



Universidade Federal do Ceará

Modelagem epidemiológica do COVID19 para o Estado do Ceará empregando o modelo SEIIR

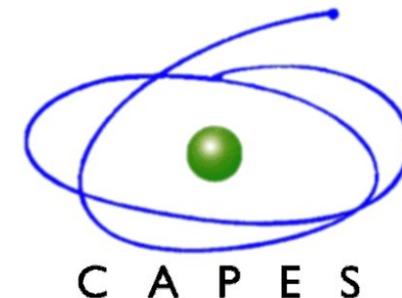
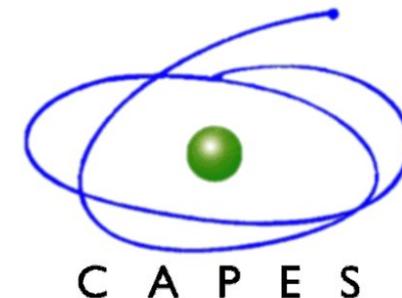
Equipe Cientista-Chefe de Dados (UFC & CAPP-IPECE):

José Soares de Andrade (UFC-Física)

Humberto Carmona (UFC-Física)

Rilder Pires (CAPP-IPECE-SEPLAG)

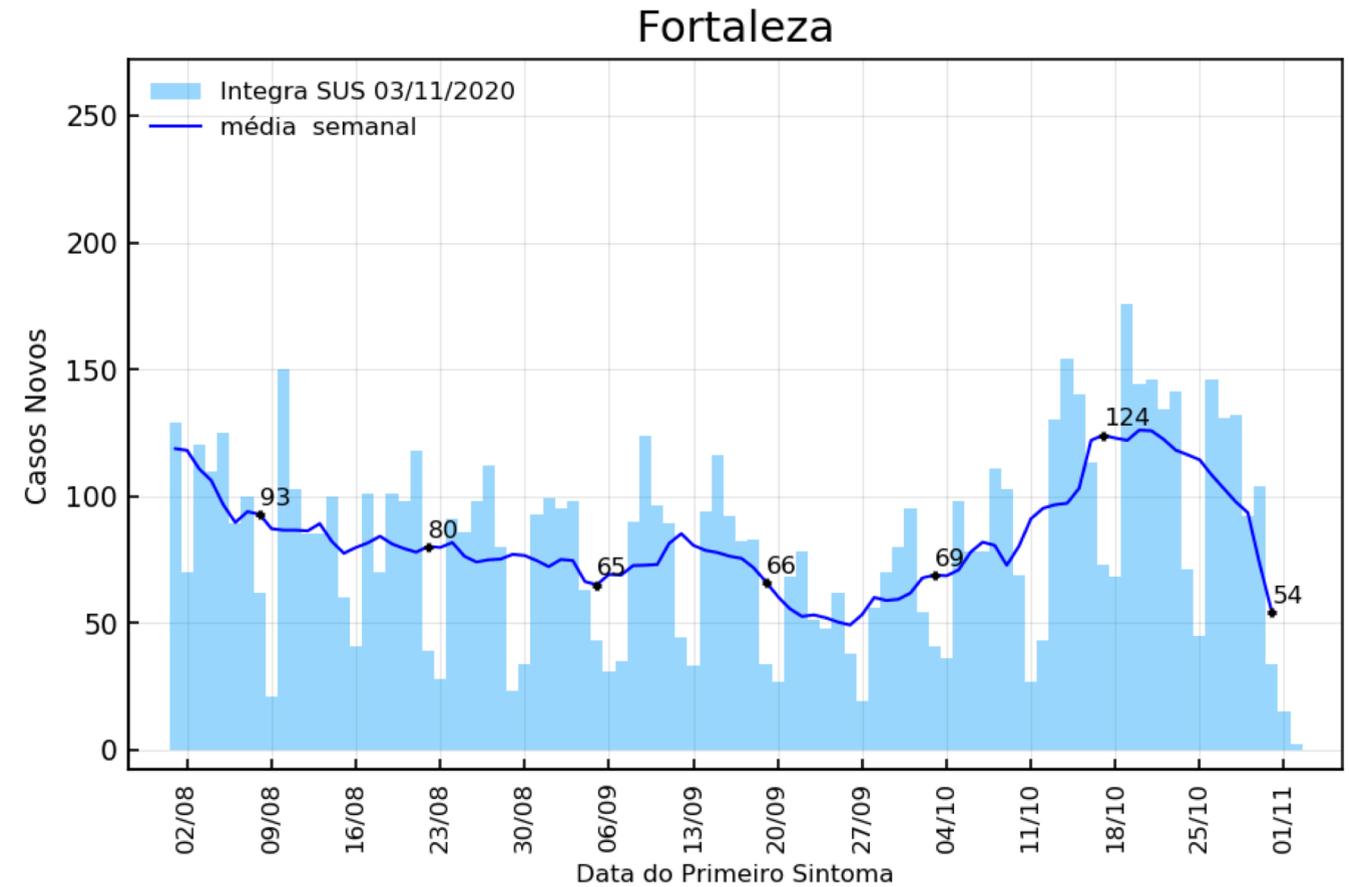
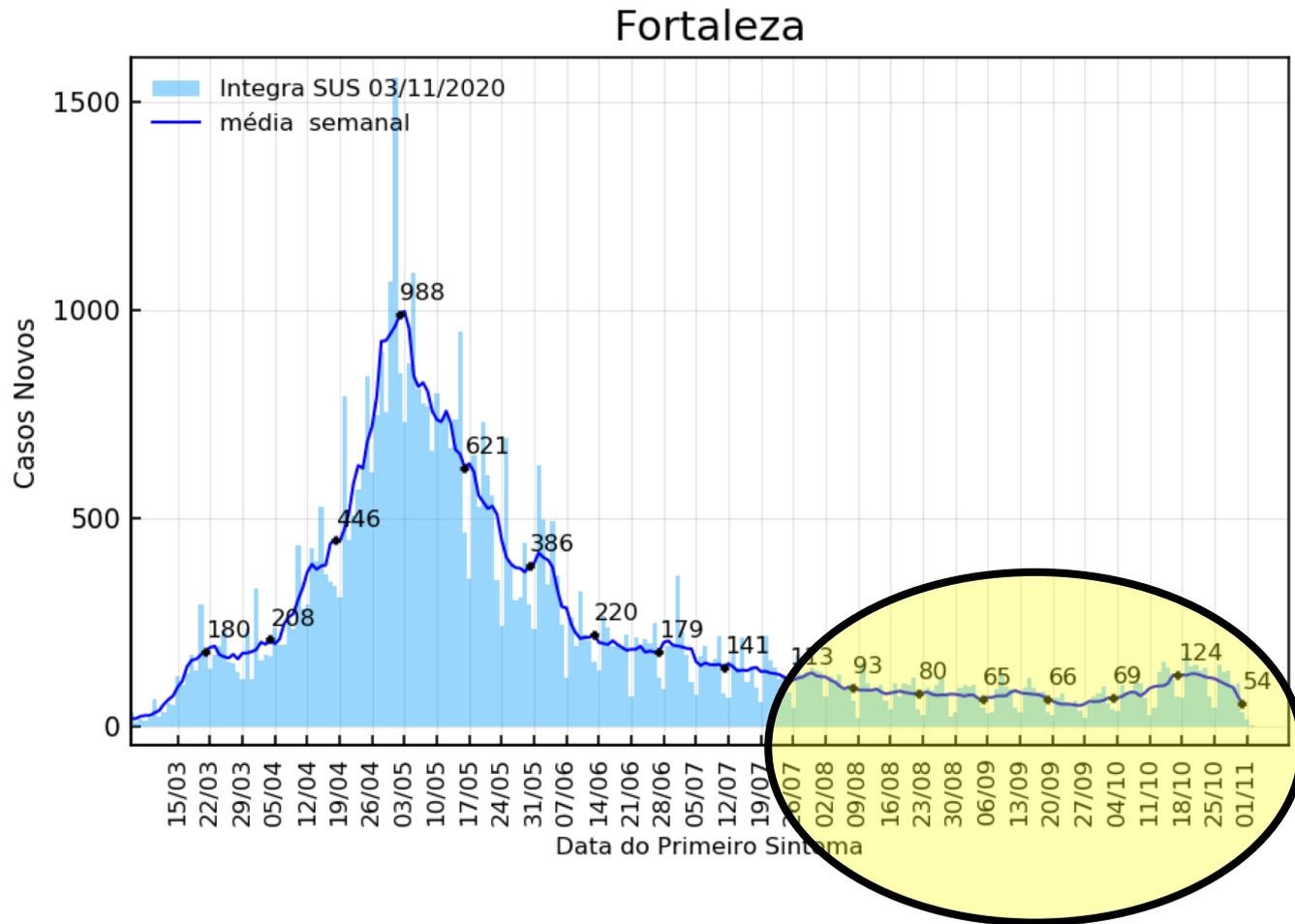
Saulo Reis (UFC-Física)



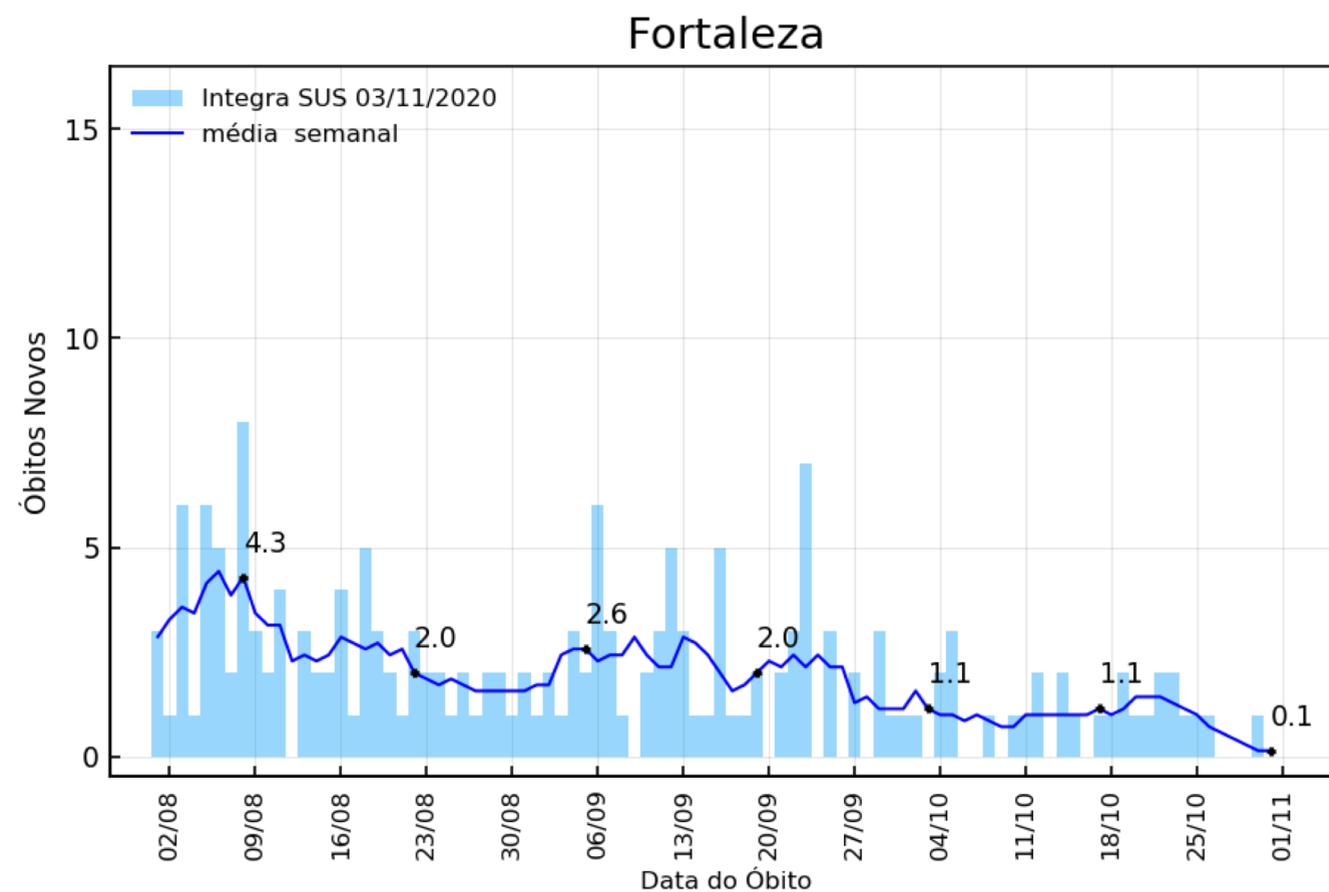
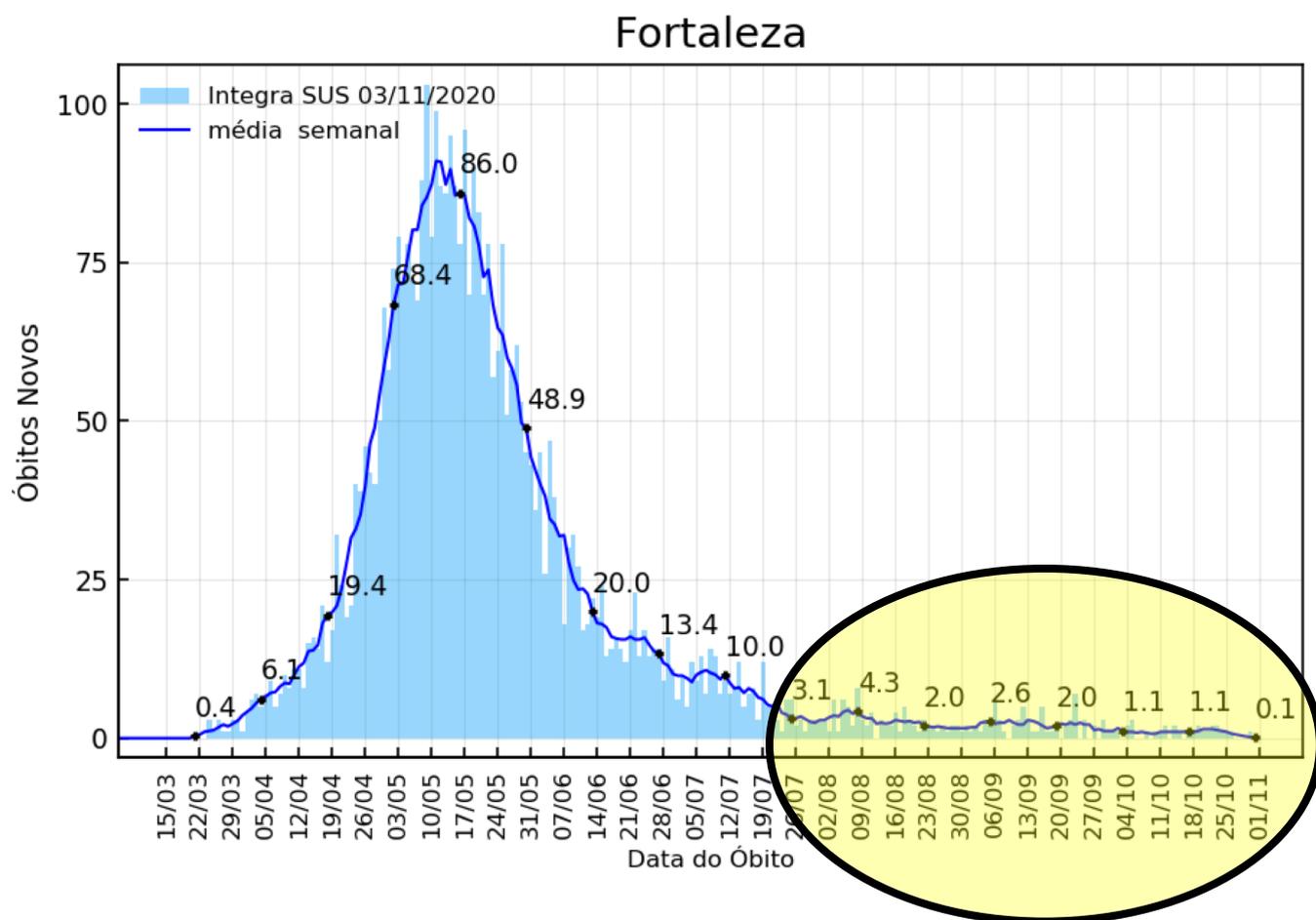
C A P E S

Fortaleza (capital)

