Epi-scanner: Scalability and Comparability for Epi-parameter Estimation

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January 27, 2025

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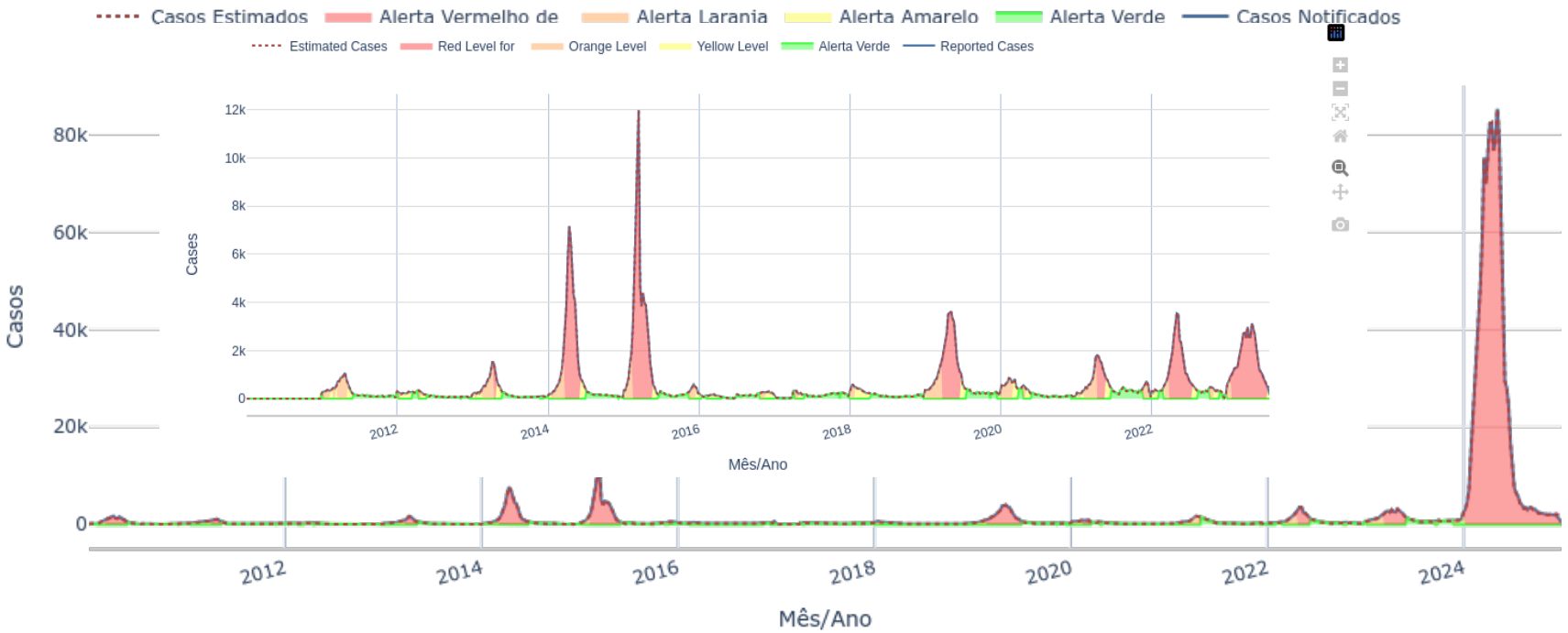
Online Monitoring of Seasonal dengue Epidemics

Infodengue (São Paulo city):



- Complex temporal patterns
- Timing and size are very important
- Inter-year variability
- Why are we monitoring?

