Ministério da Saúde
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ESCOLA NACIONAL DE SAÚDE PÚBLICA
SERGIO AROUCA
ENSP

Leptospirosis and Environment

Marilia Sá Carvalho

Summary

- What is Leptospirosis and which are the main questions
- Data sets: cases and climate
- Modelling:
  - basic model
  - climatic covariates: threshold and lags
- Problems and doubts...

Leptospirosis

- Bacterial zoonosis (*Leptospira sp*)

- Transmitted to humans through contact with urine from infected animals (rats in urban setting)

Disease cycle

Leptospirosis

- Incubation period: 5 to 25 days
- Clinical manifestations:
  - self-limiting fever, with headache and muscle pain – easily taken for a bad cold or dengue fever
  - life-threatening disease – kidney failure, pulmonary haemorrhage, Weil's syndrome
- Early treatment! Dialysis mainly

Epidemiology

- Globally spread, affecting people on all continents.
- Different epidemiological patterns:
  - Sporadic disease, related with specific occupational exposures and recreational activities
  - Slums and flooding in urban areas

In Brazil

- 10,000 reported cases per year in the major cities
- Under-registration
- 10-15% mortality when diagnosed; more due to late treatment
- Main suspected factors: poor sanitation, slum housing and flooding

Favela in Salvador


Rosalvo
Carvalho
X016672


Riachuelo
PASSAR NA RIACHUELO
TODA A DIFERENÇA.

General questions

- People living in slums – seroprevalence study estimates 23% at 50y, so what determines severe cases?
  - different virulence according to the bacteria strain
  - inoculant dose – related to behaviour (higher male prevalence – cleaning sewers) and environment
  - previous immunity – how is it acquired? (a vaccine is on its way)

Leptospirosis & Climate

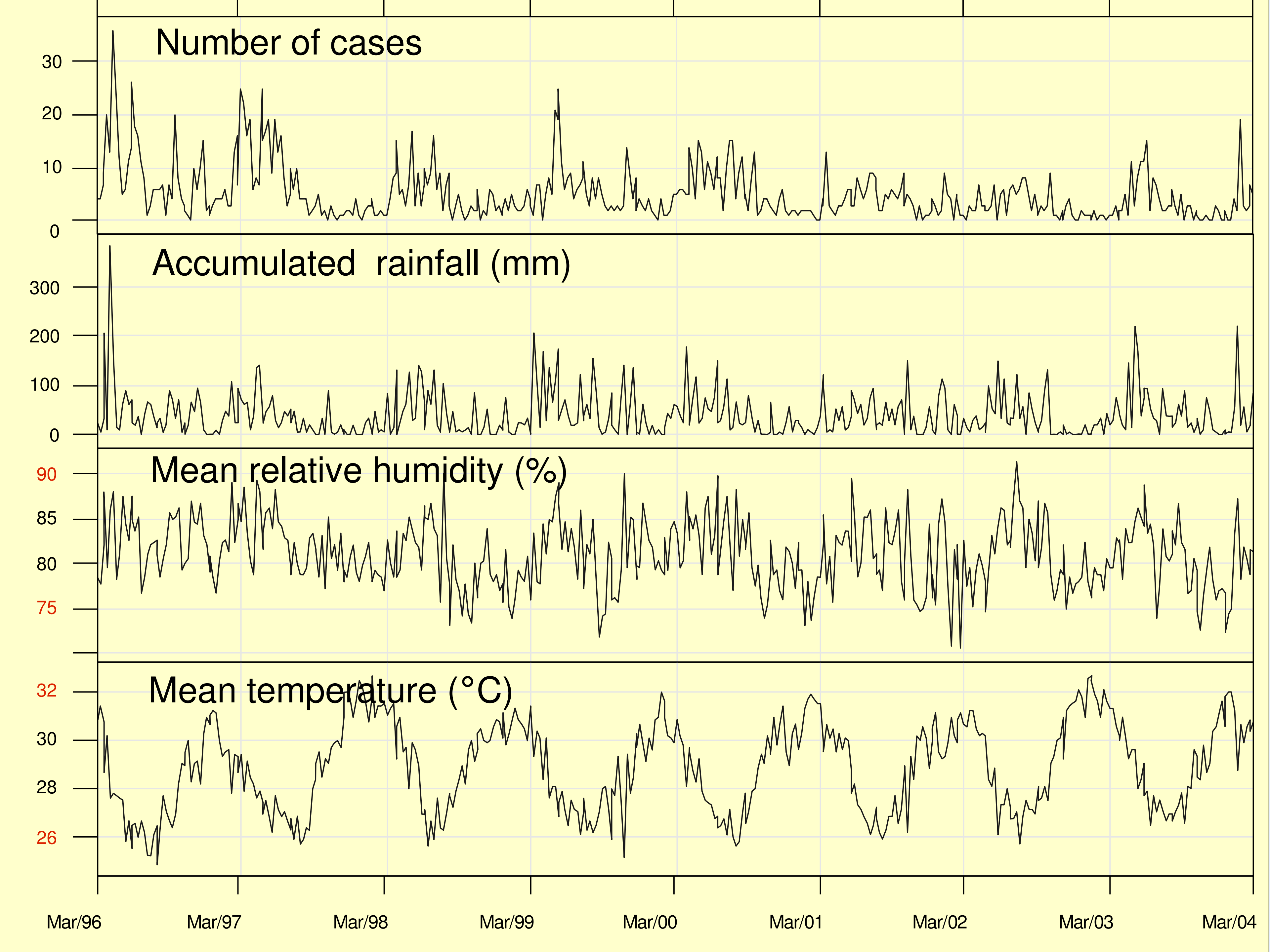
- Does rainfall really cause epidemics of severe leptospirosis? Why?
  - Reasoning: the rain clean up the rats holes, bringing to the soil surface leptospira
  - Is it a linear relationship?
- When to give an alarm to decrease fatalities – threshold

