

Supplementary material

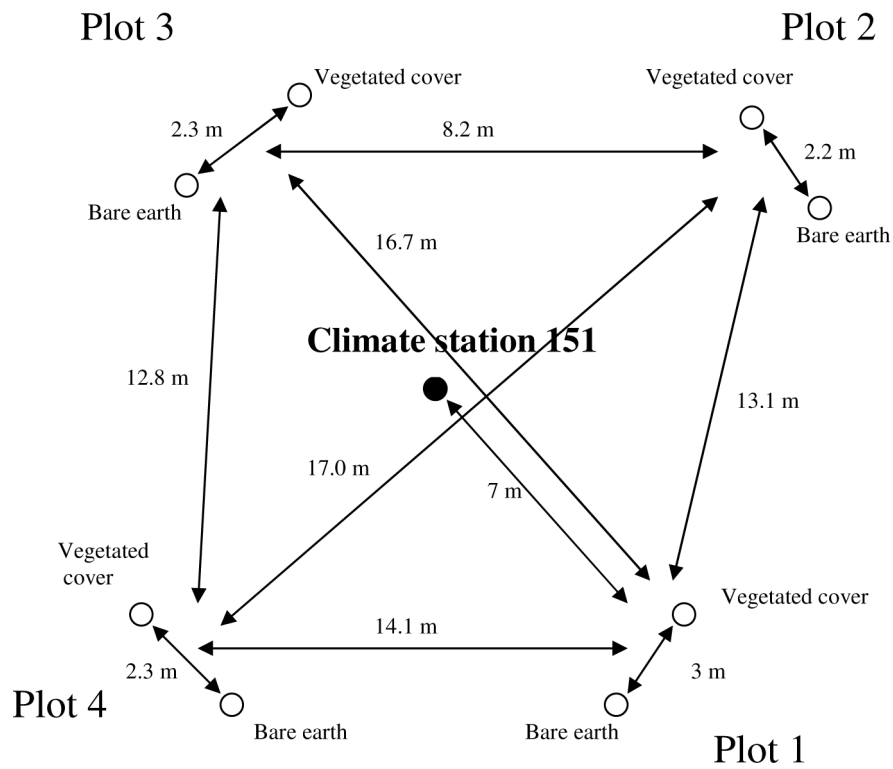


Figure S1. Location of the 16 dataloggers used in the twenty-four hour comparison of the effect of depth and ground cover. Two dataloggers were buried at each point at depths of 2 and 5 cm. Associated analysis and graphs in Table S2 and Fig 2.

