DETECTING DRIVERS OF FIRST INVASIONS USING RELATIONAL EVENT MODELS

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MOTIVATION

Rapid range expansion of an invasive species is a primary threat to global biodiversity and ecosystems. A better understanding of biological invasions may help identify potential strategies for preventing and mitigating invasion impacts.
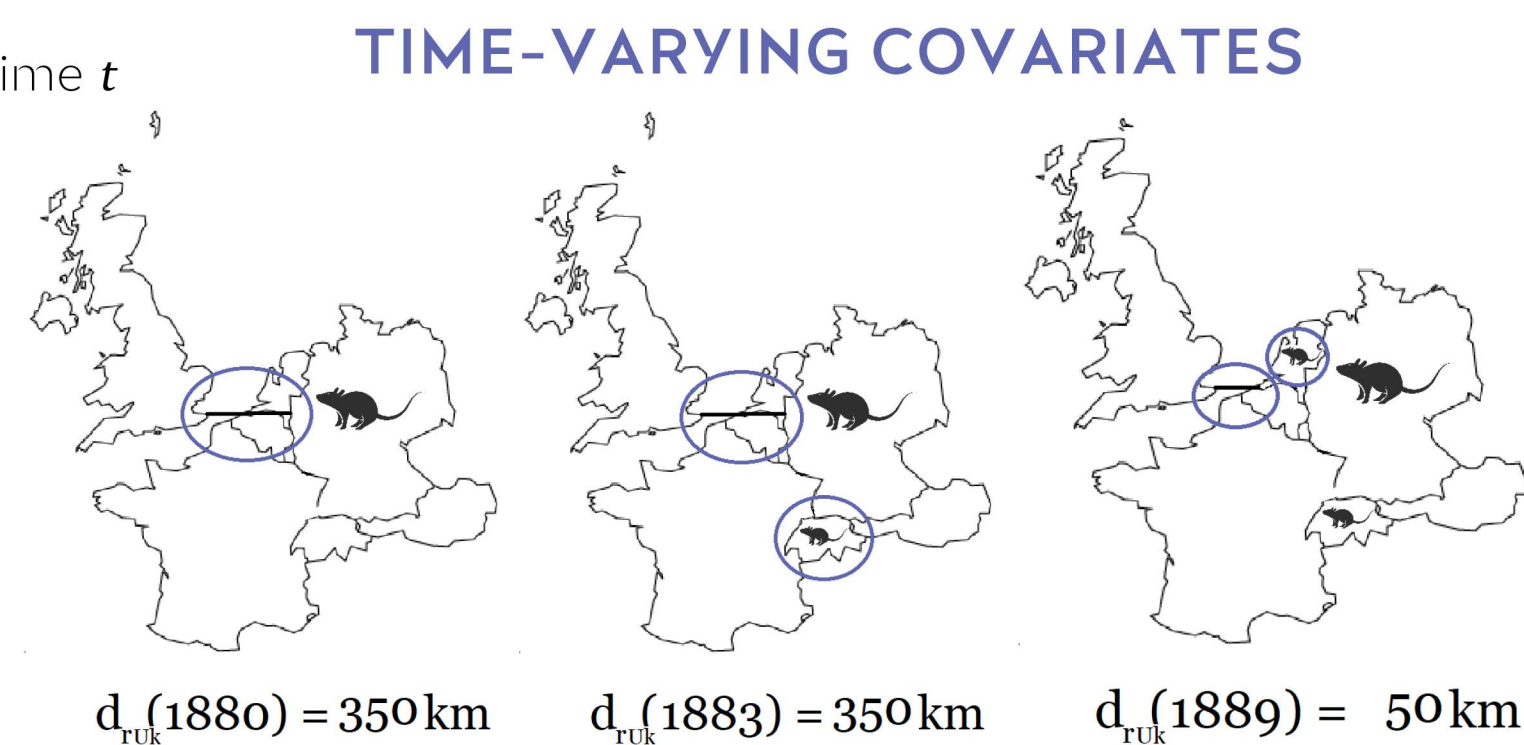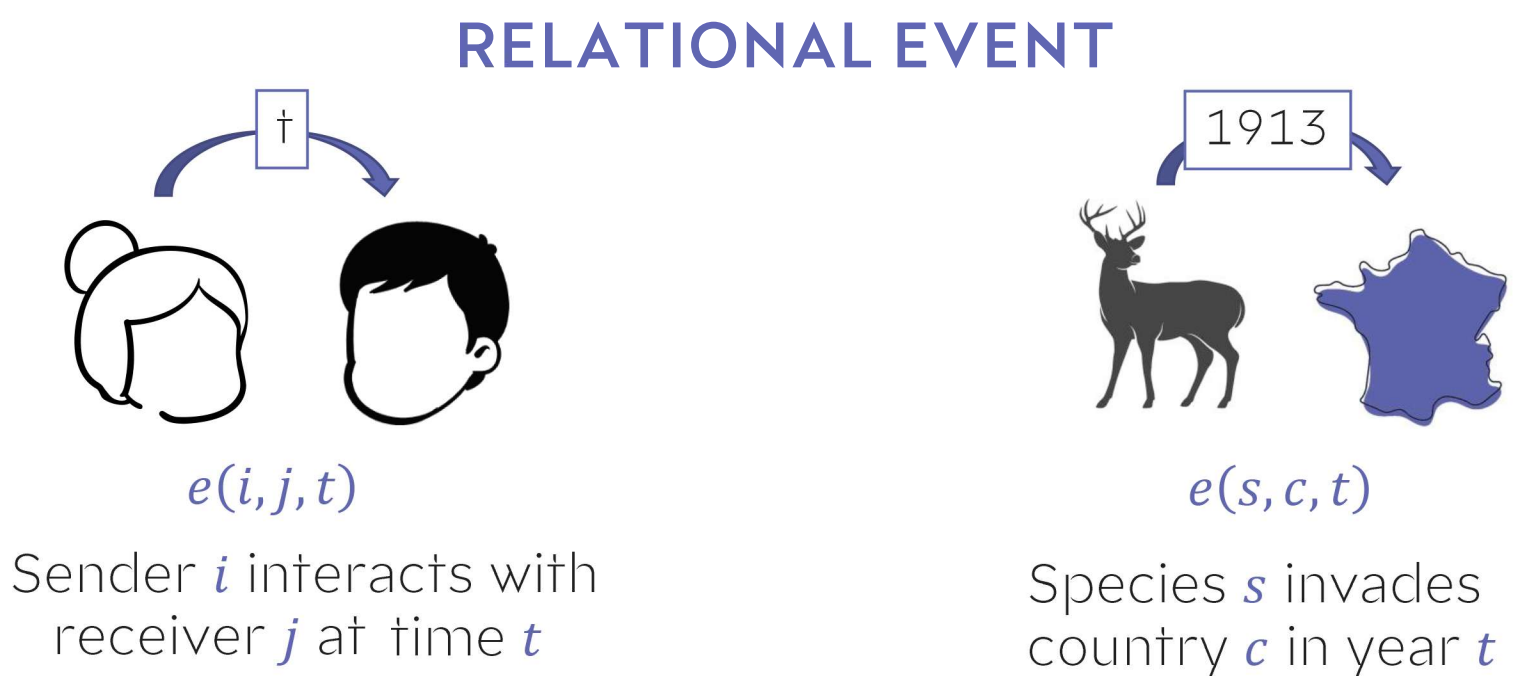
AIM: model $\lambda_{sc}(t)$= hazard of s invading c at time t

