



Universidade Federal Fluminense  
Instituto do Noroeste Fluminense de  
Educação Superior (INFES)

# ***Análise de evolução da COVID-19 no Noroeste Fluminense***

Prof. Dr. Tibério Borges Vale

Campus de Santo Antônio de Pádua/RJ  
03/06/2020

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# Histórico

- Objetivo: Auxiliar os gestores públicos do Noroeste Fluminense (em especial no município de Santo Antônio de Pádua/RJ)
- Início do trabalho:
  - Análise de boletins epidemiológicos divulgados por 6 prefeituras do Noroeste Fluminense e 1 de MG
    - Campos dos Goytacazes/RJ, Itaocara/RJ, Itaperuna/RJ, Miracema/RJ, Pirapetinga/MG, Santo Antônio de Pádua/RJ e São Fidélis/RJ.
  - Ajuste de funções exponenciais, cálculo de tempo de duplicação e aplicação de modelo SEIRD para demonstrar redução de casos causada por lockdown.

# Noroeste Fluminense

Microrregião <sup>[1][2]</sup> ⇅	Código ⇅	Localização ⇅	Municípios ⇅
Itaperuna	001		Bom Jesus do Itabapoana
			Italva
			Itaperuna
			Laje do Muriaé
			Natividade
			Porciúncula
			Varre-Sai
Santo Antônio de Pádua	002		Aperibé
			Cambuci
			Itaocara
			Miracema
			Santo Antônio de Pádua
São José de Ubá			

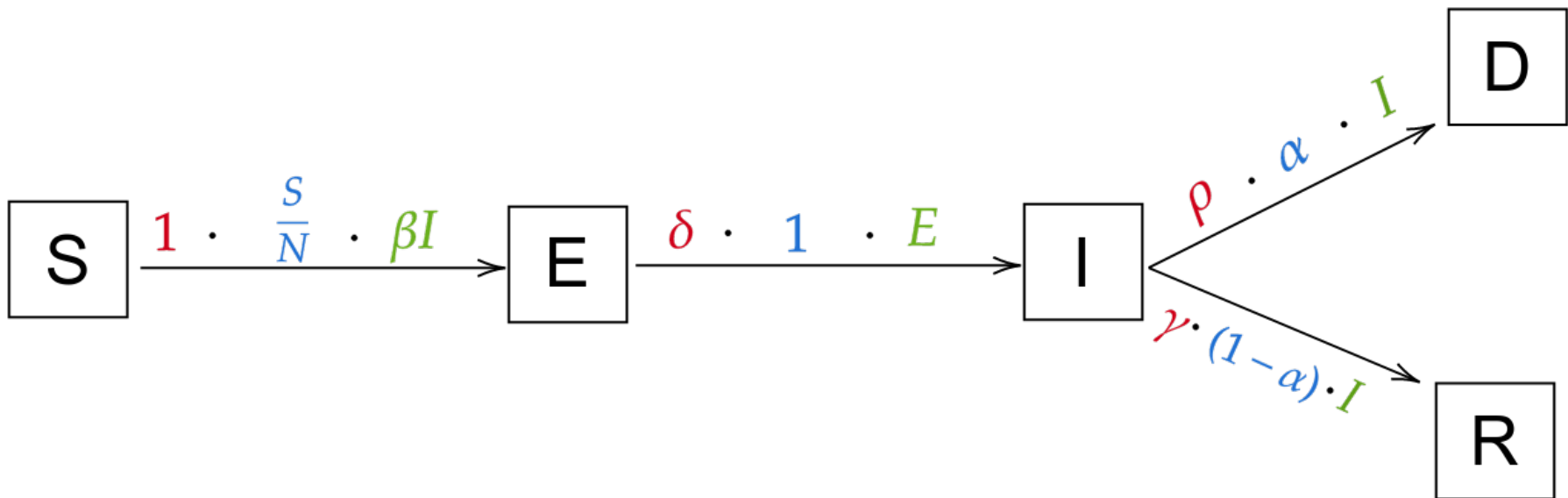
# População estimada DATASUS

- Santo Antônio de Pádua 42.479
- Macaé 256.672
- Rio de Janeiro 6.718.903
- Campos dos Goytacazes 507.548
- Itaocara 23.234
- Itaperuna 103.224
- Miracema 27.174
- São Fidélis 38.669
- Volta Redonda 273.012

# Características do modelo SEIRD

- Modelo computacional com os seguintes compartimentos:
  - **Suscetíveis**
  - **Expostos**
  - **Infectados**
  - **Recuperados**
  - **Mortos**
- Período simulado: 400 dias
- Adotar datas de primeiros sintomas
- Dados reais do SIVEP GRIPE e de SRAG (COVID)
- Potencial para ser aplicado a todos os municípios do estado do RJ.

# Características do modelo SEIRD



Modelo de Henri Froese disponível em:

<https://towardsdatascience.com/infectious-disease-modelling-beyond-the-basic-sir-model-216369c584c4>

# Características do modelo SEIRD

$$\frac{dS}{dt} = -\beta \cdot I \cdot \frac{S}{N}$$

$$\frac{dE}{dt} = \beta \cdot I \cdot \frac{S}{N} - \delta \cdot E$$

$$\frac{dI}{dt} = \delta \cdot E - (1 - \alpha) \cdot \gamma \cdot I - \alpha \cdot \rho \cdot I$$

$$\frac{dR}{dt} = (1 - \alpha) \cdot \gamma \cdot I$$

$$\frac{dD}{dt} = \alpha \cdot \rho \cdot I$$

# Características do modelo SEIRD

## Parâmetros de entrada:

- N: população da localidade (extraído do DATASUS, projeção de 2019)
- $\beta(t)$ : quantidade esperada de pessoas que um infectado contamina por dia [  $\beta = R_0(t) * \gamma$  ]
- D: dias que uma pessoa infectada pode espalhar a doença [11.5]
- $\gamma$ : proporção de infectados que se recuperam por dia ( $\gamma = 1/D$ ) [1/11.5]
- $\delta$ : taxa de permanência durante incubação ( $\delta=1/\text{incubação}$ ) [1/5.1]
- $\alpha$ : taxa de fatalidade [1.8%]
- $\rho$ : taxa na qual uma pessoa morre (= 1/dias infecção até morte) [1/14]
- L: número de dias, após o primeiro caso, até início de lockdown
- Condições iniciais:
  - $I_i$ : número inicial de infectados, parâmetro A do ajuste de curva exponencial à fase inicial dos dados observ. [  $f(x)=A*\exp(B*x)$  ]
  - $E_i$ : número inicial de pessoas expostas (considerando em média 3 pessoas por residência) [  $E_i = 2*I_i$  ].
  - $S_i$ : número inicial de pessoas suscetíveis [  $S_i = N - I_i - E_i$  ]
  - $R_i$  e  $D_i$ : números iniciais de recuperados e mortos [  $R_i = D_i = 0$  ]



# Características do modelo SEIRD

## Parâmetros de entrada:

- $R_0$ : número total de pessoas que um infectado contamina ( $R_0 = \beta / \gamma$ ) ou “número básico de reprodução”
- $R_{0\_start}$ : valor inicial de  $R_0$
- $R_{0\_end}$ : valor final de  $R_0$
- $R_0 = R_0(t) \rightarrow R_0$  efetivo

$$R_0(t) = \frac{R_{0\_start} - R_{0\_end}}{1 + e^{-k(-x+x_0)}} + R_{0\_end}$$

- Modelo precisa ajustar  $k$  e  $x_0$  aos dados observados da epidemia com métodos de otimização:

$$0.01 < k < 1.00 \quad , \quad 1 \text{ dia} < x_0 < 200 \text{ dias}$$

- O modelo também estima a sub-notificação assumindo que os dados observados precisam ser divididos por um fator (1-sub) de forma que  $0.01 < \text{sub} < 1.00$
- Métodos de otimização: Força Bruta ou Mínimos Quadrados Sequenciais ou Nelder-Mead (simplex)

# Características do modelo SEIRD

## Parâmetros de saída:

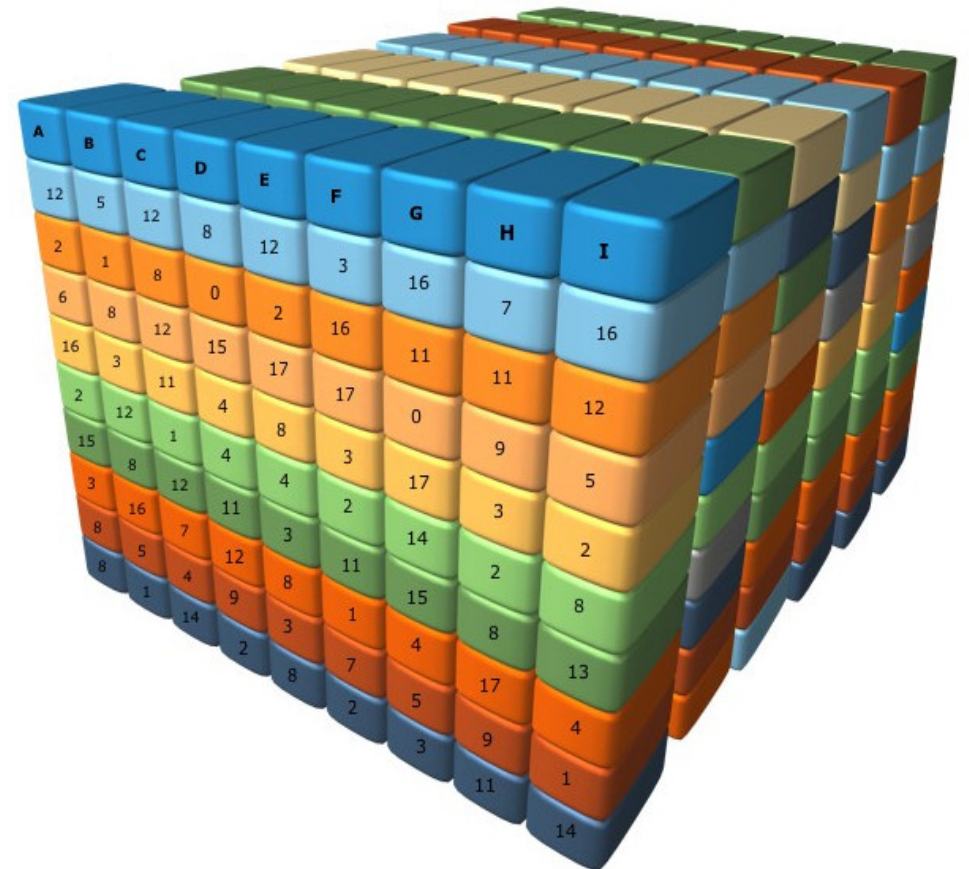
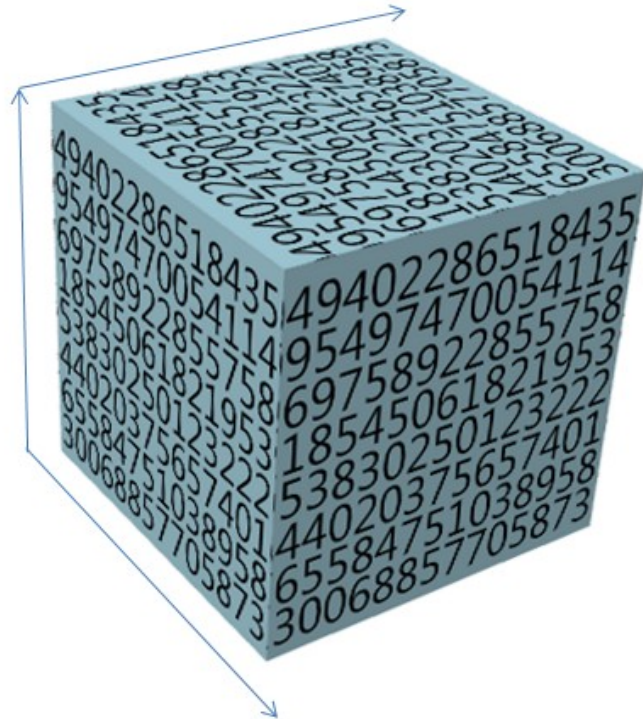
- $S(t)$ : número de pessoas suscetíveis no dia  $t$
- $E(t)$ : número de pessoas expostas no dia  $t$
- $I(t)$ : número de pessoas infectadas no dia  $t$
- $R(t)$ : número de pessoas recuperadas no dia  $t$
- $D(t)$ : número de pessoas mortas no dia  $t$
  
- O código Python faz leitura dos dados epidemiológicos disponíveis no portal Painel COVID da Secretaria Estadual da Saúde/RJ e ajusta  $R_0$  aos dados de cada município.
  
- Os dados dos gráficos a seguir foram obtidos no dia 08/06/2020.

# Otimização do modelo SEIRD

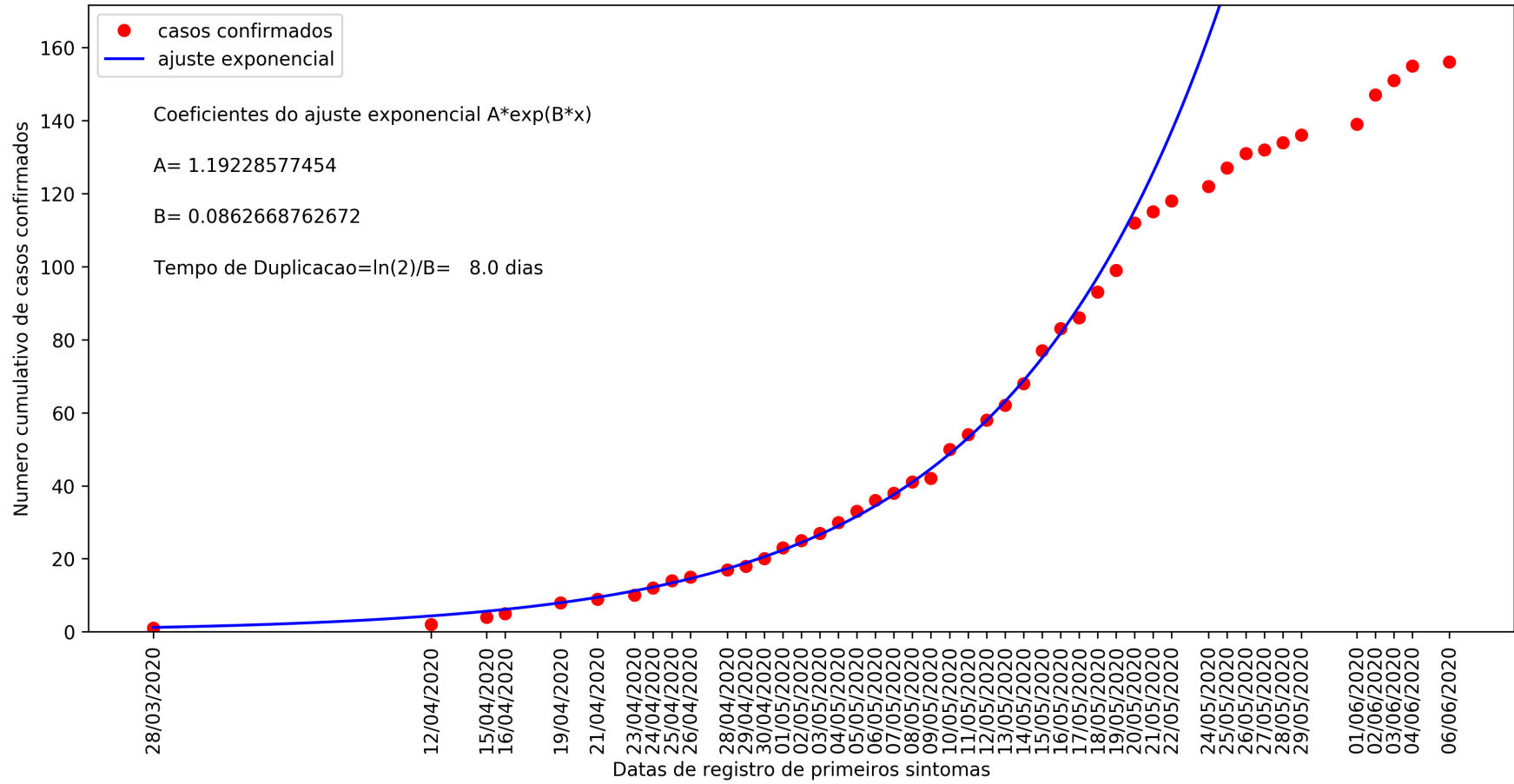
- O código Python usa os seguintes pacotes:
  - Para fazer ajuste de funções exponenciais aos dados da fase inicial: `scipy.optimize.curve_fit()`
  - Para encontrar a solução das Equações Diferenciais Ordinárias: `scipy.integrate.odeint()`
  - Para otimizar os parâmetros  $k$  e  $x_0$  que definem  $R_0$ :
    - `scipy.optimize.brute()`
    - `scipy.optimize.fmin()`
    - `scipy.optimize.minimize(method='Nelder-Mead')`
- Ajuste do modelo feito pela curva cumulativa de casos confirmados

$$\chi^2 = \sum_{t=0}^P \frac{|(1 - \text{sub}) \times \delta E(t) - \text{n}^\circ \text{ de casos novos}|}{P}$$

# Otimização do modelo SEIRD

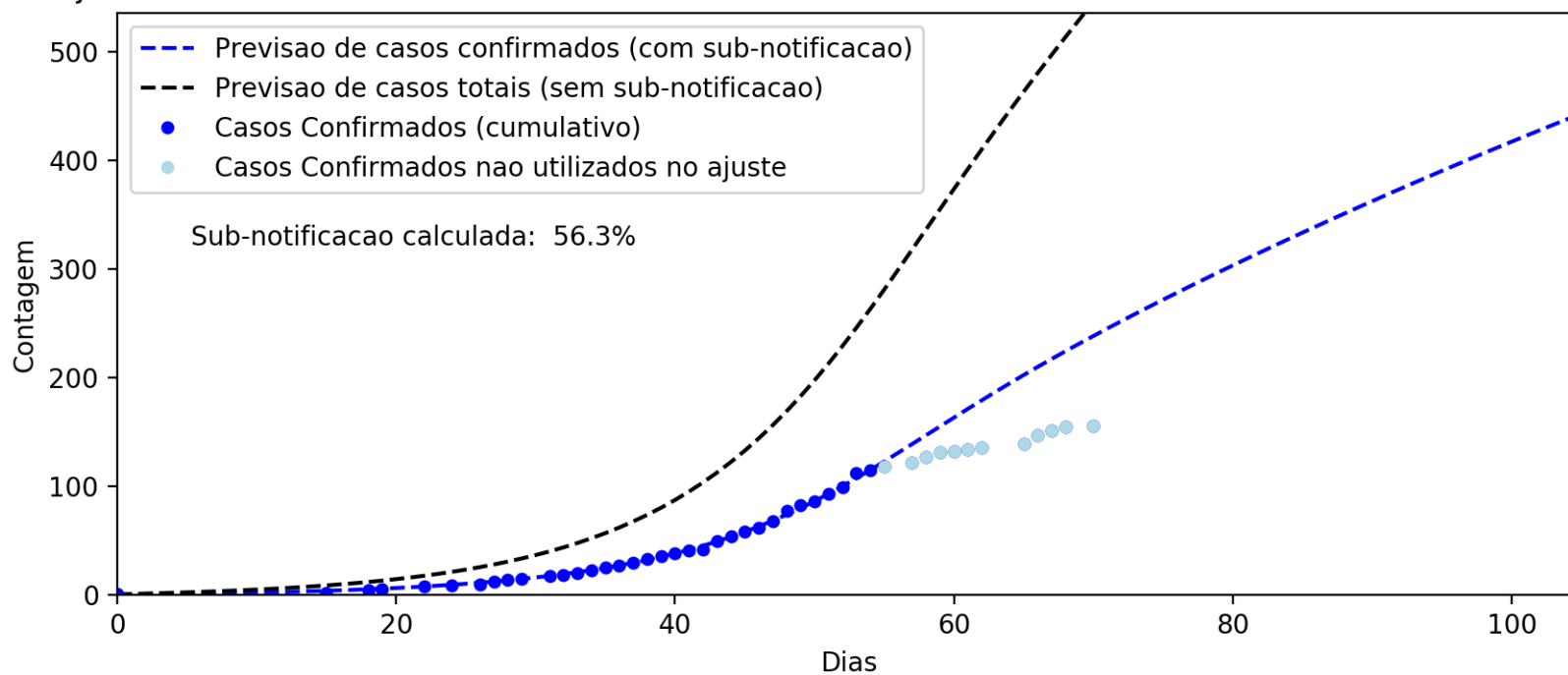


Ajuste exponencial aos dados epidemiologicos de SANTO ANTONIO DE PADUA/RJ



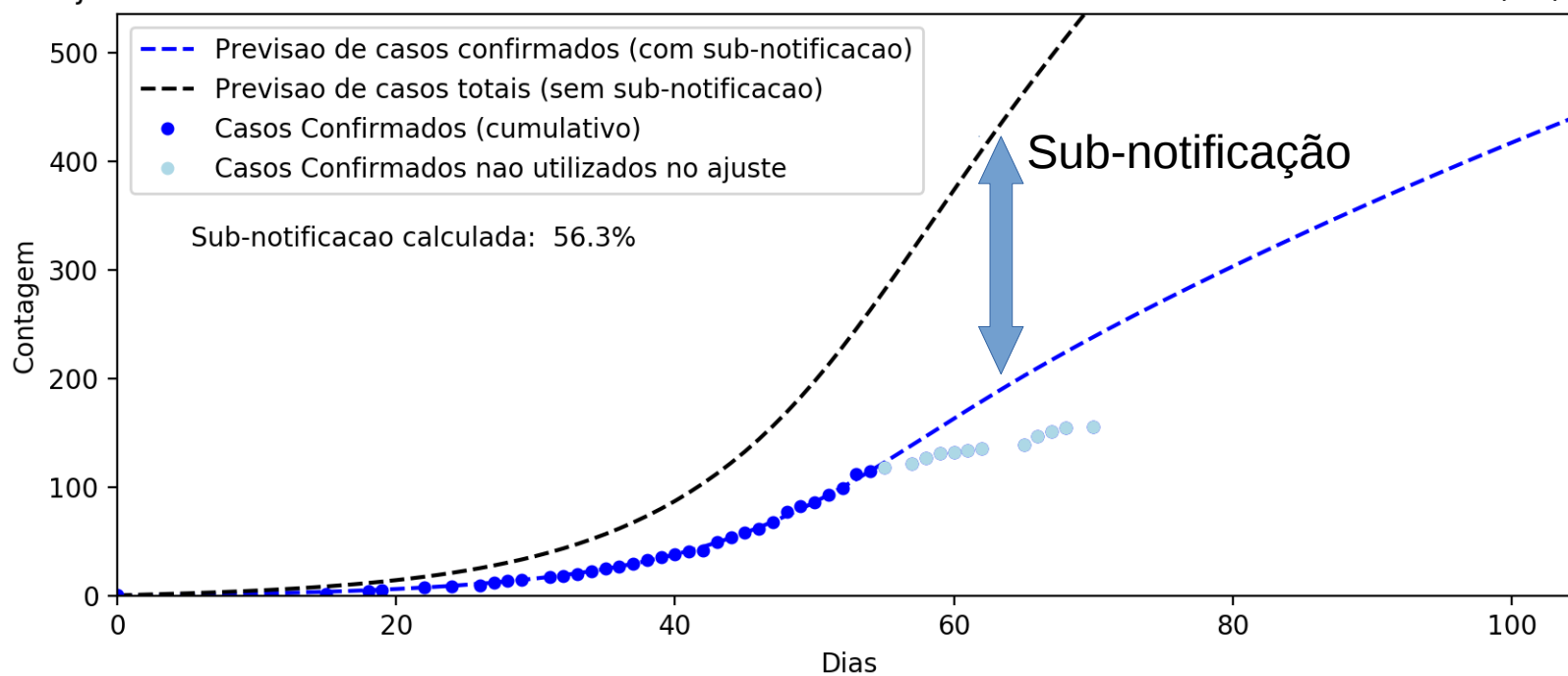
# Santo Antônio de Pádua/RJ

Ajuste do modelo aos Casos Confirmados de SANTO ANTONIO DE PADUA com dados ate 06/06/2020

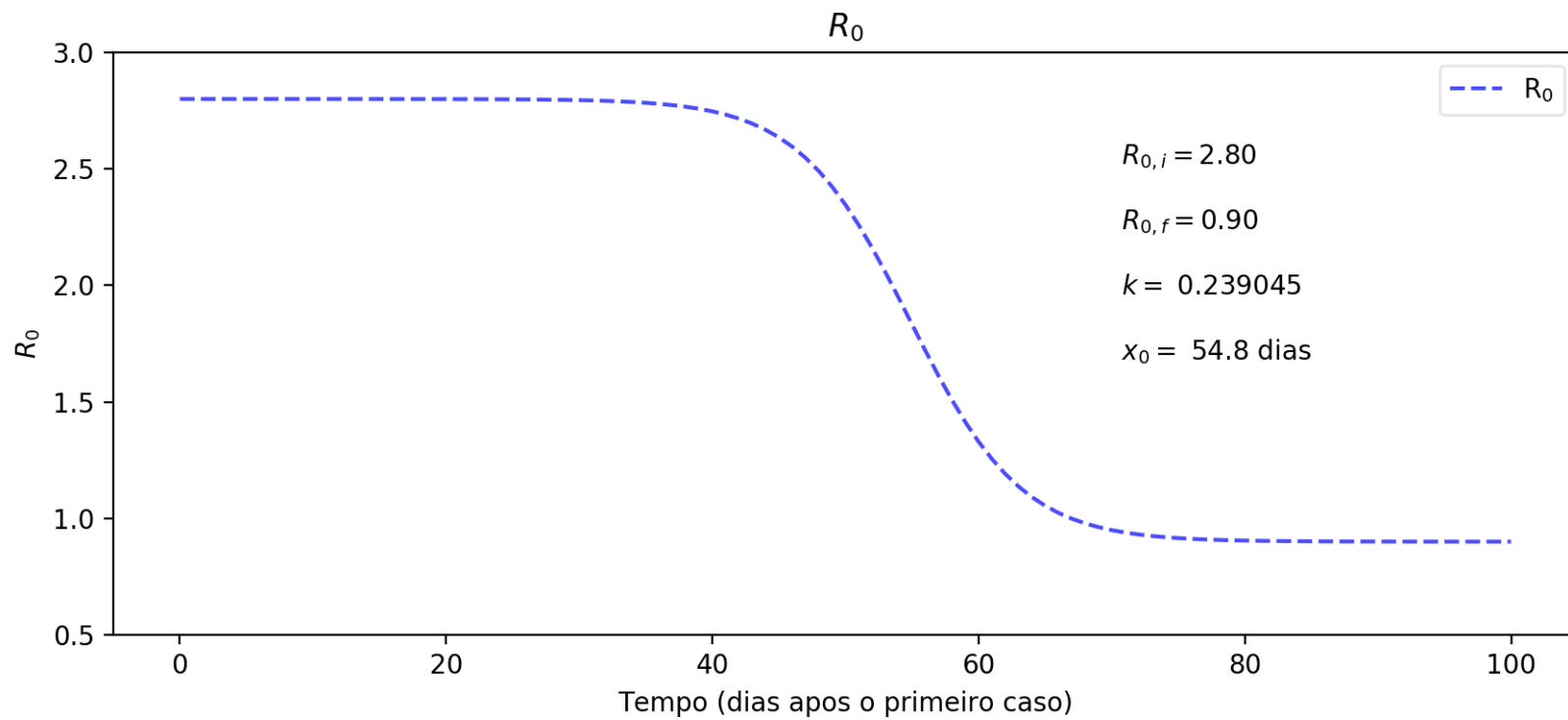


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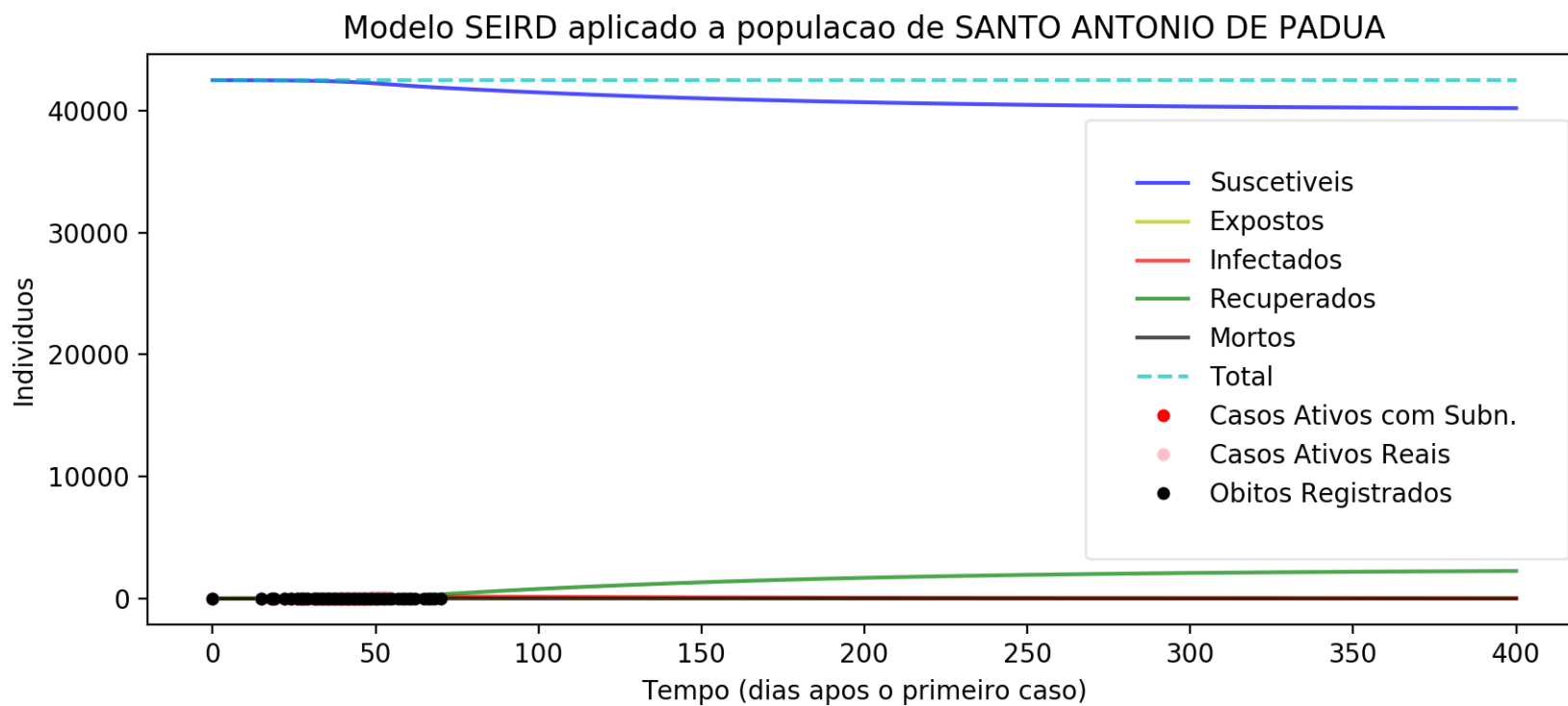


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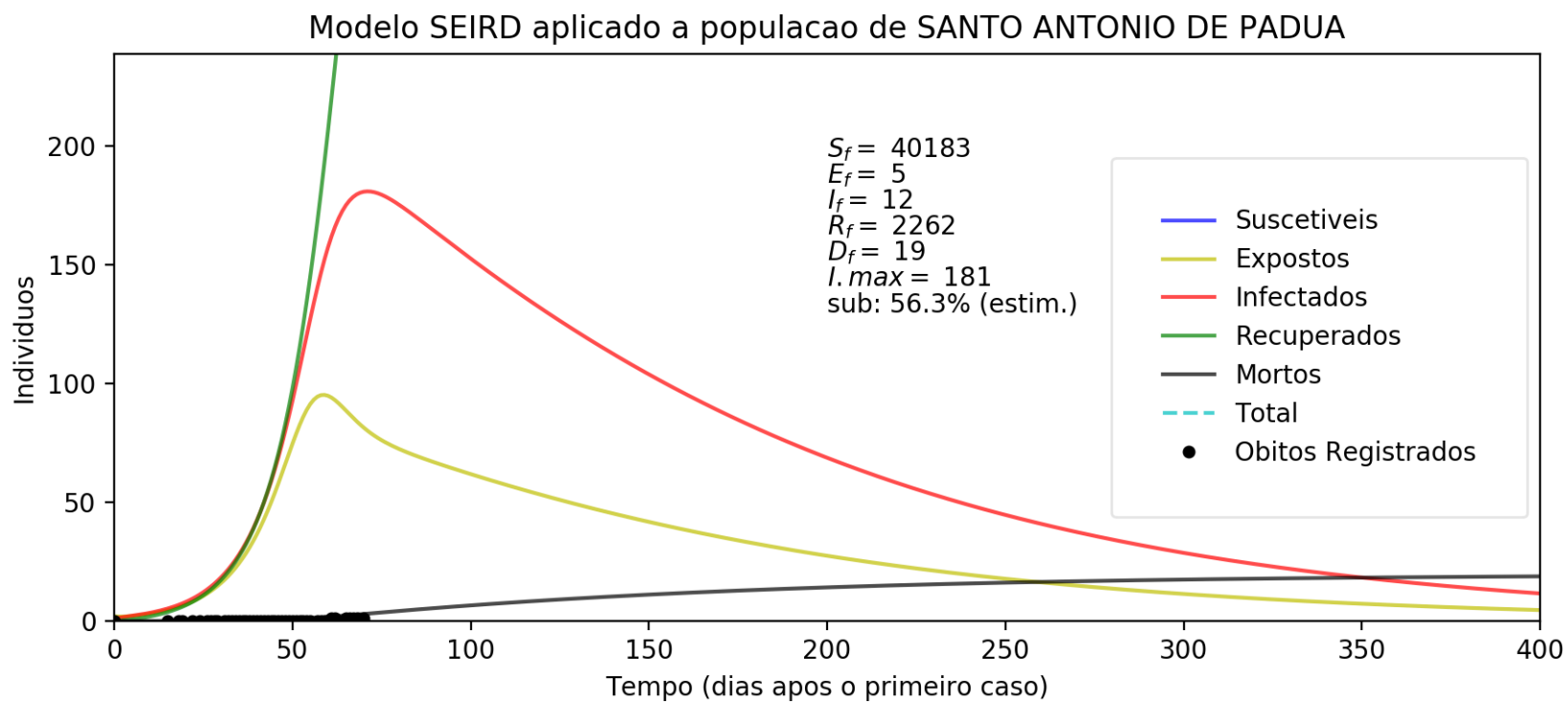




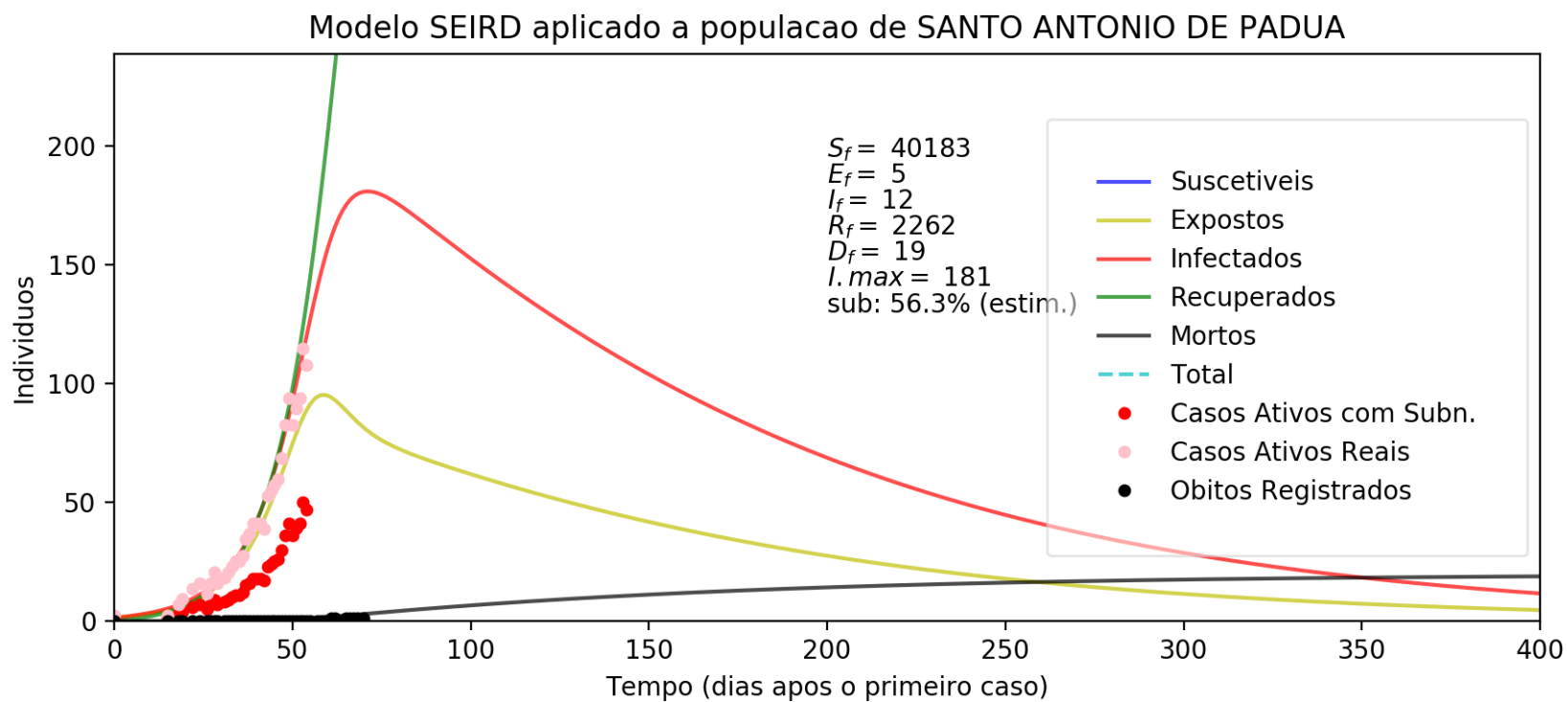
# Santo Antônio de Pádua/RJ



# Santo Antônio de Pádua/RJ

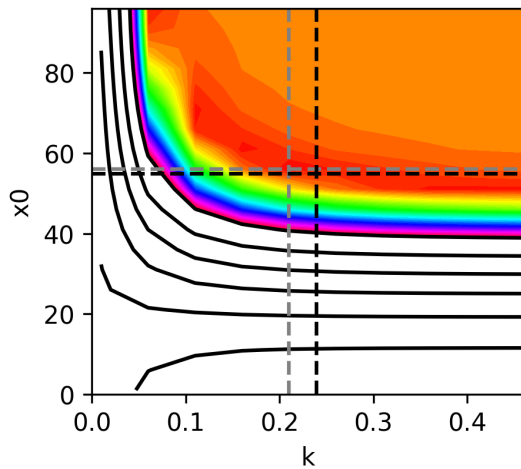


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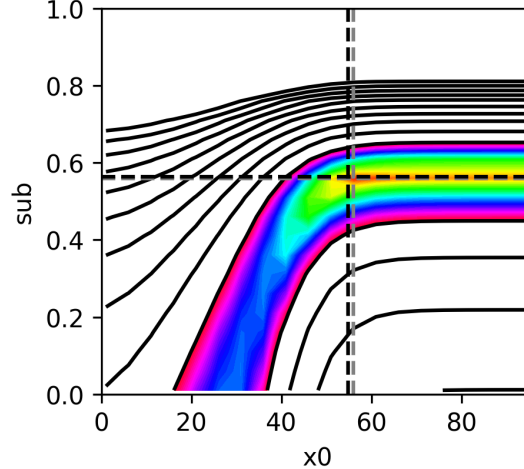


