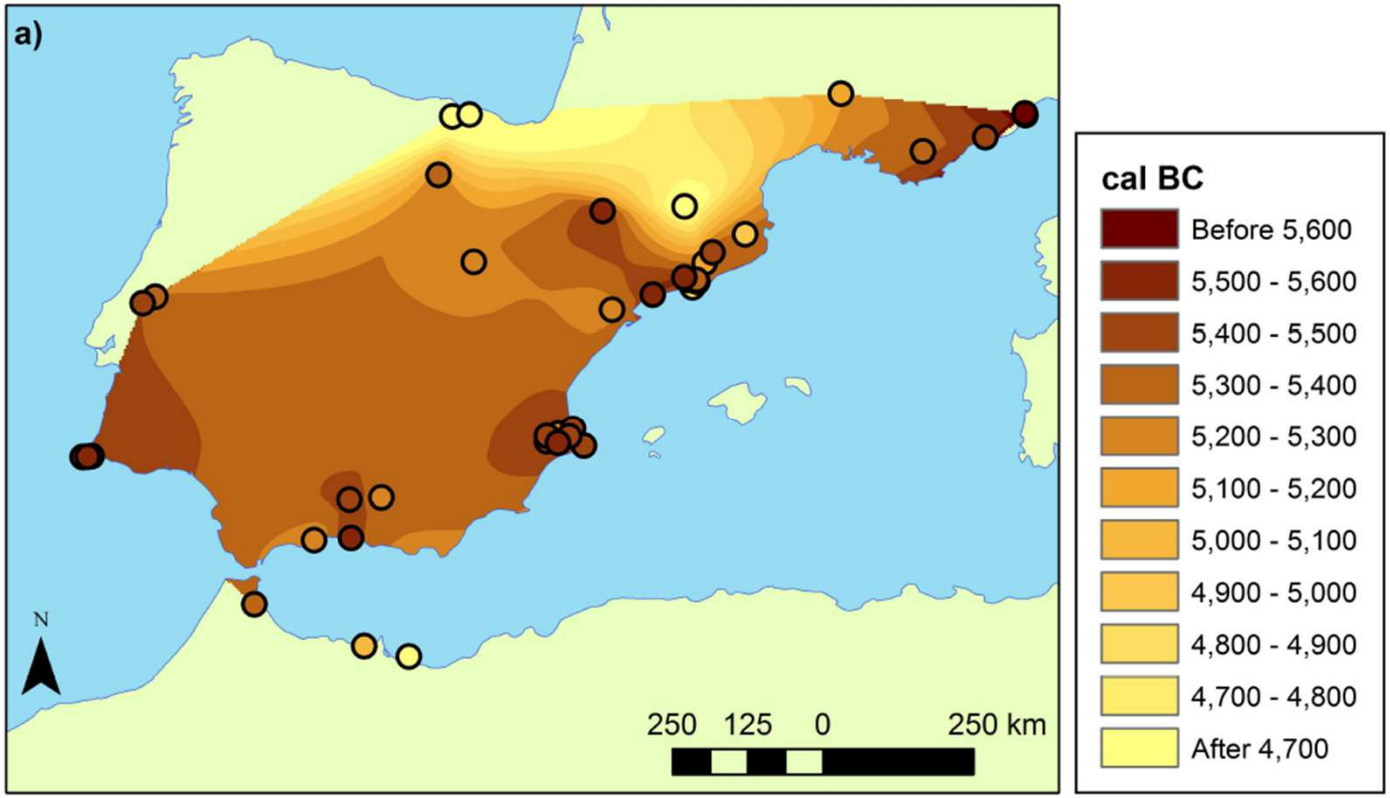
Europe and the Near East

distance~5,000 km

time~5,000 yr

Neolithic spread rate~1.0 km/yr

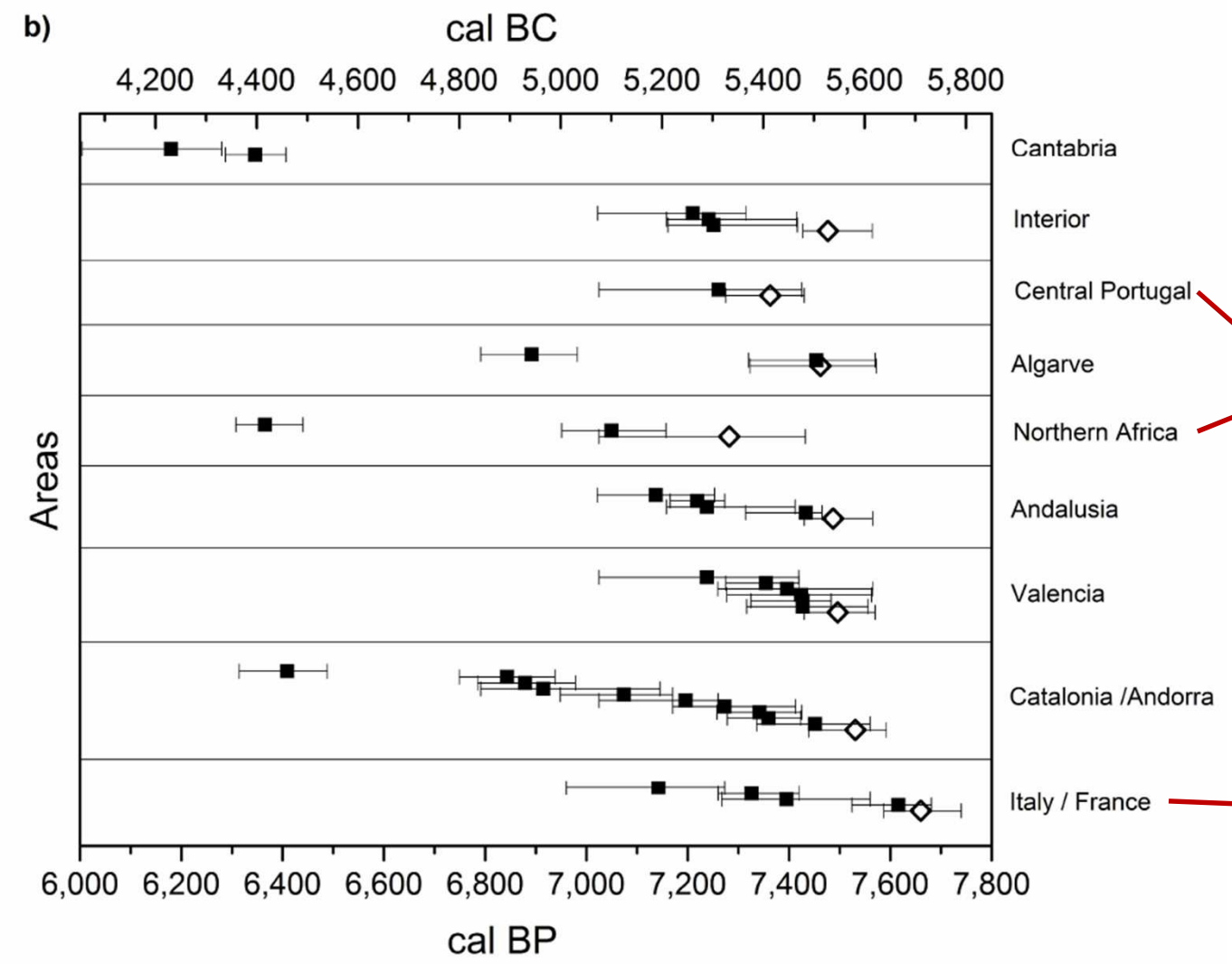
Scale 2 =SMALL
Western Mediterranean



Isern, Zilhao, Fort & Ammerman, *PNAS* 2017

