Session A25e

Dynamics of human and cultural dispersals during the Neolithic transition in Europe: Complex Systems and Prehistory

Demic versus Cultural Diffusion in the Neolithic transition in Europe and southern Africa

SimulPast
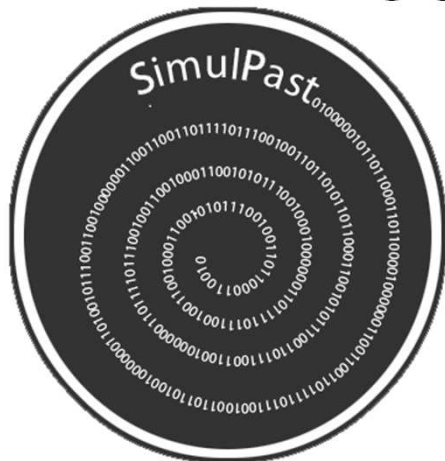
Fort, Joaquim. Universitat de Girona (joaquim.fort@udg.edu);

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Isern, Neus. Universitat Autònoma de Barcelona (neus.isern@uab.cat)

Acculturation

Cavalli-Sforza & Feldman (*book* 1979)
Boyd & Richerson (*book* 1985)
Fort (*PNAS* 2012)

Population numbers after *(P')* and before *(P)* cultural transmission (during 1 generation):

$$\text{farmers } (F): \quad P'_F = P_F + f\,\frac{P_F P_H}{P_F + \gamma P_H}$$

$$\text{hunter} - \text{gatherers } (H): \quad P'_H = P_H - f\,\frac{P_F P_H}{P_F + \gamma P_H}$$

f = intensity of cultural transmission

γ = preference of *H*s to copy *F*s rather than *H*s (if $\gamma < 1$)

Lotka-Volterra eqs. $(P'_F = P_F + \eta P_F P_H)$ are <u>not</u> realistic as:

· they are not derived from cultural transmission theory

· they yield, e.g.: if $P_H \to \infty$, then $\frac{P'_F - P_F}{P_F} \to \infty$!!

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$$\begin{cases} P_F' = P_F + f\dfrac{P_F P_H}{P_F + \gamma P_H} \approx P_F + C\, P_F \\[4mm] P_H' = P_H - f\dfrac{P_F P_H}{P_F + \gamma P_H} \approx P_H - C\, P_F \end{cases}$$

$$C = \frac{f}{\gamma}$$

if $P_H \gg P_F$, then

$\dfrac{P_F' - P_F}{P_F} = C$ is the number of *H*s converted by farmer

$\dfrac{P_F' - P_F}{P_F}$ is not ∞, in contrast to Lotka-Volterra eqs.

The front speed does not depend on f and γ separately, but only on $C = \dfrac{f}{\gamma}$.
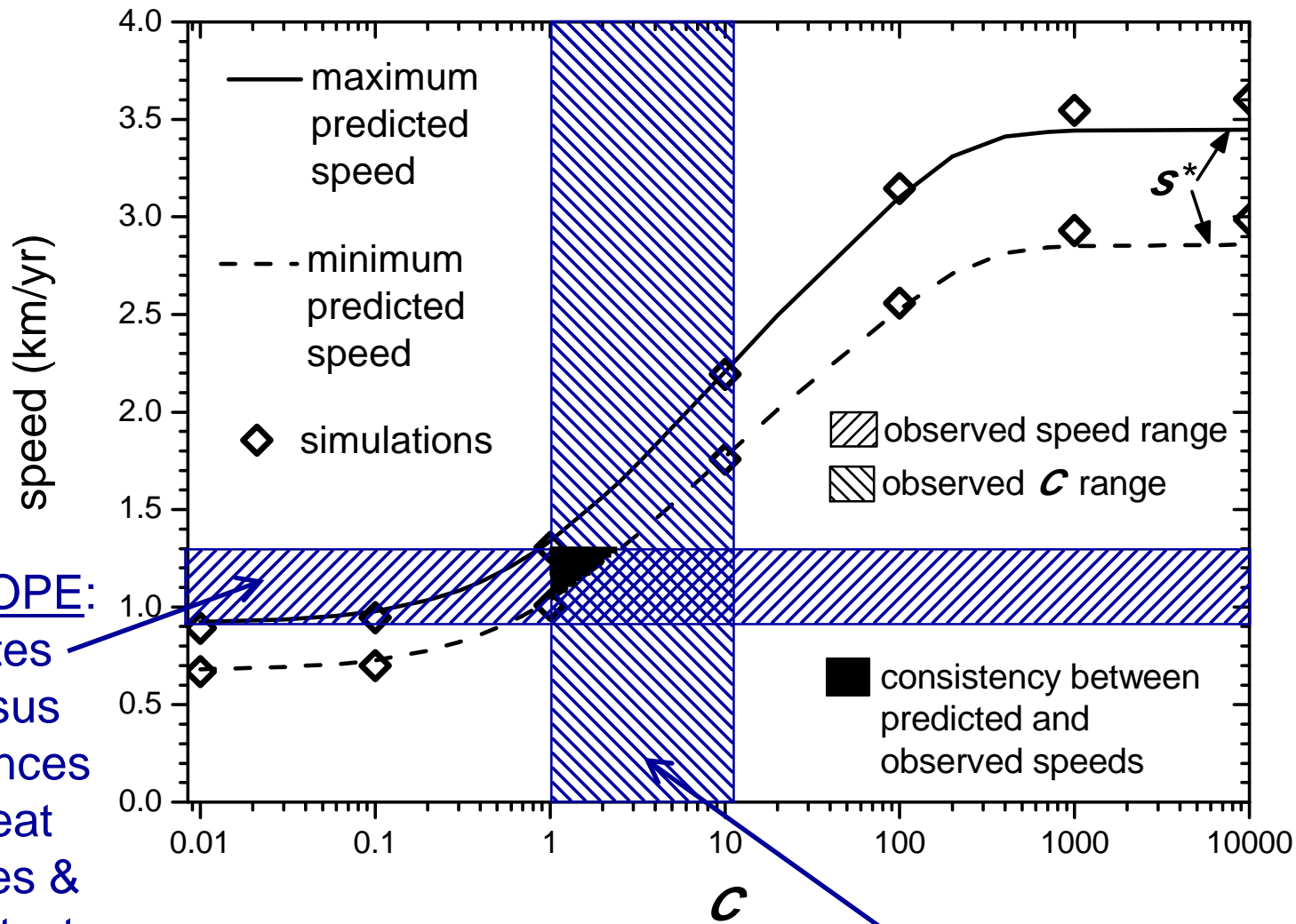
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Demic-cultural models

Steps:

1. reproduction (logistic)
2. cultural transmission (horizontal/oblique)
3. dispersal (distance kernel)

The order of events does not change the speed

This cycle is repeated many times (once per generation)

