Modelling the Neolithic transition in the Near East and Europe

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**SimulPast research project
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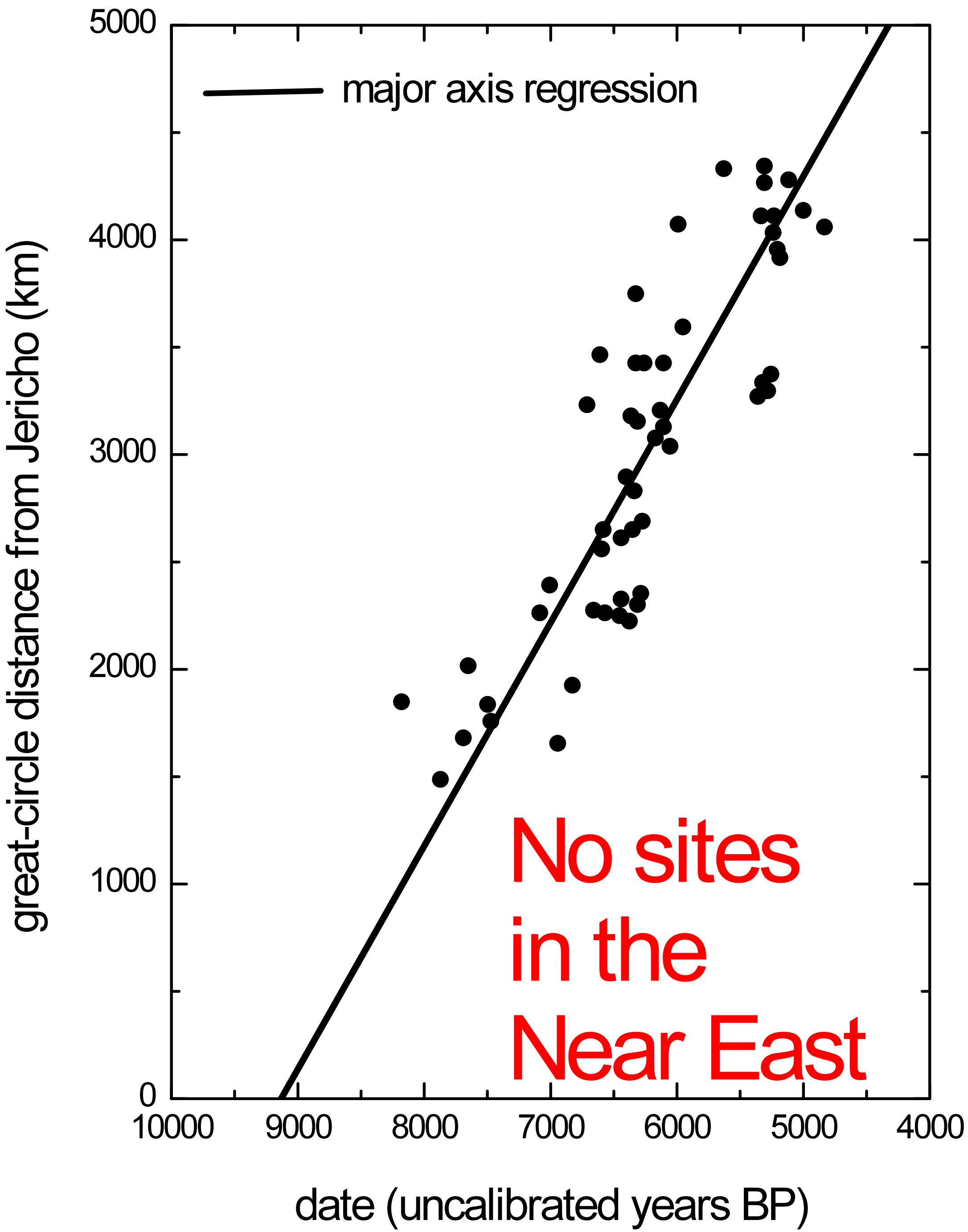
Contents

1. Neolithic databases

	sites total	Europe	Near East	Anatolia	Asia
Ammerman 1971, 1984	53	53	0	0	(9)
Gkiaska et al 2003	510	510	0	0	0
Pinhasi 2005	735	606	92	29	8
Vander Linden 2012	990	903	72	15	0

Example: Vander Linden (2012)

Coun-try	Sub-period	Site name	Site type	Lab Code	Cal BP	uncal Date BP	Material	Lati-tude	Lon-gitude
Ando-rra	Cardial	Balma Margined a	Cave	Ly-283 9	7545	6670	Wood charcoal	42.41	1.58
Aus-tria	Lengyel	Unterpull endorf	Pit	VRI-42	7013	6130	Charcoal	47.5	16.5
Aus-tria	LBK	Necken markt		OxA-15 36	7105	6210	Seeds	47.6	16.533 33
Aus-tria	LBK	Winden am See	Settle ment	Bln-55	6776	5940	Organic temper	47.95	16.833 33