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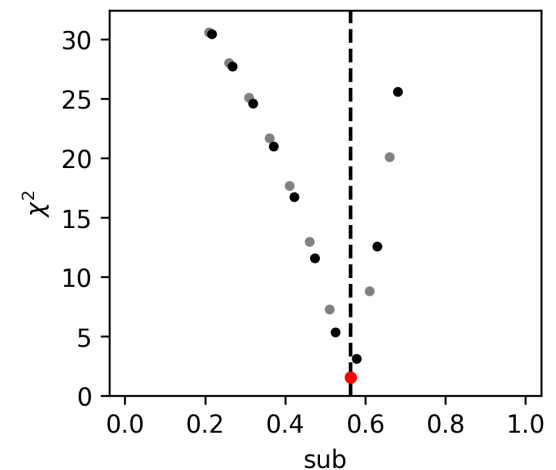
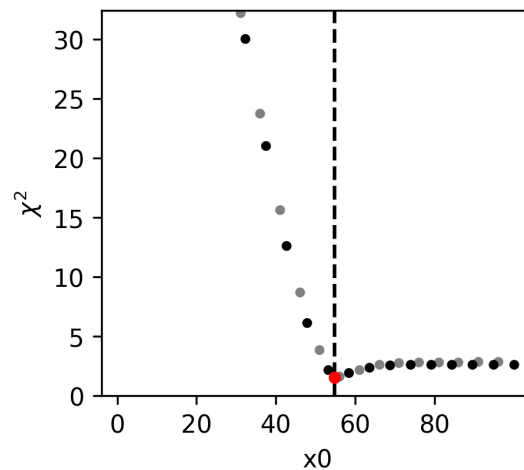
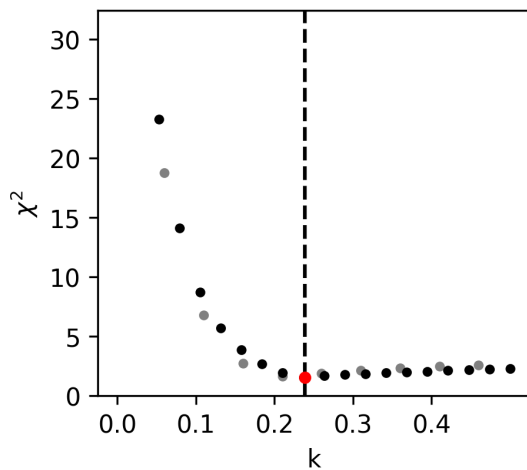
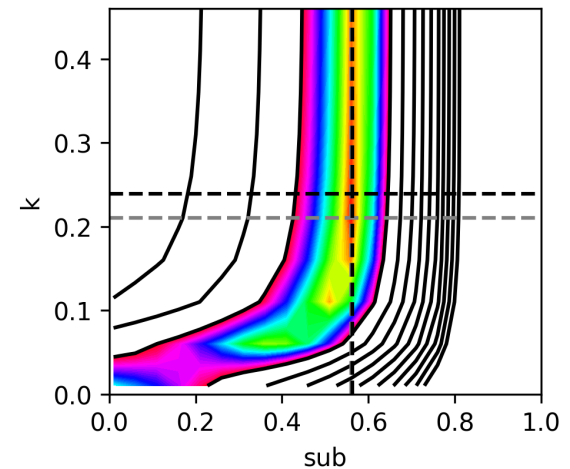
Mapa de  $\chi^2$  em sub= 56.3%



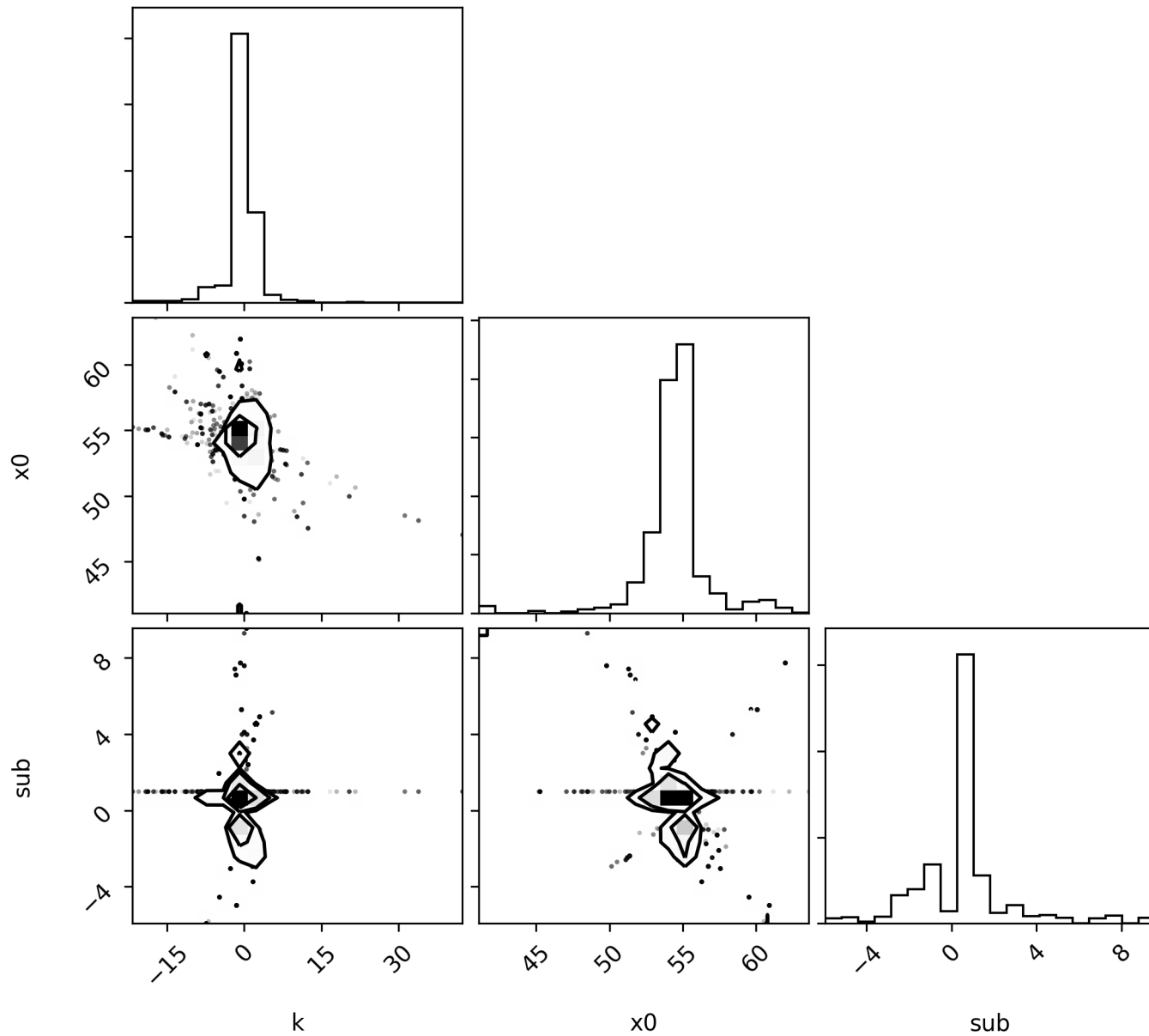
Mapa de  $\chi^2$  em k=0.23904



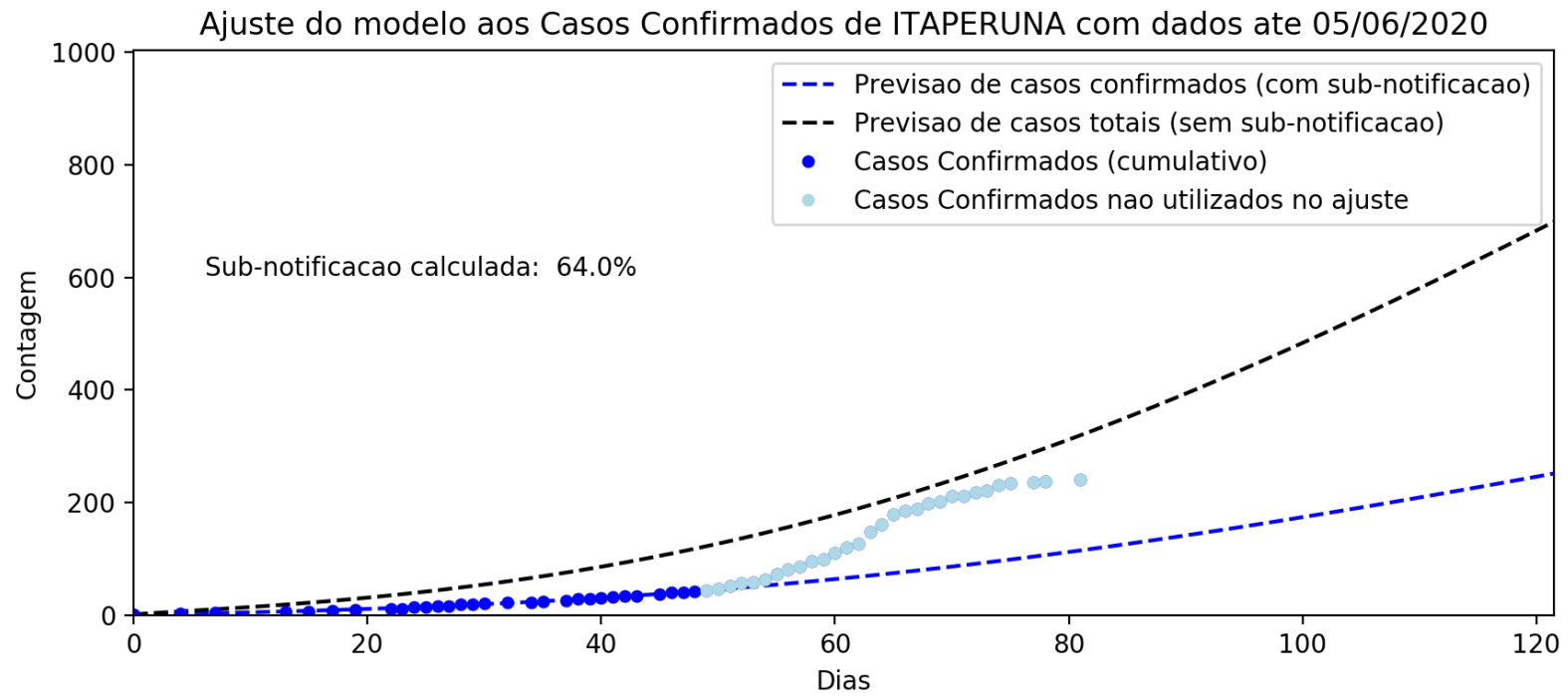
Mapa de  $\chi^2$  em x0=54.84651



# Santo Antônio de Pádua/RJ



# Itaperuna/RJ



# Itaperuna/RJ

- Reabertura de comércio no final de abril/2020
- 10/05/2020: grande aumento no nº de casos

# Prefeitura de Itaperuna, RJ, flexibiliza abertura do comércio com segundo maior número de casos de coronavírus no Noroeste Fluminense

Município, que tem 12 casos confirmados da doença, alega que a curva de difusão da Covid-19 tem se apresentado linear nas últimas semanas.

Por G1 — Norte Fluminense

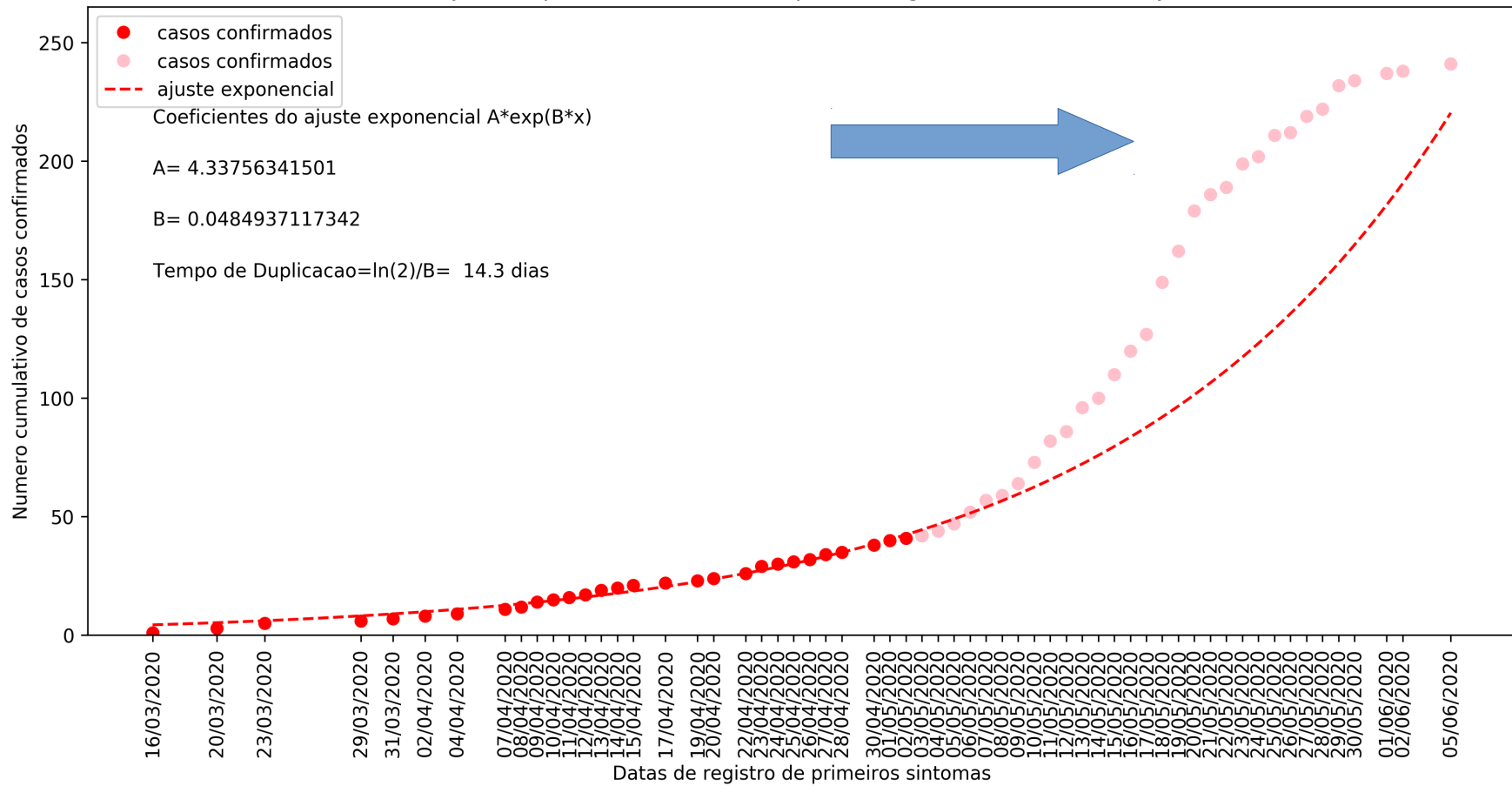
29/04/2020 13h45 · Atualizado há um mês



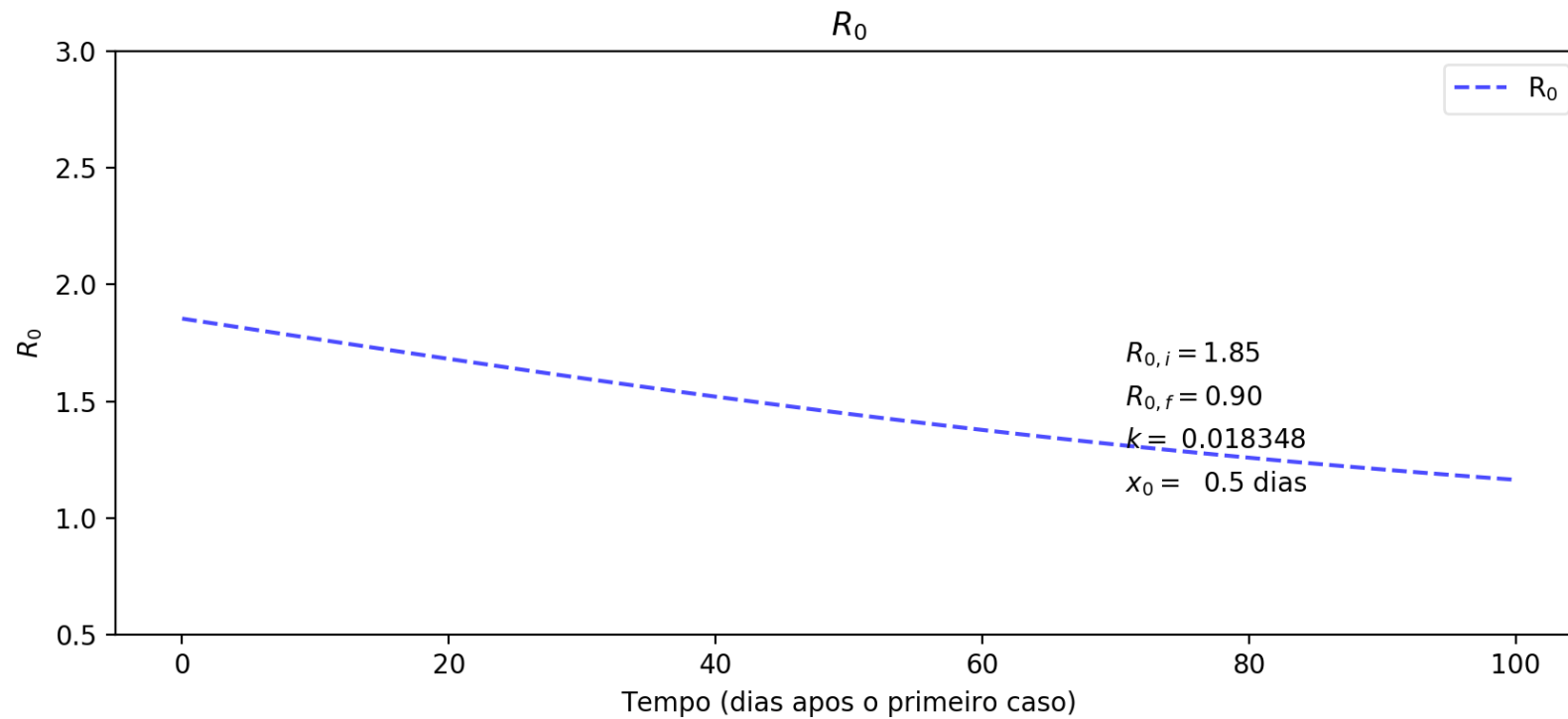


# Itaperuna/RJ

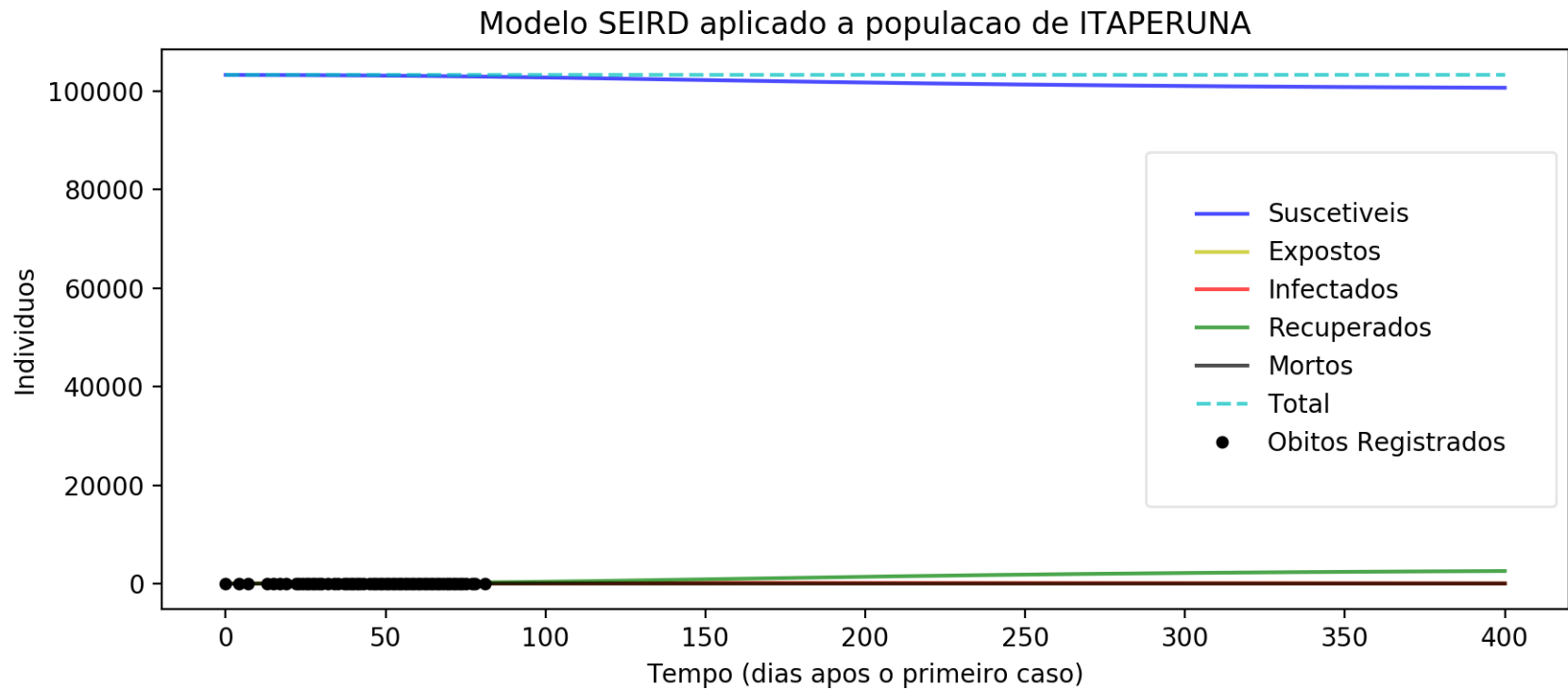
Ajuste exponencial aos dados epidemiologicos de ITAPERUNA/RJ



# Itaperuna/RJ

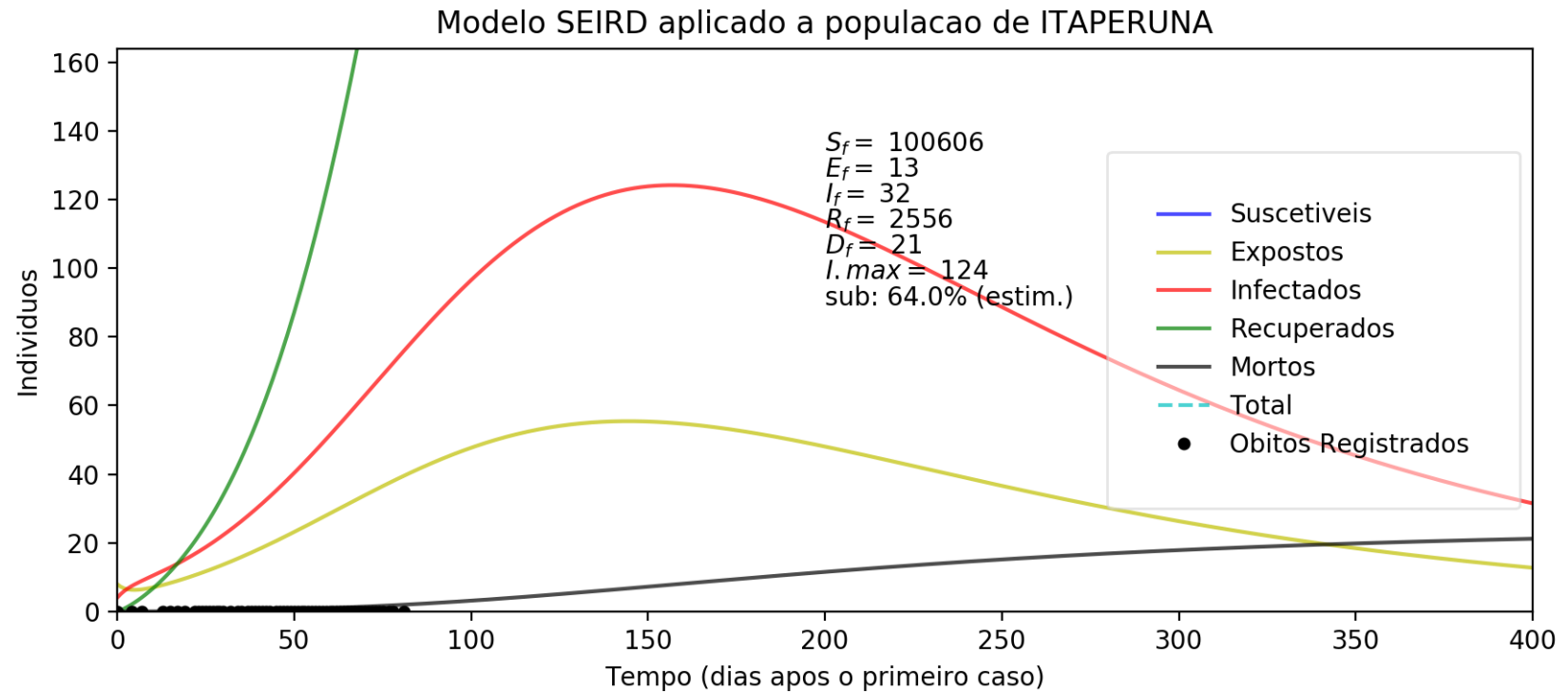


# Itaperuna/RJ



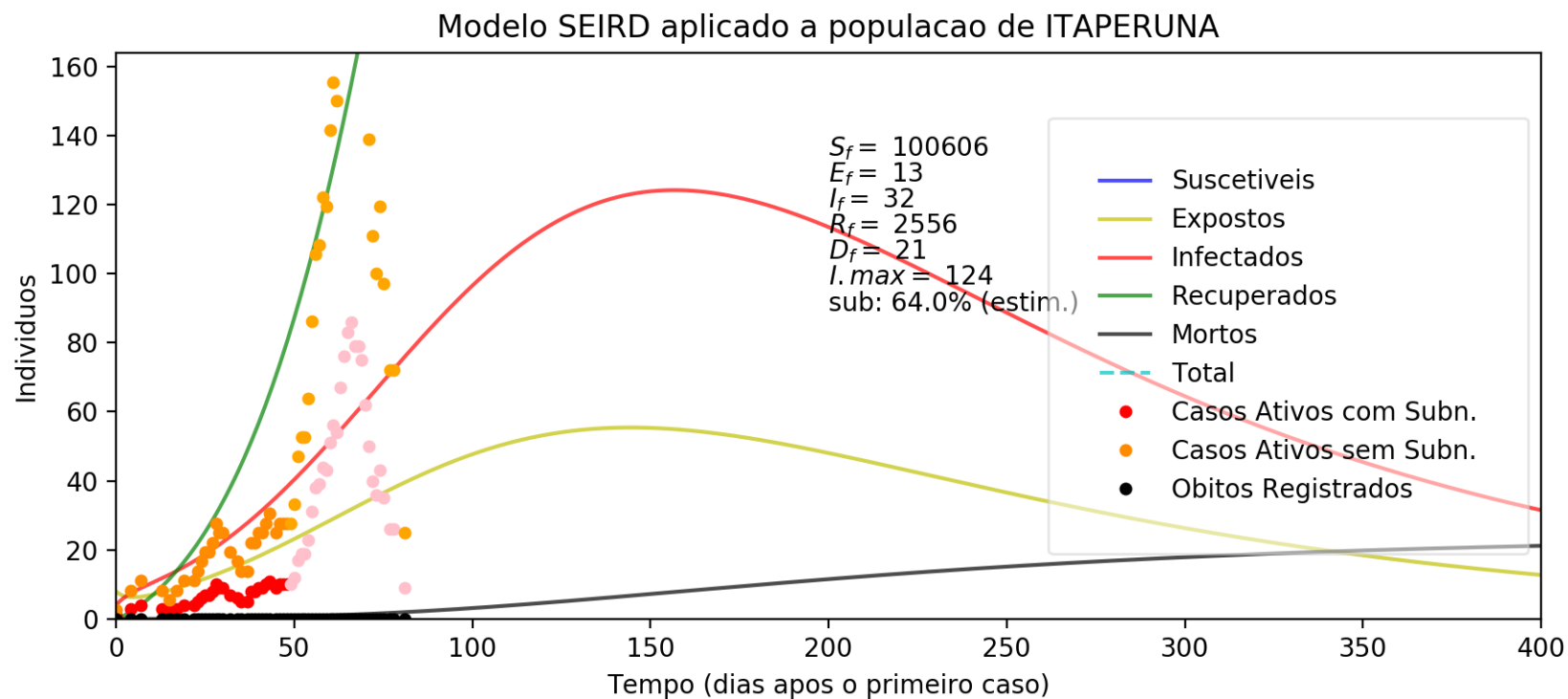
Este não é mais o cenário real de Itaperuna,  
poderia ter sido!

# Itaperuna/RJ



Este não é mais o cenário real de Itaperuna,  
poderia ter sido!

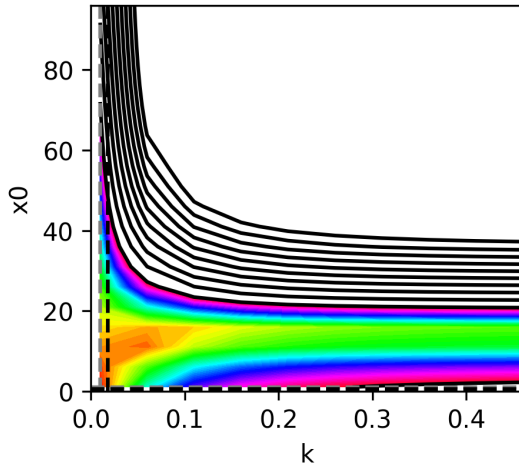
# Itaperuna/RJ



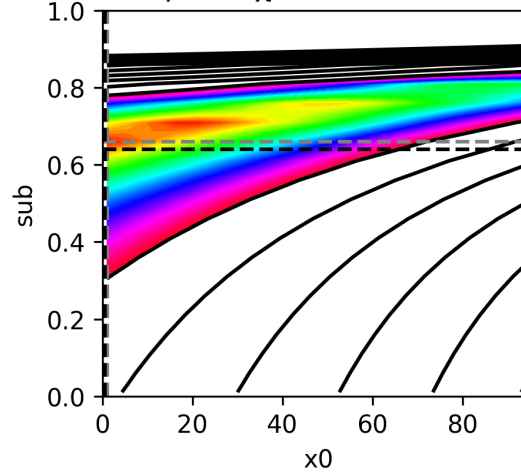
Este não é mais o cenário real de Itaperuna,  
poderia ter sido!

# Itaperuna/RJ

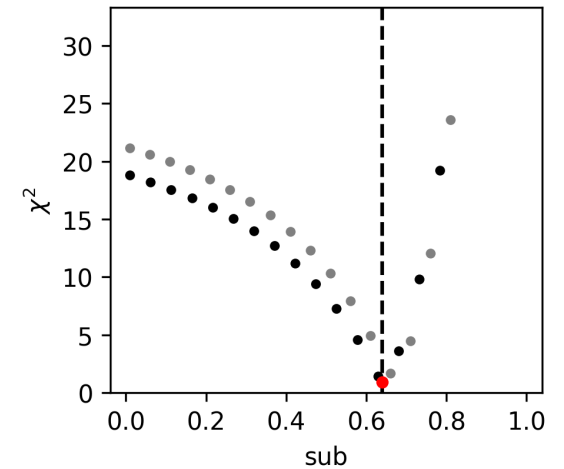
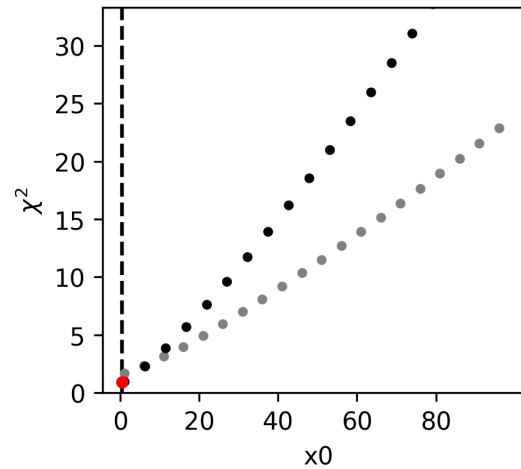
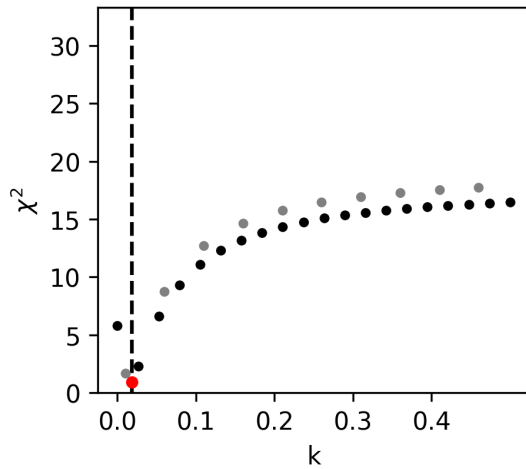
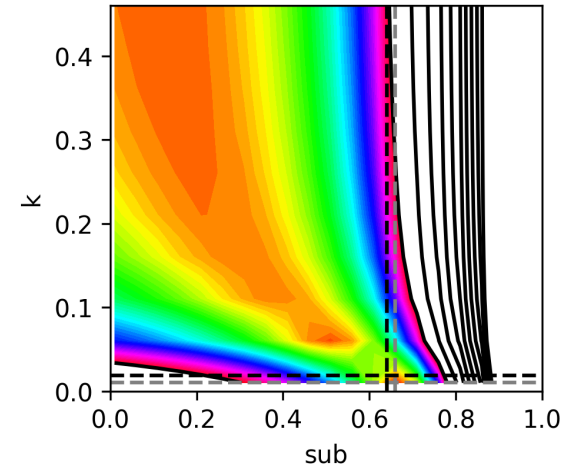
Mapa de  $\chi^2$  em sub= 64.0%



Mapa de  $\chi^2$  em k=0.01835



Mapa de  $\chi^2$  em x0=0.48130



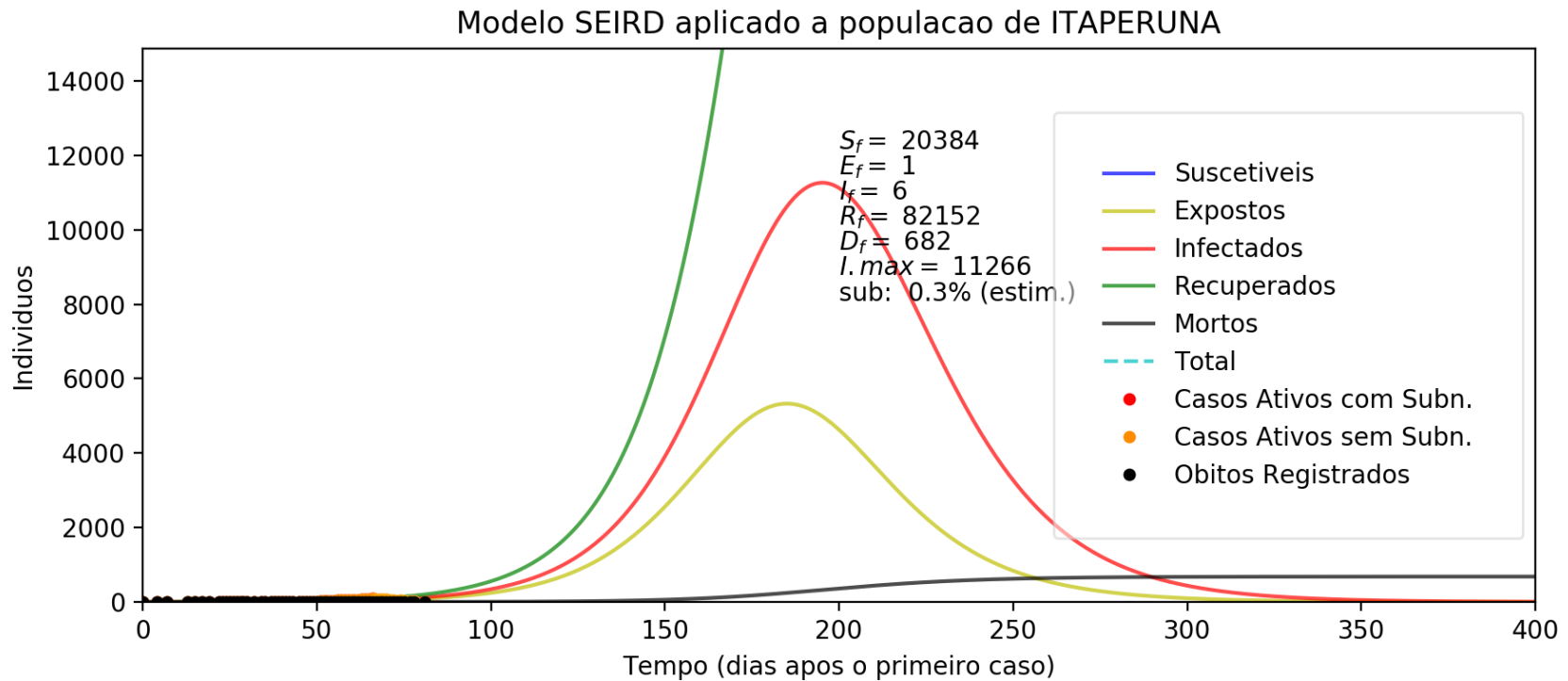
# Itaperuna/RJ



- $218/382 = 57\%$  de casos ativos
- 702 casos em monitoramento
- $382/852 = 44,8\%$  de positivos
- A cada 3 exames, 1 é positivo (31% de testes positivos) testagem devia ser maior; começou bem mas diminuíram nº de testes)
- $9 \text{ óbitos}/382 = 2,3\%$
- Provavelmente já passaram 900 casos

# Itaperuna/RJ

## cenário real (preocupante!)

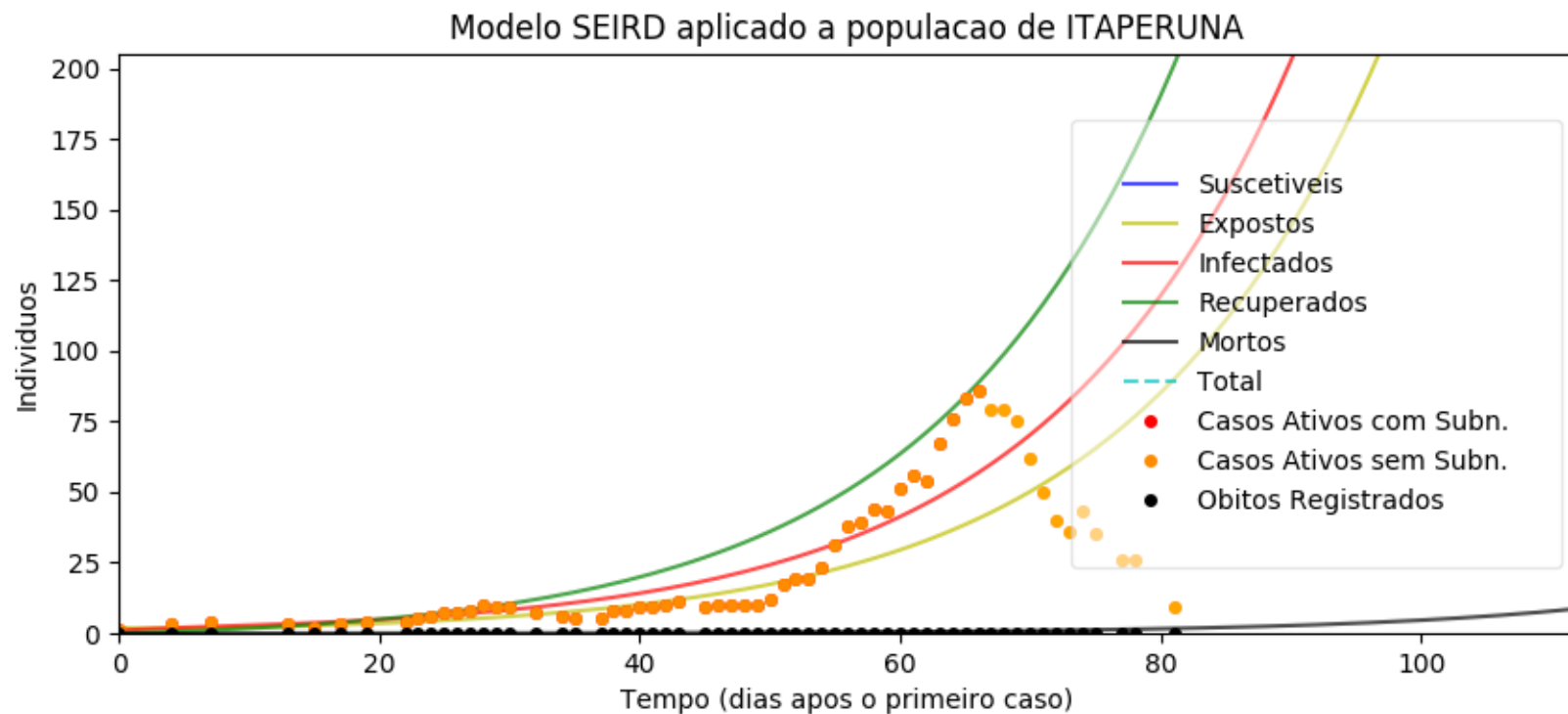


Os valores acima com certeza estão superestimados, mas apontam para um cenário preocupante.



