Appendix S1

Contents :

AedesBA Model Structure

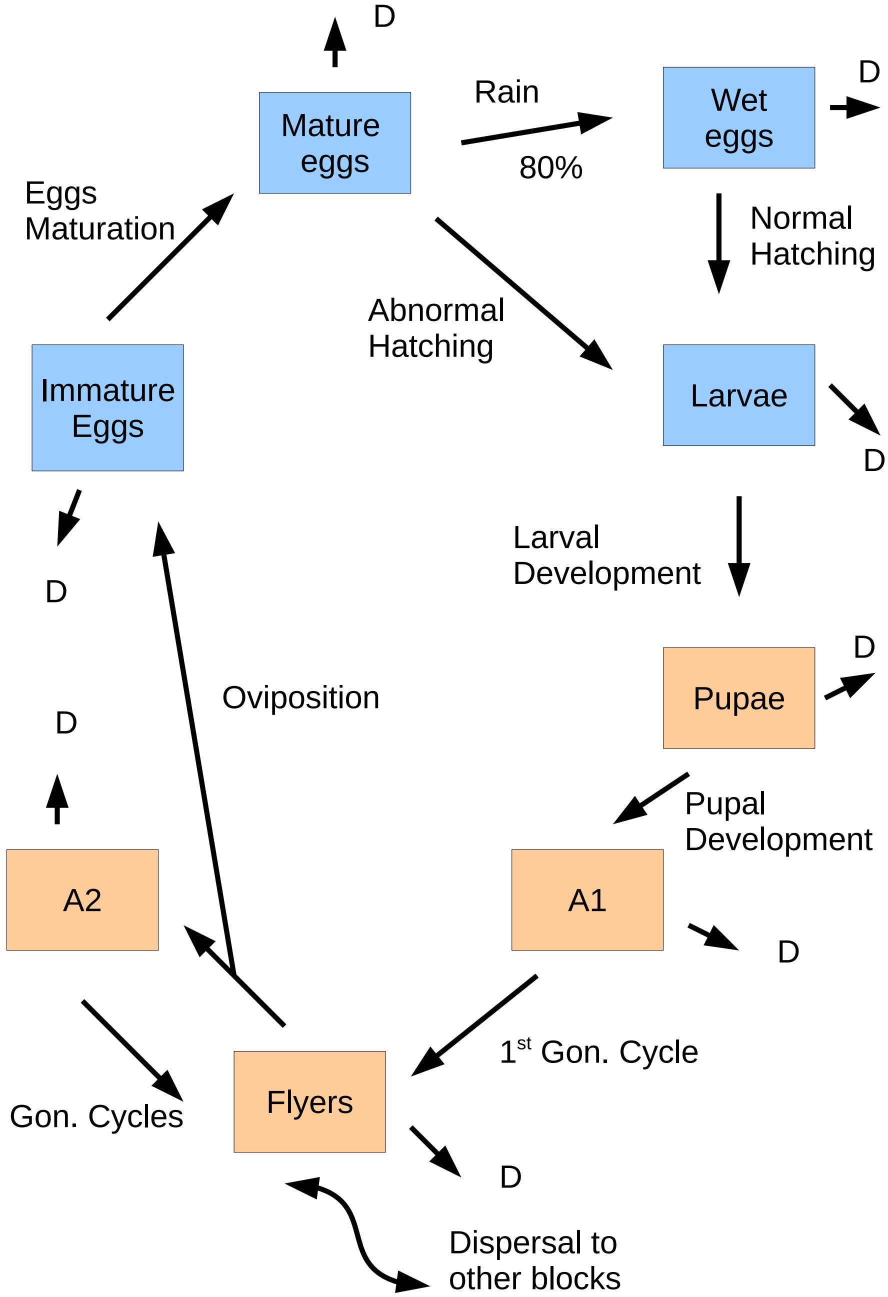

Figure S1: Life cycle of *Aedes aegypti* in the present version of the AedesBA model. Blue boxes correspond to the part of the cycle modified for the present work.

