

S3 Text: Temperature variation

As noted in the main text, Mordecai et al. (2017) fitted thermal response models to empirical data for *Ae. aegypti* and *Aedes albopictus*, defining adult fecundity, $b(t)$, using a Brière function (see Equation 8 in main text) [1]. Mordecai et al. (2017) also provided fitted functions for adult longevity and juvenile development rate, $g_j(t)$, but Brière and quadratic models would produce negative values at certain temperatures within our study range. Therefore, we fitted alternative functions for $\mu_A(t)$ and $g_j(t)$ to empirical data extracted from the literature across a spectrum of temperatures. References for studies from which data were extracted are given in S1 Table.

A Gaussian function was fitted to adult longevity data using non-linear least squares regression (see Equation 9 in main text). The p-value was <0.001 for all parameters. Following application of Equation 9, if $b(t) < 0$ or $b(t) \rightarrow \infty$, then $b(t)$ was truncated at zero.

A 2nd-degree polynomial was fitted to juvenile development time (see Equation 10 in main text), which was a significantly better fit than a linear function ($p < 0.001$, likelihood ratio test (LRT)).

To derive a temperature-dependent function for juvenile mortality, $\mu_j(t)$, it was first defined by rearranging Equation 6 (see main text), which describes juvenile survival:

$$\mu_j(t) = \frac{\ln(S_j(t))}{\tau_j(t)} \quad (\text{Equation A})$$

For the purposes of parameter estimation, it was assumed that $\tau_j(t) = \tau_j(t - 1)$ and $\delta_j(t)J(t) \approx 0$. To satisfy Equation A, $\tau_j(t)$ was defined according to Equation 10 (see main text), and based on Mordecai et al. (2017), juvenile survival was estimated using the following quadratic function:

$$S_j(t) = -c_s(T(t) - T_{0S})(T(t) - T_{MS}) \quad (\text{Equation B})$$

T_{0S} and T_{MS} are the thermal minimum and maximum respectively and c_s is a numeric constant.

Using Equations 10 and B, $S_j(t)$ and $\tau_j(t)$ were estimated for $T = 1, 2, \dots, 50$. Values of $S_j(t)$ from Equation B were truncated at zero. Juvenile mortality, $\mu_j(t)$, was subsequently calculated for $T = 1, 2, \dots, 50$ using Equation A. When $S_j(t) = 0$, then $\mu_j(t) \rightarrow \infty$. A 4th-degree polynomial was fitted to the resulting estimates of $\mu_j(t)$ using non-linear least-squares regression. This 4th-degree polynomial was a significantly better fit than 2nd- and 3rd-degree polynomials ($p < 0.001$ for both, LRT), and is defined in Equation 11 in the main text.

References

1. Mordecai EA, Cohen JM, Evans M V, Gudapati P, Johnson LR, Lippi CA, et al. Detecting the impact of temperature on transmission of Zika, dengue, and chikungunya using mechanistic models. PLoS Negl Trop Dis. 2017;11: e0005568. doi:10.1371/journal.pntd.0005568