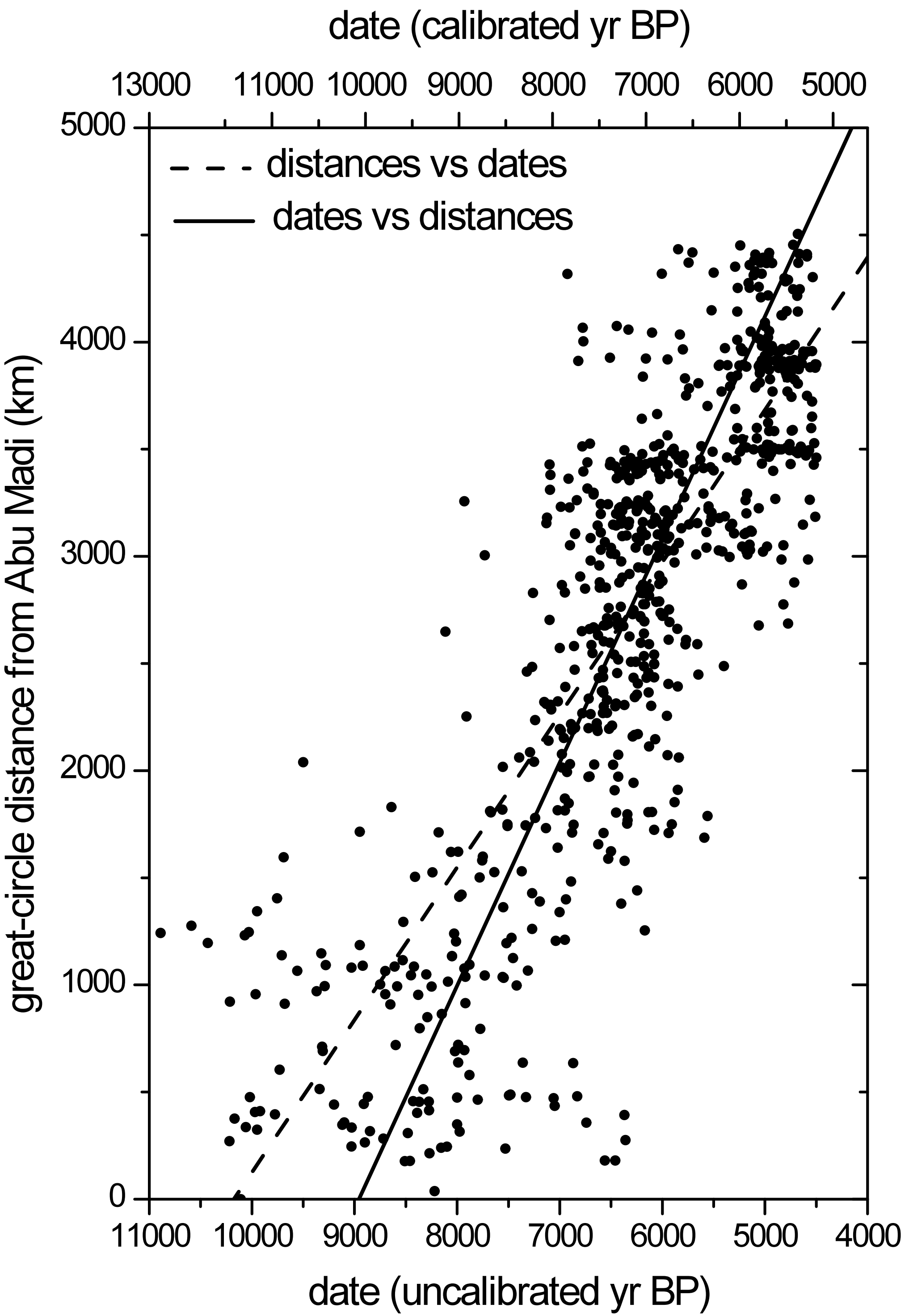


Ammerman & Cavalli-Sforza (1971)

53 sites

speed = 1.0 km/yr (0.8-1.2 km/yr)

r = 0.89 (Jericho, highest r)



Pinhasi, Fort & Ammerman (2005)

735 sites

speed = 0.7-1.1 km/yr

$r = 0.83$

2. Homogeneous models

1) Classical model:

Ammerman & Cavalli-Sforza (1971, 1973, 1984)

Reproduction+dispersal

Homogeneous model: no seas

no mountains

2) Time-delayed model:

Fort and Méndez (1999)

Fort, Pujol & Cavalli-Sforza (2004)

Pinhasi, Fort & Ammerman (2005)

Reproduction+dispersal**+delay (generation time)**

Also homogeneous: no seas, no mountains

Homogeneous models

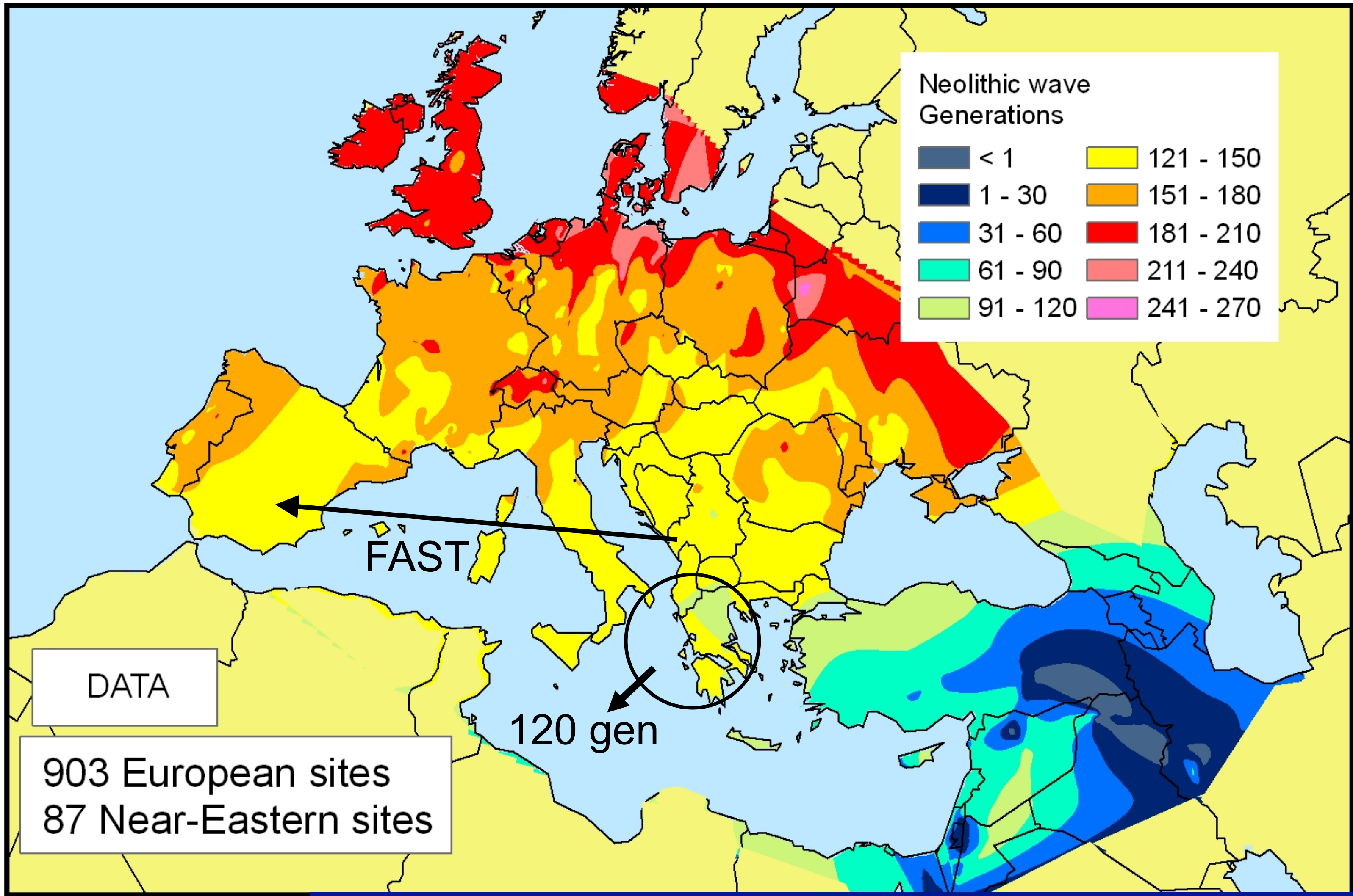
Archaeological data →1 km/yr for the spread of farming accross Europe

1) Classical model: 3 km/yr→too fast

2) Time-delayed model: 1 km/yr → it agrees with data at the global (continental) scale