Even if mesuring distances along the coast, the maximum distance is ~2,500 km

Scale 2 =SMALL
Western Mediterranean

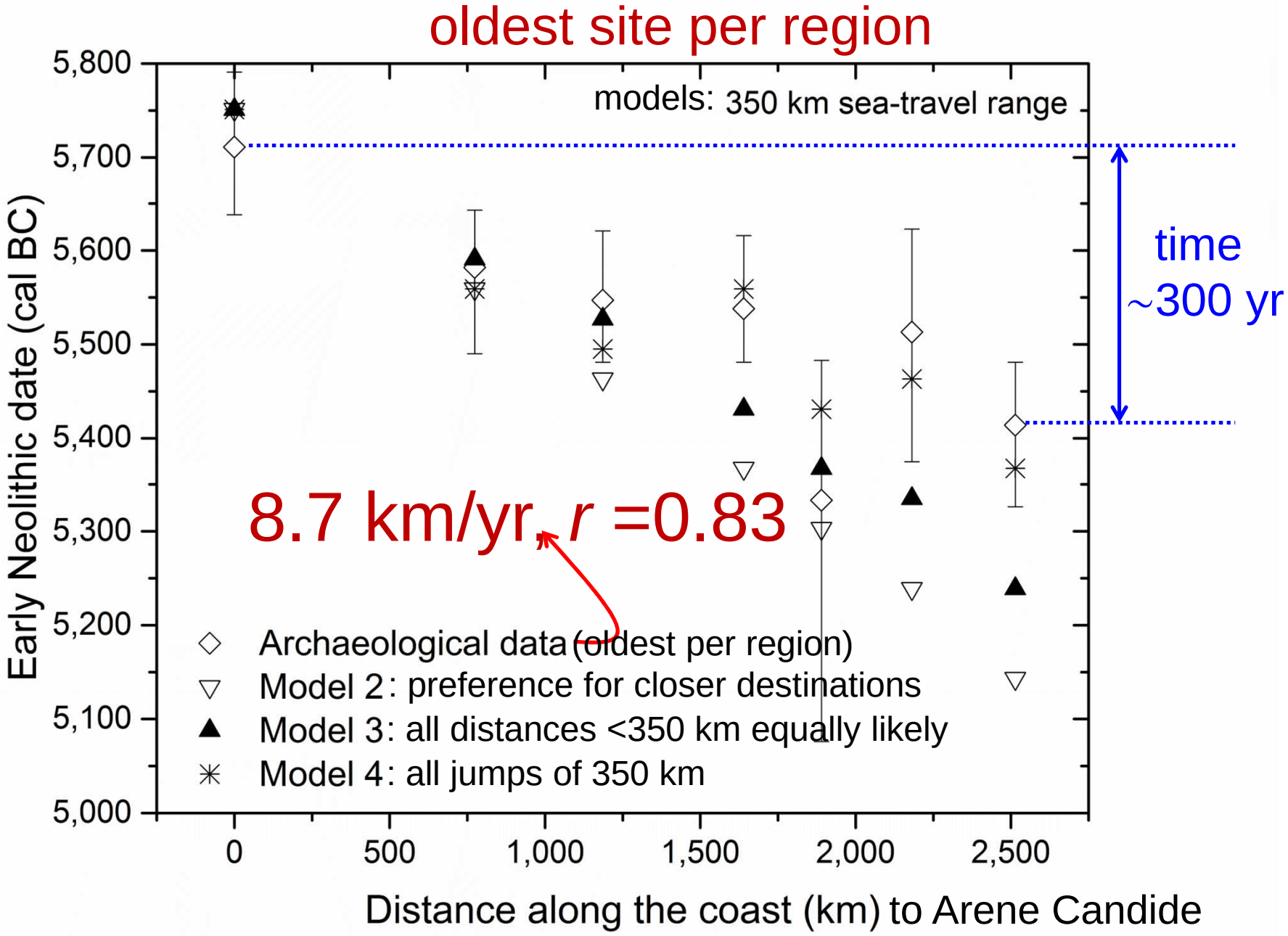


◇ oldest site per region

RECENT

OLD

Scale 2 = SMALL = Western Mediterranean



Scale 1 = LARGE: Europe and the Near East

distance~5,000 km