# Itaperuna/RJ

## cenário real (preocupante!)



# Como seria sem isolamento social?

21/05/2020 – sem isolamento social					
Município	Pico de infectados	Hospitalizações durante o pico	Nº final de Suscetíveis	Nº final de Recuperados	Nº final de Óbitos
Campos dos Goytacazes	22782	2733	315978	186559	2961
Itaocara	3409	409	2625	20290	322
Itaperuna	3614	433	69771	32445	515
Miracema	2714	325	9701	17187	272
Pirapetinga	111	13	9304	1370	21
Santo Antônio de Pádua	7129	855	4662	37225	590
São Fidélis	4851	582	8696	29505	468

# Cenário atual com isolamento social

11/06/2020 – com isolamento social					
Município	Pico de infectados	Hospitalizações durante o pico	Nº final de Suscetíveis	Nº final de Recuperados	Nº final de Óbitos
Campos dos Goytacazes (sem incluir período do lockdown) superestimado	13311	1597	332127	162507	1348
Itaocara	2045	245	5771	17317	144
Itaperuna (*)	124	15	100606	2556	21
Itaperuna (caso atual) superestimado	11266	1351	20384	82152	682
Miracema	120	14	24873	2259	19
Pirapetinga					
Santo Antônio de Pádua	181	22	40183	2262	19
São Fidélis (ausência de dados?)	4780	26	34557	4026	33

# Comparativo cenário atual x sem isolamento

Município	Pico de infectados	Hospitalizações durante o pico	Nº final de Suscetíveis	Nº final de Recuperados	Nº final de Óbitos
Campos dos Goytacazes	5,75%	58,43%	105,11%	87,11%	45,53%
Itaocara	59,99%	59,90%	219,85%	85,35%	44,72%
Itaperuna	311,73%	312,01%	29,22%	253,20%	132,43%
Miracema	4,42%	4,31%	256,4%	13,14%	6,99%
Pirapetinga					
Santo Antônio de Pádua	2,54%	2,57%	861,93%	6,08%	3,22%
São Fidélis	98,54%	4,47%	397,39%	13,65%	7,05%

# FIM

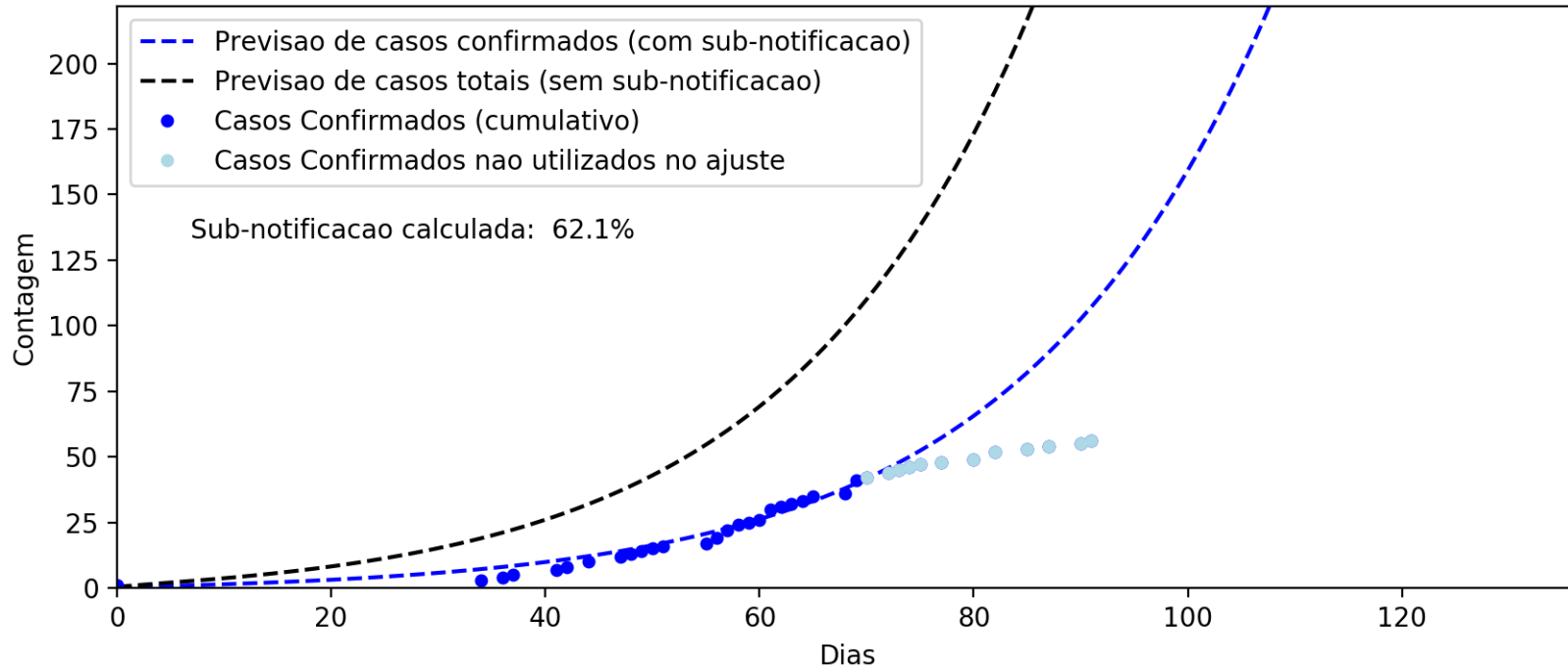
- Muito obrigado!
- Dúvidas: [tiberio\\_vale@id.uff.br](mailto:tiberio_vale@id.uff.br)
- [www.professores.uff.br/tiberio](http://www.professores.uff.br/tiberio)

# Referências

- [1] Painel COVID da Secretaria Estadual da Saúde/RJ.  
<http://painel.saude.rj.gov.br/>
- [2] DATA.RIO. <http://www.data.rio/app/painel-rio-covid-19>
- [3] Worldometers. <https://www.worldometers.info/coronavirus/>
- [4] DATASUS.<https://datasus.saude.gov.br/populacao-residente/>
- [5] Brauer, Fred; van den Driessche, Pauline; Wu, J. **Mathematical Epidemiology** . Berlin: Springer-Verlag, 2008.
- [6] Froese, Henri. **Infectious Disease Modelling: Beyond the Basic SIR Model**.  
<https://towardsdatascience.com/infectious-disease-modelling-beyond-the-basic-sir-model-216369c584c4>
- [7] Stephen A. Lauer; Kyra H. Grantz; et al. The Incubation Period of Coronavirus Disease 2019 (COVID-19) From Publicly Reported Confirmed Cases: Estimation and Application, **Annals of Internal Medicine**, Vol. 172, Nº 9, p. 577-582  
doi:10.7326/M20-0504
- [8] Reis, R. F.; Quintela, B. M.; Campos, J. O.; Gomes, J. M.; Pompei, L. T.; Rocha, B. M.; Lobosco, M.; dos Santos, R. W. **Nota Técnica 02: Características e Projeções da Pandemia COVID-19 no Brasil, Minas Gerais e Juiz de Fora**. Disponível em [http://www.ufjf.br/pgmc/files/2020/03/nt02\\_covid19\\_pgmc\\_ufjf2.pdf](http://www.ufjf.br/pgmc/files/2020/03/nt02_covid19_pgmc_ufjf2.pdf)

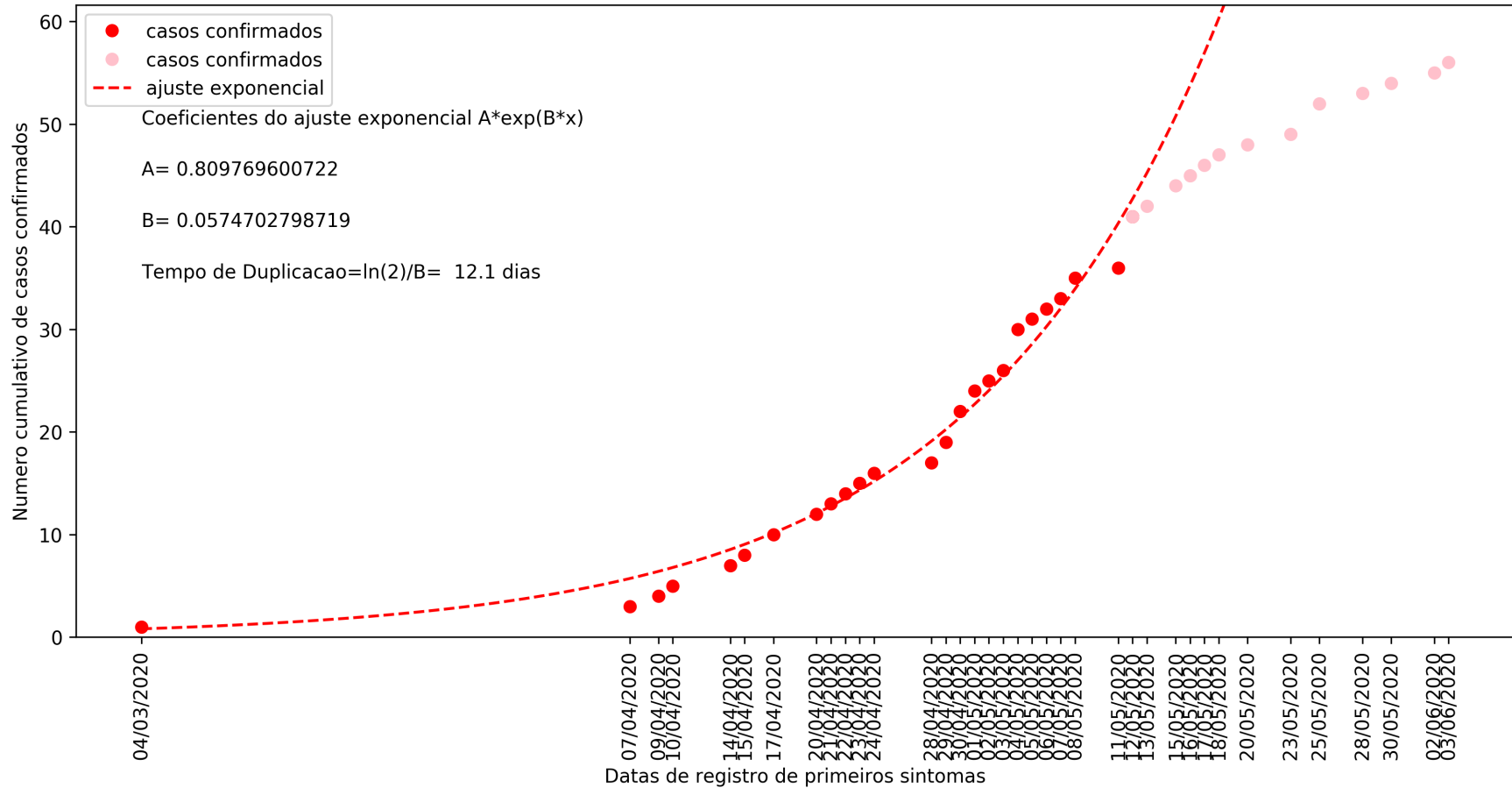
# Itaocara/RJ

Ajuste do modelo aos Casos Confirmados de ITAOCARA com dados ate 03/06/2020



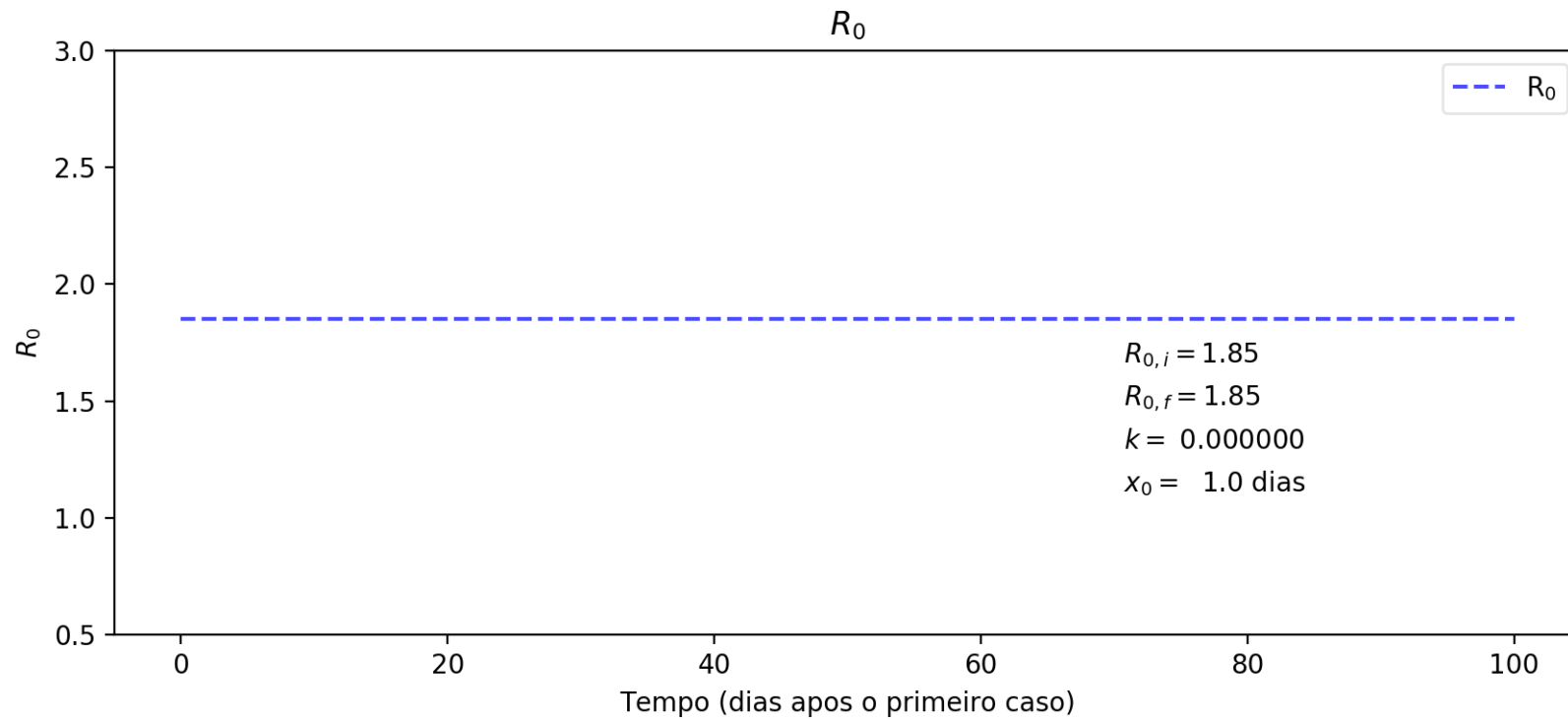
# Itaocara/RJ

Ajuste exponencial aos dados epidemiologicos de ITAOCARA/RJ



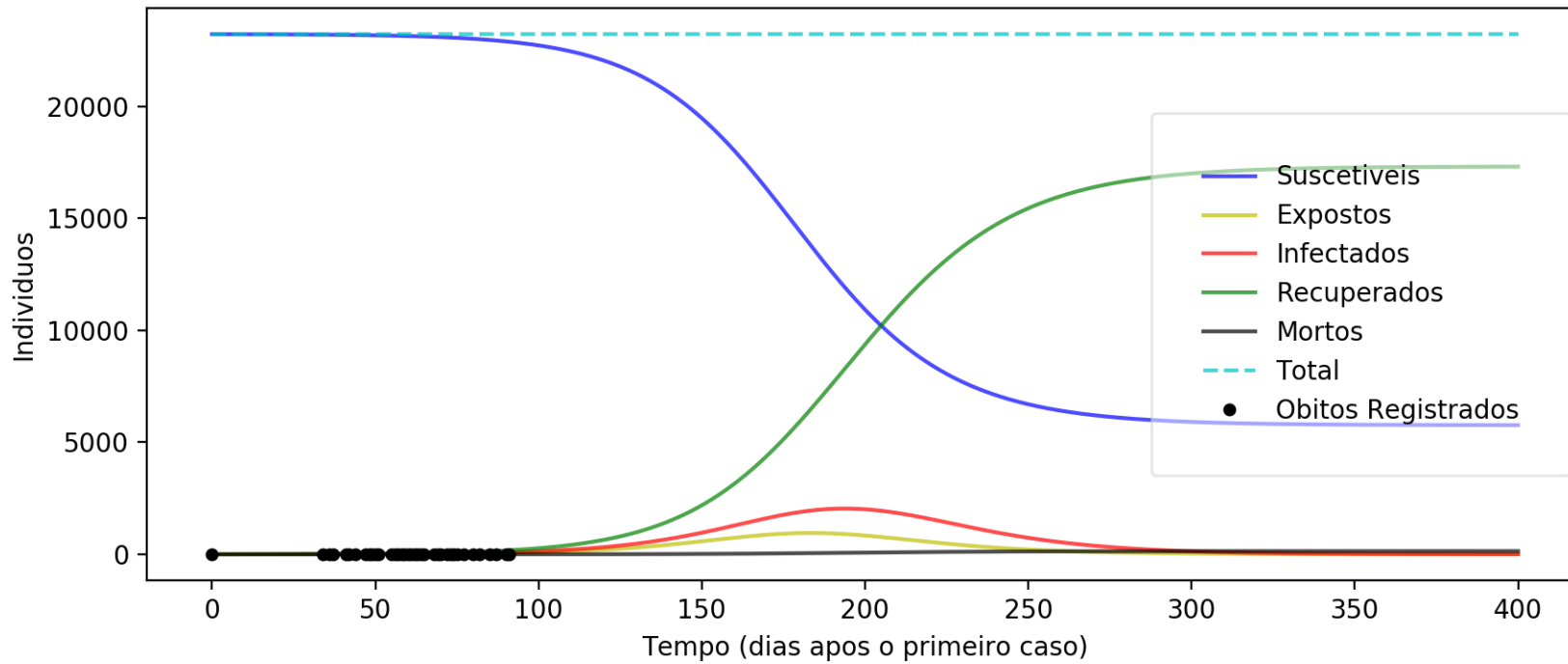


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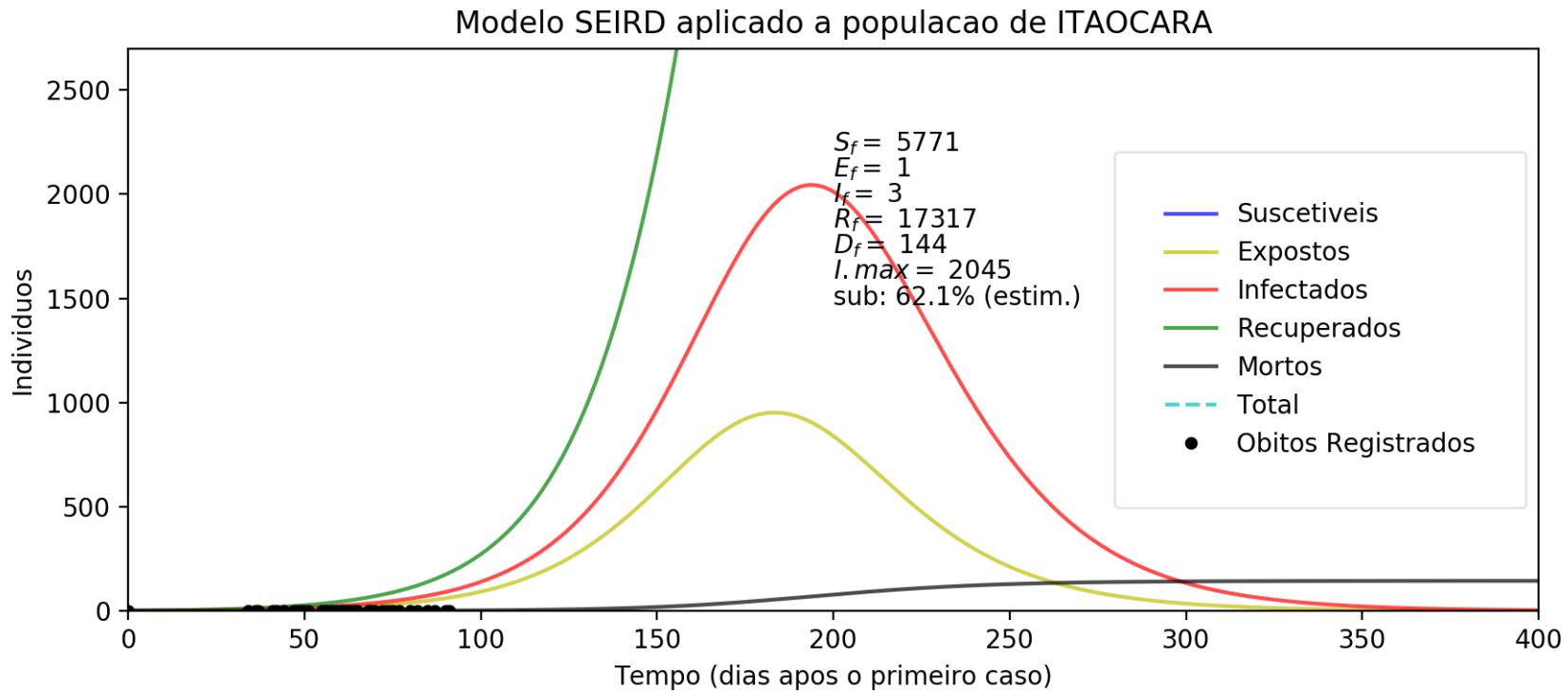


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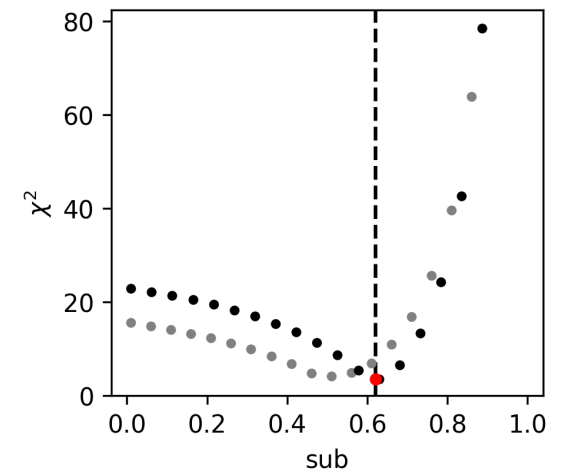
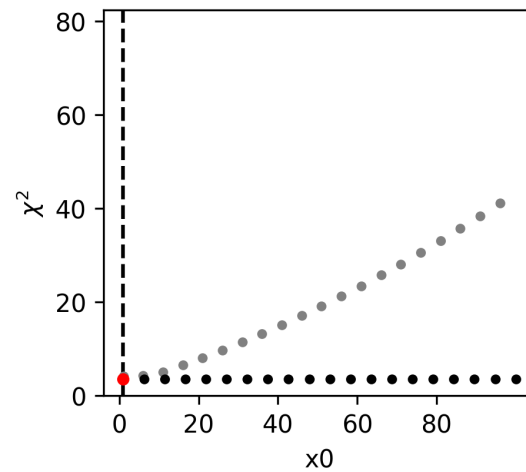
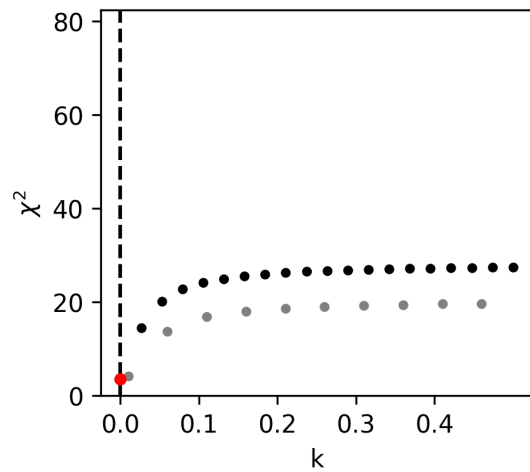
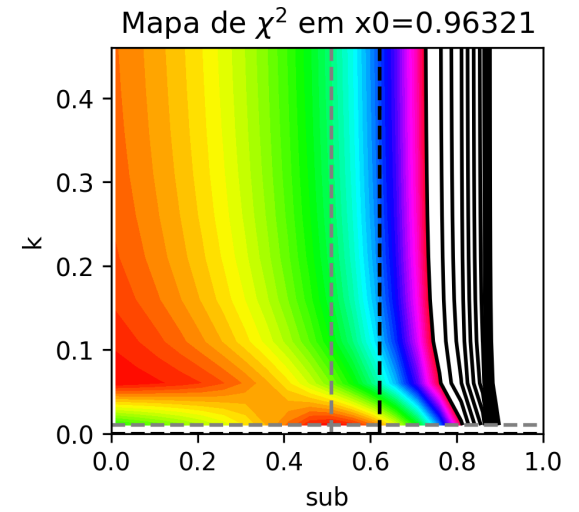
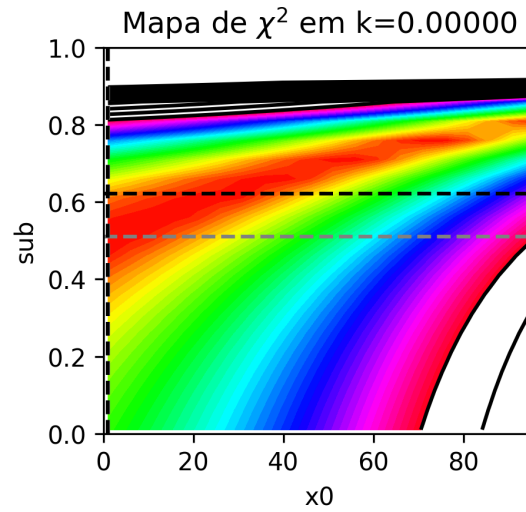
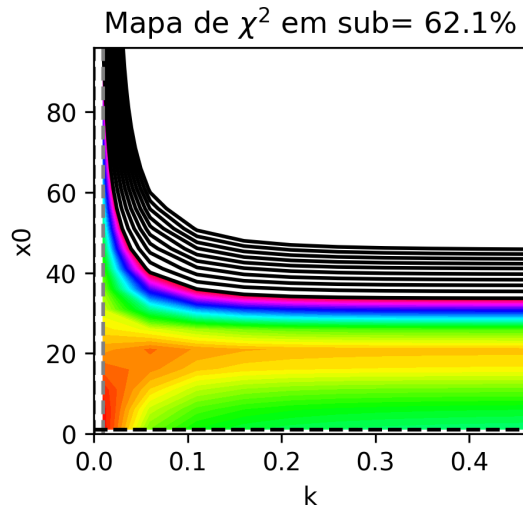
Modelo SEIRD aplicado a populacao de ITAOCARA



# Itaocara/RJ

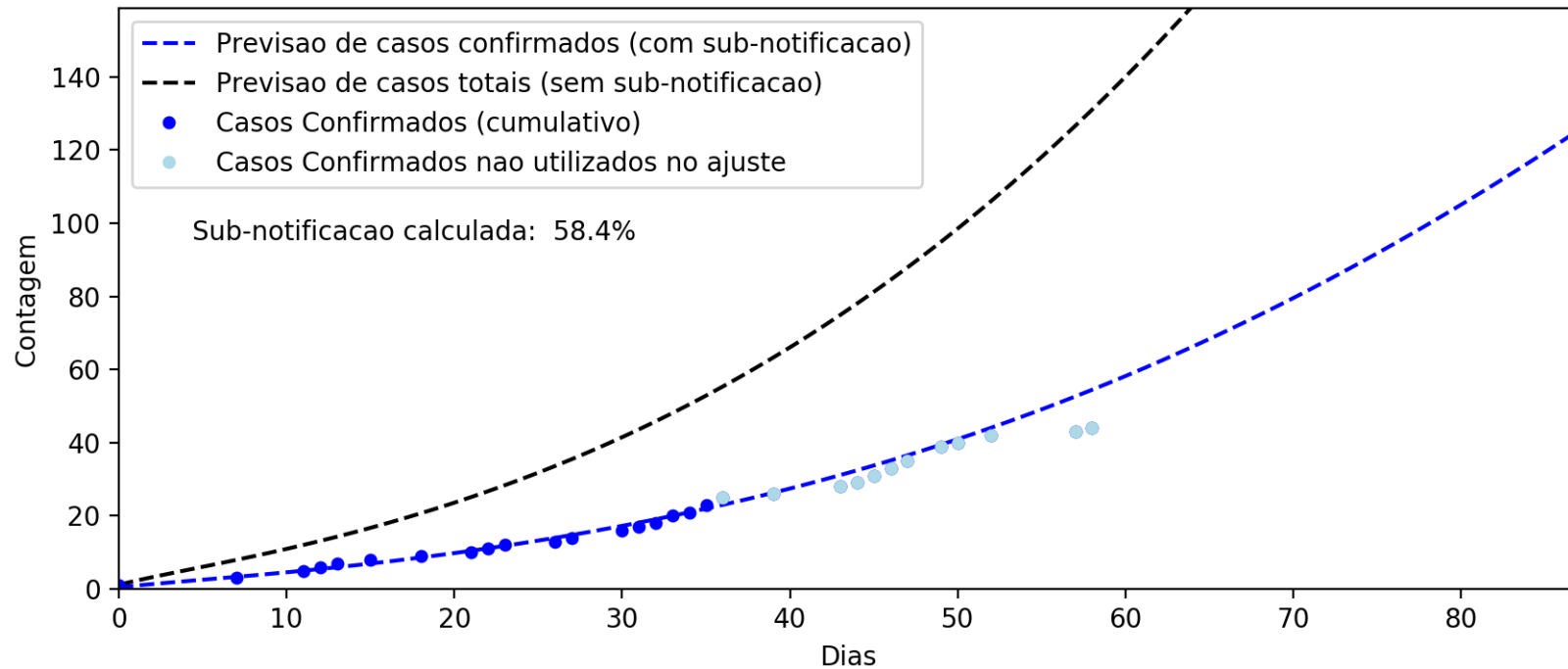


# Itaocara/RJ

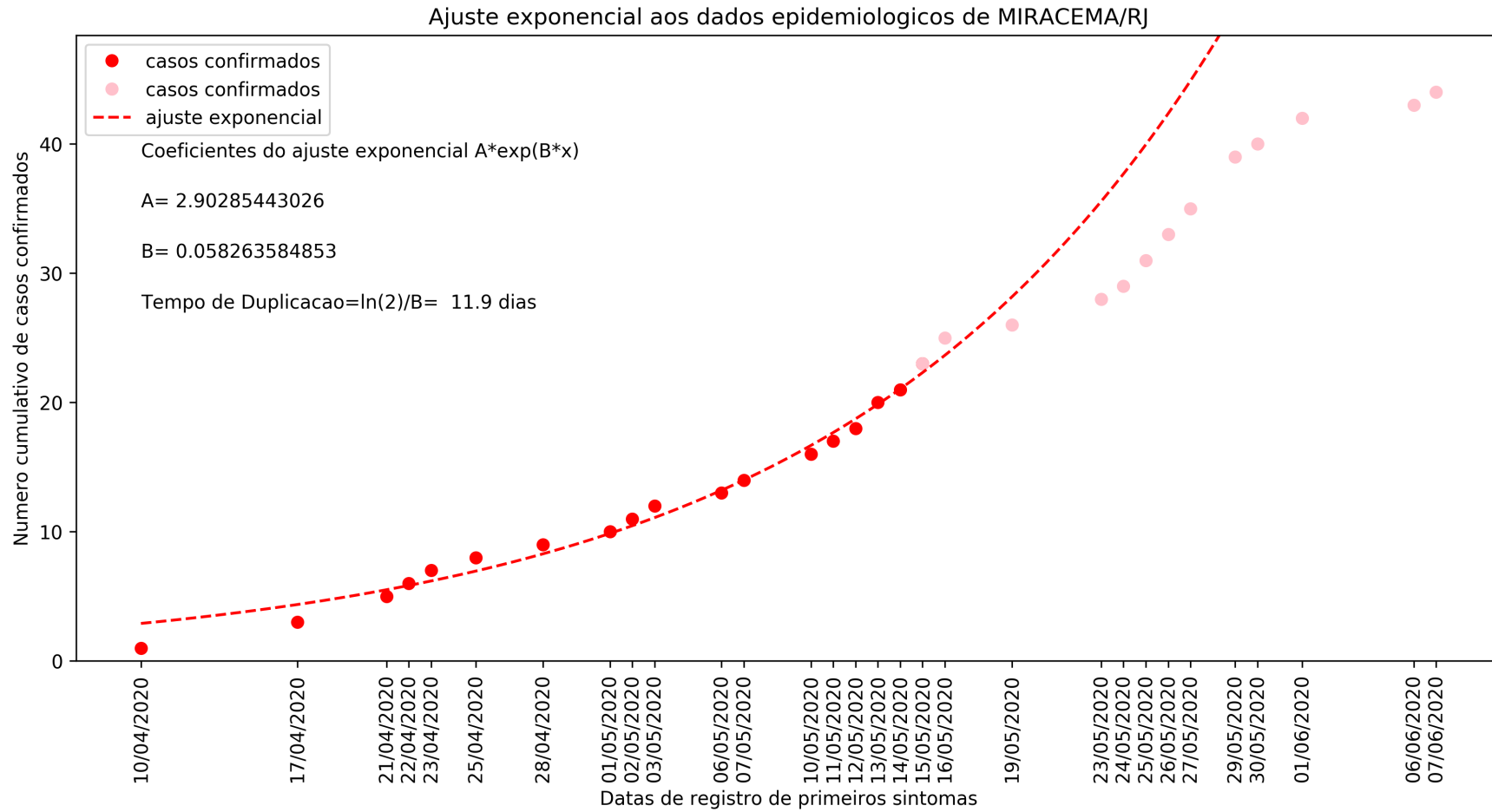


# Miracema/RJ

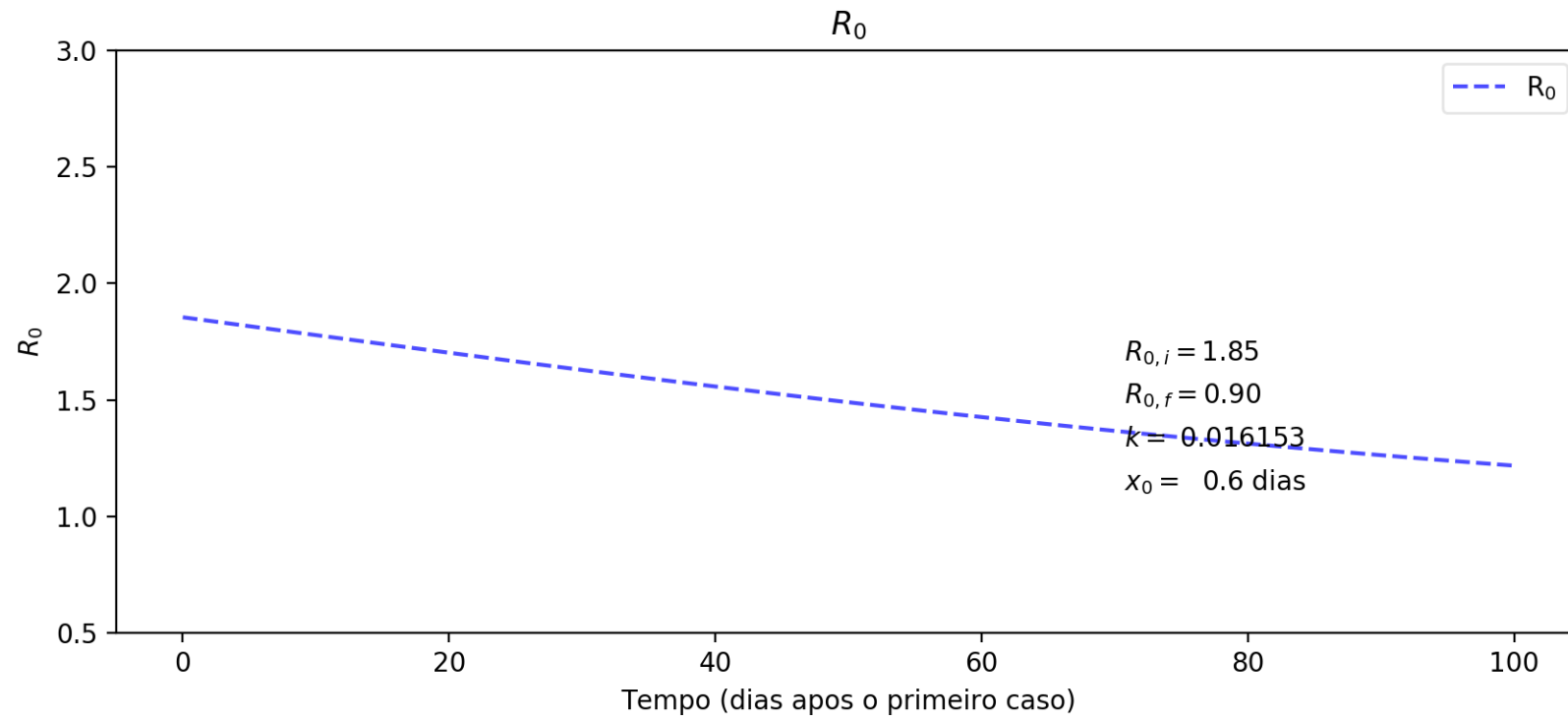
Ajuste do modelo aos Casos Confirmados de MIRACEMA com dados ate 07/06/2020