Meteorological Data

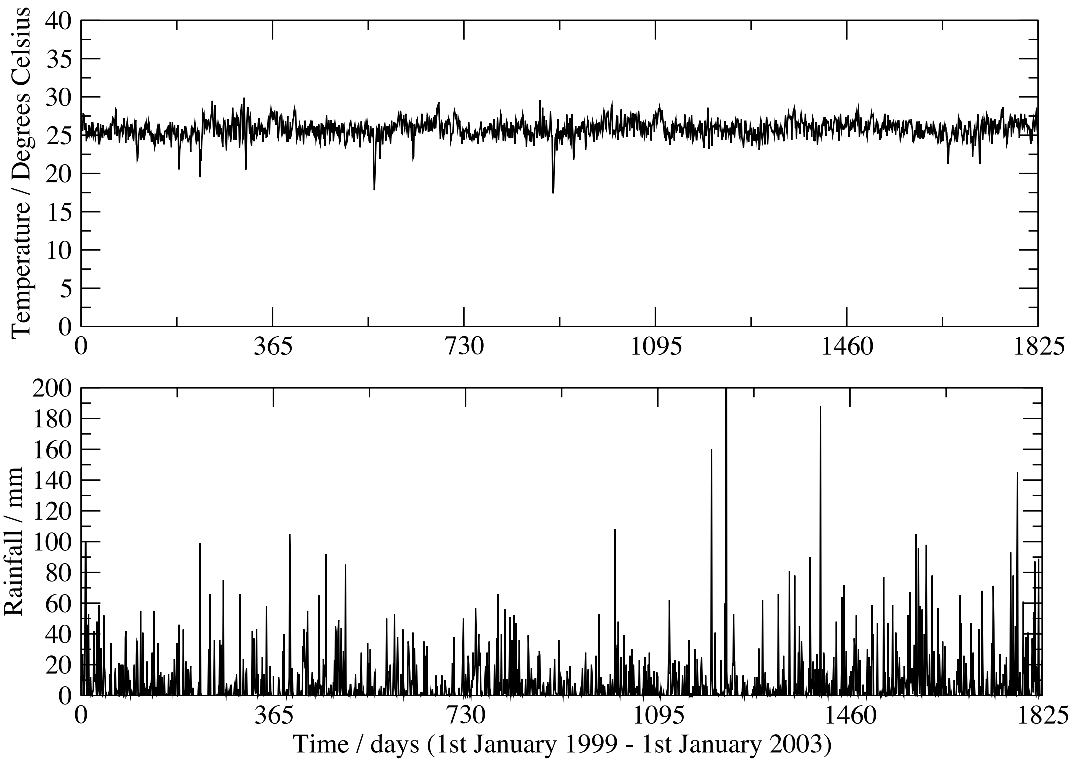

Figure S2: Mean temperature (top panel) and rainfall (bottom panel) of Iquitos (1st January 1999 – 1st January 2003).

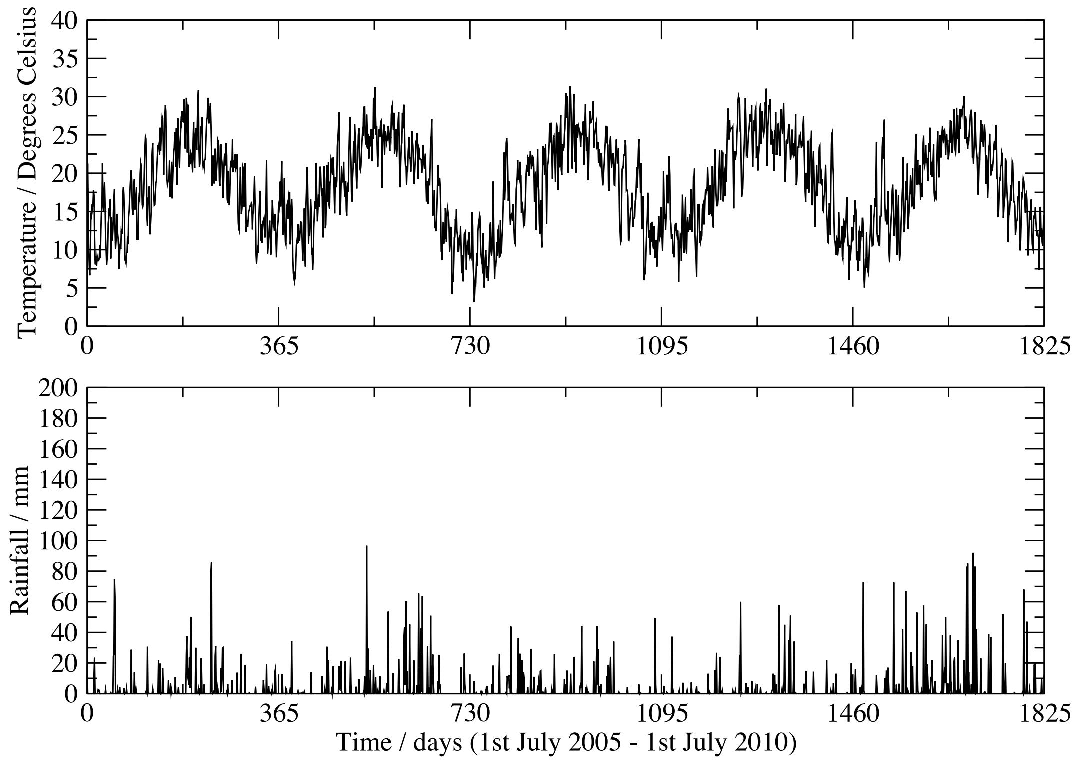

Figure S3: Mean temperature (top panel) and rainfall (bottom panel) of Buenos Aires (1st July 2005 – 1st July 2010).