time~5,000 yr

Neolithic spread rate~1.0 km/yr

Scale 2 = SMALL: The Western Mediterranean

distance~2,500 km

time~300 yr

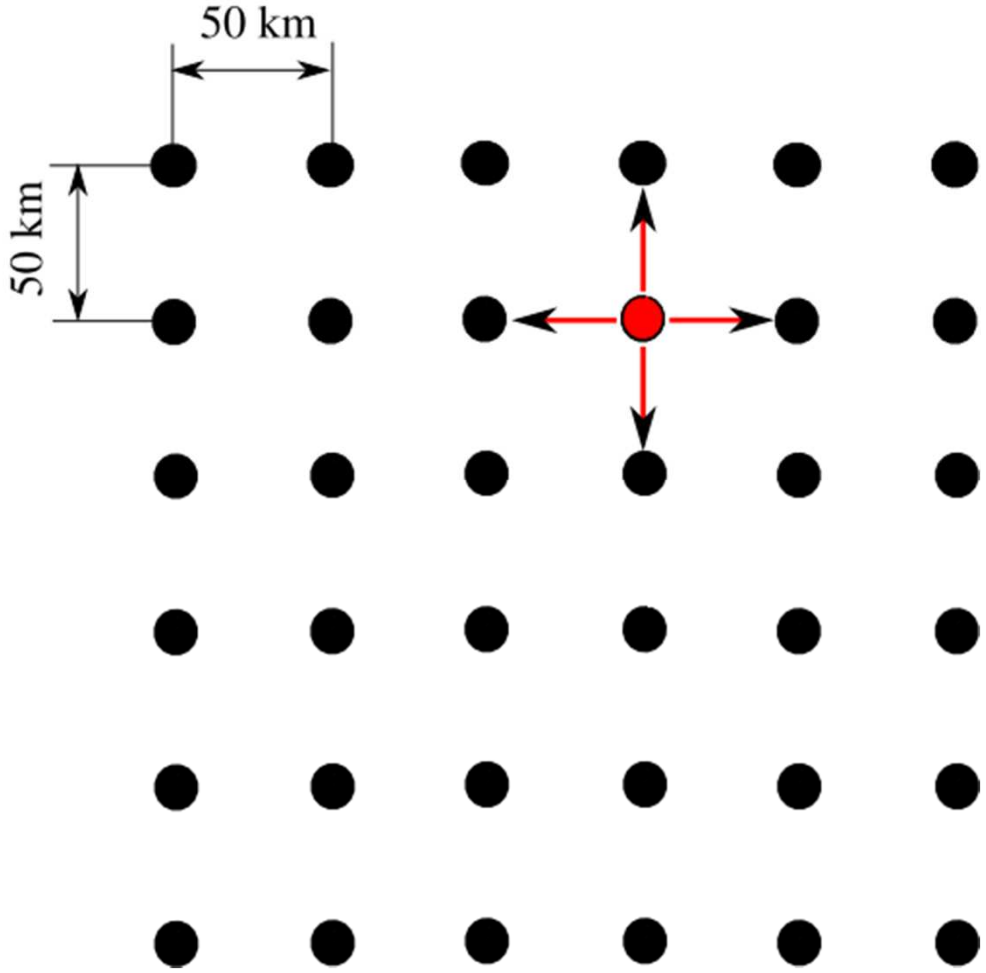
Neolithic spread rate~8.7 km/yr

Very different spread rates→The scale is very important!

Why different rates?