# Miracema/RJ

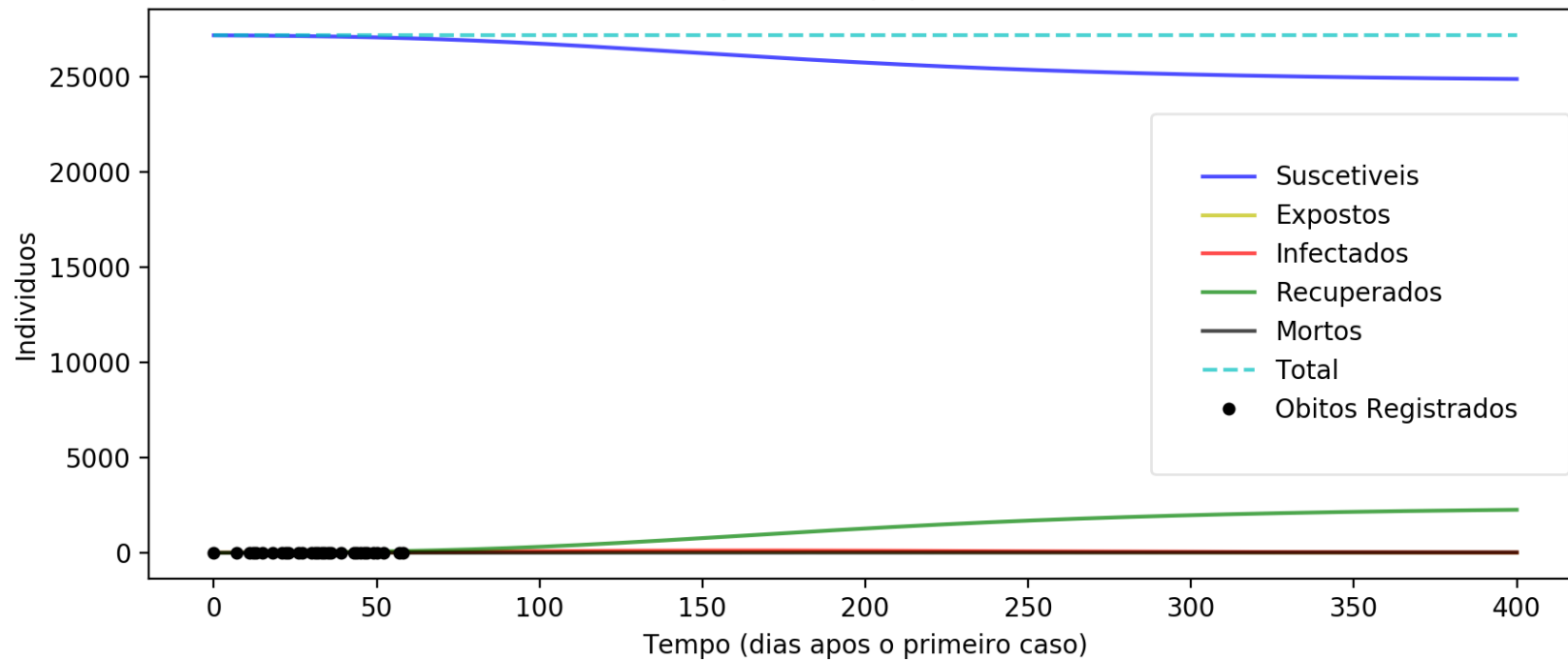


# Miracema/RJ



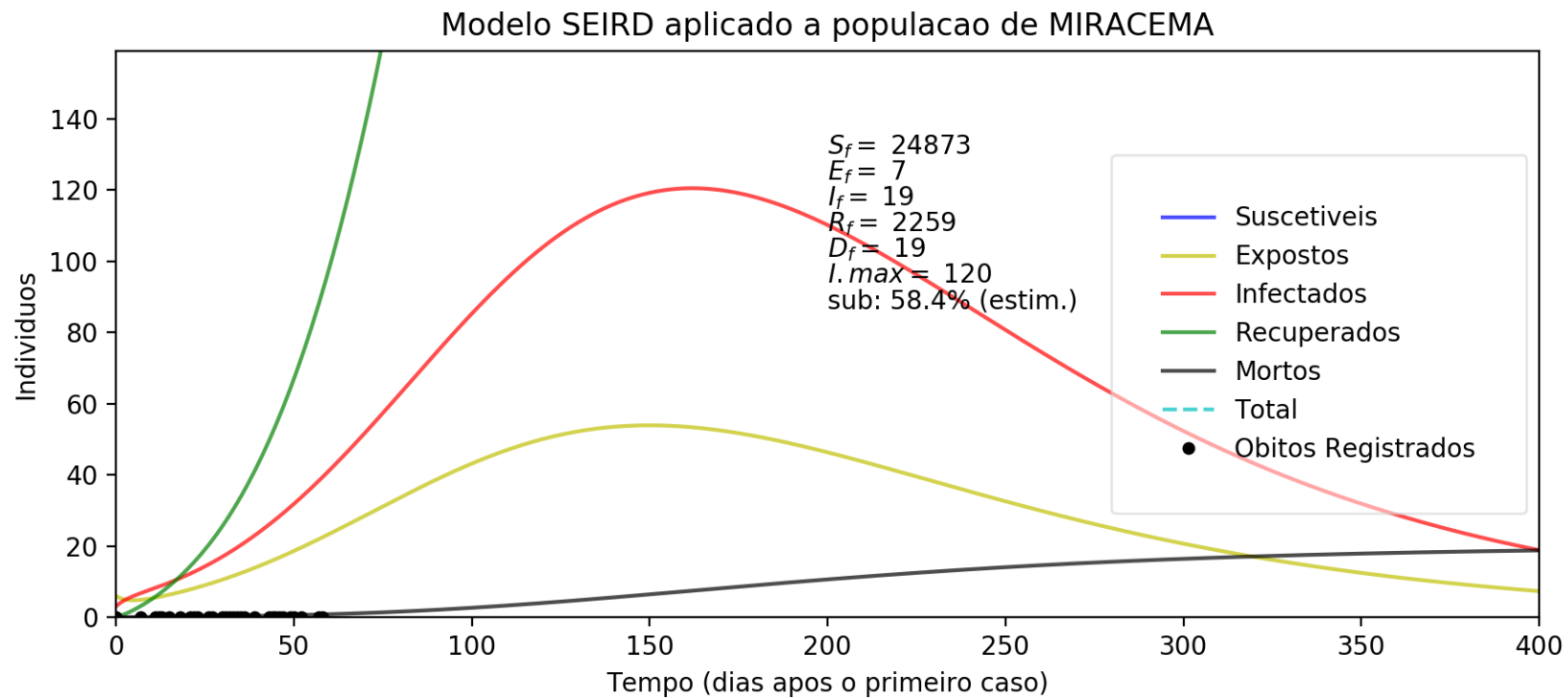
# Miracema/RJ

Modelo SEIRD aplicado a populacao de MIRACEMA

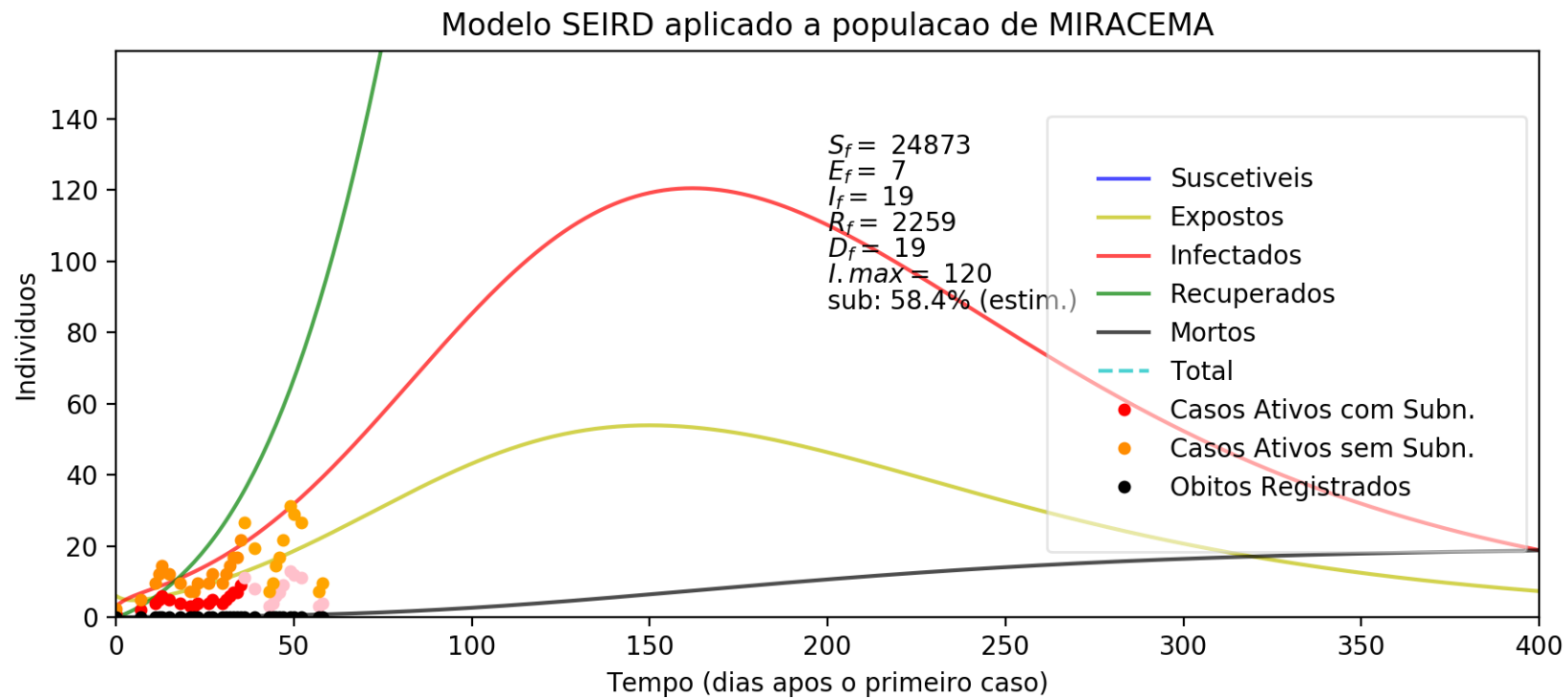


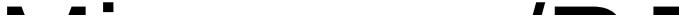


# Miracema/RJ

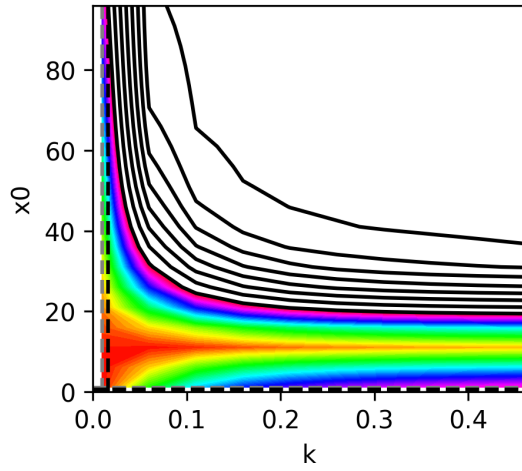


# Miracema/RJ

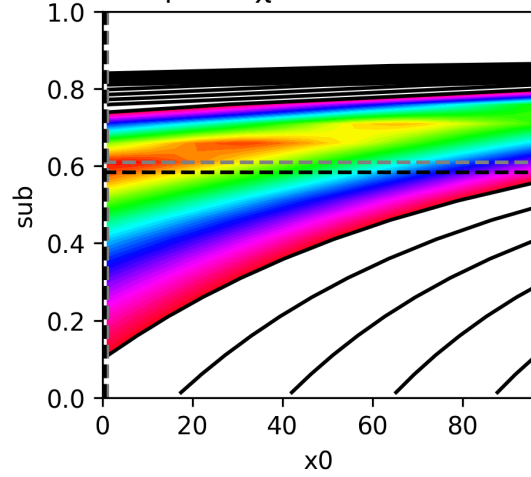




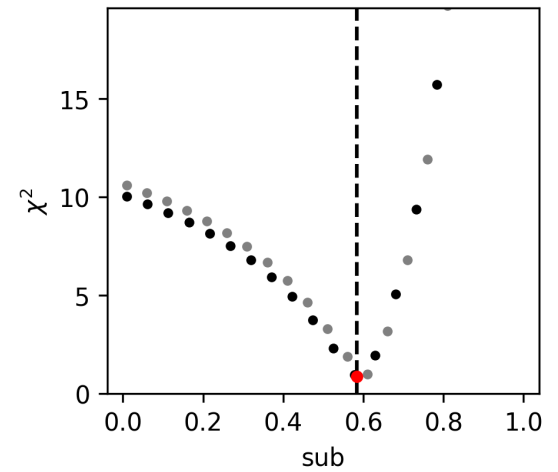
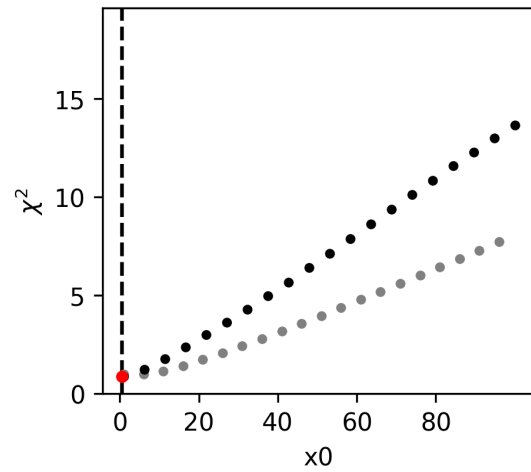
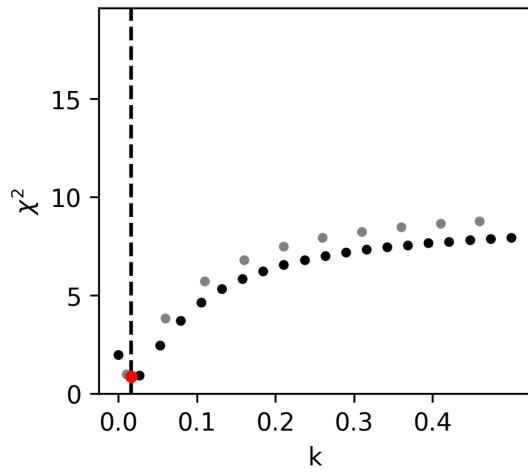
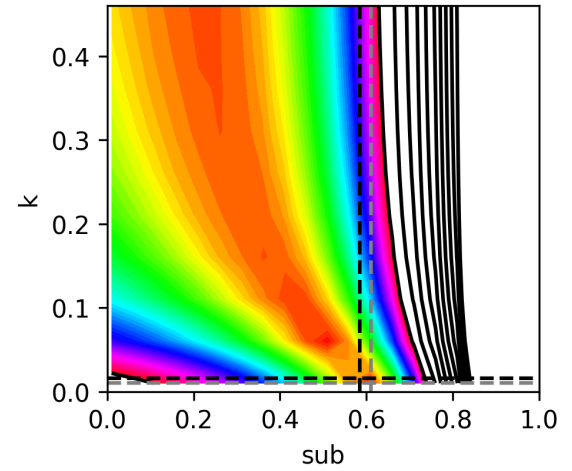
Mapa de  $\chi^2$  em sub= 58.4%



Mapa de  $\chi^2$  em k=0.01615

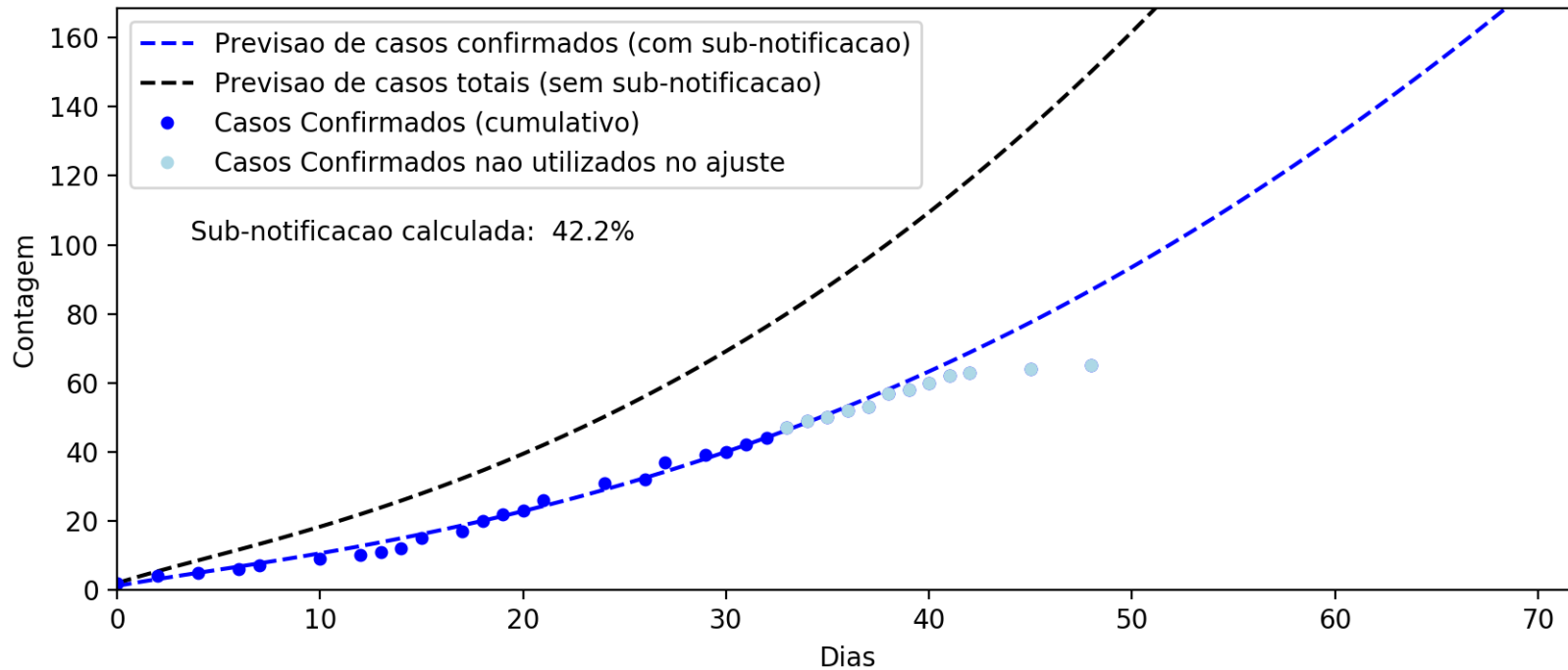


Mapa de  $\chi^2$  em x0=0.59751

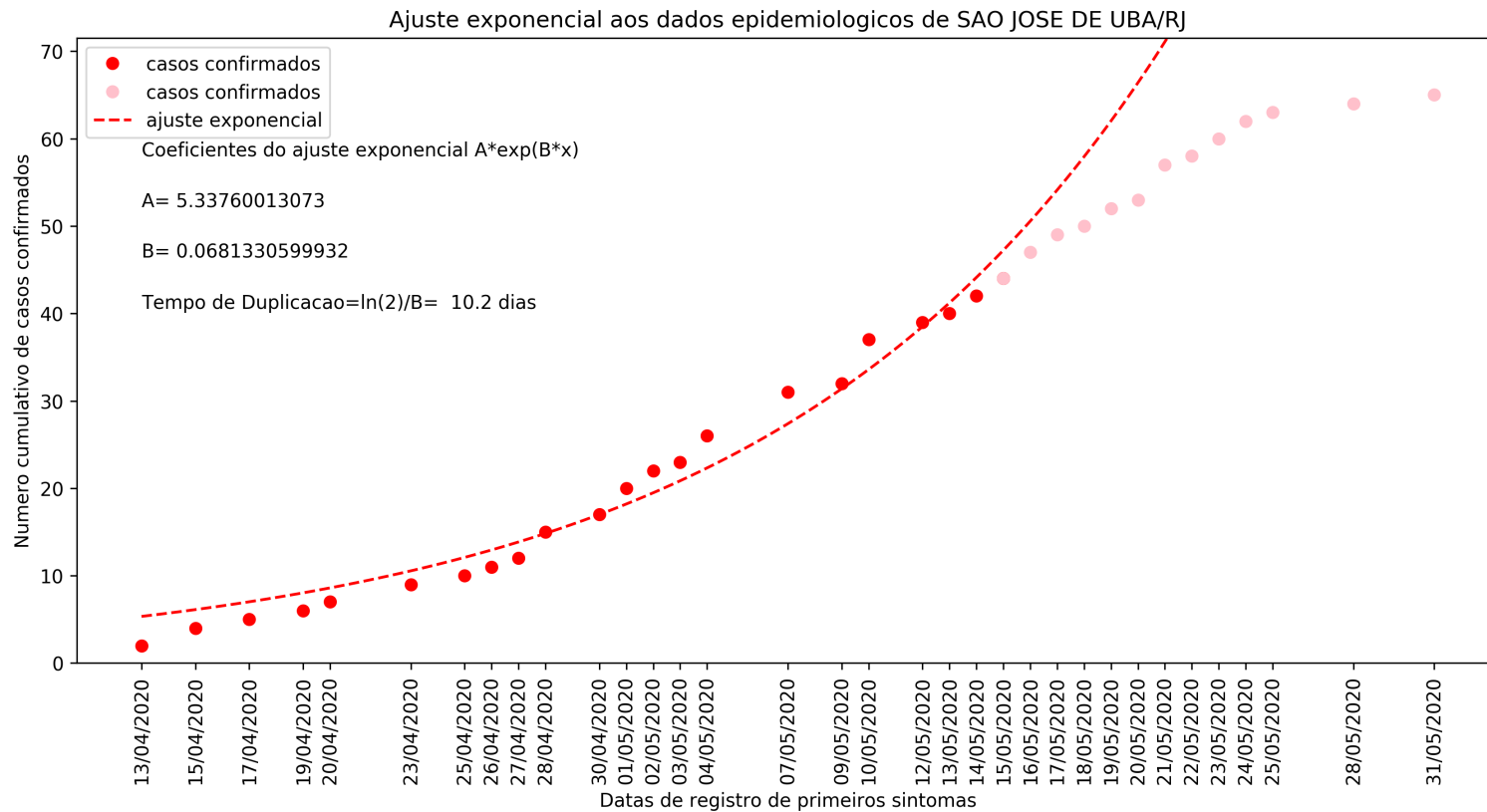


# São José de Ubá/RJ

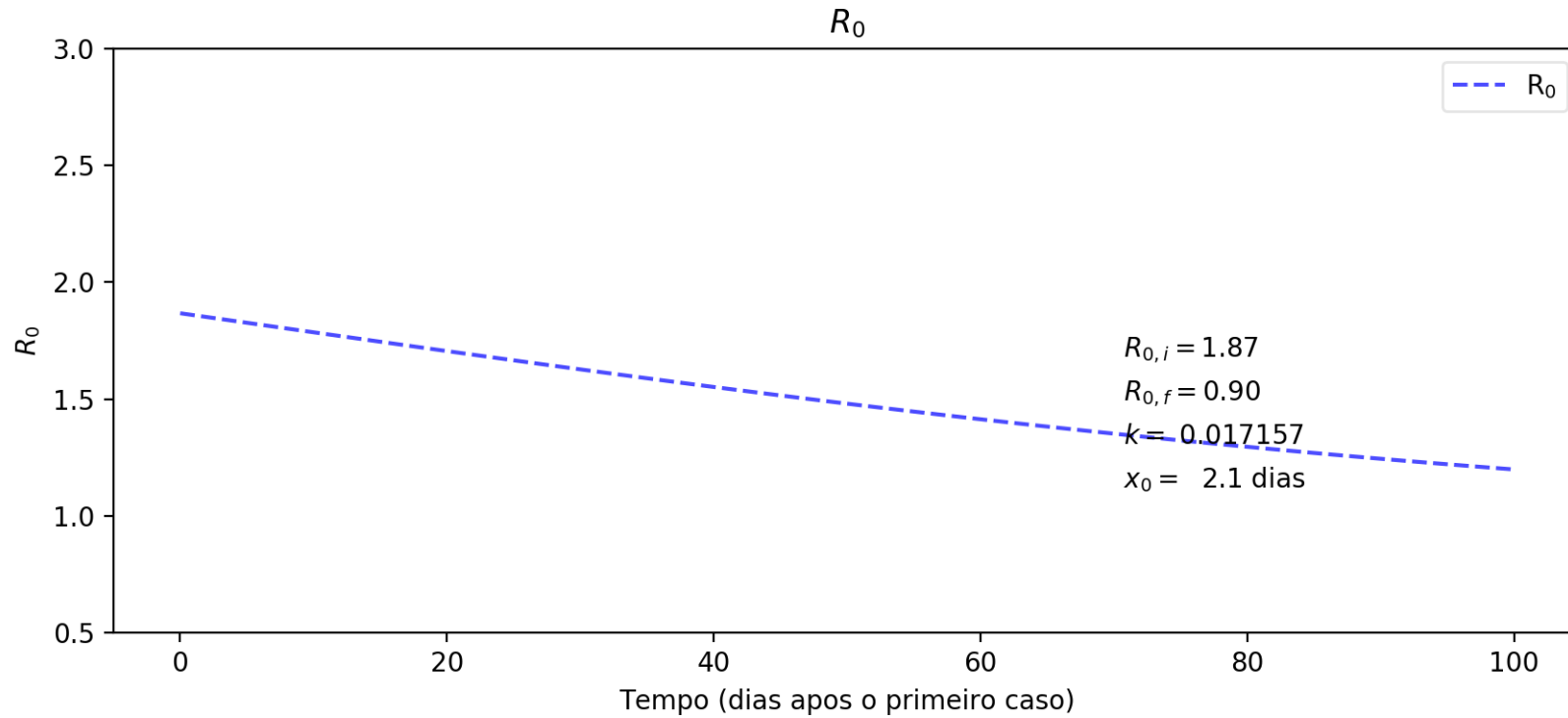
Ajuste do modelo aos Casos Confirmados de SAO JOSE DE UBA com dados ate 31/05/2020



# São José de Ubá/RJ

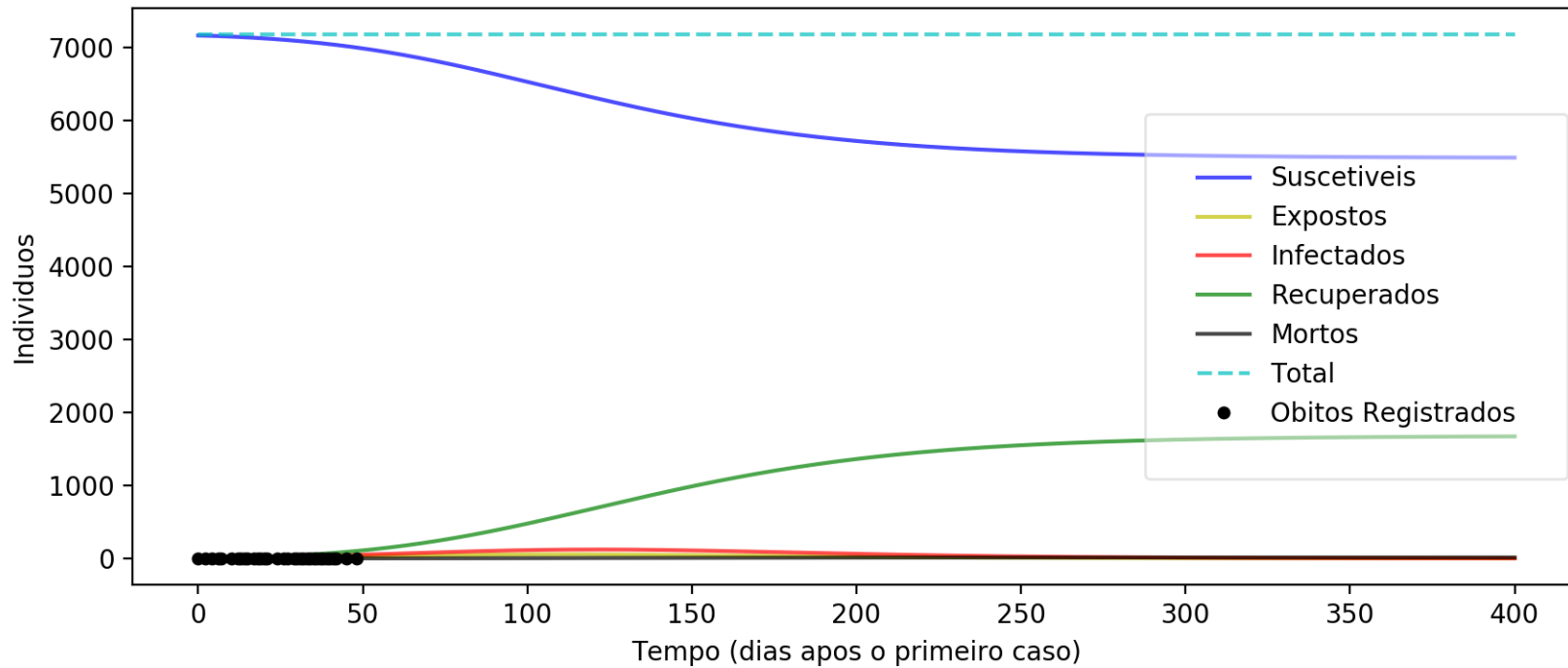


# São José de Ubá/RJ



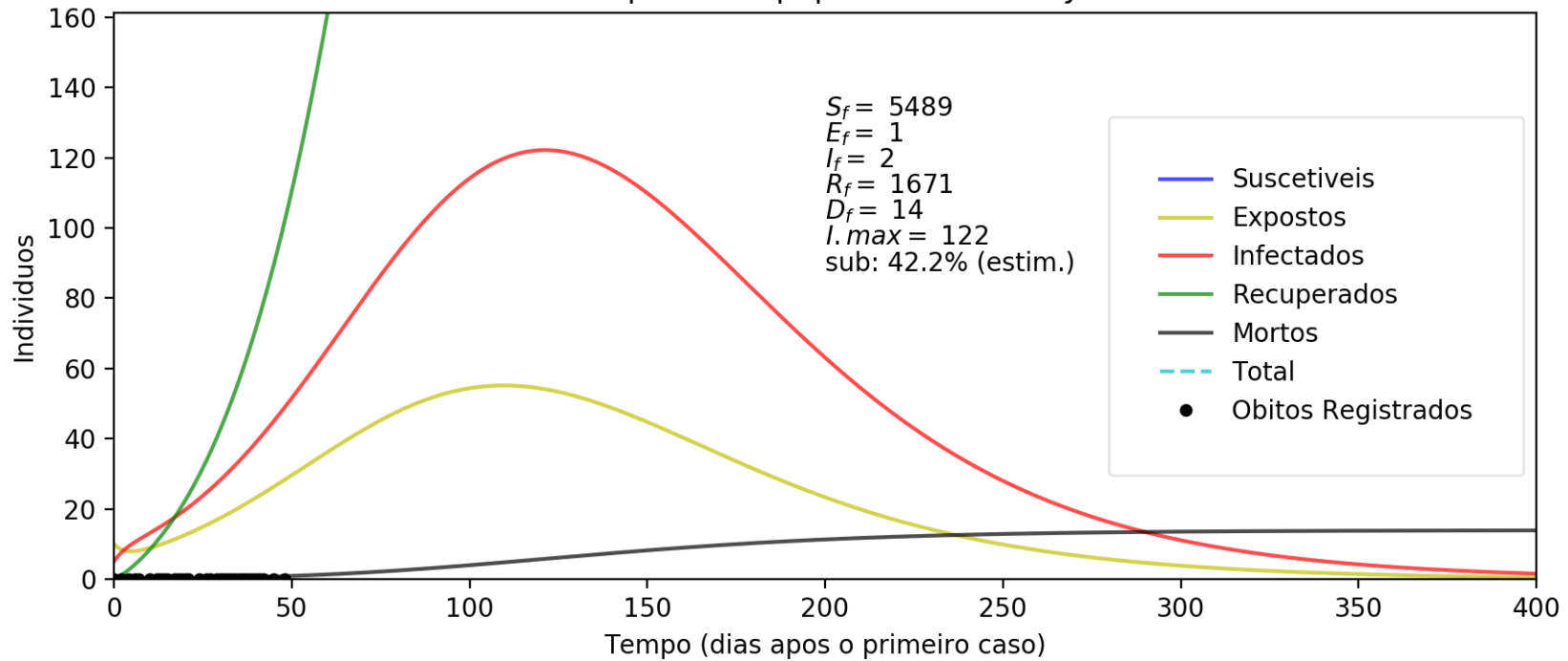
# São José de Ubá/RJ

Modelo SEIRD aplicado a população de SAO JOSE DE UBA



# São José de Ubá/RJ

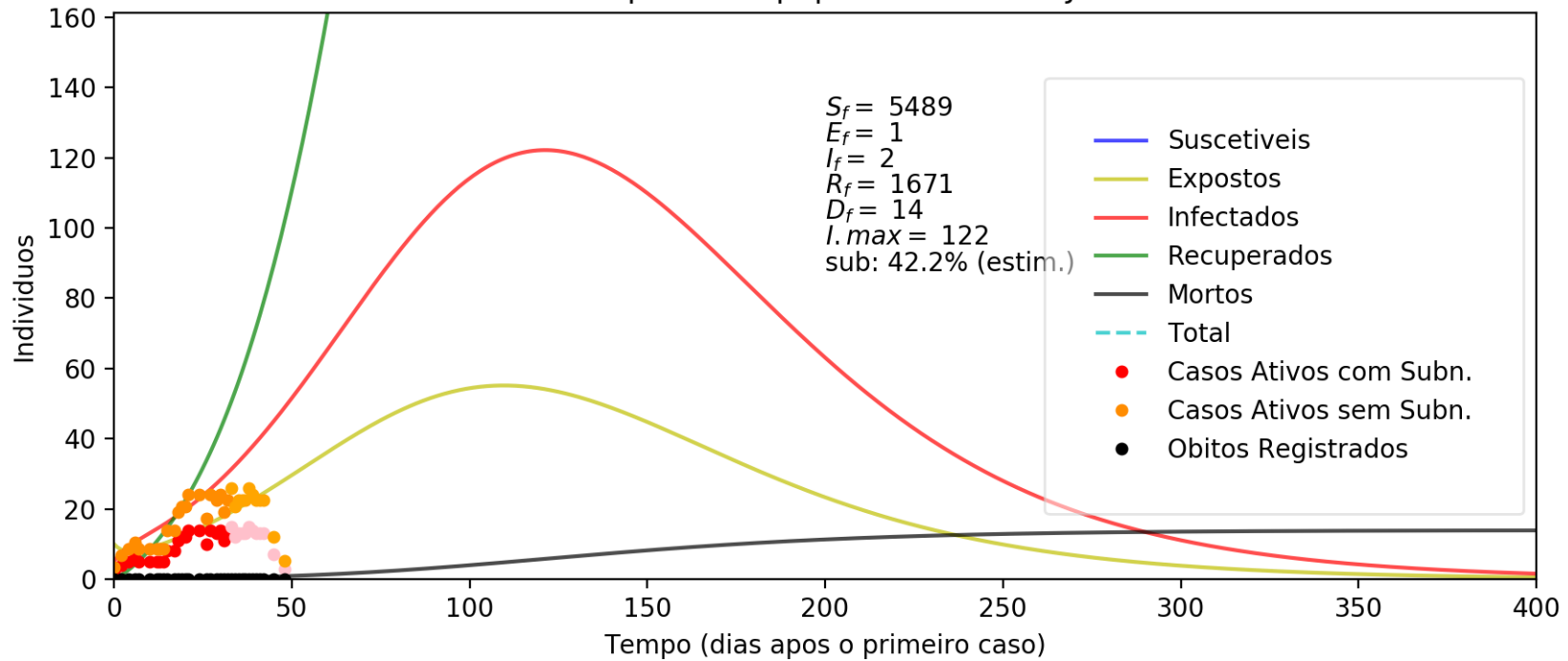
Modelo SEIRD aplicado a população de SAO JOSE DE UBA



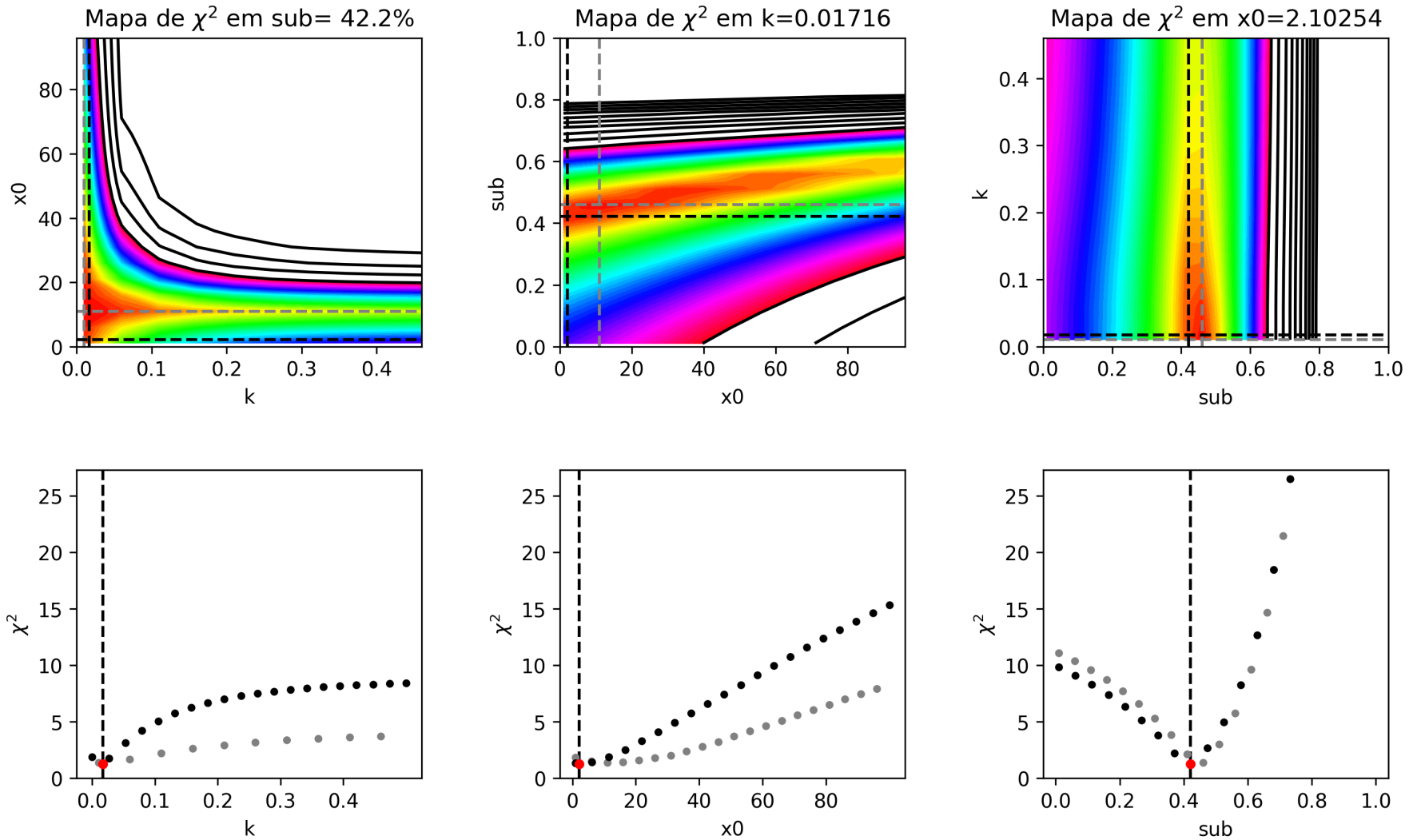


# São José de Ubá/RJ

Modelo SEIRD aplicado a população de SAO JOSE DE UBA

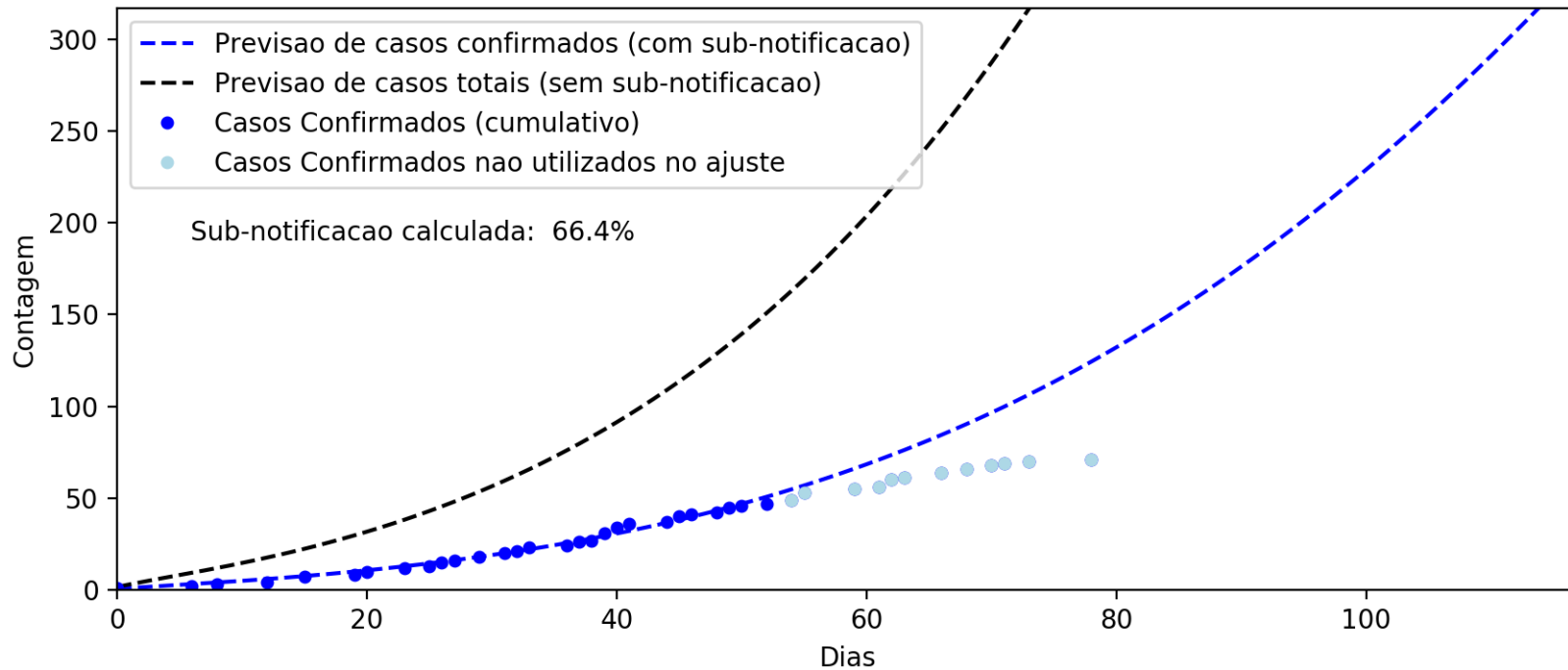


# São José de Ubá/RJ



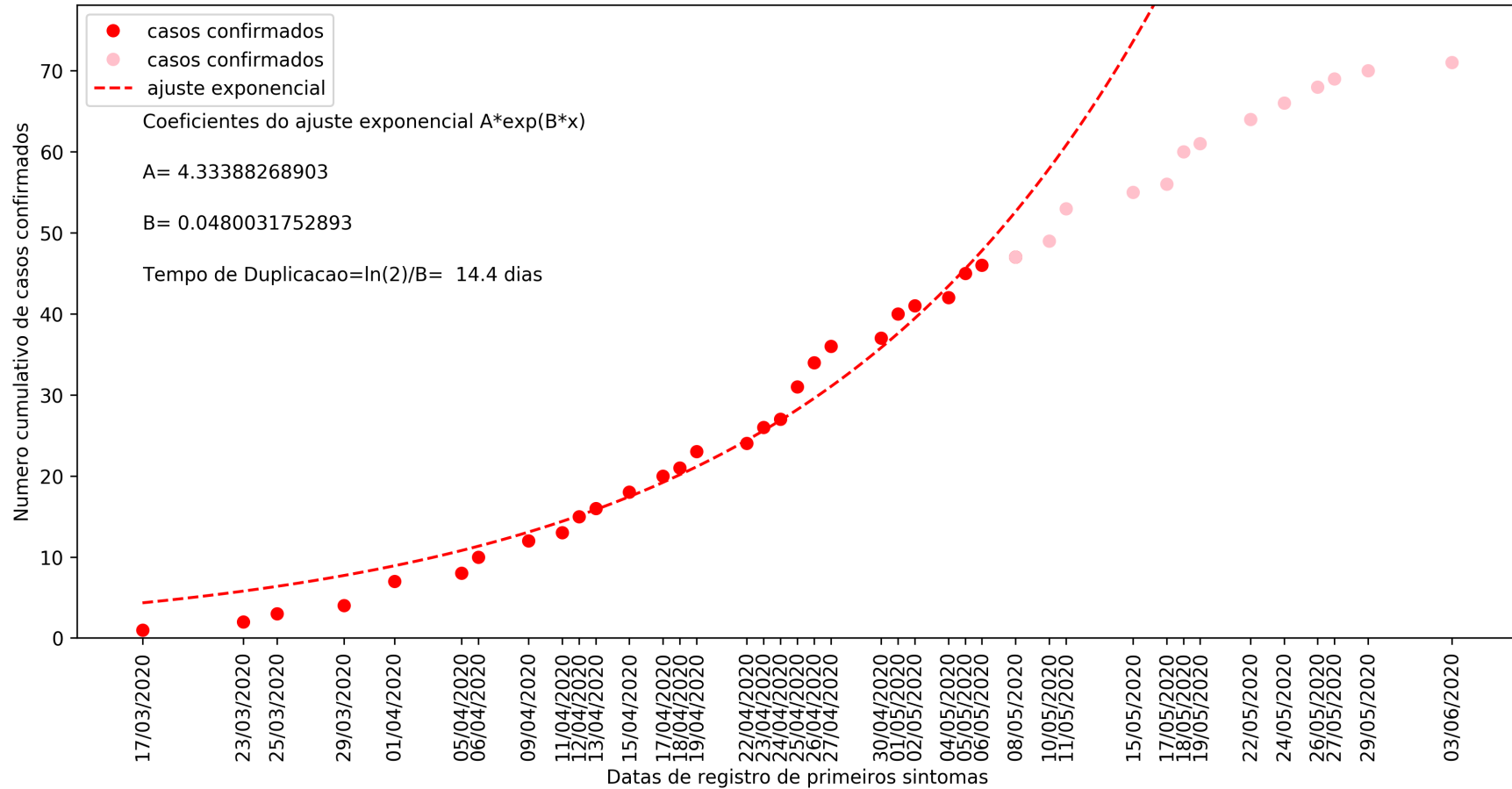
# Bom Jesus do Itabapoana/RJ

Ajuste do modelo aos Casos Confirmados de BOM JESUS DO ITABAPOANA com dados ate 03/06/2020