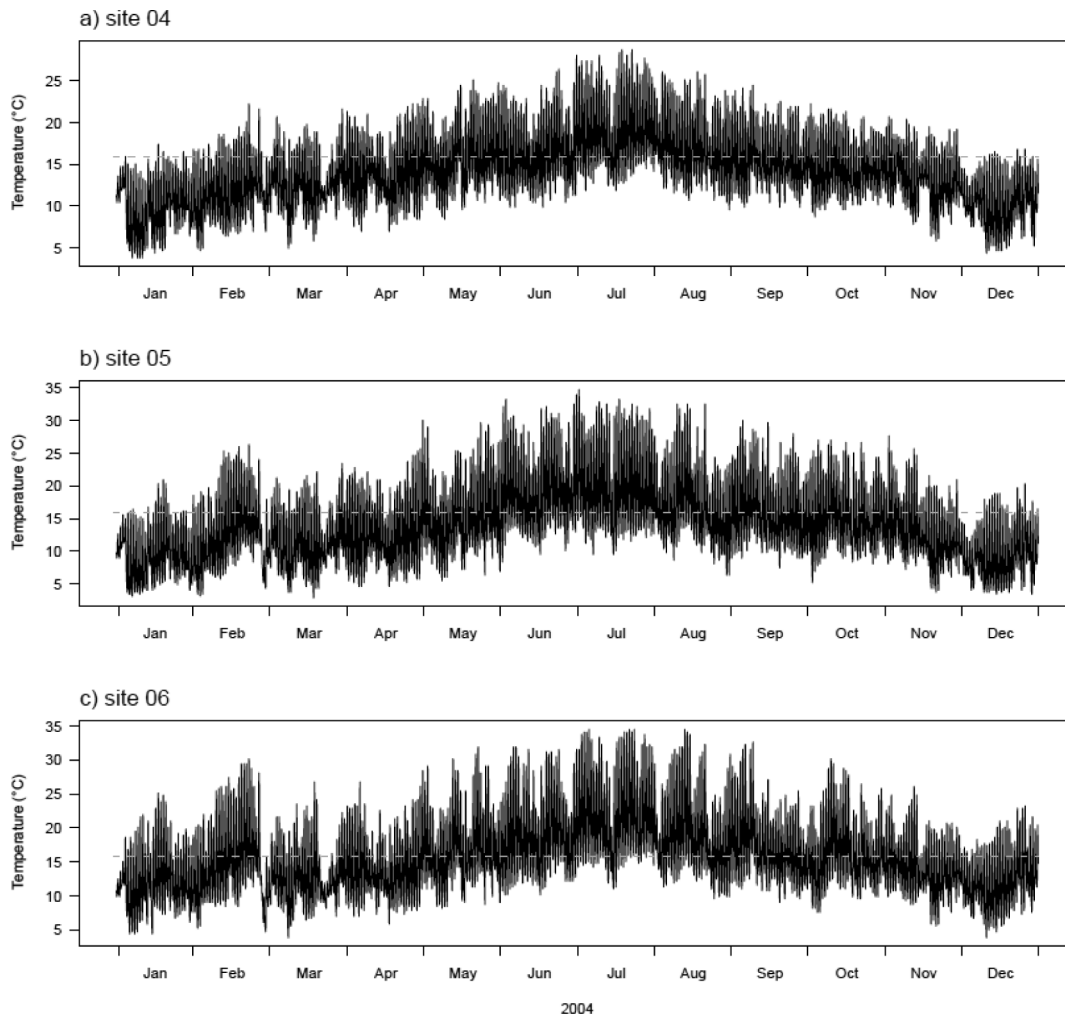


Figure S2. Annual fluctuations in temperature recorded in 2004, 5 cm below ground under a cover of bare earth. Sites 4 and 5 (lower colony) and site 6 (upper colony). Annual degree-days can be calculated as the area under the temperature profile (solid line), but above the threshold of 15.9°C (dotted line). For detail of one diurnal fluctuation, see Fig. 2 of the main paper.

