Appendix A. Sensitivity of cone heating model to variation in cone properties at 345.32 and 1221.27 degree days.

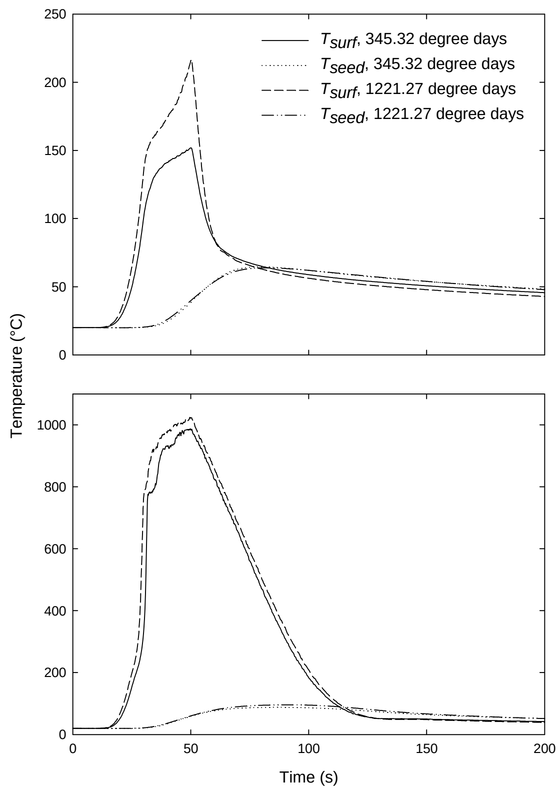

Figure A1: Sensitivity of cone heating model to variation in cone properties at 345.32 and 1221.27 degree days. Cones were heated in two plumes that produced time series of surface temperatures similar to those observed in simulated forest fires (Fig. 4). Maximum seed temperatures for cone properties at 345.32 and 1221.27 degree days varied by 1.2 % (top) and 9.37 % (bottom), so mean cone properties calculated over the entire sampling period were used for subsequent simulations.

Appendix B. Mean (± SEM) physical properties of cones as a function of accumulated degree days from ordinal day 1.

