Speed of Bluetongue epizootic wave in France during the 2006-2008 outbreak

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Introduction

➤ Bluetongue (BT) is an infectious disease of ruminants transmitted by biting midges (genus *Culicoides*) [1]

➤ In 2006-2009 northwest Europe experienced a major BT outbreak due to the Bluetongue Virus serotype 8 (BTV-8) [2]:

- rapid spread to 14 countries
- > 86,000 contaminated farms

➤ France was heavily impacted: >43,000 affected holdings in 2007-2008

Date of the 1st BTV-8 clinical case occurrence in France[3]

Objectives

1. Estimate the velocity of the BTV-8 epizootic wave

2. Investigate which main environmental factors influence this velocity

Materials and Methods

Step 1: estimation of the velocities of BT spread [3]

Date and location of the 1st BTV-8 clinical cases in 10,994 municipalities

⬇ Model A

Trend-Surface Analysis (TSA) combined with a spatial error Simultaneous Autoregressive Model (SAR$_{err}$)

Estimated velocities of BT spread

Step 2: explanatory modelling of the estimated velocities

Estimated velocities of BT spread in 4,495 municipalities

Model B
SAR$_{err}$

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meteorological conditions | elevation | host density | vaccination | landscape diversity
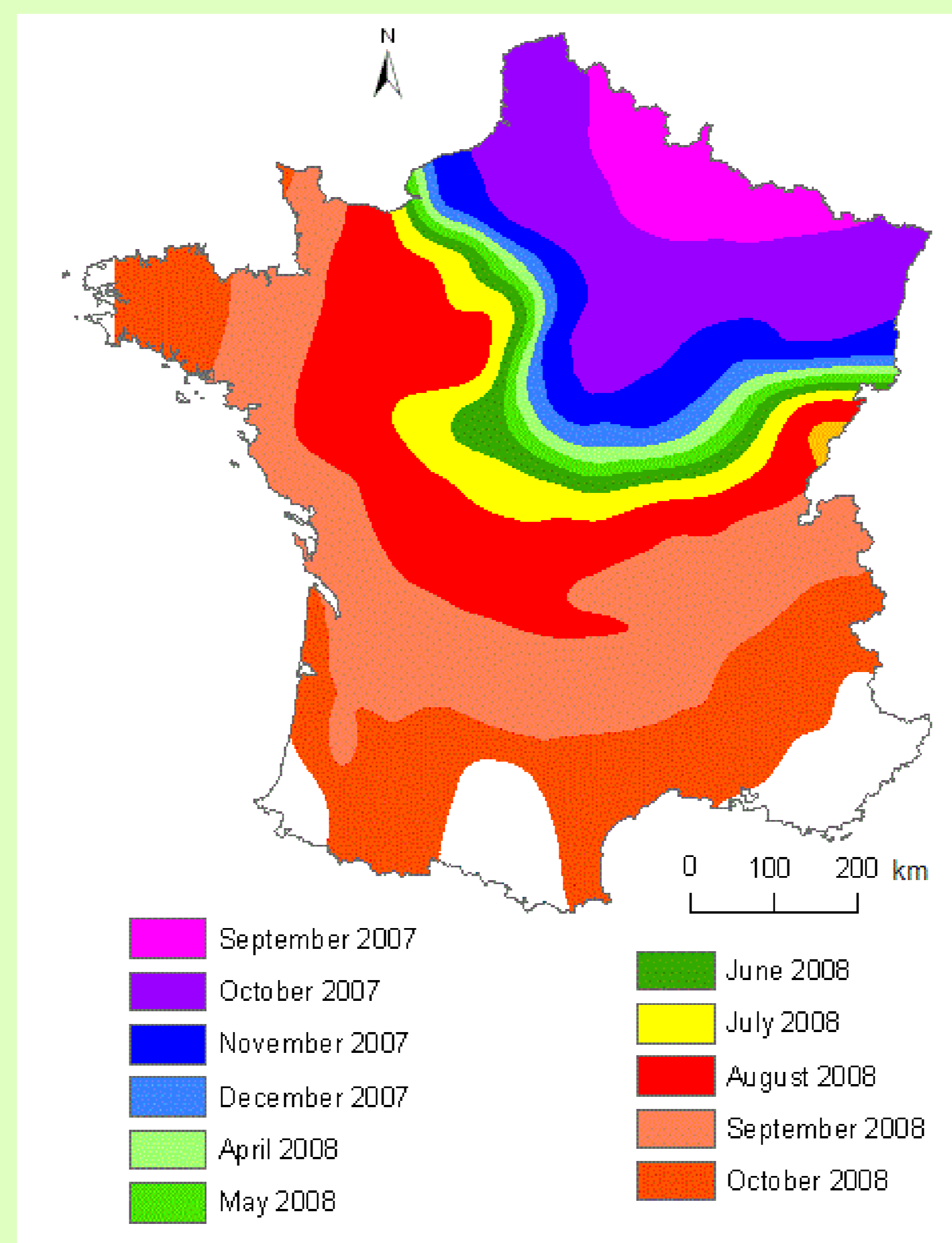
Backward model selection based on AIC for models A and B