Questions

- Other environment factors: humidity & temperature
- Time delay
  - duration of incubation period – related to inoculant dosis
  - duration of the *Leptospira* on the soil – related with temperature and moisture on the soil

Data

- Salvador surveillance system
- Cases: weekly aggregated
- Climate covariates:
  - Mean weekly temperature (°C)
  - Mean weekly relative humidity (%)
  - Weekly accumulated rainfall (mm)



Number of cases
0
10
20
30
Accumulated rainfall (mm)
0
100
200
300
Mean relative humidity (%)
75
80
85
90
Mean temperature (°C)
26
28
30
32
Mar/96
Mar/97
Mar/98
Mar/99
Mar/00
Mar/01
Mar/02
Mar/03
Mar/04

The basic model

$$Y(t) \sim Poisson(\mu_t)$$

$$\ln(\mu_t) = \beta_t + \phi_t$$

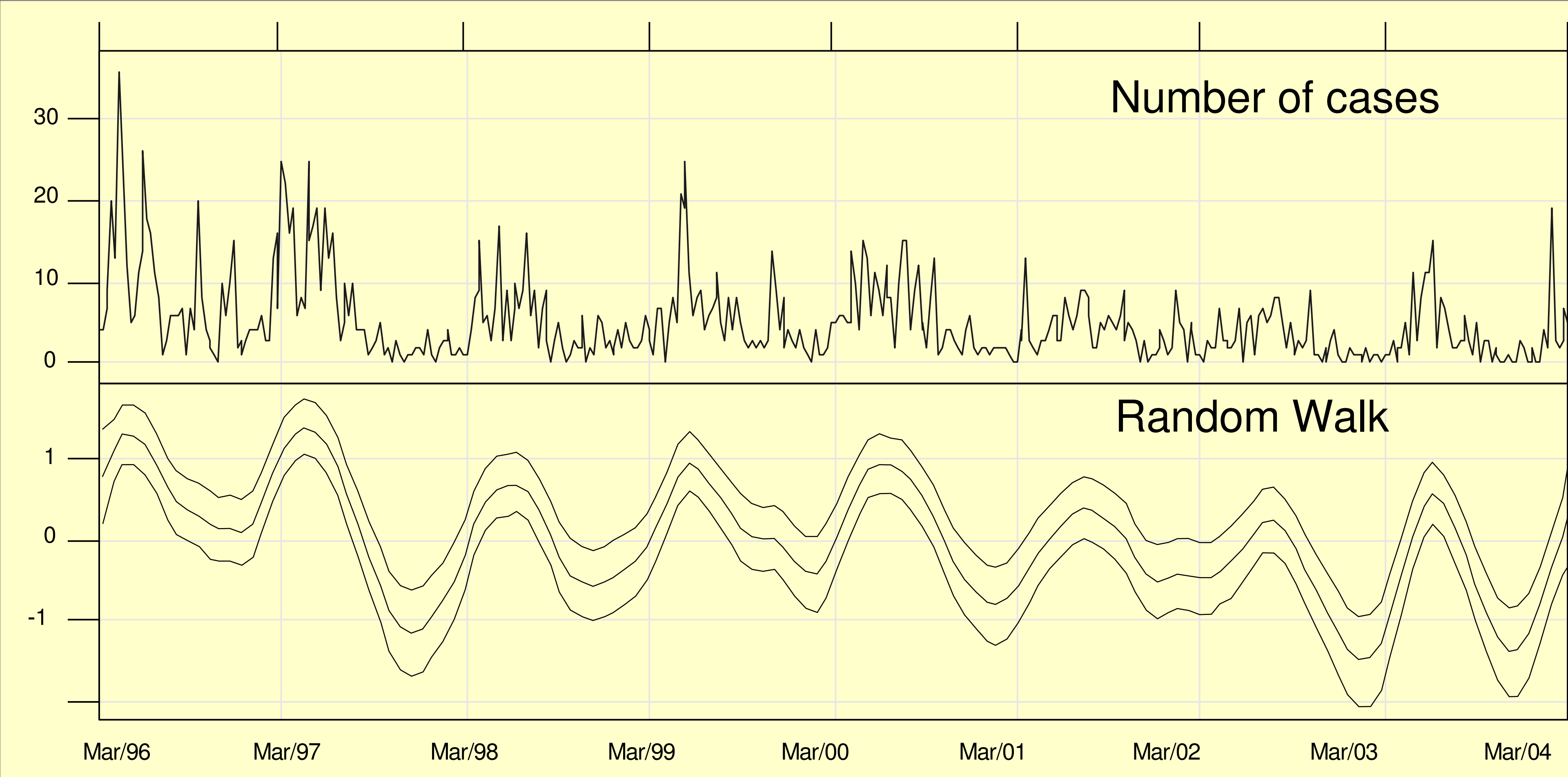
where:

$\beta_t = 2\beta_{t-1} - \beta_{t-2} + \epsilon_t$ (2nd order random walk prior)

$\phi_t \sim N(0, \sigma^2)$ (temporal random effect, accounting for overdispersion)

Fitted in BayesX

(www.stat.uni-muenchen.de/~bayesx/bayesx.html)



- Seasonality
- Downward general trend?

Including climate covs

- Which are the important temporal lags?
- Is the corresponding effect linear?