RELATIONAL EVENT

$e(i,j,t)$
Sender i interacts with receiver j at time t

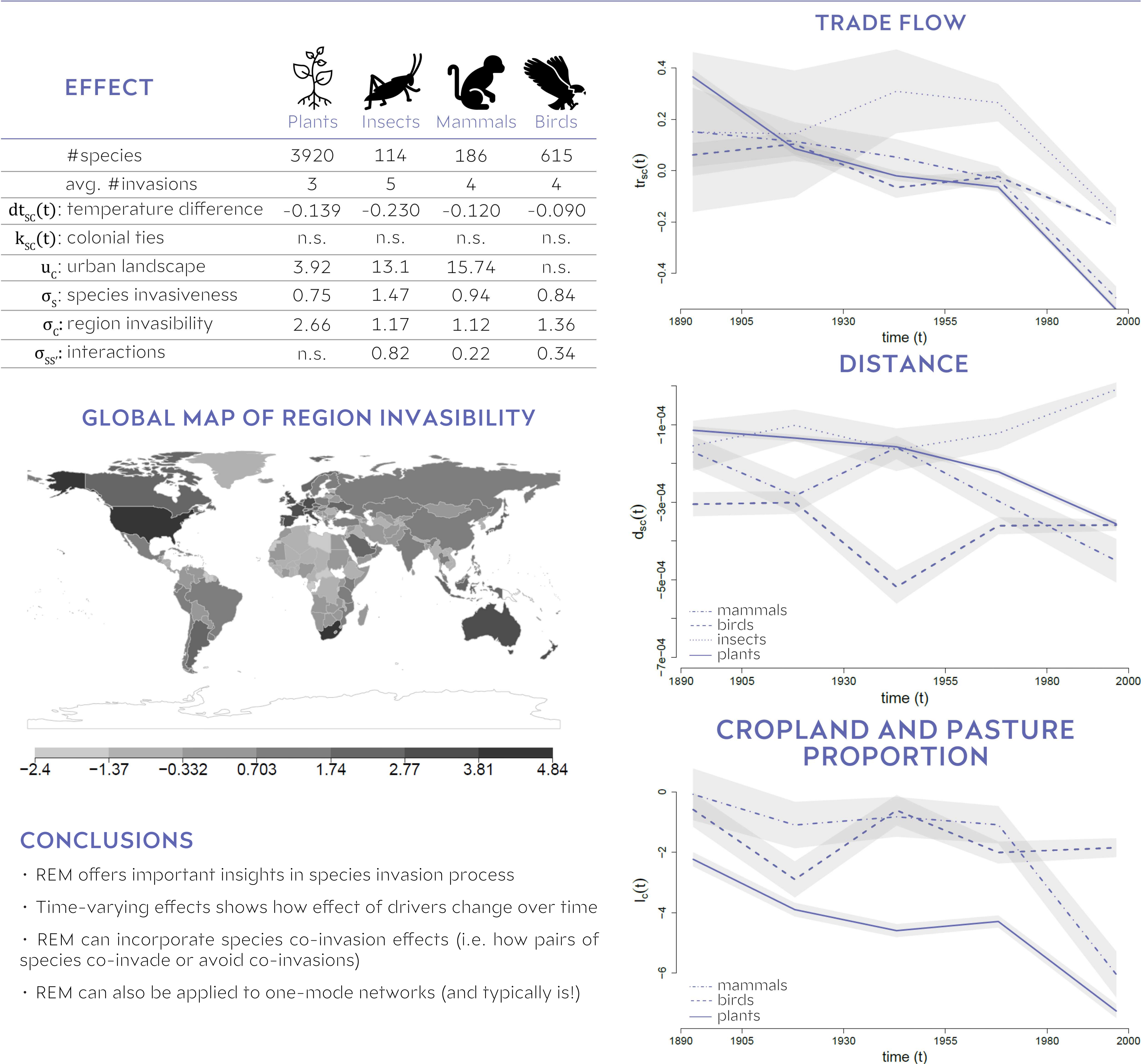$e(s,c,t)$
Species s invades country c in year t

MODEL

$$\log\lambda_{sc}(t) = \log\lambda_0(t) + dt_{sc}(t)\beta_1 + k_{sc}(t)\beta_2 + u_c(t)\beta_3 + d_{sc}(t)\beta_4(t) + l_c(t)\beta_5(t) + tr_{sc}(t)\beta_6(t) + b_s + b_c + b_{ss'}$$

where
$dt_{sc}(t)$: min temperature diff between c and countries invaded by s by time t
$k_{sc}(t)$: presence of s at time t in colonial power to which c belongs
$u_c(t)$: the proportion of urban area in country c at time t
$d_{sc}(t)$: distance to region nearest to c invaded by s by time t
$l_c(t)$: sum of cropland and pasture proportions in country c at time t
$tr_{sc}(t)$: annual trade between c and regions invaded by s by time t
b_s: invasiveness of species s
b_c: popularity of country c
$b_{ss'}$: species s and s' interaction

TIME-VARYING COVARIATES

$d_{ruk}(1880) = 350\,km$ $d_{ruk}(1883) = 350\,km$ $d_{ruk}(1889) = 50\,km$

RESULTS

TRADE FLOW

EFFECT	Plants	Insects	Mammals	Birds
#species	3920	114	186	615
avg. #invasions	3	5	4	4
$dt_{sc}(t)$: temperature difference	-0.139	-0.230	-0.120	-0.090
$k_{sc}(t)$: colonial ties	n.s.	n.s.	n.s.	n.s.
u_c: urban landscape	3.92	13.1	15.74	n.s.
σ_s: species invasiveness	0.75	1.47	0.94	0.84
σ_c: region invasibility	2.66	1.17	1.12	1.36
$\sigma_{ss'}$: interactions	n.s.	0.82	0.22	0.34

GLOBAL MAP OF REGION INVASIBILITY

-2.4   -1.37   -0.332   0.703   1.74   2.77   3.81   4.84

DISTANCE

mammals
birds
insects
plants

CROPLAND AND PASTURE PROPORTION

mammals
birds
plants

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CONCLUSIONS

· REM offers important insights in species invasion process

· Time-varying effects shows how effect of drivers change over time

· REM can incorporate species co-invasion effects (i.e. how pairs of species co-invade or avoid co-invasions)

· REM can also be applied to one-mode networks (and typically is!)

CARD

CENTRE FOR APPLIED RESEARCH AND DEVELOPMENT