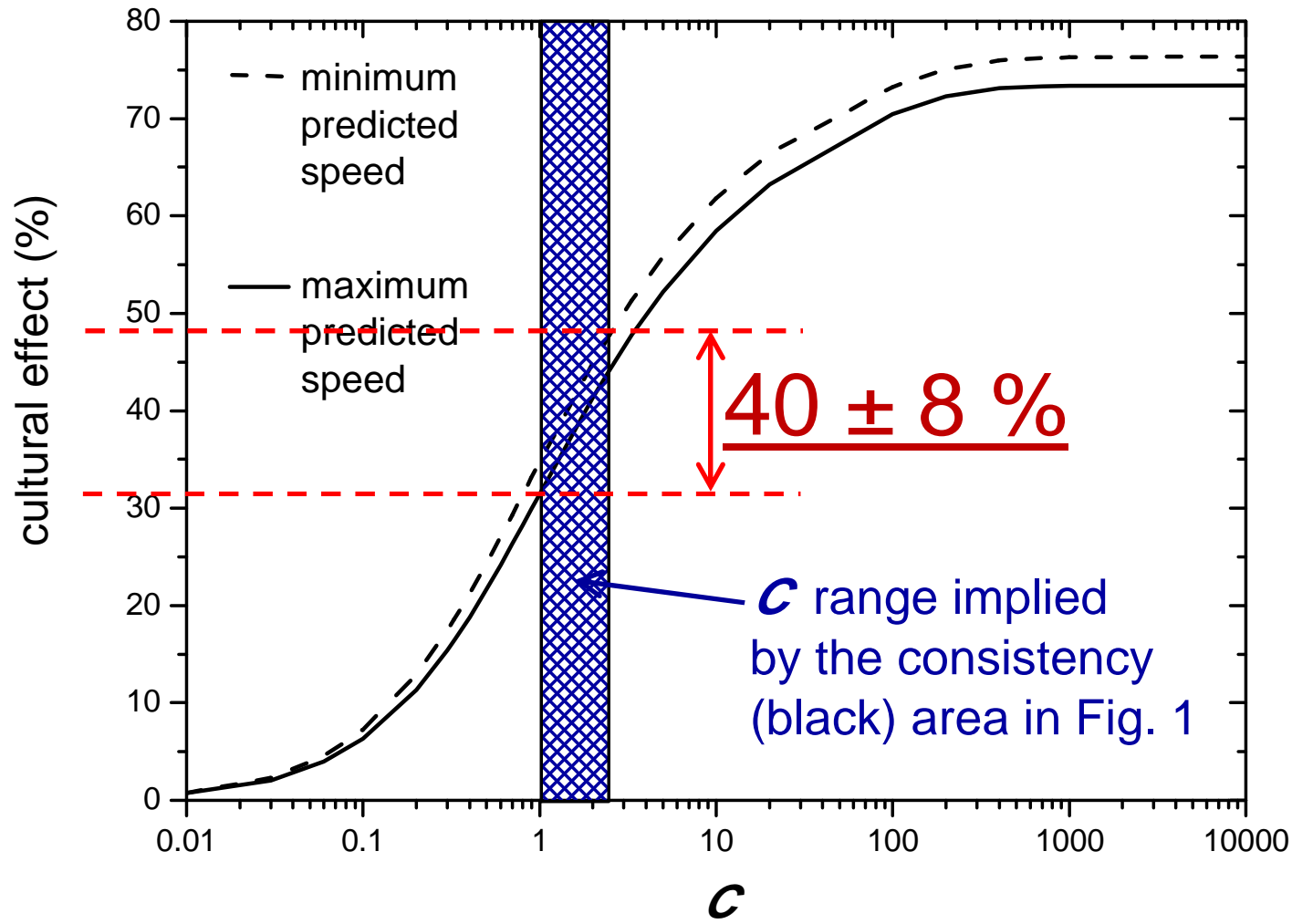# Effect of acculturation intensity *C* on the front speed in Europe

EUROPE: Dates versus distances (great circles & shortest paths)
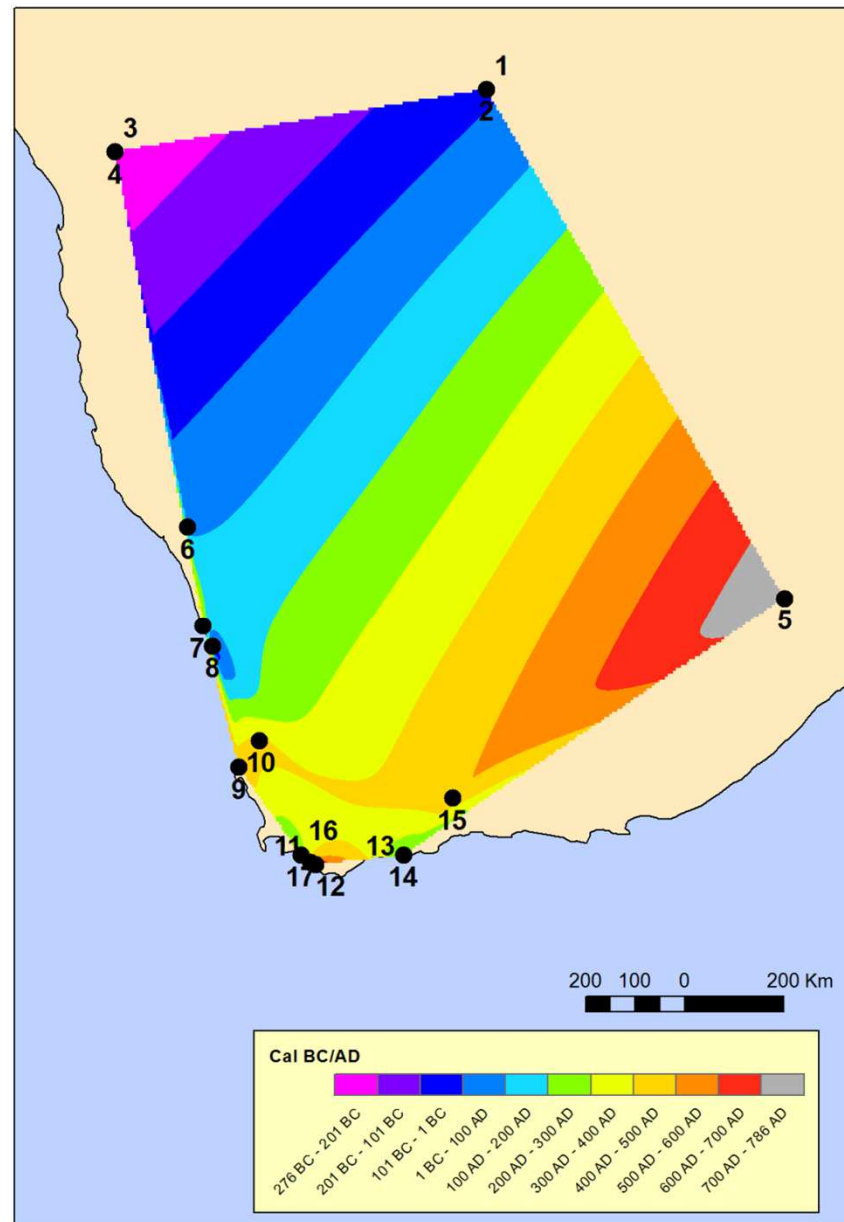
Ache hunter-gatherers (Paraguay)

Fort, *PNAS* (2012)

Effect of cultural diffusion in Europe

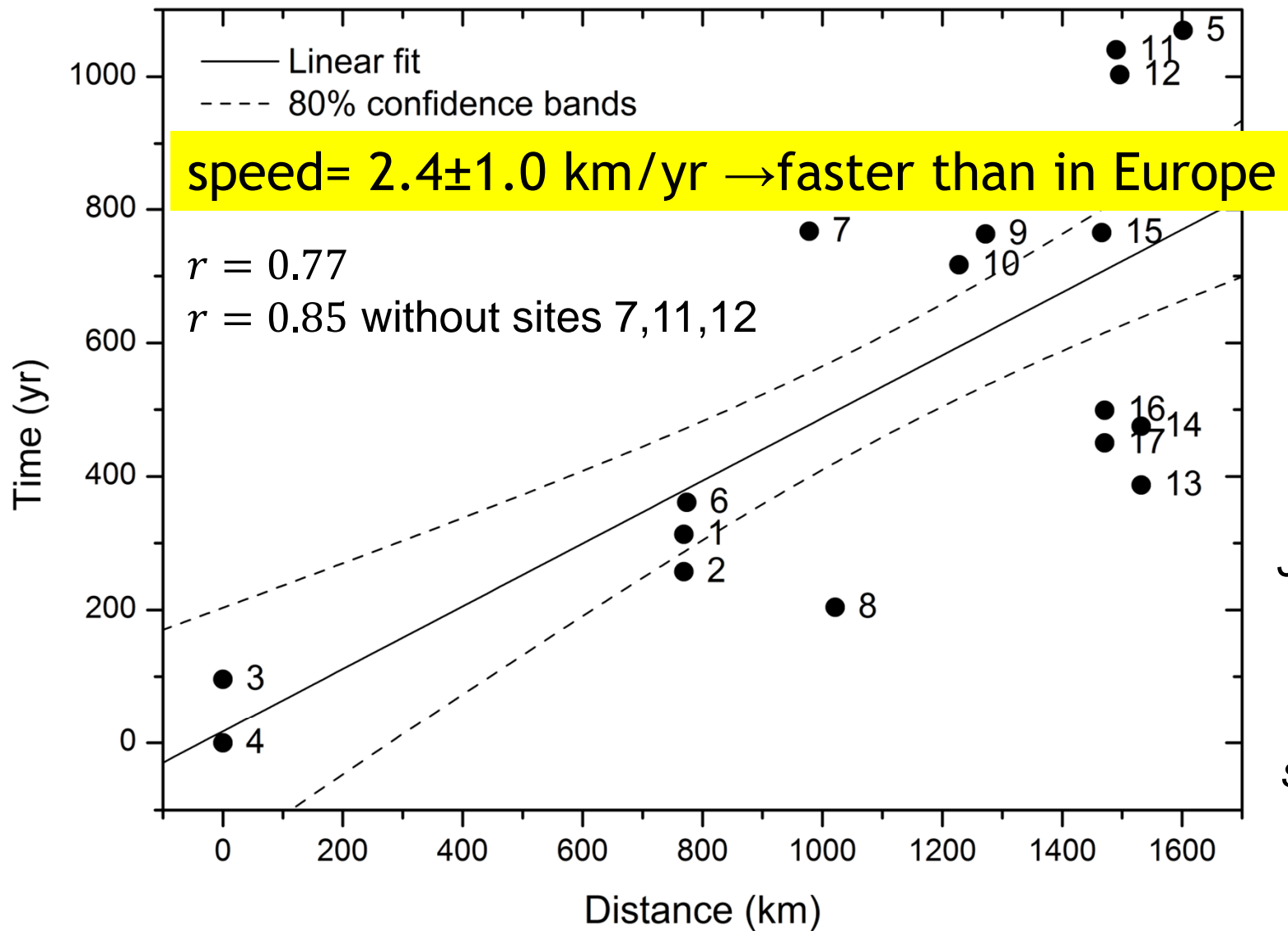Effect (%) = (speed – demic speed) /speed · 100