Dados atualizados em 03/11/2020

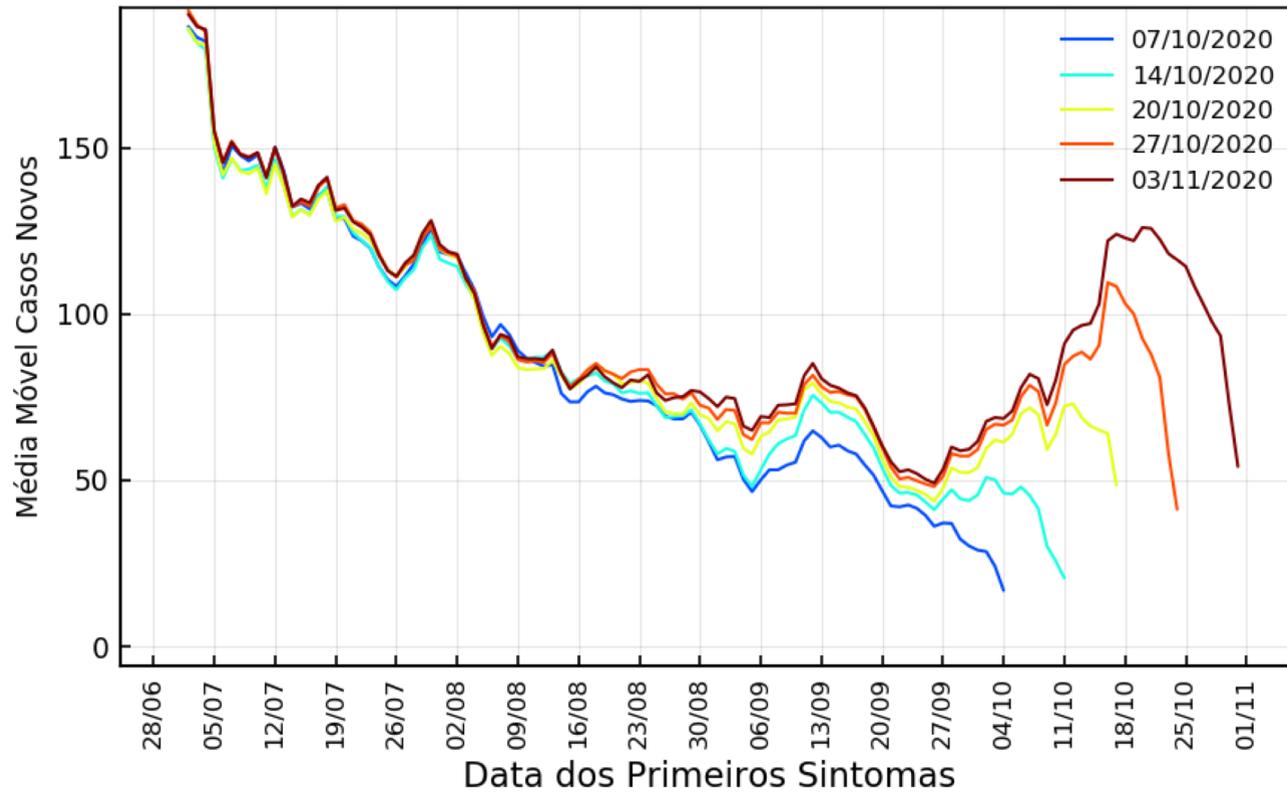


Dados atualizados em 03/11/2020

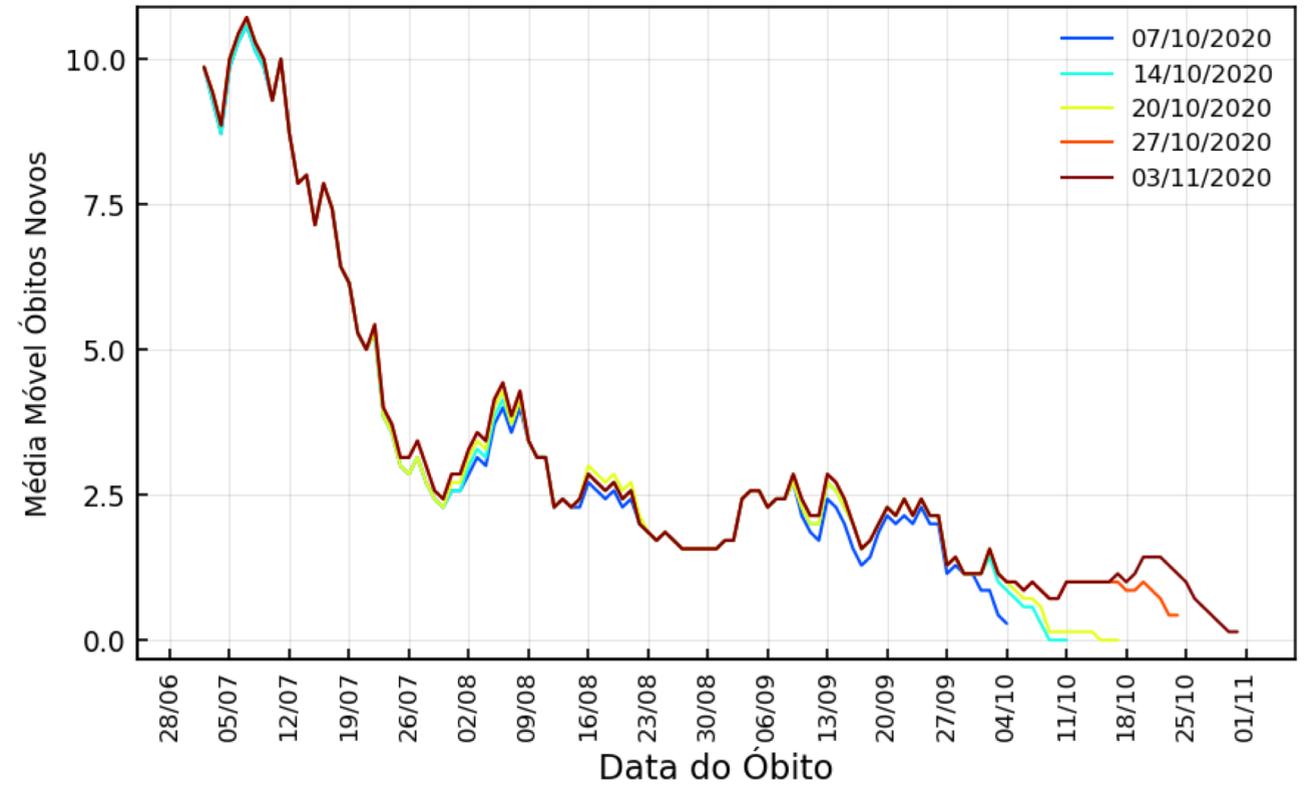


Evolução dos Dados INTEGRASUS Casos & Óbitos

Fortaleza

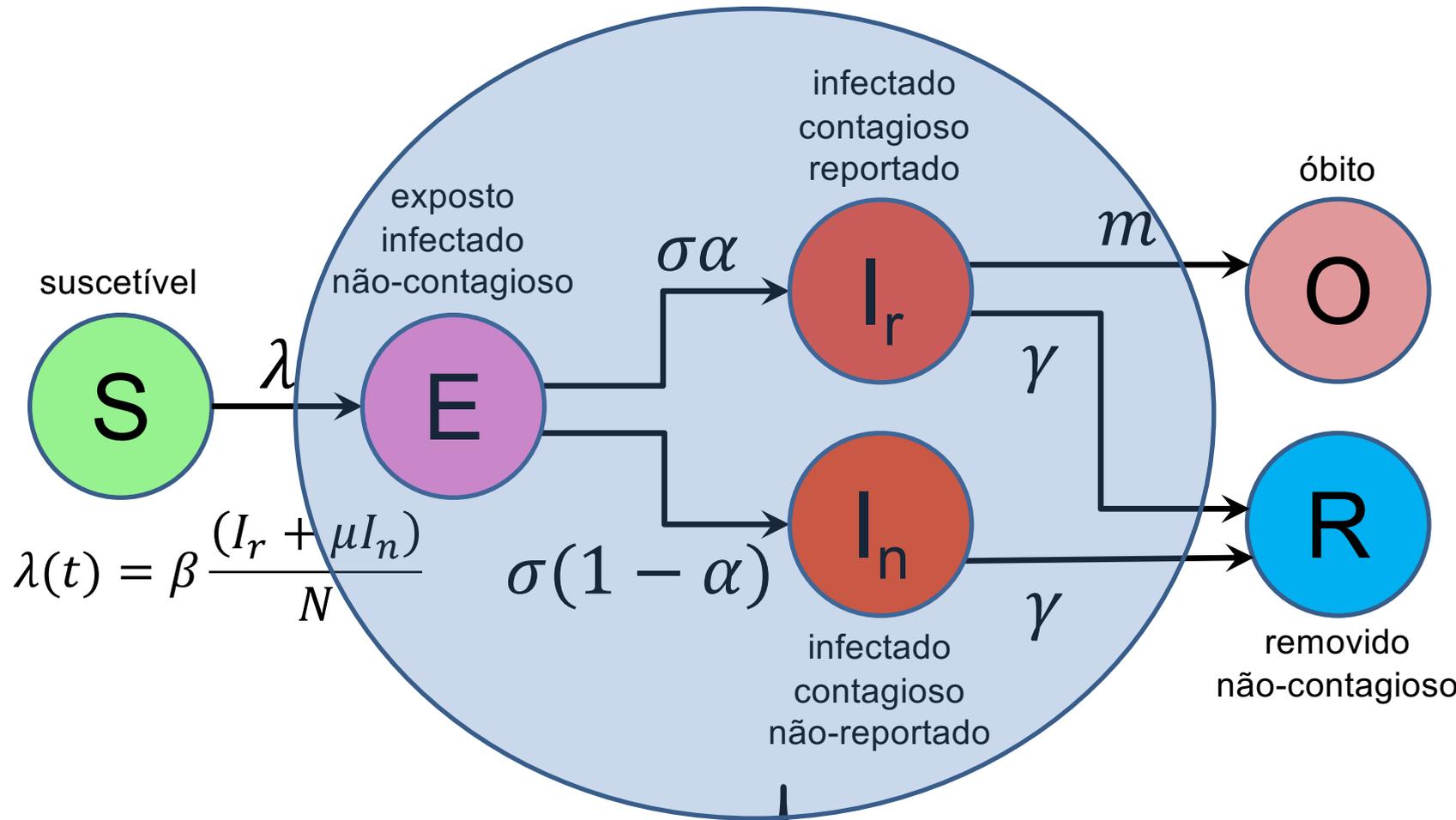


Fortaleza



Projeto Cientista Chefe de Dados – COVID19 no Ceará

Modelo SEIR [Li et al., Science 368, 489-493 (2020)]



$$\frac{dS}{dt} = -\beta \frac{(I_r + \mu I_n)S}{N}$$

$$\frac{dE}{dt} = \beta \frac{(I_r + \mu I_n)S}{N} - \sigma E$$

$$\frac{dI_r}{dt} = \alpha \sigma S - \gamma I_r - m I_r$$

$$\frac{dI_n}{dt} = (1 - \alpha) \sigma S - \gamma I_n$$

$$\frac{dR}{dt} = \gamma I_r + \gamma I_n$$

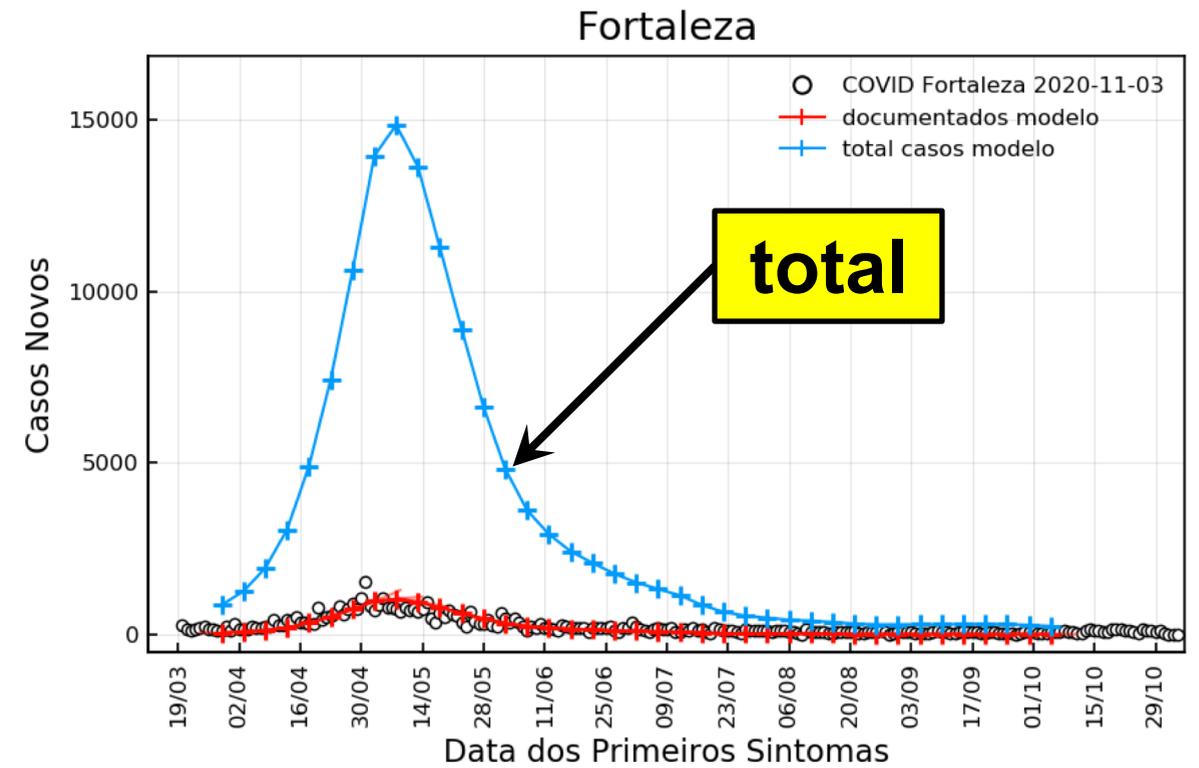
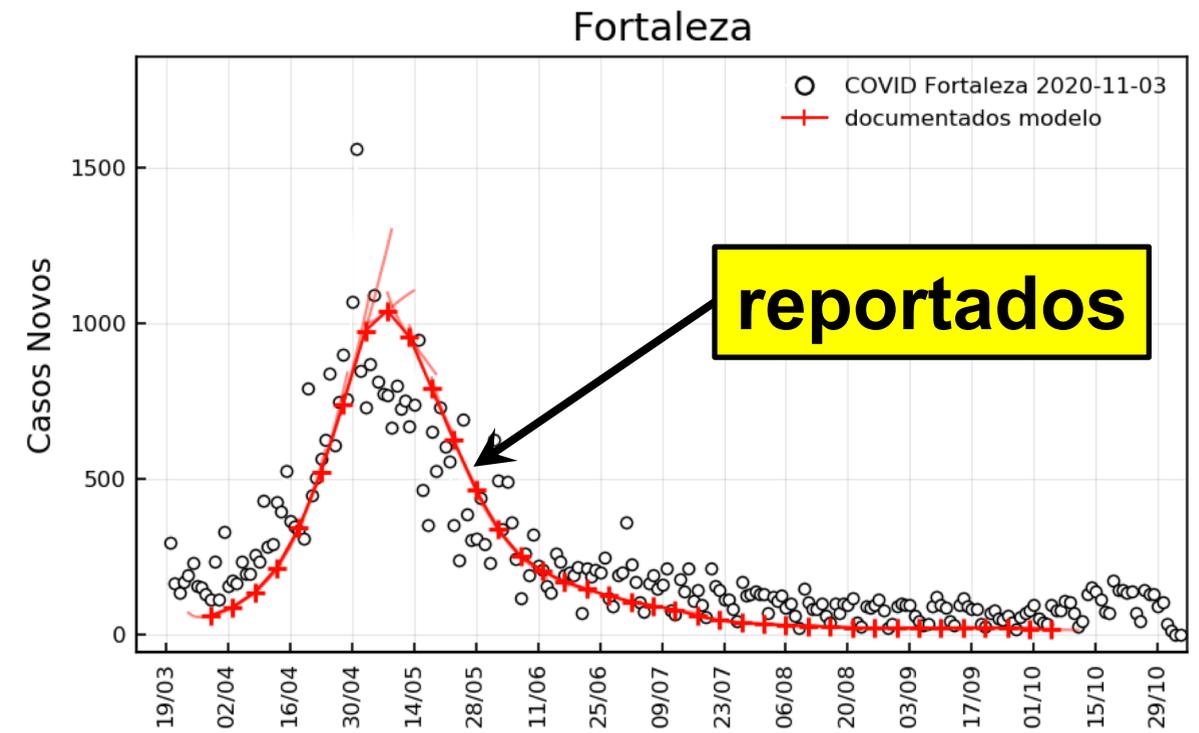
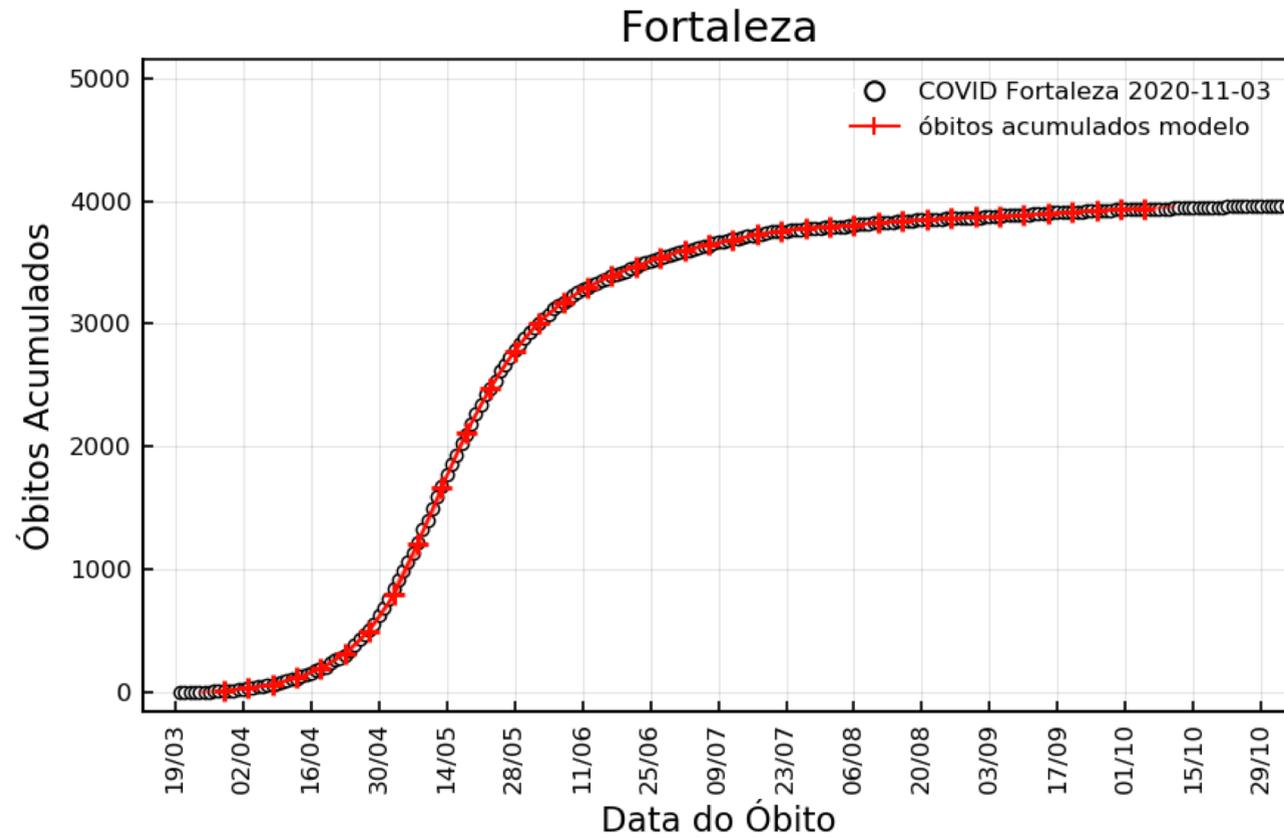
$$\frac{dO}{dt} = m I_r$$