Effects of Artificial Weather on Mosquito Population Dynamics

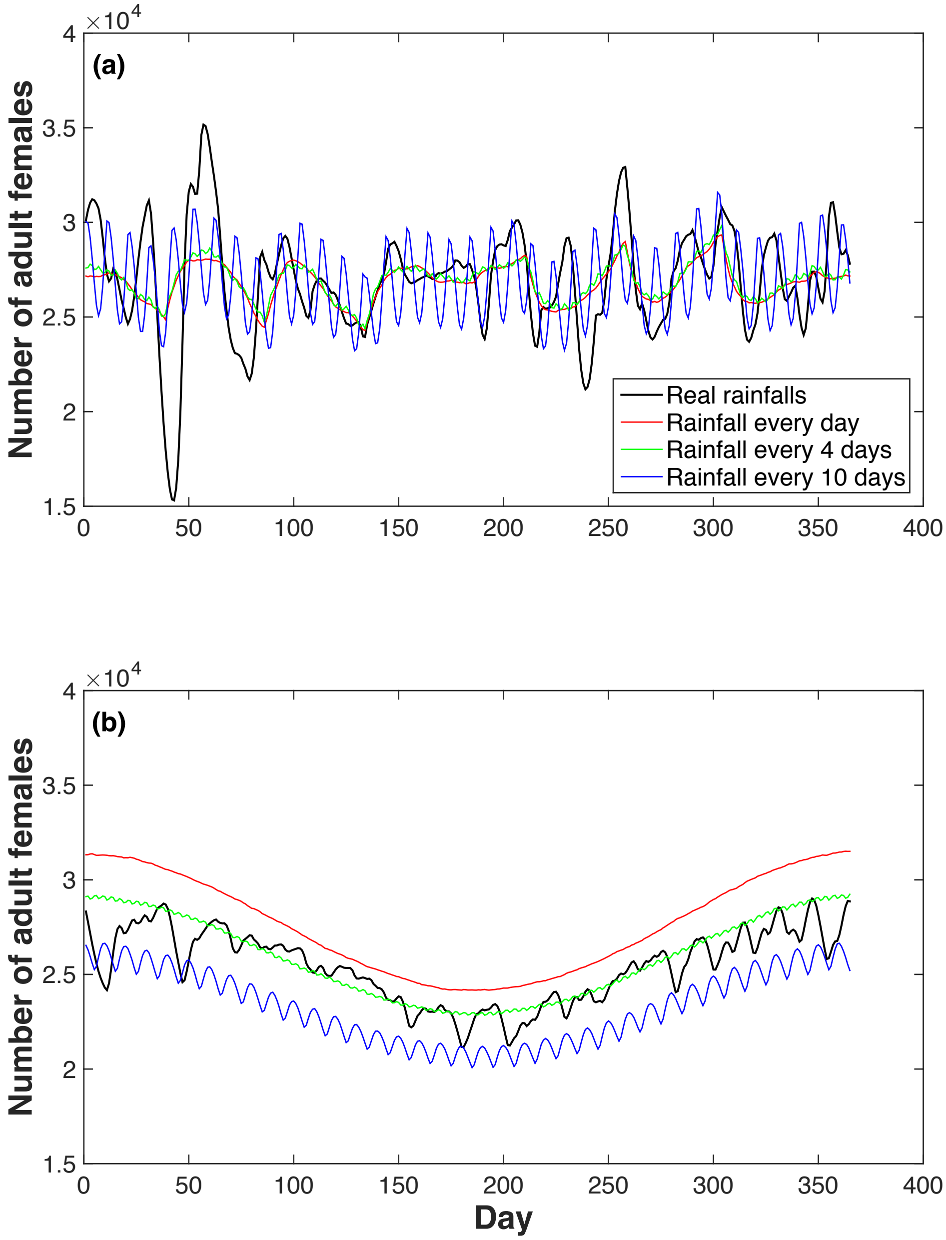

Figure S4: Effect of sinusoidally varying temperature on the adult female population, under various rainfall regimes: actual daily rainfall (black lines), rainfall every day (red lines), rainfall every 4 days (green lines) and rainfall every 10 days (blue lines). The amount of each rainfall is adjusted in the periodic regimes so that the annual total is the same across all 4 regimes. (a) Top panel: Skeeter Buster model. (b) Bottom panel: AedesBA model.

Buenos Aires Simulations

Buenos Aires – Calibration

Calibration in Buenos Aires was carried out like in Iquitos, with the exception of the addition of manually-filled containers to Skeeter Buster (see Methods section). Preliminary runs of Skeeter Buster with different proportions of manually-filled containers per block showed (Fig. S5, top panel) that the sensitivity of the number of adult females to this proportion varied across years. This sensitivity was lowest for the year 2009-2010, and so we used this period to carry out calibration of the two models. Calibration curves were then constructed for each model by varying food input per container (in Skeeter Buster) and number of breeding sites (in AedesBA) and calculating the number of adult females across the productive season (see Methods) (Figure S5, bottom panel and figure S6). Choosing to operate at similar average densities as in Iquitos, we obtained default values of 4.2717 $mg.day^{-1}$ per container in Skeeter Buster and 35 breeding sites per block in AedesBA. All subsequent simulations regarding Buenos Aires were carried out using these values.

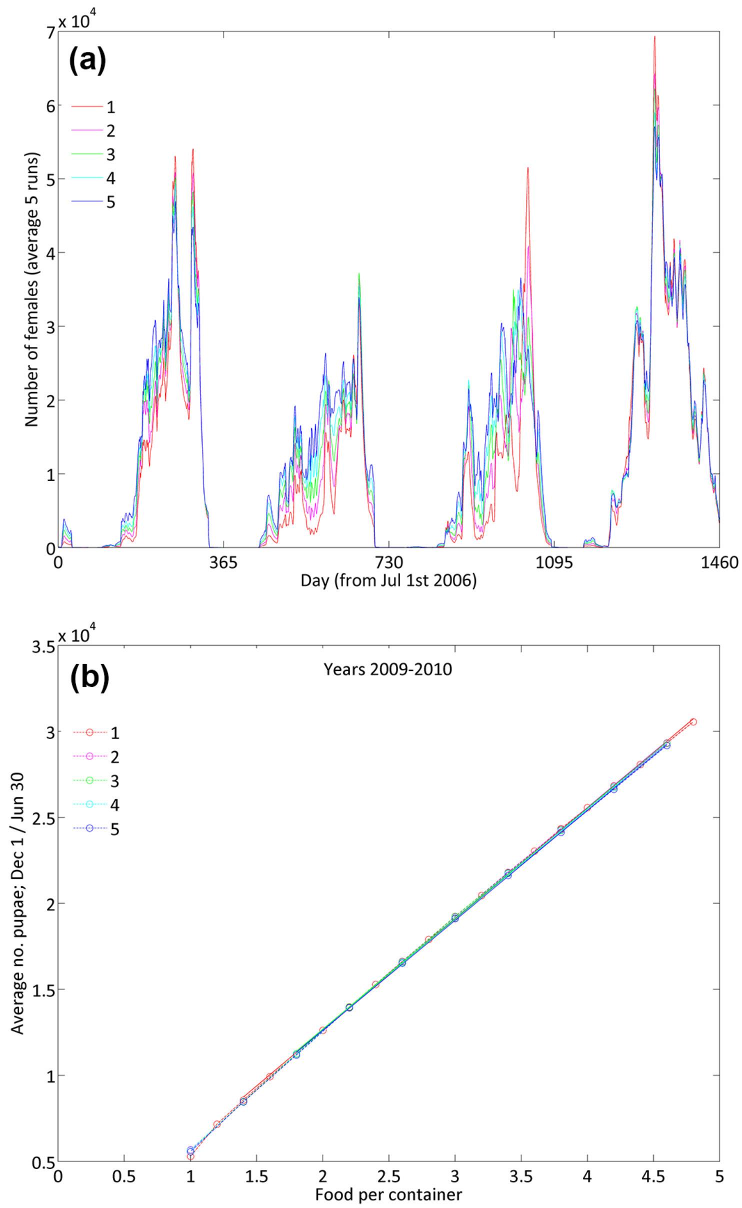

Figure S5: Skeeter Buster calibration in Buenos Aires. (a) Top panel: runs of Skeeter Buster with different numbers of manually-filled containers per block, from 1 to 5 such containers (shown in the legend). (b) Bottom panel: Calibration curves constructed by varying food input per container, for different numbers of manually filled containers, calculated specifically in the period 2009-2010.