Fort, *PNAS* (2012)

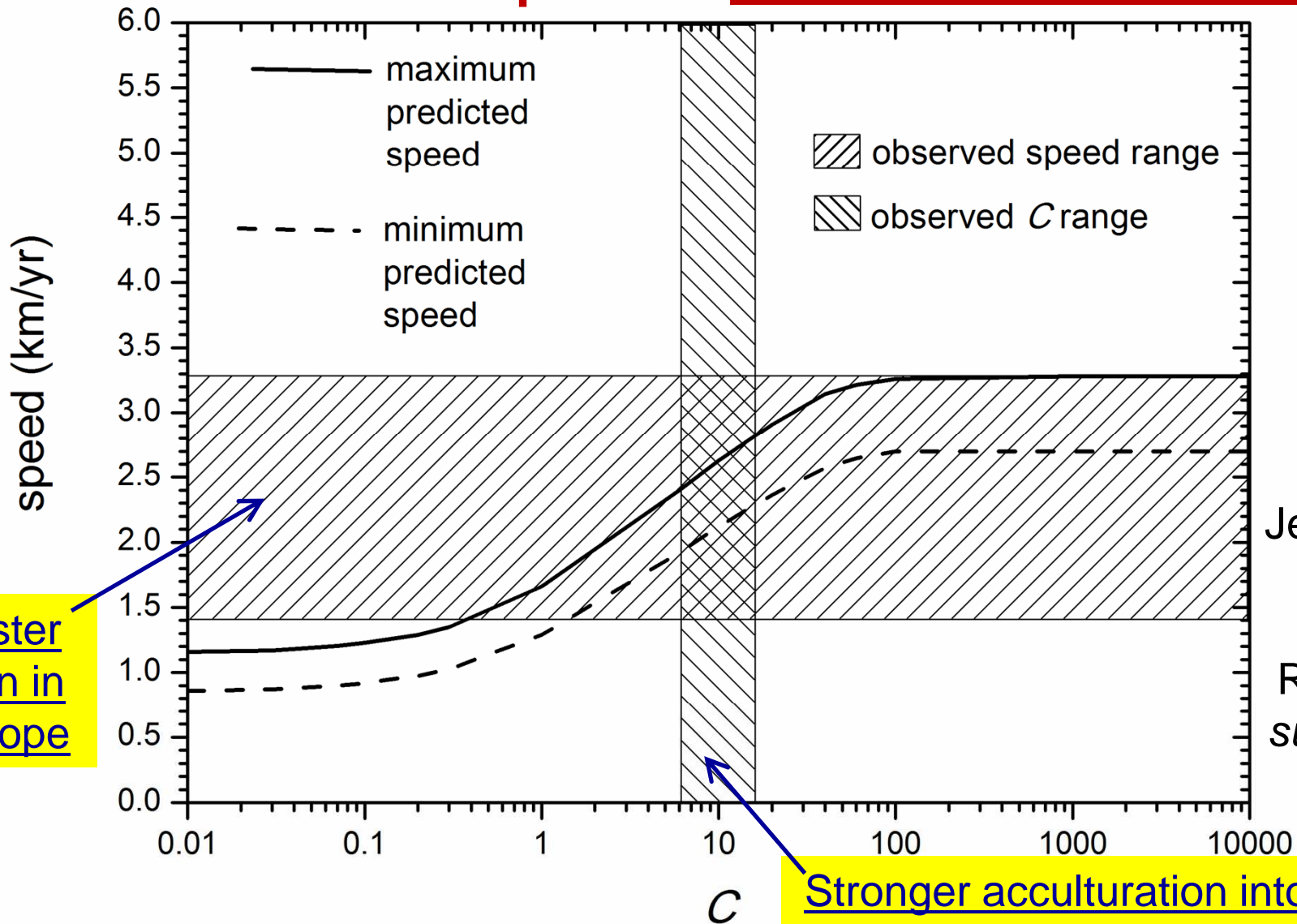# The Neolithic transition in southern Africa

Jerardino, Fort, Isern, Rondelli, *submitted* (2014)

The Neolithic transition in southern Africa

Jerardino,
Fort,
Isern,
Rondelli,
submitted
(2014)

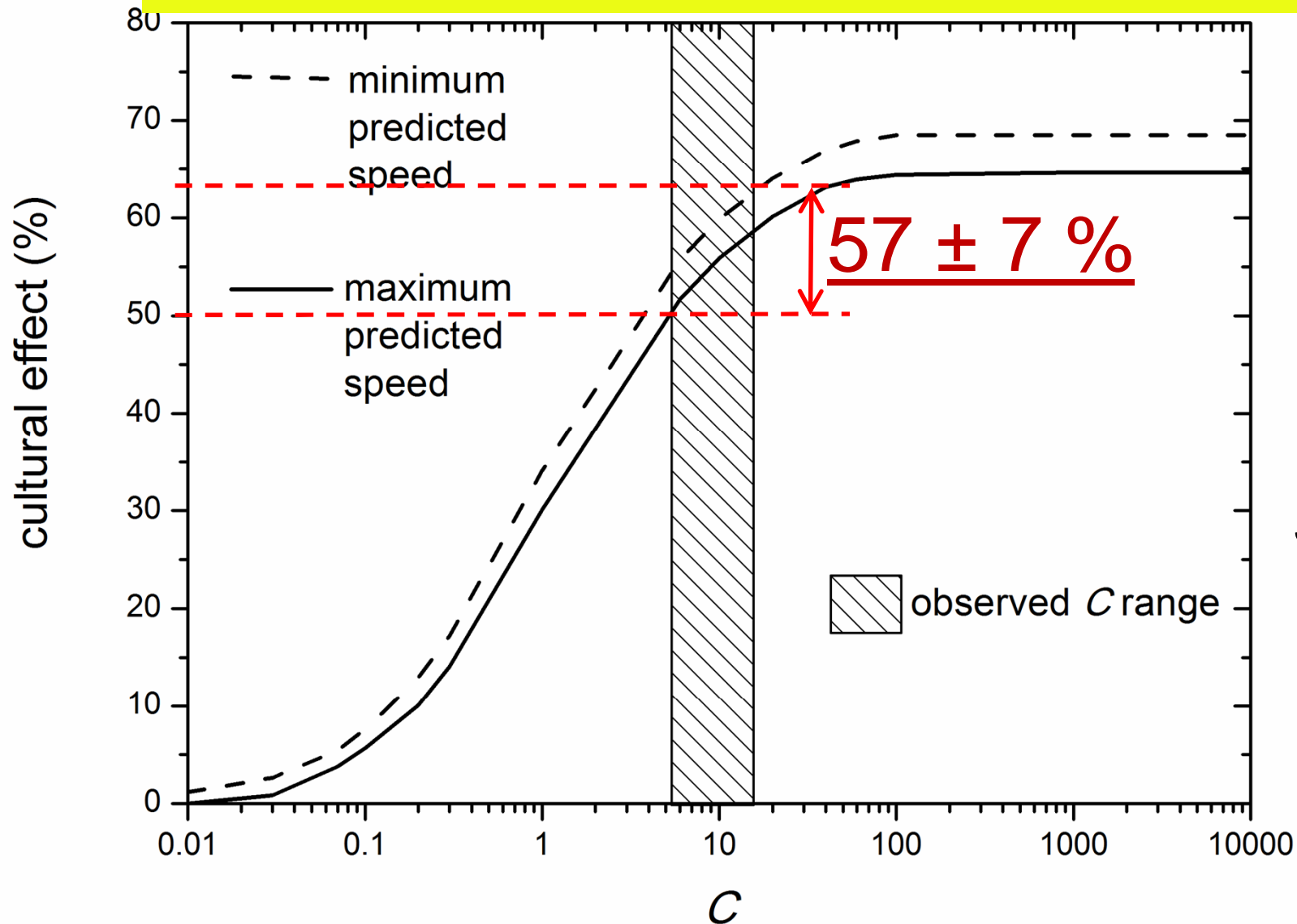# Effect of acculturation intensity C on the front speed in southern Africa