$$\mathbf{V} = [S, E, I_r, I_n, R, O] \quad \mathbf{P} = [\beta, \mu, \alpha, \sigma, \gamma, m]$$

espaço de estados

espaço de parâmetros

Inferência Casos & Óbitos

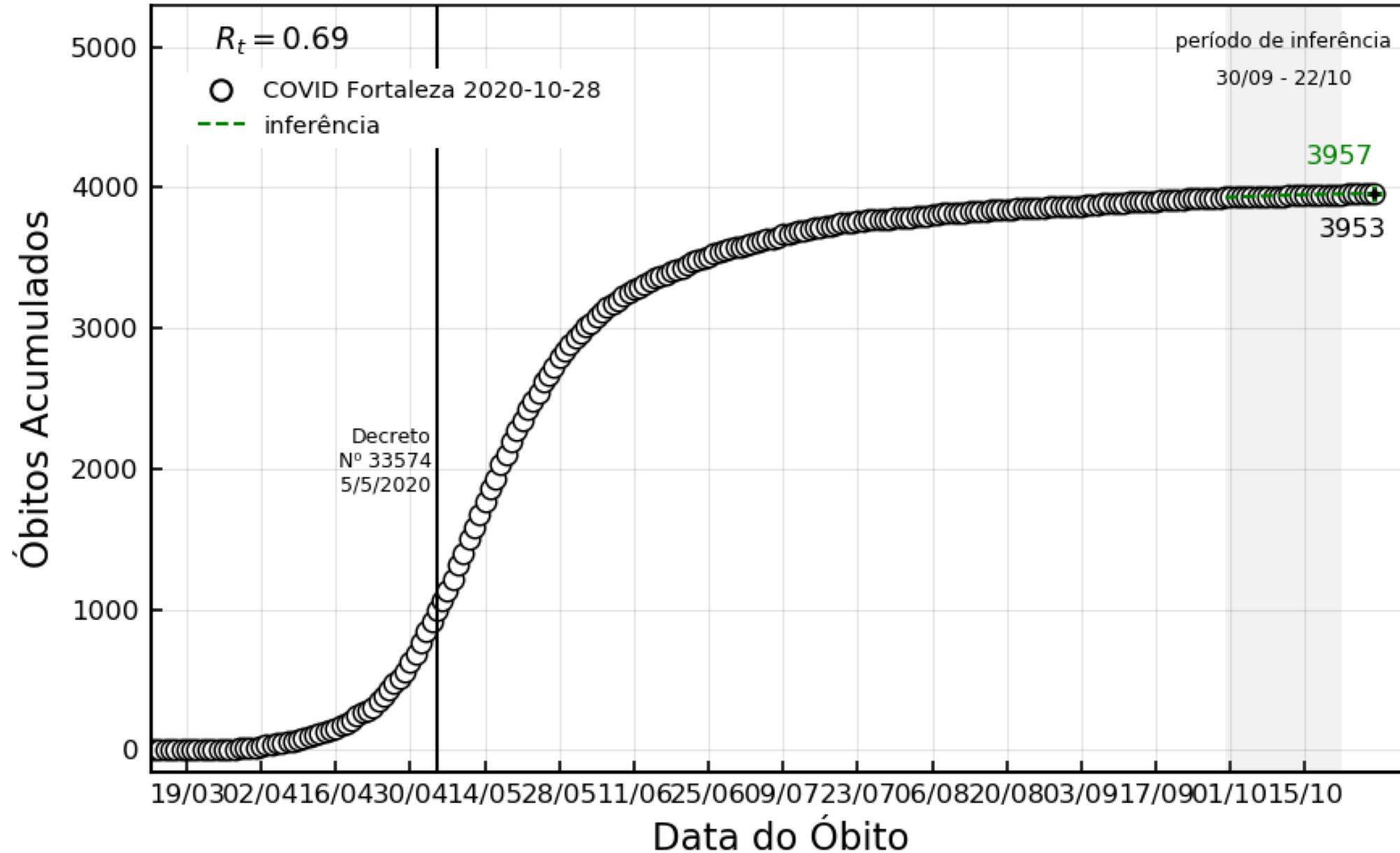


Limitações para inferência com Casos:

- ✓ Curva de evolução instável (atualização retroativa);
- ✓ Testagem insuficiente para o total de infectados;
- ✓ Data dos primeiros sintomas imprecisa;
- ✓ Distinção entre reportados (I_r) e não-reportados (I_n).

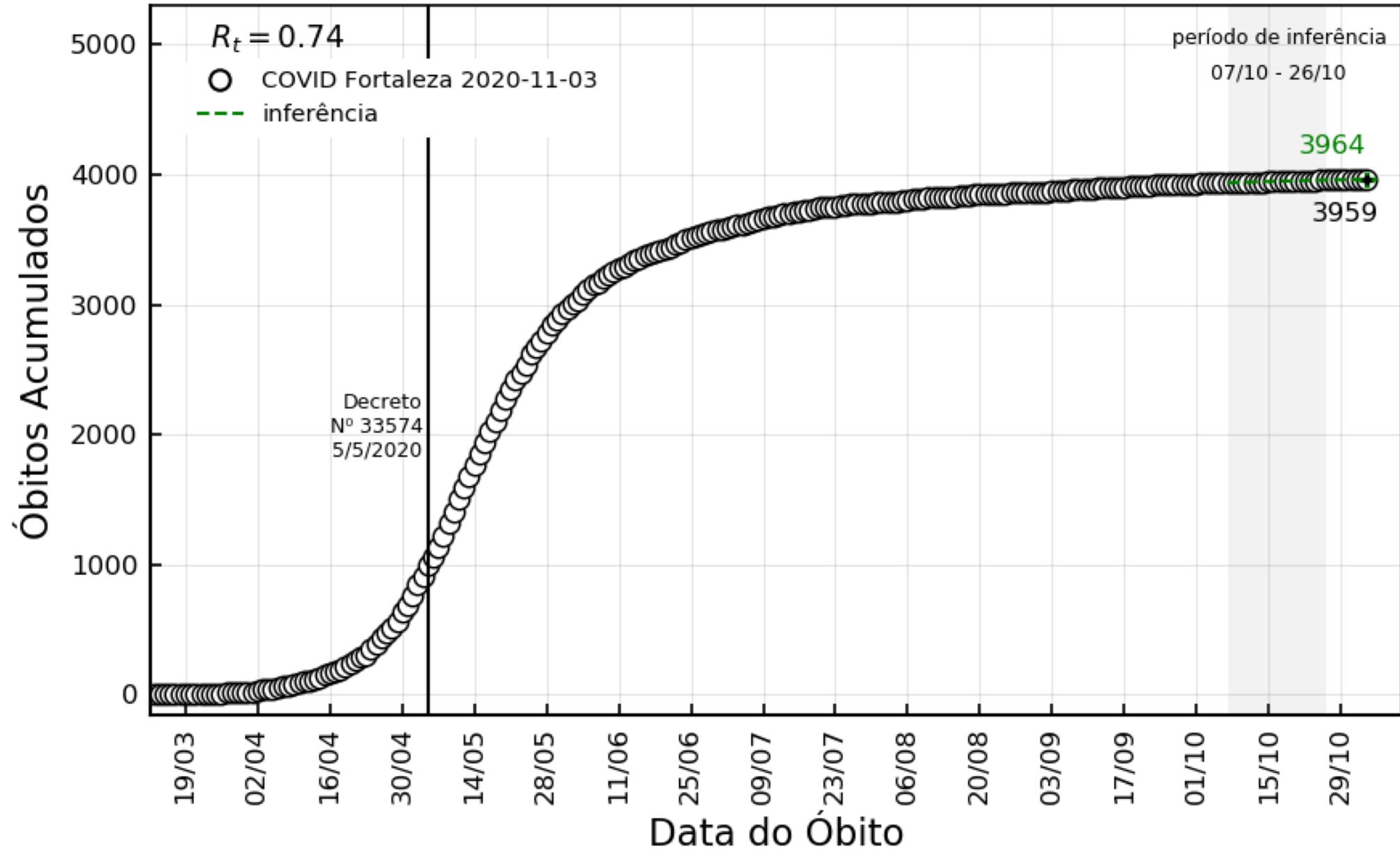
Inferência 28/10/2020

Fortaleza

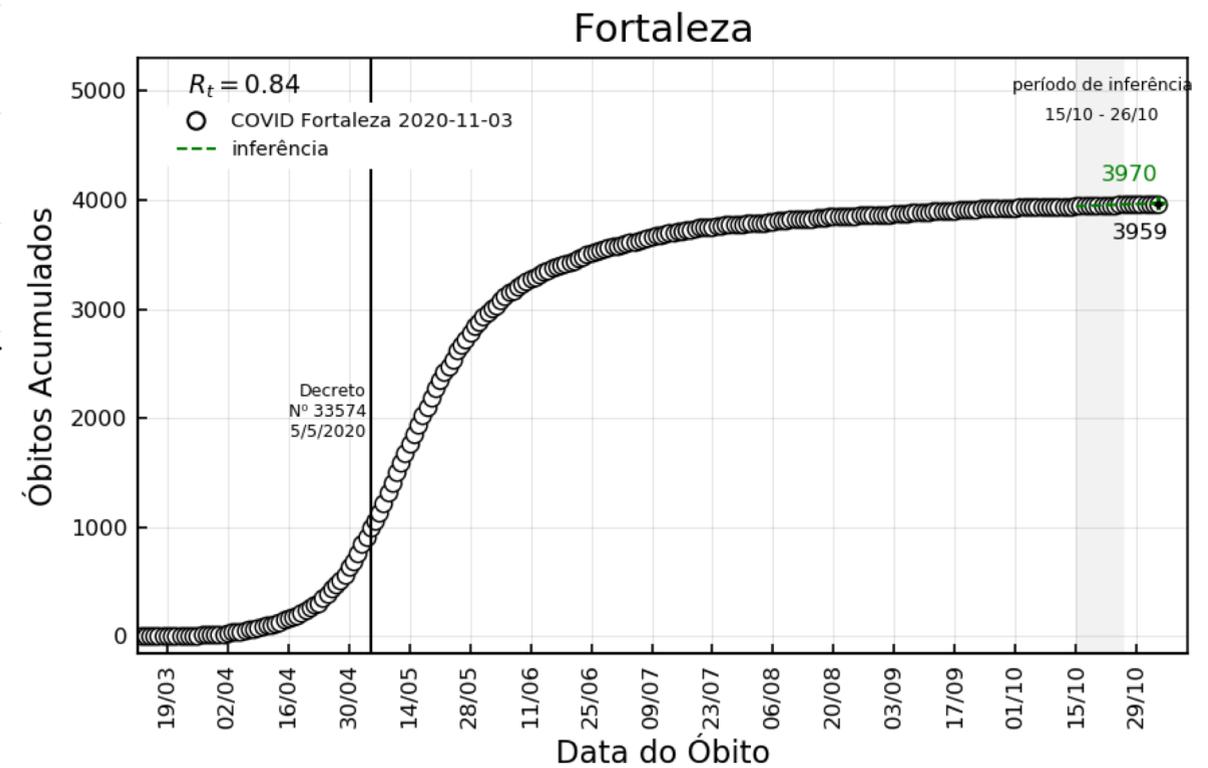
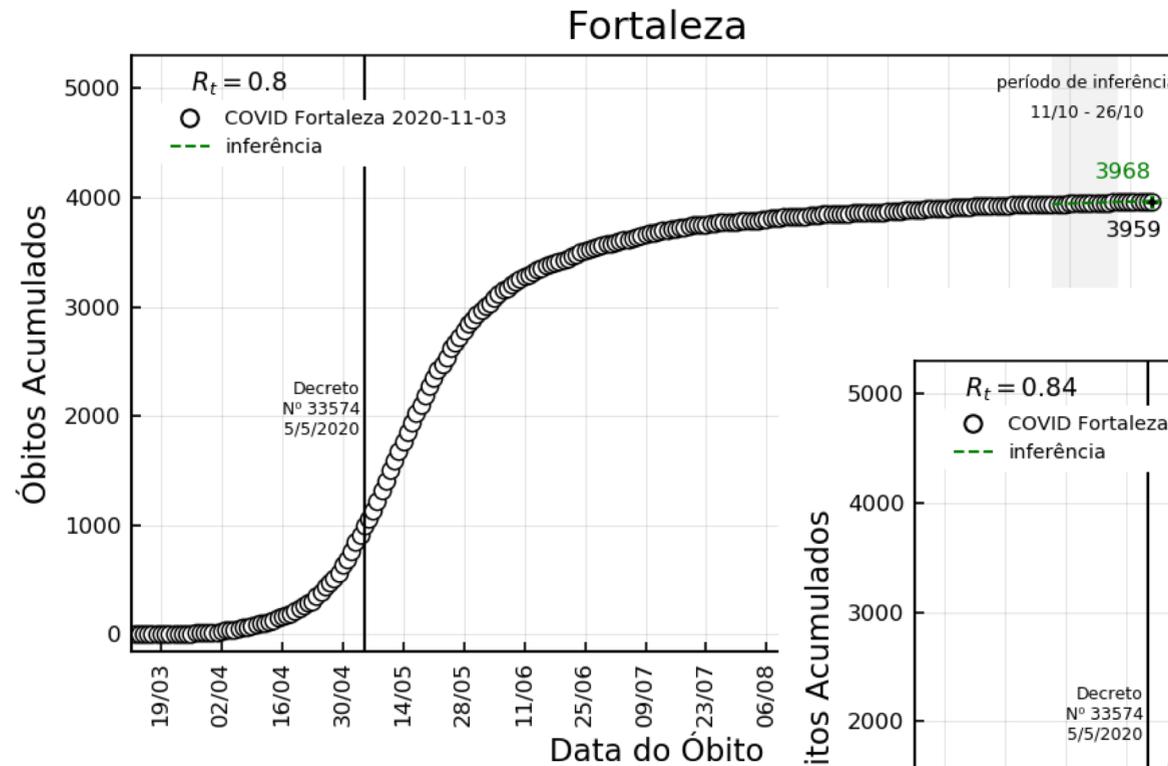
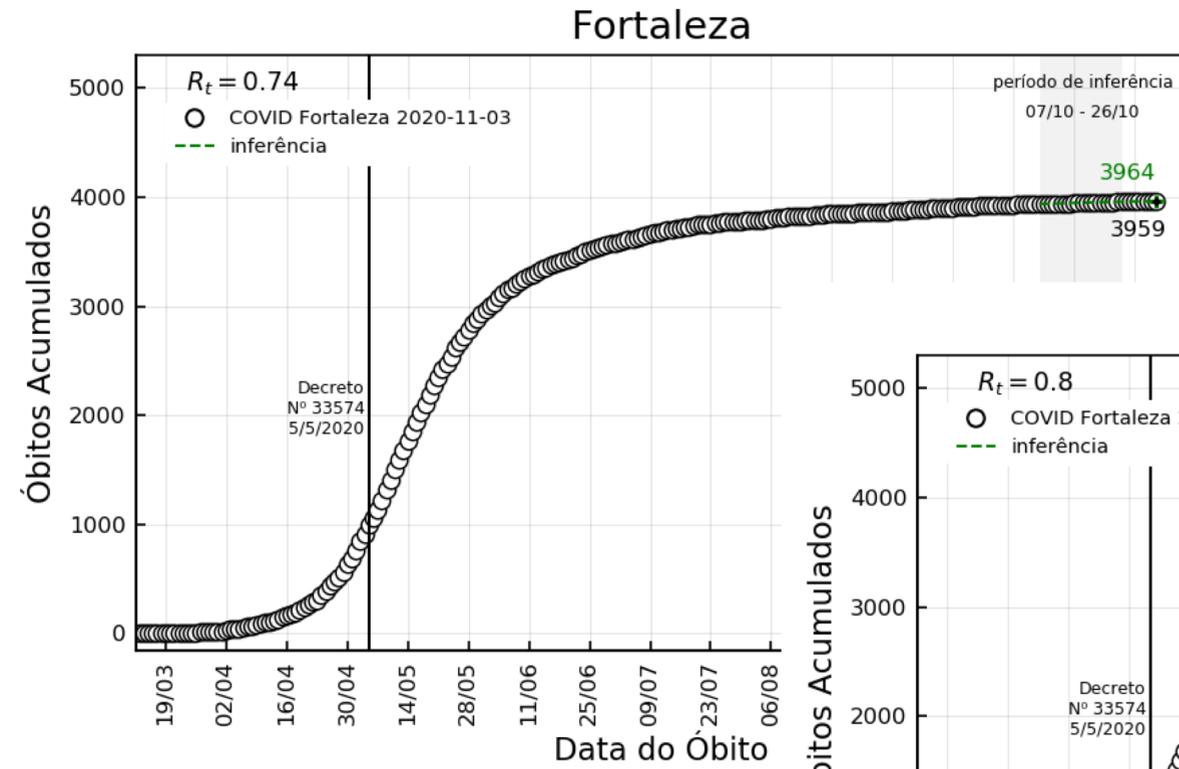