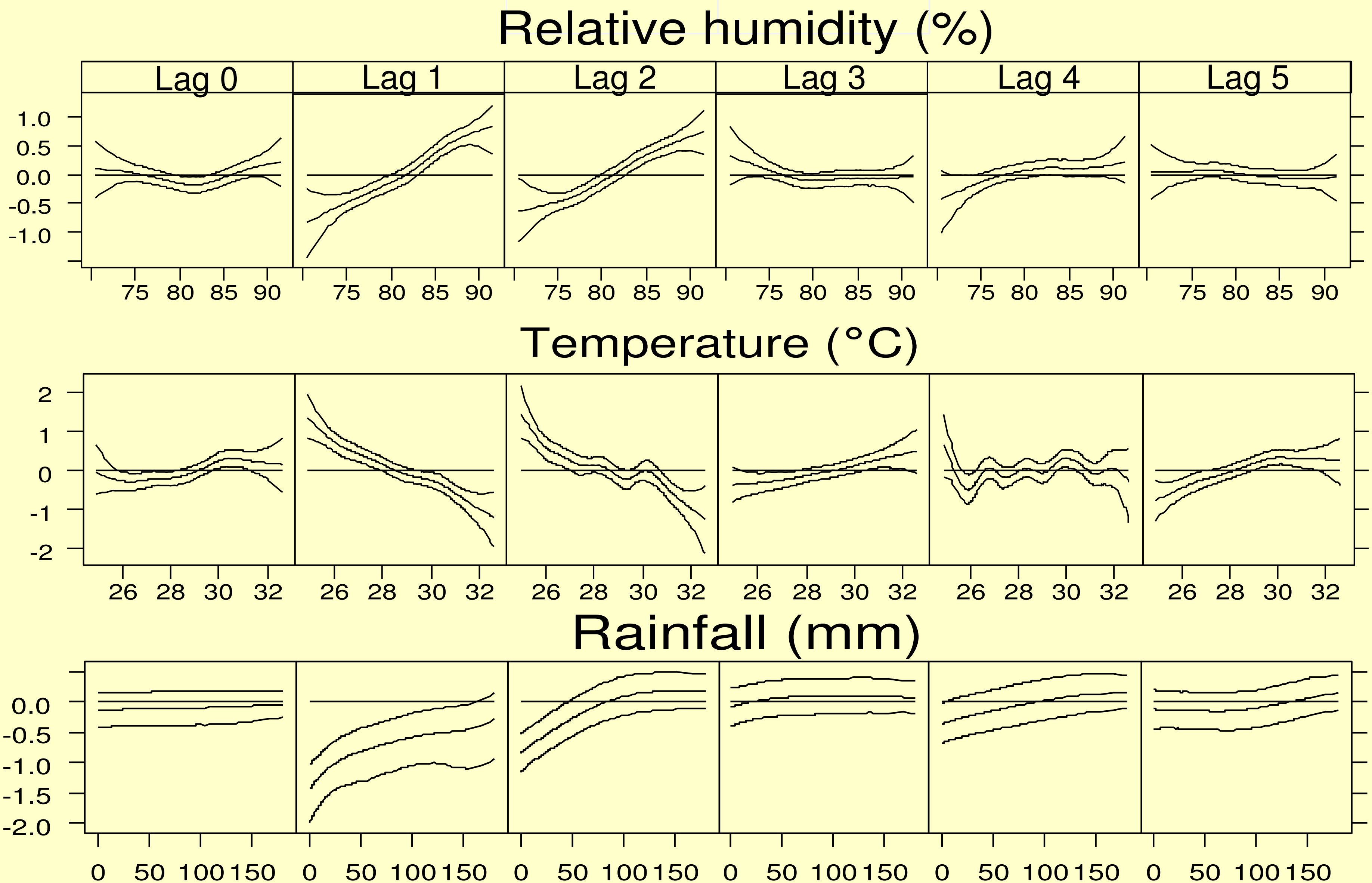
$$\ln(\mu_t) = \beta_t + \phi_t + \sum_{k=0}^{5} \psi_k(x_{t-k})$$