Scale 1 = LARGE: Europe and the Near East

Homogeneous model



$0<p_e<1$ persistence

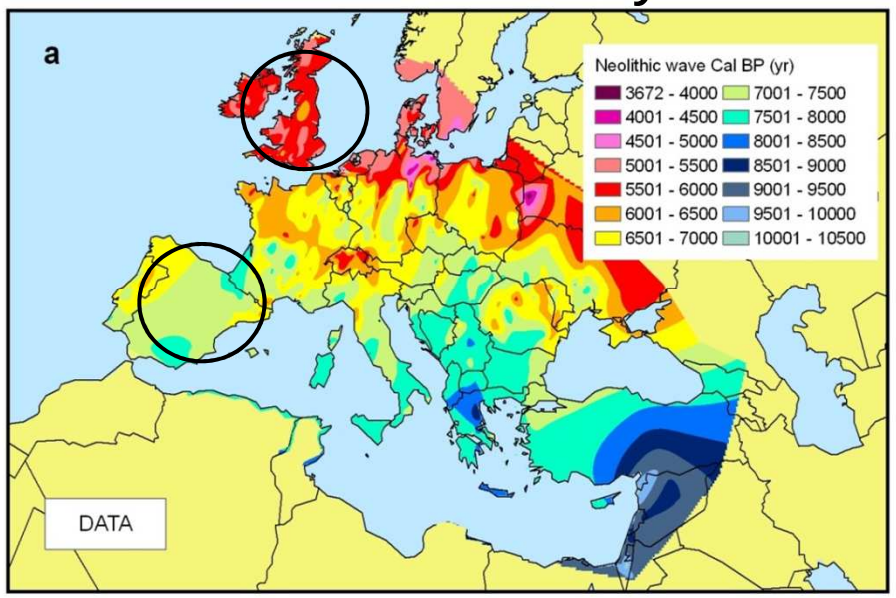
a fraction p_e stays

$(1-p_e)/4$ move in each direction

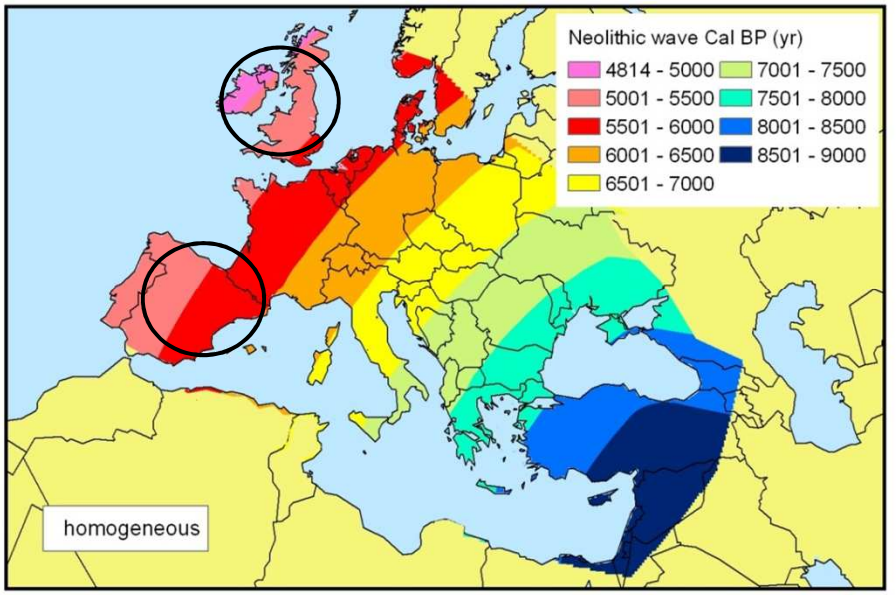
$P(t+1)=Ro\ P(t)$

Pre-industrial farmers:
Reproduction: Ro=2.2
per generation (32 yr)
p_e= 0.38, d= 50 km