Jerardino, Fort, Isern, Rondelli, *submitted* (2014)

Faster than in Europe

Stronger acculturation into herding than into farming

Effect of cultural diffusion in southern Africa
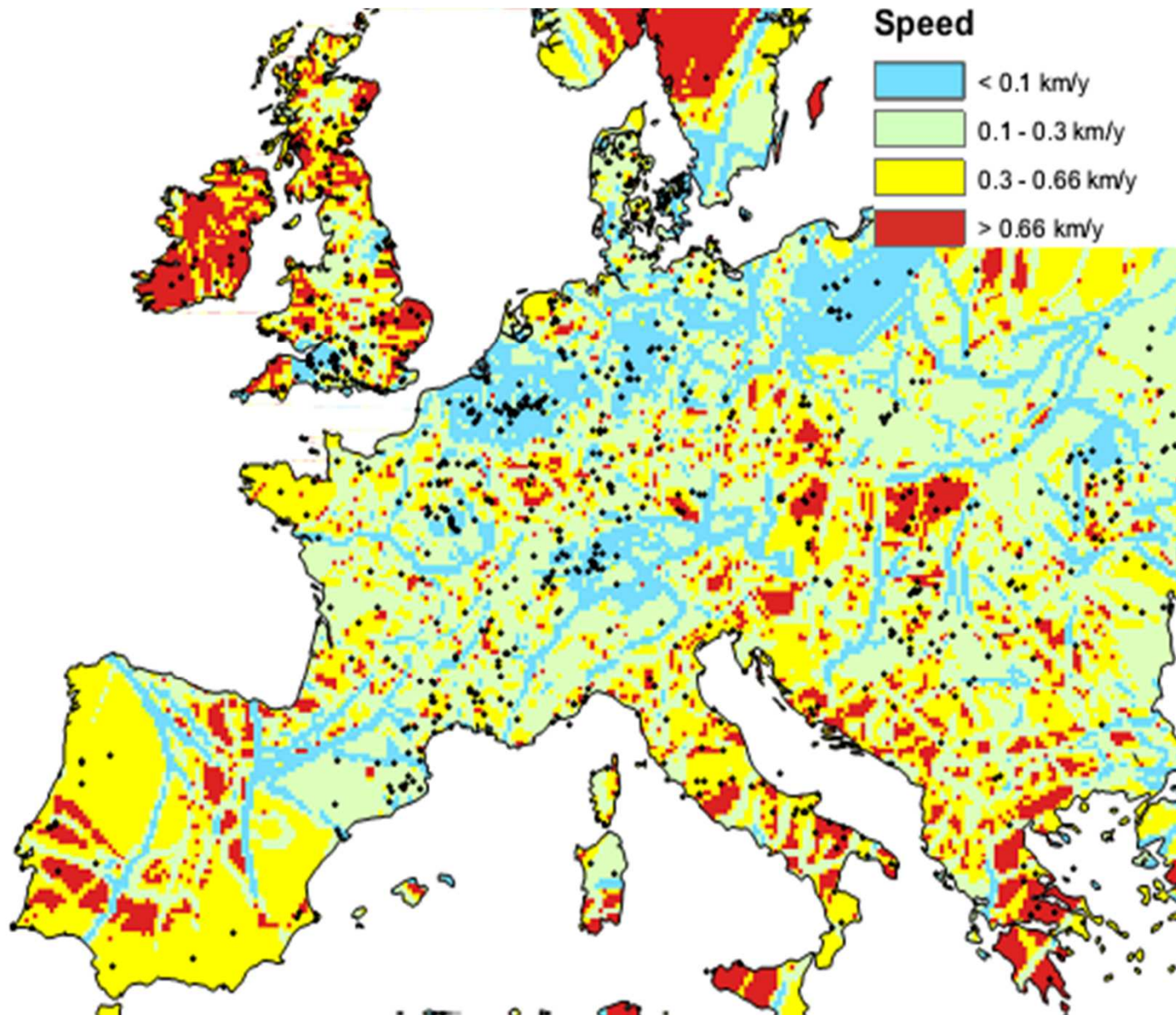
Effect (%) = (speed – demic speed) /speed · 100