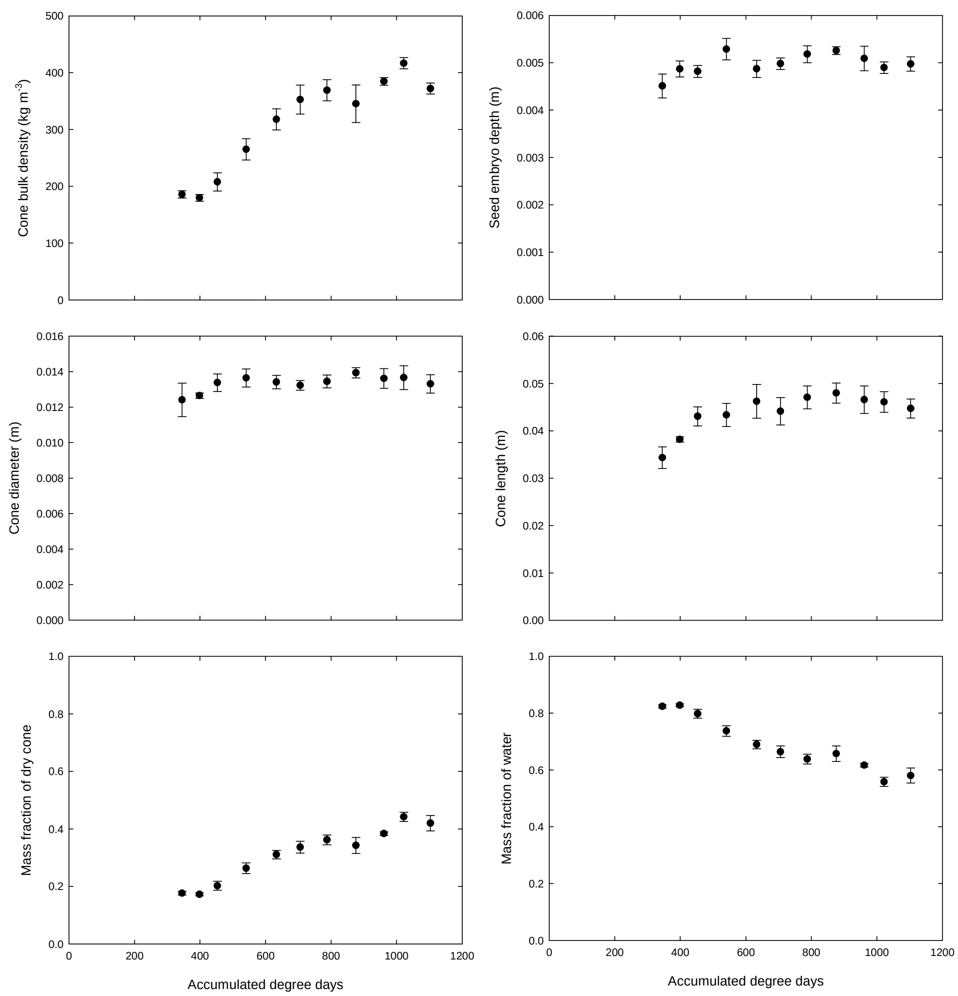

Figure B1: Mean (± SEM) physical properties of cones as a function of accumulated degree days from ordinal day 1. Data are consistent with those reported for white spruce at Chalk River, Ontario (Winston and Haddon, 1981).

Appendix C. Vertical wind profile prescribed at $x = 0$.

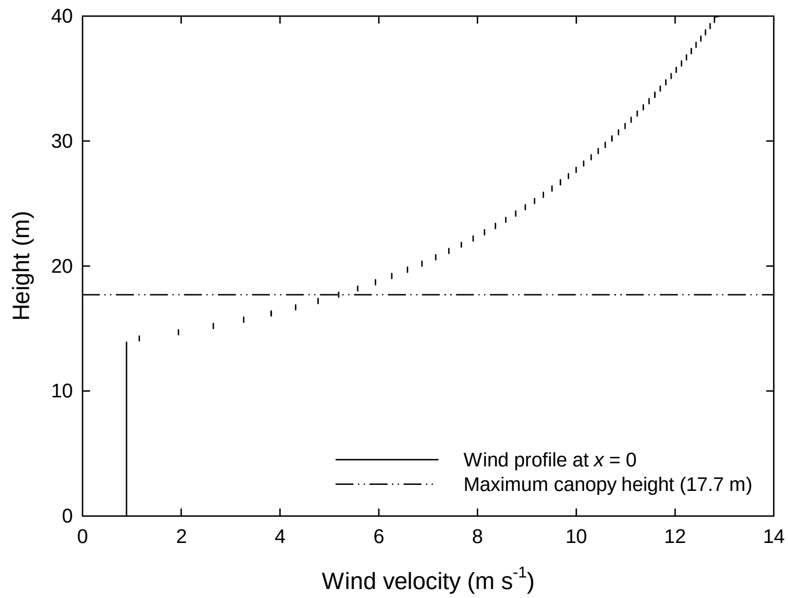

Figure C1: Vertical wind profile prescribed at $x = 0$ (Albini and Baughman, 1979).

Discontinuities reflect averaging of wind velocity over discrete 0.5 m height increments.

Appendix D. Plan view of computational domain.