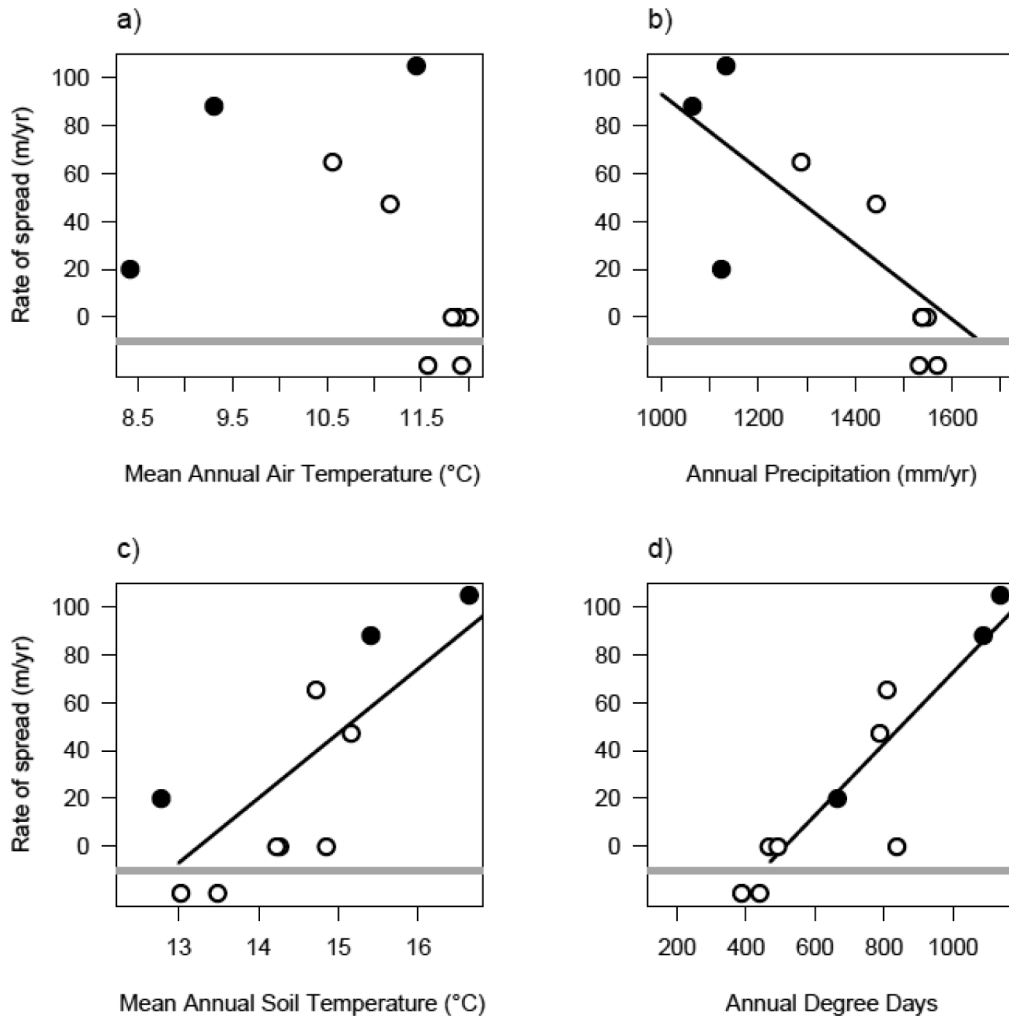


Figure S3. Univariate relationships between four environmental variables and rate-of-spread of the Argentine ant population front. Environmental variables (a and b) were obtained from GIS climate surfaces, interpolated at the same eight points where soil temperatures were measured (Fig. 1 and 3). Solid circles = sites in upper colony, open circles = sites in lower colony. Two circles below the grey line represent sites 2 and 22, close to Hosmer Grove, where Argentine ants have never been recorded; these were not used in fitting the regression. Annual degree days show the tightest relationship and the clearest separation between colonised and uncolonised sites.

a) Mean annual air temperature: $r^2 = 0.09$, $F_{1,6} = 0.613$, $p = 0.46$.

b) Annual precipitation: $r^2 = 0.59$, $F_{1,6} = 8.08$, $p = 0.03$.

c) Mean annual soil temperature: $r^2 = 0.51$, $F_{1,6} = 6.15$, $p = 0.05$.

d) Annual degree days (above 15.9°C): $r^2 = 0.76$, $F_{1,6} = 18.7$, $p = 0.005$ (= Fig. 3 of main paper).

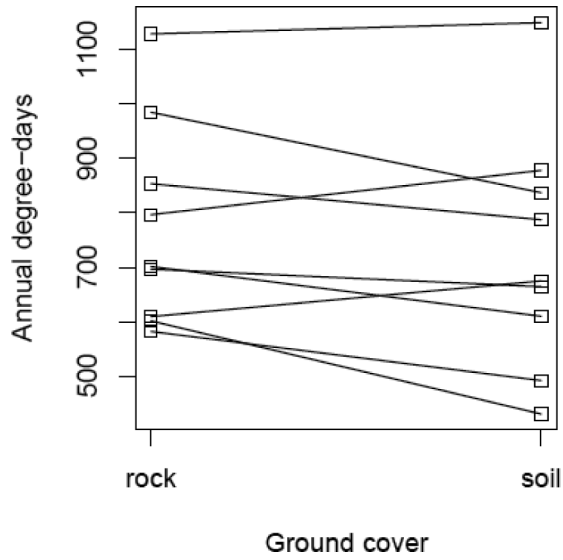


Figure S4. Comparison of annual degree days recorded 5 cm under soil or rocks at 9 paired sites. There is no significant difference between a groundcover of soil vs rocks ($t = 1.6$, $DF = 8$, $p\text{-value} = 0.15$, mean difference = 48 degree-days (95%CI = -21 : +117)).

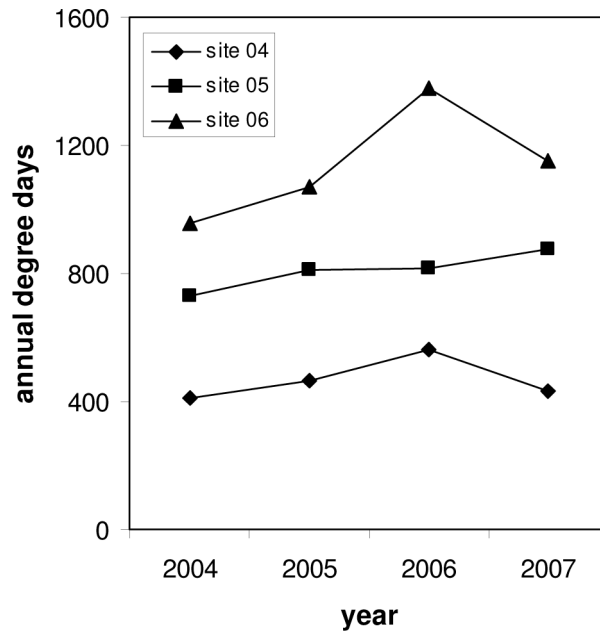


Figure S5. Annual variation in accumulated degree days recorded 5 cm under soil at three dataloggers sites measured over four consecutive years.