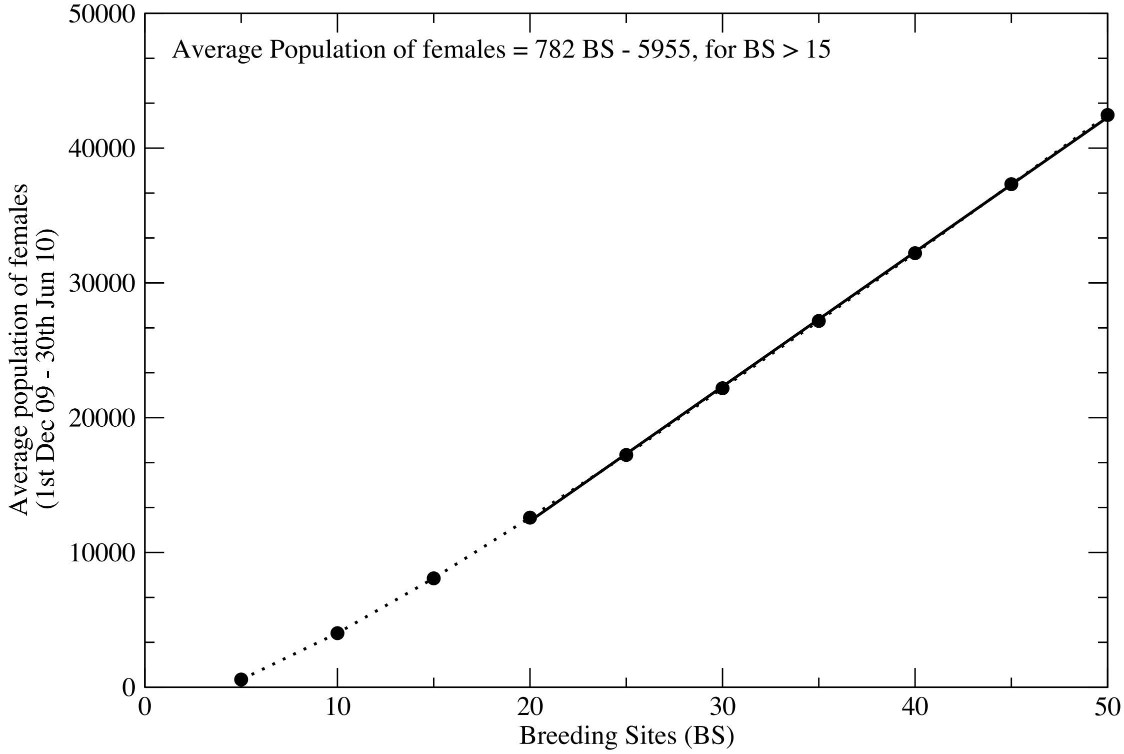

Figure S6: AedesBA calibration curve for Buenos Aires in the period 2009-2010.

Buenos Aires – Artificial weather results

Given that Buenos Aires has a highly seasonal climate, we felt that exploring artificial weather conditions would be a much less informative exercise than it was for the Iquitos setting. Consequently we omit this exploration here.

Buenos Aires – Simulated control results

We studied the effect on the female adult population of three vector control interventions. These interventions consisted of the complete elimination of adults, larvae and both populations simultaneously for one week (days 175 – 181 of the second year of simulation, corresponding to the dates: 23rd to 29th December 2009). We ran the models with the real daily temperatures and real rainfalls of the city of Buenos Aires from 1st July 2008 to 30th June 2010. In the AedesBA model only normal hatching was considered (hatching triggered by rainfalls greater than 7.5 mm / day).

Figure S7 shows the time-course of the total female population in the 20x20-block grid for both populations without interventions and under the three different simulated interventions: adulticidal control ((a) and (b)), larvicidal control ((c) and (d)) and both controls simultaneously ((e) and (f)). As we previously observed in the control interventions simulated for Iquitos, the AedesBA model shows that adulticidal control is more efficient than larvicidal control. The recovery of the population after the intervention is slow to reach the non-intervention values by the end of the *Aedes aegypti* activity season. The use of the combined strategy of adulticidal and larvicidal control does not show any significant advantage compared to the adulticidal control. In