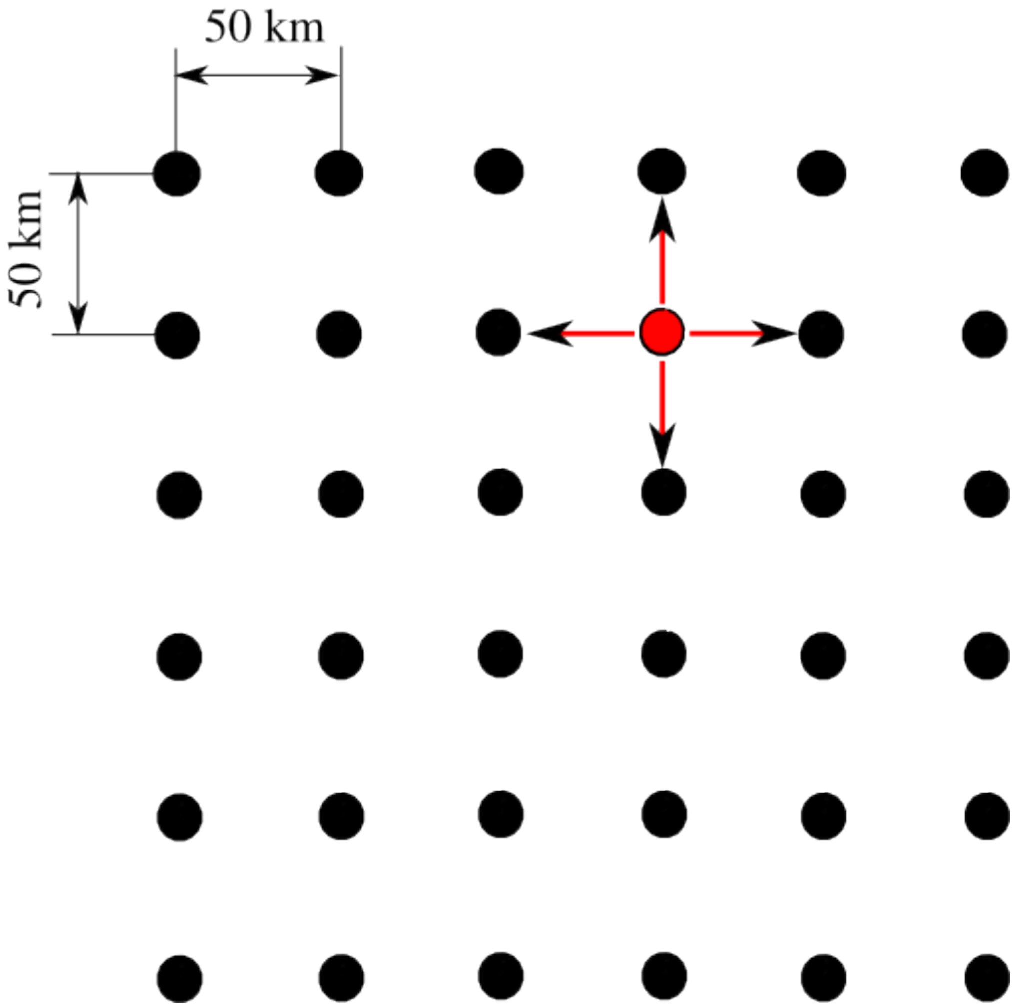
How about local scales? Method: isochrones

Data: time origin at Jericho (11,863 cal yr BP)
(other origins: lower *r*, similar maps) 1 gen=32 yr



Database by vander Linden

Homogeneous models



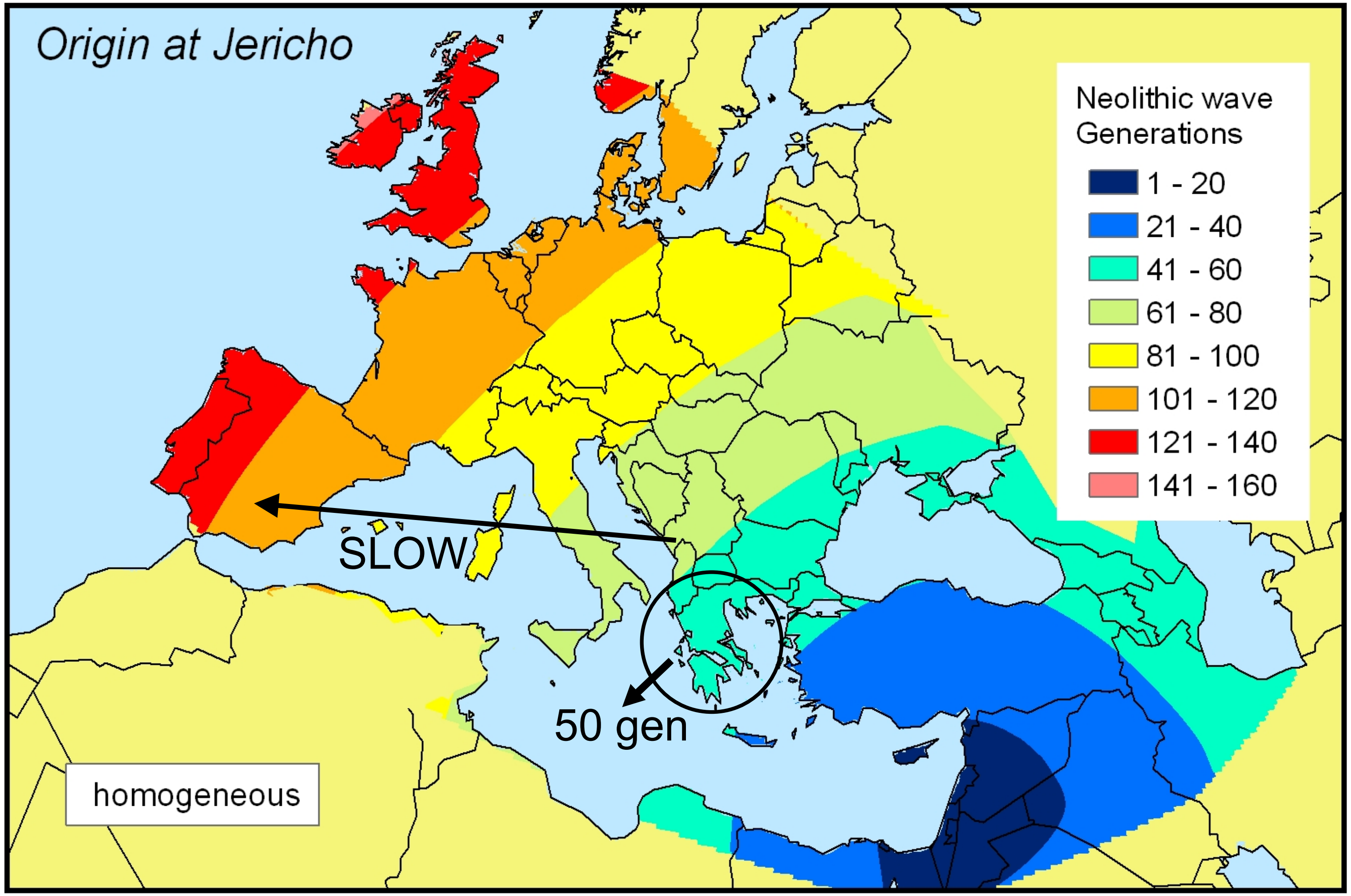
$0<p_e<1$ persistency

a fraction p_e stays

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

p_e= 0.38, d= 50 km, reproduction Ro=2.2 per generation (32 yr) (pre-industrial farmers)

Homogeneous model



Major inconsistency

Homogeneous model:

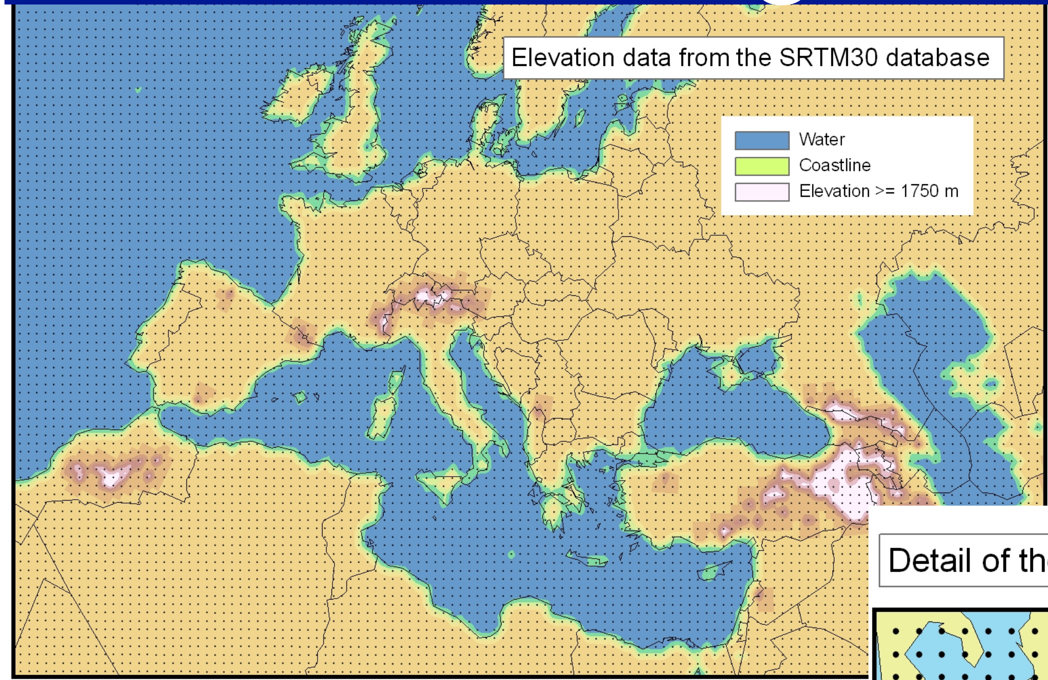
arrival to Greece in 50 generations

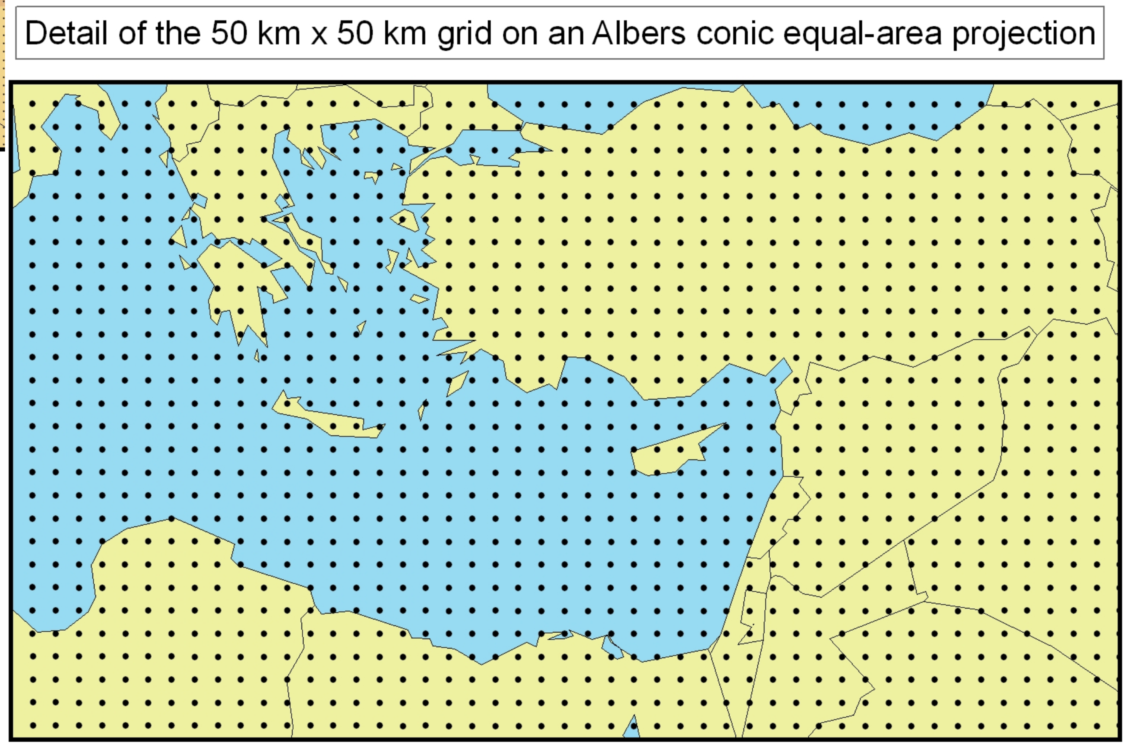
Data:

arrival to Greece in 120 generations

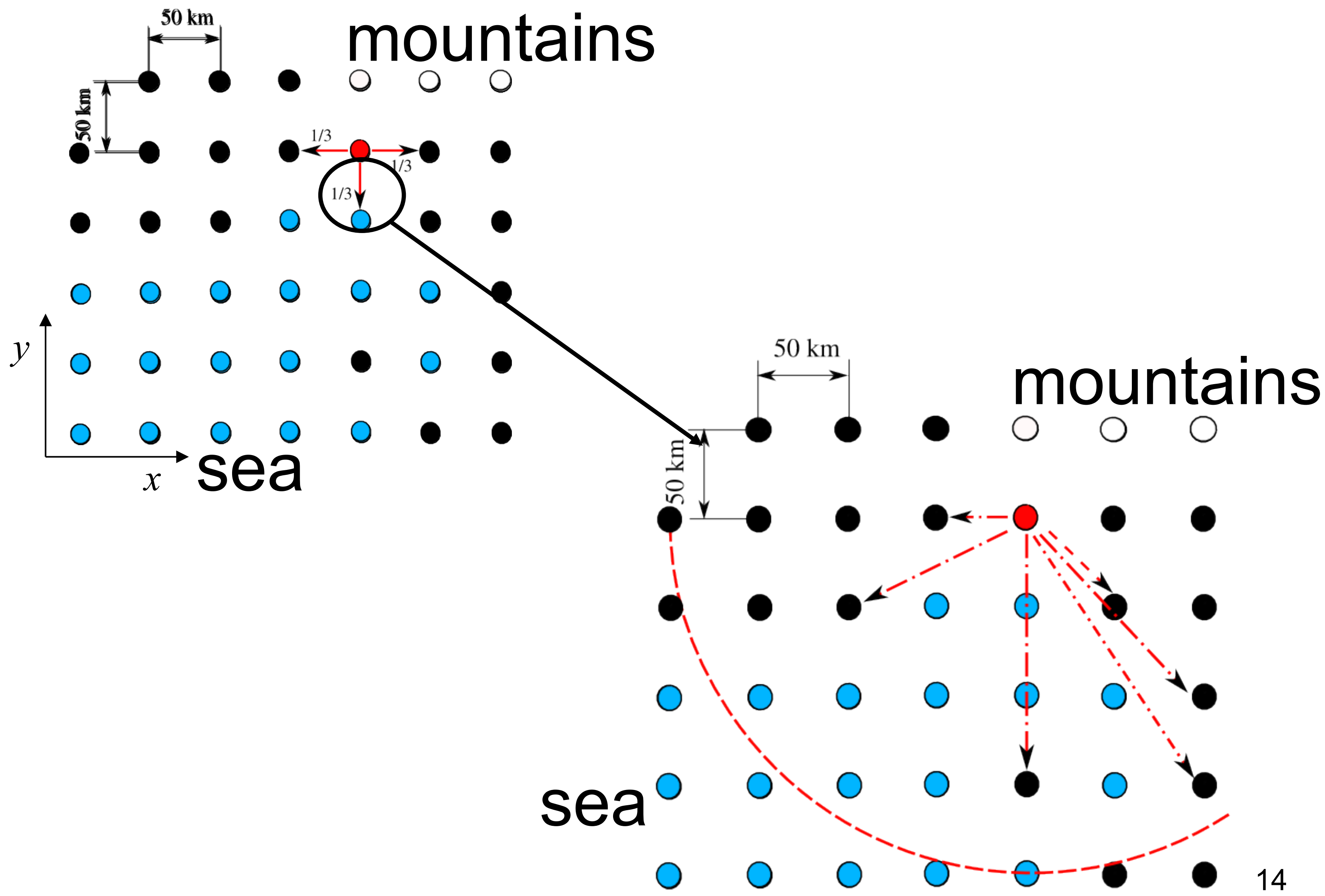
Let us introduce non-homogeneous models

3. Non-homogeneous models= grid



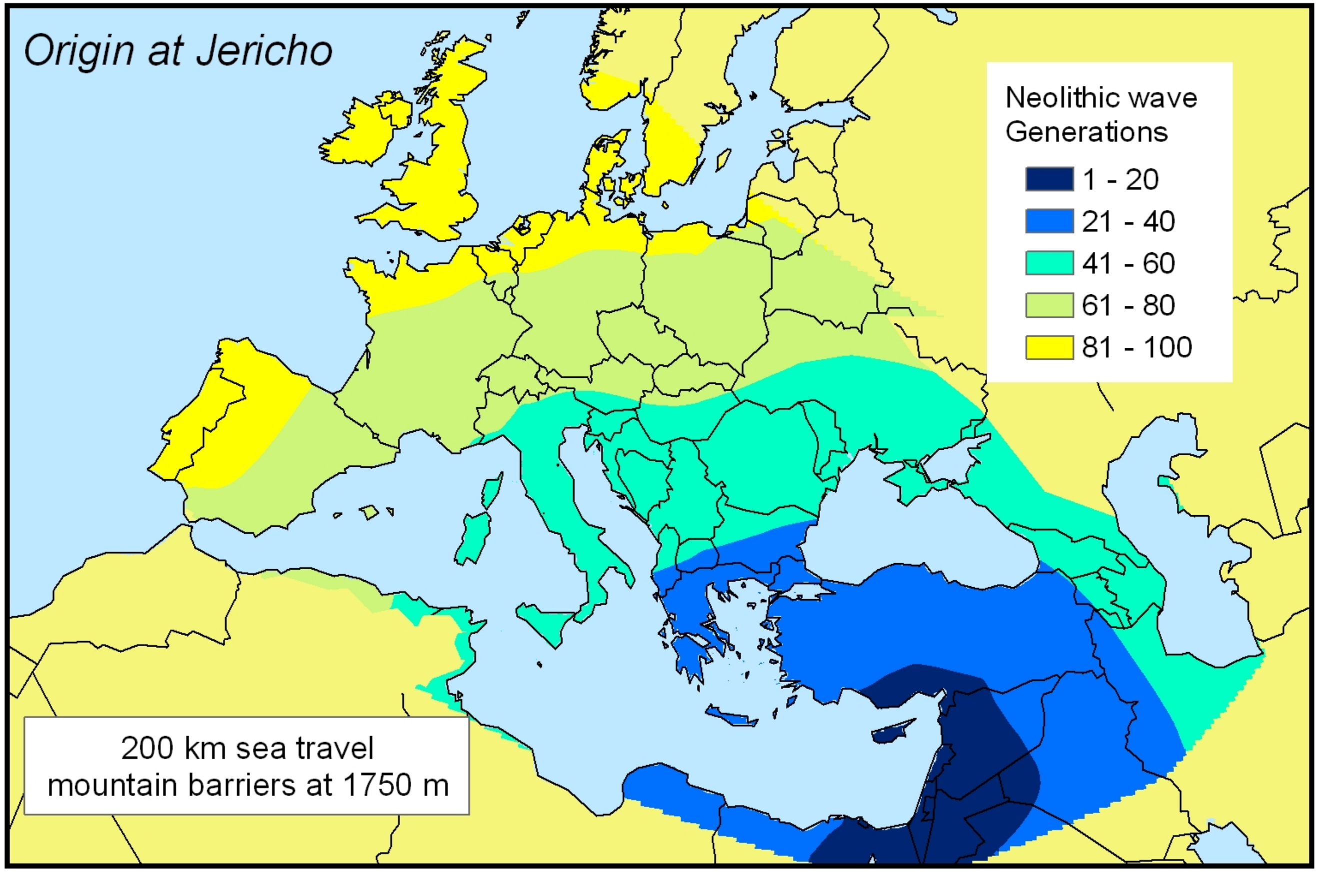


Non-homogeneous models

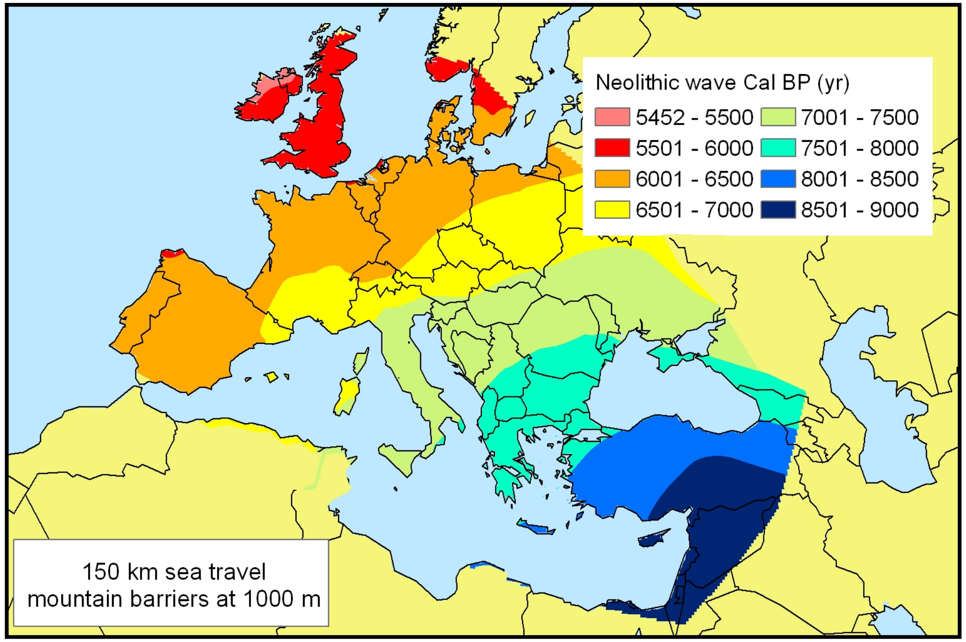


Non-homogeneous models

Sea travels do not solve the inconsistency, because the front reaches Greece still sooner (in about 30 generations for the following example):