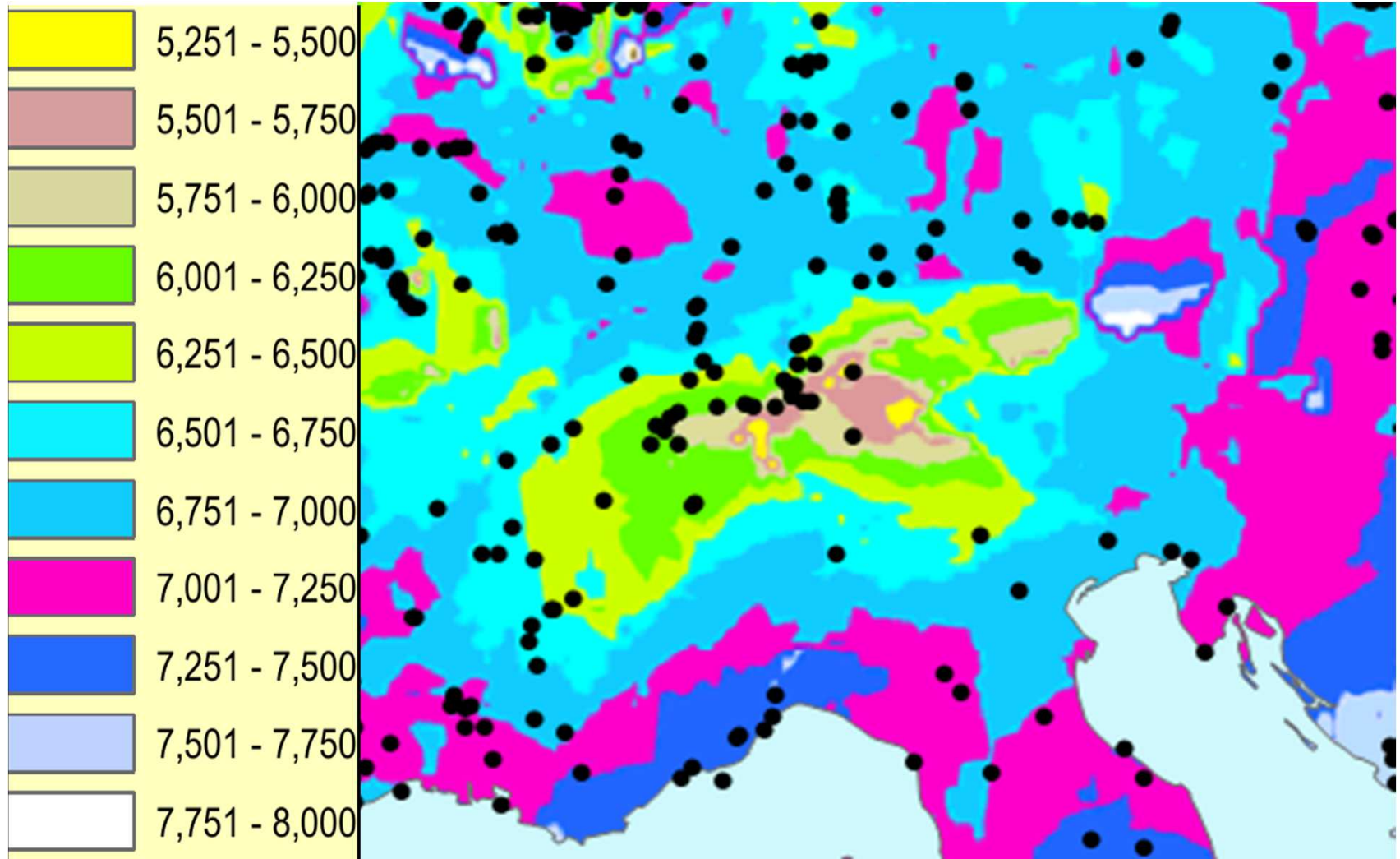Jerardino, Fort, Isern, Rondelli, *submitted* (2014)
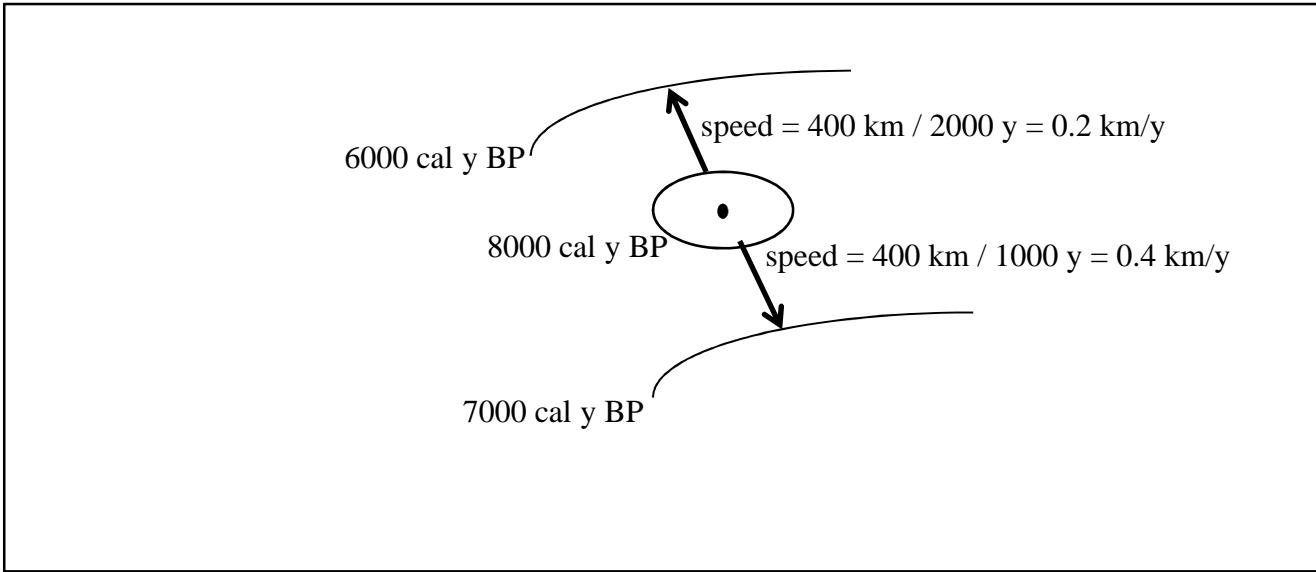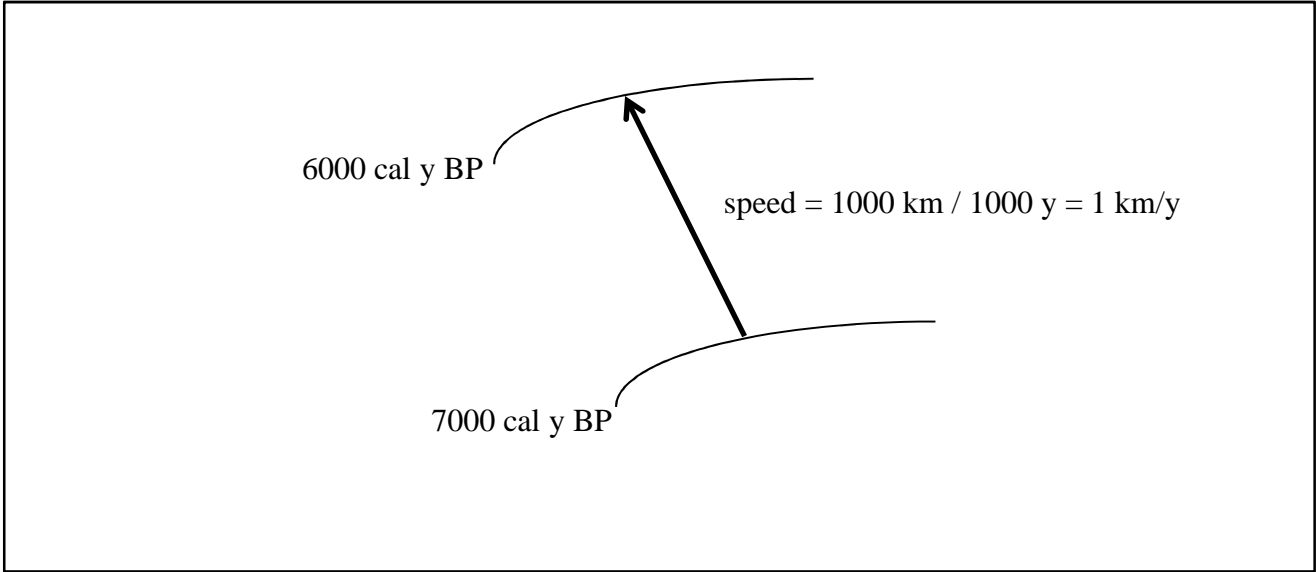
Local features in Europe
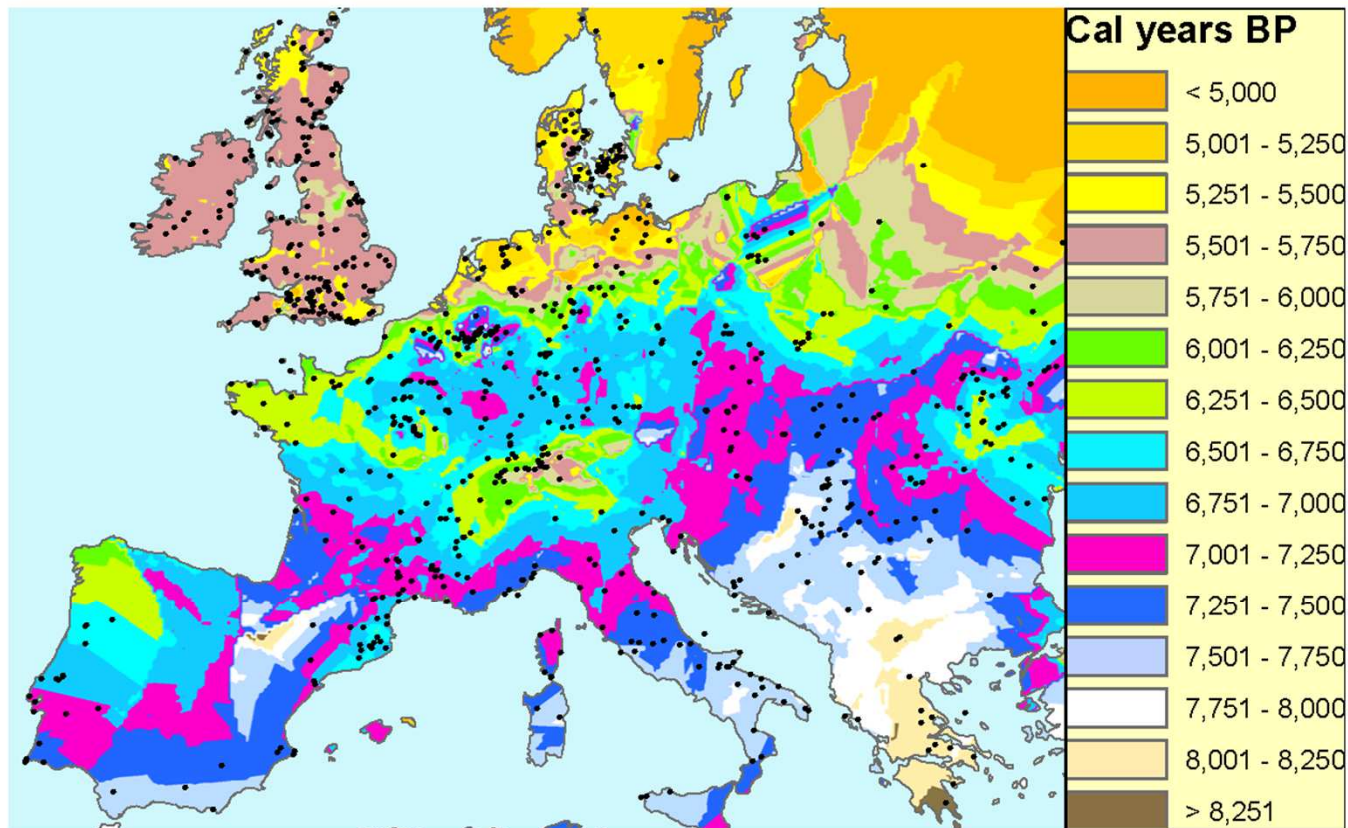
Fort,
J. R. Soc.
Interface
(2014)

