

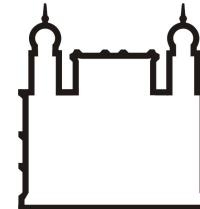


Ciência para a saúde da população brasileira

Seasonality and spatial dynamics of dengue fever

Cláudia Codeço
Fiocruz, Rio de Janeiro
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San Jose, january 2012

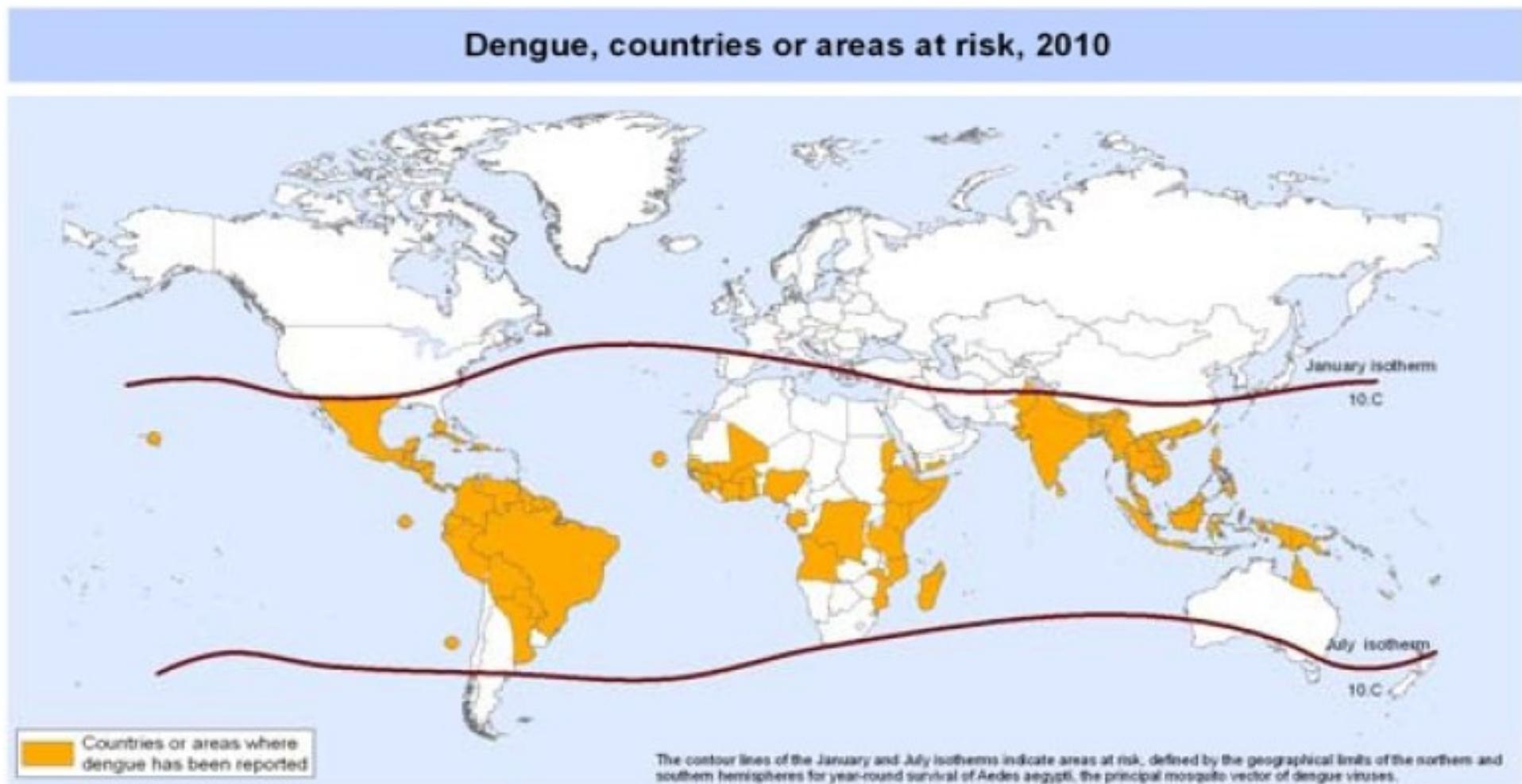


Ministério da Saúde

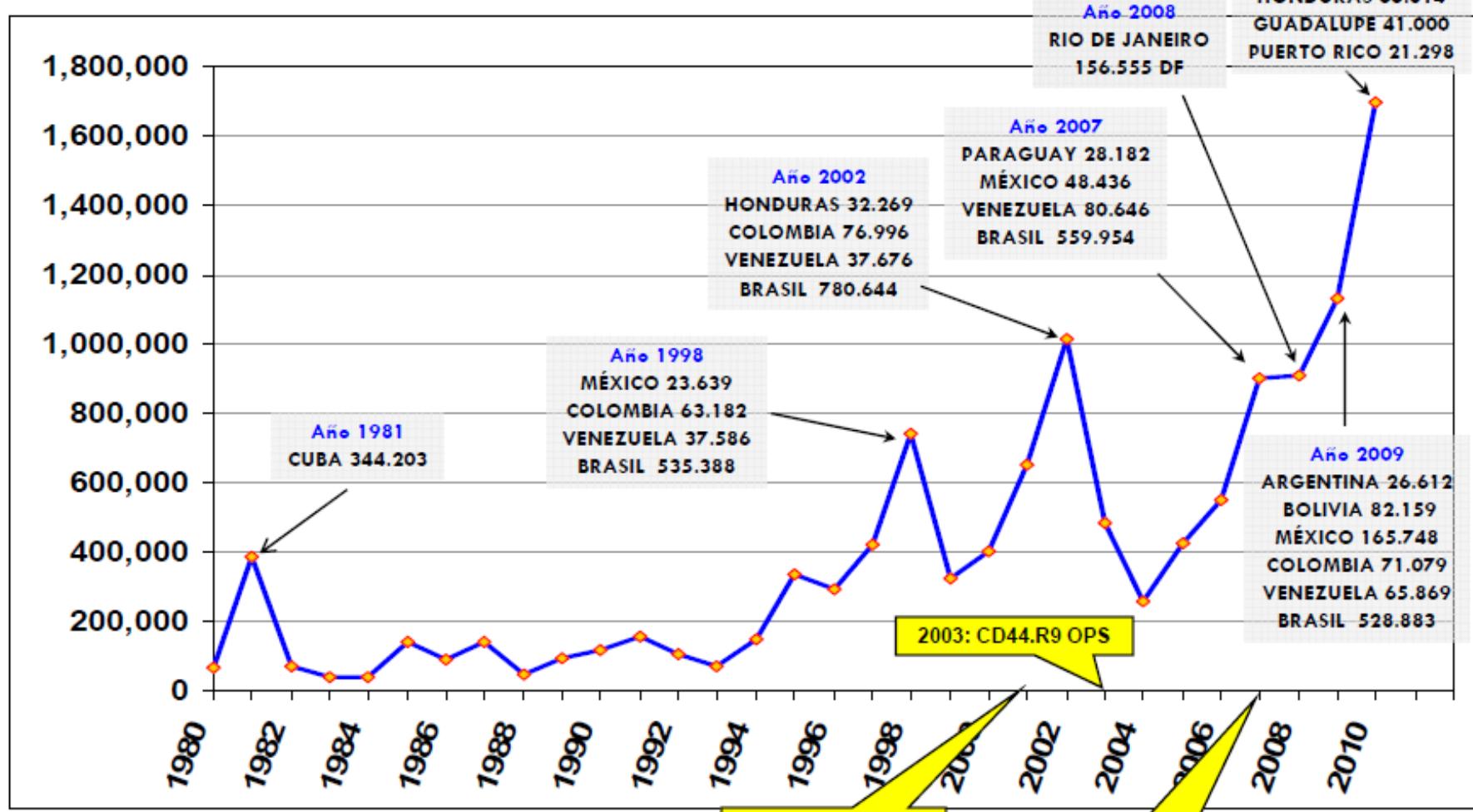
FIOCRUZ

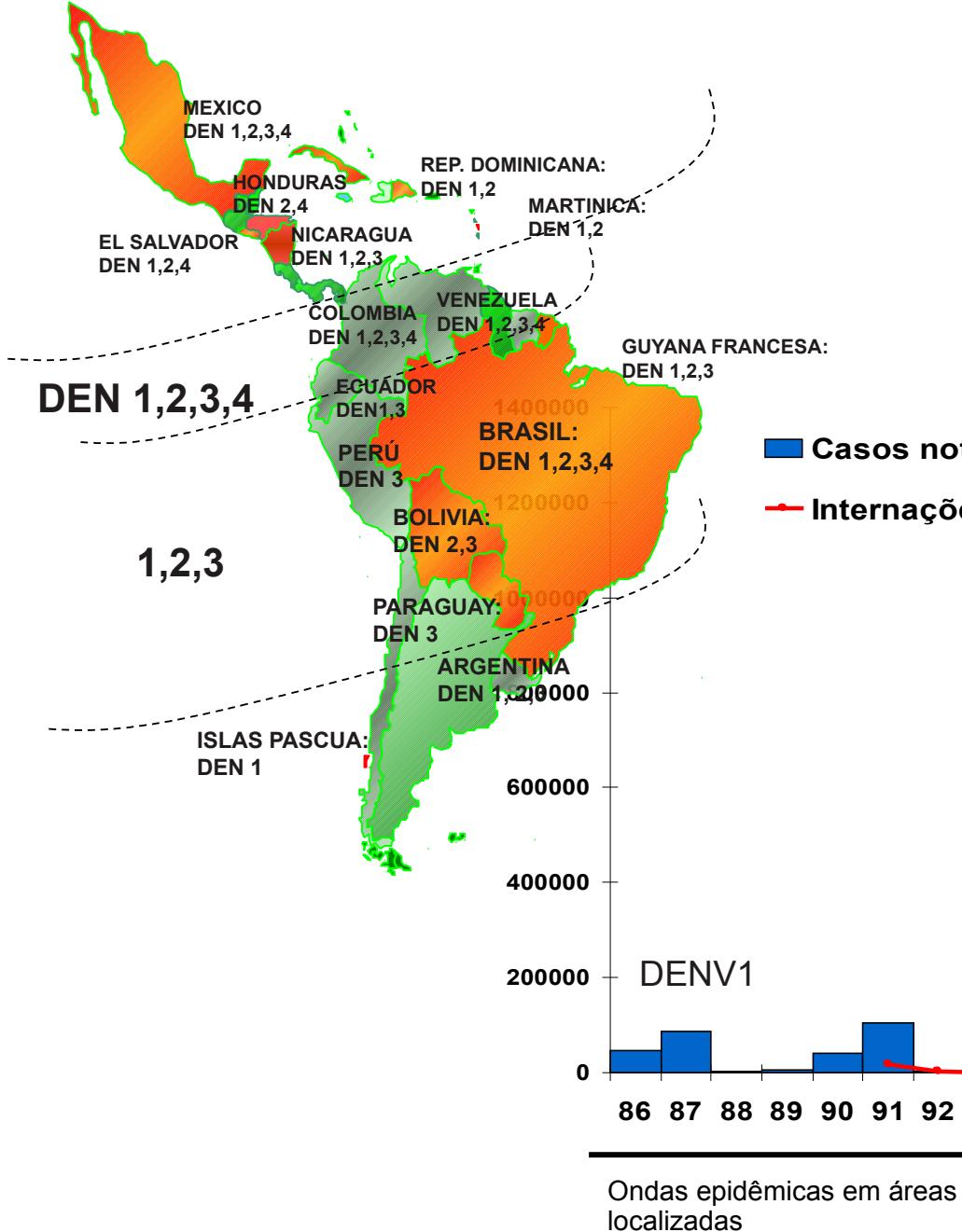