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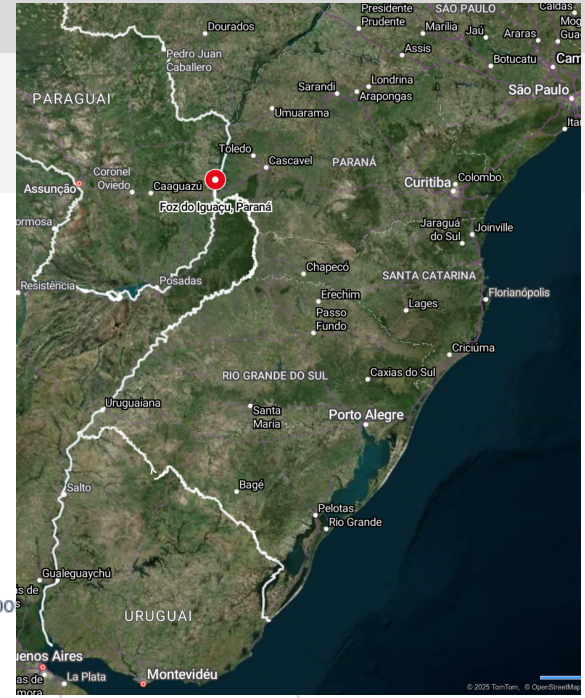
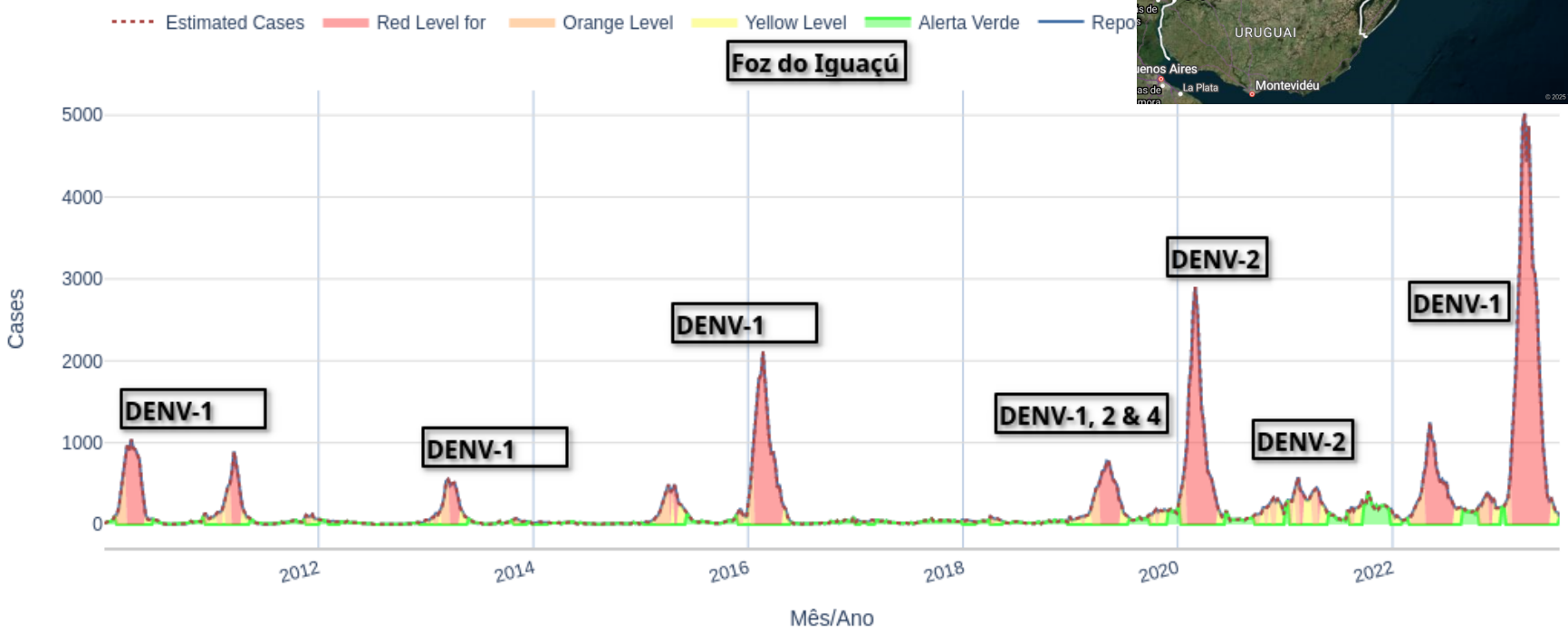
Alternation of Serotypes

Dominating Serotypes:





Problem statement

MBD diseases such as dengue and chikungunya are endemic and seasonal in Brazil, sharing the same vector.

Goals:

To extract descriptors(parameters) of epidemics that can help us understand the impact of environmental and control variables on disease dynamics.