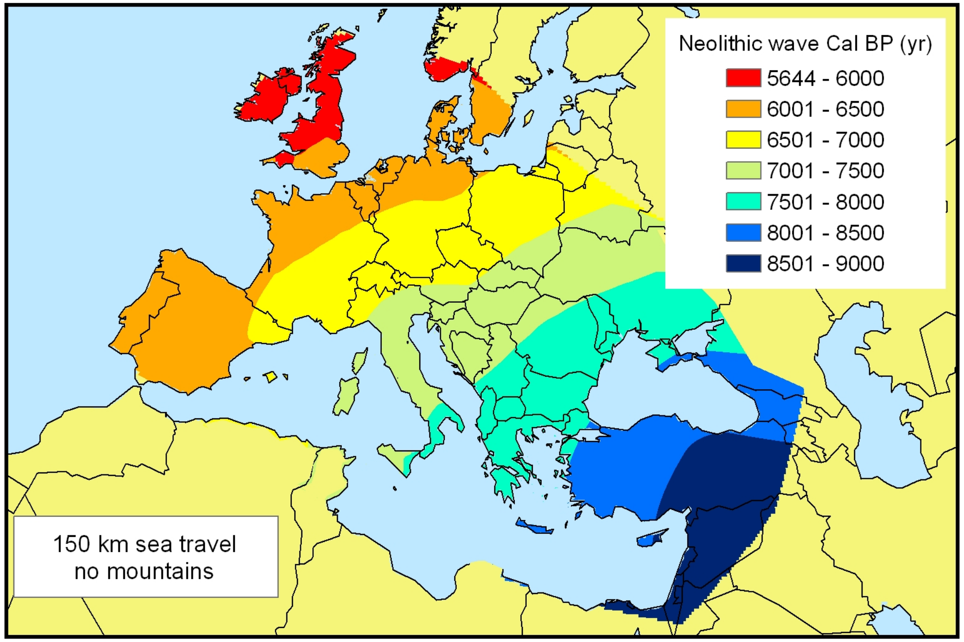


Mountain barriers have only local effects:



mountain barriers above 1000m

(above 1750m† the effect is still smaller)



no mountain barriers

† 1750m is used to avoid isolated sites

Recall the inconsistency:

Models: arrival to Greece in 30-50 generations.
Data: arrival to Greece in 120 generations.
Possible solution:

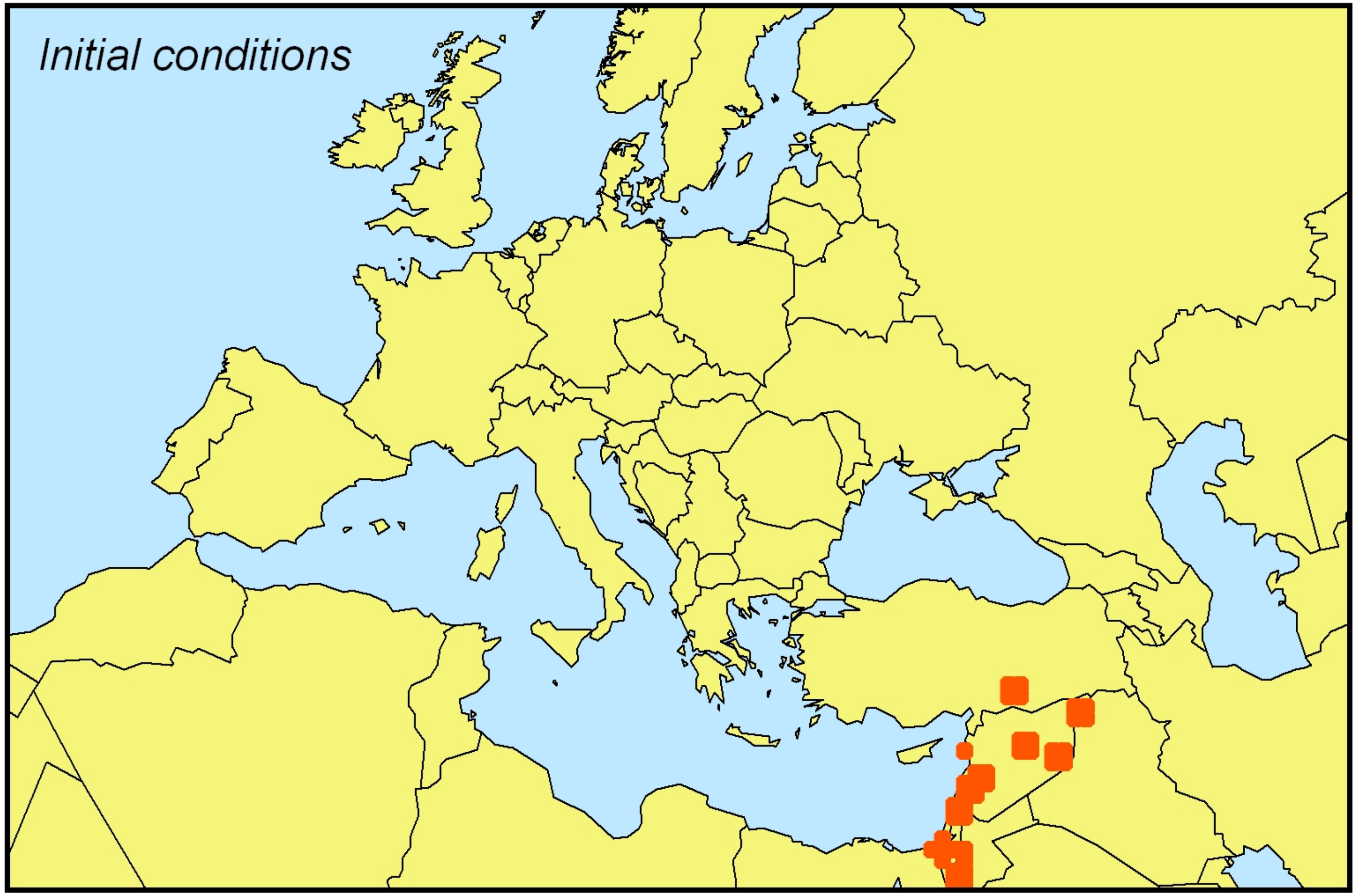
· Europe: a well-established set of farming practices spread.

· Near East: innovations appeared in different times and places→no front propagation!