Fundação Oswaldo Cruz

In the world

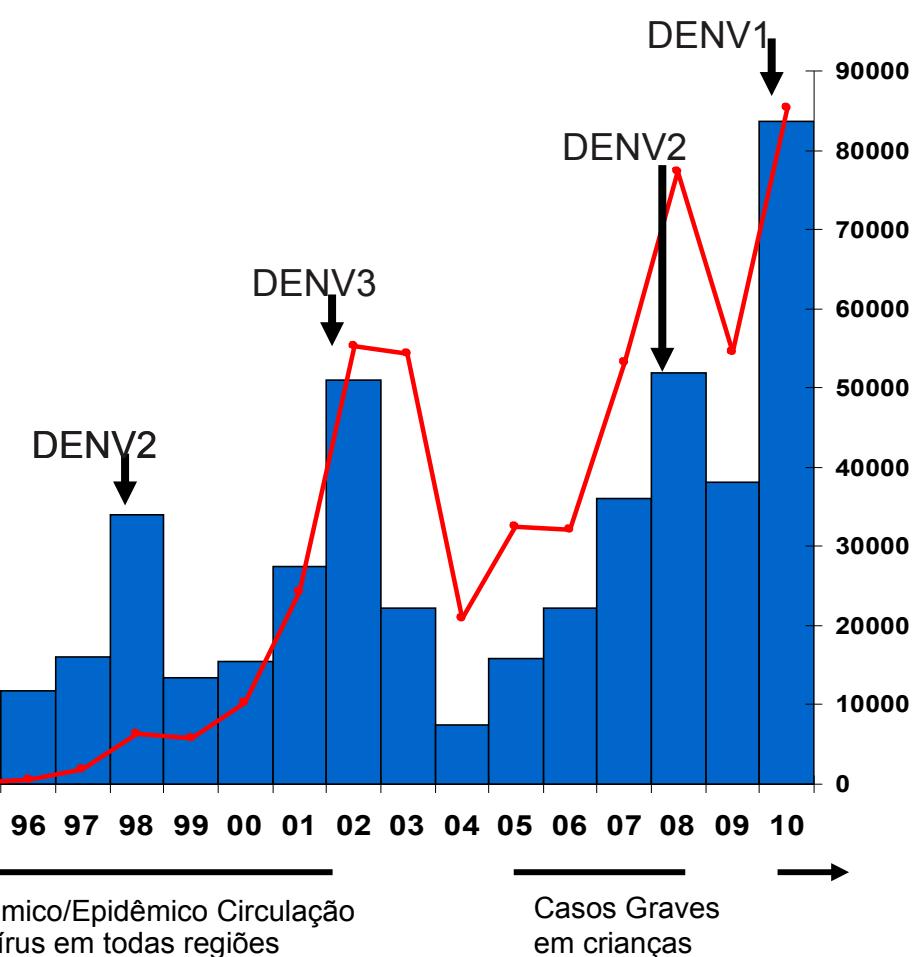


Evolución del dengue en las Américas 1980-2010





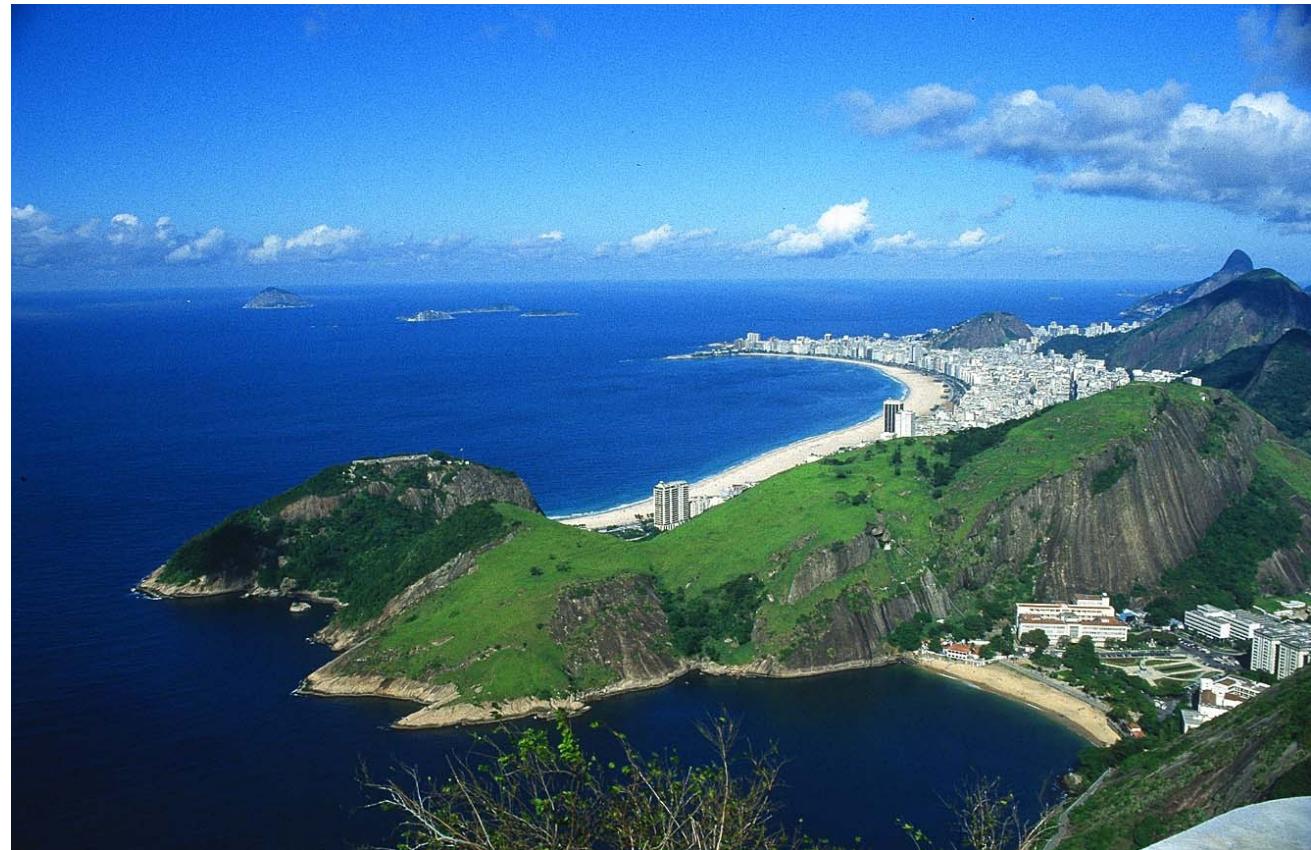
In Brazil



Rio de Janeiro

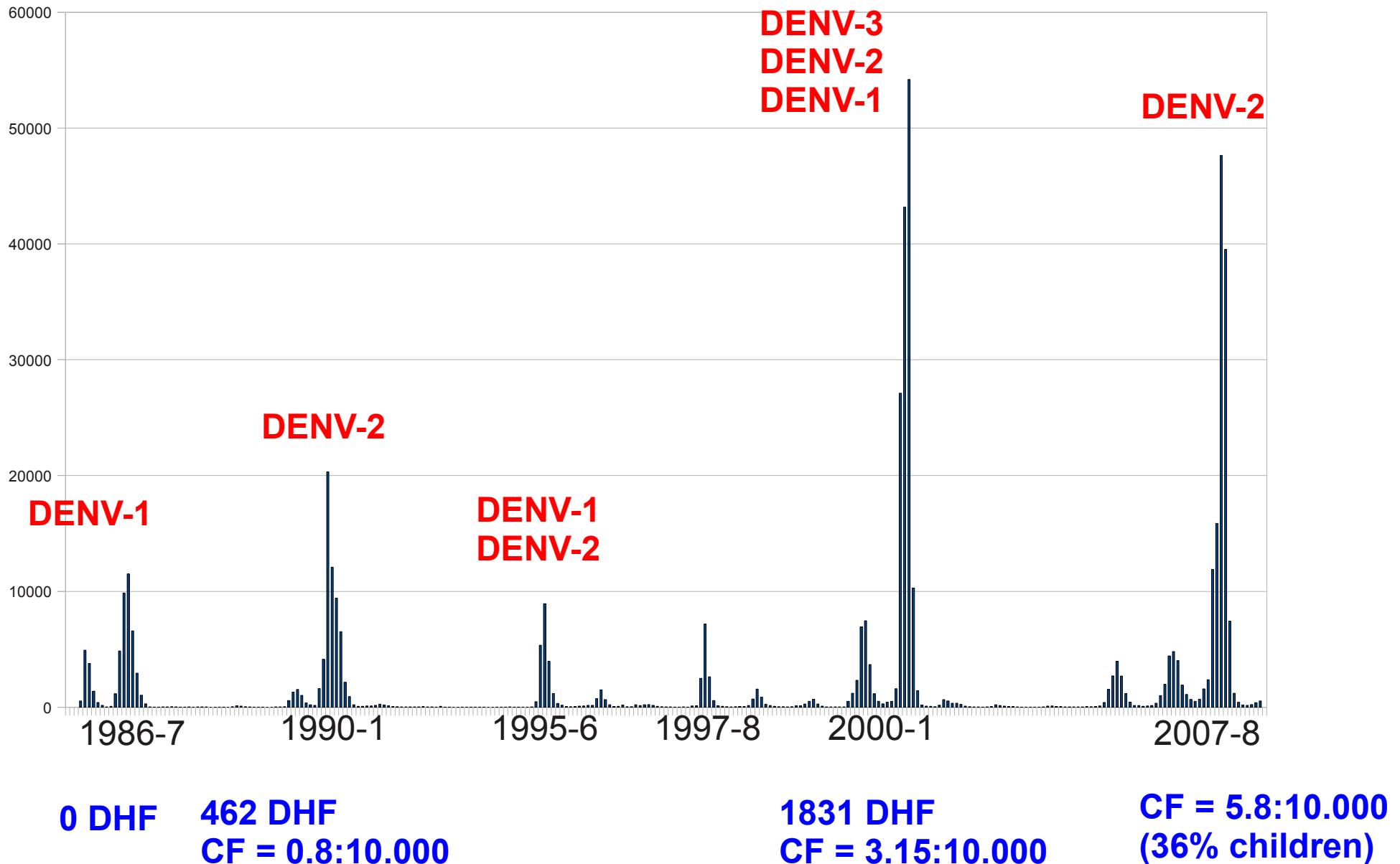


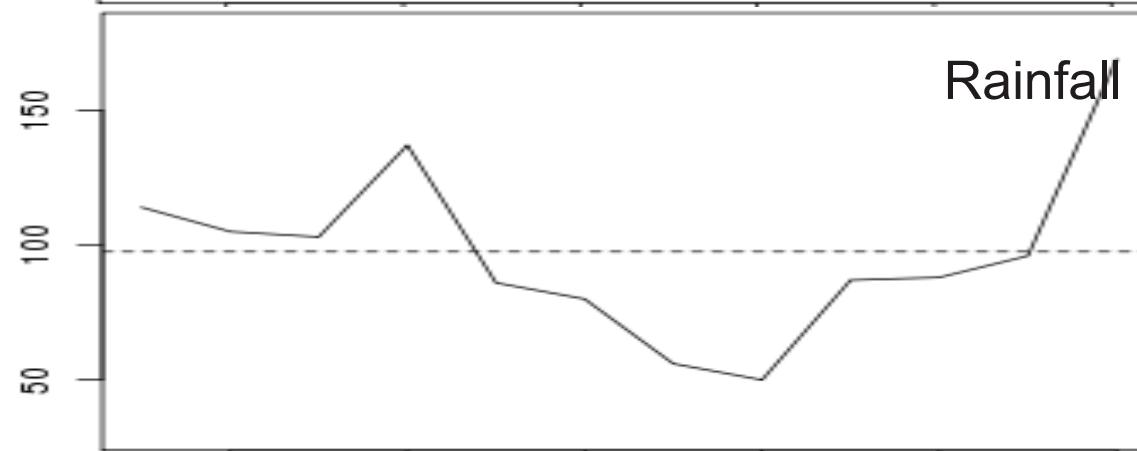
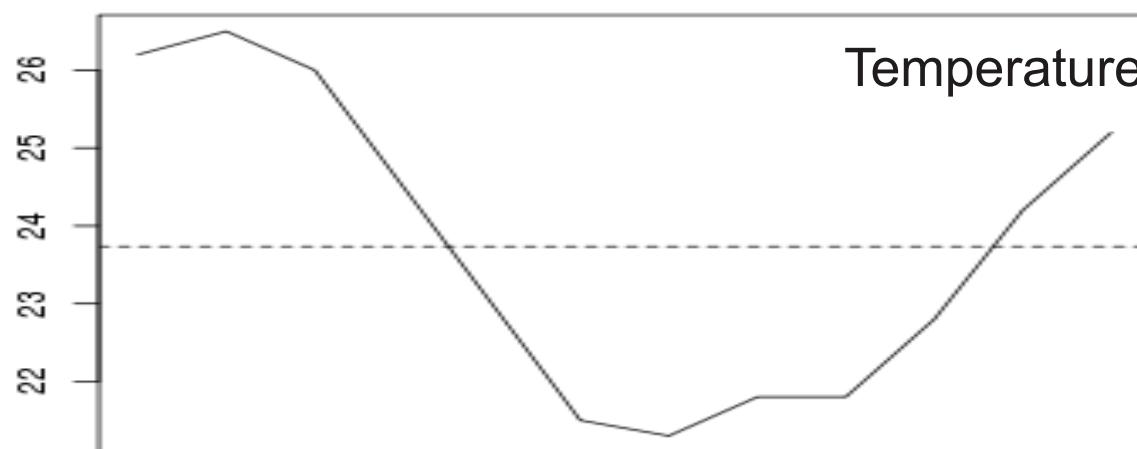
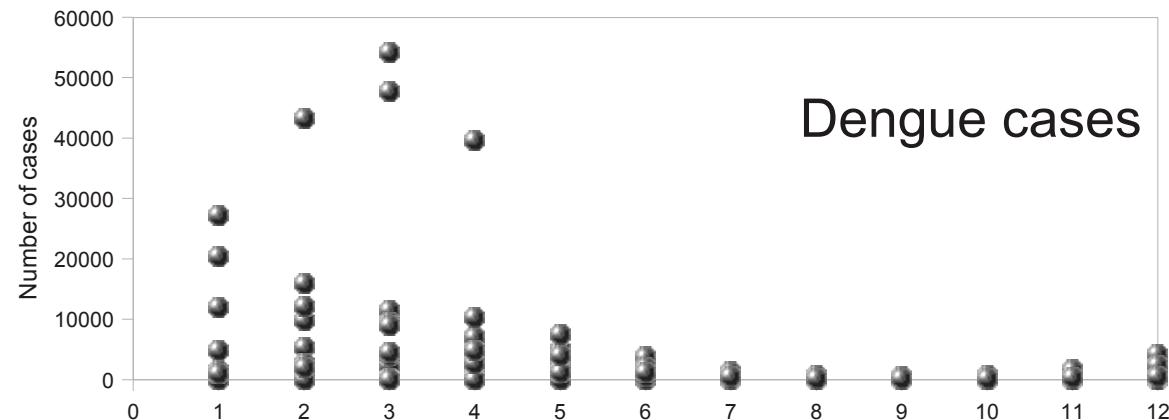
Population: 6.000.000
Neighborhoods: 160
Favelas: 749