Results and Discussion
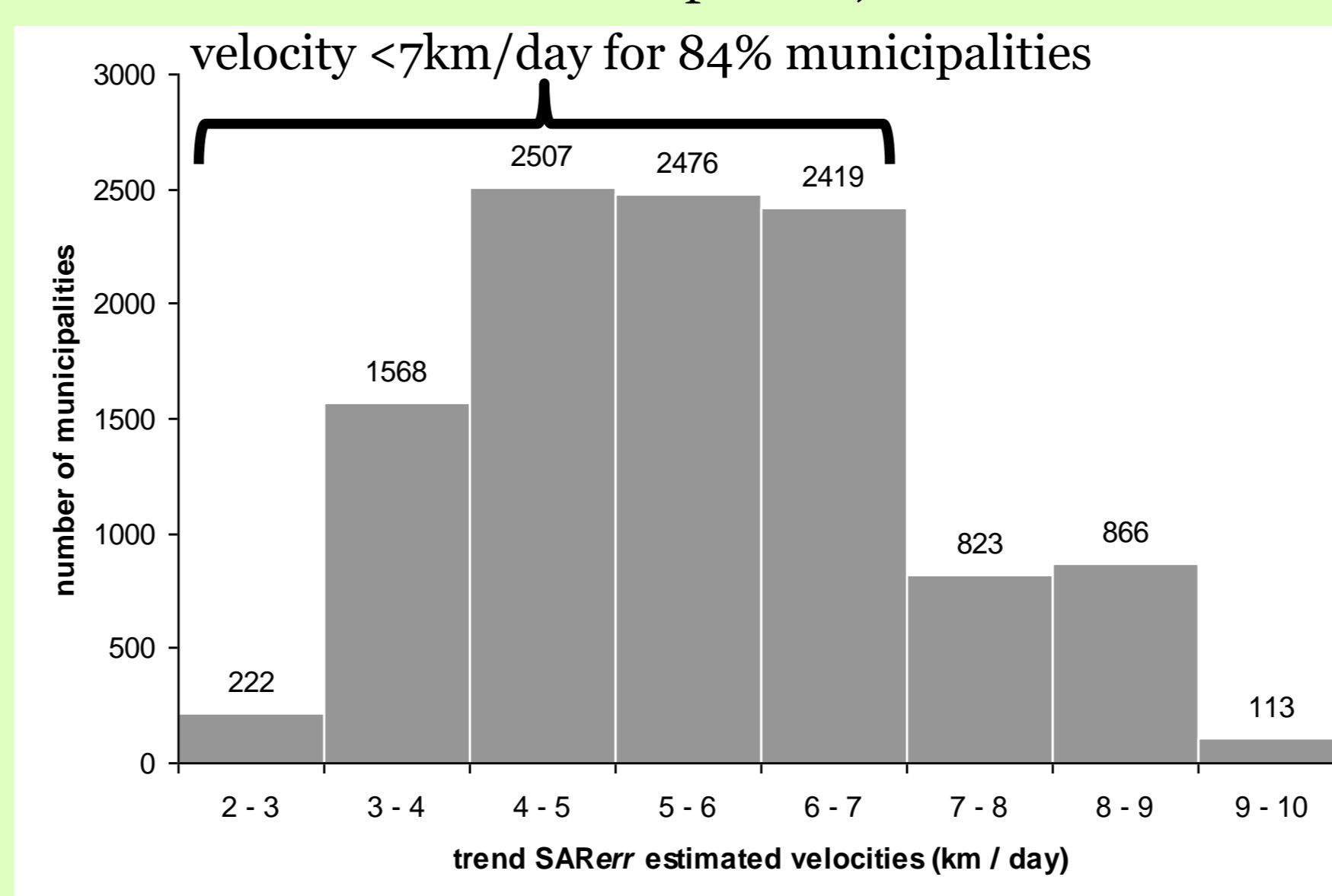
Step 1: estimation of the velocities of BT spread

➤ **Model A**: R² = 0.96

Predicted date of the 1st clinical case occurrence [3]

- September 2007
- October 2007
- November 2007
- December 2007
- April 2008
- May 2008
- June 2008
- July 2008
- August 2008
- September 2008
- October 2008

➤ Average estimated velocity = 5.6 km/day [3]
➤ Variations according to areas and time period: between 2.1 and 9.3 km/day