Inferência 03/11/2020

Fortaleza



Janela de Inferência & R_t



**Optamos por fazer monitoramento.
Não são projeções.**

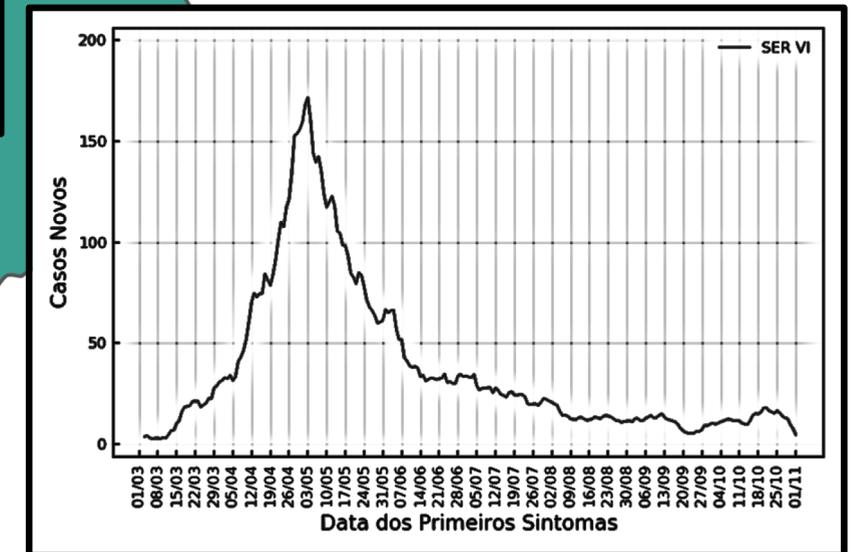
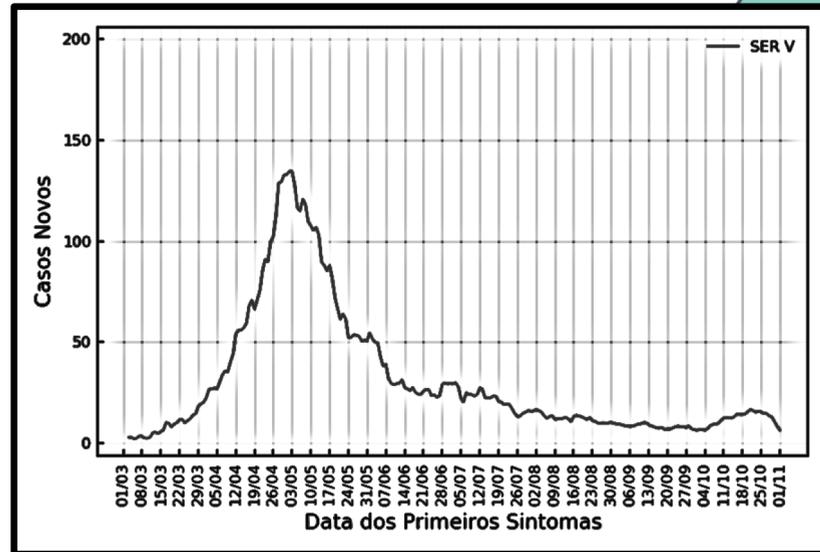
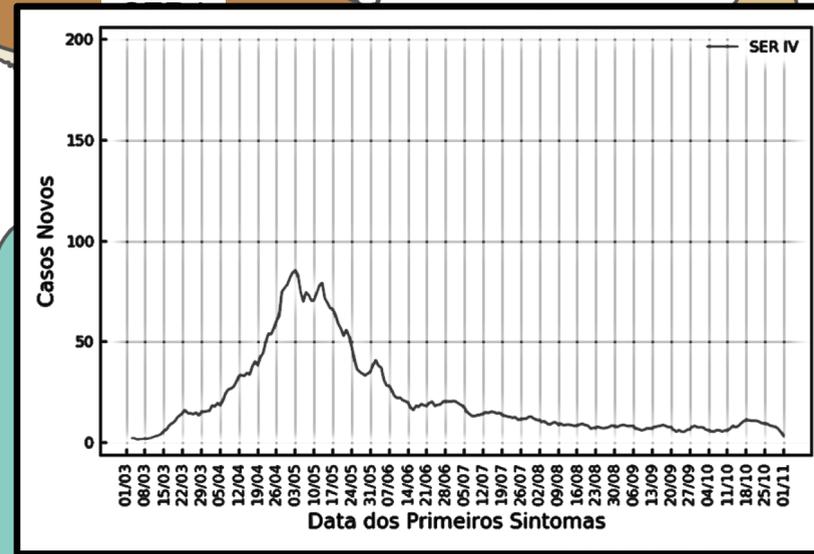
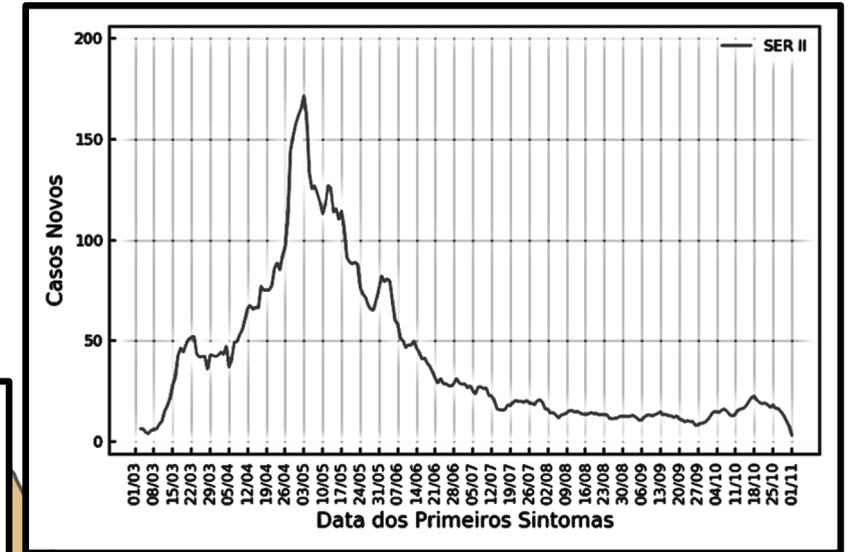
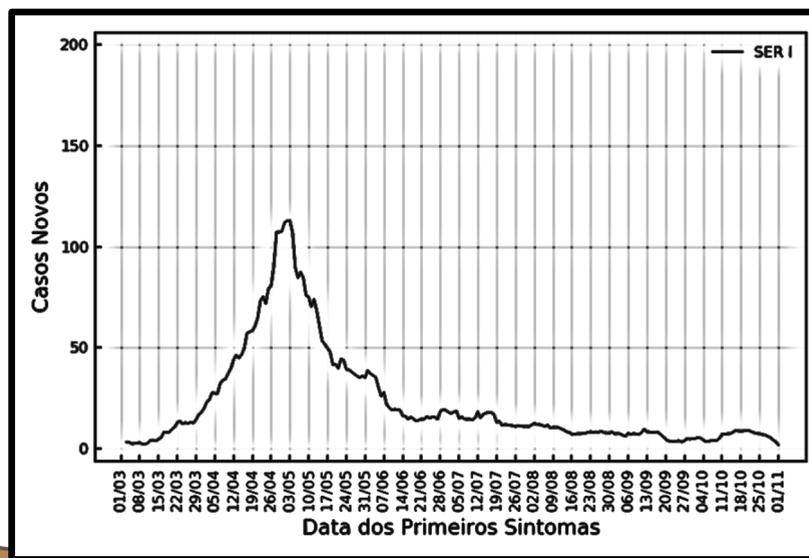
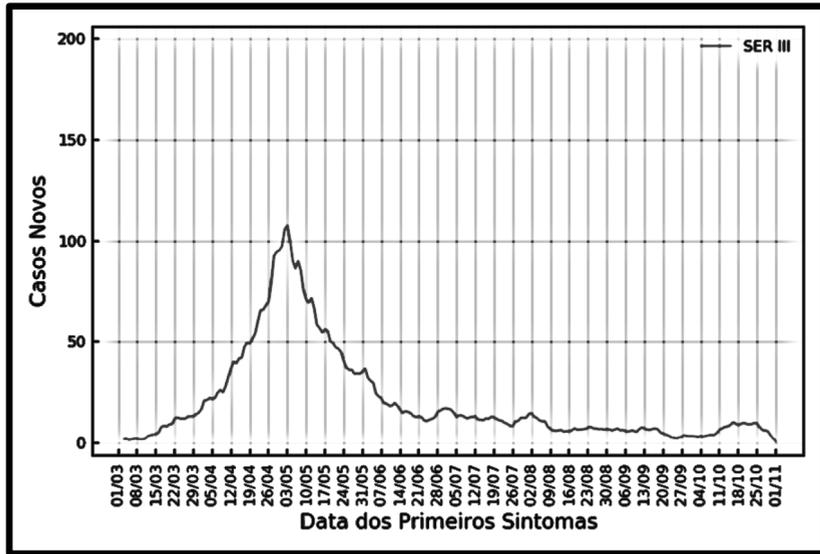
Fortaleza & Regiões

REGIONAL	POPULAÇÃO
SER I	396135
SER II	395593
SER III	379246
SER IV	310568
SER V	553642
SER VI	573205

População de Fortaleza = 2.608.389 habitantes

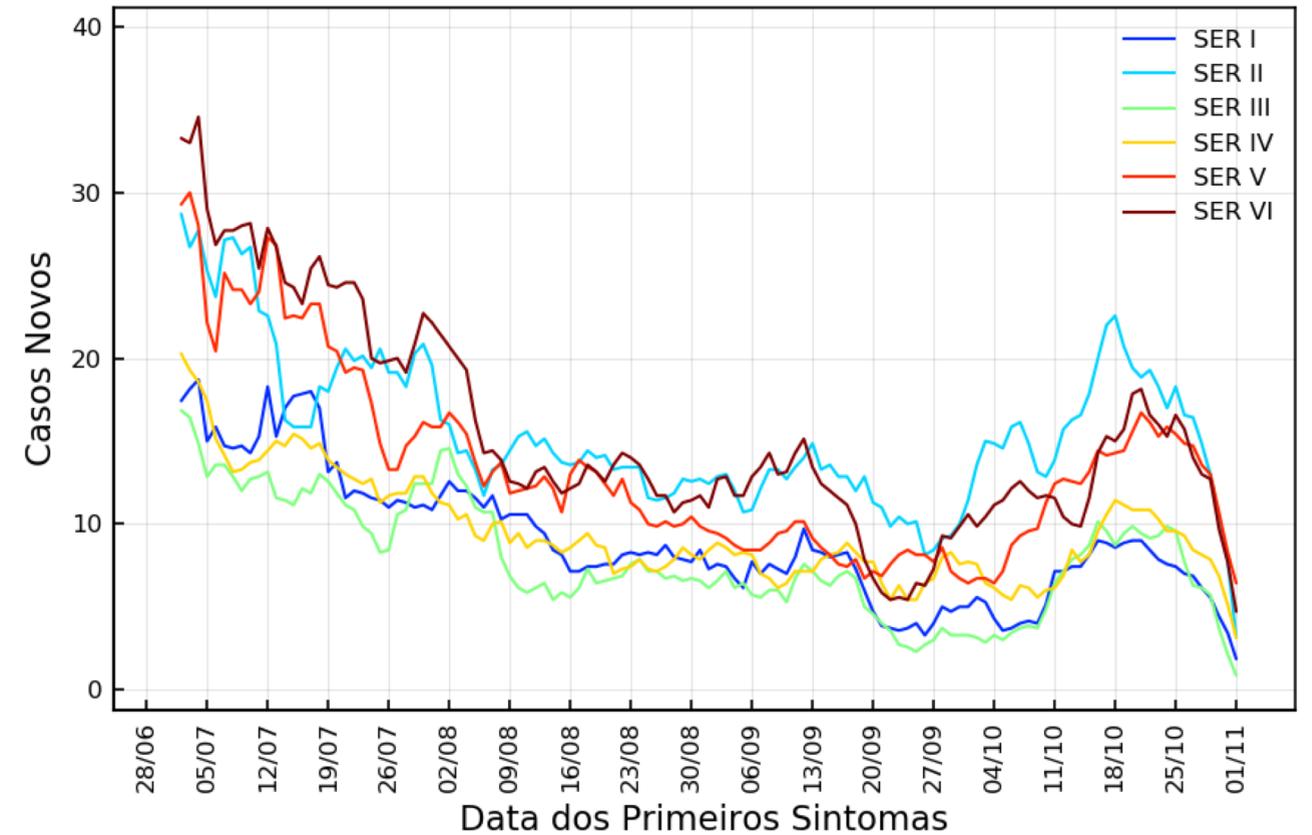
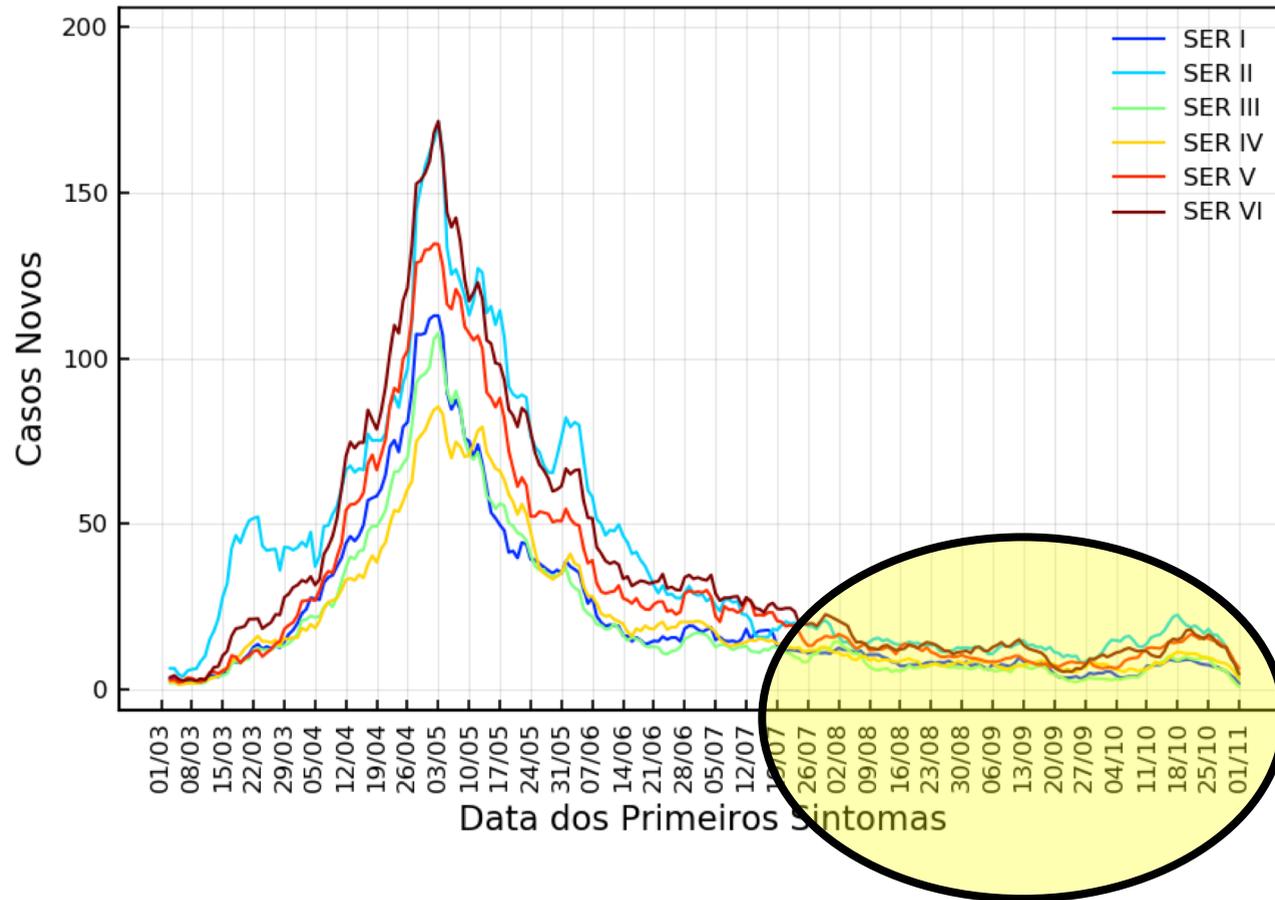
Evolução da Epidemia em Fortaleza por Regionais