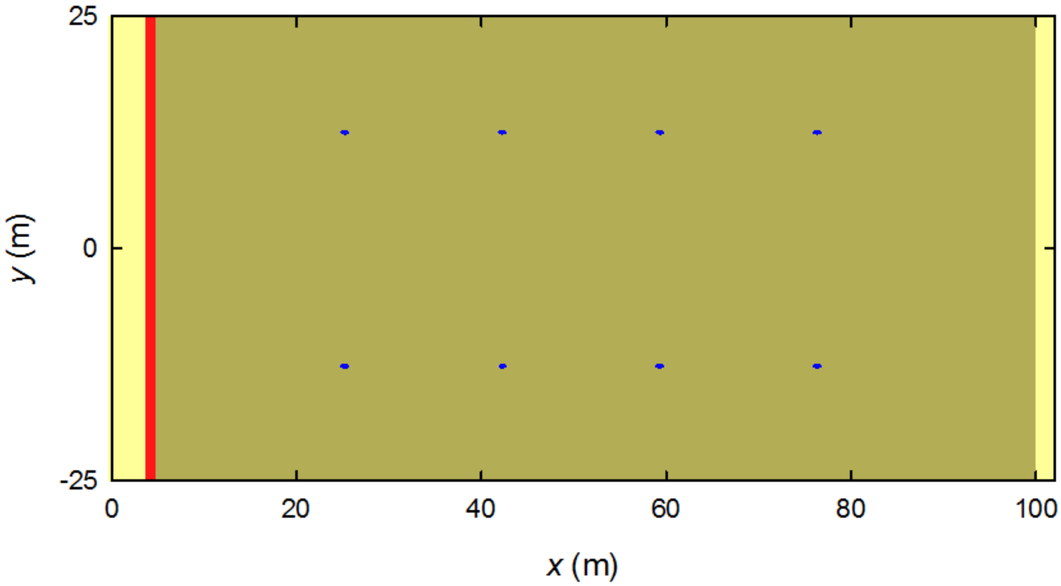

Figure D1: Plan view of computational domain showing locations of ignition source (red), surface fuelbed (brown), and vertical cone arrays (blue ellipsoids; not to scale).

Appendix E. Typical *u*-velocities at the *y* = 0 plane in the absence of fire.

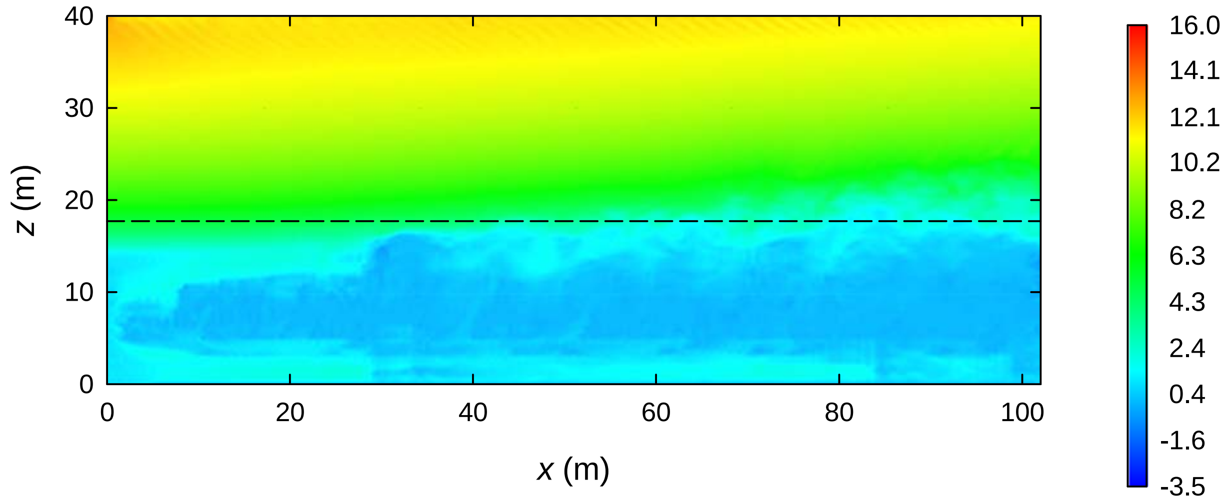

Figure E1: Typical *u*-velocities (m/s) at the *y* = 0 plane in the absence of fire. A time-averaged wind profile is prescribed at *x* = 0 (see Eqn. 8 and Figure C1; Albini and Baughman, 1979)). Dashed line indicates the maximum canopy height of *z* = 17.7 m.

Appendix F. Maximum seed temperature for cones in five simulated forest fires.