$\psi_k()$ is a nonparametric spline

$x_{t-5}, \ldots, x_t$ measures humidity OR temperature OR rainfall

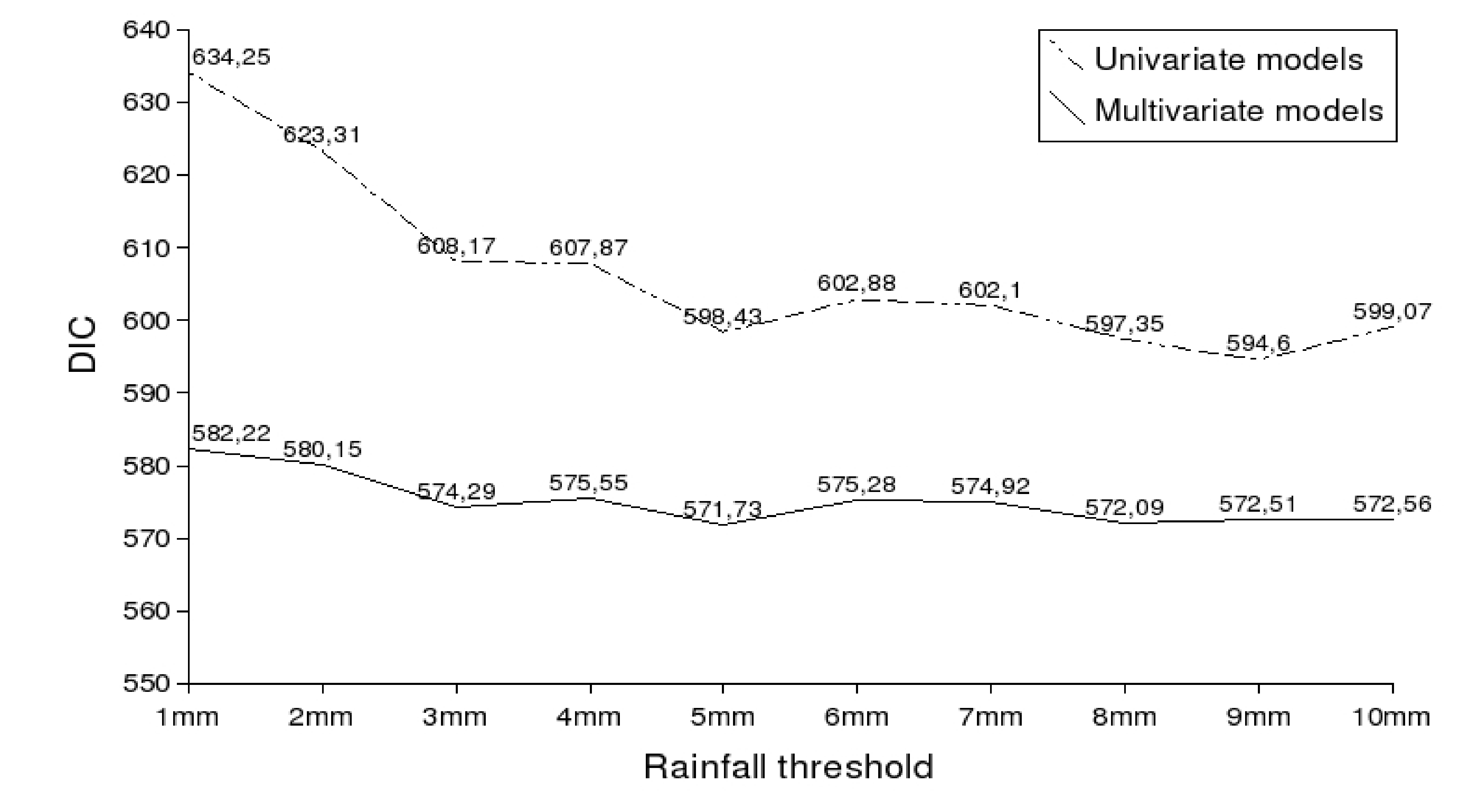
k lags, from the same week $k=0$ up to the 5th previous one