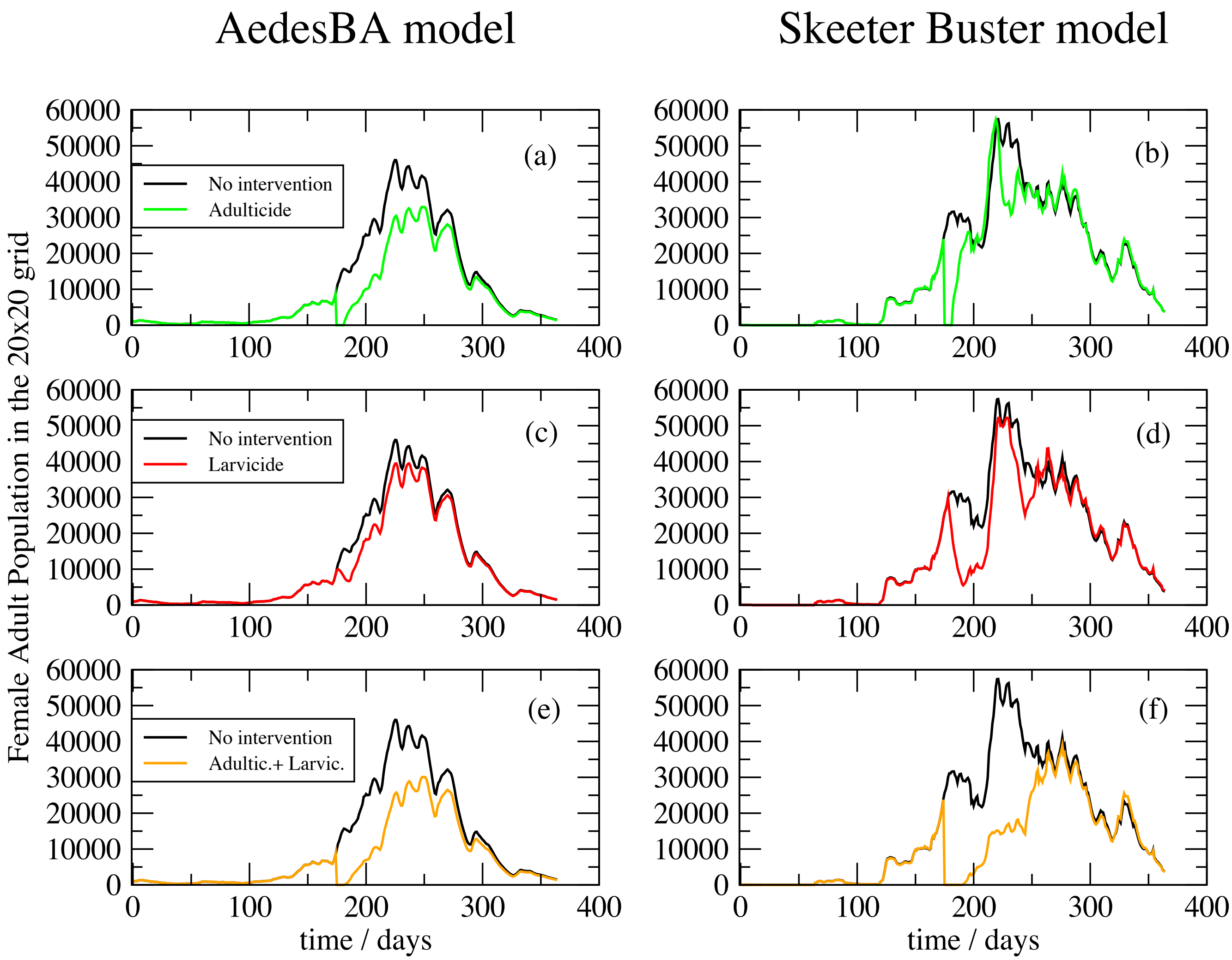

Figure S7: Effect of control strategies on the female adult population in Buenos Aires. Three different strategies were simulated: use of adulticides (green line, first row: panels a and b), use of larvicides (red line, second row: panels c and d) and use of adulticides and larvicides simultaneously (orange line, third row: panels e and f). The control strategies were carried out along one week (days 175-181, 23rd to 29th December) with 100 % efficiency. The time-course of the total female population in the grid without intervention (black line) and under the appropriate intervention is shown in each panel. AedesBA model (first column, panels a, c and e) and Skeeter Buster model (second column, panels b, d and f). All results shown are averages over 20 simulation runs.

contrast, for the Skeeter Buster model we observe that the combined strategy of adulticidal and larvicidal control seems to be the most efficient of the three strategies simulated.

In order to study the effect of adult dispersal in the recovery of the populations we again simulated interventions in only a small part of the 20x20-block grid, treating a square area of 100 blocks in the center of the 20x20 grid. The three control strategies, use of adulticides, larvicides and both simultaneously, were carried out for one week (days 175 – 181 of the second year of simulation, corresponding to the dates: 23rd to 29th December 2009). The time-courses of the female adult population densities (population per block under control) for both models without interventions and for the three control strategies in the 20x20 grid and in the 10x10 grid are shown in Figure S8. As we observed for Iquitos, population recovery in the AedesBA model is slightly faster in the case of control in the 10x10 grid compared to when control is applied to the entire arena. Again, this is also the case for the Skeeter Buster model when either adulticidal or larvicidal control was performed; furthermore, in the case of simultaneous adulticidal and larvicidal control a bigger difference is observed between the outcomes when intervention occurs in the entire arena or in its central section.

As for the Iquitos model, we illustrate spatiotemporal dynamics of the population by depicting the behavior seen along a transect taken through the grid. Figure S9 shows the female adult population along a 20 block transect over time. The first row (panels a, b and c) corresponds to adulticidal, larvicidal and combined controls for the AedesBA model, and the second row (panels d, e and f) corresponds to adulticidal control, larvicidal control and both controls for the Skeeter Buster model.