- Do it efficiently
- Do it comparably (use the same model)
- Parameters of interest: R0, EW of the peak,
  - $\mathcal{R}_0$
  - Peak week
  - Peak size
  - Start, end, and duration of the epidemic
  - Total cases

Modeling the Epidemic curves

Simple Logistic function (Richards function) that matches cumulative incidence.

$$J(t) = L - L\left[1 + \alpha e^{b(t-t_j)}\right]^{-\frac{1}{\alpha}}$$

where $J(t)$ is the cumulative number of cases at time t, L is the total number of cases at the end of the season and t_j is the week of the peak. SIR model parameters can be obtained from this fitted function;

$$\beta = \frac{b}{\alpha};\ \gamma = b\left(\frac{1}{\alpha} - 1\right);\ \mathcal{R}_0 = \frac{\beta}{\gamma}$$

arXiv > q-bio > arXiv:2407.21286

Quantitative Biology > Populations and Evolution

[Submitted on 31 Jul 2024]

Large-scale Epidemiological modeling: Scanning for Mosquito-Borne Diseases Spatio-temporal Patterns in Brazil

Eduardo C. Araujo, Claudia T. Codeço, Sandro Loch, Luã B. Vacaro, Laís P. Freitas, Raquel M. Lana, Leonardo S. Bastos, Iasmim F. de Almeida, Fernanda Valente, Luiz M. Carvalho, Flávio C. Coelho

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Fitting the Model to Data

Let $\xi := \{L, \alpha, b, t_j\}$ be the set of parameters of the Richards function to be estimated. The model is fit to data by minimizing the following error:

$$\text{argmin}_{\xi} \sum_{t=1}^{\tau} \frac{[C(t) - J(t, \xi)]^2}{\tau}, \tag{1}$$

where $C(t)$ is the observed cumulative number of cases at week t and $\tau = 52$.

To better match the seasonality of dengue, $t = 1$ corresponds to actual EW 40.