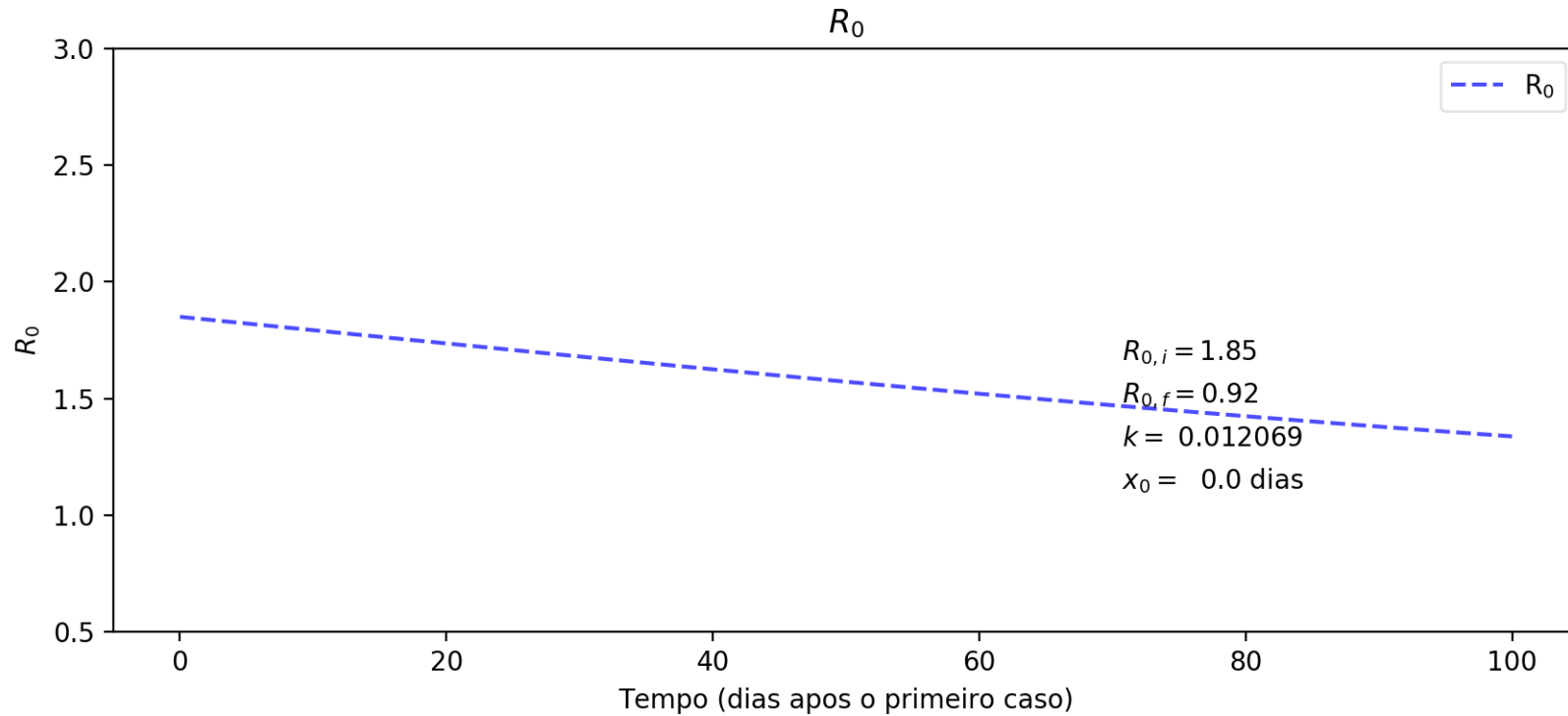


# Bom Jesus do Itabapoana/RJ

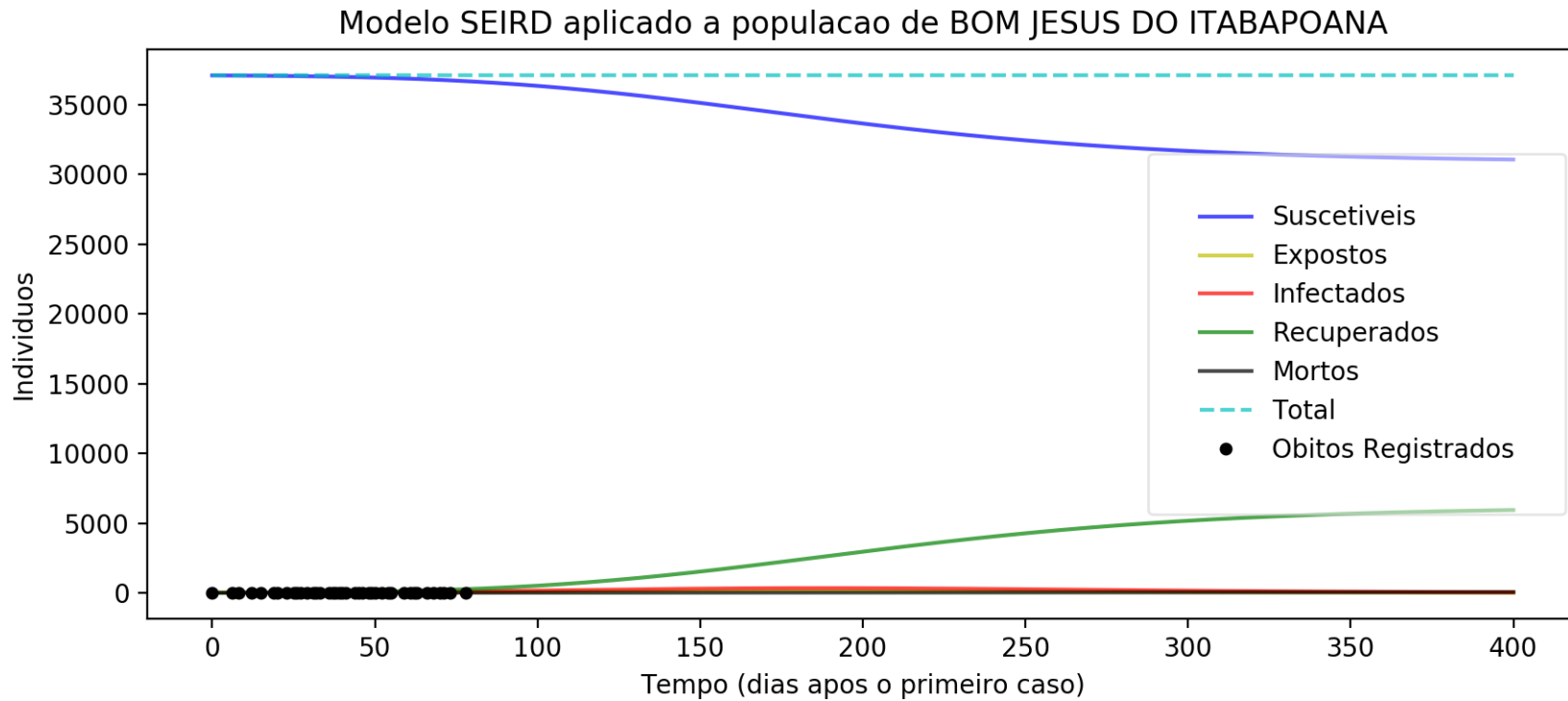
Ajuste exponencial aos dados epidemiologicos de BOM JESUS DO ITABAPOANA/RJ



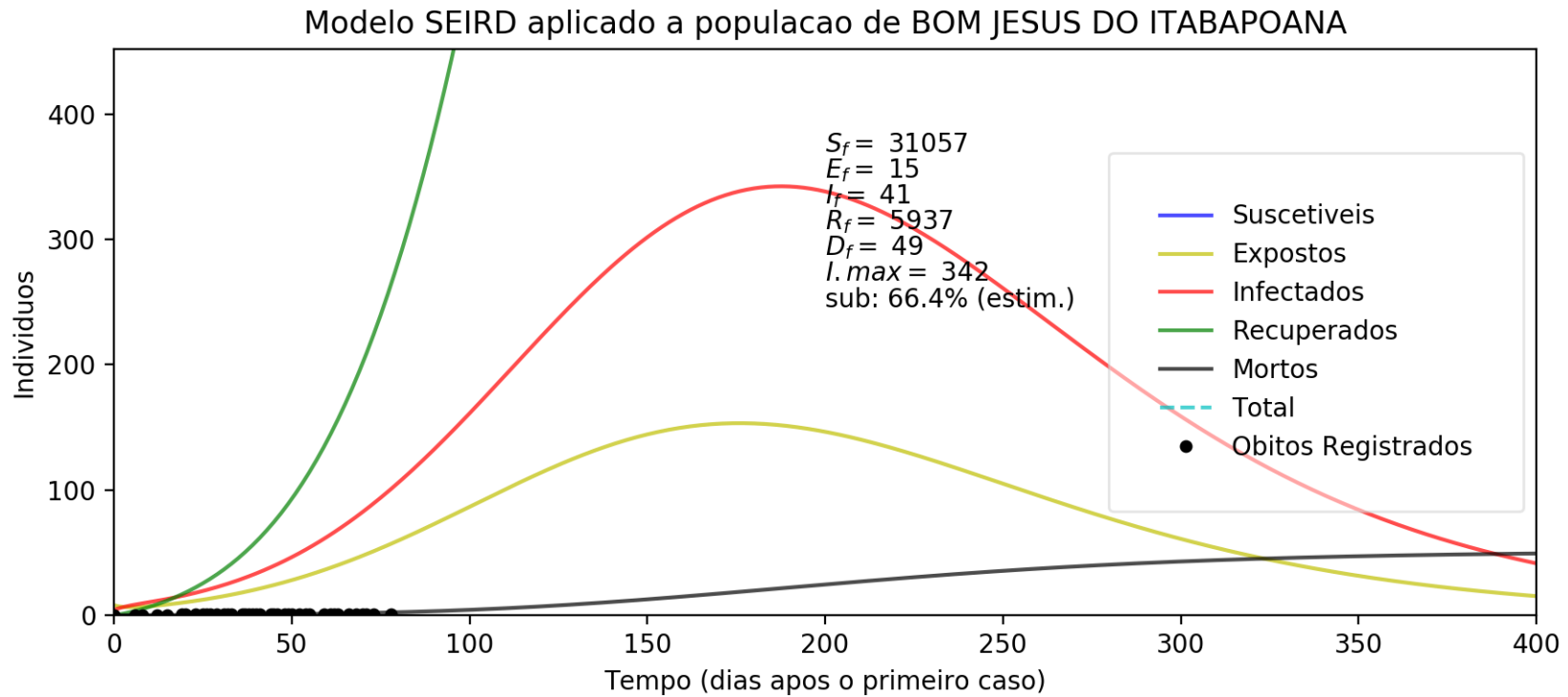
# Bom Jesus do Itabapoana/RJ



# Bom Jesus do Itabapoana/RJ

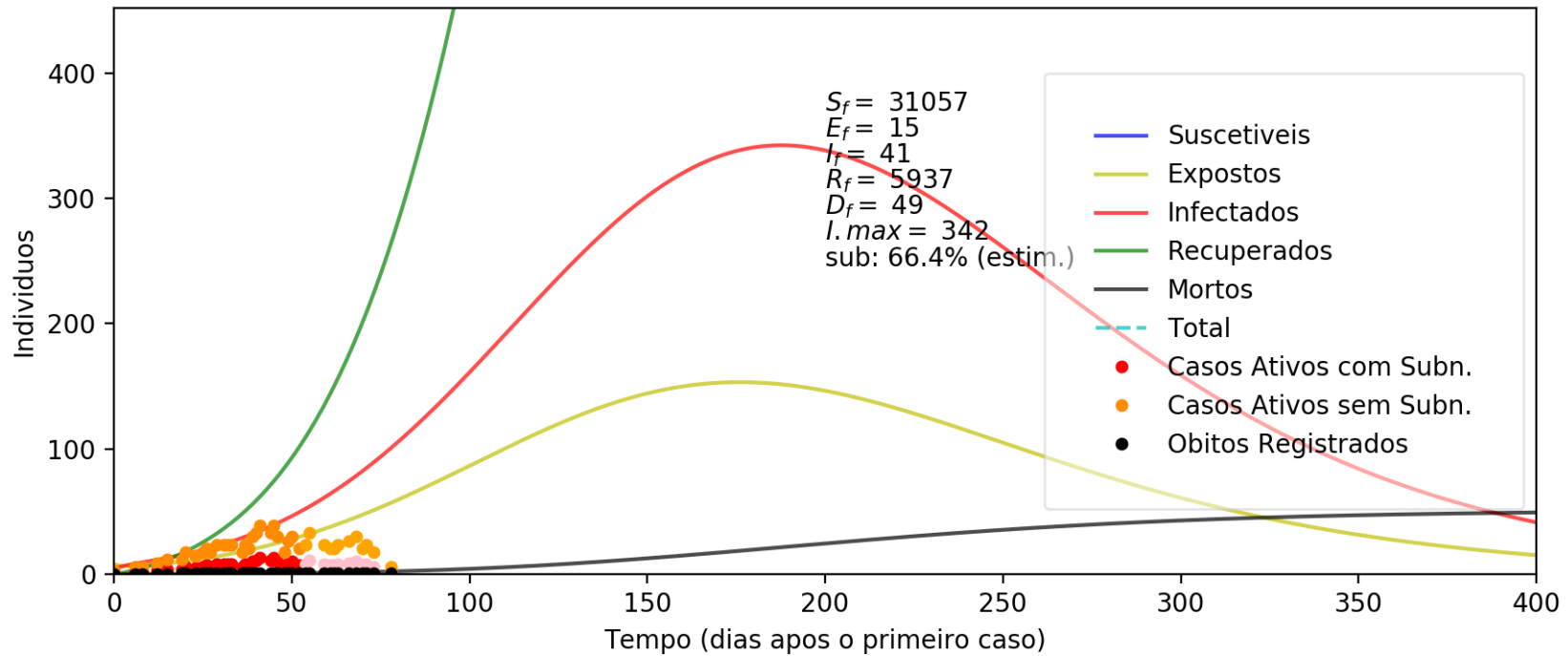


# Bom Jesus do Itabapoana/RJ



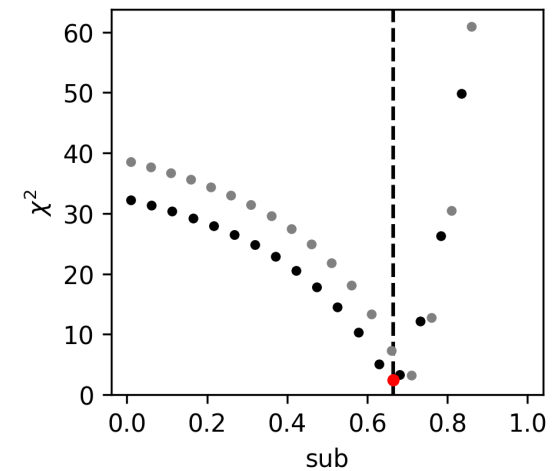
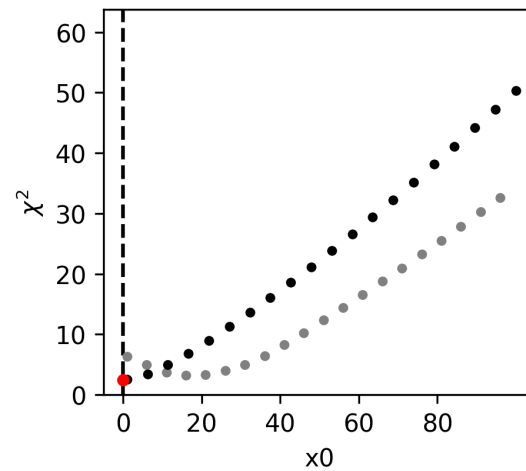
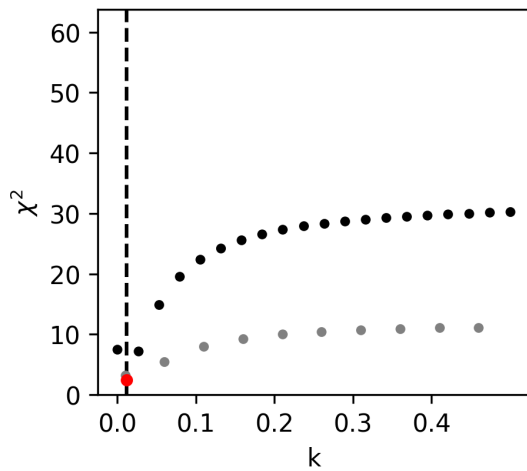
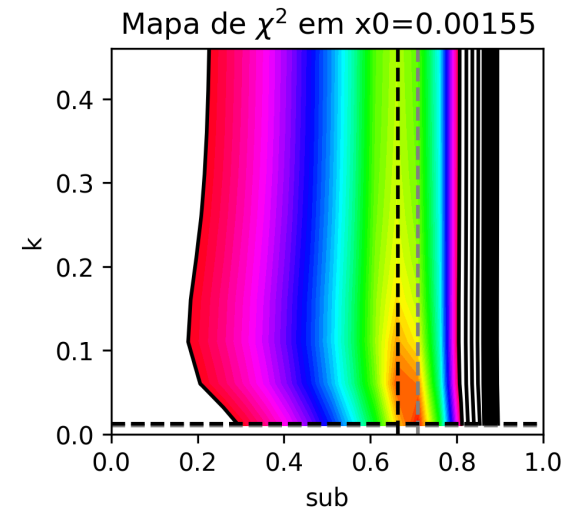
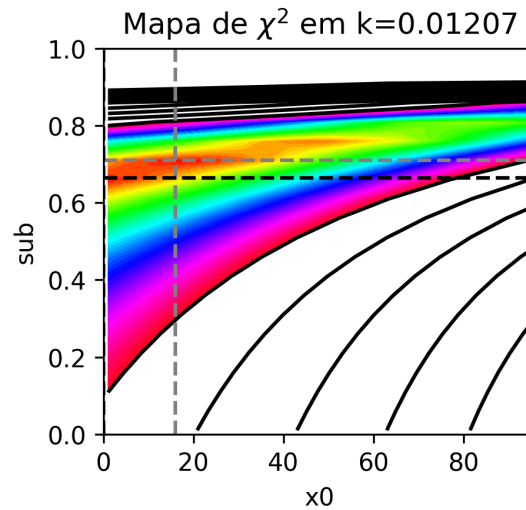
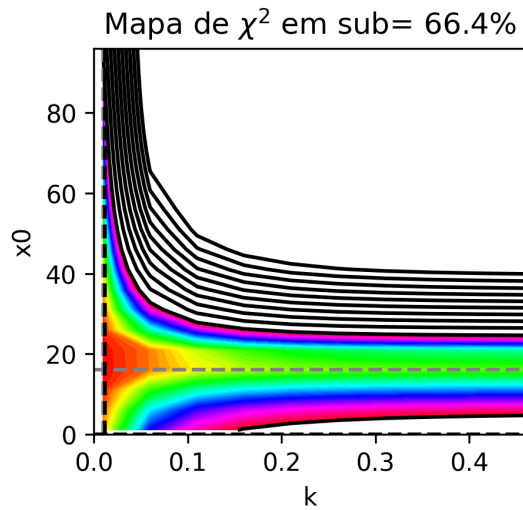
# Bom Jesus do Itabapoana/RJ

Modelo SEIRD aplicado a população de BOM JESUS DO ITABAPOANA



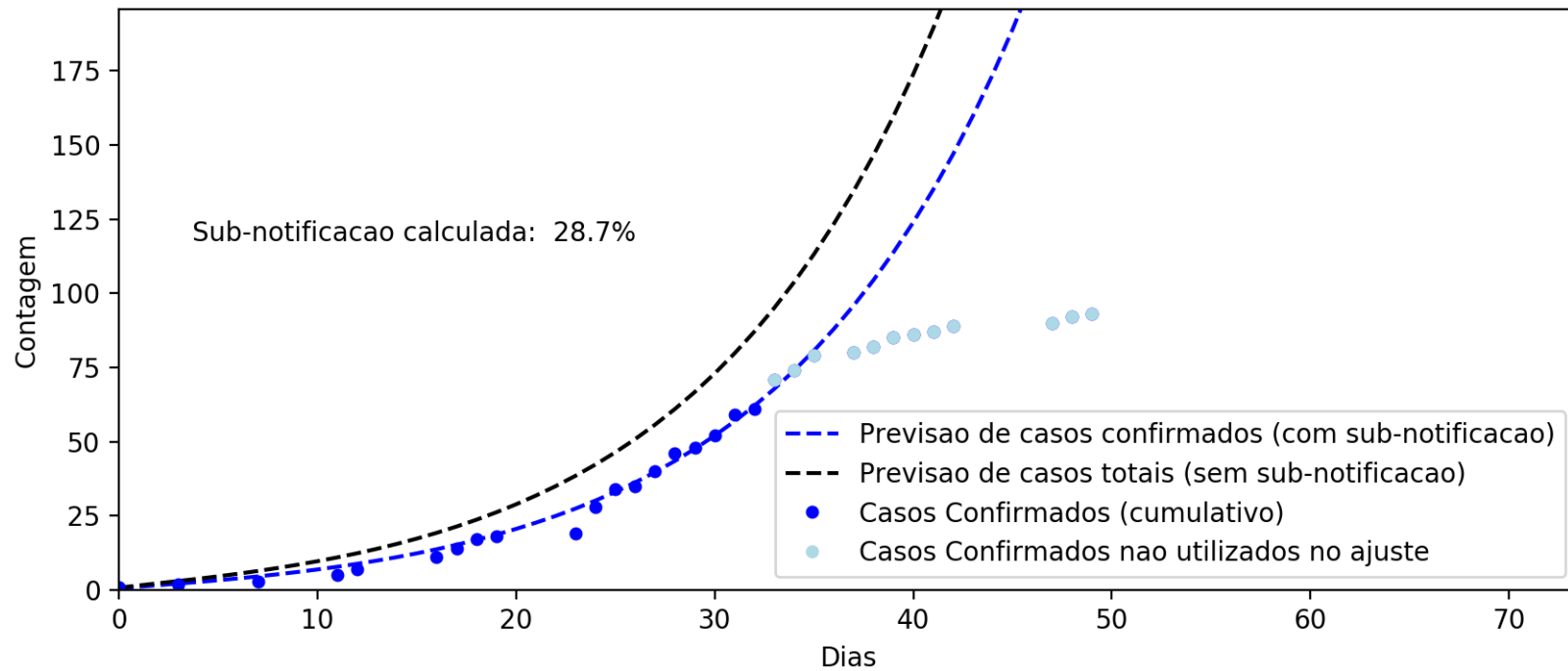


# Bom Jesus do Itabapoana/RJ

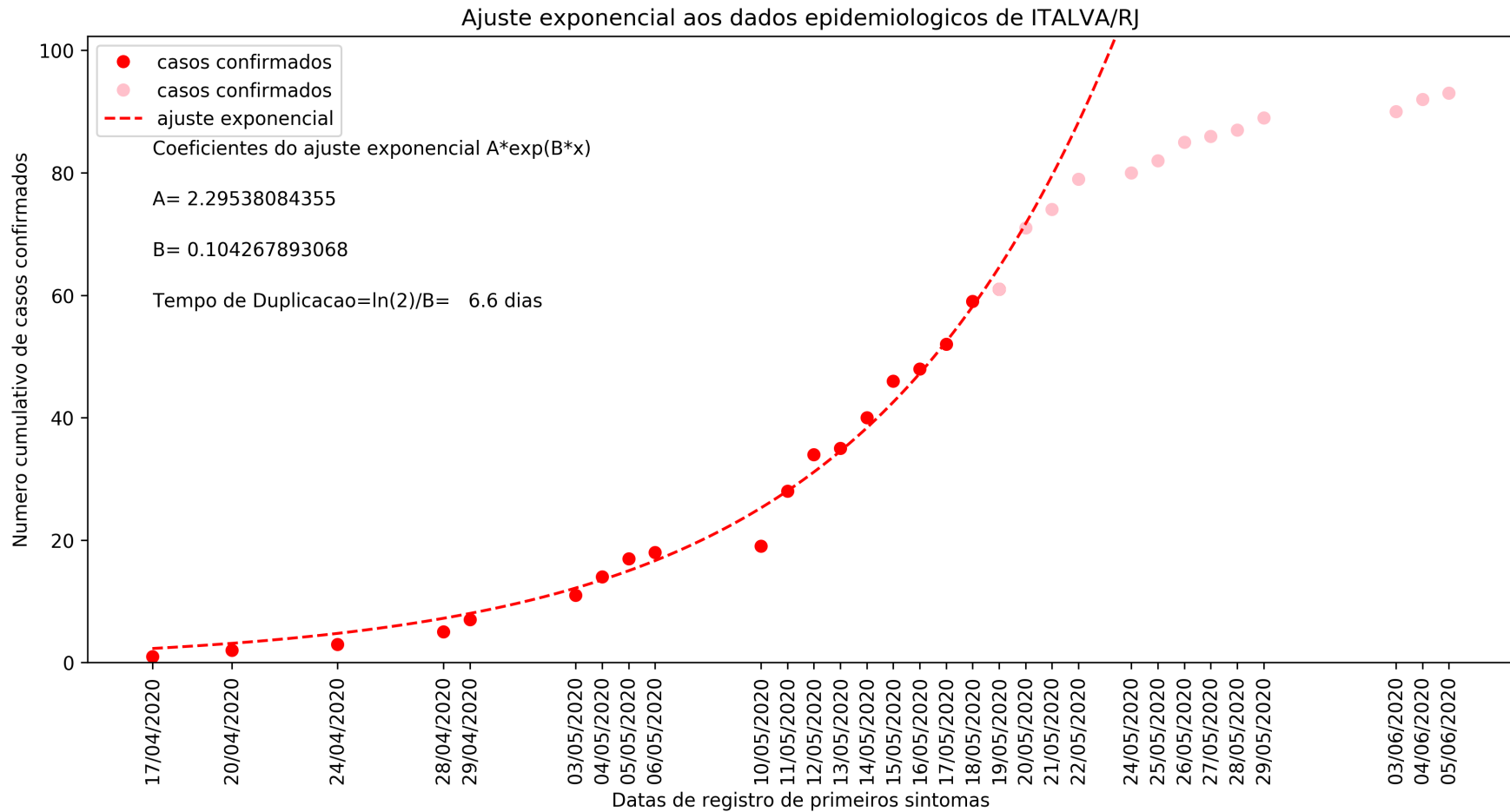


# Italva/RJ

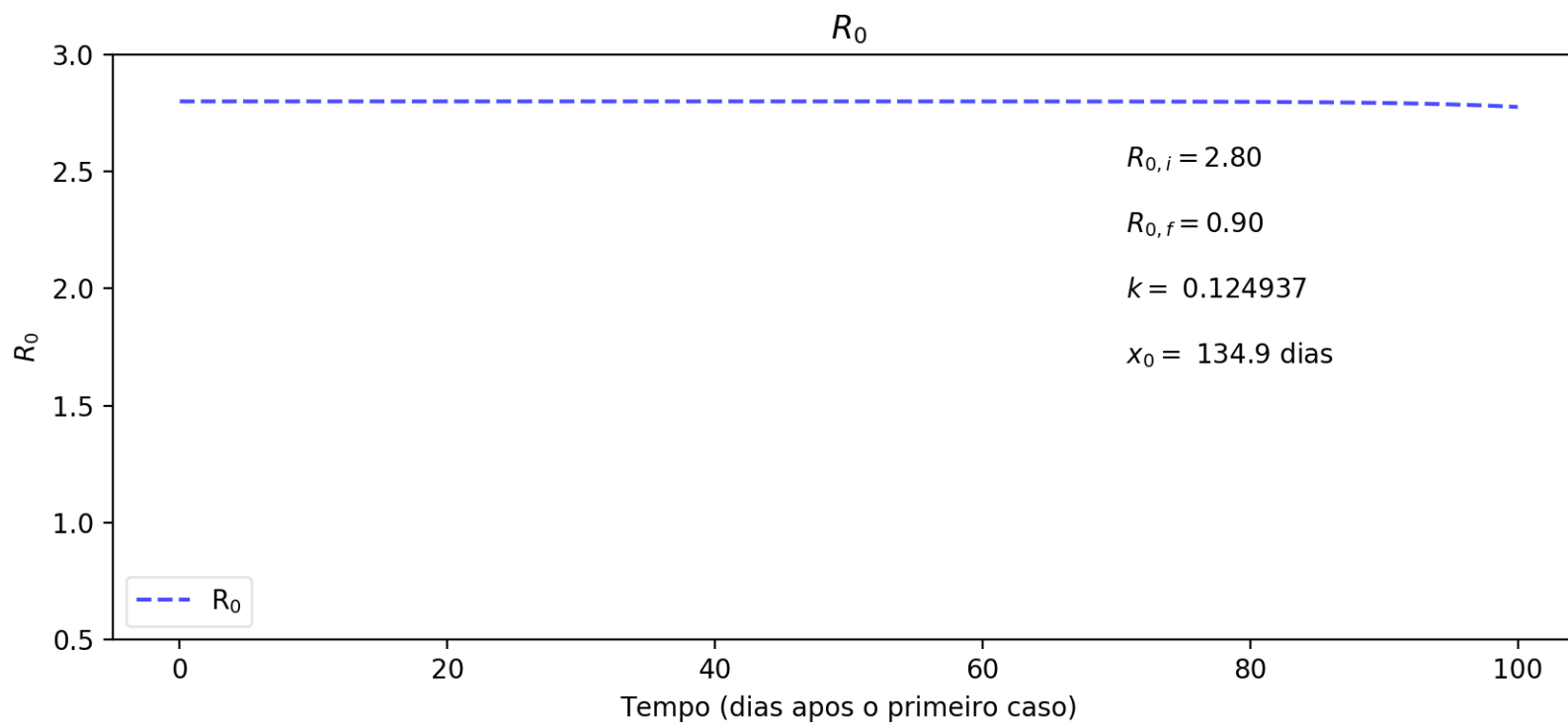
Ajuste do modelo aos Casos Confirmados de ITALVA com dados ate 05/06/2020



