Modelling language shift in Carinthia, Austria

K. Prochazka* and G. Vogl

University of Vienna, Faculty of Physics, Boltzmanngasse 5, 1090 Vienna, Austria
*katharina.prochazka@univie.ac.at

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Background

Use of the minority language Slovenian in Carinthia, Austria, has been steadily declining over the past century. Despite supportive measures, language shift (speakers abandoning use of one language for another) is taking place which reduces cultural diversity.

One way of monitoring this language shift on a large scale is using methods from the natural sciences where dealing with big sets of data is common. Language shift has previously been described by computer simulations based on models of diffusion from solid state physics.[1–3]

Most of these simulations use differential equations derived from Fick's laws of diffusion. We present a different approach: **an agent-based model to simulate the action of individual speakers** to model language shift **over time and space** in Carinthia.

[1] C. Schulze, D. Stauffer, S. Wichmann. Commun Comput Phys 3, 271–294 (2008). [2] A. Kandler. Hum Biol 81, 181–210 (2009). [3] N. Isern, J. Fort. J R Soc Interface 11 (2010).

Our approach: An agent-based model

speaker distribution at beginning

67	0	0
124	75	0
0	12	77

the language spreads from every location where speakers live to neighbouring regions

Gaussian spread function S

0.8	0.1	0.2
1.0	0.8	0.2
0.2	0.7	0.8

0.1	0.3	0.2
0.7	0.4	0.1
0.1	0.5	0.3

language promoting factors

$H = \sum_i h_i \cdot H_i$

e. g. bilingual schools

spread probability $p \sim S \cdot H$

0.08	0.03	0.04
0.70	0.32	0.02
0.02	0.35	0.24

0.09	0.72	0.38
0.53	0.13	0.91
0.67	0.82	0.22

random numbers

if $p >$ random number then speakers are gained

67	0	0
126	77	0
0	12	79

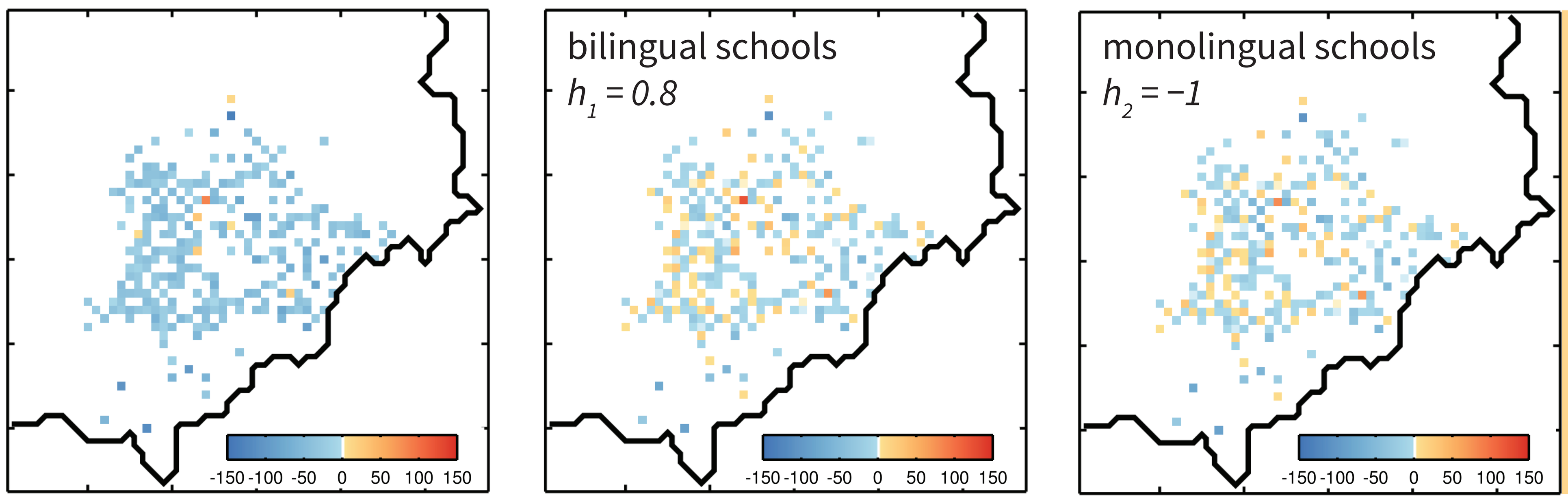
based on a model developed for use in ecology:
[4] G. Vogl et al. Eur Phys J Special Topics 161, 167–173 (2008).
[5] M.G. Smolik et al. J Biogeogr 37, 411–422 (2010).
[6] R. Richter et al. J Appl Ecol 50, 1422–1430 (2013).