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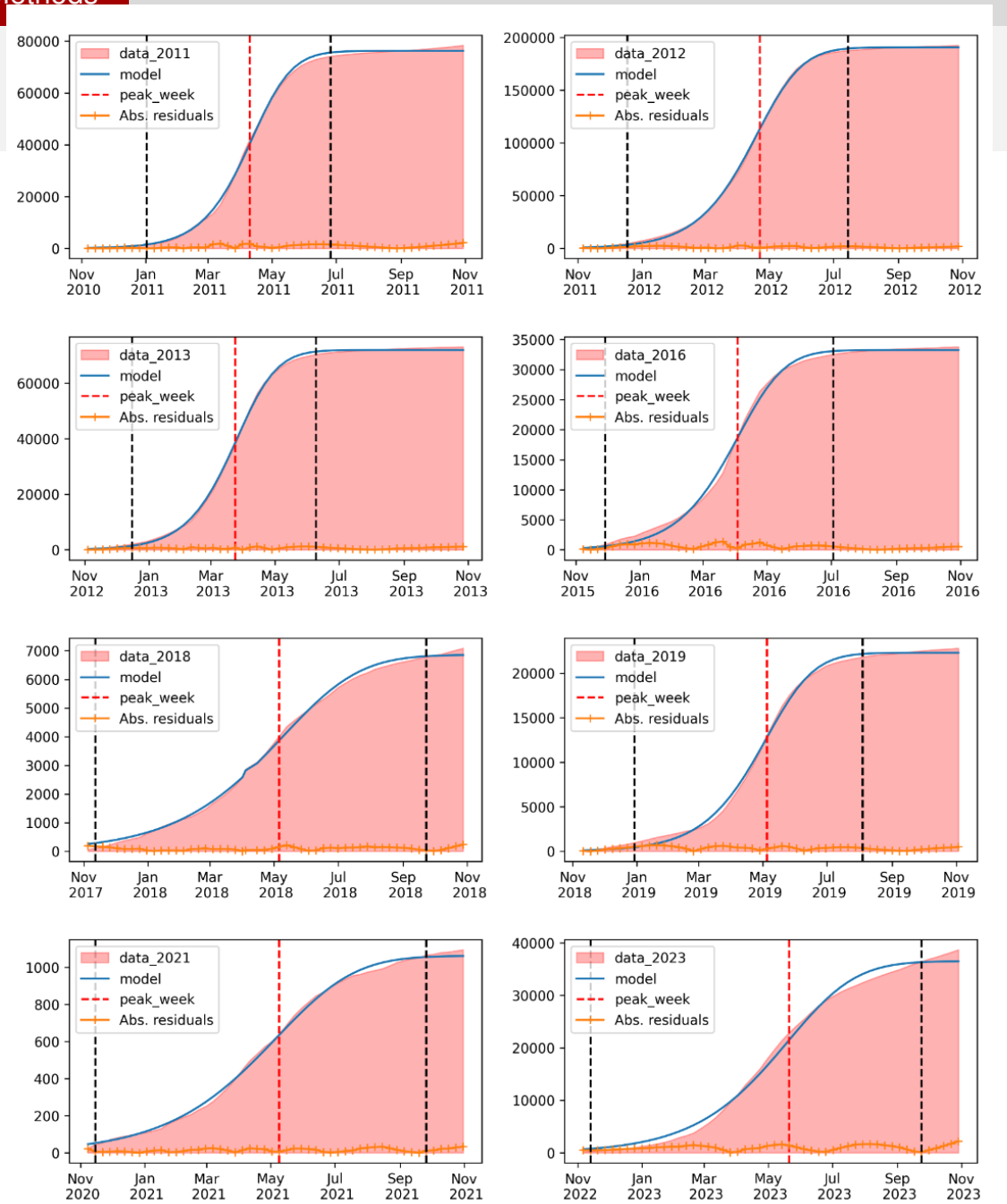
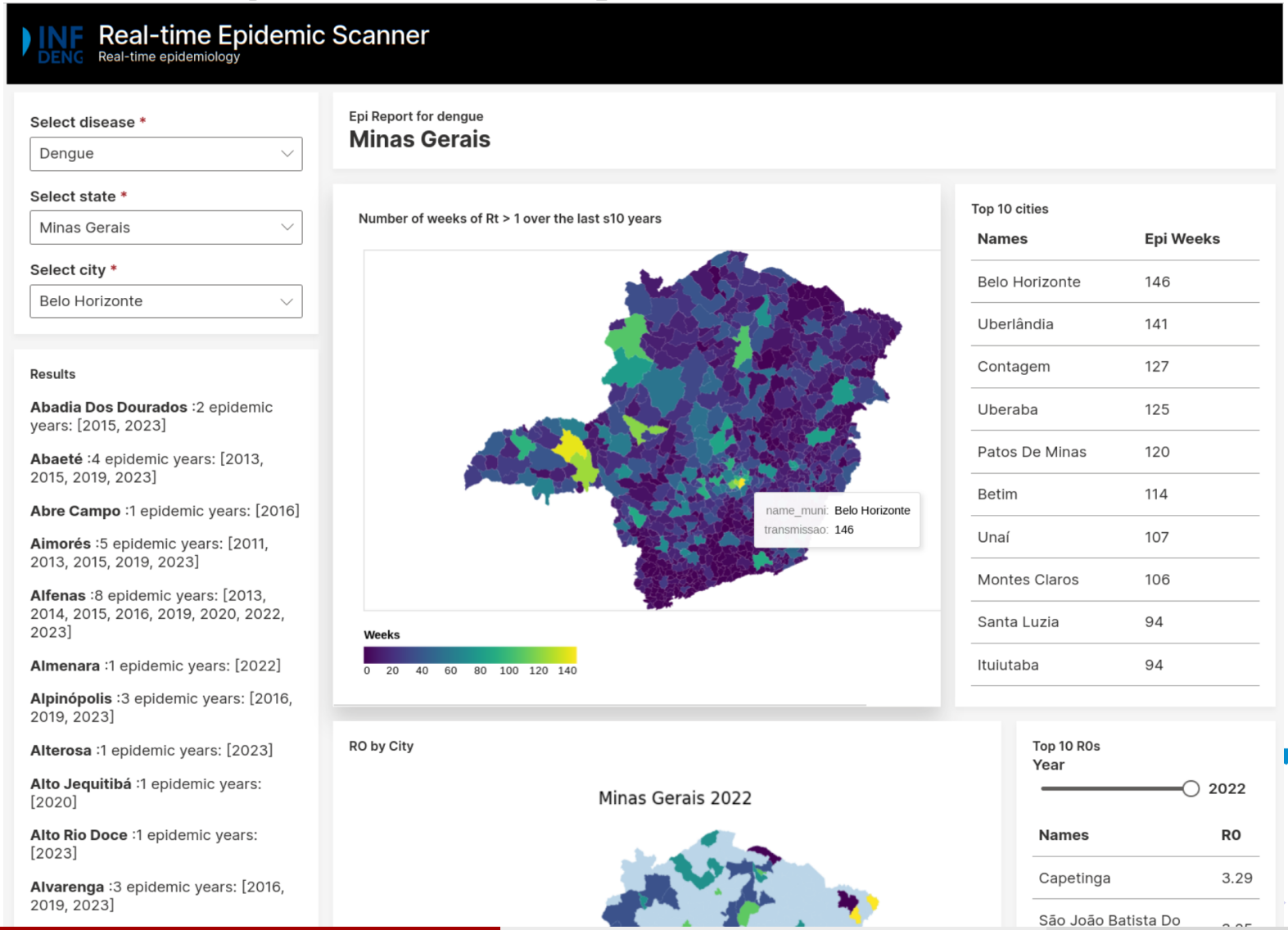
Example fit