Premises: 2.000.000
Population
in Favelas: 1.000.000



Port-of-entry of DENV 1, 2, and 3

Dengue in Rio de Janeiro



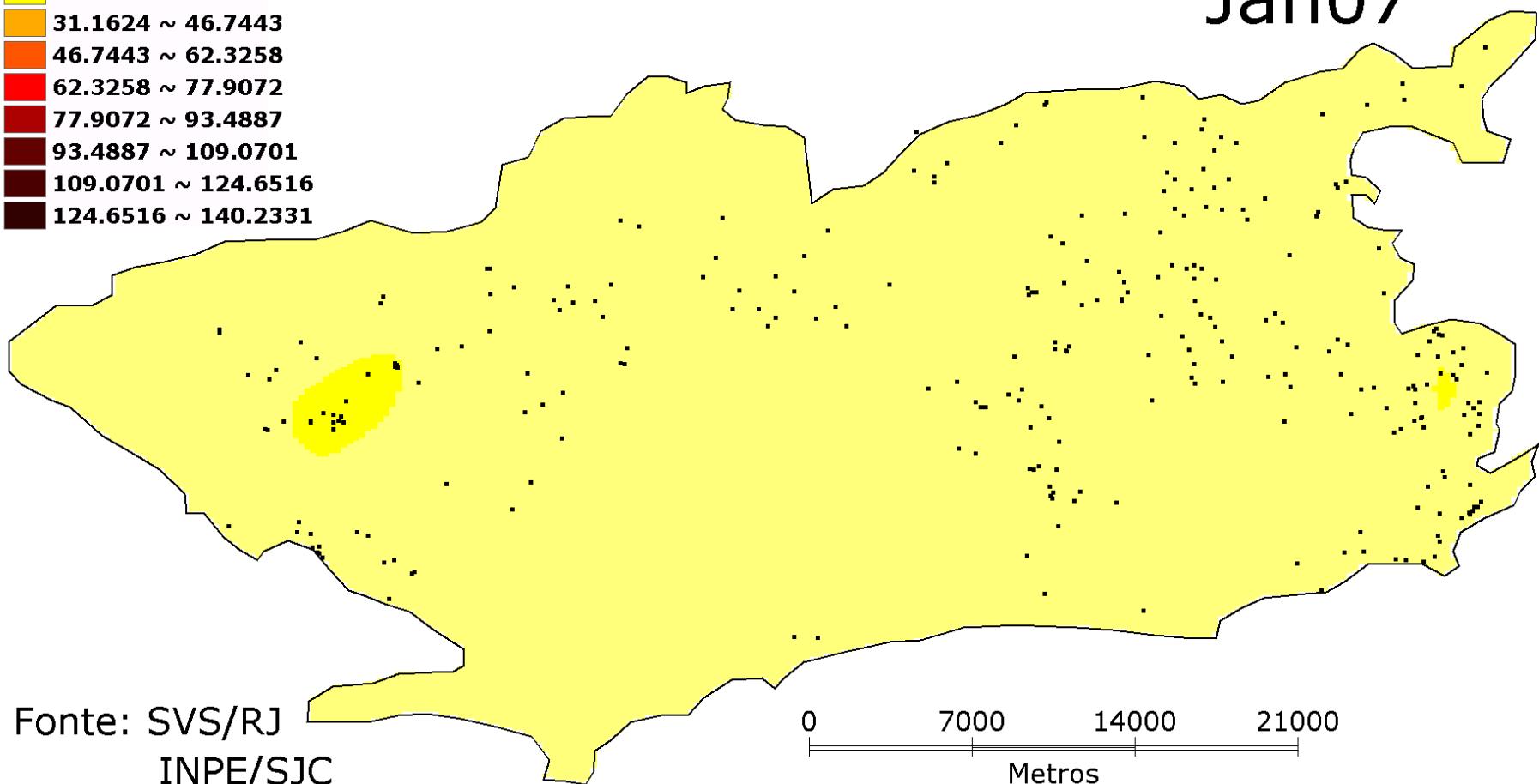


Município do Rio de Janeiro - Casos de dengue 2007

Legenda

- 0.0001 ~ 15.5814
- 15.5814 ~ 31.1624
- 31.1624 ~ 46.7443
- 46.7443 ~ 62.3258
- 62.3258 ~ 77.9072
- 77.9072 ~ 93.4887
- 93.4887 ~ 109.0701
- 109.0701 ~ 124.6516
- 124.6516 ~ 140.2331