Some results: change in Slovenian speakers in the district Völkermarkt

more parameters = better simulation

Gaussian spread S only

language promoting factors $H = h_1 \cdot H_1 + h_2 \cdot H_2$



comparison

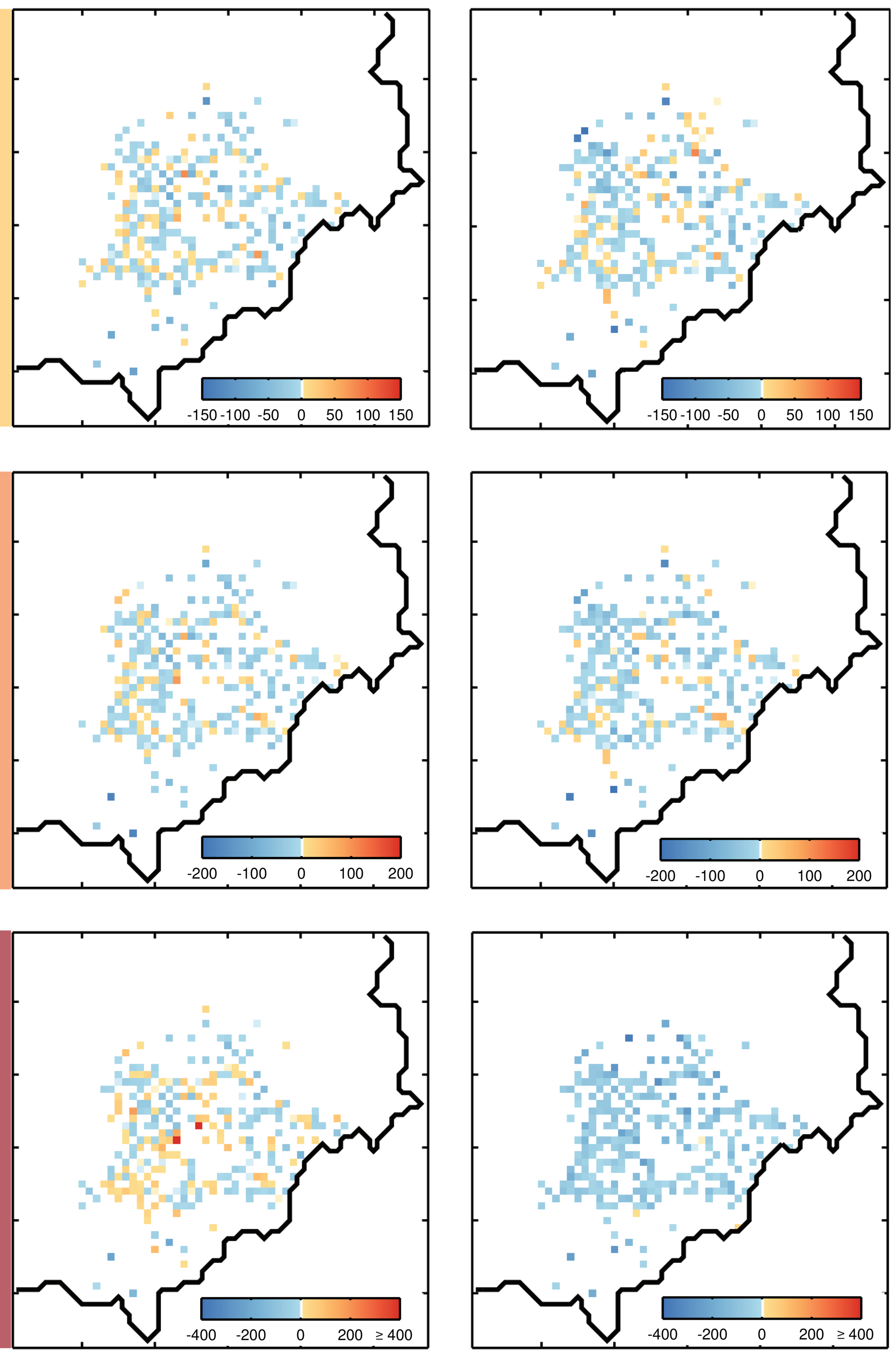
simulation (2 parameters in H optimised for 1900)

real data

1880 to 1900

1880 to 1910

1880 to 1934



Graphs show absolute change in Slovenian speaker numbers (red = more, blue = fewer). Grid size is 1 × 1 km. Real data taken from the Austrian census (Statistik Austria).

Conclusion

Language use and its spatio-temporal changes **can be simulated with an agent-based model using only quantifiable parameters.**

Language loss speeds up over time (more blue in graph = fewer speakers): optimization for a single period of time is not sufficient **→ time-dependent parameters**

Discrete events influencing language use (e. g. wars) **are difficult to incorporate in the model.**

dynamics of condensed systems

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