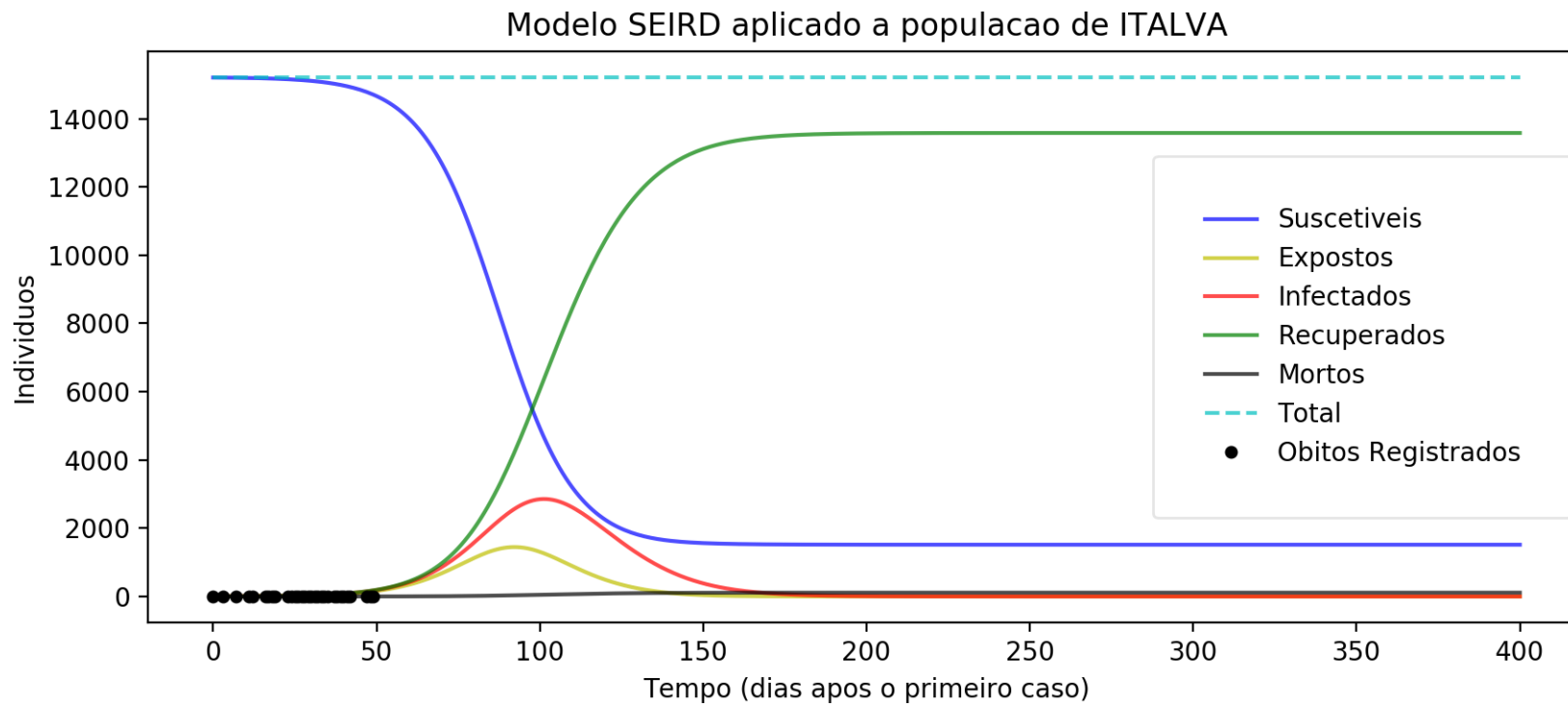
# Italva/RJ



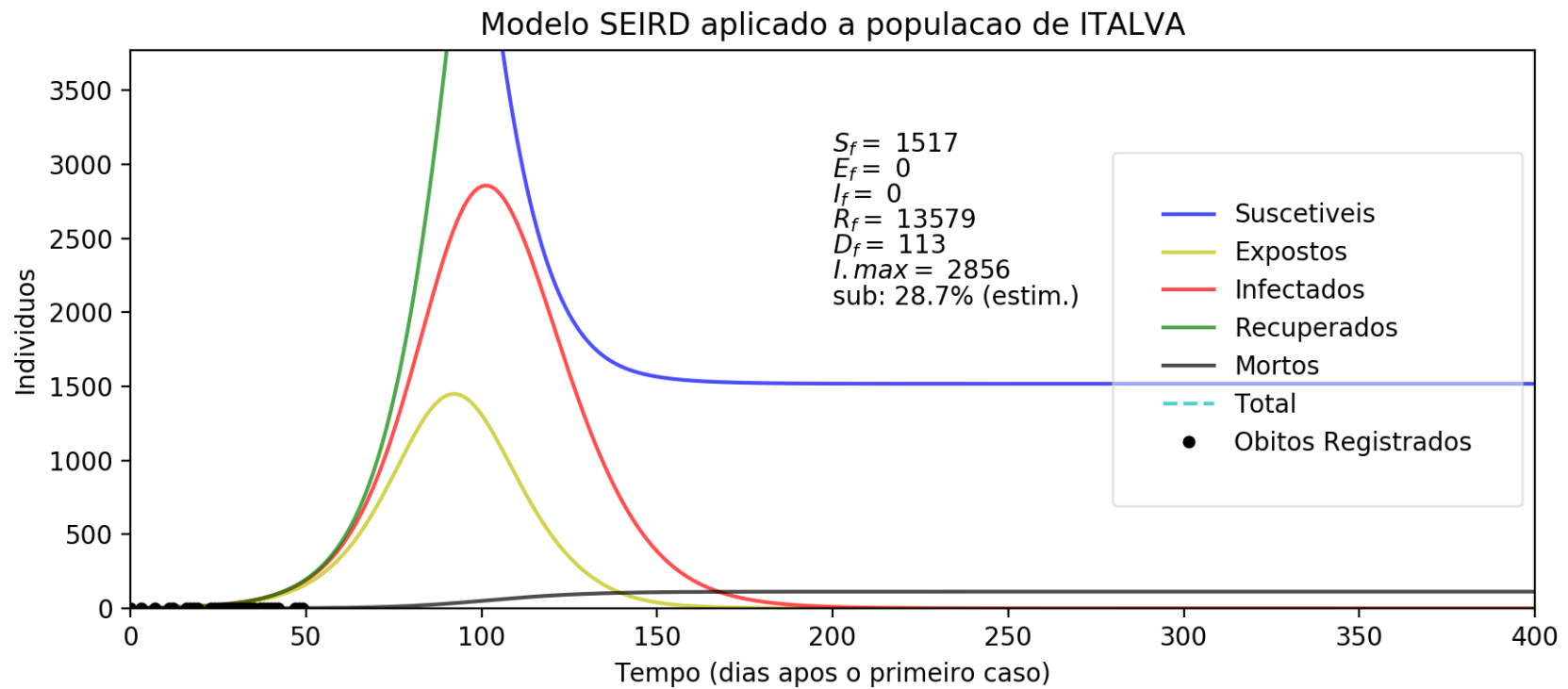
# Italva/RJ



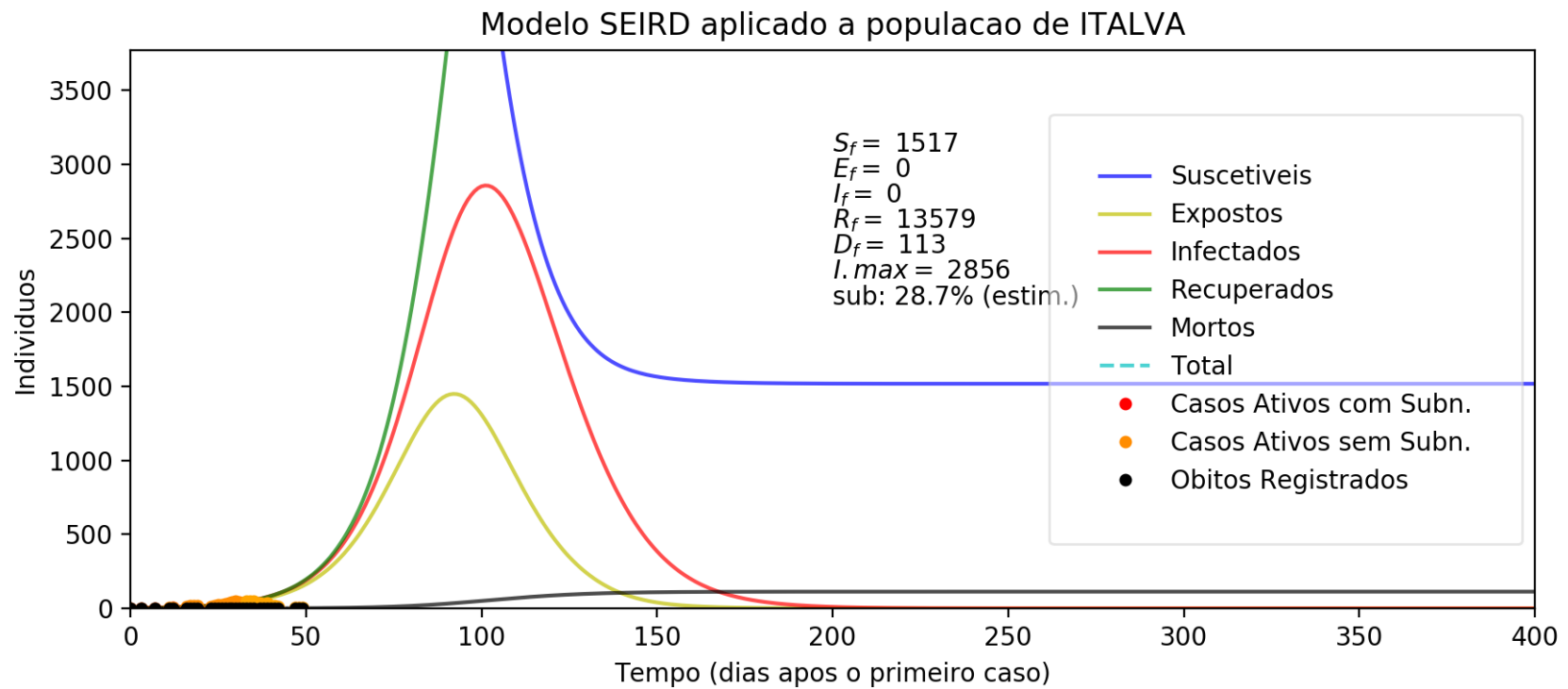
# Italva/RJ



# Italva/RJ

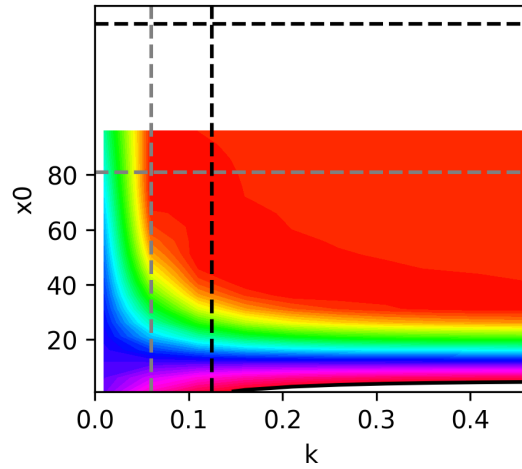


# Italva/RJ

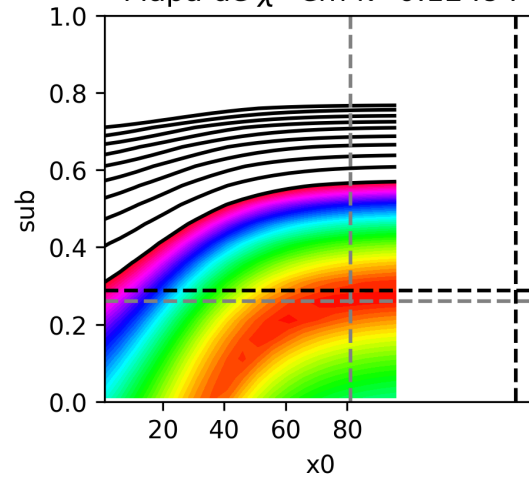


# Italva/RJ

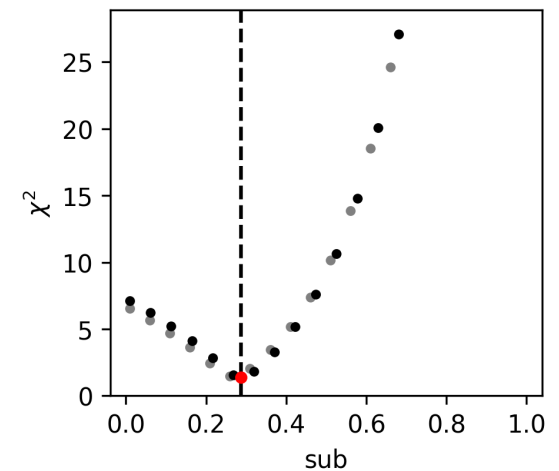
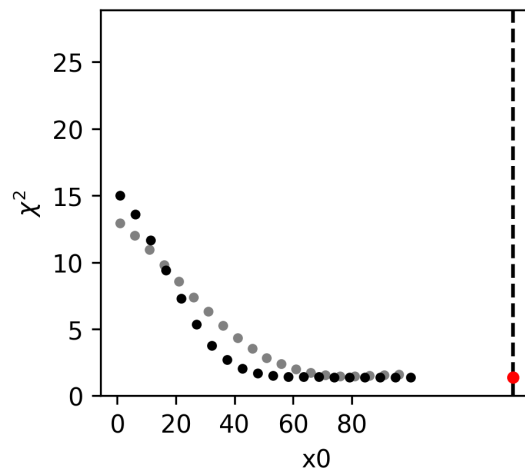
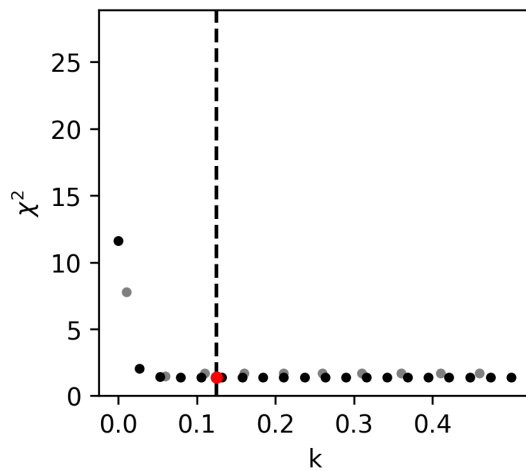
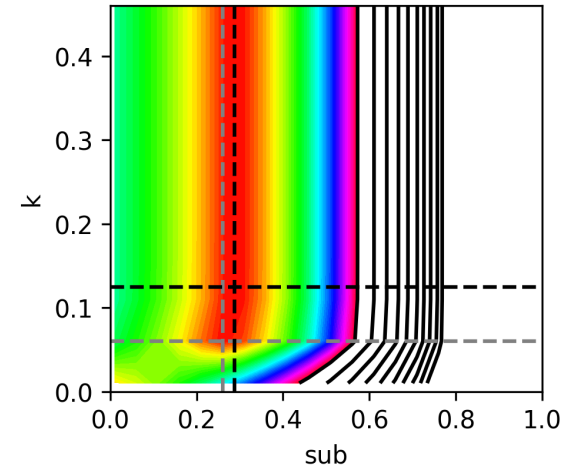
Mapa de  $\chi^2$  em sub= 28.7%



Mapa de  $\chi^2$  em k=0.12494

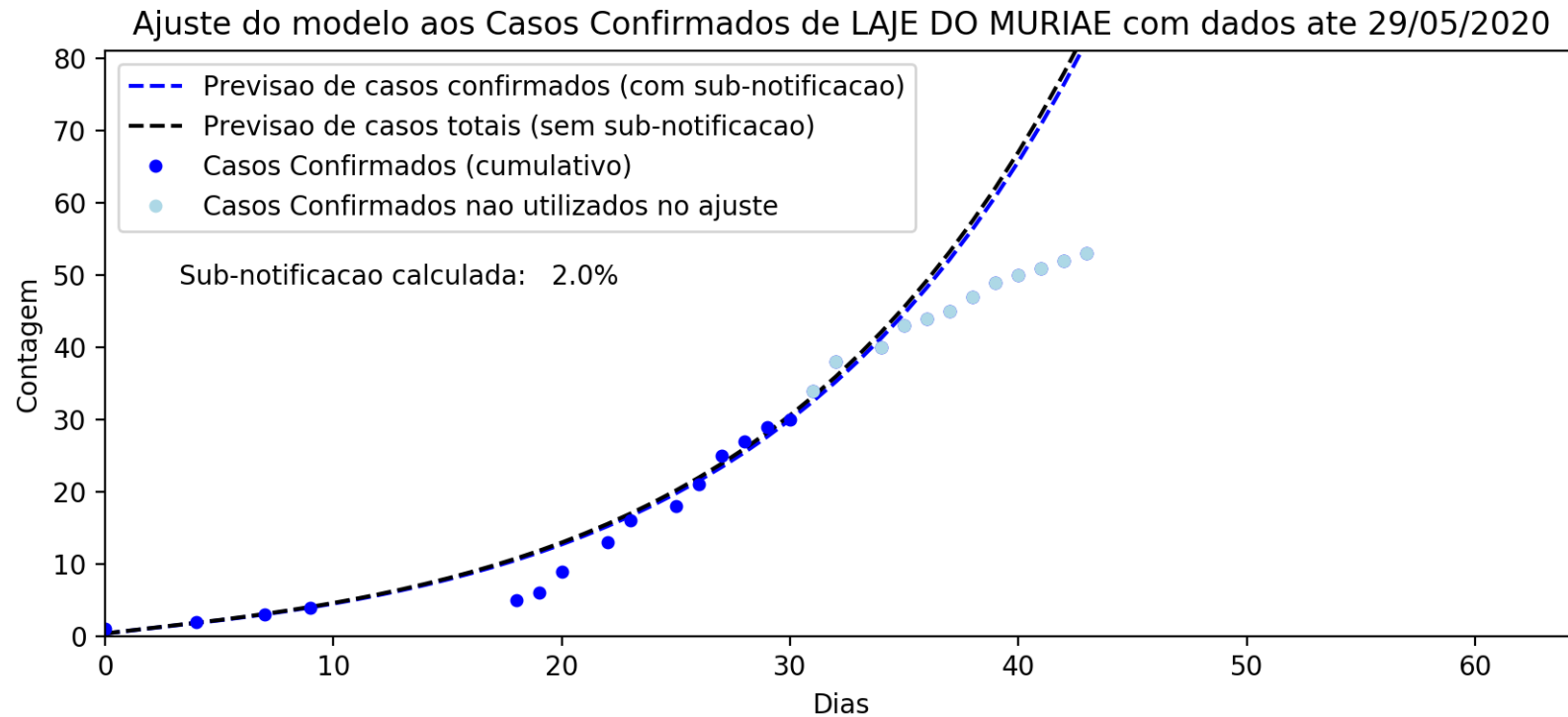


Mapa de  $\chi^2$  em x0=134.93948



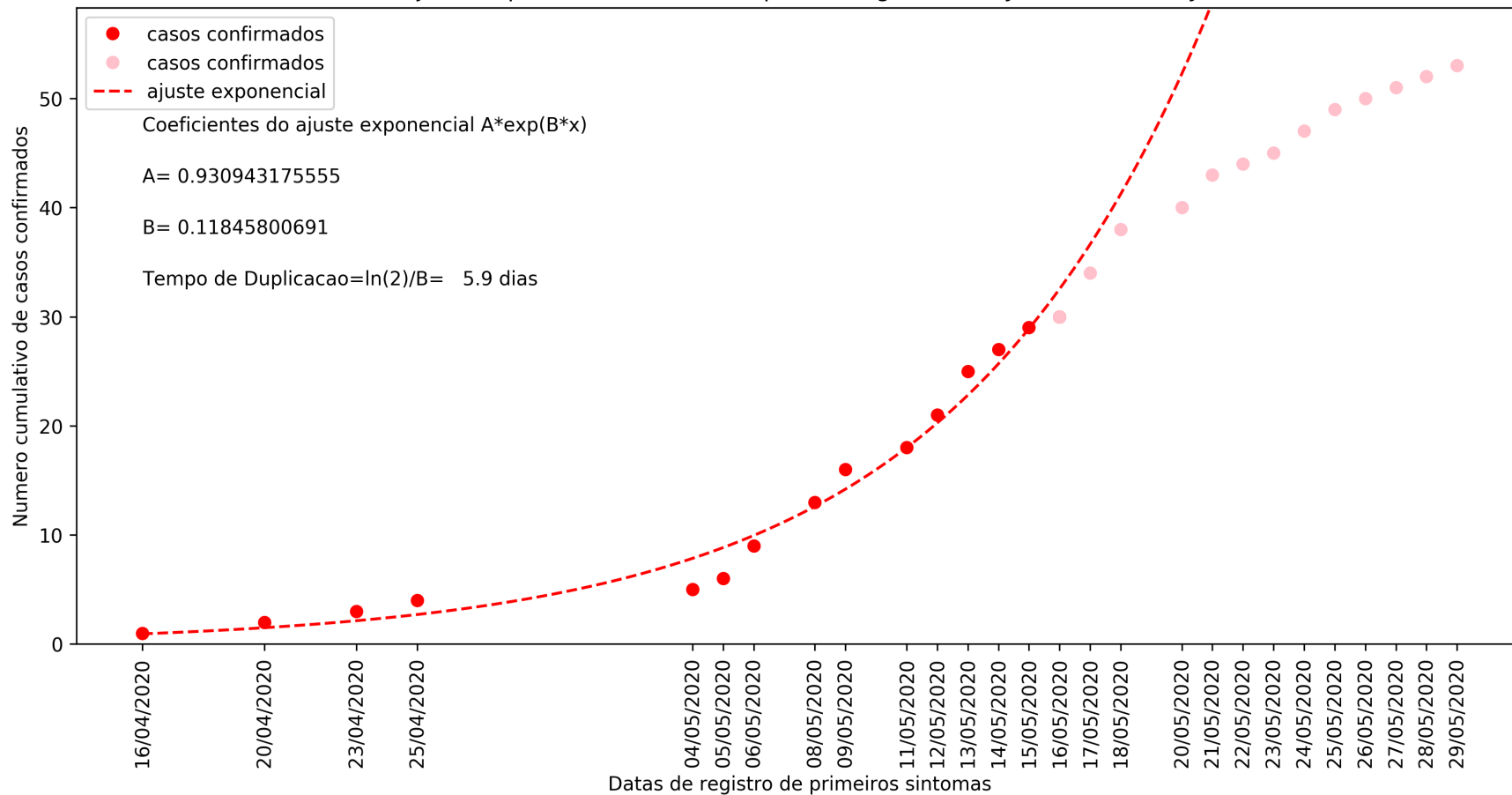


# Laje do Muriaé/RJ

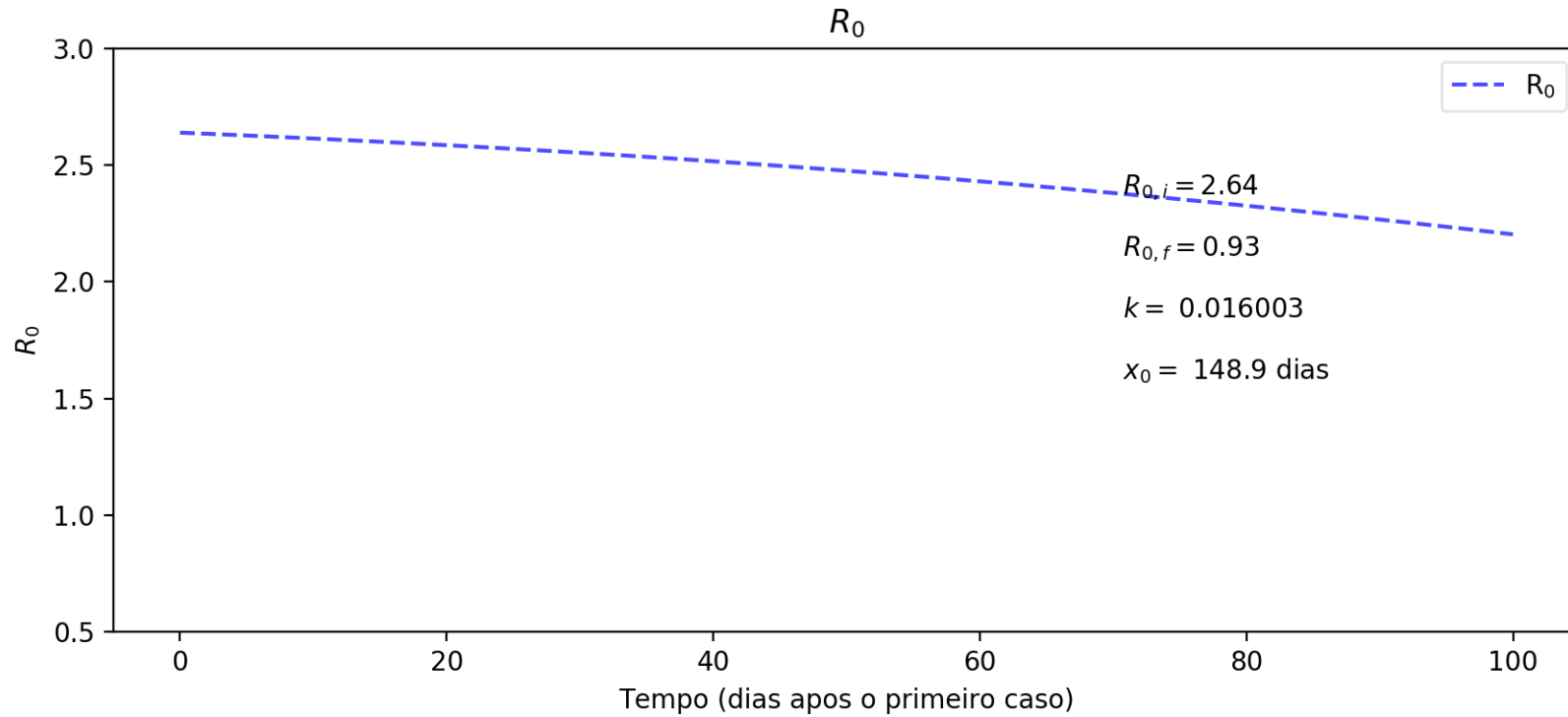


# Laje do Muriaé/RJ

Ajuste exponencial aos dados epidemiológicos de LAJE DO MURIAE/RJ

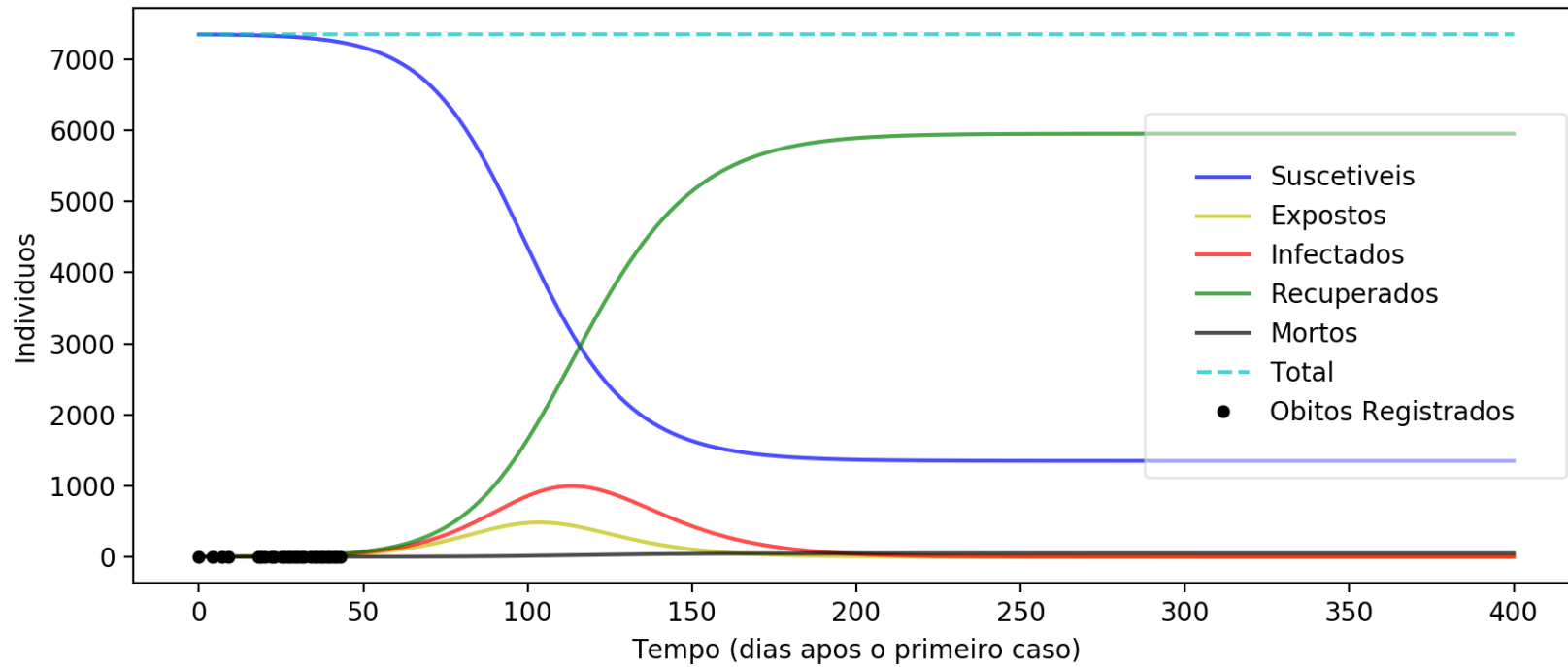


# Laje do Muriaé/RJ



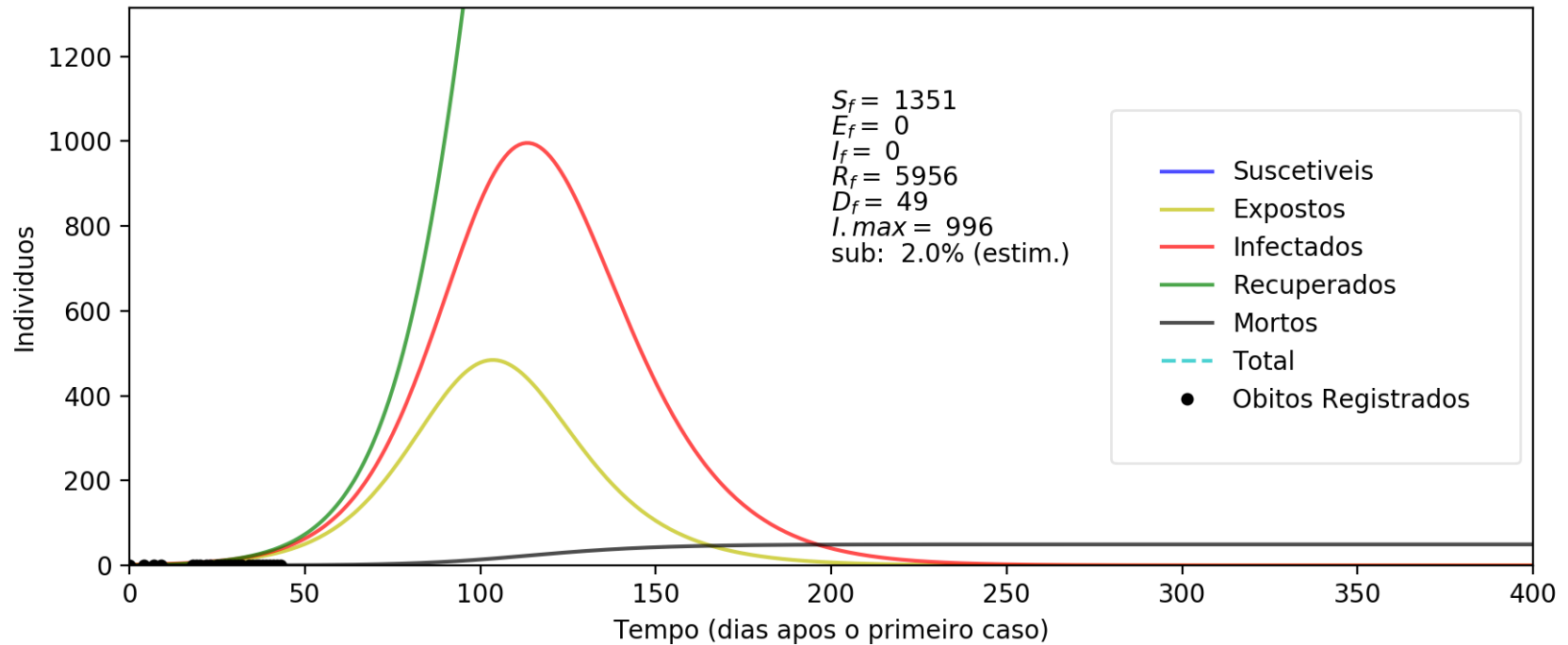
# Laje do Muriaé/RJ

Modelo SEIRD aplicado a populacao de LAJE DO MURIAE



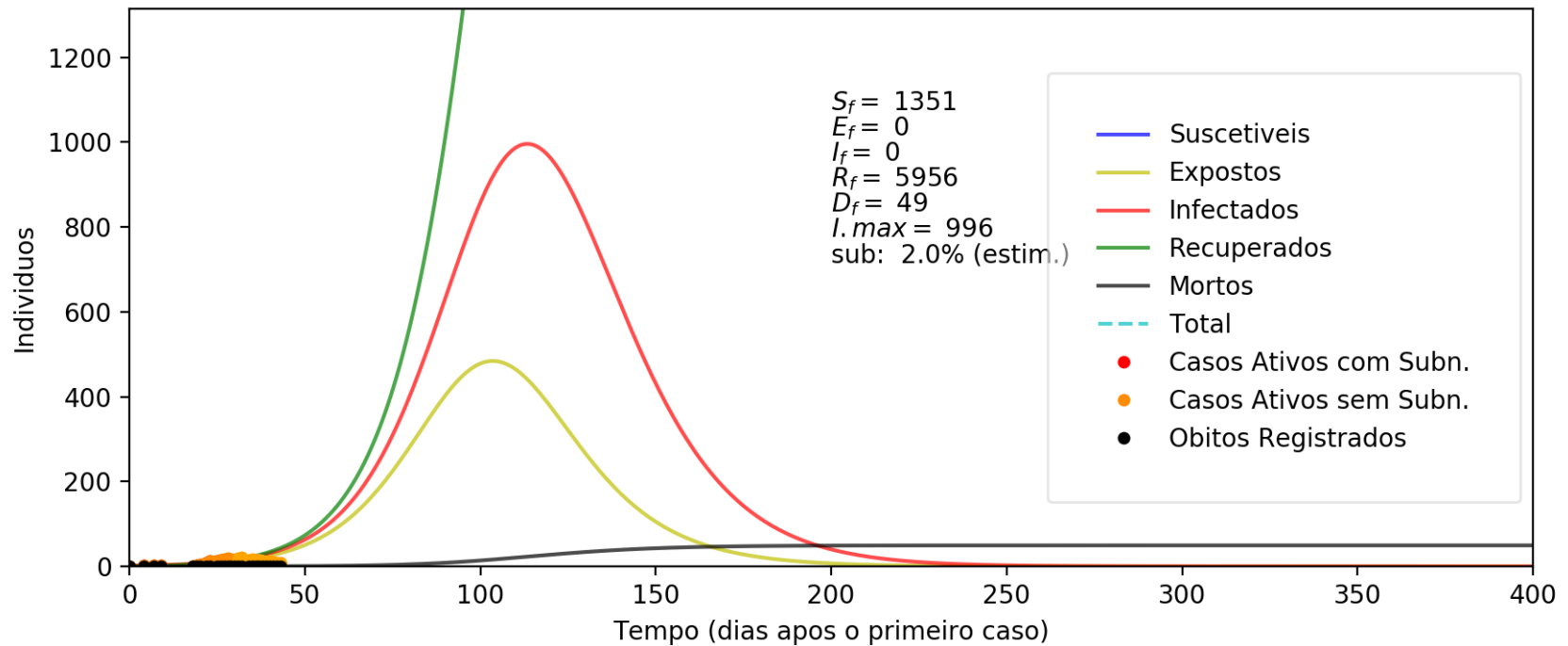
# Laje do Muriaé/RJ

Modelo SEIRD aplicado a população de LAJE DO MURIAE

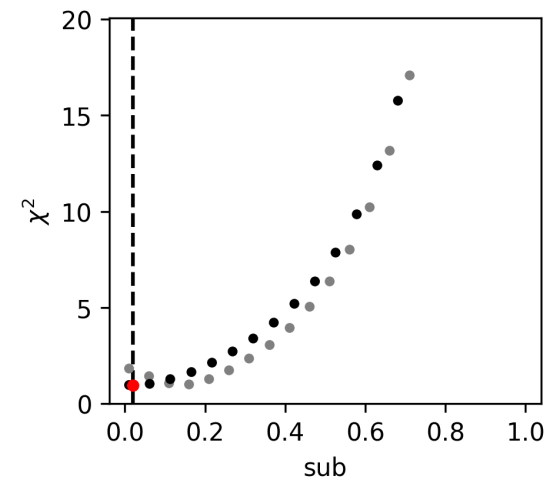
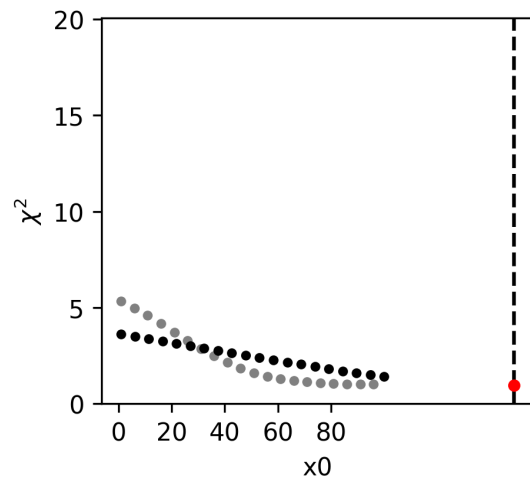
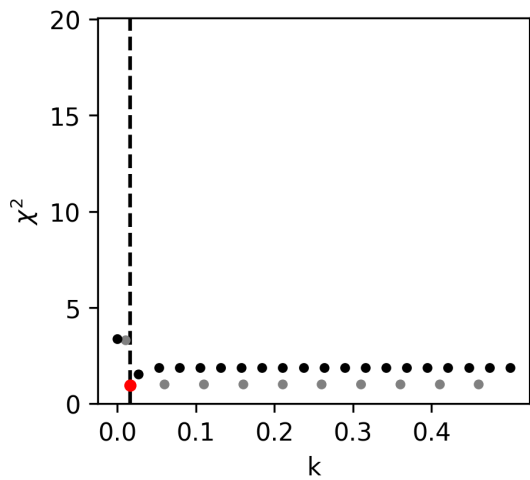
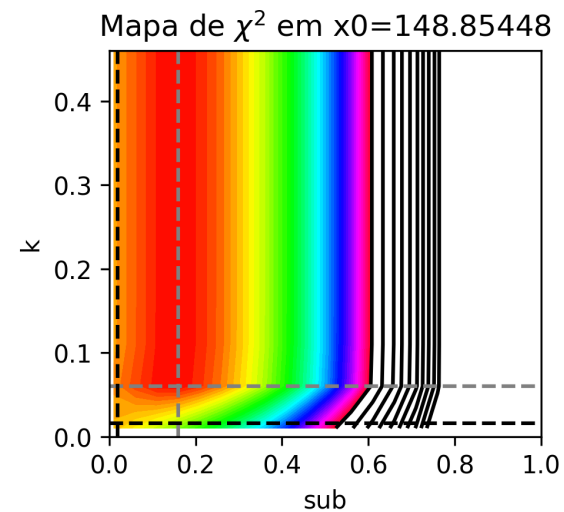
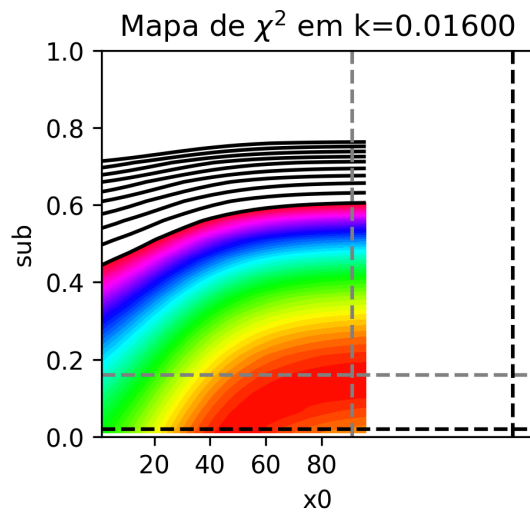
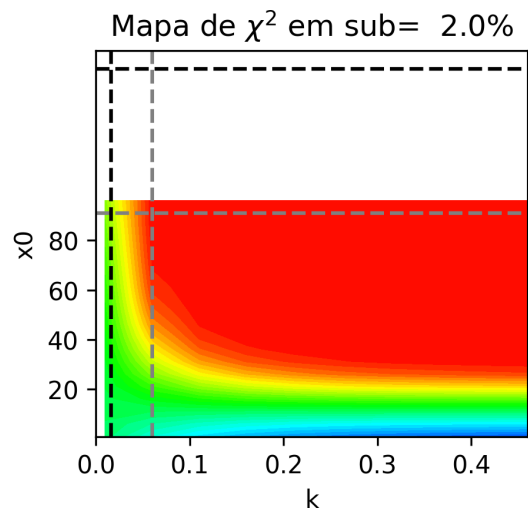


# Laje do Muriaé/RJ

Modelo SEIRD aplicado a populacao de LAJE DO MURIAE

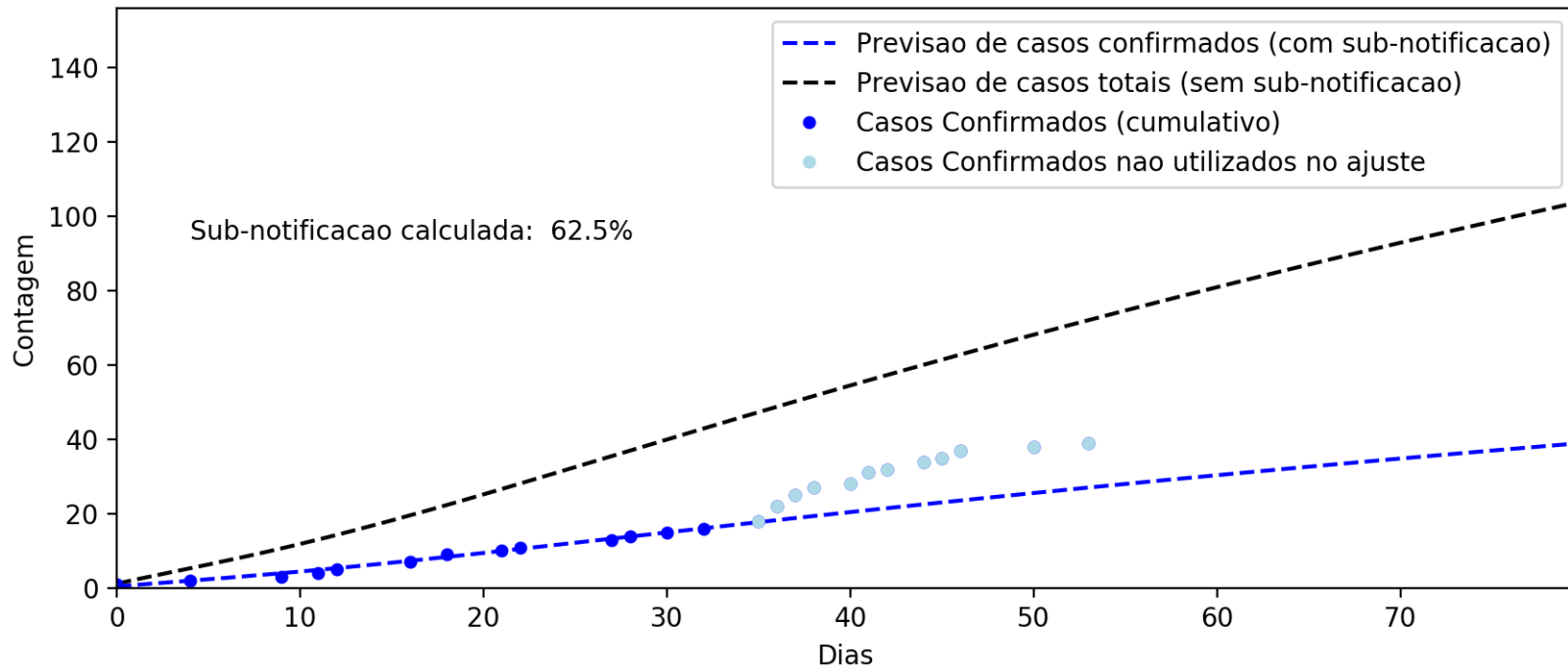


# Laje do Muriaé/RJ



# Natividade/RJ

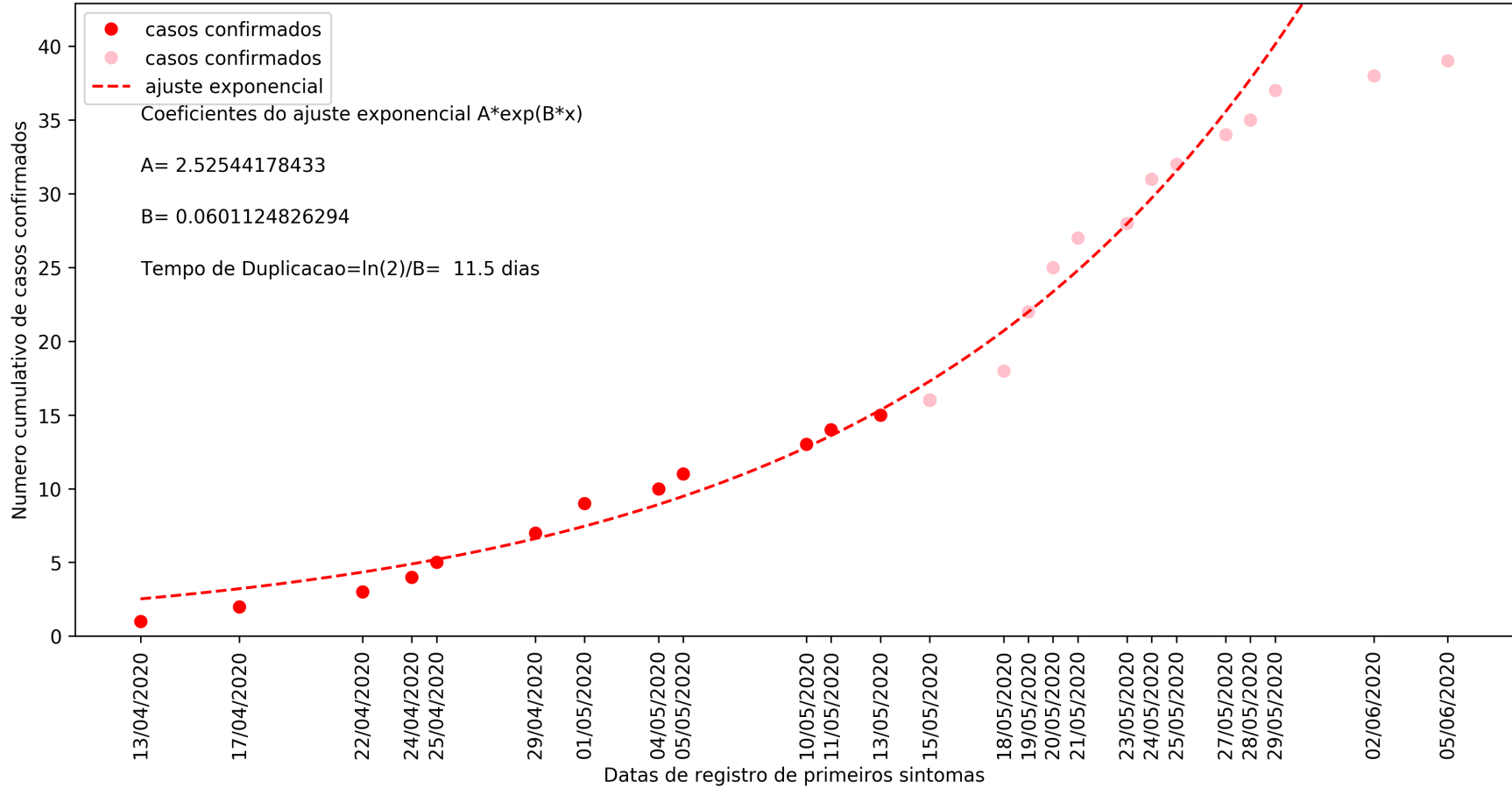
Ajuste do modelo aos Casos Confirmados de NATIVIDADE com dados ate 05/06/2020