Casos & Data Primeiros Sintomas



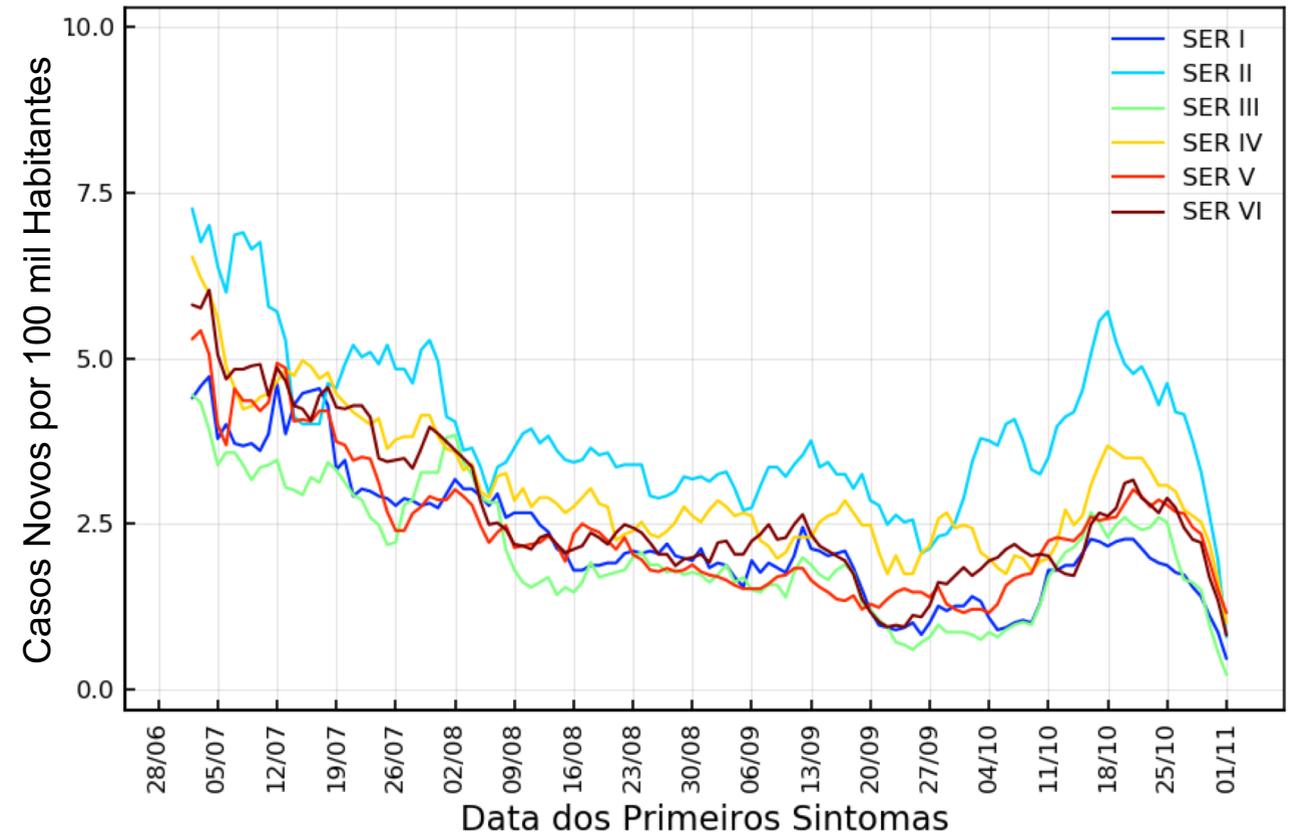
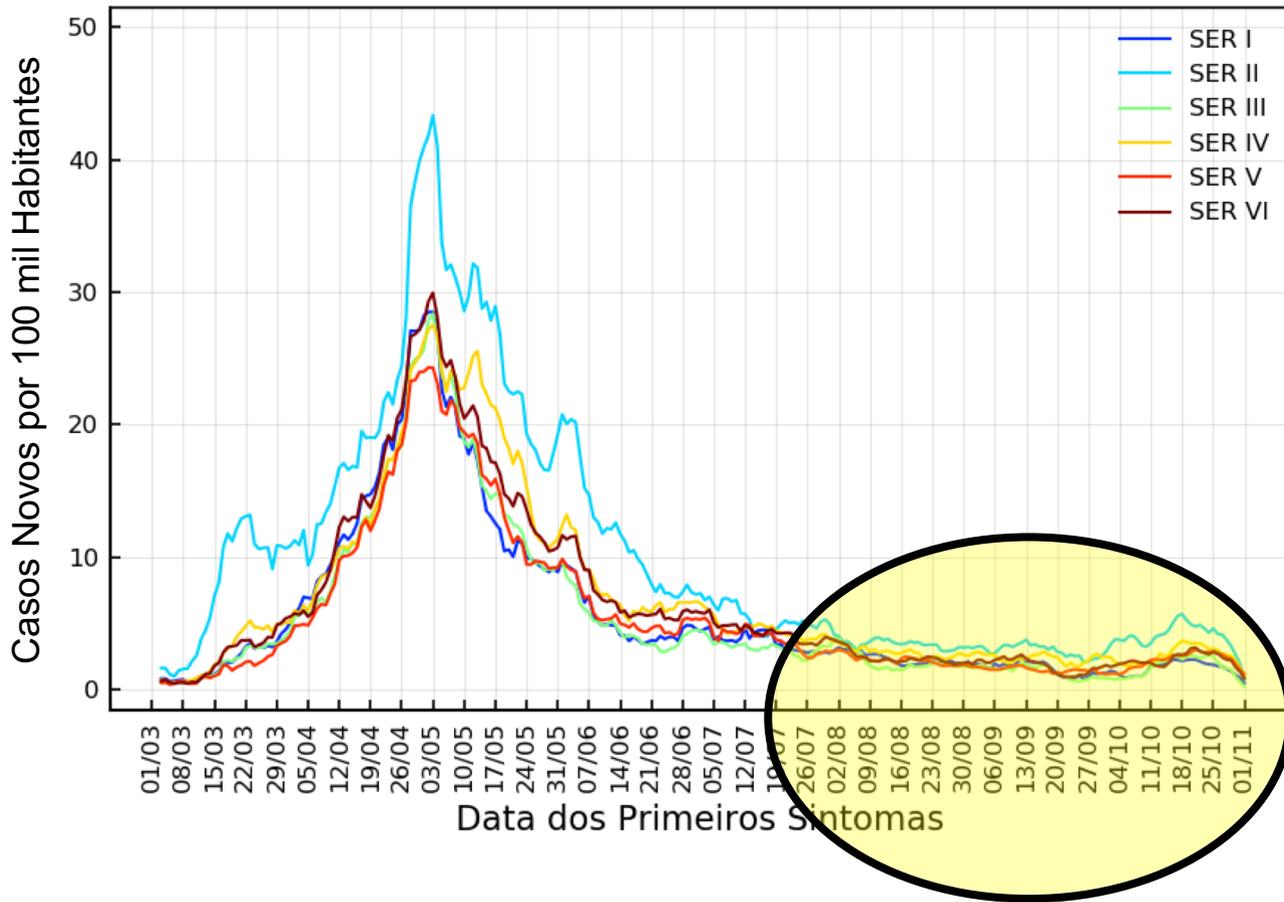
Evolução da Epidemia em Fortaleza por Regionais

Casos Novos & Data dos Primeiros Sintomas



Evolução da Epidemia em Fortaleza por Regionais

Casos Novos por 100 mil habitantes & Data dos Primeiros Sintomas



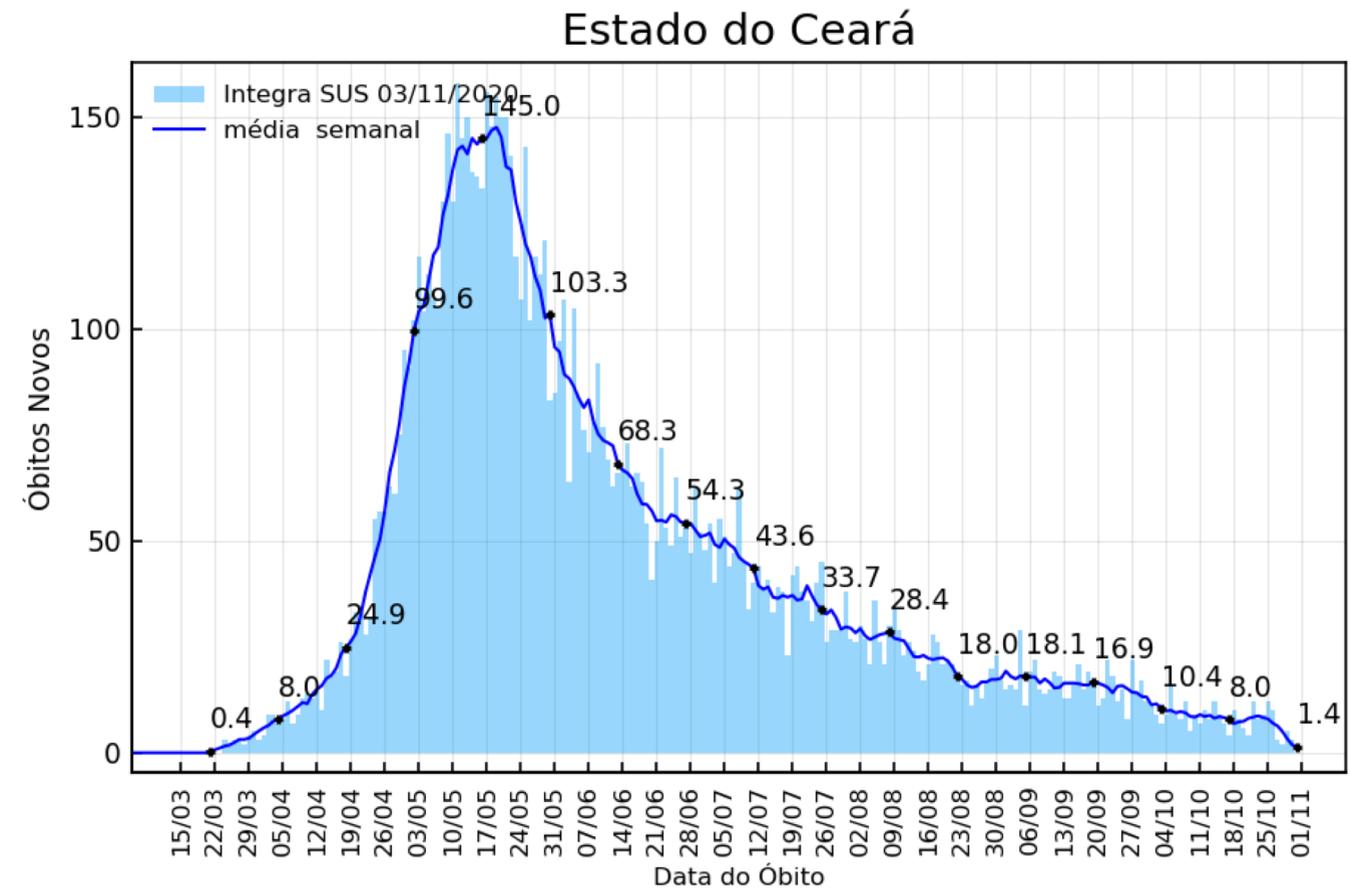
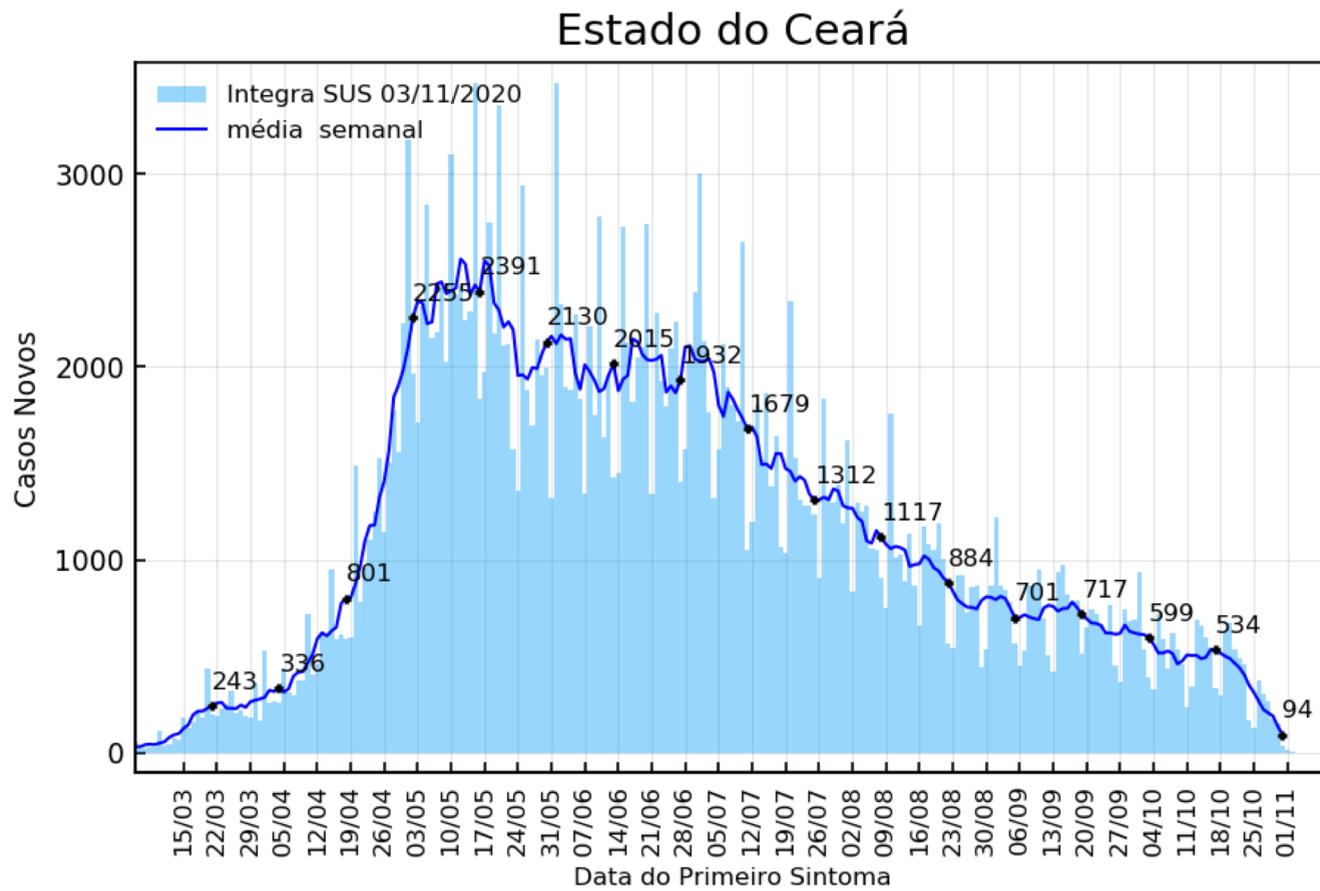
Ceará & Regiões

REGIÃO	POPULAÇÃO (IBGE 2020)
Fortaleza	4.817.822
Sobral	1.643.656
Cariri	1.523.245
Sertão Central	652.591
Litoral Leste/Jaguaribe	549.789

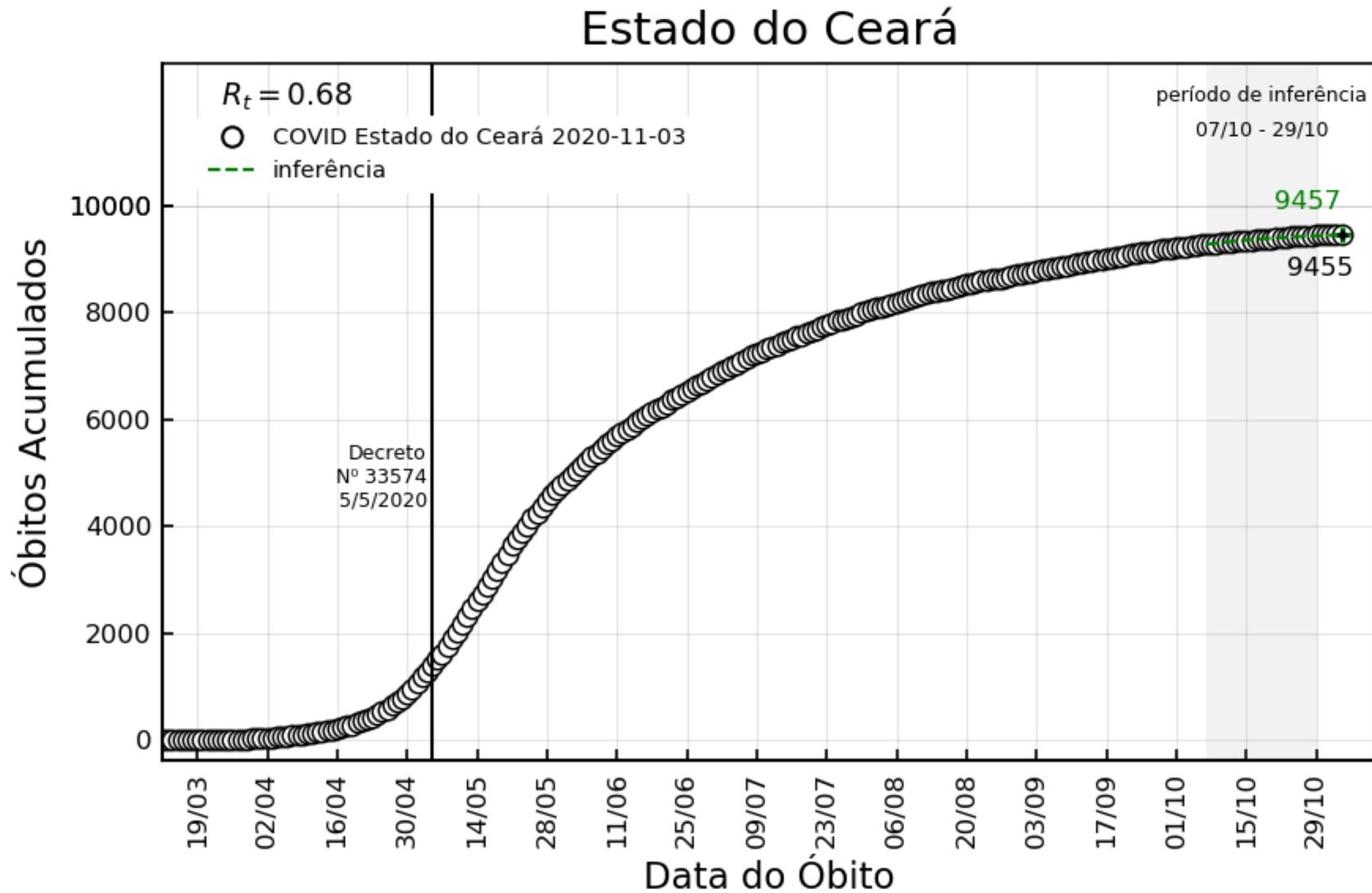
População do Ceará = 9.187.103 habitantes

Estado do Ceará

Dados atualizados em 03/11/2020



Dados atualizados em 03/11/2020

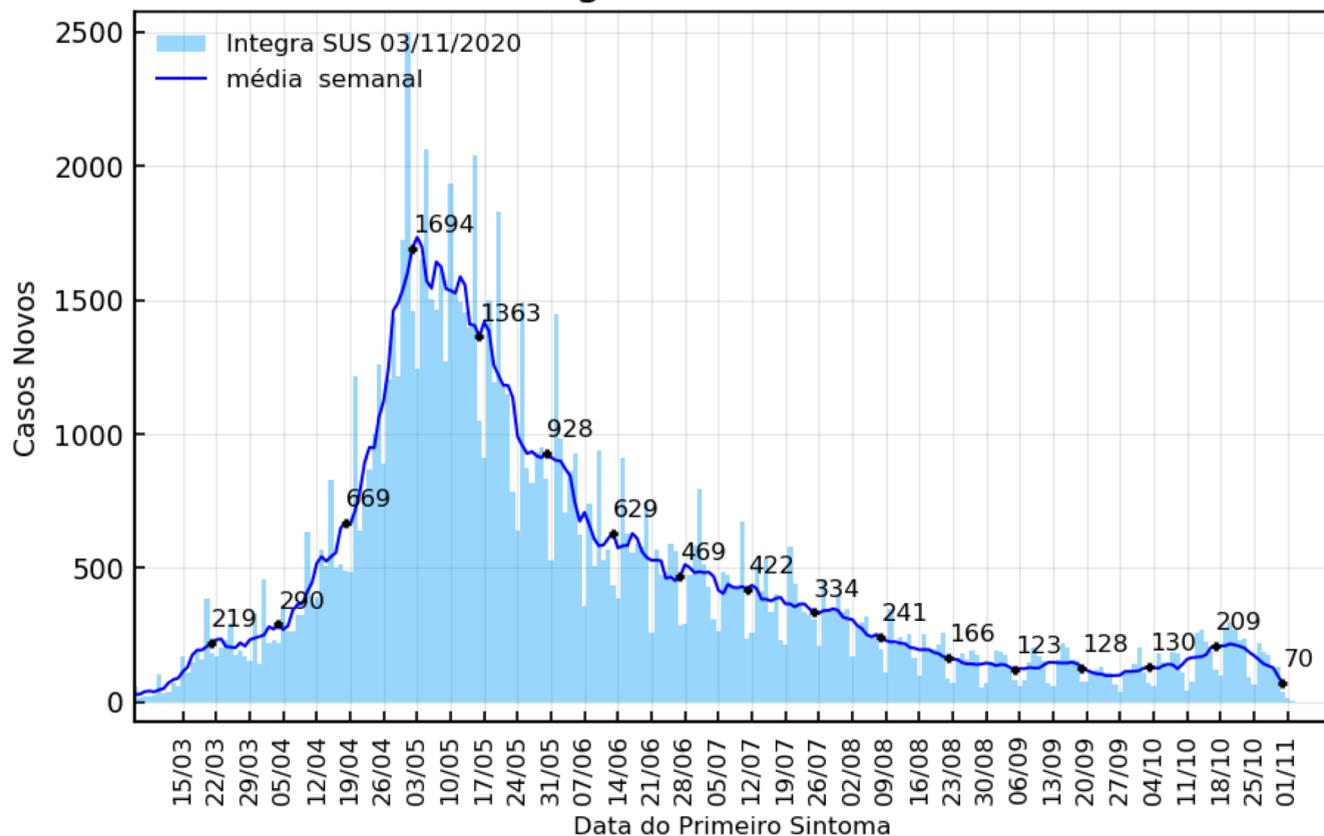


Janela de Inferência	R_t
05/08 – 04/09	0.76
12/08 – 11/09	0.77
19/08 – 18/09	0.79
26/08 – 25/09	0.82
09/09 – 01/10	0.77
16/09 – 08/10	0.63
23/09 – 15/10	0.67
30/09 – 22/10	0.69
07/10 – 29/10	0.68