Table S1. List of sites where dataloggers were deployed, their ground cover characteristics and the time periods for which annual degree day accumulation was calculated. A surface cover of “grass” may include other low vegetation such as sedges, herbs and mosses.

Site	Population	Latitude (°N)	Longitude (°W)	Ground cover	Sep '03-04	Sep '04-05	Jan '06-07	Mar '06-07	Feb '07-08	May '07-08	Years of data
01	neither	20.767	156.236	grass	*	*					2
02	neither	20.763	156.236	grass	*	*					2
				soil	*	*					2
03	lower	20.763	156.241	grass	*	*					2
				soil	*	*					2
04	lower	20.767	156.240	grass	*	*					2
				soil	*	*	*		*		4
				rock					*		1
05	lower	20.749	156.245	soil	*	*	*		*		4
				rock					*		1
06	upper	20.737	156.221	soil	*	*	*		*		4
				rock					*		1
07	lower	20.760	156.249	soil			*				1
				rock			*				1
08	upper	20.734	156.232	soil			*			*	2
09	upper	20.739	156.235	soil			*		*		2
				rock			*		*		2
10	lower	20.757	156.241	soil			*				1
				rock			*				1
11	neither	20.719	156.166	soil				*			1
12	neither	20.690	156.144	soil				*			1
13	neither	20.690	156.143	shrub				*			1
14	neither	20.690	156.139	soil				*			1
15	neither	20.720	156.150	soil				*			1
16	neither	20.718	156.160	soil				*			1
17	neither	20.721	156.170	soil				*			1
18	neither	20.733	156.160	soil				*			1
19	neither	20.737	156.177	soil				*			1
20	neither	20.752	156.207	soil				*			1
21	lower	20.762	156.242	soil					*		1
				rock					*		1
22	neither	20.767	156.236	soil						*	1
23	lower	20.761	156.240	soil						*	1
24	lower	20.762	156.241	soil						*	1
25	lower	20.766	156.237	rock						*	1
26	lower	20.765	156.237	soil						*	1
				rock						*	1
28	lower	20.761	156.240	soil						*	1
29	lower	20.764	156.238	soil						*	1
				rock						*	1

Table S2. Linear mixed effects model for the effect of ground cover and depth below ground on 24-h degree-days (Fig. 2 of main paper). Fitted using maximum likelihood, with the “lme” function of the “nlme” package in R2.6.0.

Random effects:

```
Formula: ~1 | plot
          Intercept Residual
StdDev:      0.15    0.23
```

Fixed effects: degree-days ~ depth + cover + depth * cover

	Value	Std.Error	DF	t-value	p-value
Intercept	3.9	0.16	9	24.7	0.0000
depth5	-1.3	0.19	9	-7.1	0.0001
coverveg	-3.3	0.19	9	-17.7	0.0000
depth5:coverveg	0.9	0.27	9	3.5	0.0069

Correlation:

	Intercept	depth5	coverveg
depth5	-0.60		
coverveg	-0.60	0.50	
depth5:coverveg	0.42	-0.71	-0.71

Table S3. Comparison of a spatial regression (GLS) with an ordinary regression (Fig. 3 of main paper), using the “anova” function of R2.6.0.

	Model	df	AIC	BIC	logLik	Test	L.Ratio	p-value
Ordinary regression	1	3	76*	76	-35			
Spatial (GLS)	2	5	80	81	-35	1 vs 2	7.8e-09	1

Table S4. Comparison of a spatial regression (GLS) with an ordinary regression (Fig. 4 of main paper), using the “anova” function of R2.6.0.

	Model	df	AIC	BIC	logLik	Test	L.Ratio	p-value
Ordinary regression	1	8	837	854	-411			
Spatial (GLS)	2	10	822*	843	-401	1 vs 2	19	0.0001