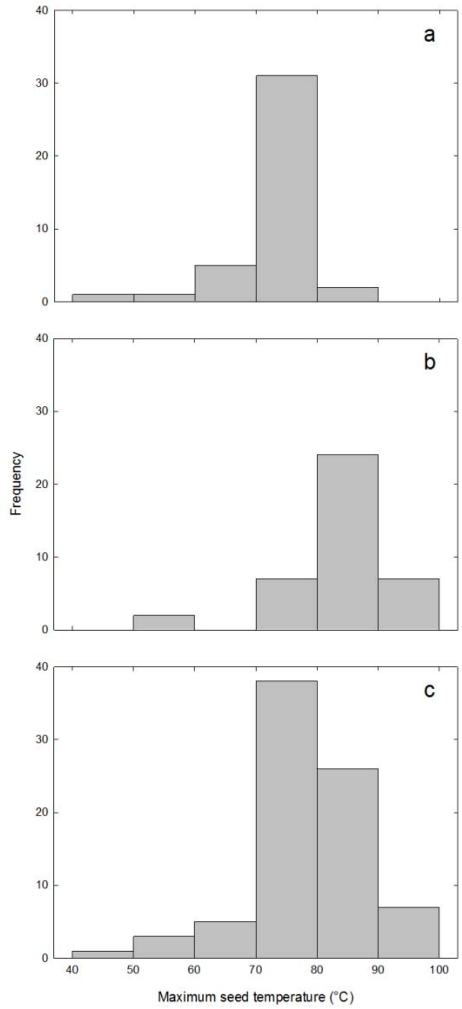

Figure F1: Maximum seed temperature for cones in five simulated forest fires at heights *z* = 17.7 m (a), *z* = 8.7 m (b), and *z* = 17.7 and 8.7 m combined (c).

Appendix G. Maximum seed temperature in cones plotted against time-integrated total heat flux.

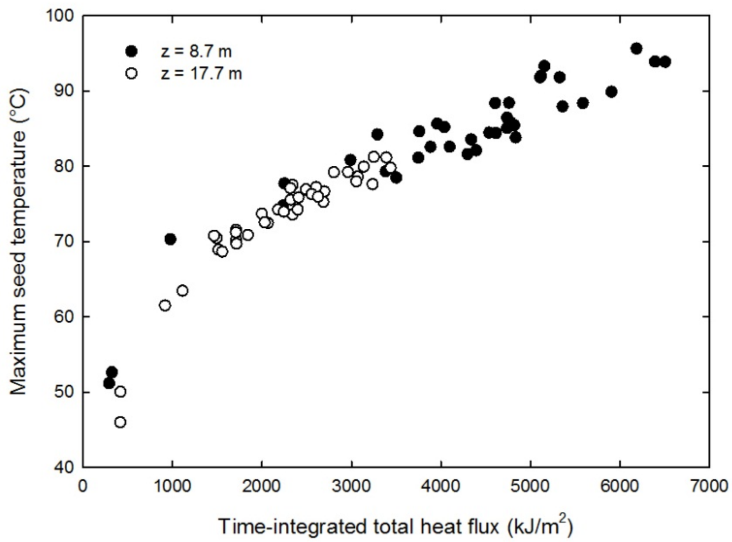

Figure G1: Maximum seed temperature in cones plotted against time-integrated total heat flux.

Each point is an individual cone.

Appendix H. Timing of fire occurrence and seed development.