Jan07

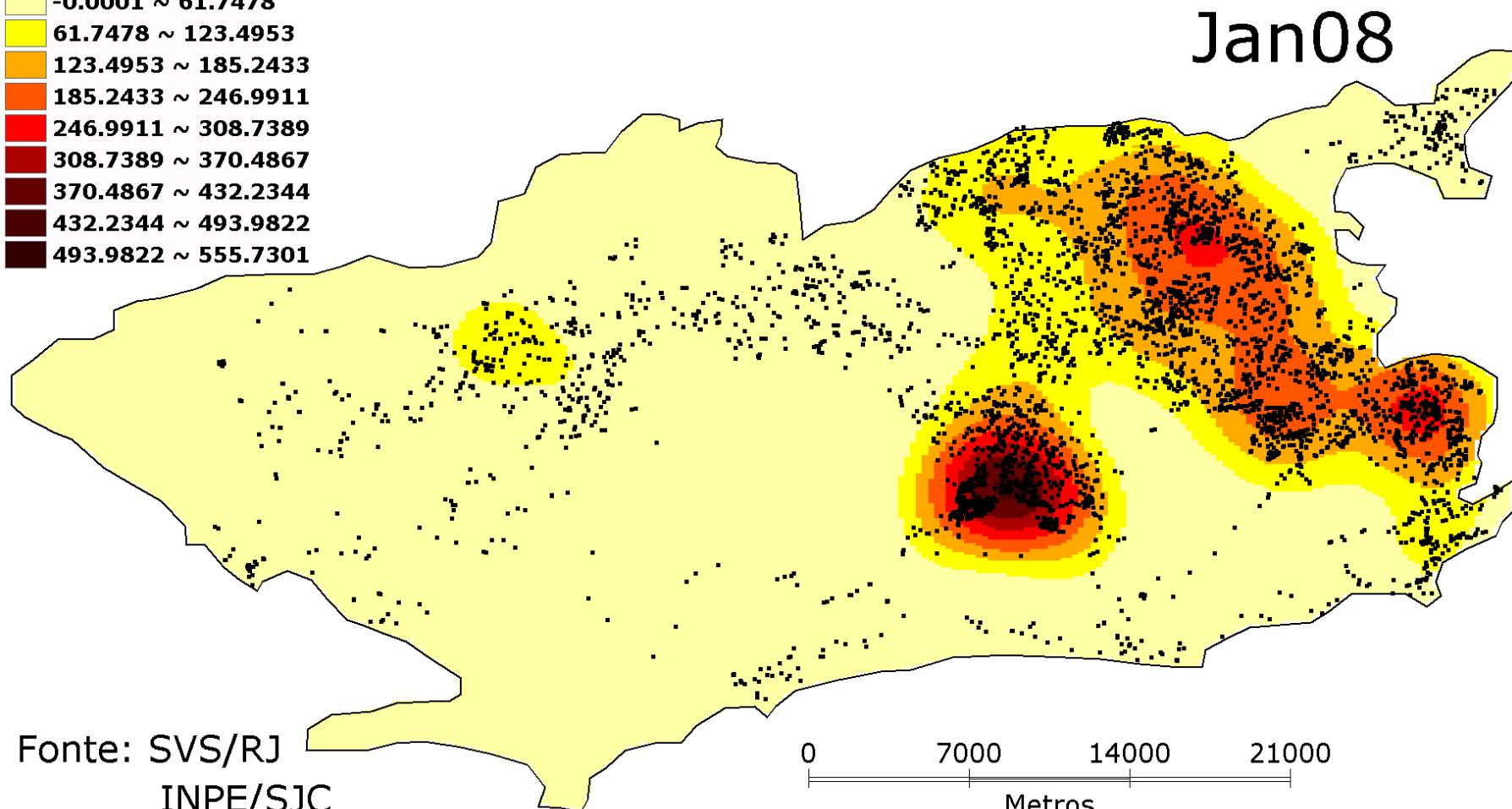


Fonte: SVS/RJ
INPE/SJC

Município do Rio de Janeiro - Casos de dengue 2008

Legenda

-0.0001 ~ 61.7478
61.7478 ~ 123.4953
123.4953 ~ 185.2433
185.2433 ~ 246.9911
246.9911 ~ 308.7389
308.7389 ~ 370.4867
370.4867 ~ 432.2344
432.2344 ~ 493.9822
493.9822 ~ 555.7301



Study goals:

- To understand and model quantitatively the seasonal dynamics of dengue:
 - Early warning
 - Climate change
 - Best timing for control strategies
- To understand spatial heterogeneity

82 week entomological survey with ovitrap and adultrap (september 2006 to march 2008)



Legend
Neighborhoods
1 Tubiacanga
2 Higienópolis
3 Palmares
□ Study area



Font:

Ortophoto: PortalGeo - IPP- Rio de Janeiro

Digital map: Geoprocessing Laboratory - ICICT/ Fiocruz

TARGET



TRAP



INDEX

Eggs/trap

% Positive traps

Ovitraps

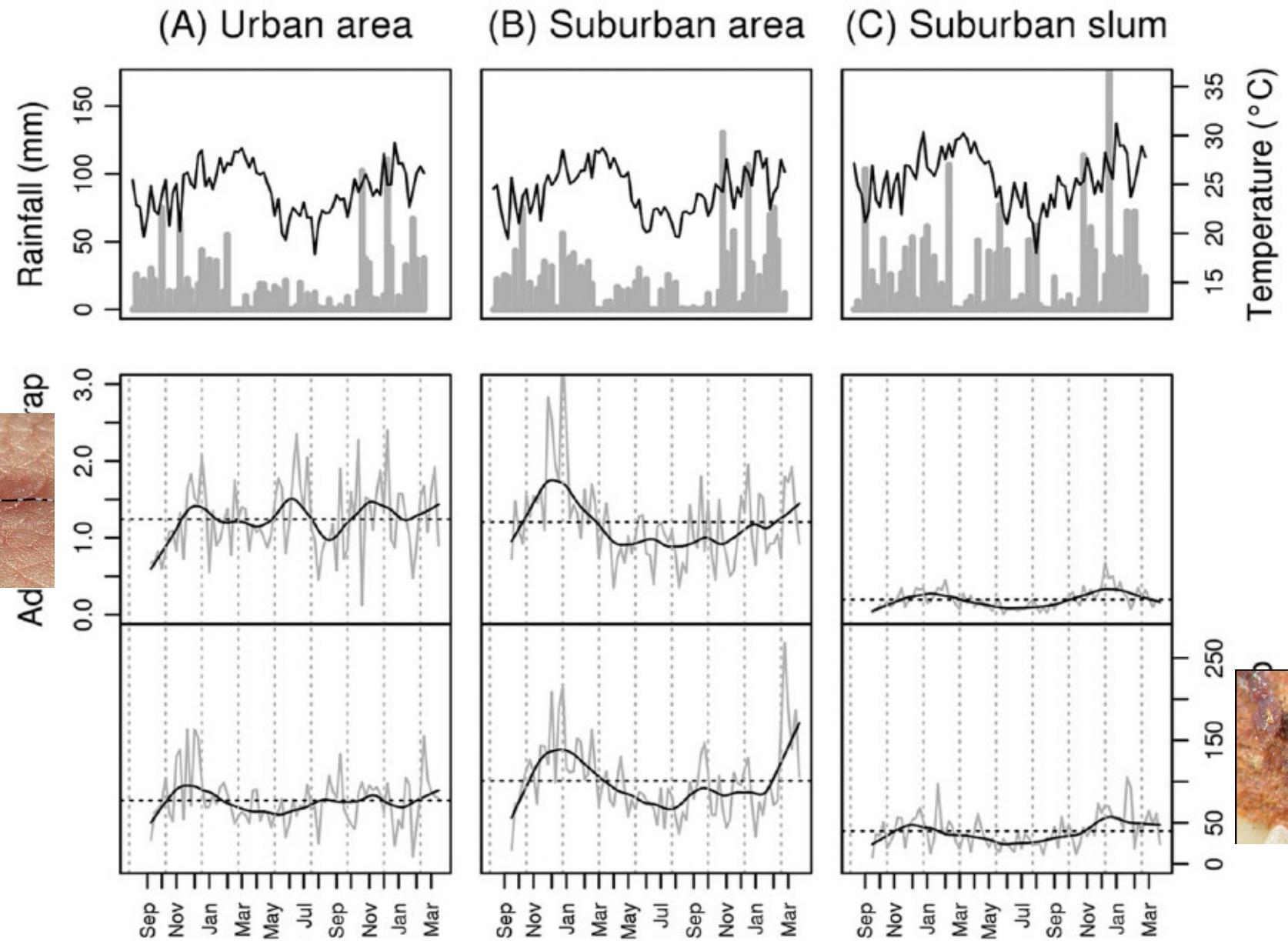


Adults/trap

% Positive traps

Mosquitraps

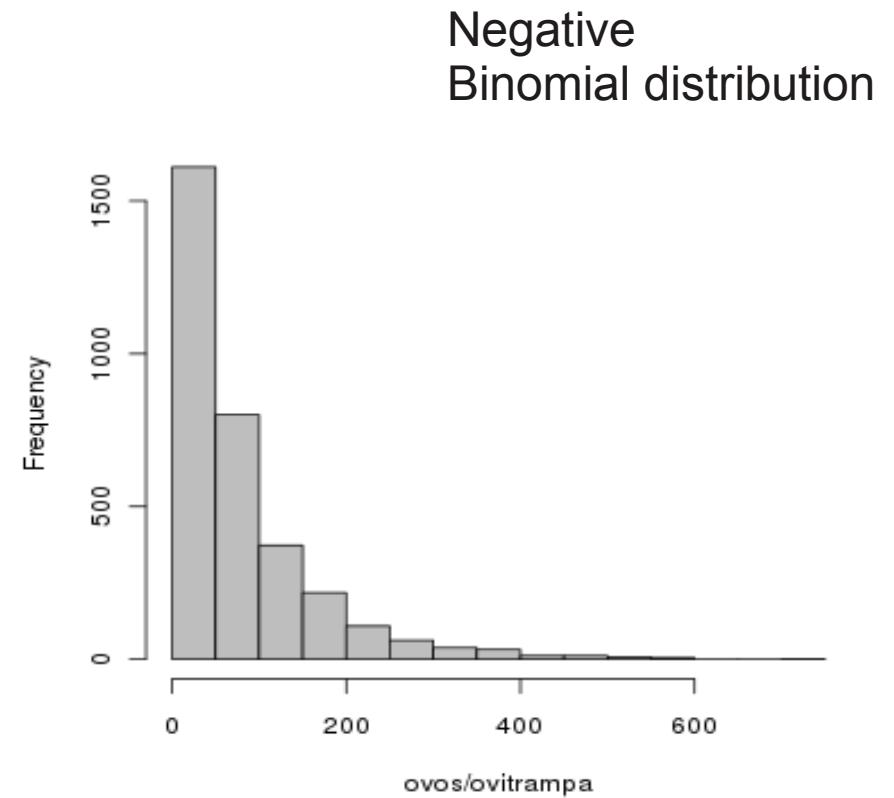
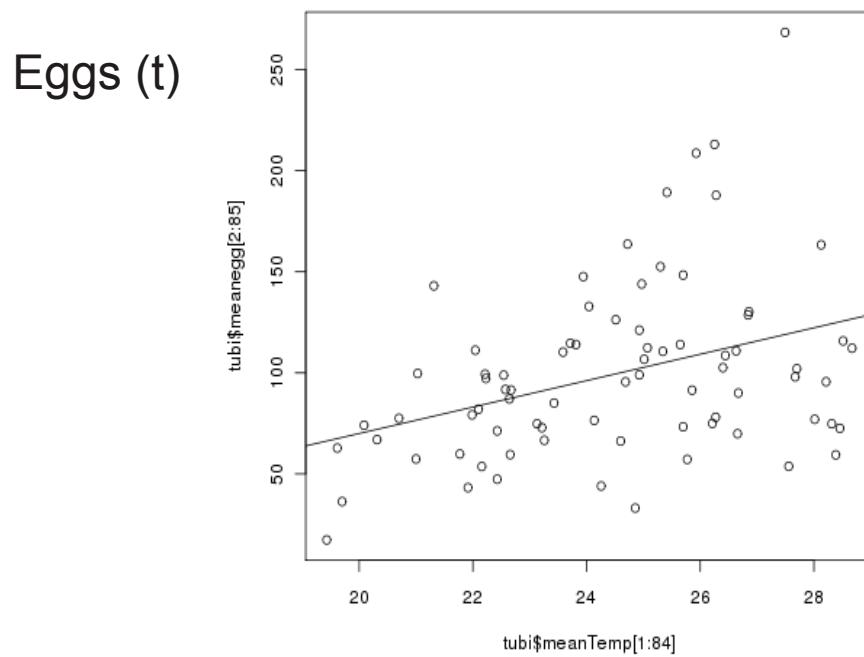
Time series of captured adults and eggs: seasonality?



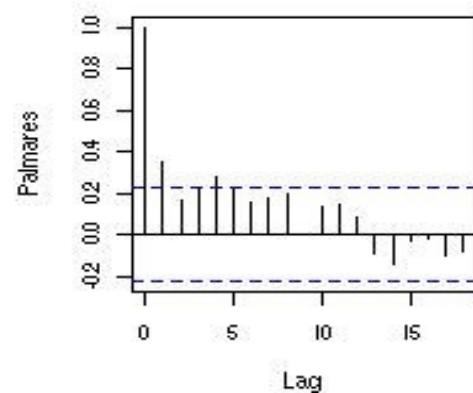
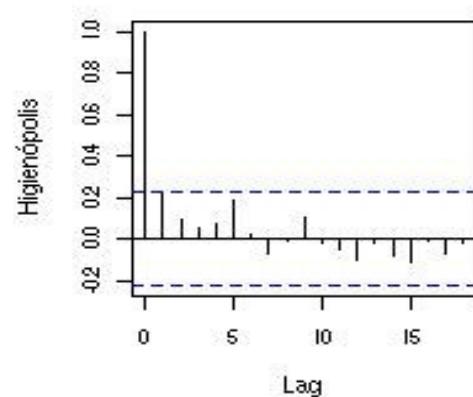
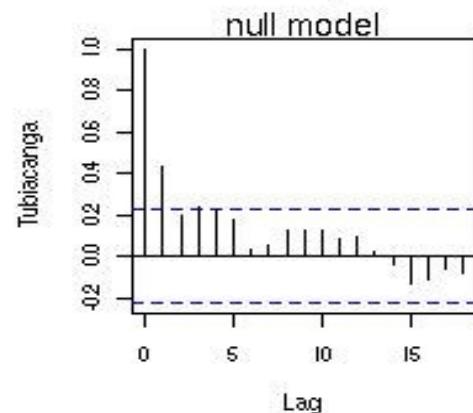
General linear modeling: quantitative predictions of the effect of climate on mosquito abundance

Hypotheses:

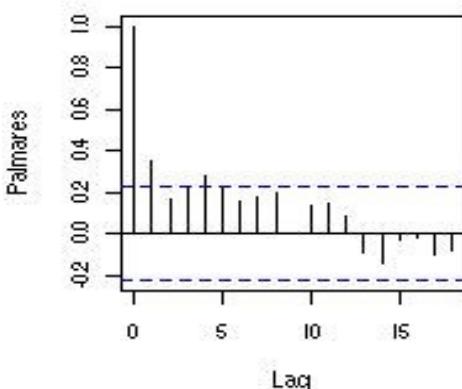
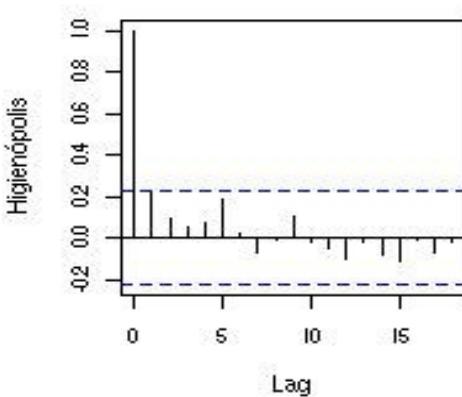
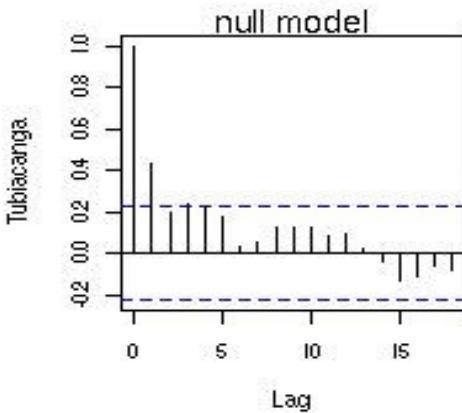
- Higher temperatures imply more mosquitos with a certain delay
- More rainfall imply more mosquitos with a certain delay



Auto-correlation structure



Auto correlation structure



Models:

$$Y_t \sim NegBin$$

$$E[Y_t] = a_0 \quad \text{null}$$

$$E[Y_t] = a_0 + a_1 Y_{t-1} \quad \text{AR1}$$

$$E[Y_t] = a_0 + a_1 Y_{t-1} + a_2 Temp_{t-m} \quad \text{+ temperature}$$

$$E[Y_t] = a_0 + a_1 Y_{t-1} + a_2 Temp_{t-m} + a_3 Chuva_{t-n} \quad \text{+ rain}$$

Model comparison

- Likelihood based criterion (AIC)
- Pearson's correlation
- Residuals

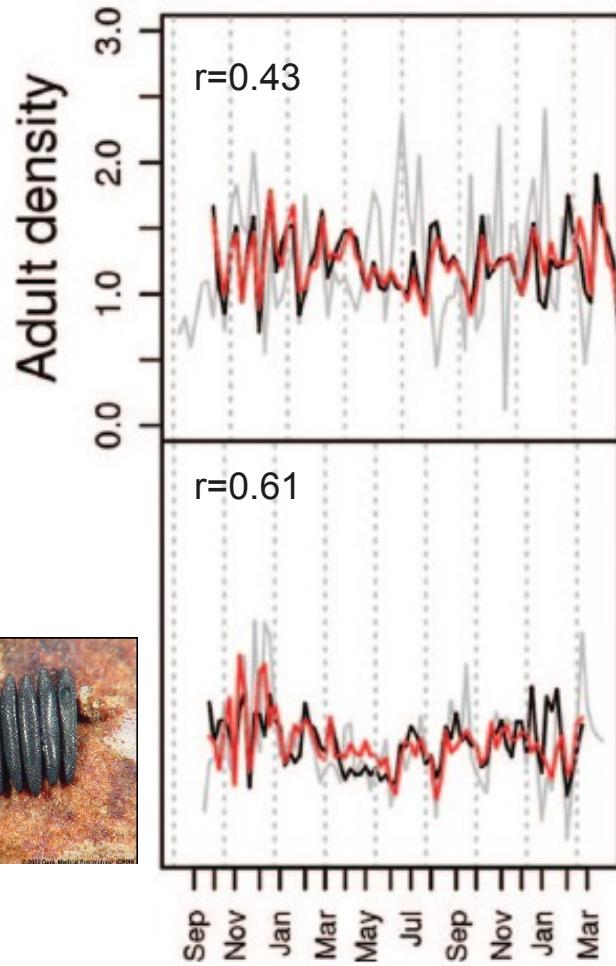
GAM model was required:

Smooth temperature term (non linear)



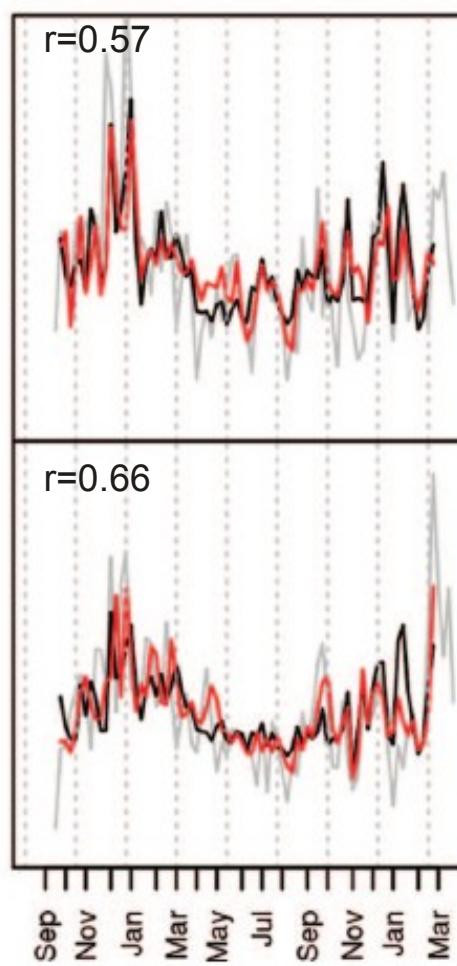
AR(1)+TEMP(1)+CHUVA(4)

(A) Urban area



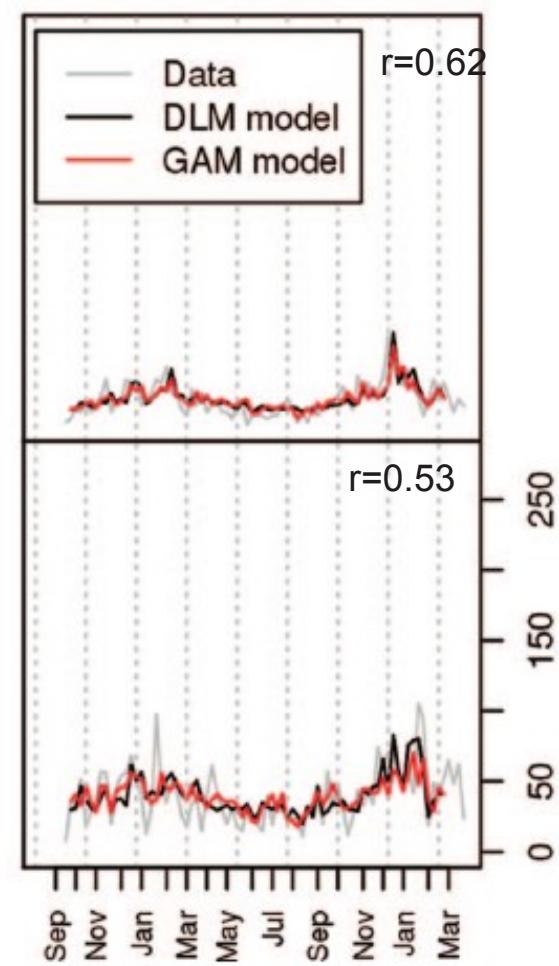
AR(1)+TEMP(1)

(B) Suburban area



AR(1)+TEMP(1)

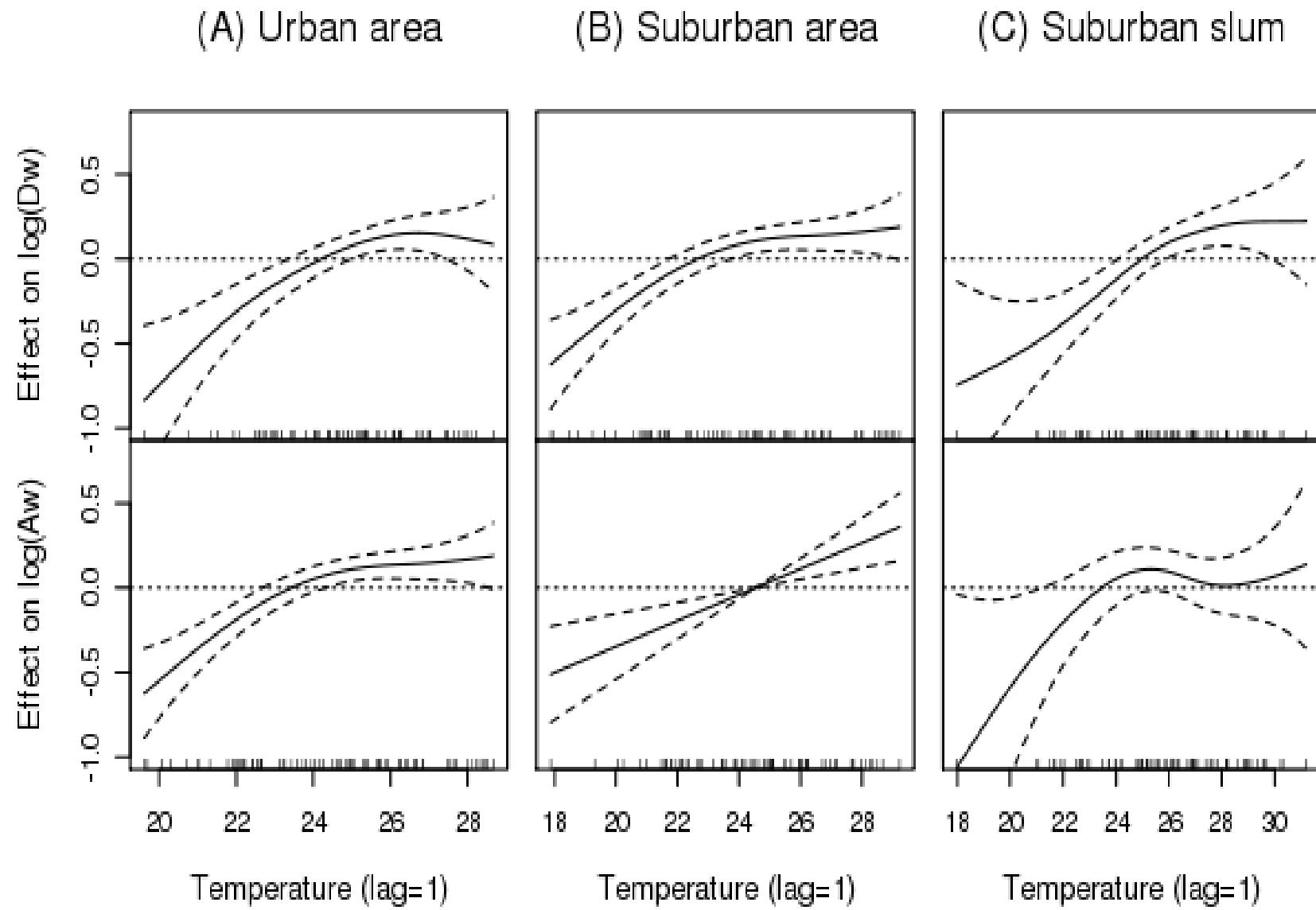
(C) Suburban slum

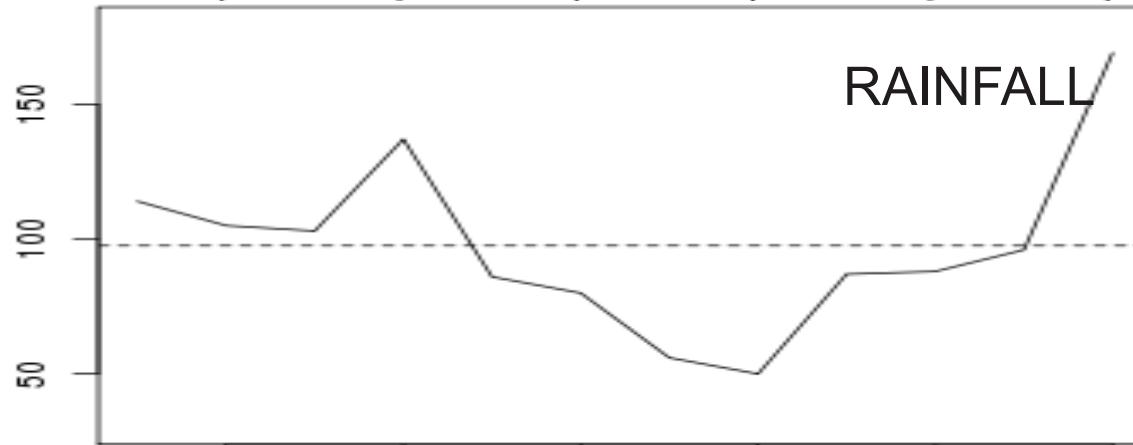
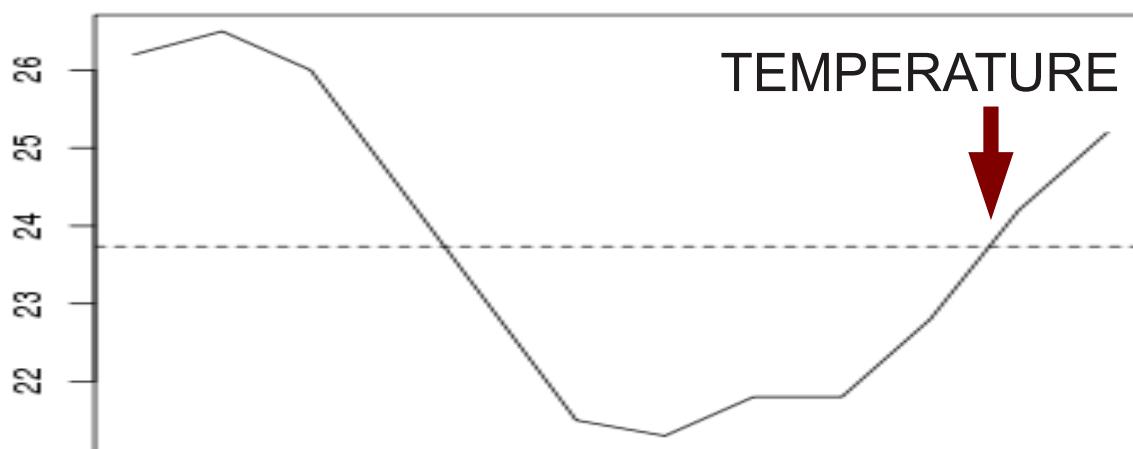
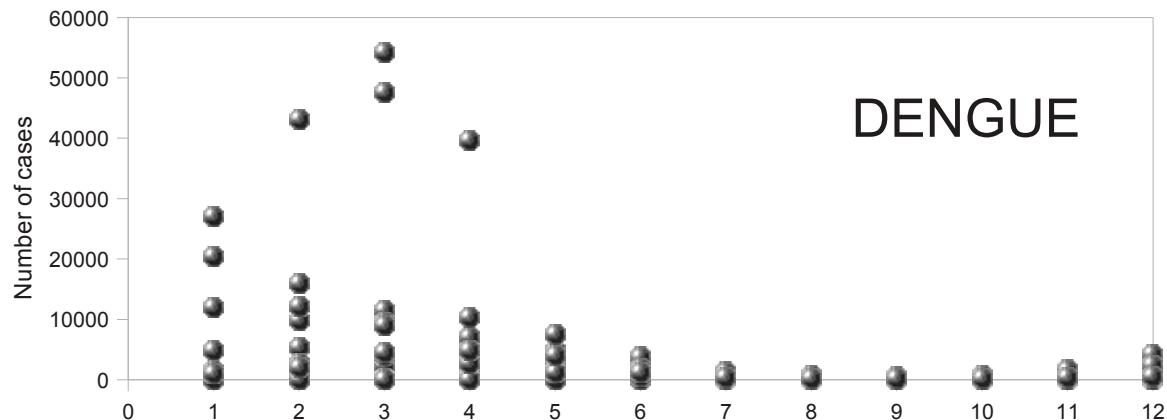