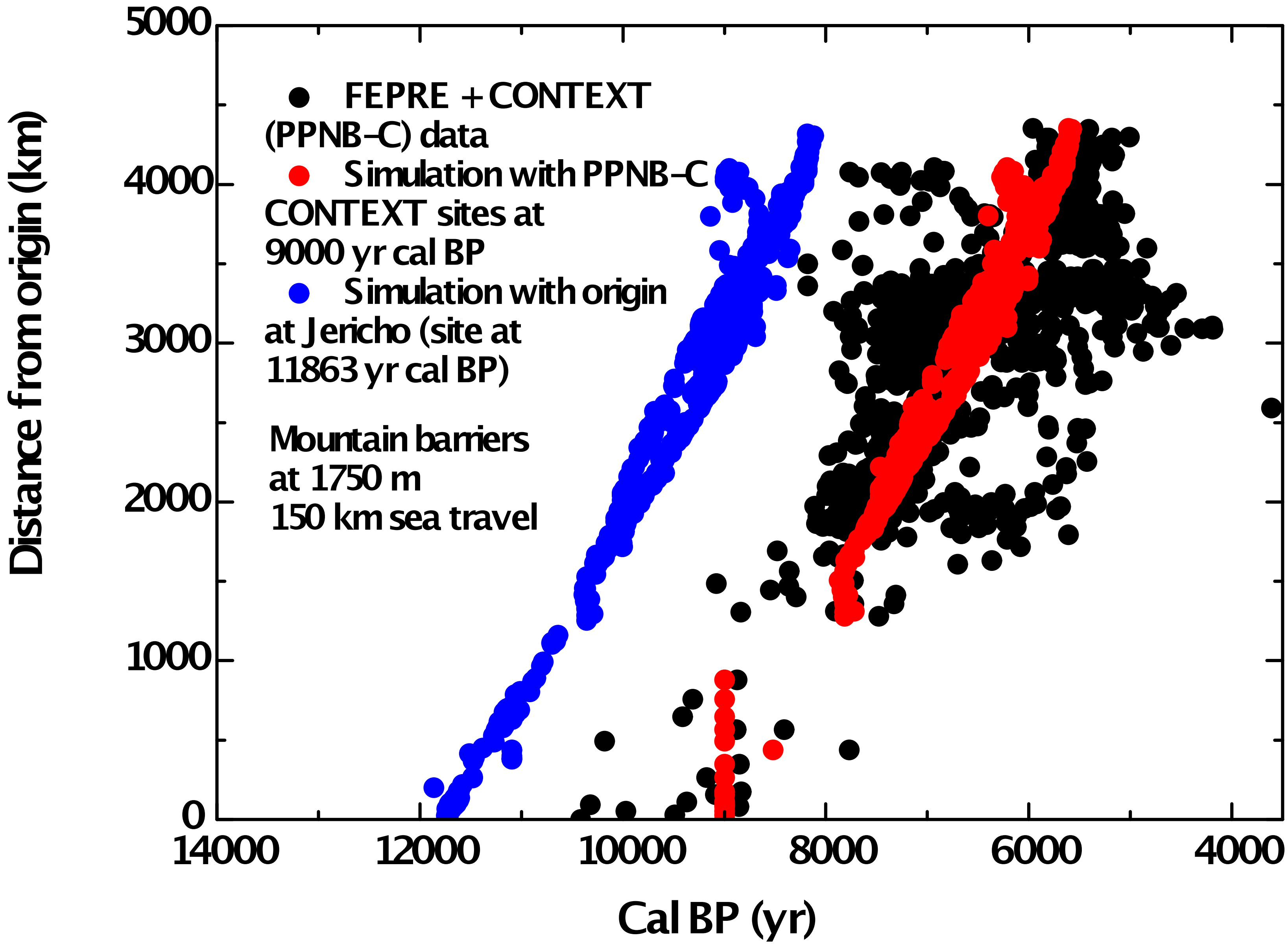
· Near East: PPNB/C cultures correspond to the final, more homogeneous set of farming practices, from which the spread to Europe proceeded→use only PPNB/C sites.

Solving the inconsistency

Set PPNB/C sites (red squares in the map) full of farmers at 9000 cal yr BP (=average of their dates)



Solving the inconsistency

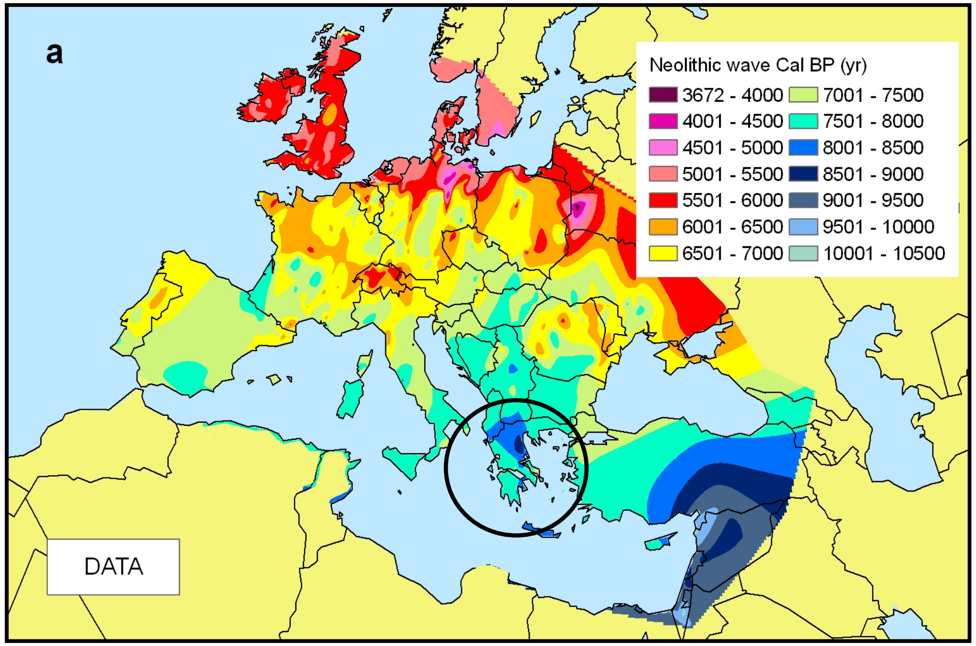


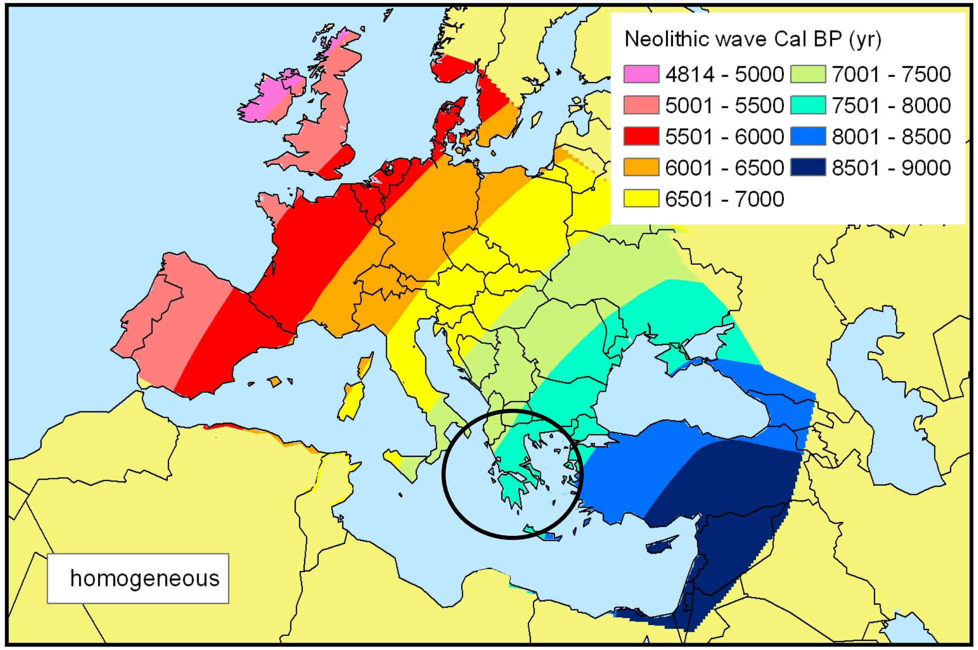
blue circles: 87 Near Eastern sites

red+black circles: 16 PPNB/C sites (Jericho is not one of them)

distances computed from Hemar for red+black circles

Back to the homogeneous model





The inconsistency is solved (assuming the simulated front begins to spread at 9000 cal yr BP)