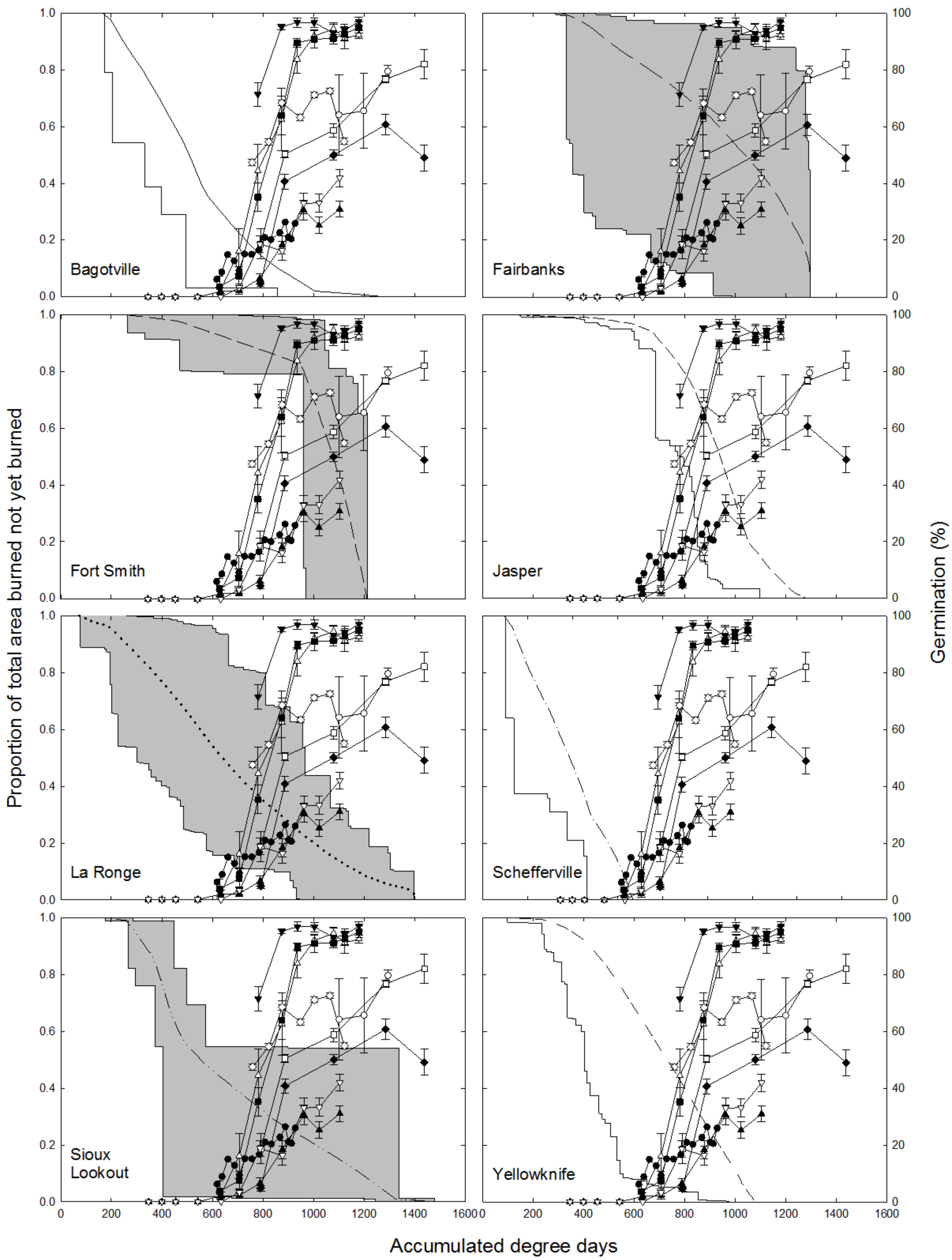

Figure H1: Timing of fire occurrence and seed development. For observation areas with fire end dates, grey areas define the space within which the actual distribution resides. The actual distributions are monotonically decreasing between the upper left and lower right corners of each area, and can be estimated by assuming the area burned by each fire occurs on the start date (left boundary), end date (right boundary), or by assuming steady state spread (center dashed lines) between start and end dates. For observation areas without fire end dates, distributions can estimated assuming the area burned by each fire occurs on the start date (left-hand solid lines) or assuming steady state spread (right-hand lines) between start dates and estimated end dates (not shown; see methods). Error bars are standard error. ▲ Calgary, non-stratified (2010 data); ▽ Calgary, stratified (2010 data); ◆ Chalk River, non-stratified (Winston and Haddon, 1981); □ Chalk River, stratified (Winston and Haddon, 1981); ■ Fairbanks, non-stratified (Zasada, 1978); ▼ Fairbanks, stratified (Zasada, 1973); △ Fairbanks, stratified (Zasada, 1978); ○ Indian Head, stratified (Cram and Worden, 1957);● Kananaskis Country (Crossley, 1953); ◇ Kananaskis Country, stratified (2006 data). Line styles for distributions estimated by steady state assumption correspond to those from Fig. 6.