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Fort,
J. R. Soc.
Interface
(2014)

5,251 - 5,500
5,501 - 5,750
5,751 - 6,000
6,001 - 6,250
6,251 - 6,500
6,501 - 6,750
6,751 - 7,000
7,001 - 7,250
7,251 - 7,500
7,501 - 7,750
7,751 - 8,000

Fort,
J. R. Soc.
Interface
(2014)

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6000 cal y BP

speed = 1000 km / 1000 y = 1 km/y

7000 cal y BP

6000 cal y BP

speed = 400 km / 2000 y = 0.2 km/y

8000 cal y BP

speed = 400 km / 1000 y = 0.4 km/y

7000 cal y BP

Fort,
*J. R. Soc.
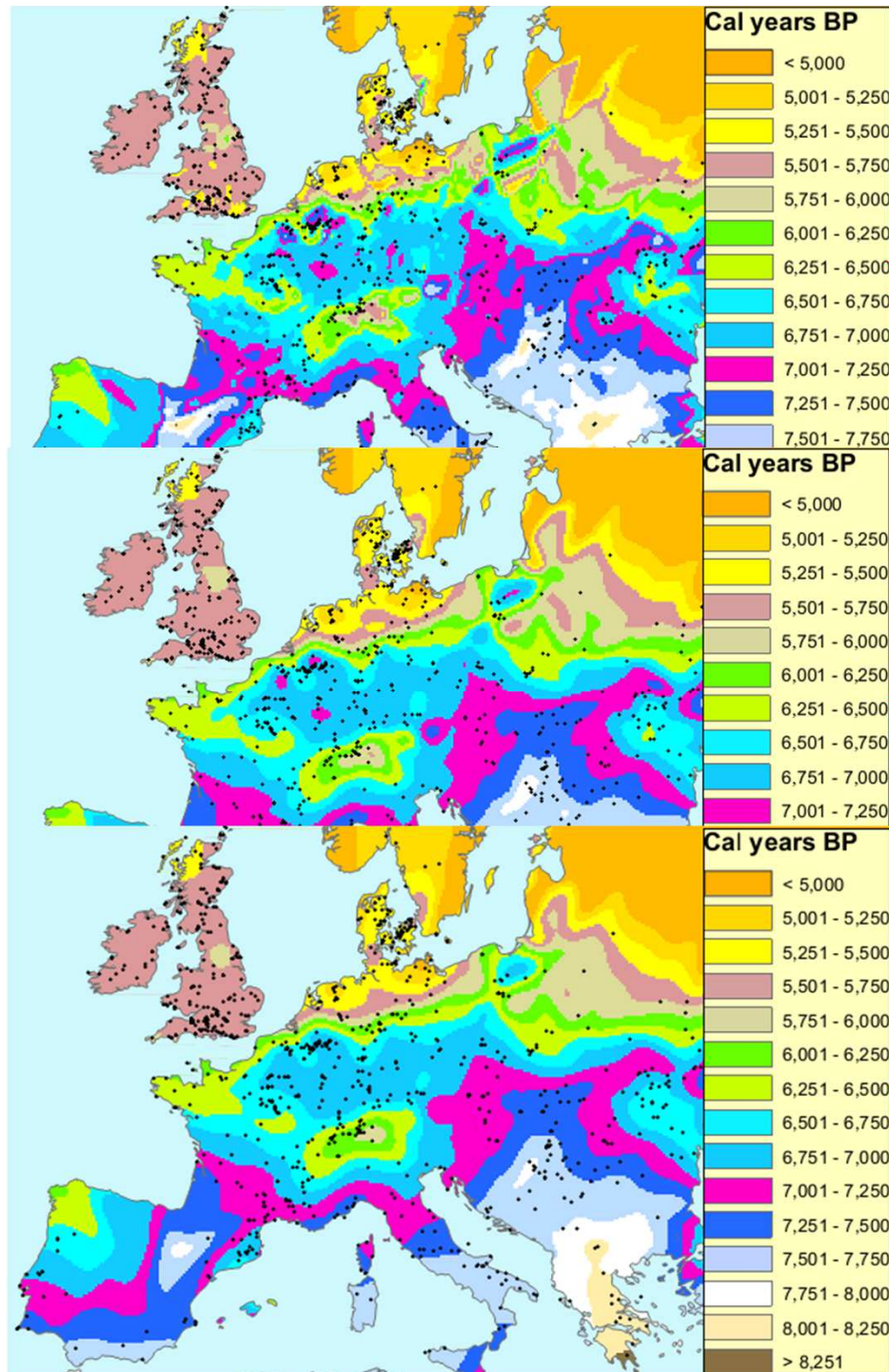Interface*
(2014)