AR(1)+TEMP(1)

AR(1)+TEMP(1)+CHUVA(1)

AR(1)+TEMP(1)+CHUVA(4)





Mosquito growth

Serological survey

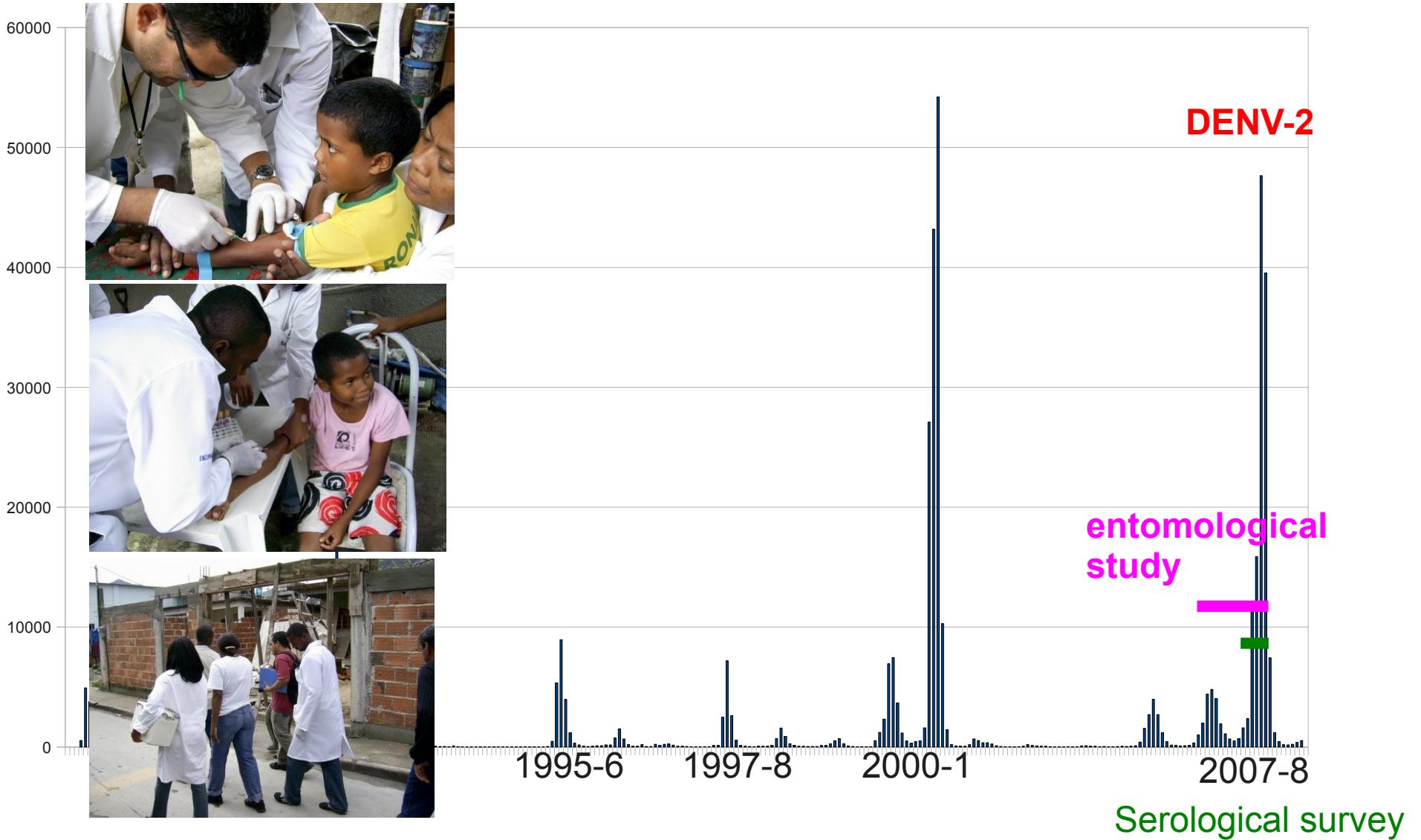


Table 1. Serological surveys, July-November 2007 and February-April 2008 in three areas, Rio de Janeiro, Brazil.

Area (type)	Serum sample (IgM) - Surveys			Serum sample (IgG) - Surveys		
	1 st	2 nd	Seroconversion paired sample (IgM)	1 st	2 nd	Seroconversion paired sample (IgG)
Higienópolis (Urban)	n	43	29	28	43	29
	Positives	1*	4**	2	37	27
	Median Age (range)	28.5 (4-79)	42 (4-79)	40.50 (4-79)	28.5 (4-79)	42 (4-79)
Tubiacanga (Suburban)	n	157	122	117	157	122
	positives	2 ⁺	5 ⁺⁺	4	90	75
	Median Age (range)	11 (4-74)	12 (4-74)	12 (4-74)	11 (4-74)	12 (4-74)
Palmares (Suburban slum)	n	126	107	102	126	107
	positives	6 [†]	15 ^{††}	11	72	73
	Median Age (range)	11 (1-52)	11 (1-52)	10 (1-52)	11 (1-52)	11 (1-52)
Total	positives/total	9/326	24/258	17/247	199/326	175/258
						13/247

Number of asymptomatic individuals: *1; **2; ⁺ 2; ⁺⁺ 4; [†] 4; ^{††} 10.

Recent dengue infection was defined by the detection of DENV IgM antibodies in any sample (first or second sample) within the last 6

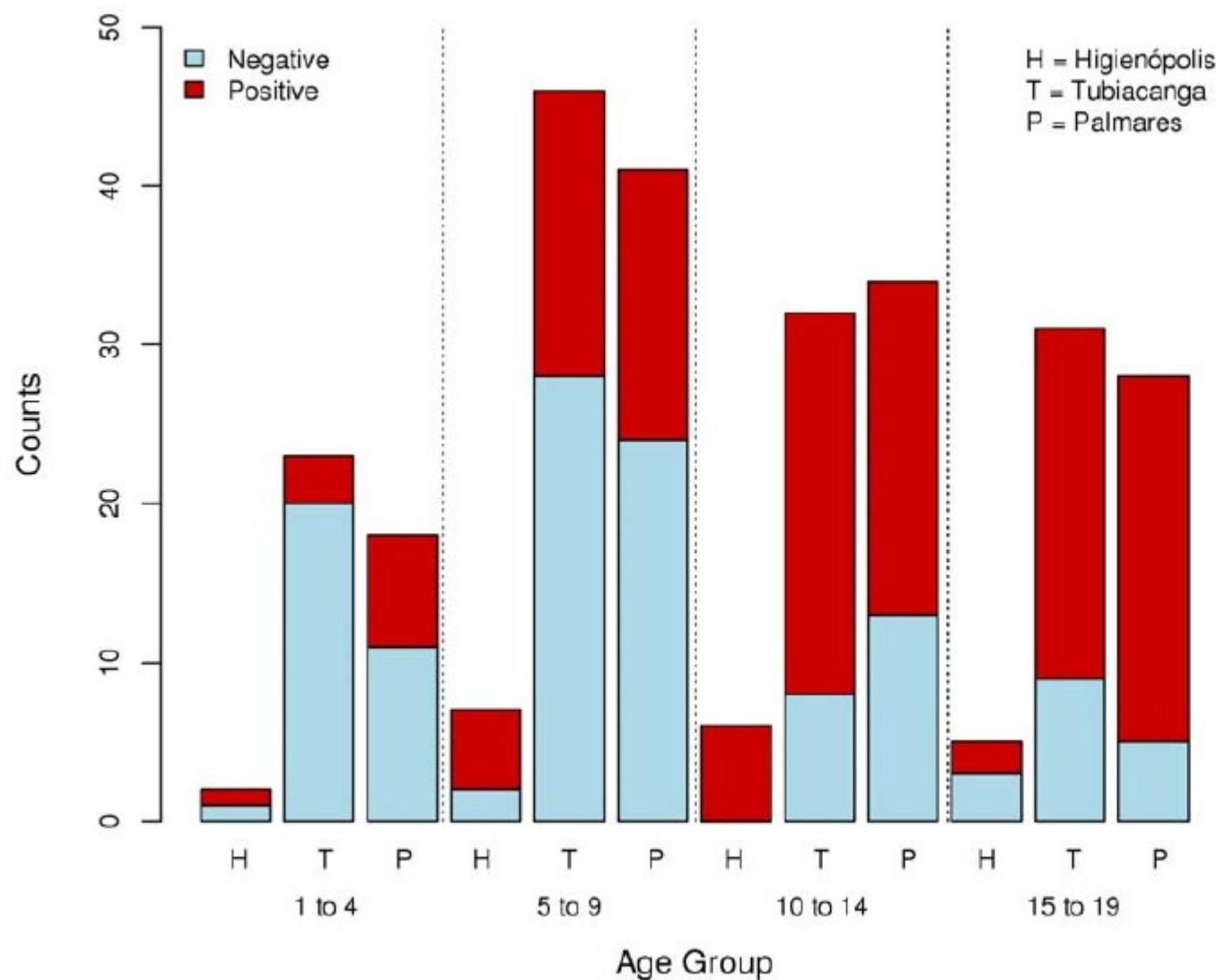
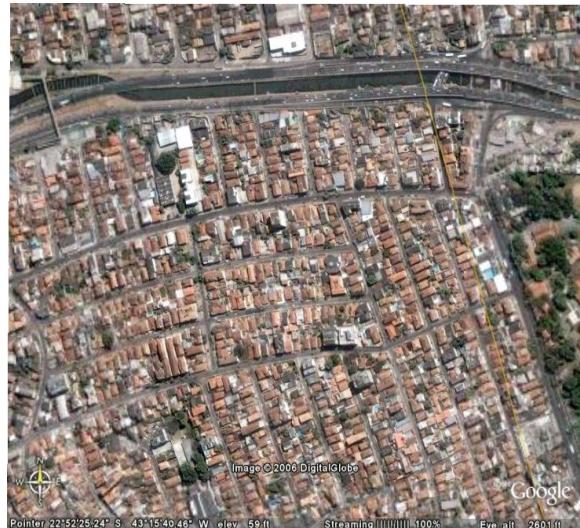