Appendix I: Multiple regression analysis of time-integrated heat flux on cone surfaces as a function of cone heating time, cone height, and fire intensity.

Backwards stepwise multiple regression was used to relate time-integrated heat flux on cone surfaces (Fig. G1) to cone heating time, cone height, and fire intensity. The heating time for each cone was defined as the period for which total surface flux (sum of positive convective and radiative heat fluxes on the cone) was greater or equal to 1 kJ/m^2 and cone height was taken as 8.7 or 17.7 m (see methods).

In an attempt to identify relevant fire intensities (see discussion), three calculations were made for each cone: mean global intensity, flux-weighted global intensity, and mean local intensity. For mean and flux-weighted global intensities, global intensity I (kW/m) was first calculated for each timestep i according to

$$I_i = \frac{\dot{Q}_i}{L} \qquad \text{D1}$$

where $\dot{Q}_i$ is the total heat release rate (kW) and L is the fireline length in the y-direction (50 m). Mean global fire intensity $\overline{I}$ is then simply

$$\overline{I} = \frac{\sum_{i=1}^{n} I_i}{n} \qquad \text{D2}$$

where n is the number of timesteps. Note that $i = 1$ corresponds to the timestep where the total surface first flux exceeded 1 kJ/m^2 and n corresponds to the timestep where the total surface flux last fell below 1 kJ/m^2; when this occurred more than once, *i* and *n* were based on the first and last instances, respectively. Flux-weighted global intensity was calculated as

$$I_w = \sum_{i=1}^{n} I_i \frac{q_i''}{q_1'' + q_2'' + \ldots + q_n''} \qquad \text{D3}$$

where q_i'' is the total surface flux (kJ/m2) at timestep *i*. Thus, I_w is weighted in favor of those timesteps for which total surface flux was greatest.

Mean local intensity was calculated using Eqns D1 and D2, except total heat release rate $\dot{Q}_i$ was obtained for 12.5 x 12.5 x 40 m volumes around each cone array and the calculation considered only those timesteps where $\dot{Q}_i$ was greater than zero (12.5 m is a rough estimate of the average flame depth for the five crown fire simulations).

Statistical analyses were conducted using the statistical software R (R Development Core Team 2011). For flux-weighted global intensity, the variance of time-integrated surface flux was normalized using $\log_{10}$-transformation. Multiple regression results are summarized in Table I1.

Table I1: Backwards Stepwise Multiple Regression Analysis of Time-Integrated Surface Flux as a Function of Cone Height, Heating Time, and Fire Intensity Calculated in Three Ways[a]

Intensity calculation and variables	β	SE	t	P
Mean global intensity (model $F_{4,75} = 37.17$, $P < 0.001$, $R^2 = 0.65$)				
Heating time	18.480	4.543	4.07	<0.001
Height	-213.700	24.110	-8.87	<0.001
Intensity	0.051	0.019	2.64	<0.05
Heating time^2	-0.026	0.010	-2.63	<0.05
Flux-weighted global intensity (model $F_{5,74} = 31.25$, $P < 0.001$, $R^2 = 0.66$)				
Heating time	0.009	0.002	4.08	<0.001
Height	-0.063	0.010	-6.25	<0.001
Intensity	0.000	0.000	4.10	<0.001
Heating time^2	-0.000	0.000	-2.97	<0.01
Intensity^2	-0.000	0.000	-3.61	<0.001
Mean local intensity (model $F_{4,75} = 49.76$, $P < 0.001$, $R^2 = 0.71$)				
Heating time	3.124	1.191	2.62	<0.05
Height	-218.700	20.340	-10.75	<0.001
Intensity	2.029	0.396	5.12	<0.001
Intensity^2	-0.000	0.000	-4.26	<0.001

[a]Table includes final models after removal of insignificant explanatory variables ($P \geq 0.05$).

Intercepts were significant for all models ($P < 0.0001$) and are not shown.

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