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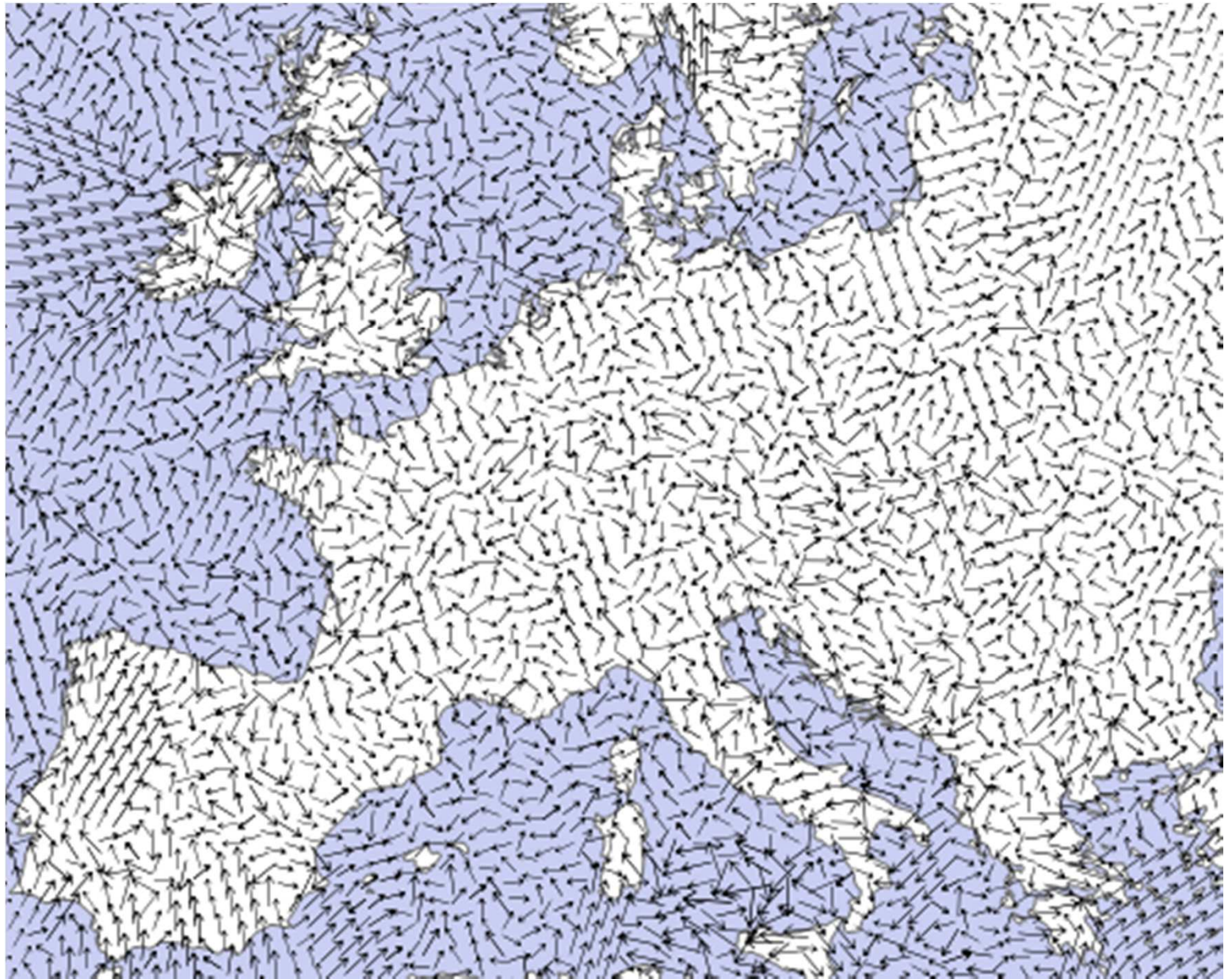
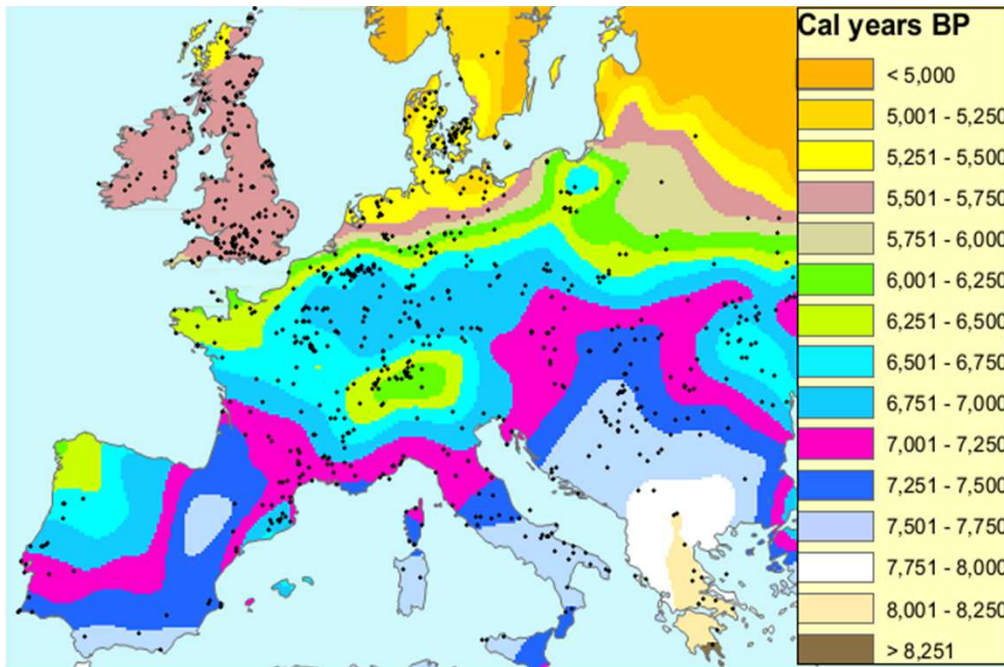Fort,
J. R. Soc.
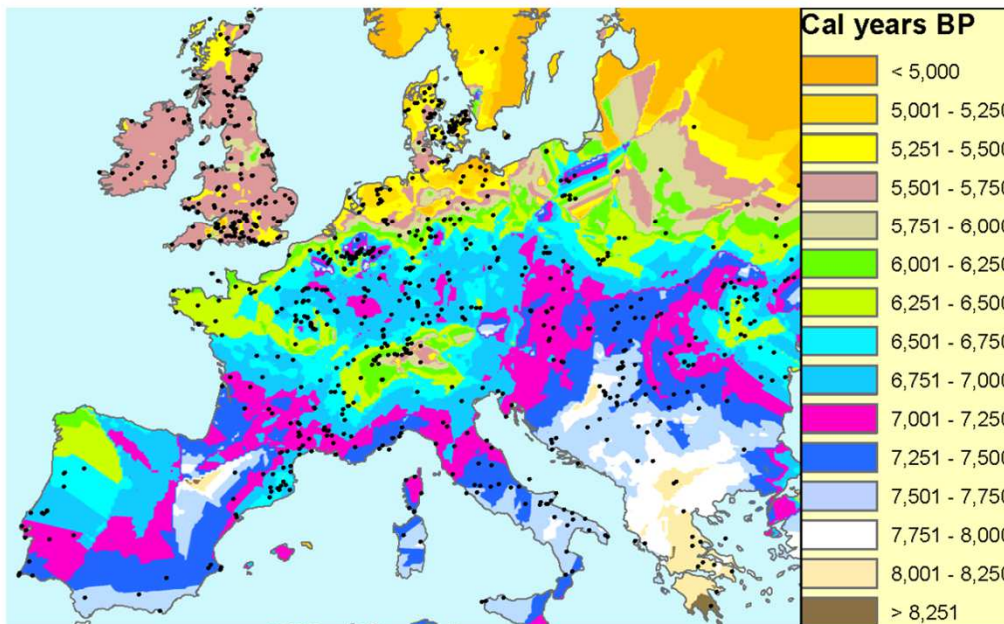*Interface*
(2014)

smoothing
1 time

10 times

Fort,
*J. R. Soc.
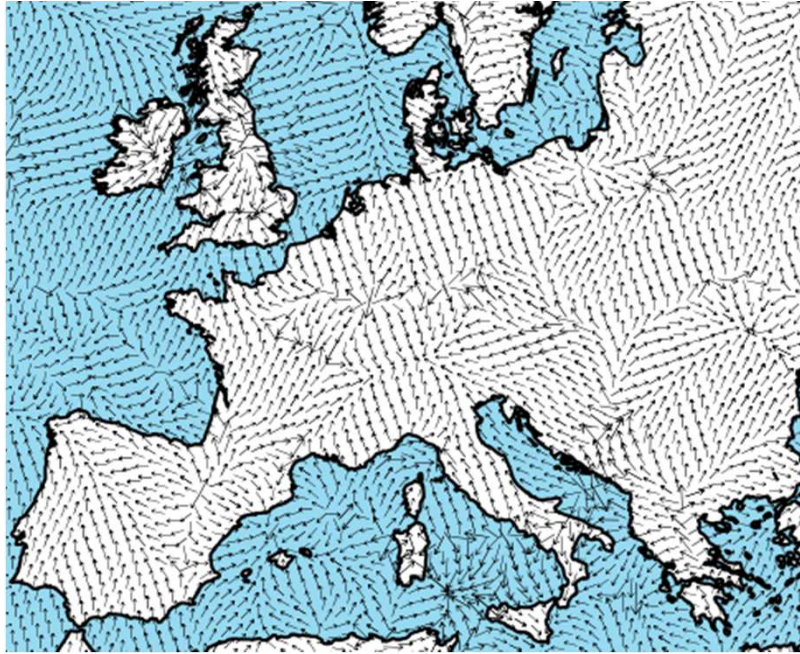Interface*
(2014)

20 times

16

smoothing
40 times

(60 times→ same results)