Lags and Linearity



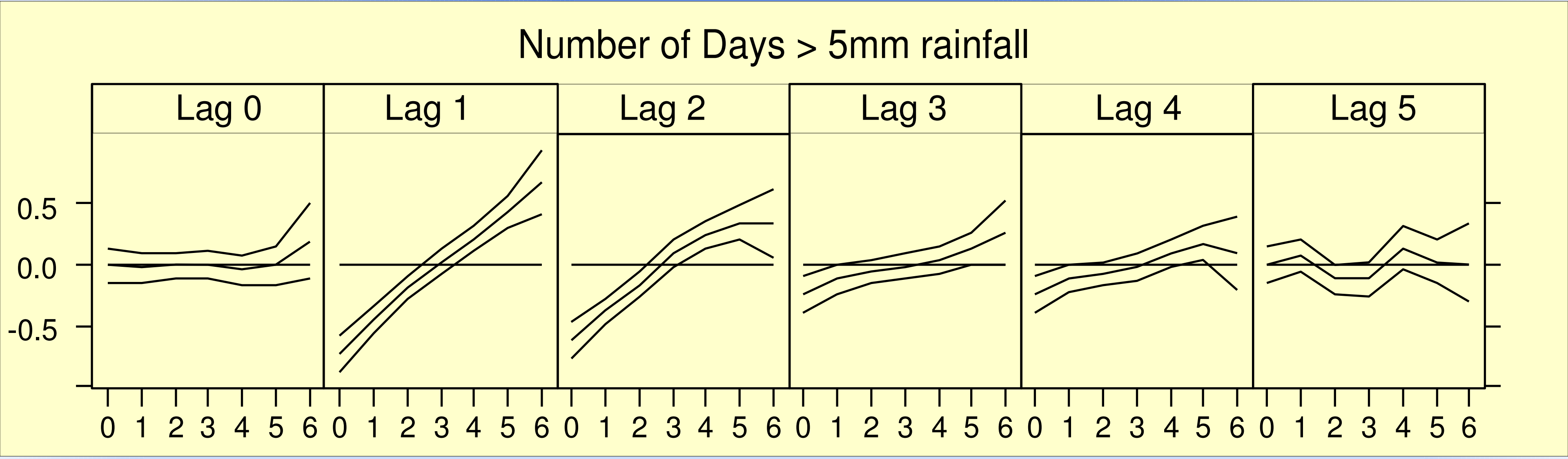
Rain > 5mm

- Comparison of DIC of models with different thresholds



Rain > 5mm

- Chosen based on…. civil defence information as well

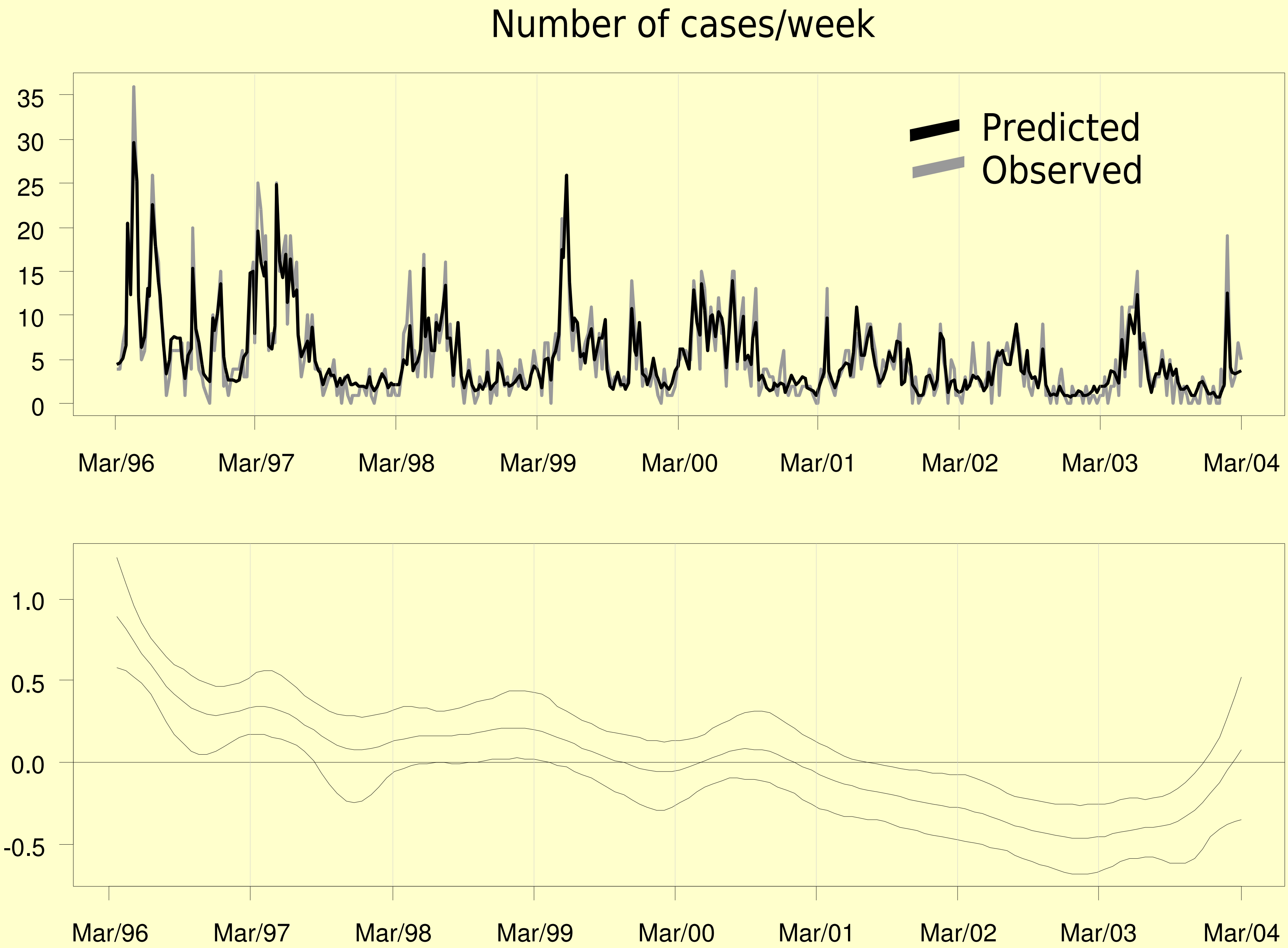


Complete model

$$
\begin{aligned}
\ln(\mu_t) = \mu_0 + \beta_t + \phi_t + \\
&+ \beta_{H1}(Humid_1) + \beta_{H2}(Humid_2) + \\
&+ \beta_{T1}(Temp_1) + \beta_{T2}(Temp_2) + \\
&+ \beta_{R1}(Rain_1) + \beta_{R2}(Rain_2) + \beta_{R3}(Rain_3) + \beta_{R4}(Rain_4)
\end{aligned}
$$