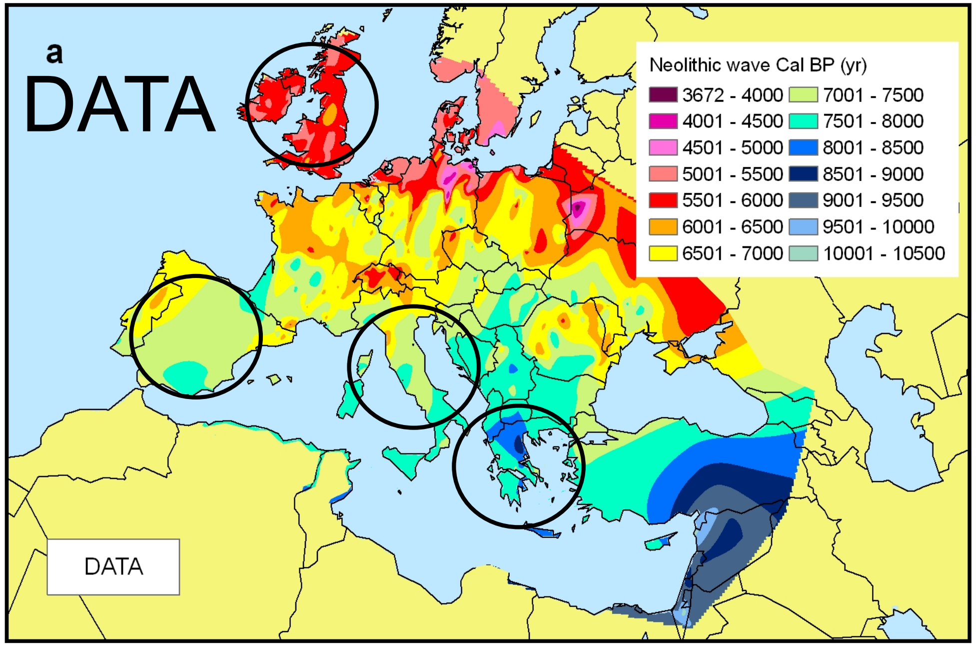
But the front arrives too late to the Adriatic and Iberian peninsulas

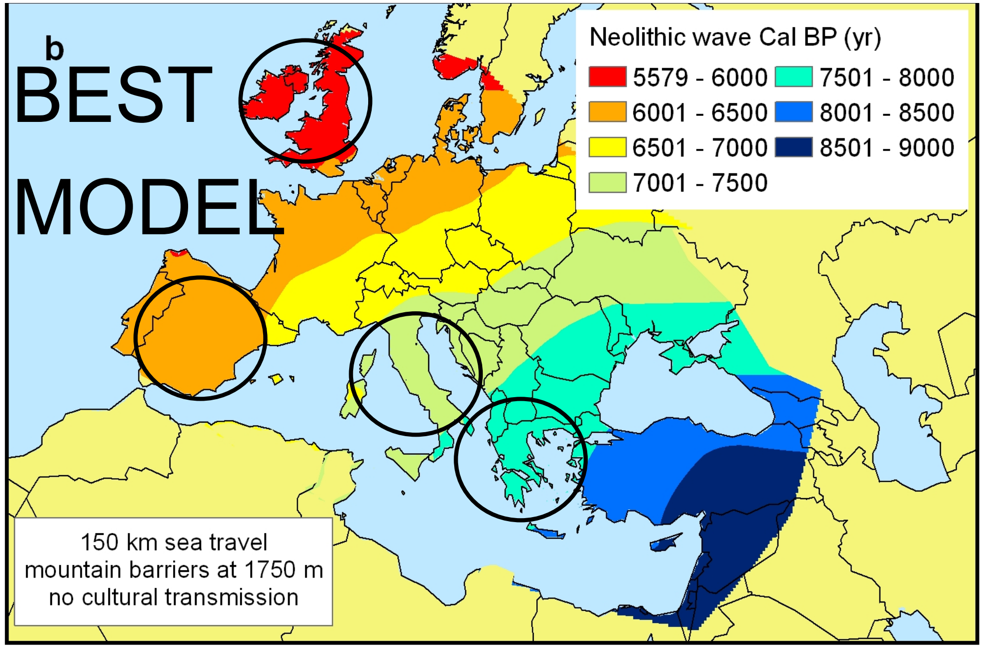
Let us consider non-homogeneous models

Mean error per site in the arrival time of the Neolithic front

Dataset (in addition to the 903 European sites)	Initial Conditions used in the Simulations	Homogeneous Model	Mean Error, Model with Sea Travels < 100 km and Mountains > 1750 m	Mean Error, Model with Sea Travels < 150 km and Mountains > 1750 m	Mean Error, Model with Sea Travels < 200 km and Mountains > 1750 m
87 Near-Eastern sites	Single origin at Jericho	2088 yr	2024 yr	2508 yr	2899 yr
16 PPNB/C sites (1st approach)	Single origin at Hemar†	815 yr	759 yr	1152 yr	1553 yr
16 PPNB/C sites (2nd approach)	PPNB/C sites full of farmers at 9,000 cal yr BP	685 yr	680 yr	**542 yr** **BEST MODEL**	646 yr

† Hemar is the oldest of the PPNB/C sites in the database





Circles indicate better agreement than for the homogeneous model

American Antiquity (2012)

Database by Marc vander Linden

Simulation programs by Toni Pujol

4. Conclusions

- Major inconsistency: according to models, the Neolithic front would have arrived to Greece in less than half the time implied by the data.
- It can be solved including only PPNB/C sites in the Near East.
- Best model: sea travel up to 150 km.
- Mountain barriers: neglibible effect.

5. SimulPast transversal group

Case Study CS6, Neolithic front spread

· Europe: 4 published papers with acknowledgements to SimulPast (G8)

· Asia:
profs. Madella, Rondelli... (G1, CSIC)
prof. Ibáñez ... (G3, CSIC)
prof. Stride ... (G4, UB)

SimulPast transversal group

Possible additional topics

- Bronze+iron transition-urnfield people, prof. Barceló (G7, UAB)
- Diffusion of pottery (prof. Ibáñez, G3)
- Diffusion of sickles (prof. Ibáñez, G3)
- ...