DATA → 1 km/yr



HOMOGENEOUS MODEL → 1 km/yr

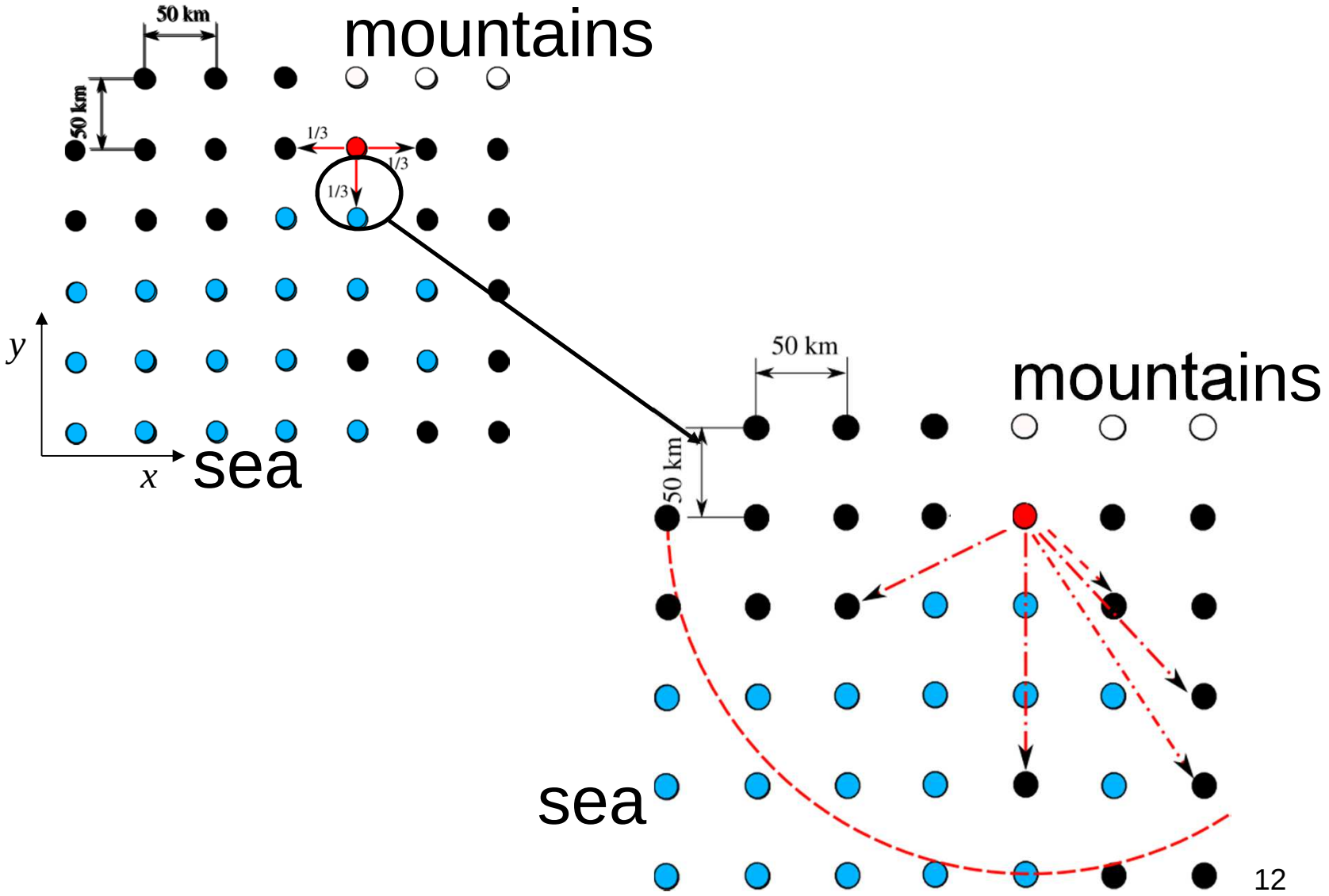


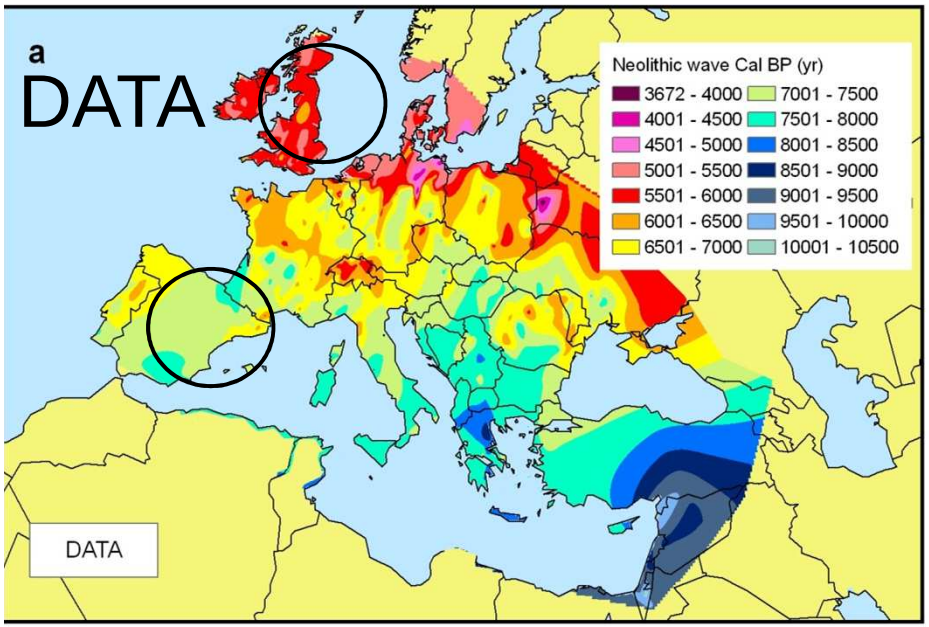
The homogeneous model (with jumps of 50 km, from ethnographic data) agrees with the average observed speed but not with local features (circles).