No
smoothing
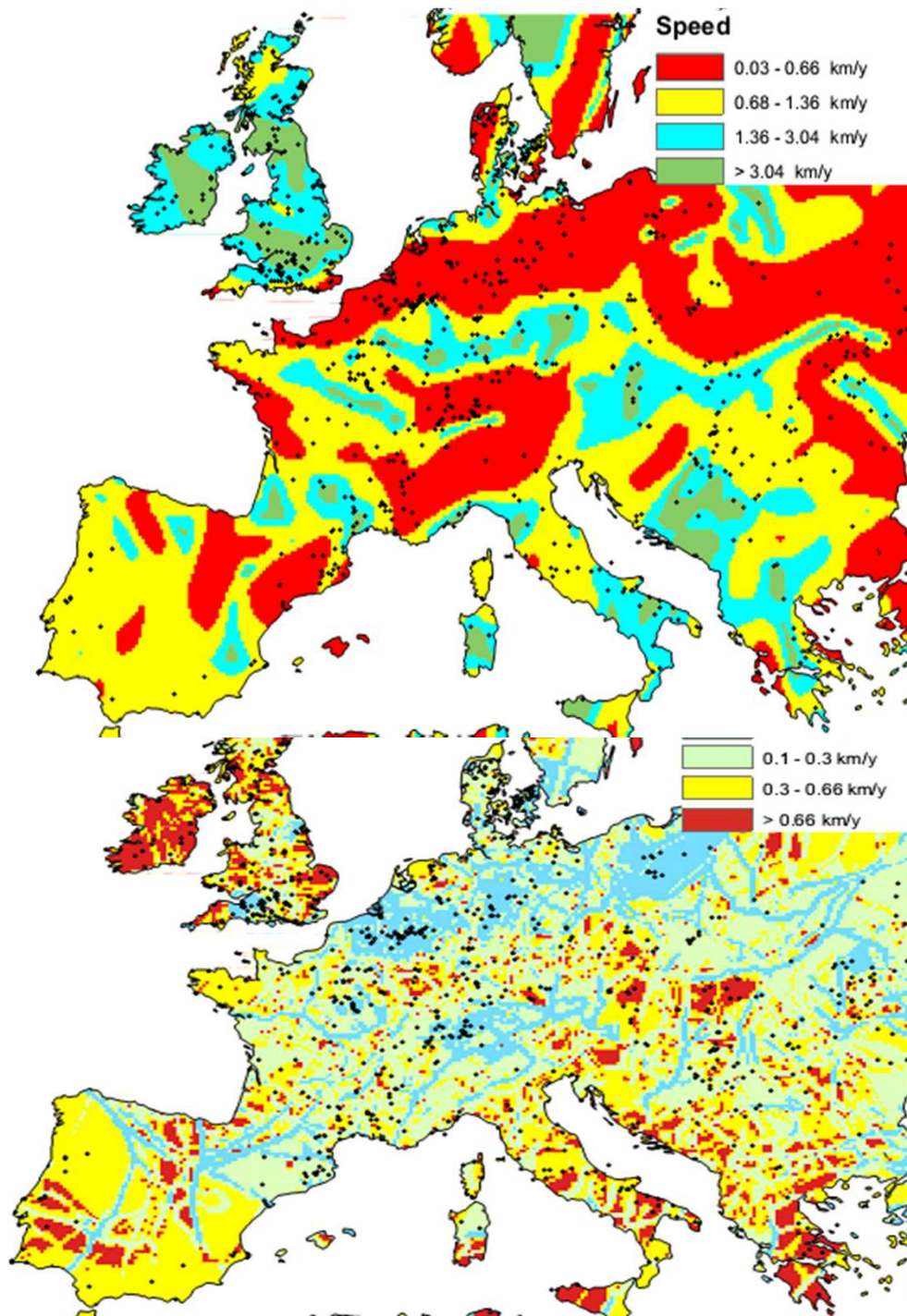
Fort,
J. R. Soc.
Interface
(2014)

Fig. 1

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smoothing
40 times

(60 times→ same results)

No smoothing

Fort,
J. R. Soc.
Interface
(2014)

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Speed
- 0.03 - 0.66 km/y
- 0.68 - 1.36 km/y
- 1.36 - 3.04 km/y
- > 3.04 km/y

smoothing
40 times

- 0.1 - 0.3 km/y
- 0.3 - 0.66 km/y
- > 0.66 km/y

No smoothing

Fort,
J. R. Soc.
Interface
(2014)

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Smoothing 40 times

Speed

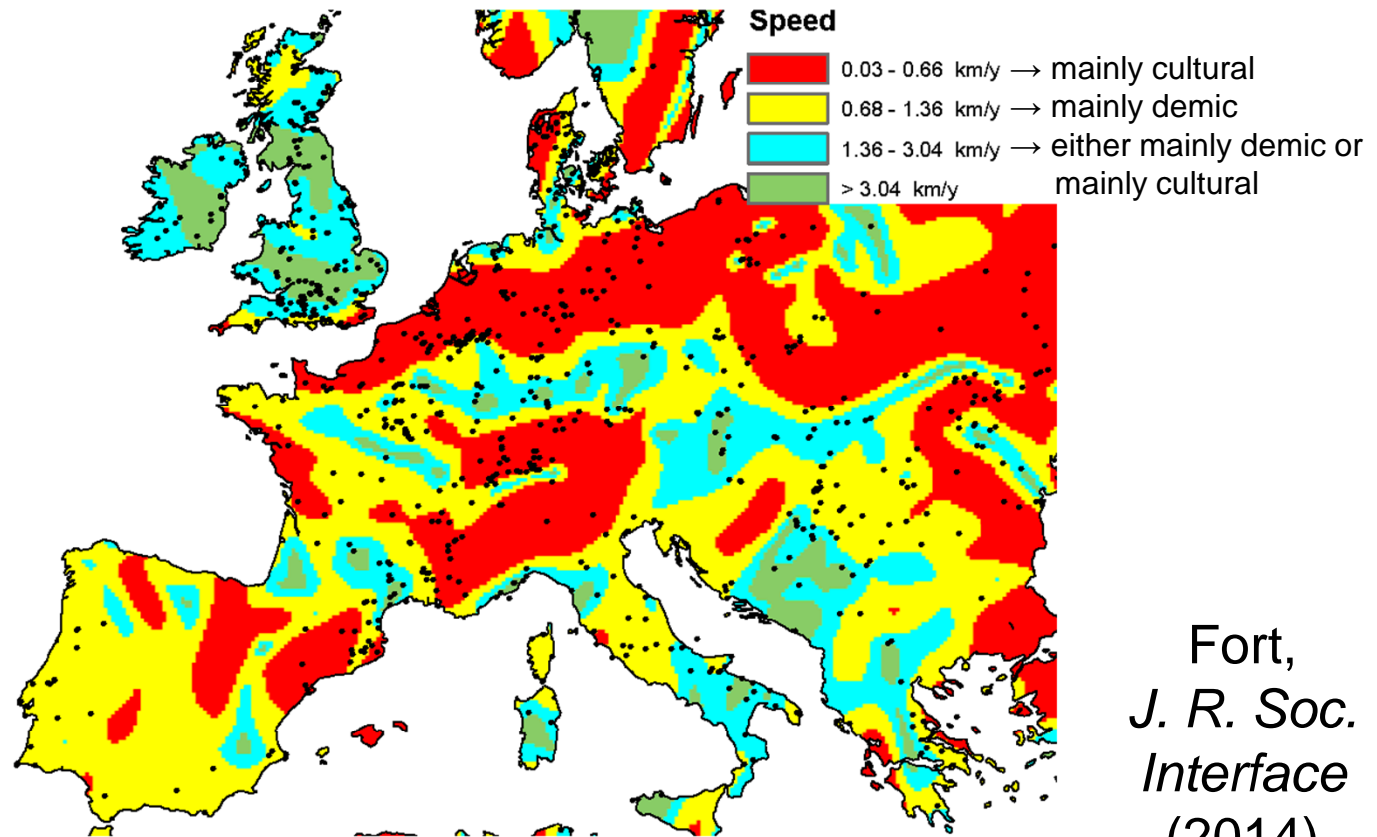|		
🟥	0.03 - 0.66 km/y →	mainly cultural
🟨	0.68 - 1.36 km/y →	mainly demic
🟦	1.36 - 3.04 km/y →	either mainly demic or
🟩	> 3.04 km/y	mainly cultural

Fort,
J. R. Soc.
Interface
(2014)

Fig. 3

It would help a lot to measure <u>prehistoric</u> dispersal kernels, if possible (Genetics?)