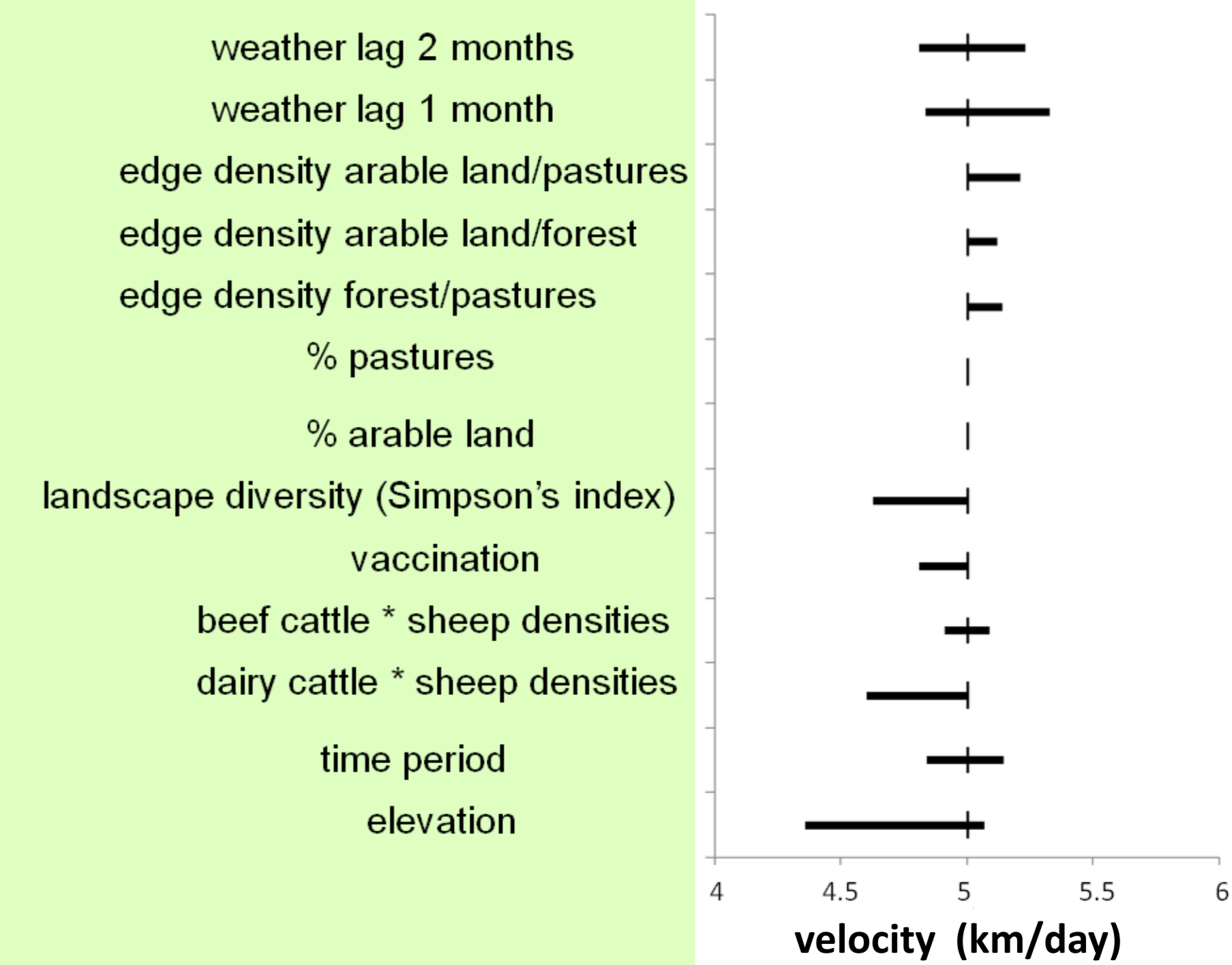Distribution of estimated BTV-8 velocities (10,994 municipalities)

velocity <7km/day for 84% municipalities

Step 2: explanatory modelling of the estimated velocities

➤ **Model B**: R² = 0.87
➤ 16 explicative variables in the model

The highest velocities were associated with low elevation, low rainfall with mid temperatures, low dairy cattle and high beef cattle densities.

The lowest velocities were associated with high elevation, high rainfall, high dairy cattle density and vaccination.

Range of variations in velocities due to each covariate

weather lag 2 months
weather lag 1 month
edge density arable land/pastures
edge density arable land/forest
edge density forest/pastures
% pastures
% arable land
landscape diversity (Simpson's index)
vaccination
beef cattle * sheep densities
dairy cattle * sheep densities
time period
elevation

Conclusion

➤ **Average estimated velocity of BTV-8 spread in France = 5.6 km/day**

➤ **Local spread due to active flight of the vectors and short range movements of livestock/wildlife**

➤ **Velocity of BT spread mostly influenced by elevation, meteorological conditions and host availability**

References

[1] Carpenter S *et al.* (2009) Trends Microbiol 17: 172-178
[2] Wilson AJ and Mellor PS (2009) Phil Trans R Soc B 364: 2669-2681
[3] Pioz M *et al.* (2011) Vet Res 42:60

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