Rio de Janeiro



The Web tool

`info.dengue.mat.br/epi-scanner`



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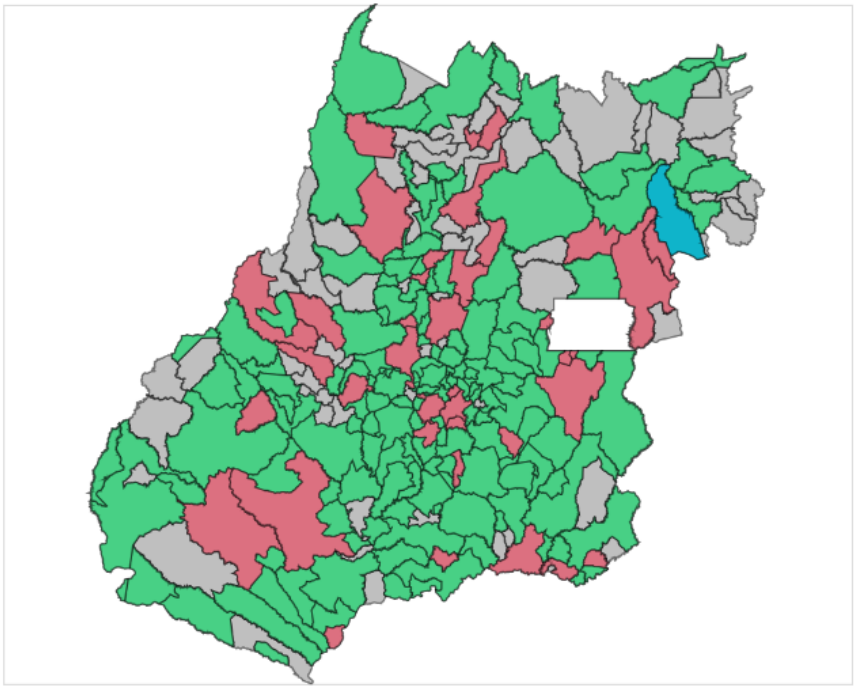
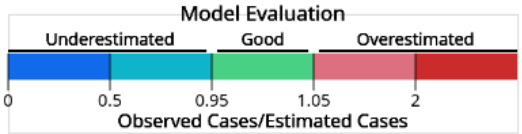
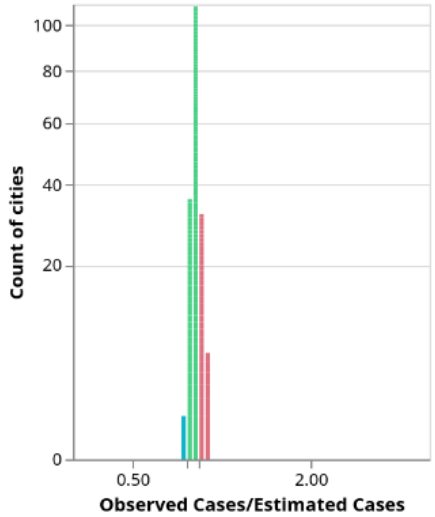
Goodness of fit





* Cities in gray did not have an epidemic detected.



Range	Range Counts(%)
(0.0, 0.5]	0 (0.0%)
(0.5, 0.95]	1 (0.54%)
(0.95, 1.05]	145 (78.8%)
(1.05, 2.0]	38 (20.65%)
(2.0, inf]	0 (0.0%)

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Usability

Health services base control measures on Epidemiological expectations.