Effects

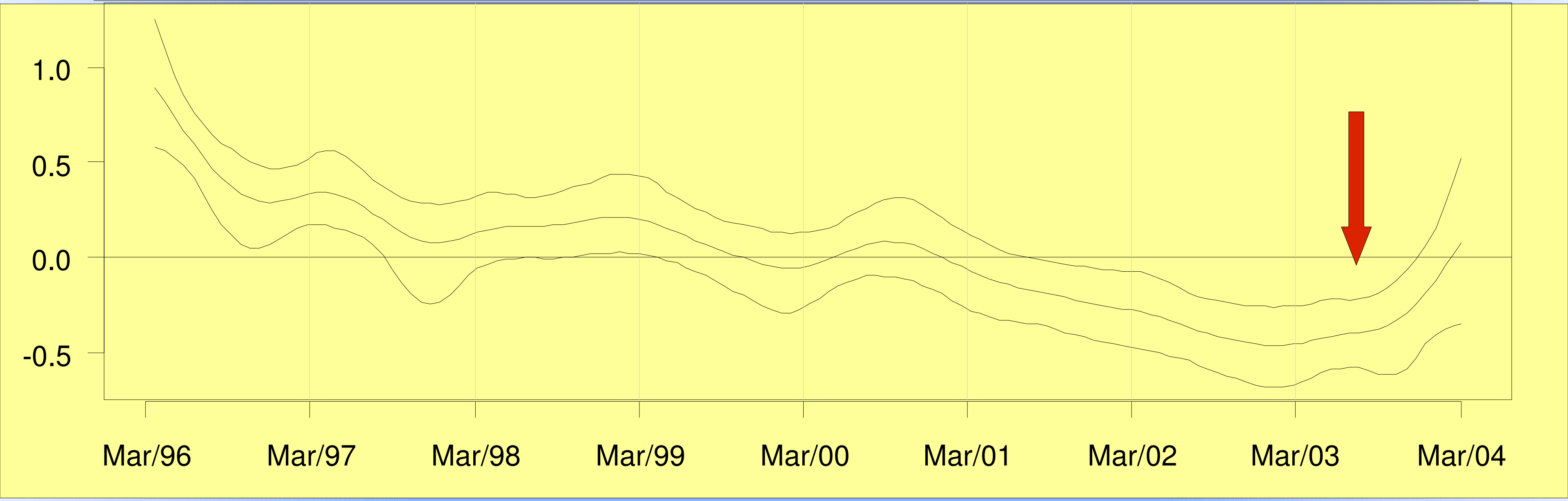
Variables	Relative risk exp(β)	2.5% quantile	97.5% quantile
Mean relative humidity, week(t-1)	**1,045834**	1,024385	1,067776
Mean relative humidity, week(t-2)	**1,055043**	1,032454	1,078136
Mean temperature, week(t-1)	0,945387	0,873472	1,020173
Mean temperature, week(t-2)	1,055784	0,976662	1,139499
Num. days rain > 5mm, week(t-1)	**1,150296**	1,093561	1,210880
Num. days rain > 5mm, week(t-2)	**1,117894**	1,059795	1,175944
Num. days rain > 5mm, week(t-3)	**1,067789**	1,027711	1,109781
Num. days rain > 5mm, week(t-4)	**1,063815**	1,023835	1,106515


Number of cases/week
Predicted
Observed
35
30
25
20
15
10
5
0
Mar/96
Mar/97
Mar/98
Mar/99
Mar/00
Mar/01
Mar/02
Mar/03
Mar/04
1.0
0.5
0.0
-0.5
Mar/96
Mar/97
Mar/98
Mar/99
Mar/00
Mar/01
Mar/02
Mar/03
Mar/04

Conclusions

- Leptospirosis depends upon:
  - rainfall (up to 4 weeks previously),
  - humidity (up to 2 weeks previously),
  - not temperature.
- Alert to public health and guidelines to emergency doctors

Downward trend?



- climate related – *el niño* phenomena?
- structural changes in favelas – no!
- sanitation – Blue Bahia (World Bank project) was entirely devoted to touristic areas

Statistical problems

- Better models to discover the rainfall threshold?
- How to analyse the lagged effect?
  - Colinearity!
  - Polynomial distributed lag models (package pdl in R)

Future research

- Space-time analysis – data is now localised in small area, in a GIS, with level curves (1m) and socio-economic covariates
- The *Natural history of severe leptospirosis* project (NIH grant) – a longitudinal study going on in Pau-da-Lima favela, already in its 3rd visit
- Vaccine – phase 1

Acknowledgements

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