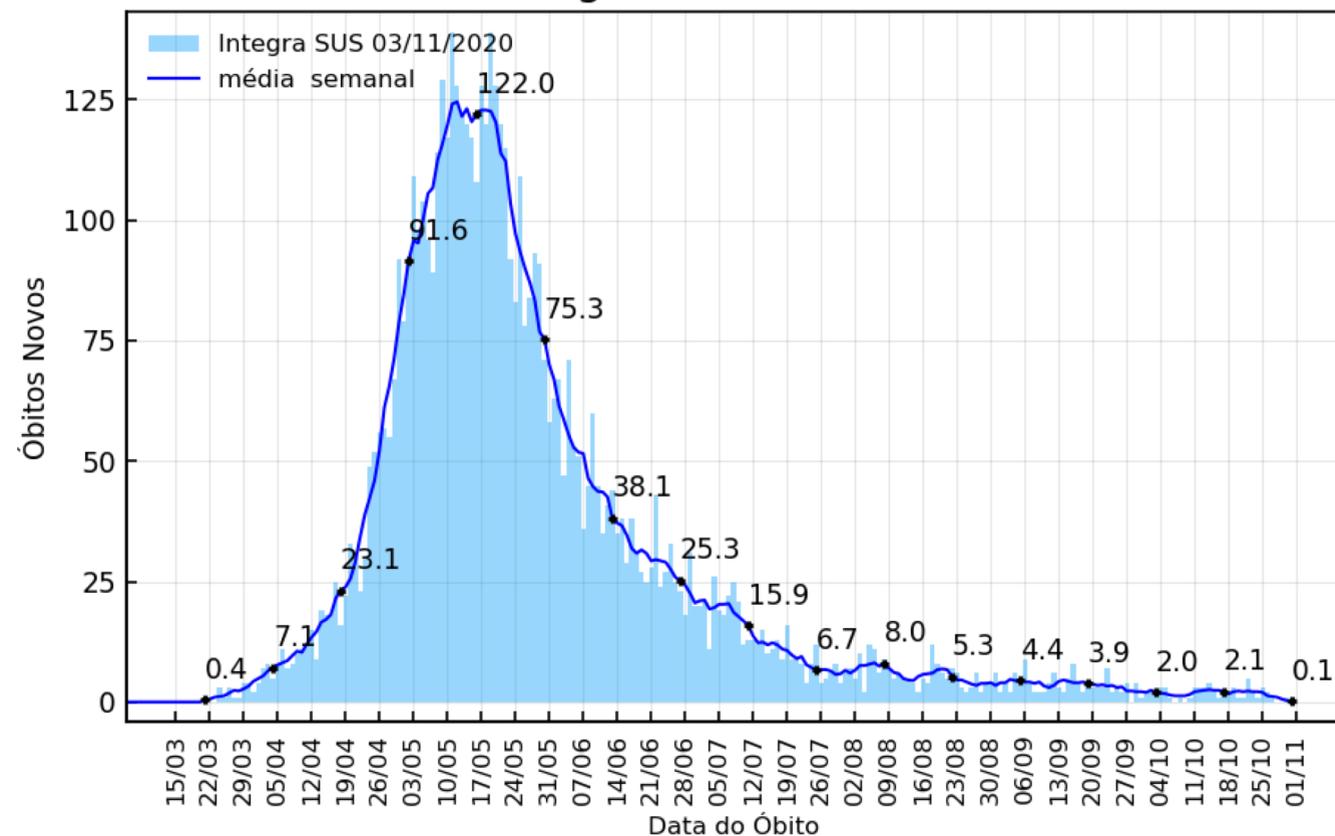
Região Fortaleza

Dados atualizados em 03/11/2020

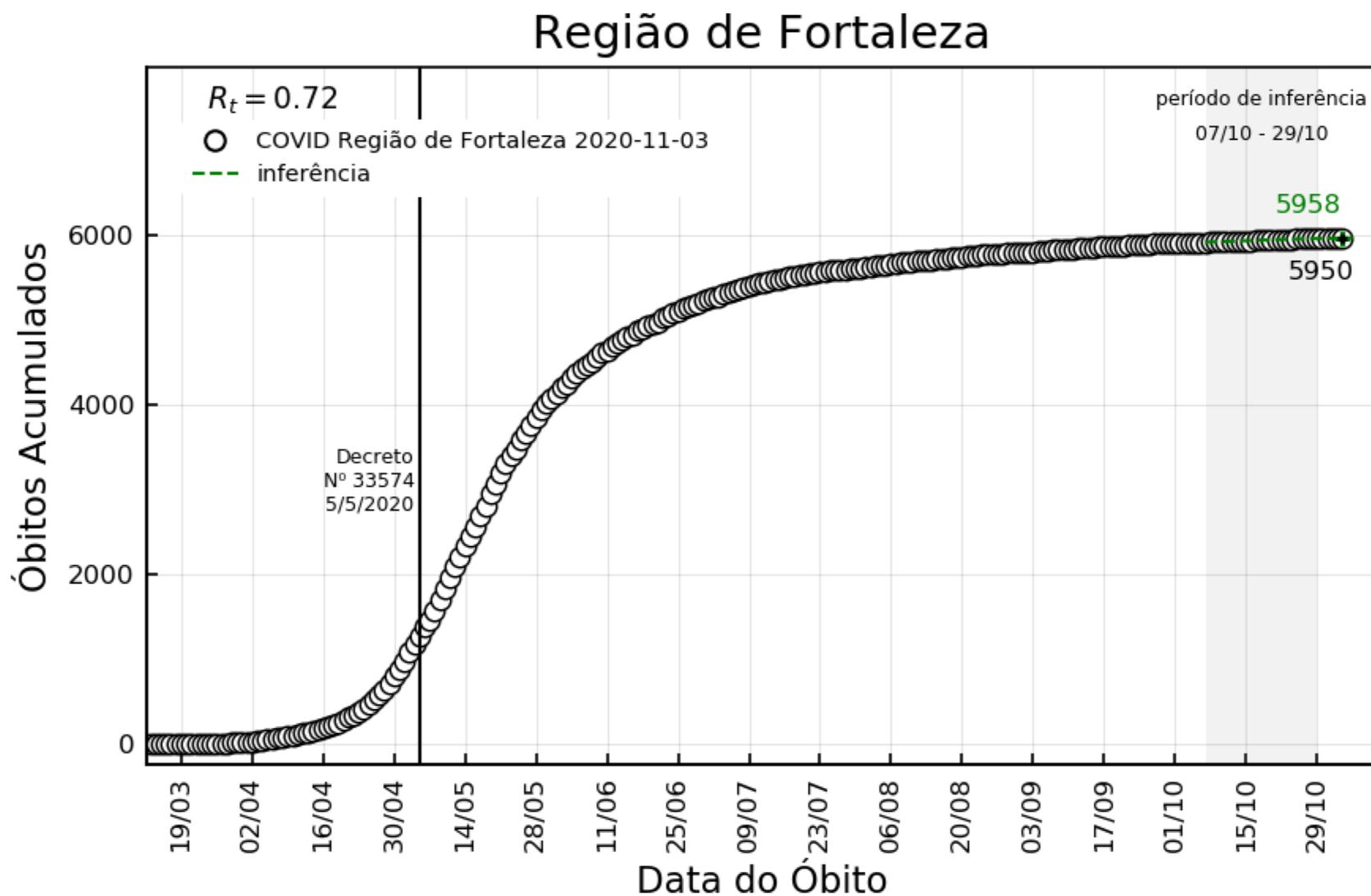
Região de Fortaleza



Região de Fortaleza



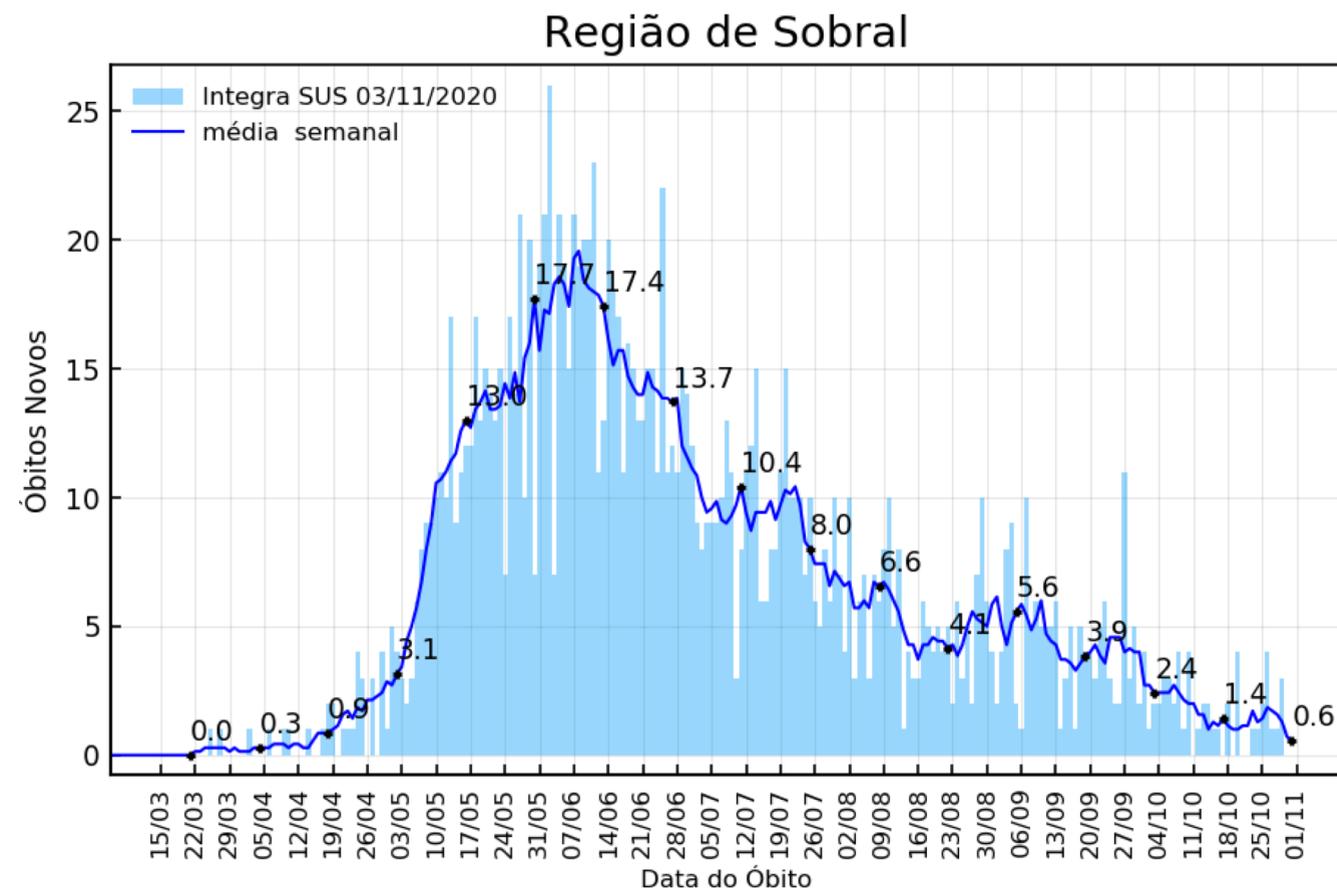
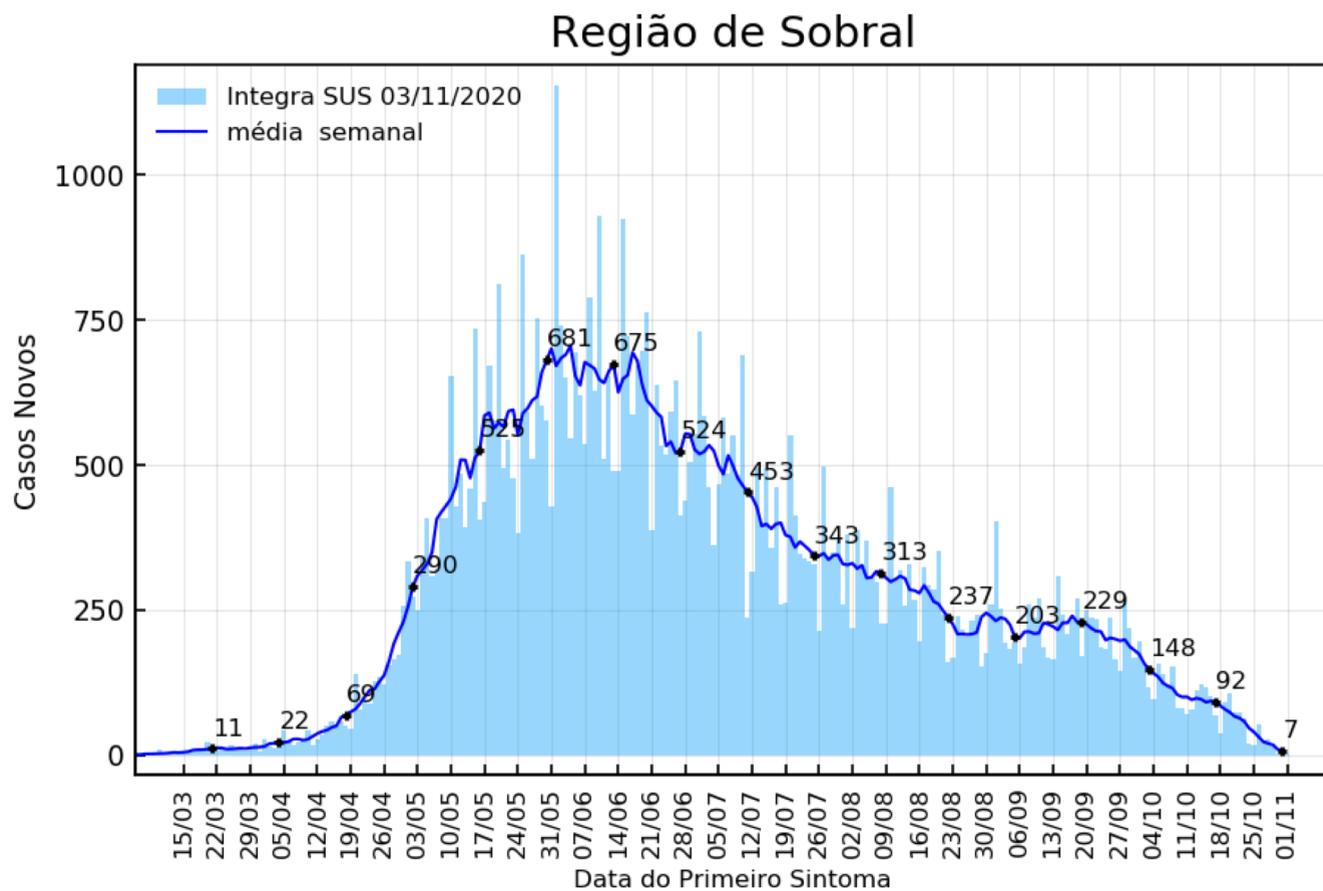
Dados atualizados em 03/11/2020



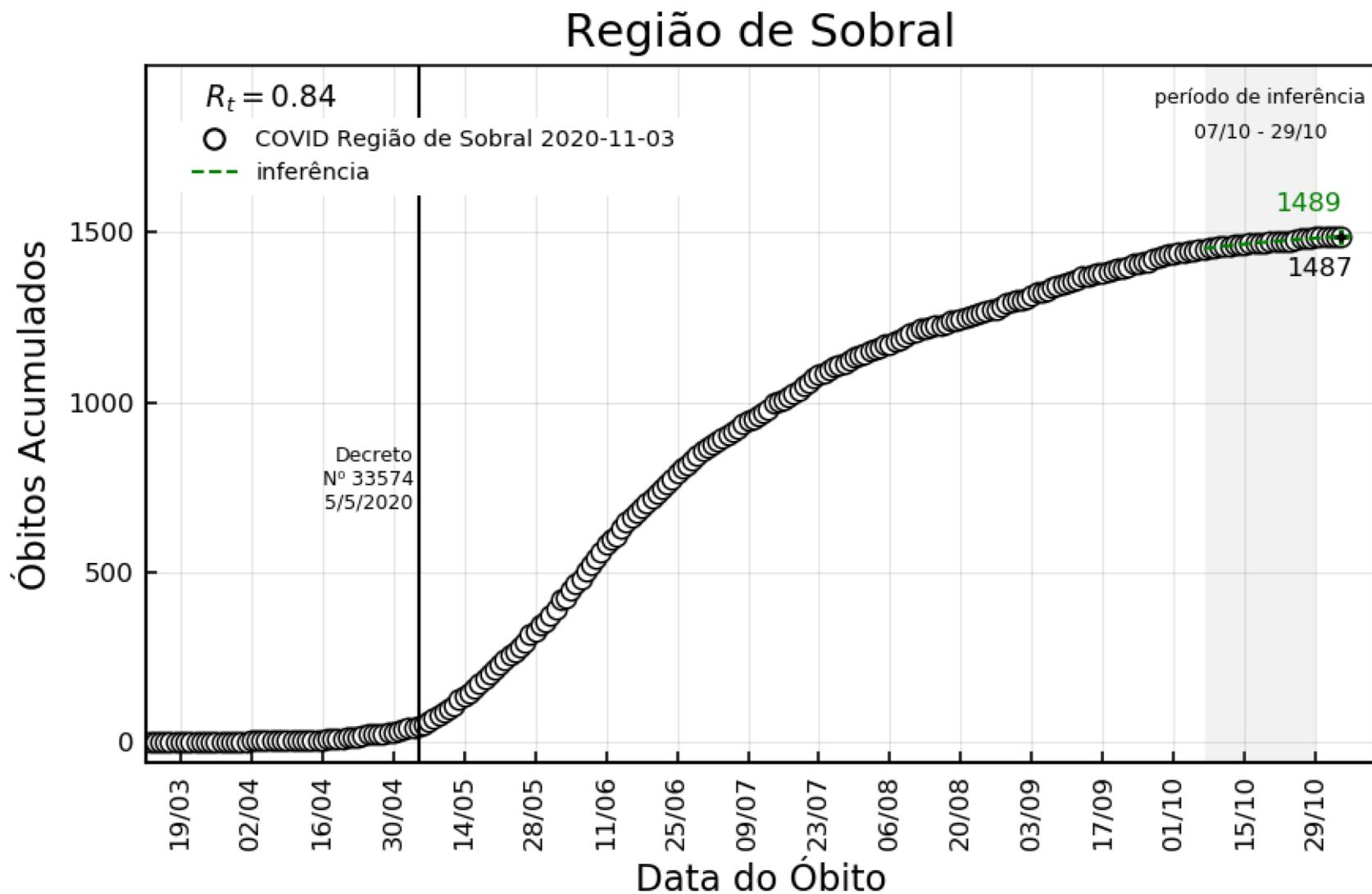
Janela de Inferência	R_t
29/07 – 28/08	0.76
05/08 – 04/09	0.81
12/08 – 11/09	0.76
19/08 – 18/09	0.75
26/08 – 25/09	0.86
09/09 – 01/10	0.75
16/09 – 08/10	0.75
23/09 – 15/10	0.76
30/09 – 22/10	0.77
07/10 - 29/10	0.72