Main questions:

- Are we having an epidemic next year?
- How big?
- How soon?

Requirements

- Comparable results
- FAIR (Findable, Accessible, Interoperable, Reusable)
- Up-to-date estimates

The dataset

Usage examples

Python3 | R | curl

```
import requests

episcanner_api = "https://api.mosqlimate.org/api/datastore/episcanner/"

params = {
  "disease": "dengue",
  "uf": "SP"
}

resp = requests.get(episcanner_api, params=params)

items = resp.json() # JSON data in dict format
```

Mosqlimate API Documentation

Home | Model Registry | Datastore | Tutorials | Back to API

Datastore

- Datastore API
- Infodengue
- Climate
- Mosquito
- Episcanner parameters

Episcanner paramet

EpiScanner Data

Here you get access to Real-time Epidemic Scanner data from the Epi-Scanner tool, co-developed by the InfoDengue project. These data, described below, are based on the analyze of the expansion of dengue, zika and chikungunya in Brazil using up-to-date incidence data from Infodengue.

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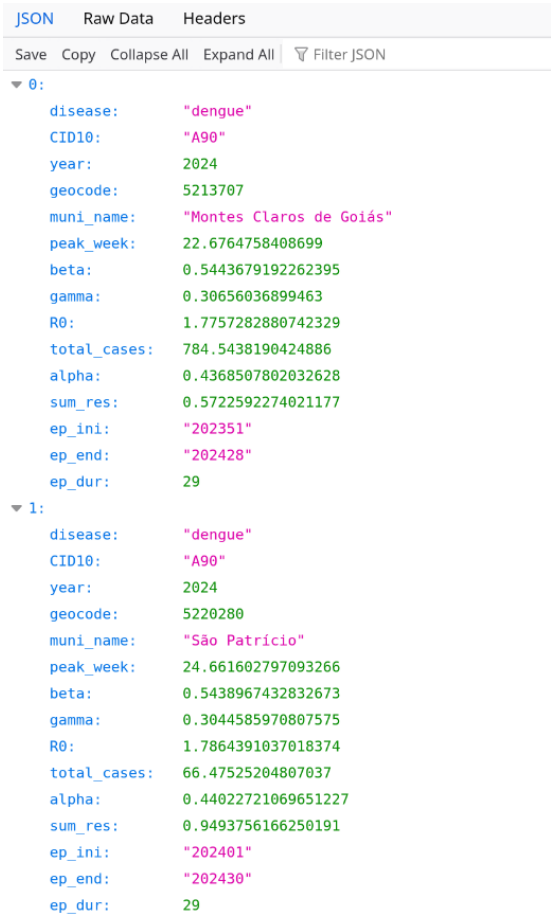
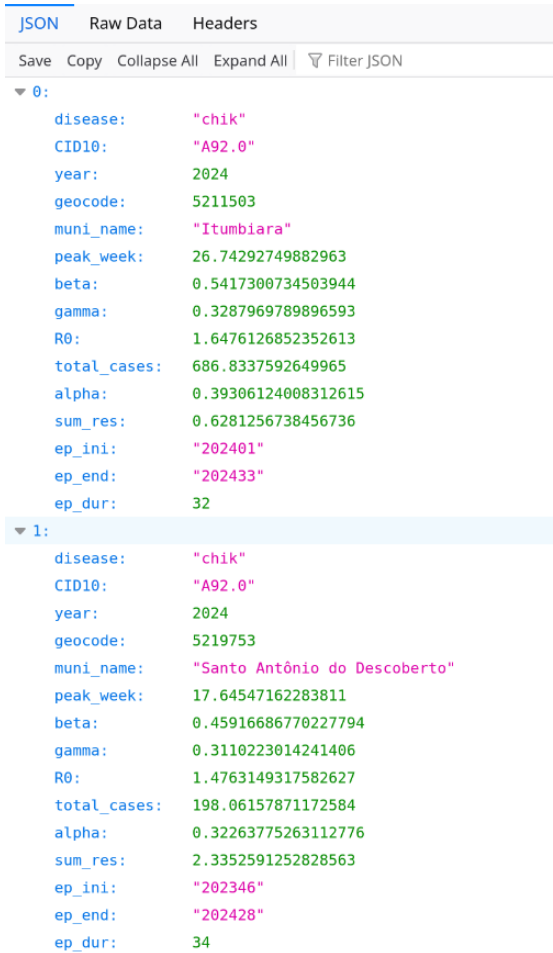
Data format