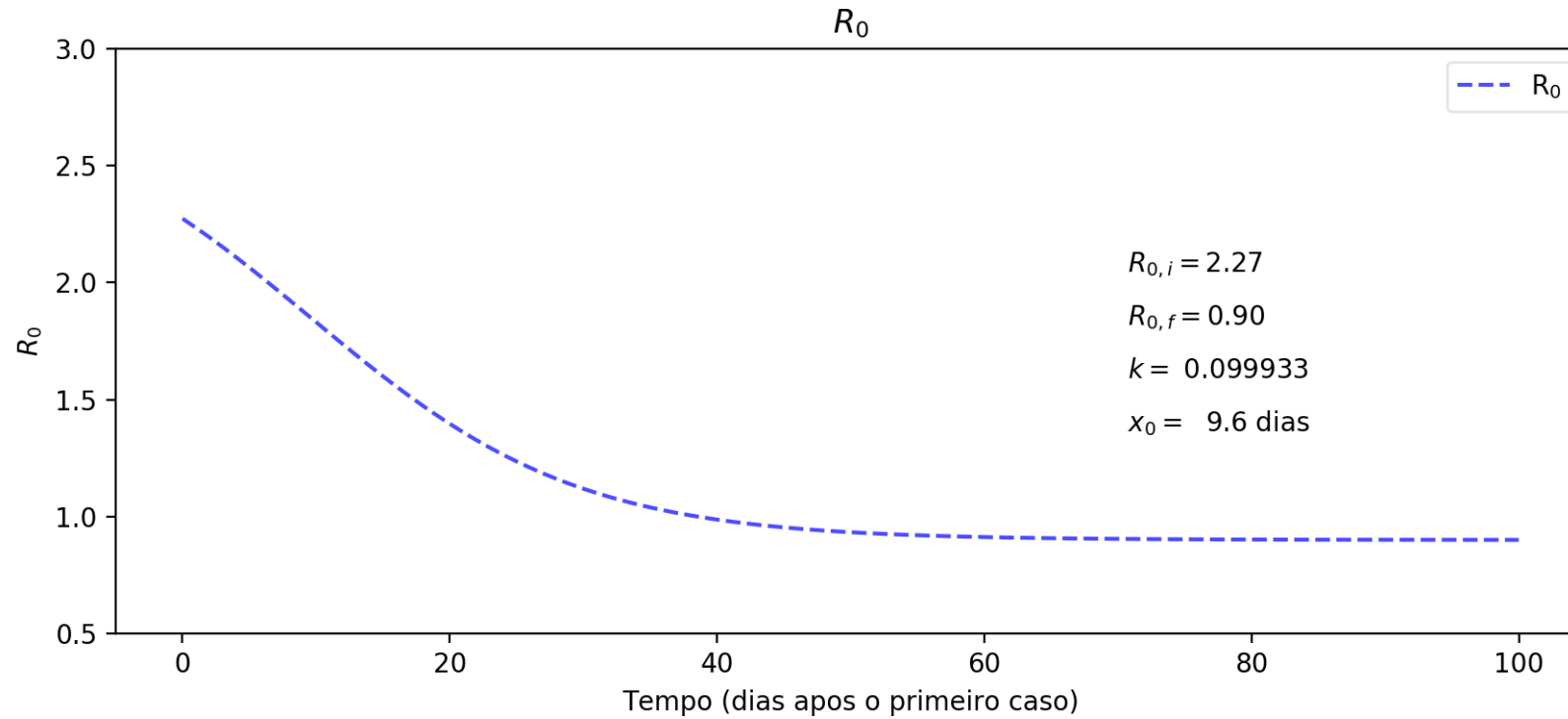


# Natividade/RJ

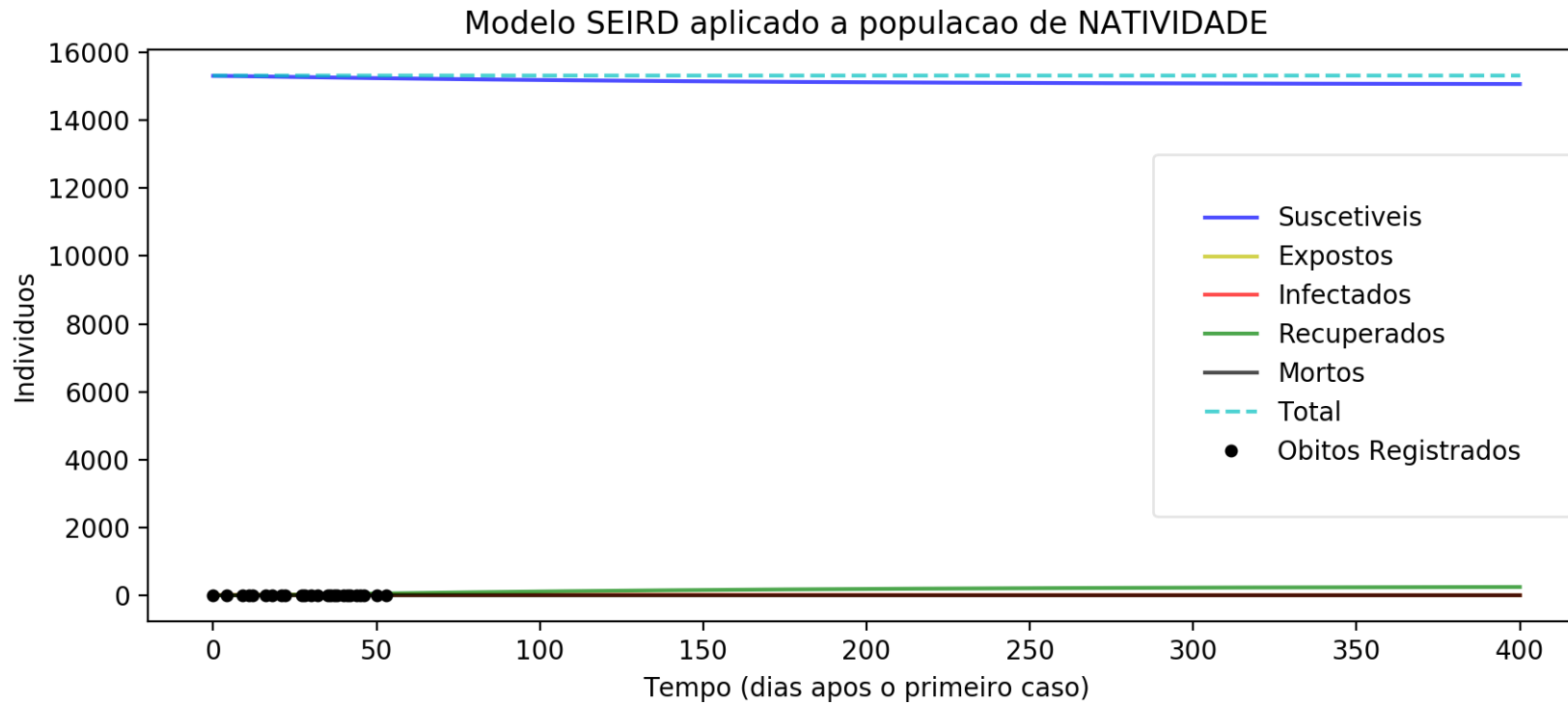
Ajuste exponencial aos dados epidemiologicos de NATIVIDADE/RJ



# Natividade/RJ

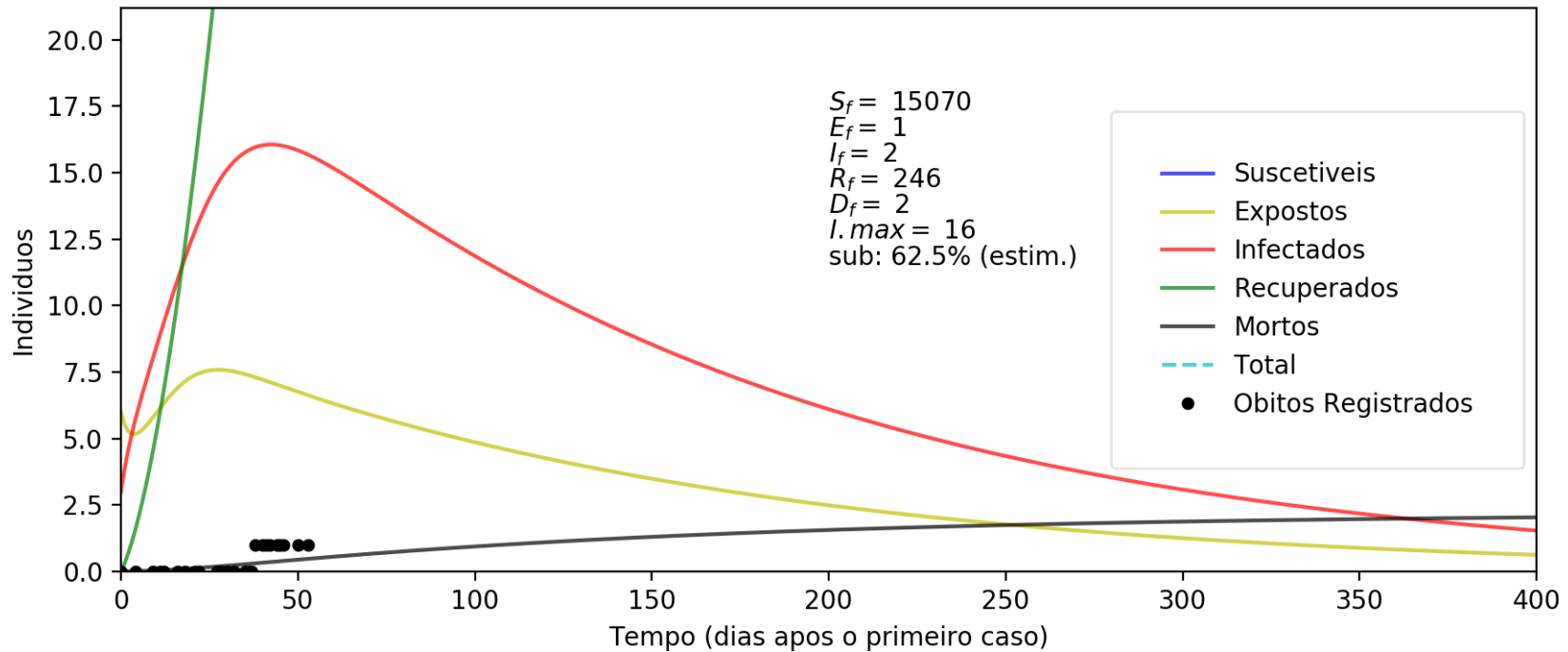


# Natividade/RJ



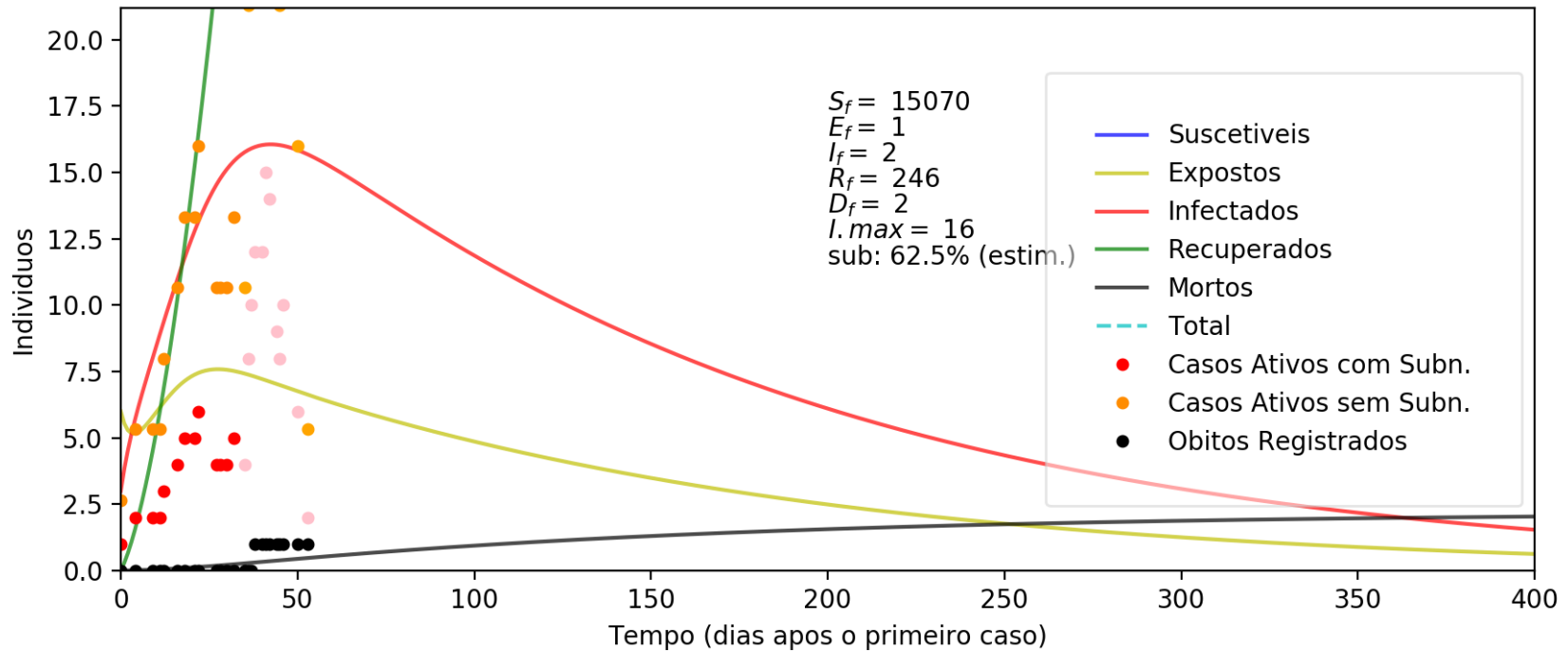
# Natividade/RJ

Modelo SEIRD aplicado a população de NATIVIDADE

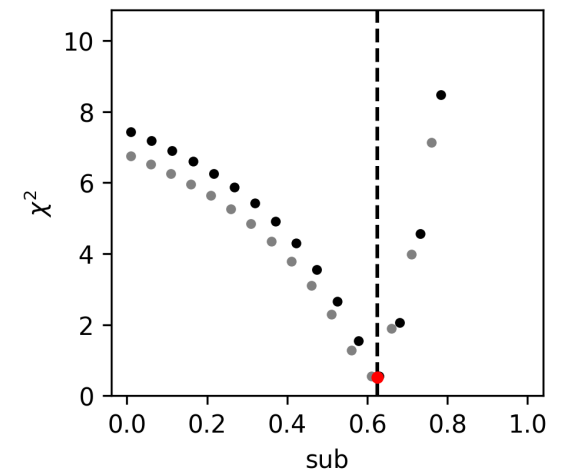
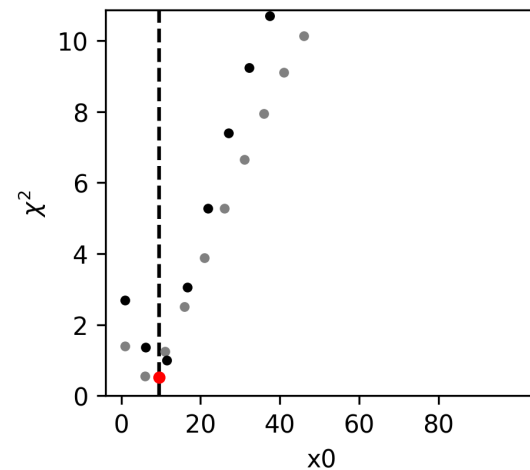
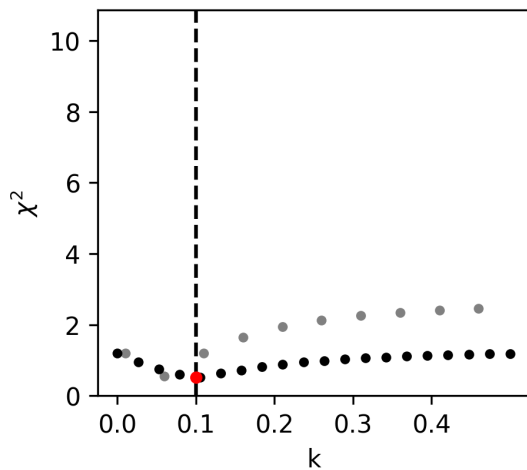
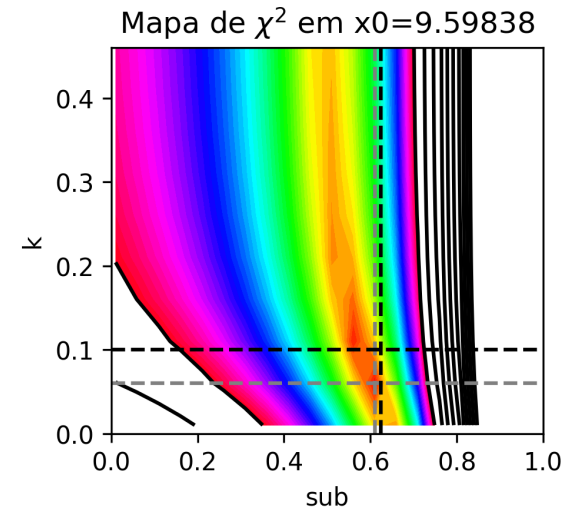
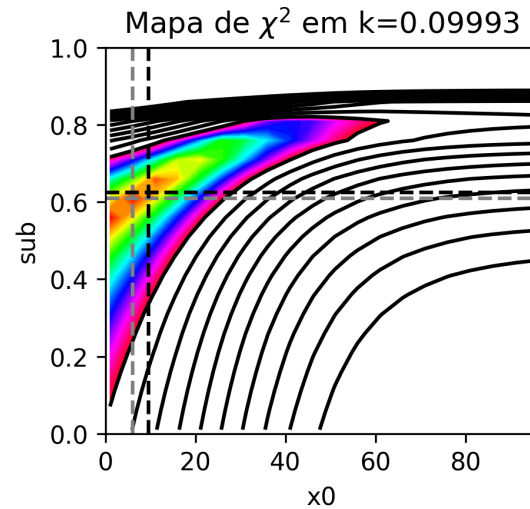
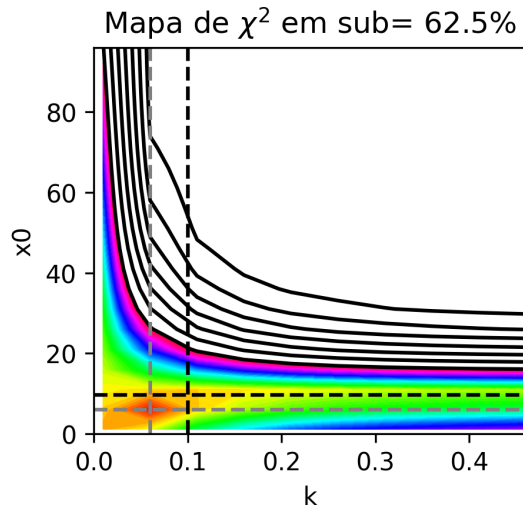


# Natividade/RJ

Modelo SEIRD aplicado a população de NATIVIDADE

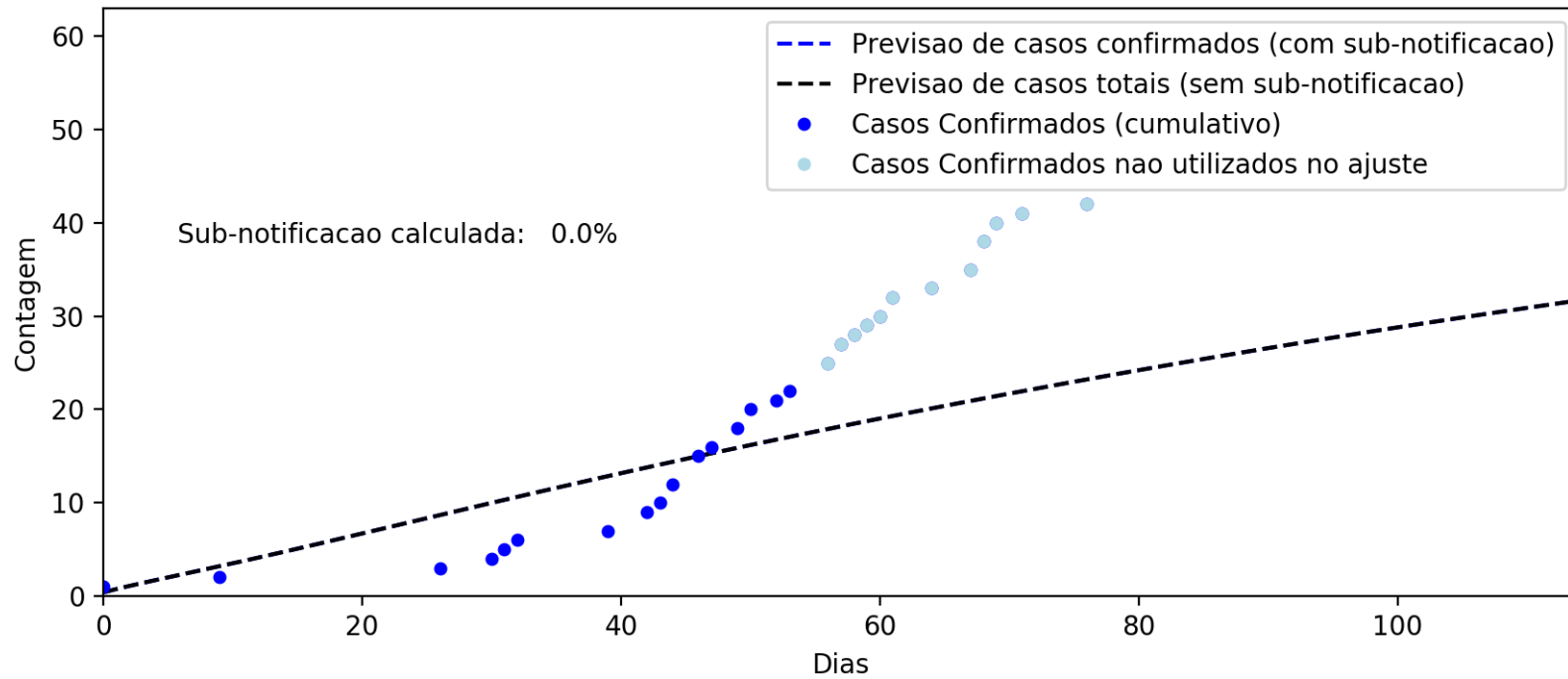


# Natividade/RJ



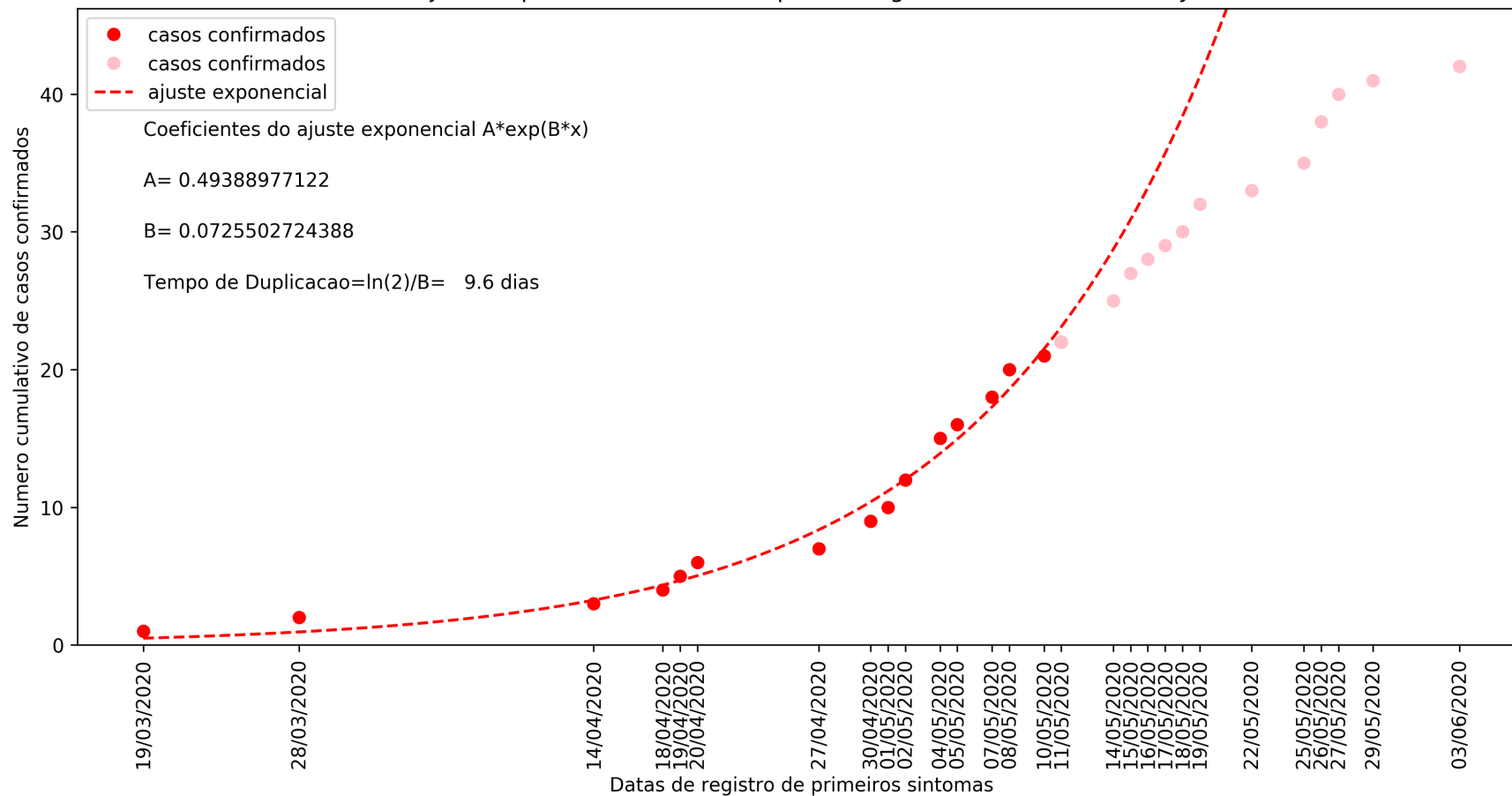
# Porciúncula/RJ

Ajuste do modelo aos Casos Confirmados de PORCIUNCULA com dados ate 03/06/2020



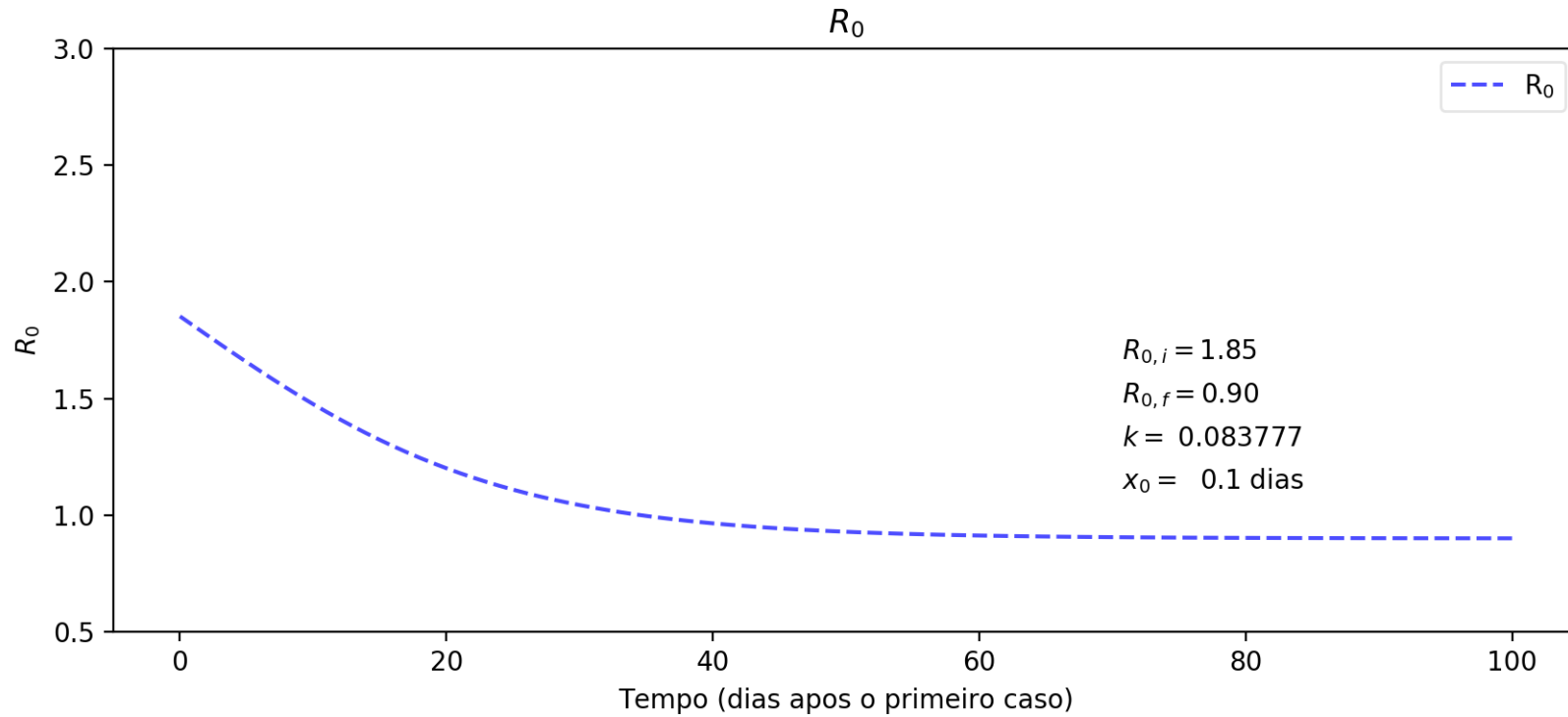
# Porciúncula/RJ

Ajuste exponencial aos dados epidemiológicos de PORCIUNCULA/RJ





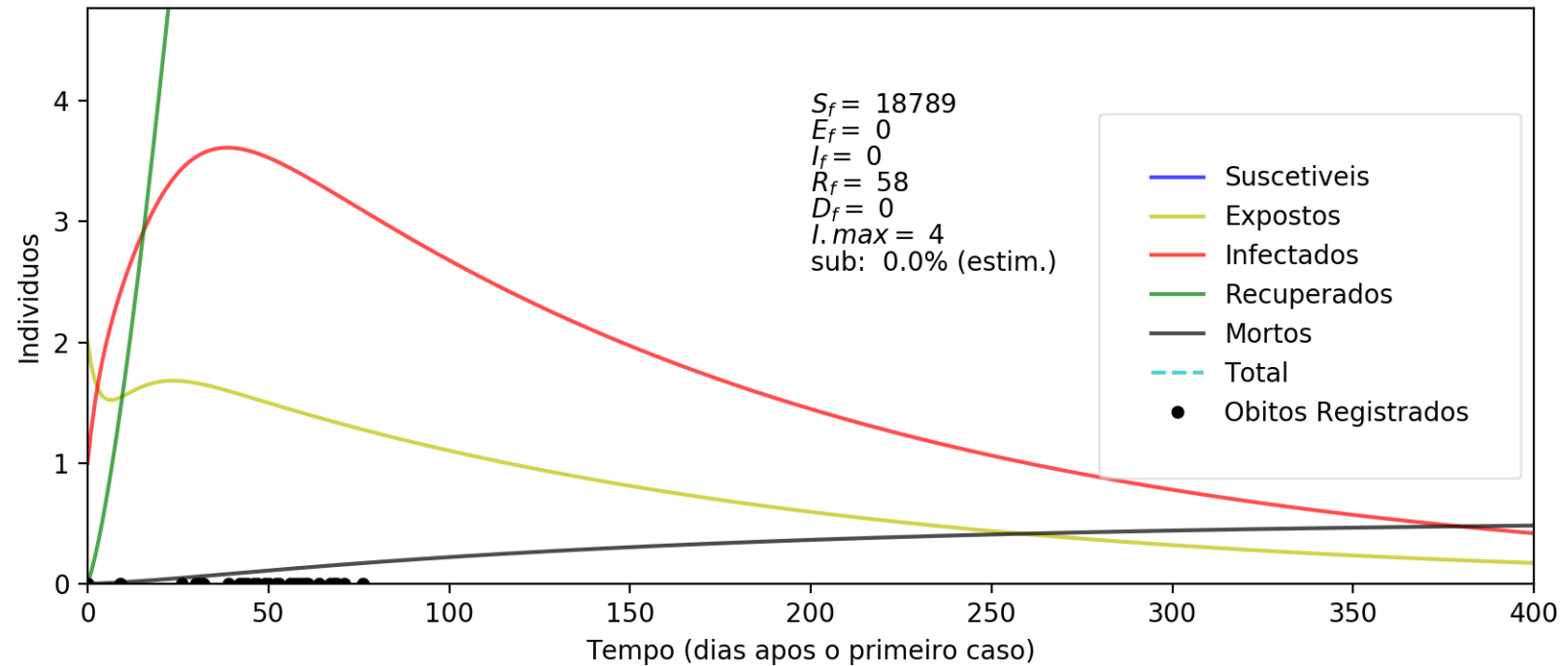
# Porciúncula/RJ





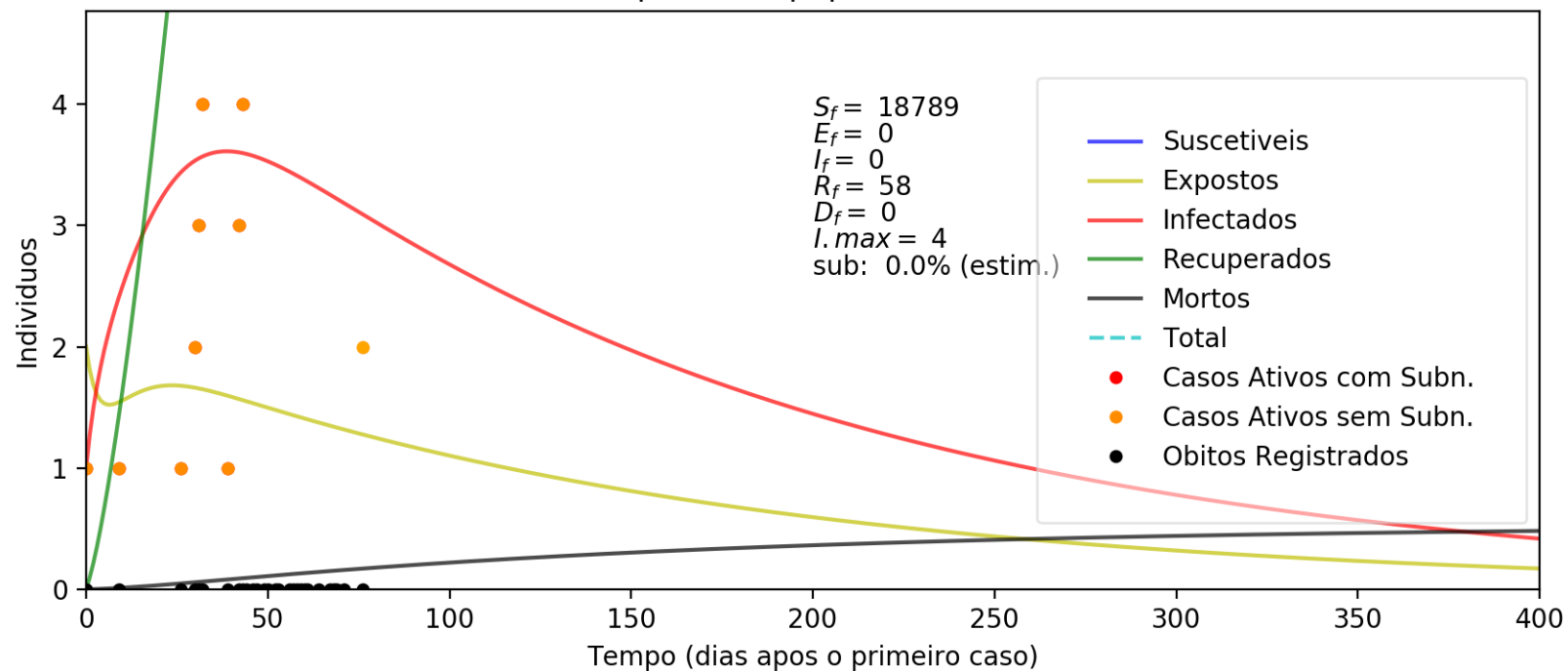
# Porciúncula/RJ

Modelo SEIRD aplicado a população de PORCIUNCULA

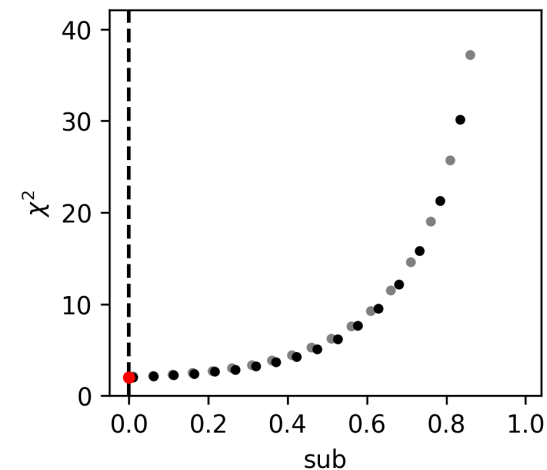
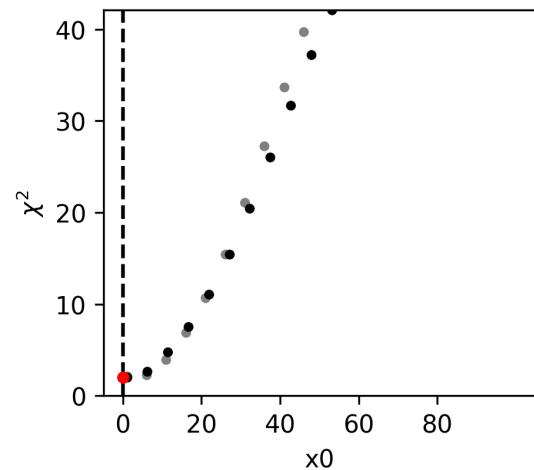
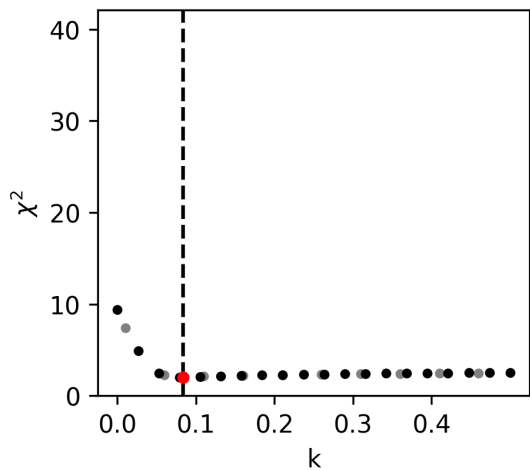
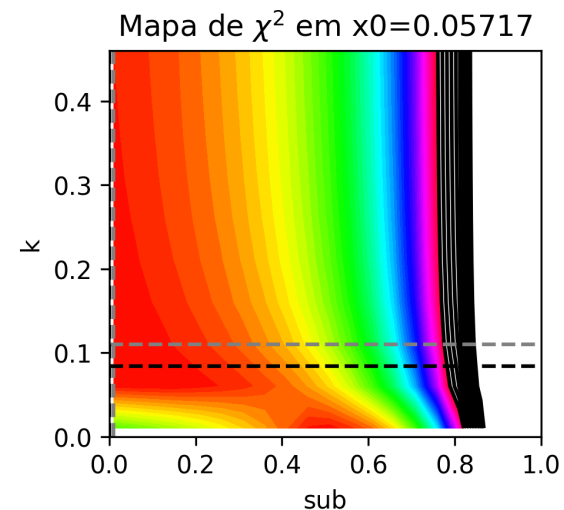
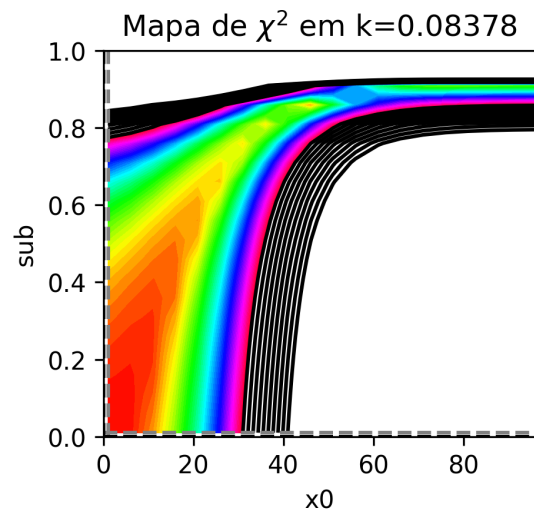
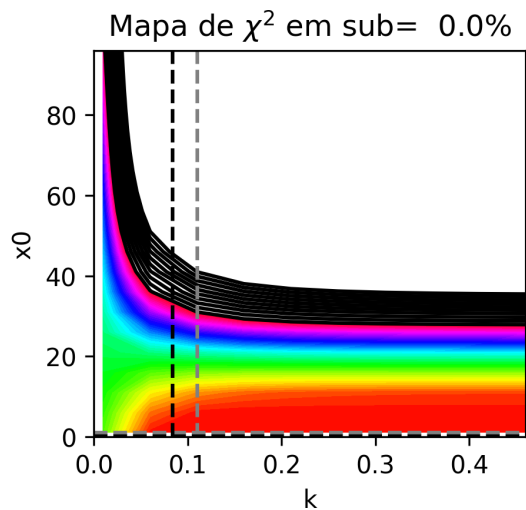