Região Sobral

Dados atualizados em 03/11/2020



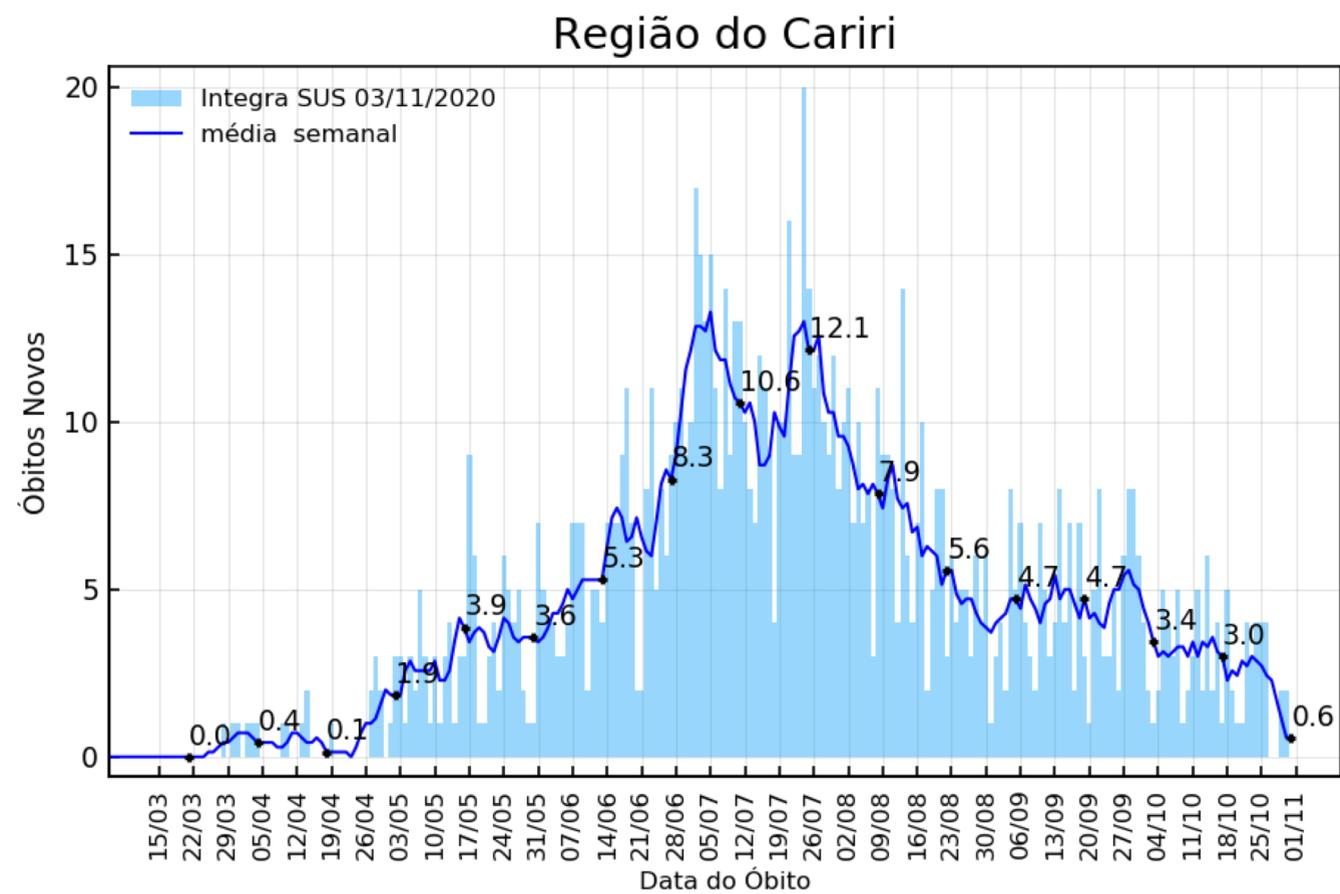
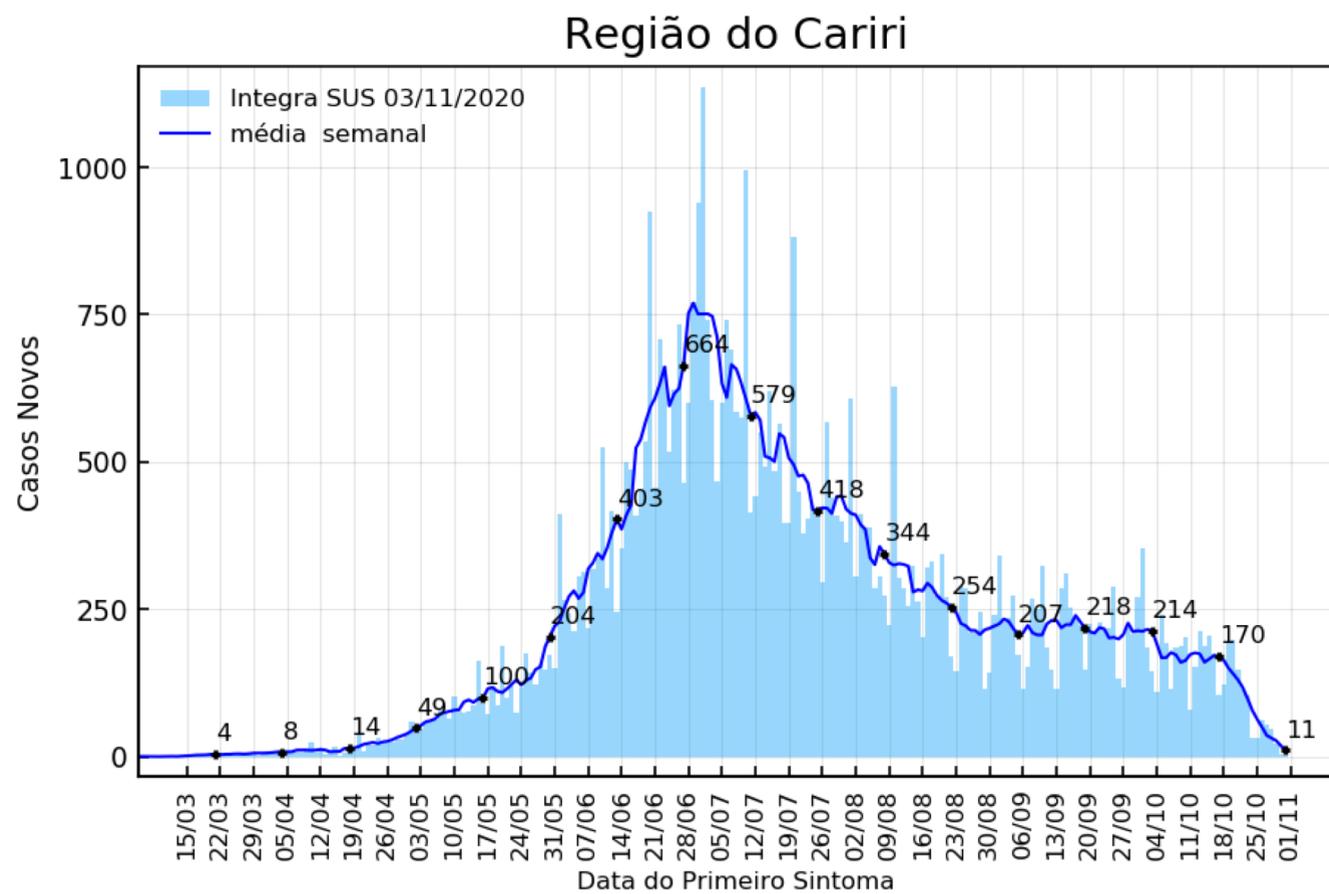
Dados atualizados em 03/11/2020



Janela de Inferência	R_t
29/07 – 28/08	0.80
05/08 – 04/09	0.82
12/08 – 11/09	1.07
19/08 – 18/09	0.95
26/08 – 25/09	0.95
09/09 – 01/10	0.97
16/09 – 08/10	0.84
23/09 – 15/10	0.84
30/09 – 22/10	0.71
07/10 – 29/10	0.84

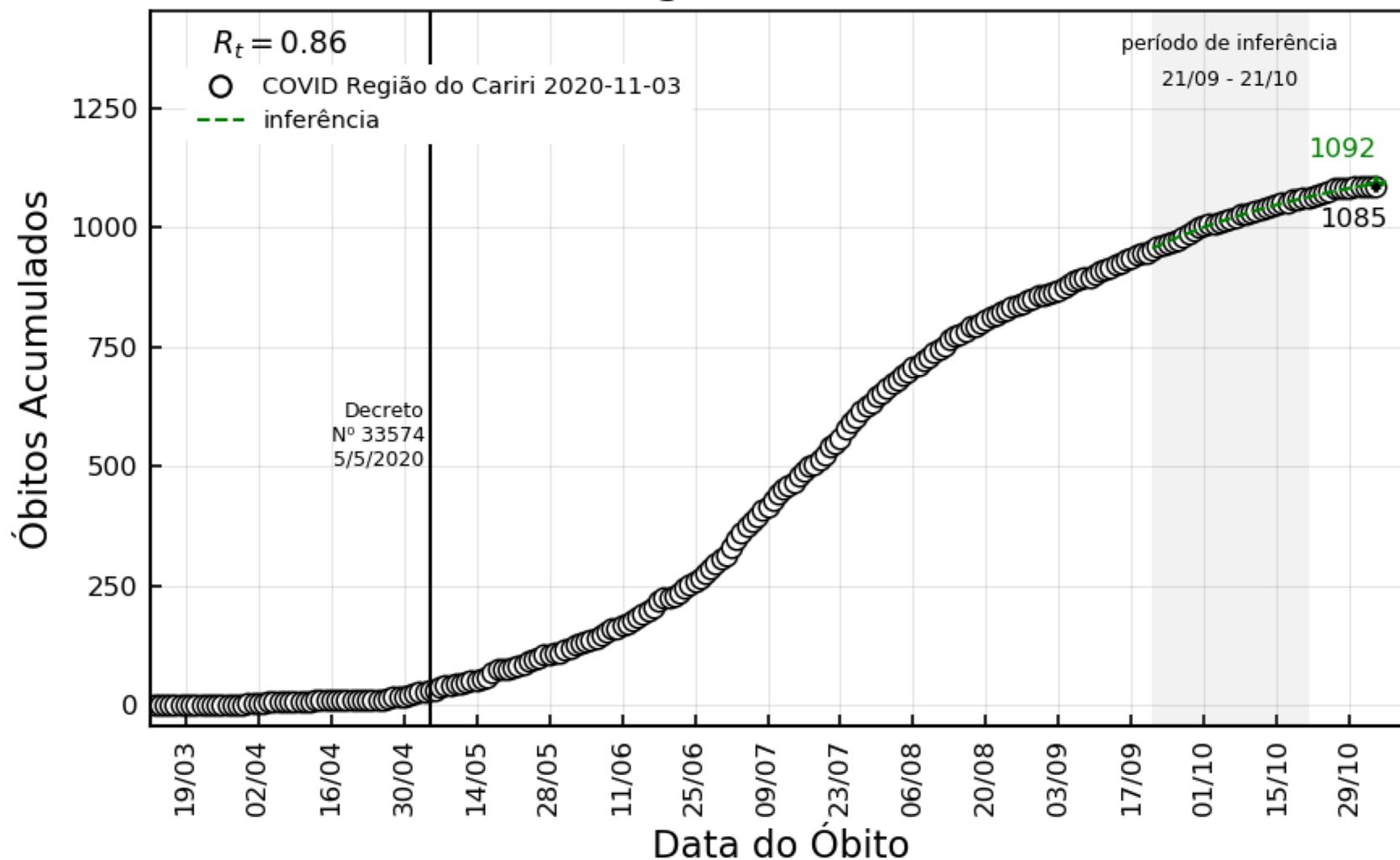
Região Cariri

Dados atualizados em 03/11/2020



Dados atualizados em 03/11/2020

Região do Cariri

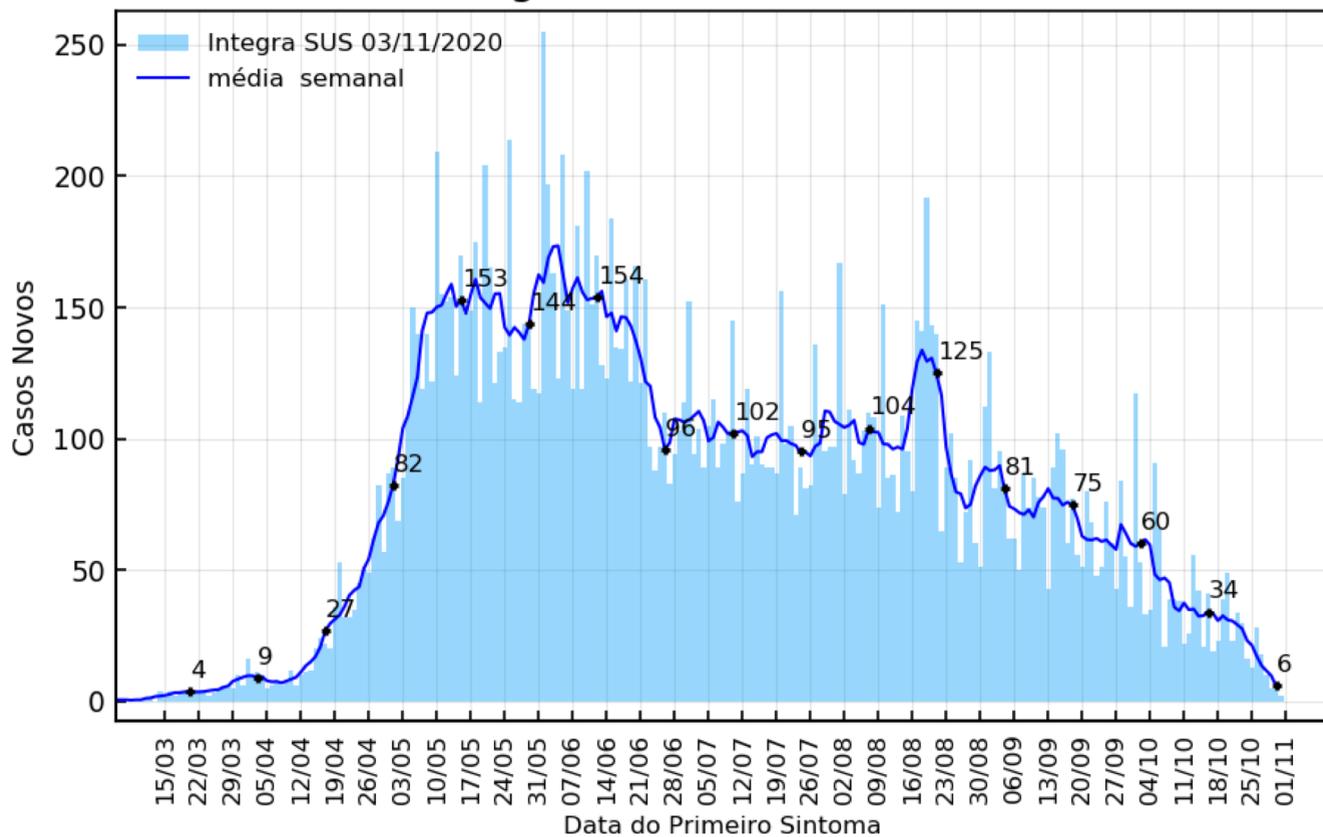


Janela de Inferência	R_t
02/08 – 03/09	0.84
09/08 – 10/09	0.90
16/08 – 17/09	0.98
23/08 – 21/09	1.01
30/08 – 29/09	1.03
07/09 – 07/10	1.07
14/09 – 14/10	0.86
21/09 – 21/10	0.86