https://api.mosqlimate.org/api/datastore/episcanner/?disease=dengue&uf=GO



https://api.mosqlimate.org/api/datastore/episcanner/?disease=chikungunya&uf=GO

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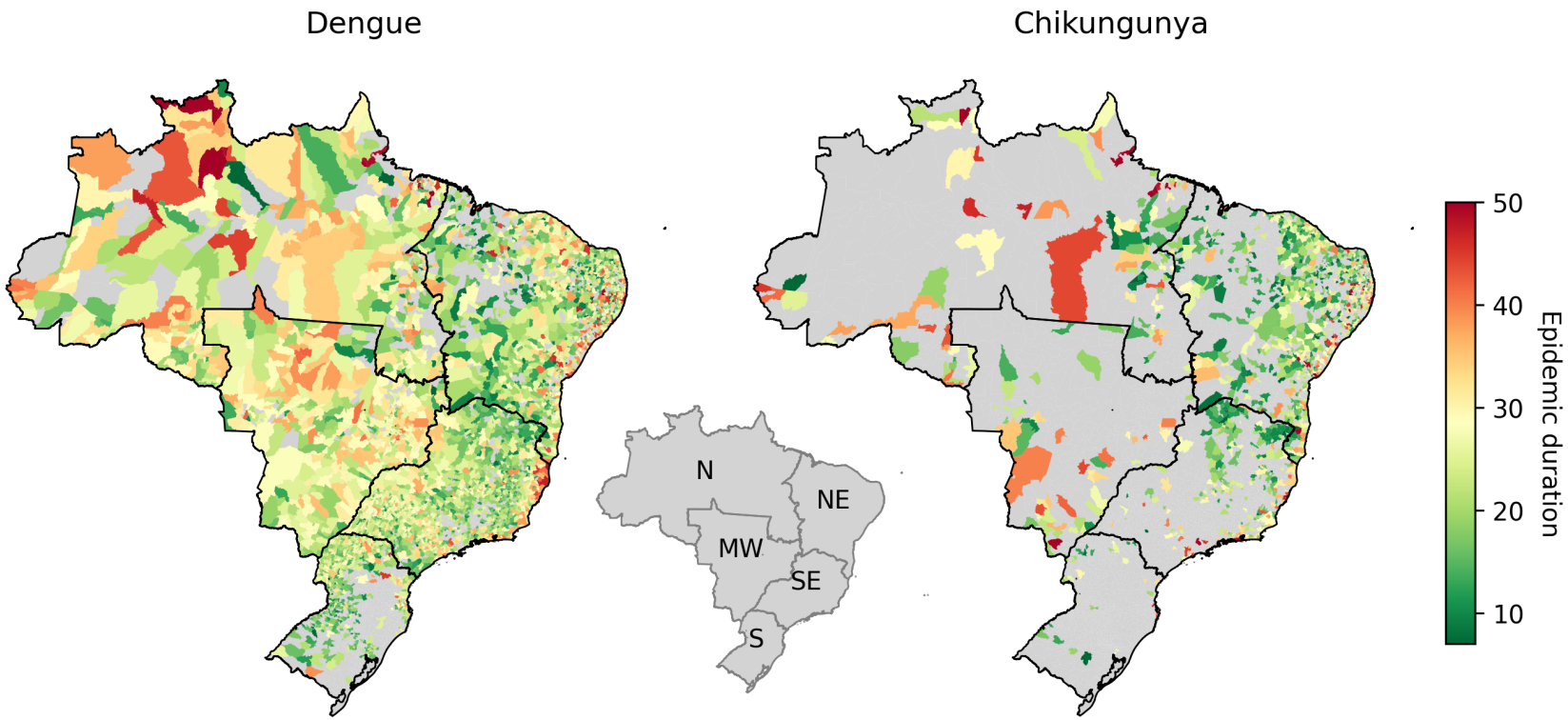
Spatial patterns