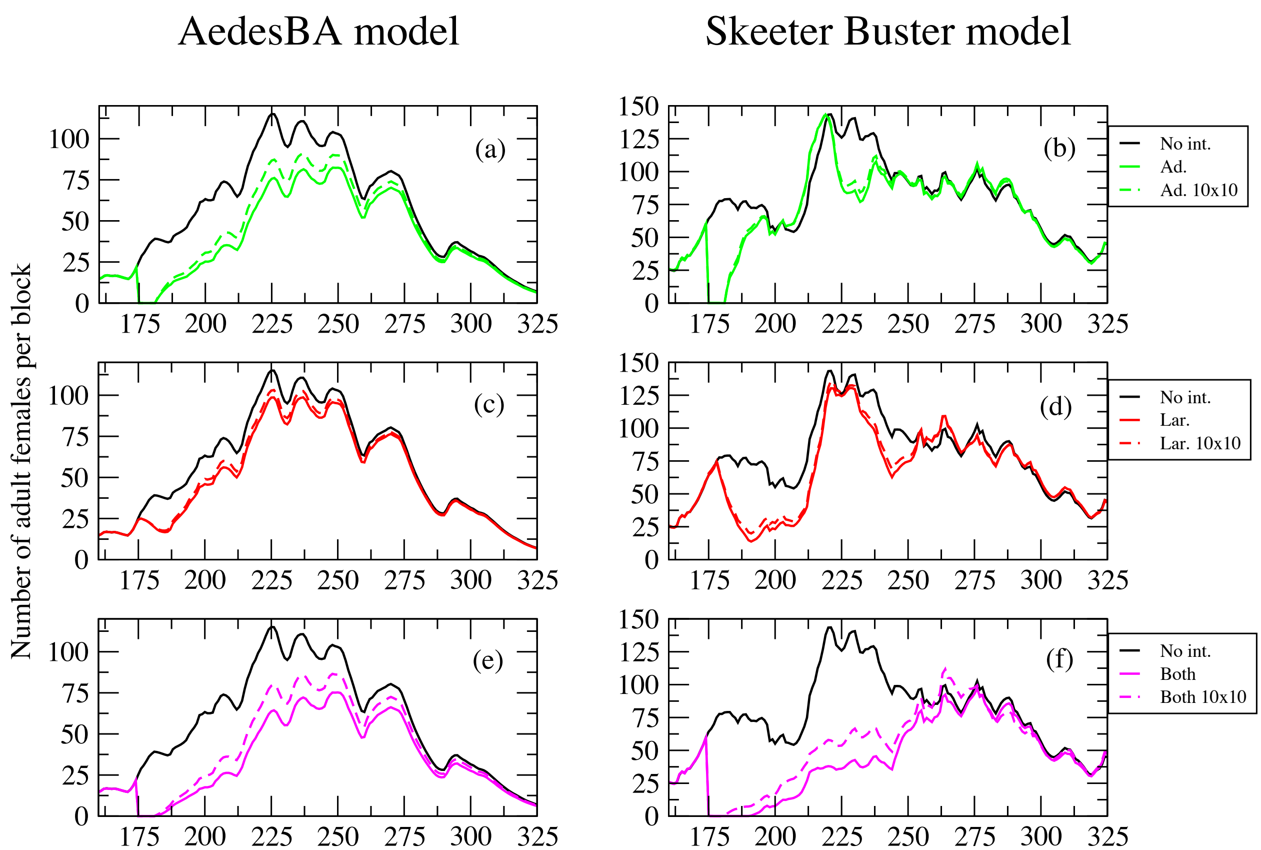

Figure S8: Effect of different control strategies on the female adult population when the control was performed in the whole area (20x20 blocks grid) and in a smaller area of 10x10 blocks in the center of the 20x20 grid. First column (panels a, c and e) show results of the AedesBA model and second column (panels b, d and f) show results of the Skeeter Buster model. Different rows depict different interventions: first row (panels a and b) adulticide, second row (panels c and d) larvicide, third row (panels e and f) adulticide and larvicide simultaneously. The time-course of the female adult population density (population per block under control) is shown in each panel: Population without intervention (black line), population under the three control strategies in the whole grid (use of adulticides (green solid line), larvicides (red solid line), both simultaneously (magenta solid line), and the same three strategies in the 10x10 grid (colored dashed lines). All strategies were carried out along one week (days 175-181, 23rd to 29th December) with 100 % efficiency. All results shown are averages over 20 simulation runs.