Figure 4. Dengue seroprevalence per age group. Dengue seroprevalence per age group (1 to 4, 5 to 9, 10 to 14, 15 to 19), red are positive and blue indicate negative cases in Higienópolis (urban), Tubiacanga (suburban) and Palmares (suburban slum) neighborhoods in Rio de Janeiro, Brazil.

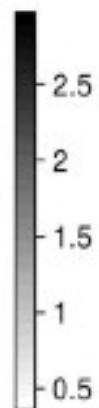
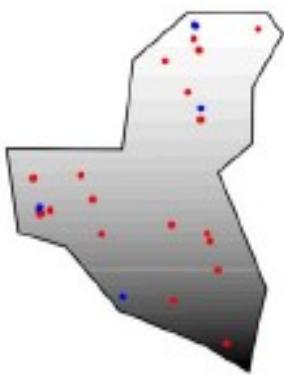
Table 2. Individual risk factors odds ratio for seroprevalence in three areas, Rio de Janeiro, Brazil.

Risk factor	Higienópolis			Tubiacanga			Palmares		
	N	OR	P	N	OR	P	N	OR	P
Sex	Male	22	1	73	1		61	1	
	Female	22	1.179e+08	0.99	89	1.93	0.05	70	0.66 0.26
Age	0–10 years	10	1	77	1		64	1	
	11–20 years	10	1.000e+00	1.00	55	7.91	0.001	60	3.42 0.01
	21–100 years	24	3.662e+08	0.99	30	25.39	0.001	7	4.15 0.22
Self-reported past history of dengue	No	34	1	143	1		106	1	
	Yes	10	2.478e+07	0.99	19	5.00	0.05	25	5.35 0.05
Yellow fever vaccination	No	40	1	147	1		129	1	
	Yes	4	7735420.4	0.99	15	1.96	0.27	2	1.634e+06 0.98

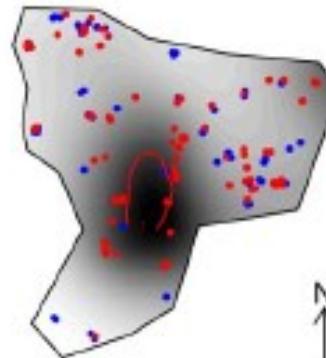
Seropositivity odds ratio



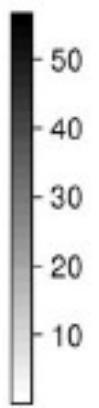
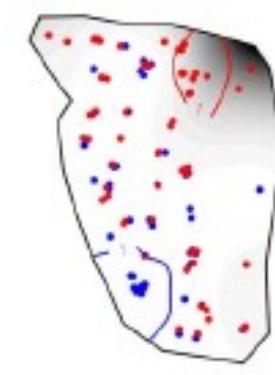
Higienópolis



Tubiacanga

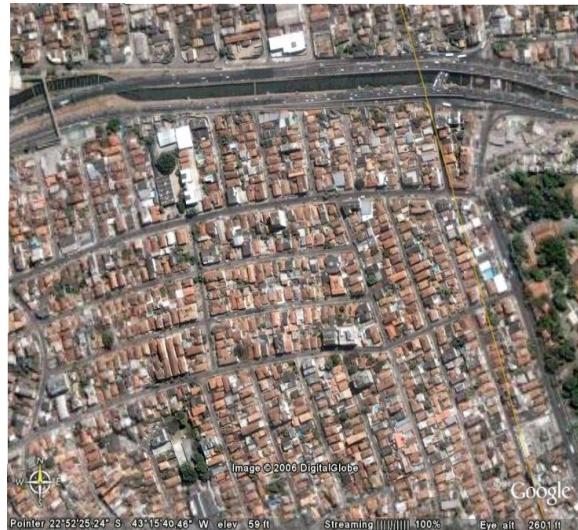


Palmares

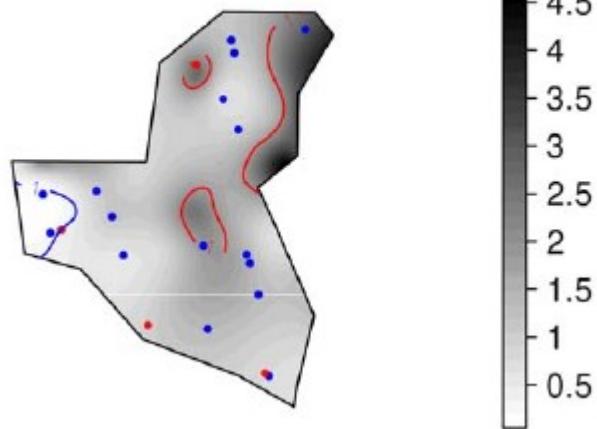


Seropositive cases

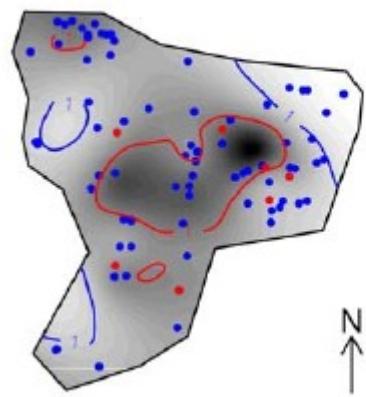
Mosquito density x recent infections



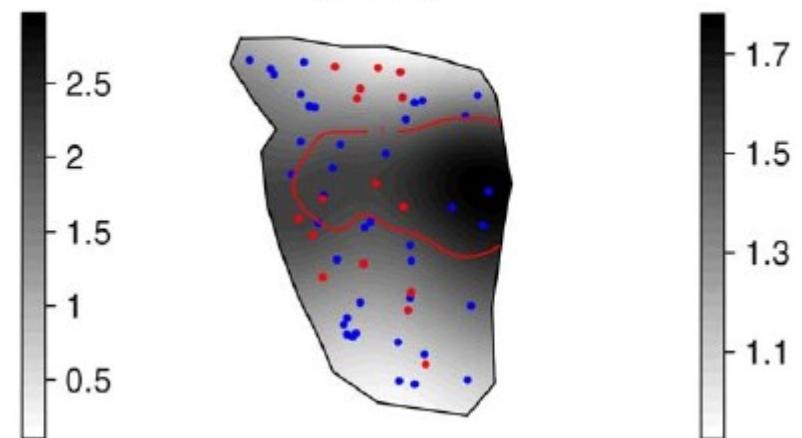
Higienópolis



Tubiacanga



Palmares



Recent cases

Main results

- There is a threshold at 22-24 C above which *Aedes aegypti* is not constrained by temperature.
- Temperature at lag 1 and rainfall can account for 50-60% mosquito abundance variability
- There is a lag of ca. 2 months between mosquito increase and dengue cases increase
- No direct association between mosquito's hotspots and risk of infection
- Apparent association between risk of infection and closeness to high commutation areas.

Temporal Distribution of *Aedes aegypti* in Different Districts of Rio De Janeiro, Brazil, Measured by Two Types of Traps

N. A. HONÓRIO,^{1,2} C. T. CODEÇO,³ F. C. ALVES,⁴ M.A.F.M. MAGALHÃES,⁵
AND R. LOURENÇO-DE-OLIVEIRA¹

J. Med. Entomol. 46(5): 1001–1014 (2009)

Spatial Evaluation and Modeling of Dengue Seroprevalence and Vector Density in Rio de Janeiro, Brazil

Nildimar Alves Honório^{1*}, Rita Maria Ribeiro Nogueira², Cláudia Torres Codeço³, Marilia Sá Carvalho³, Oswaldo Gonçalves Cruz³, Mônica de Avelar Figueiredo Mafra Magalhães⁴, Josélio Maria Galvão de Araújo², Eliane Saraiva Machado de Araújo², Marcelo Quintela Gomes¹, Luciane Silva Pinheiro¹, Célio da Silva Pinel⁵, Ricardo Lourenço-de-Oliveira¹



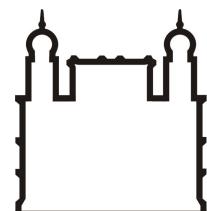
Acknowledgements

Entomology, Fiocruz:

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- Marilia Sá, Aline Nobre, Flavio Coelho
- **Rede Pronex Modelagem em Dengue CNPq**



Ministério da Saúde

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Contato: codeco@fiocruz.br