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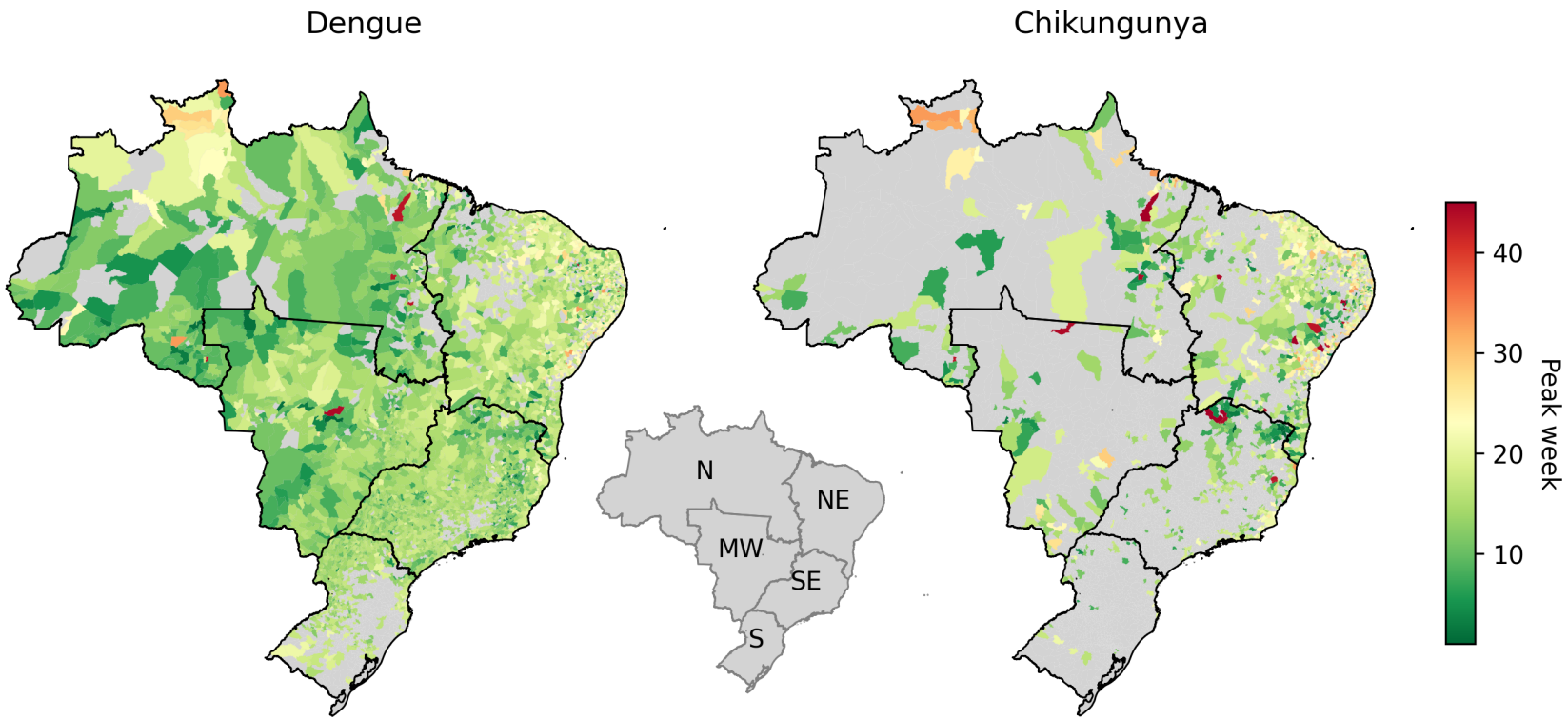
Spatial patterns



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Summary

- Episcanner is available as an opensource tool
- It can be adapted for any SIR-like epidemic curve
- Models are re-estimated every week.
- Parameters have been used successfully in forecasting models
- Main requirement for usage is consistent availability of data
- We welcome collaborators!

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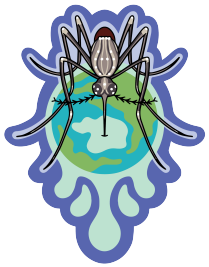
Acknowledgements

Episcanner has benefitted from the collective effort of the teams of Infodengue and the Mosqlimate projects.

INFO DENGUE

`info.dengue.mat.br`



`mosqlimate.org`

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Thank you!

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