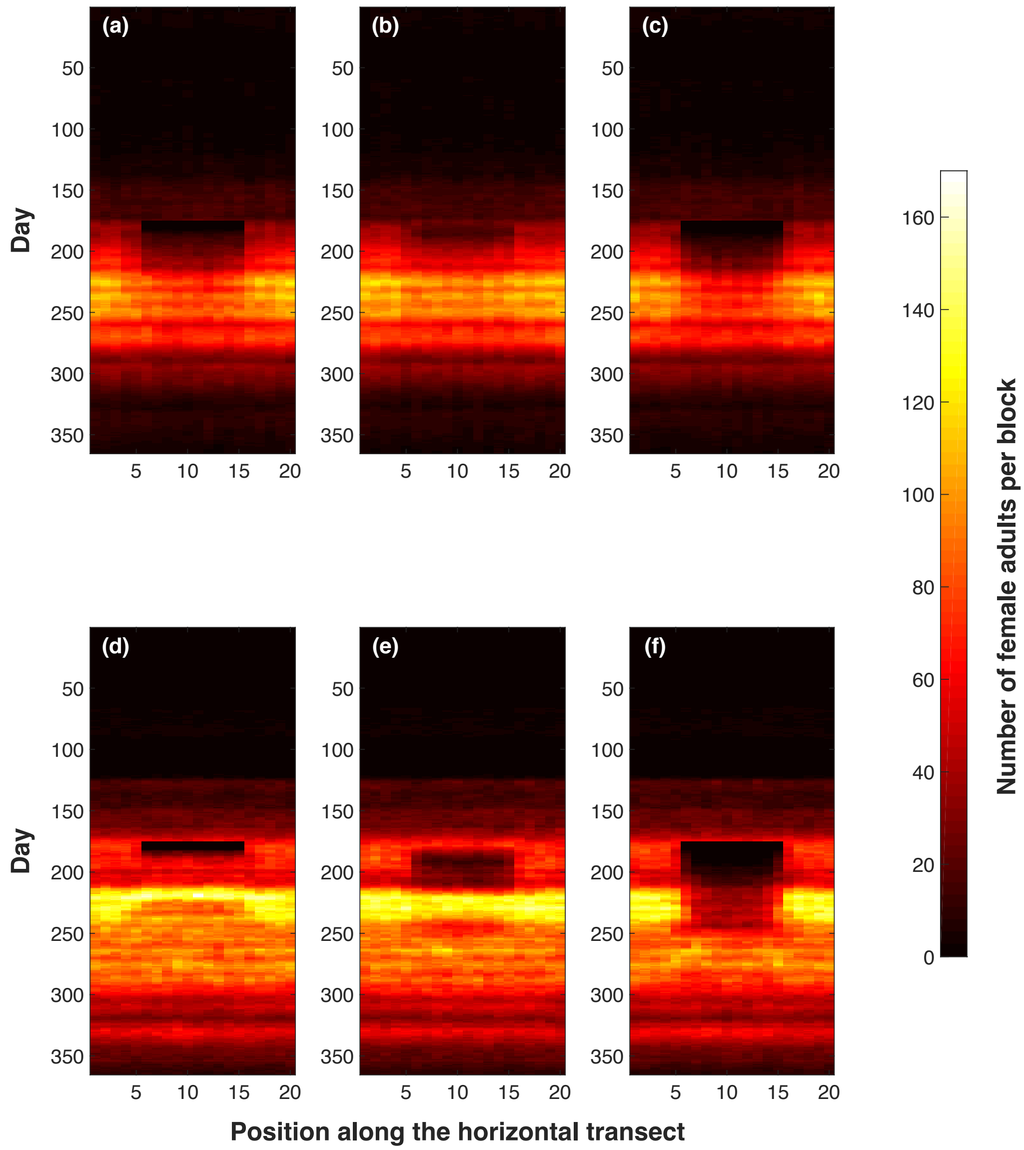

Figure S9: Evolution of the female adult population (in the Buenos Aires setting) along a 20-block transect taken through the center of the grid under various control interventions. The x-axis corresponds to the block position along the 20-block transect, the y-axis corresponds to time. The color corresponds to the number of female adults in a given block according to the color bar on the right. First row (panels a, b and c): AedesBA model. Second row (panels d, e and f): Skeeter Buster model. First column (panels a and d): use of adulticide. Second column (panels b and e): use of larvicide. Third column (panels c and f): simultaneous use of adulticide and larvicide. Each control strategy was simulated with 100% efficiency during days 175 through 181 in a 10x10 grid in the center of the 20x20 simulation arena. Results shown are averages over 5 simulation runs.

Finally, as for Iquitos, we studied another control intervention that consisted of a comprehensive control where individuals of all stages (eggs, larvae, pupae and adults) were removed from the target area. Here we employed a square grid of 45x45 blocks and the target area consisted of the 900 blocks (i.e. 30x30 blocks) in the center of the grid. Because of the complete removal of the local population, the recovery process is strongly influenced by mosquito dispersal into the central area, i.e. involves recolonization. Figure S10 shows the effect of the total elimination of individuals of all mosquito stages on the evolution of the female adult population in Buenos Aires. Similar time courses of the female adult population density are observed for both models. Spatiotemporal dynamics are illustrated in Figure S11, which shows the evolution of the female adult population along a 45 block transect across the grid. We observe a D-shape recovery after intervention in agreement with a recolonization process due to adult dispersal.