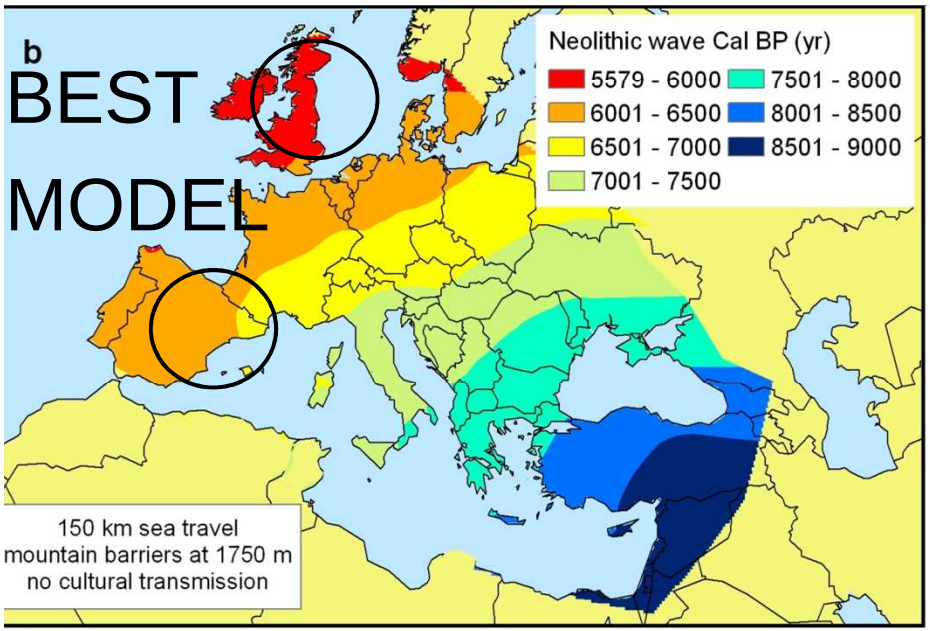
Fort, Pujol & vander Linden, *Amer. Antiq.* (2012)