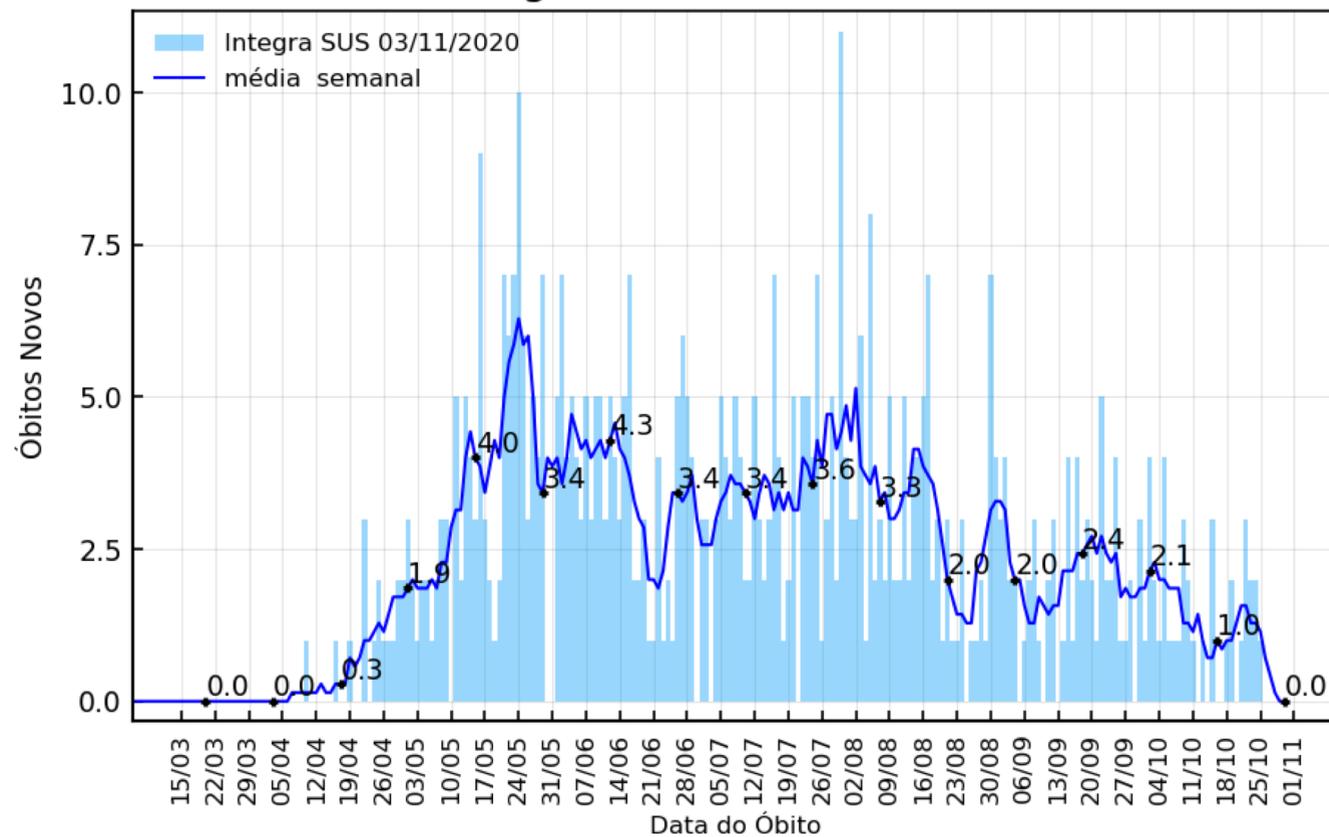
Região Sertão Central

Dados atualizados em 03/11/2020

Região do Sertão Central

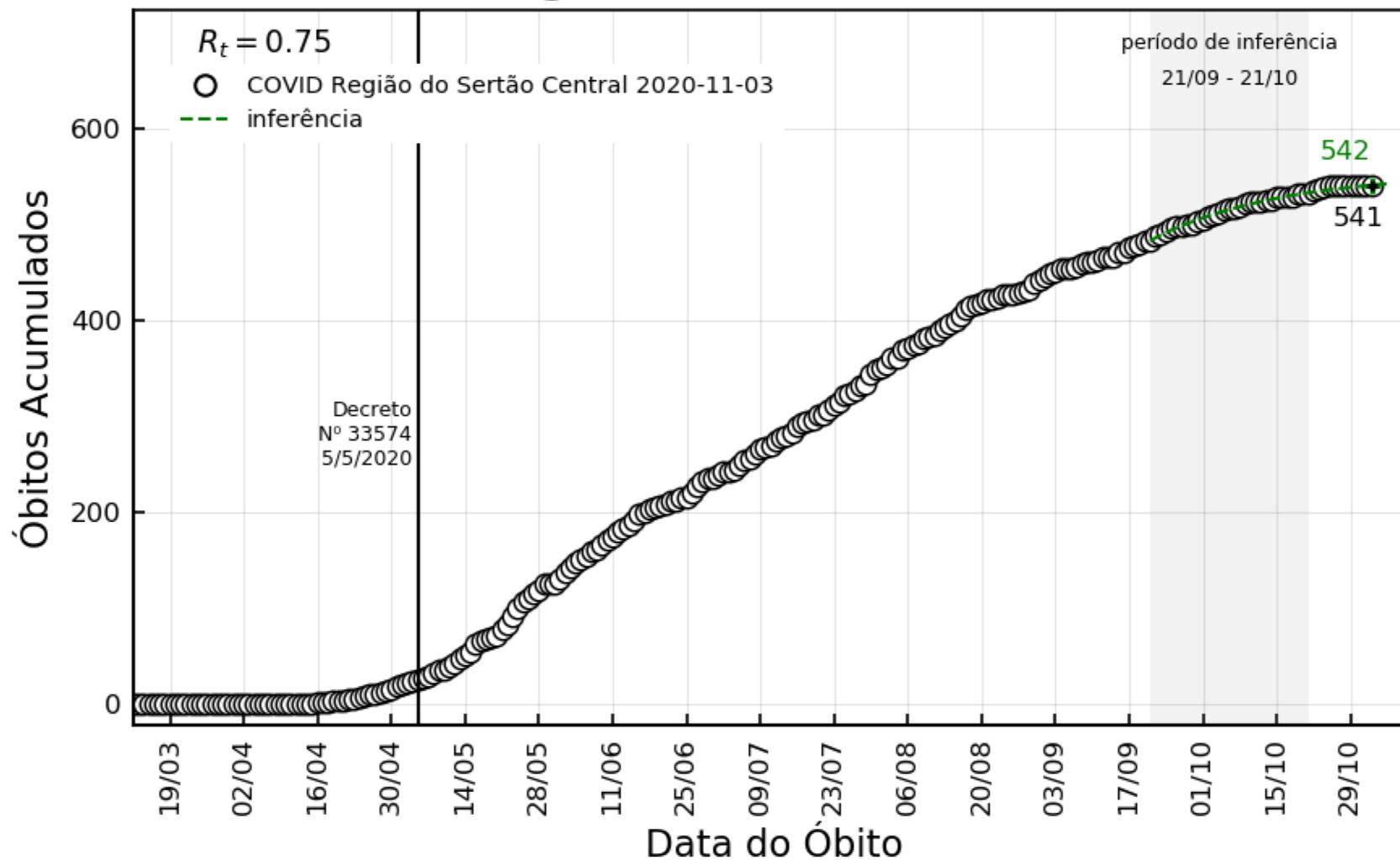


Região do Sertão Central



Dados atualizados em 03/11/2020

Região do Sertão Central



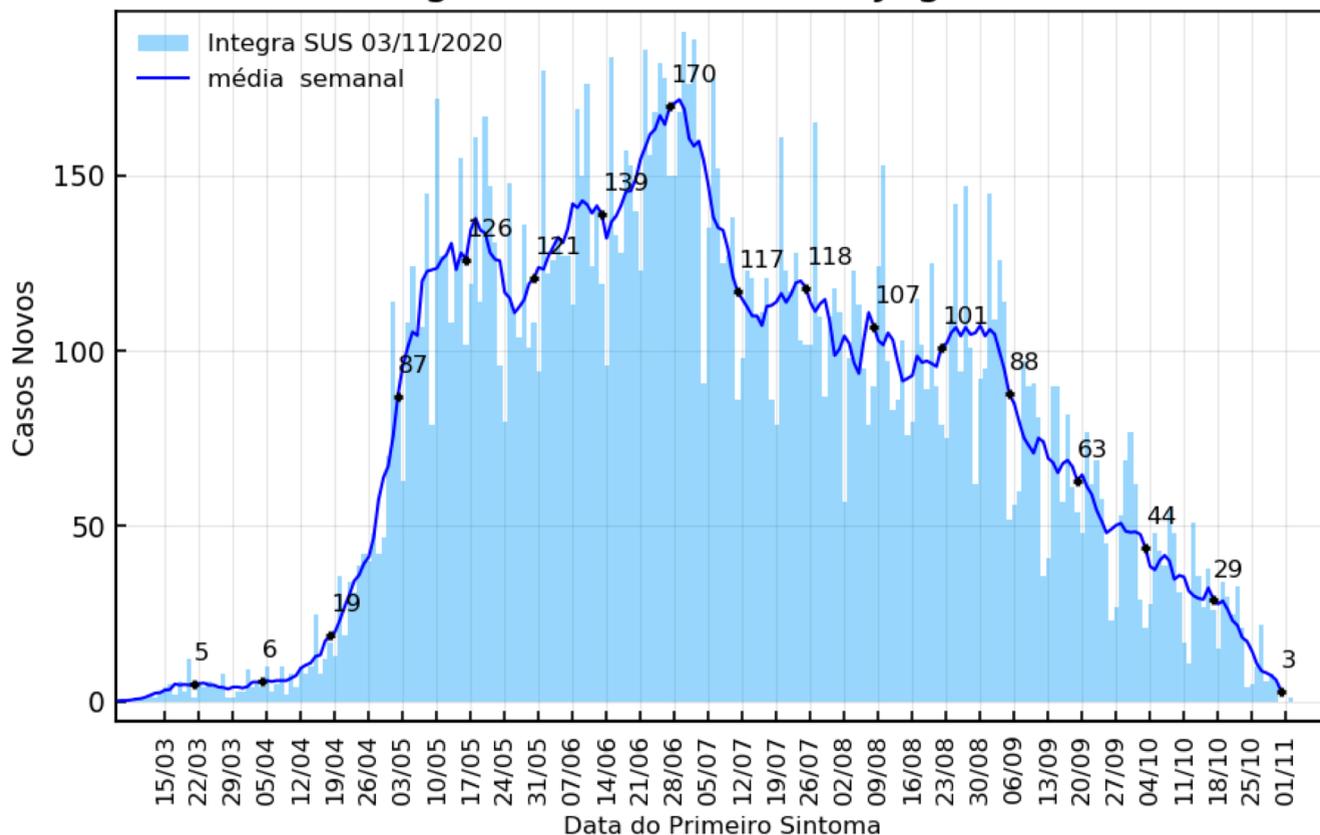
Janela de Inferência	R_t
12/07 – 13/08	1.09
19/07 – 20/08	1.06
29/07 – 31/08	0.91
05/08 – 07/09	0.78
16/08 – 15/09	0.79
23/08 – 21/09	0.79
30/08 – 29/09	0.84
07/09 – 07/10	0.91
14/09 – 14/10	0.78
21/09 – 21/10	0.75

Região

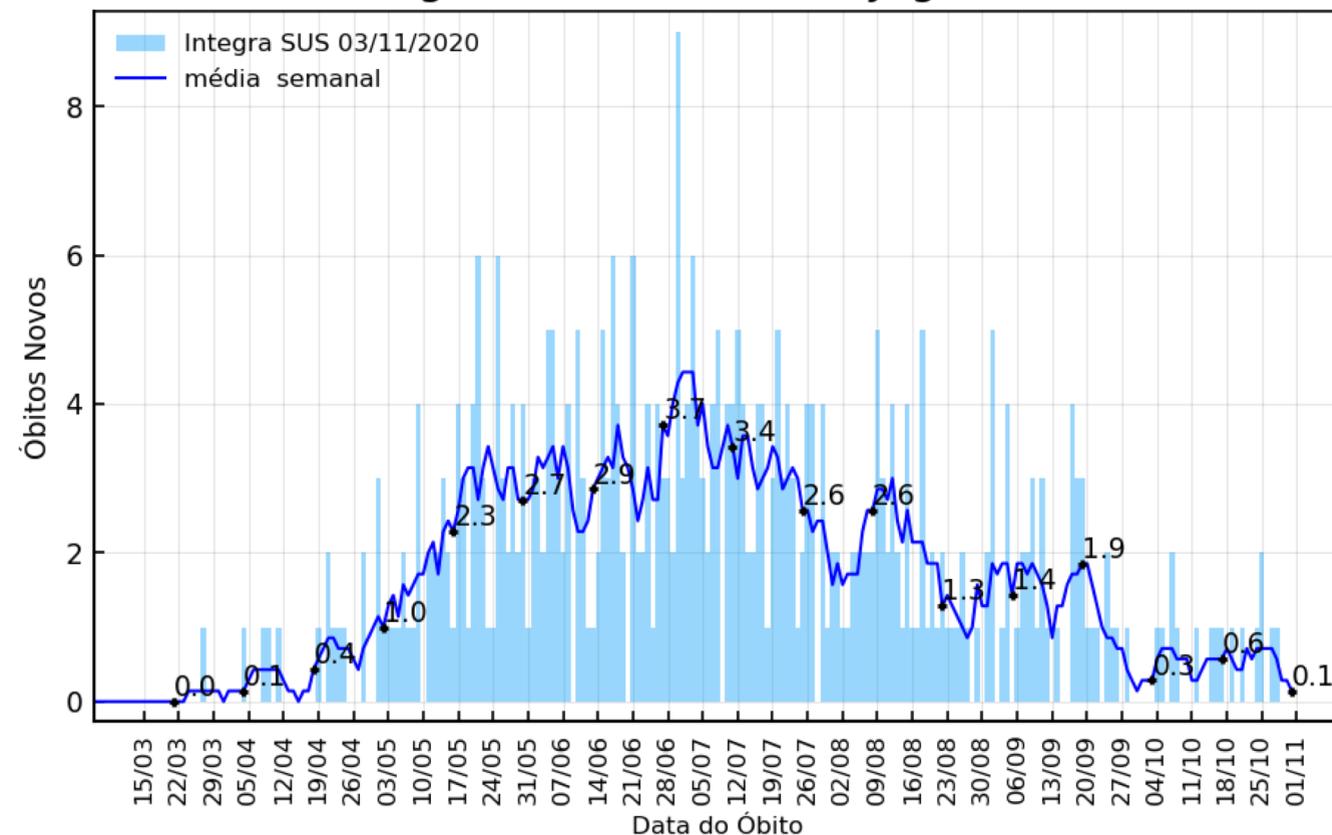
Litoral Leste/Jaguaribe

Dados atualizados em 03/11/2020

Região do Litoral Leste/Jaguaribe

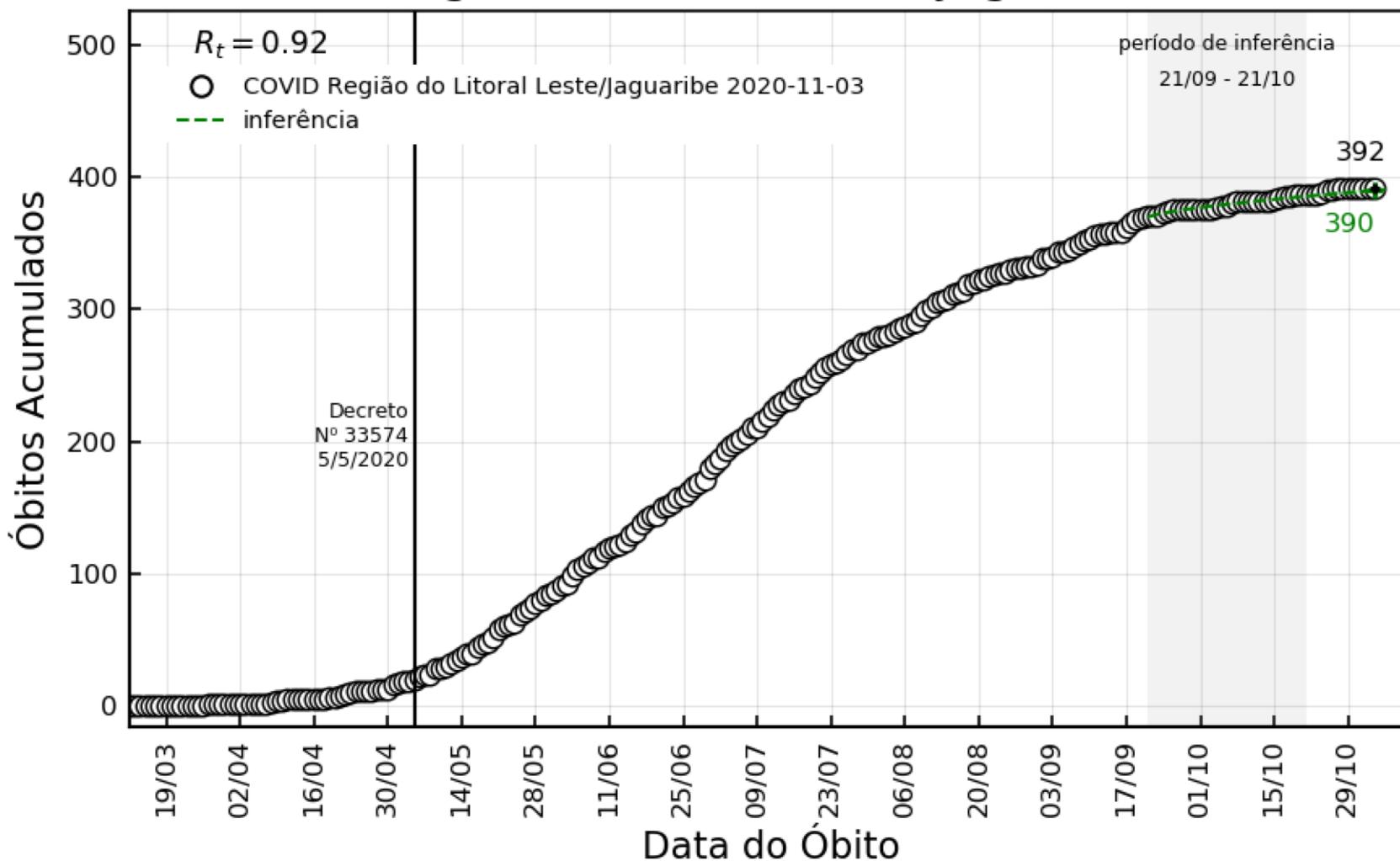


Região do Litoral Leste/Jaguaribe



Dados atualizados em 28/10/2020

Região do Litoral Leste/Jaguaribe



Janela de Inferência	R_t
12/07 – 13/08	0.91
19/07 – 20/08	0.99
29/07 – 31/08	0.90
05/08 – 07/09	0.81
16/08 – 15/09	0.80
23/08 – 21/09	0.85
30/08 – 29/09	0.86
07/09 – 07/10	0.82
14/09 – 14/10	0.86
21/09 – 21/10	0.92