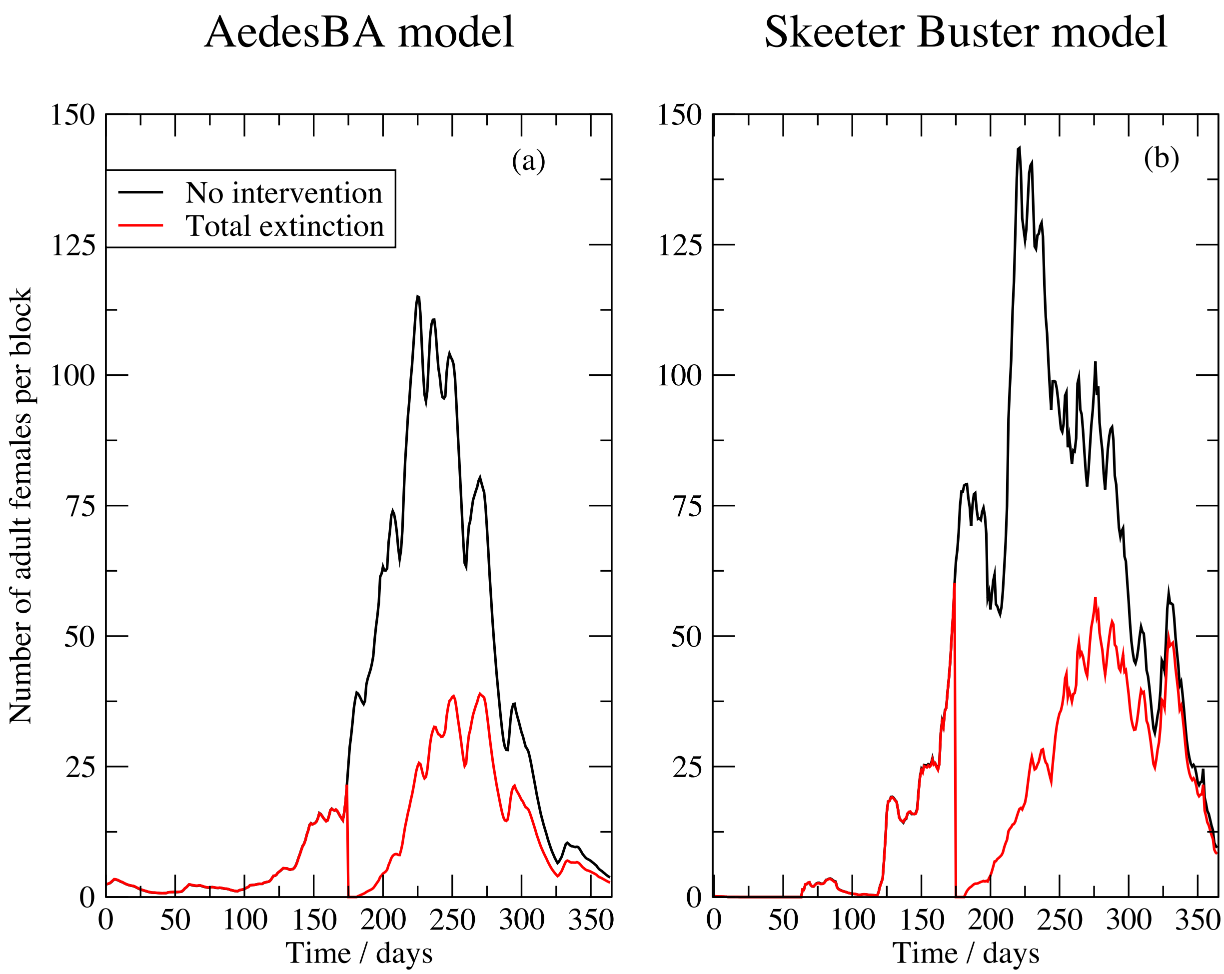

Figure S10: Effect of the total elimination of individuals of all mosquito stages on the evolution of the female adult population in Buenos Aires. The control strategy was simulated with 100 % efficiency in a 30x30 grid in the center of a 45x45 grid along one week (days 175 through 181 of the second year of simulation, 23rd to 29th December). The time course of the female adult population density (number of adult females per block) is shown in each panel: population without intervention (black line) and control strategy (red line). All results shown are averages over 20 simulation runs.

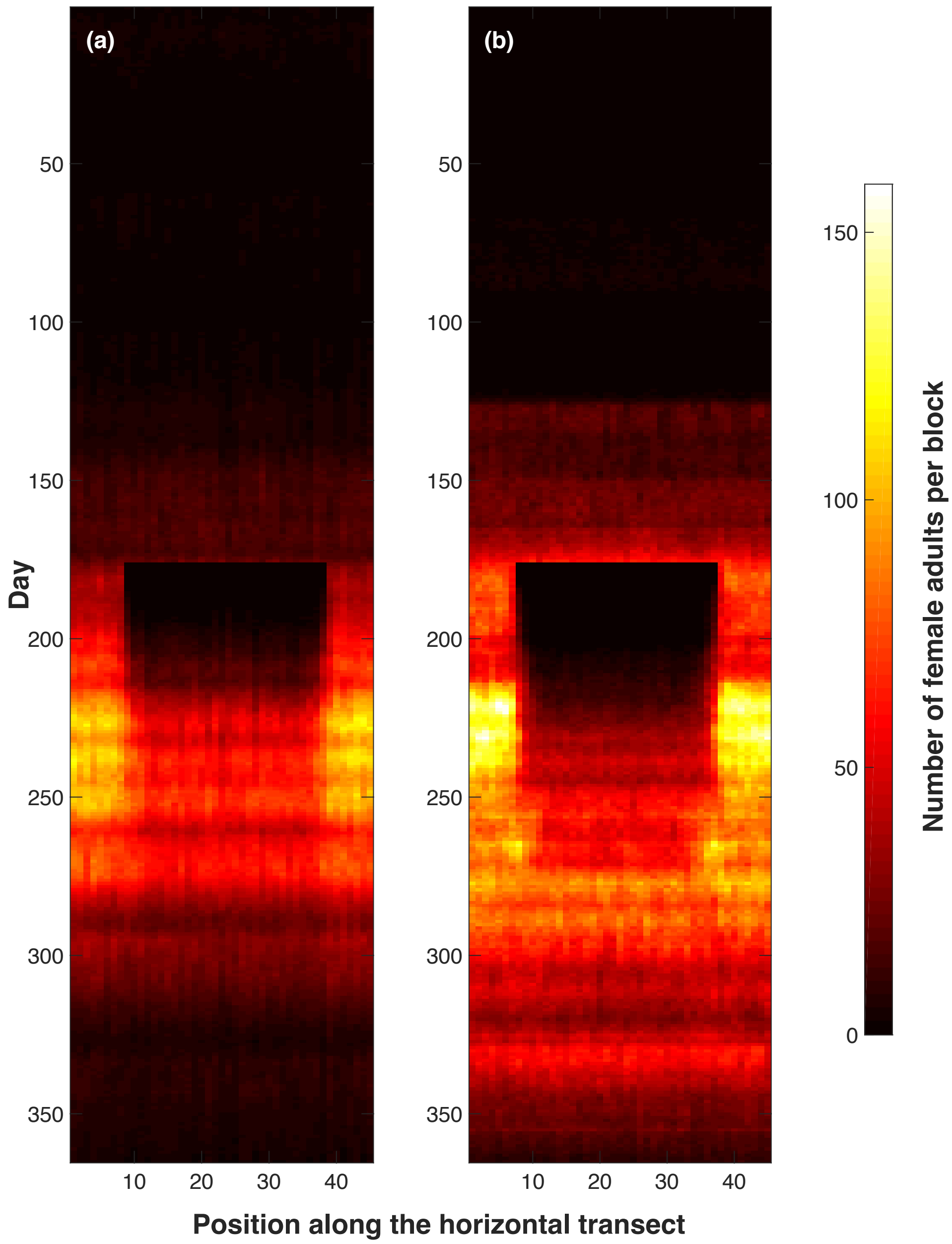

Figure S11: Evolution of the female adult population (in the Buenos Aires setting) along a 45 block transect taken through the center of the grid, with targeted elimination of all mosquito stages in the central area. The horizontal axis corresponds to the block position along the 45-block transect, the vertical axis corresponds to time. The color corresponds to the number of female adults in a given block according to the color bar on the right. Panel (a): AedesBA model. Panel (b): Skeeter Buster model. Control was simulated during days 175 through 181 in a 30x30 grid in the center of the 45x45 simulation arena, and was assumed to eliminate all mosquito stages (eggs, larvae, pupae and adults of both sexes) with 100% efficiency in each targeted block. All results shown are averages over 5 simulation runs.