Scale 1 = LARGE: Europe and the Near East

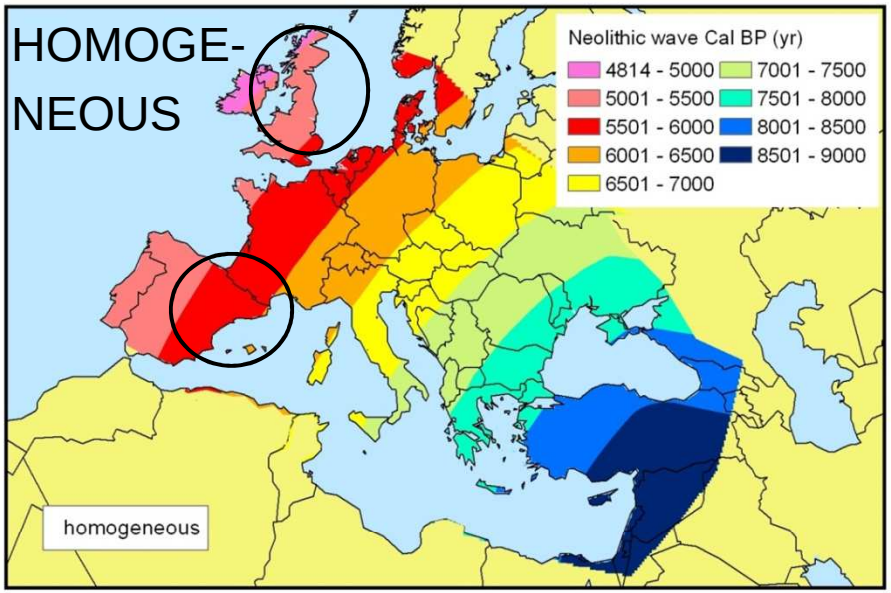
Non-homogeneous models





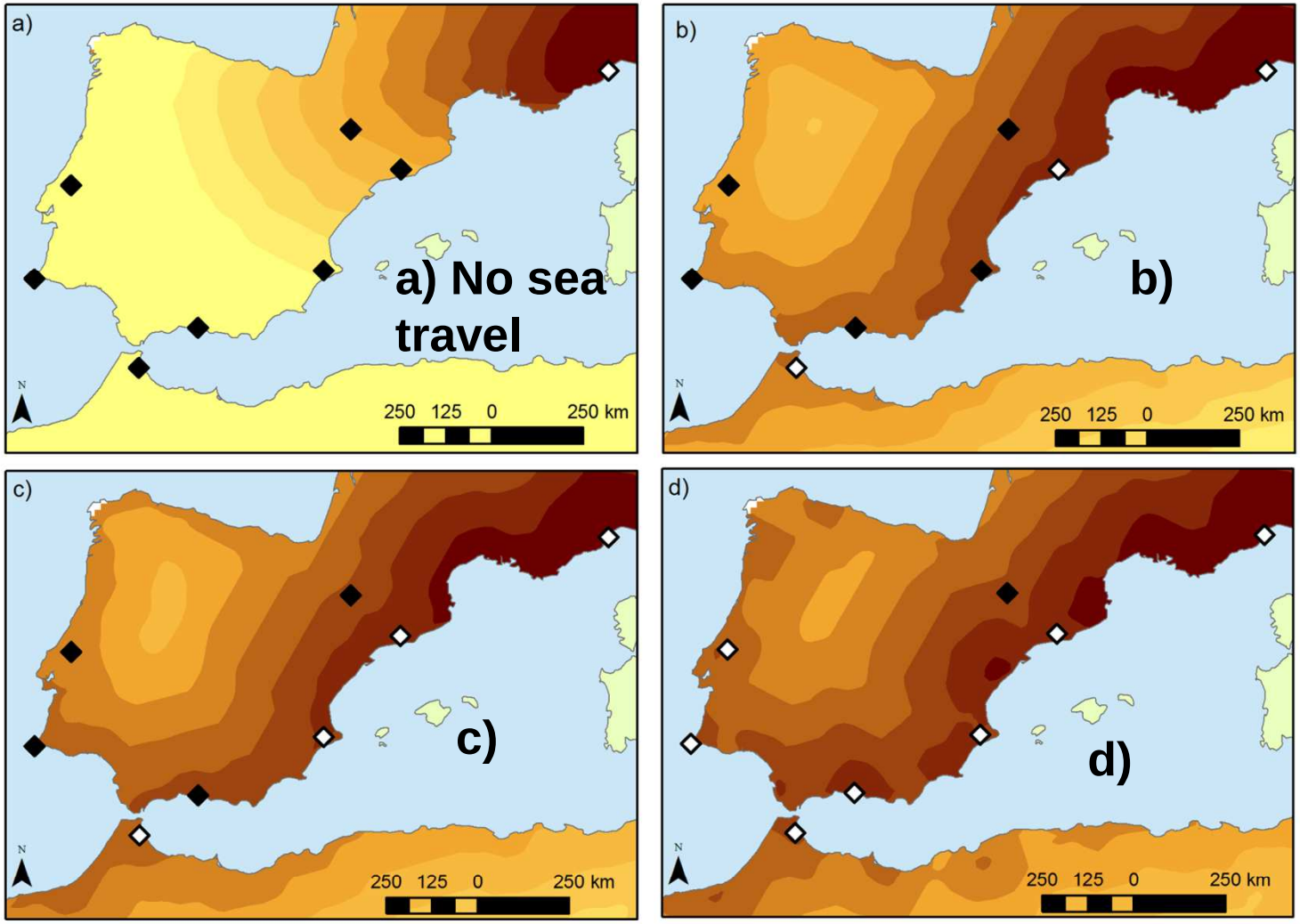


Circles indicate better agreement than for the homogeneous model



Fort, Pujol & vander Linden
Amer. Antiq. (2012)

Scale 2 = SMALL = Western Mediterranean



◇ **within range**

◆ **too late**

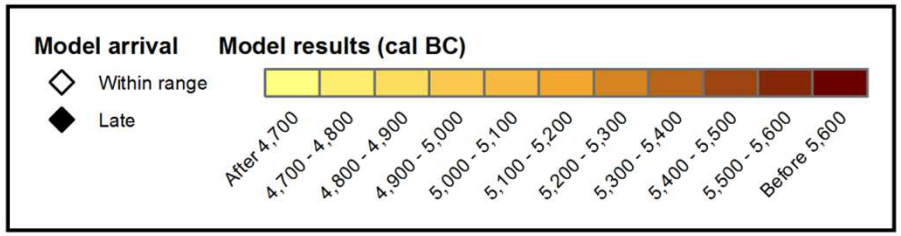
b)-d) Sea travel up to 350 km

b) preference for closer destinations

b) all distances within 350 km equally likely

b) all jumps of 350 km

Isern, Zilhao, Fort & Ammerman, *PNAS* 2017



CONCLUSIONS

- If we look at different scales, the Neolithic spread rates are very different: 1 km/yr vs 9 km/yr !
- Sea travel accelerates the spread substantially.
- This can be explained by different dispersal behaviors for the population: 50 km/generation for inland travel vs. 350 km/generation for sea travel.
- These conclusions can be reached only by performing analyses at different scales.