# Porciúncula/RJ

Modelo SEIRD aplicado a populacao de PORCIUNCULA



# Porciúncula/RJ



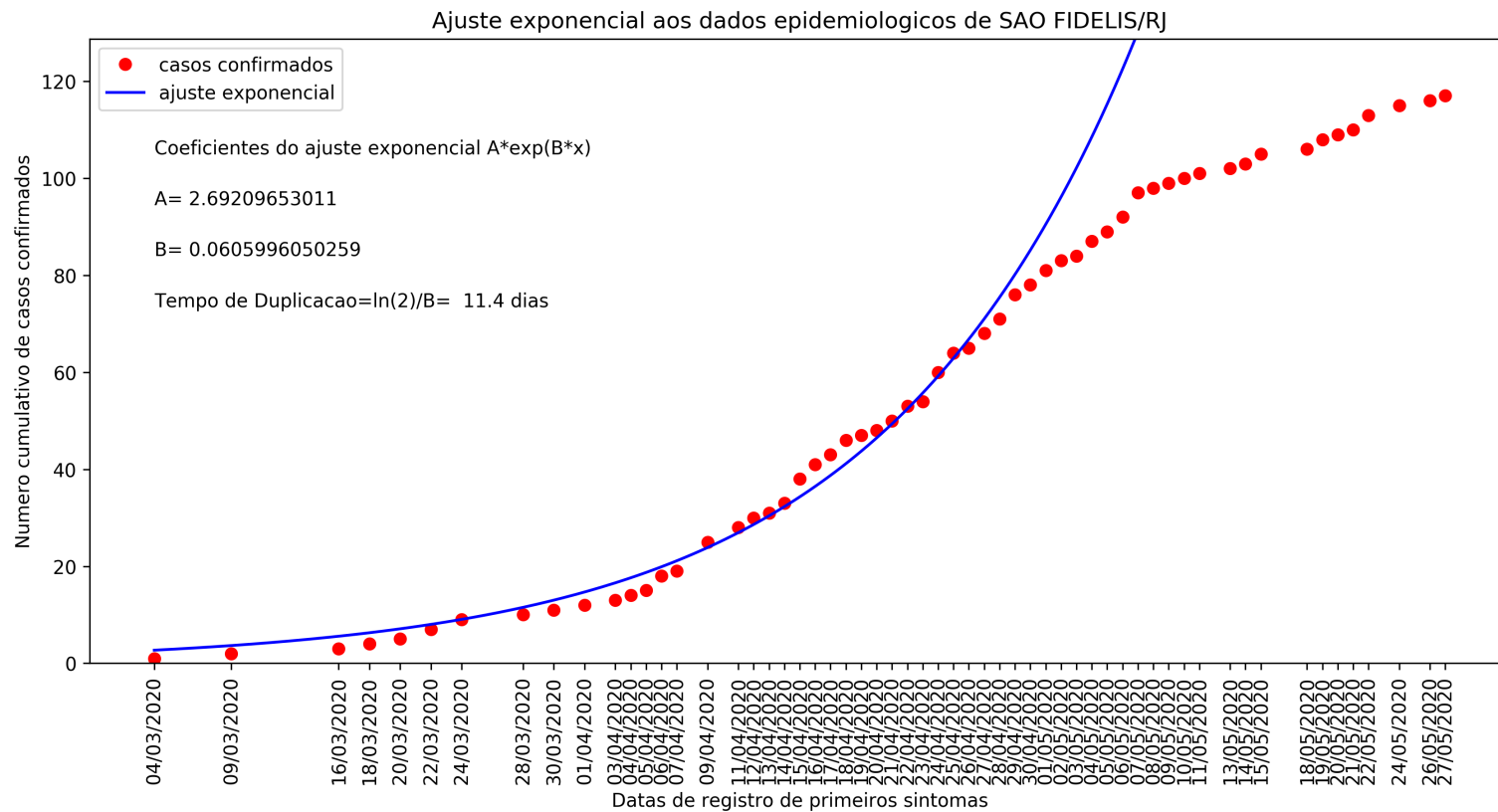
# Varre-Sai/RJ

- Apresenta apenas 13 casos até 11/06/2020
- Não é possível ajustar o modelo com tão poucos casos
- 1º caso começou a apresentar sintomas em 10/05/2020

# Outros municípios do RJ

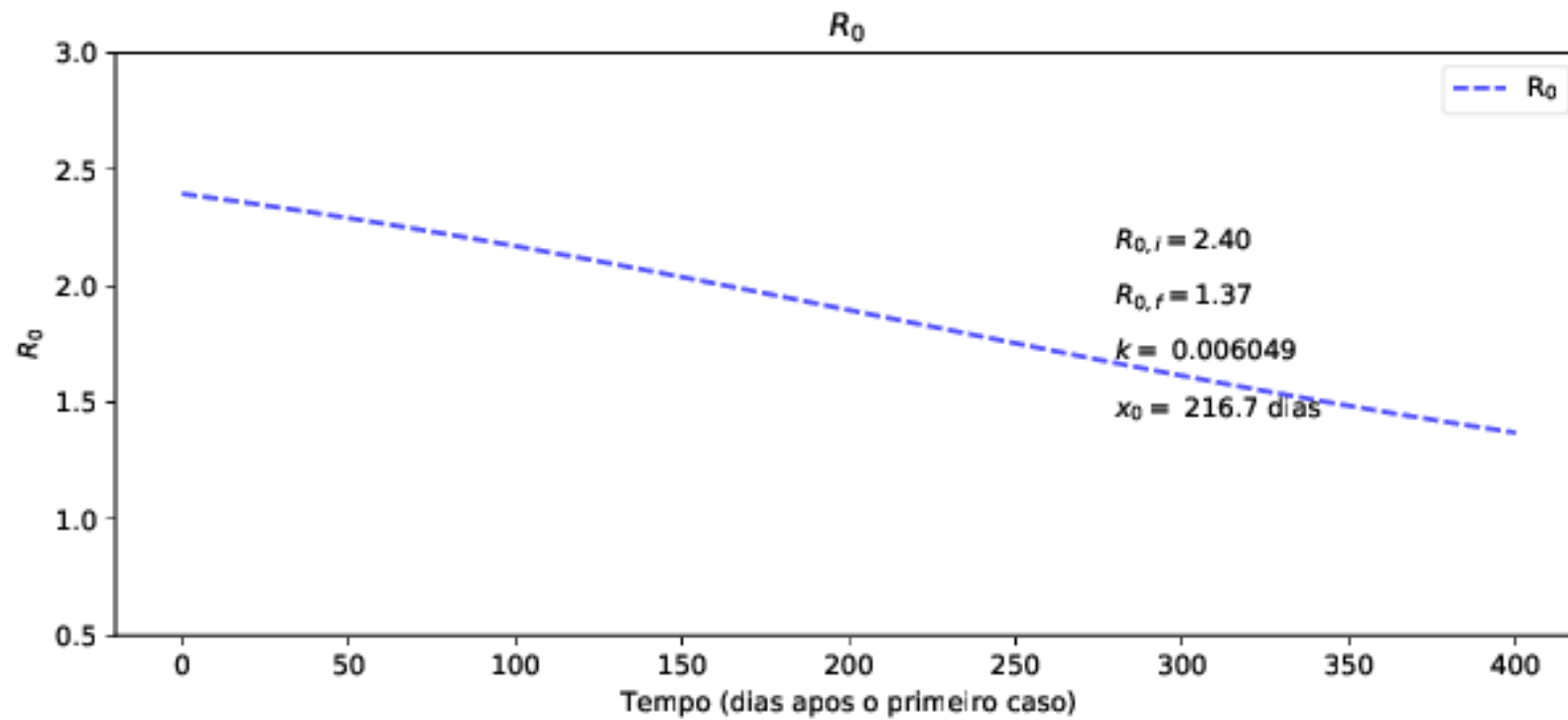
- Os próximos gráficos de outros municípios foram feitos em data anterior
- Os dados utilizados foram obtidos em 31/05/2020, com casos registrados antes desta data.
- Os dados também foram obtidos no Painel Coronavírus da Secretaria de Saúde do RJ.
- A versão do código Python utilizado ainda não estava tão otimizada e aperfeiçoada quanto em 11/06/2020.
- Recomenda-se cautela na análise dos gráficos a seguir.

# São Fidélis/RJ

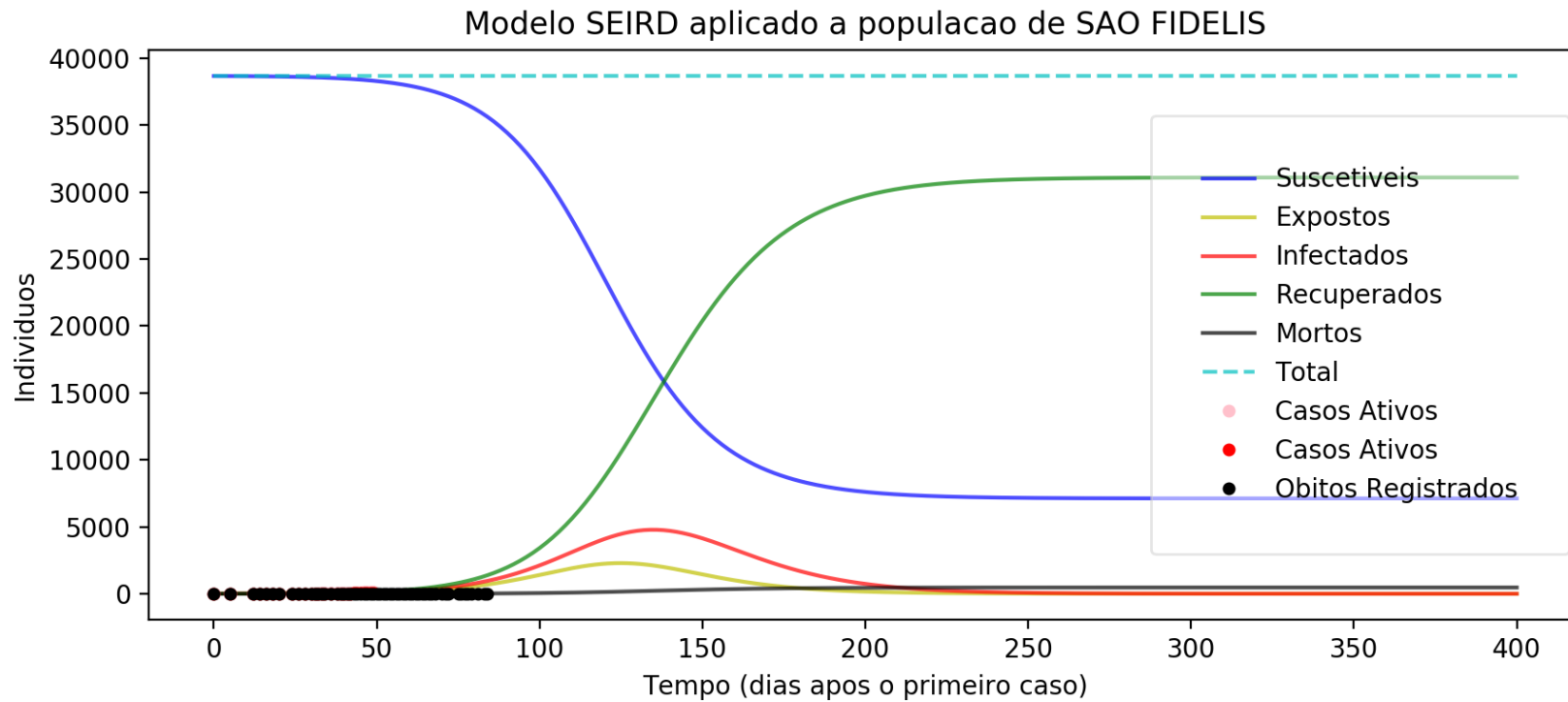




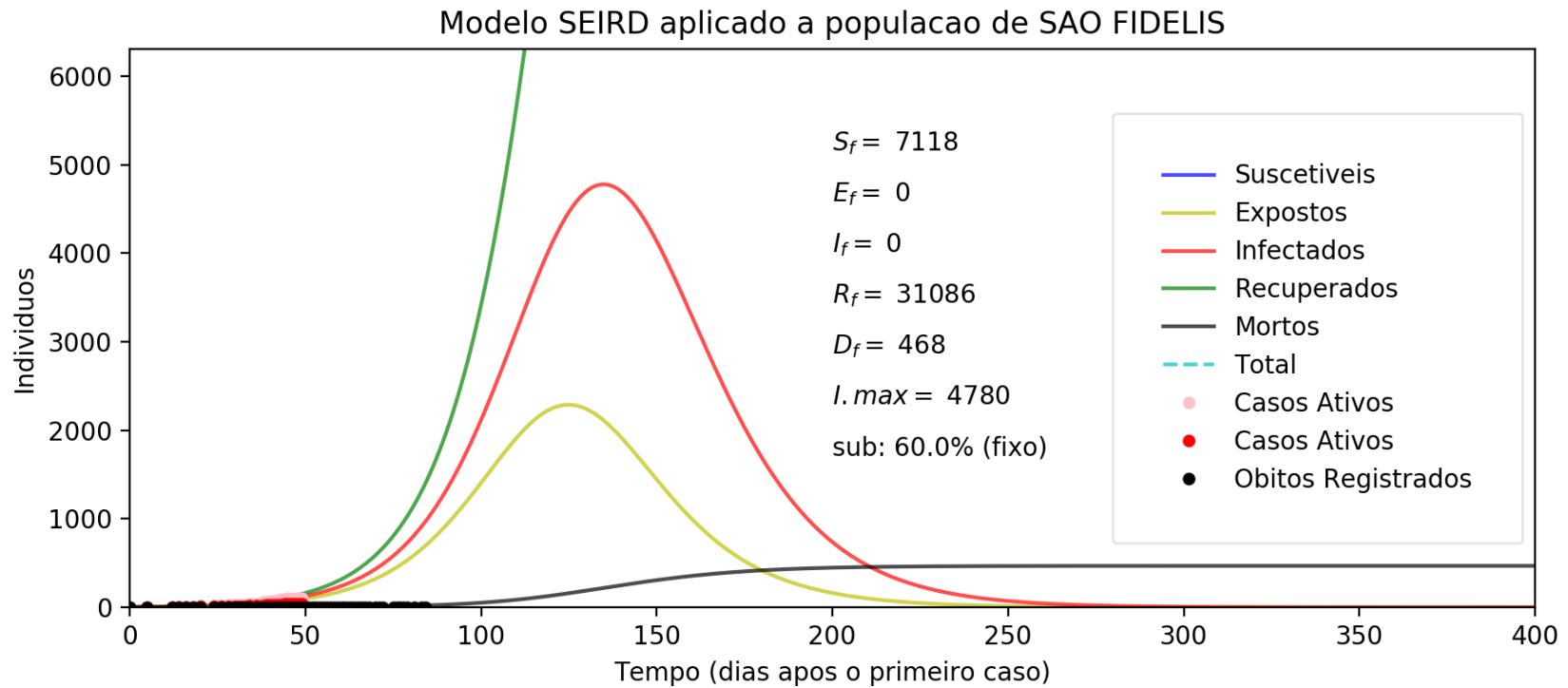
# São Fidélis/RJ



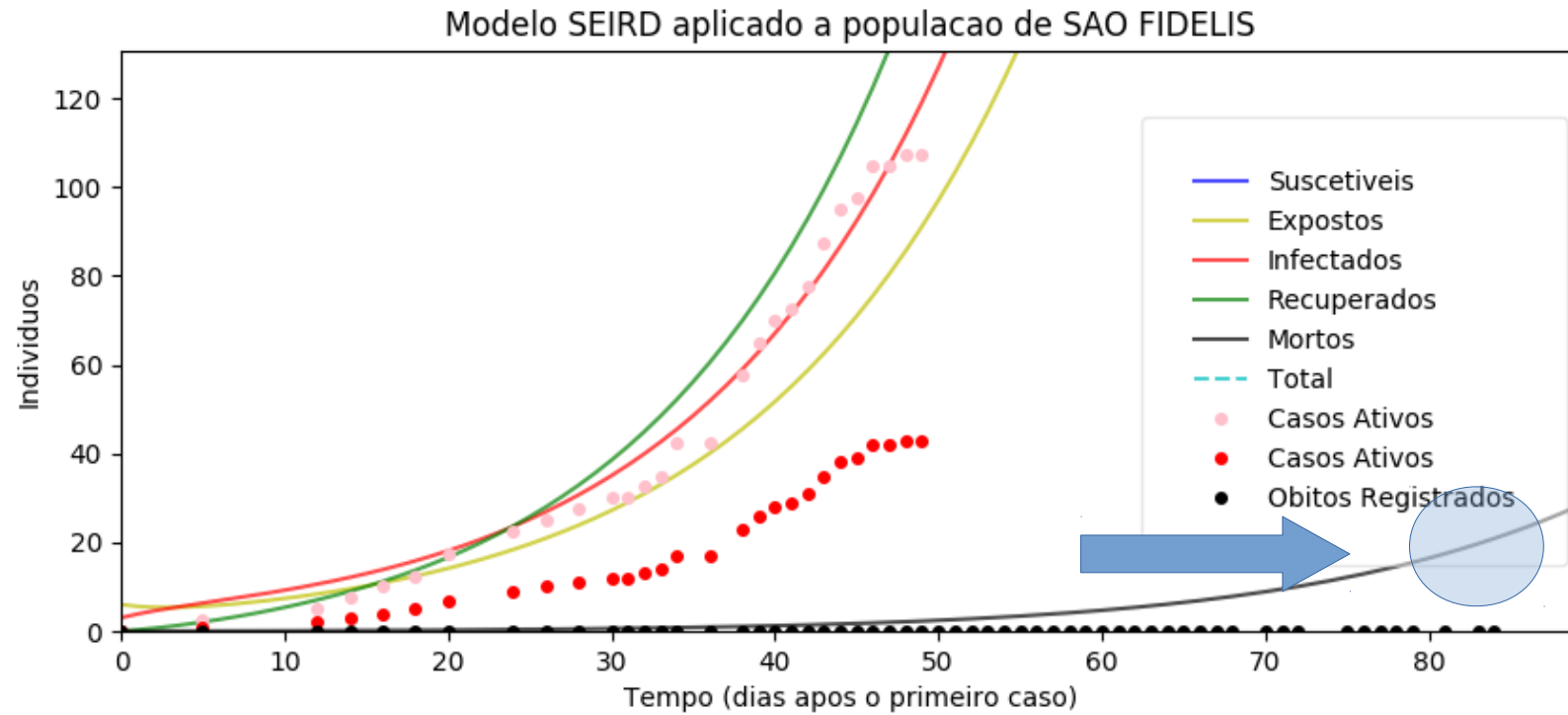
# São Fidélis/RJ



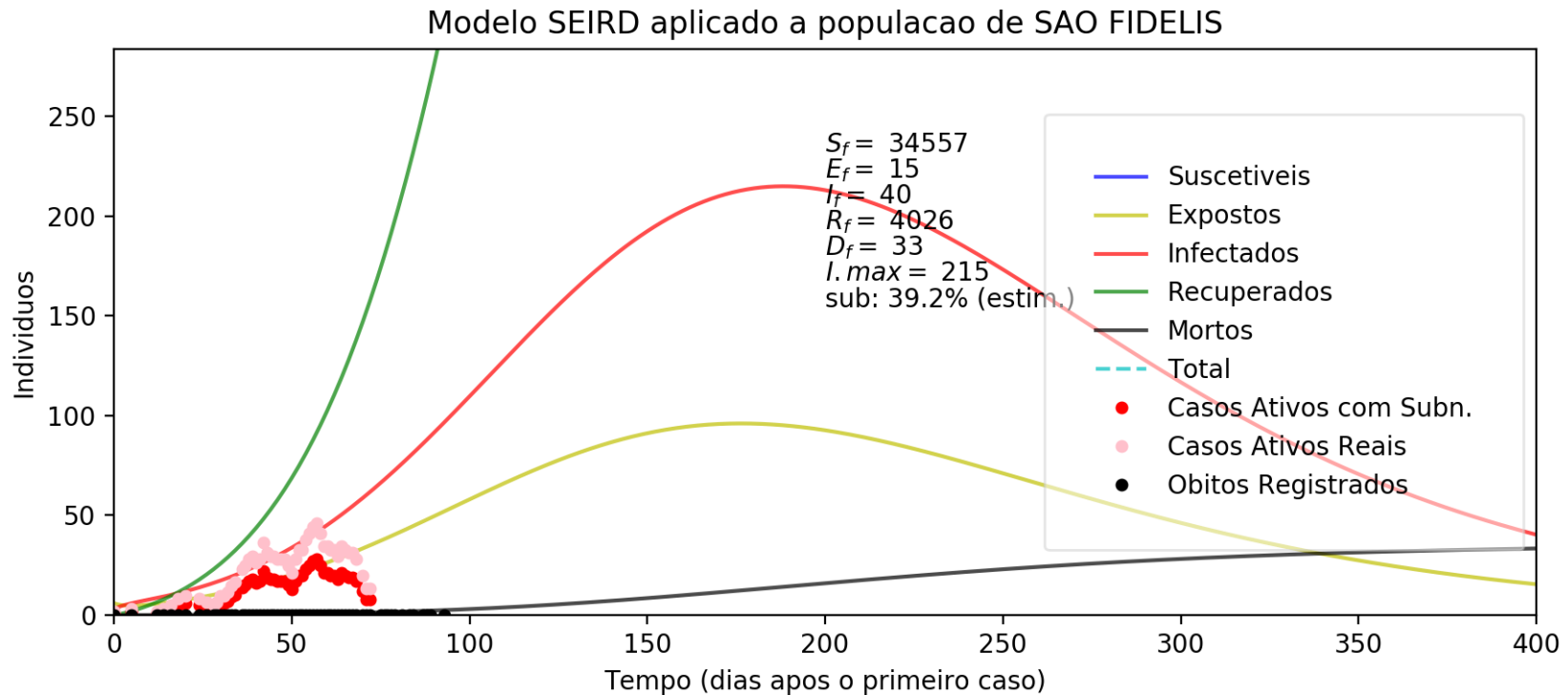
# São Fidélis/RJ



# São Fidélis/RJ

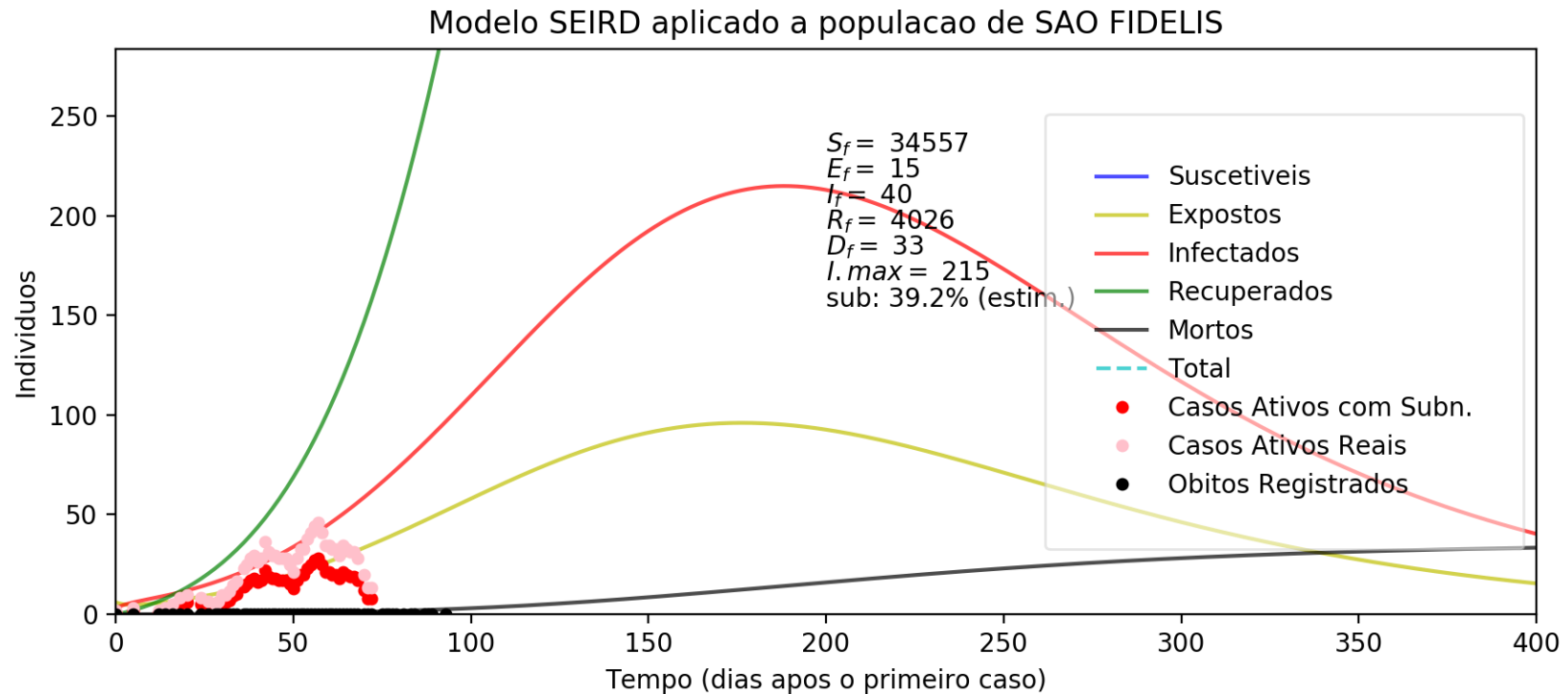


# São Fidélis/RJ: 11/06/2020



Não sei o que ocorre no município...

# São Fidélis/RJ: 11/06/2020

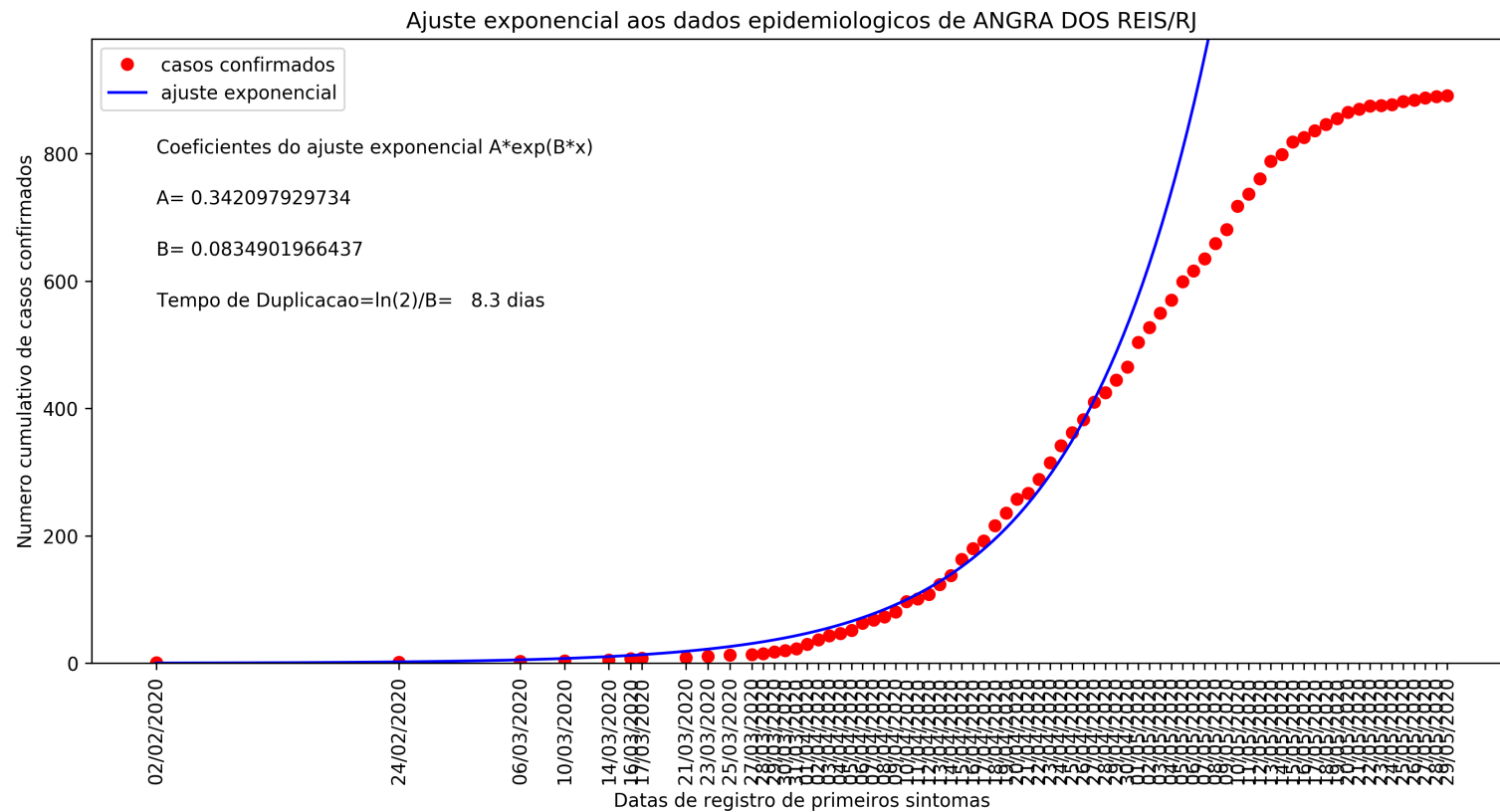


Não sei o que ocorre no município...

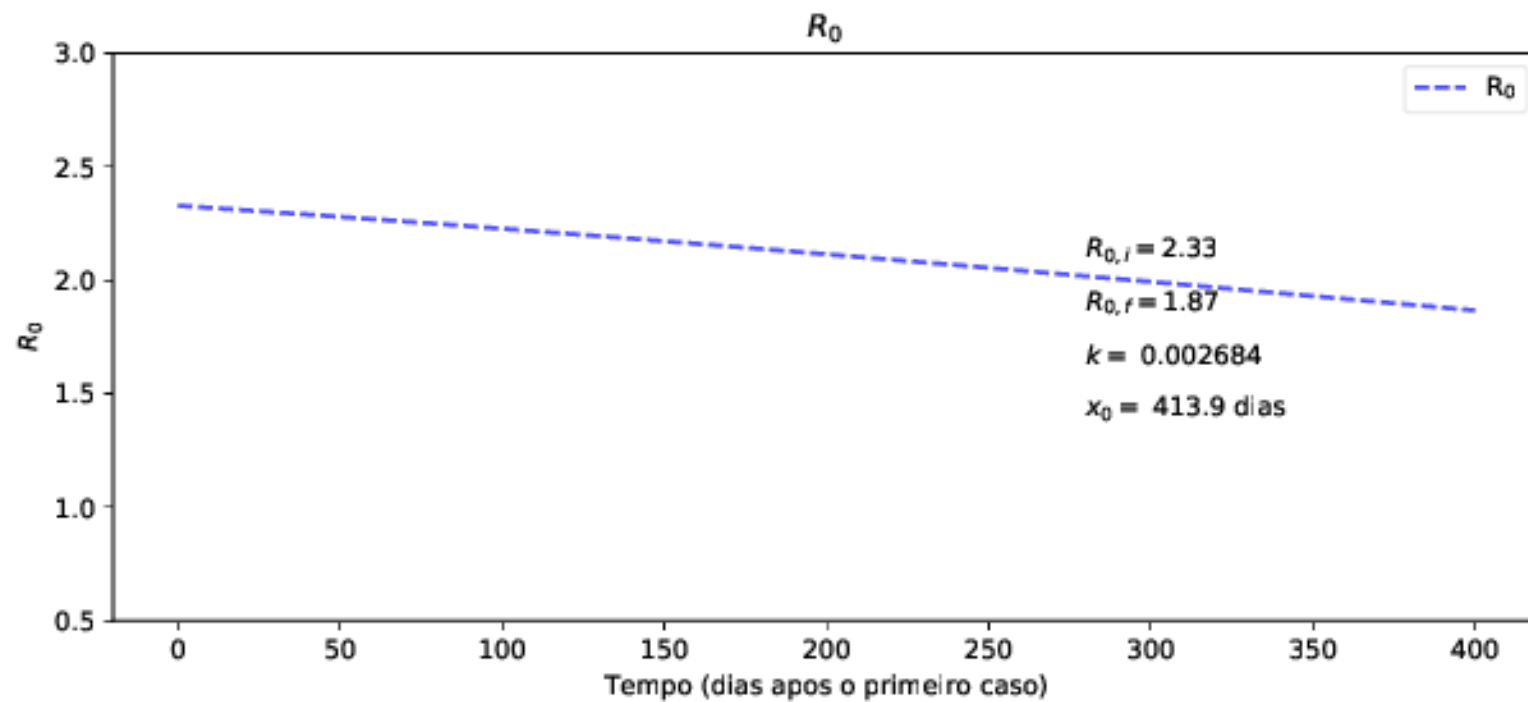
<https://www.serranewsRJ.com.br/2020/06/prefeitura-de-sao-fidelis-pendura-flamulas-com-mensagens-de-esperanca.html>

<https://sfnoticias.com.br/dia-de-corpus-christi-tera-missas-online-e-translado-do-santissimo-sacramento-por-ruas-de-sao-fidelis>

# Angra dos Reis/RJ

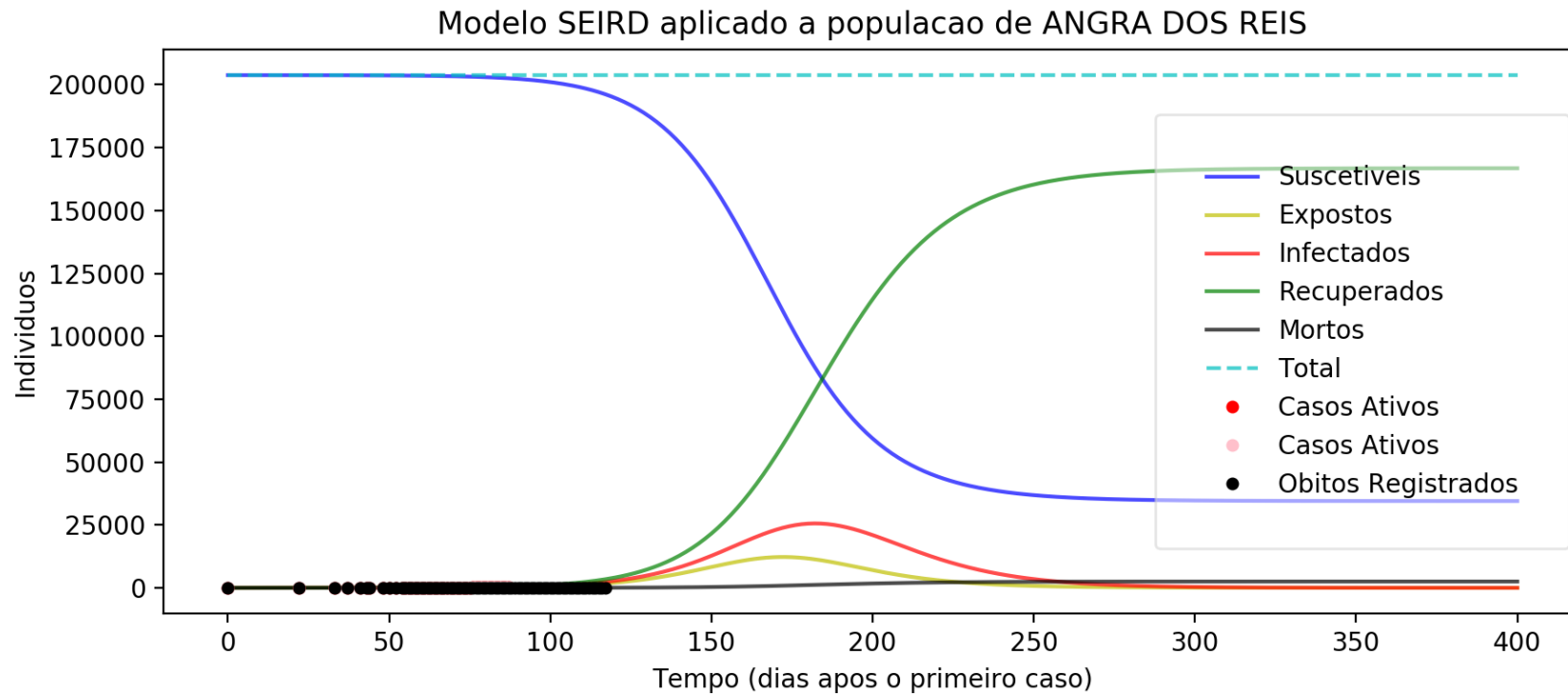


# Angra dos Reis/RJ



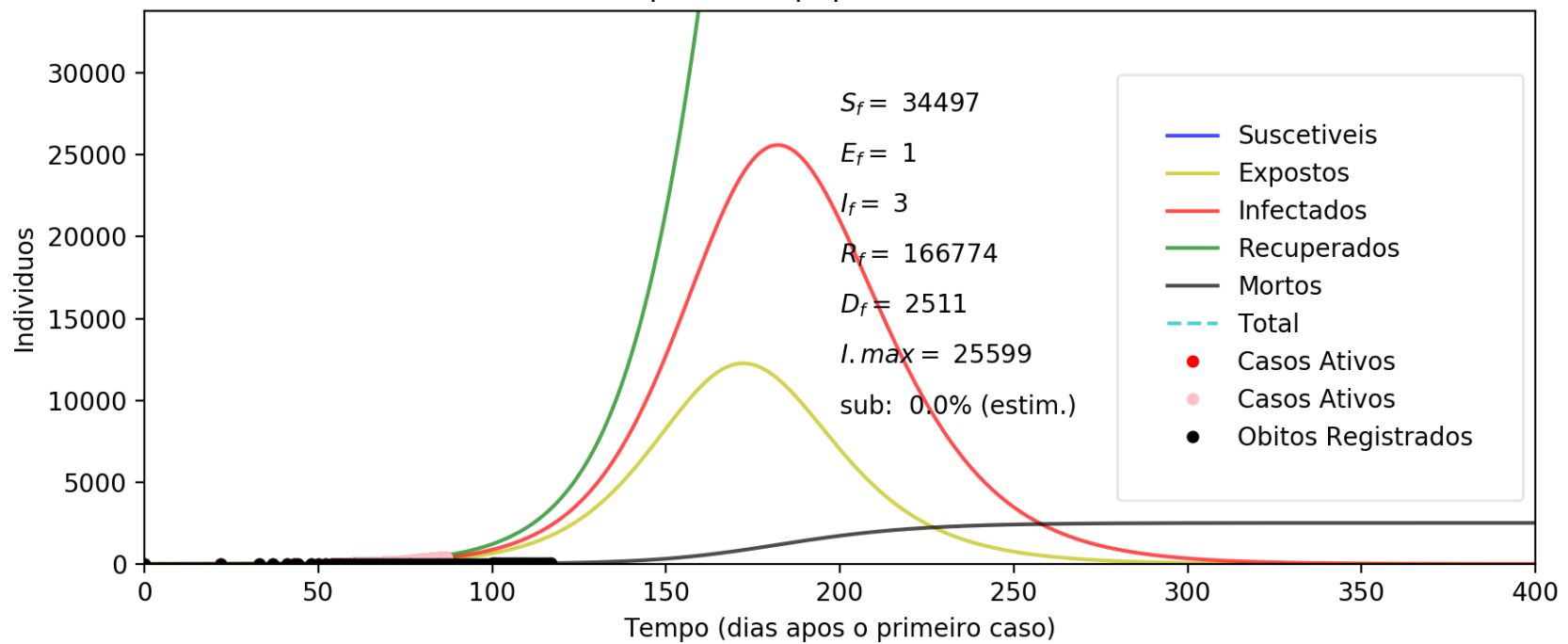


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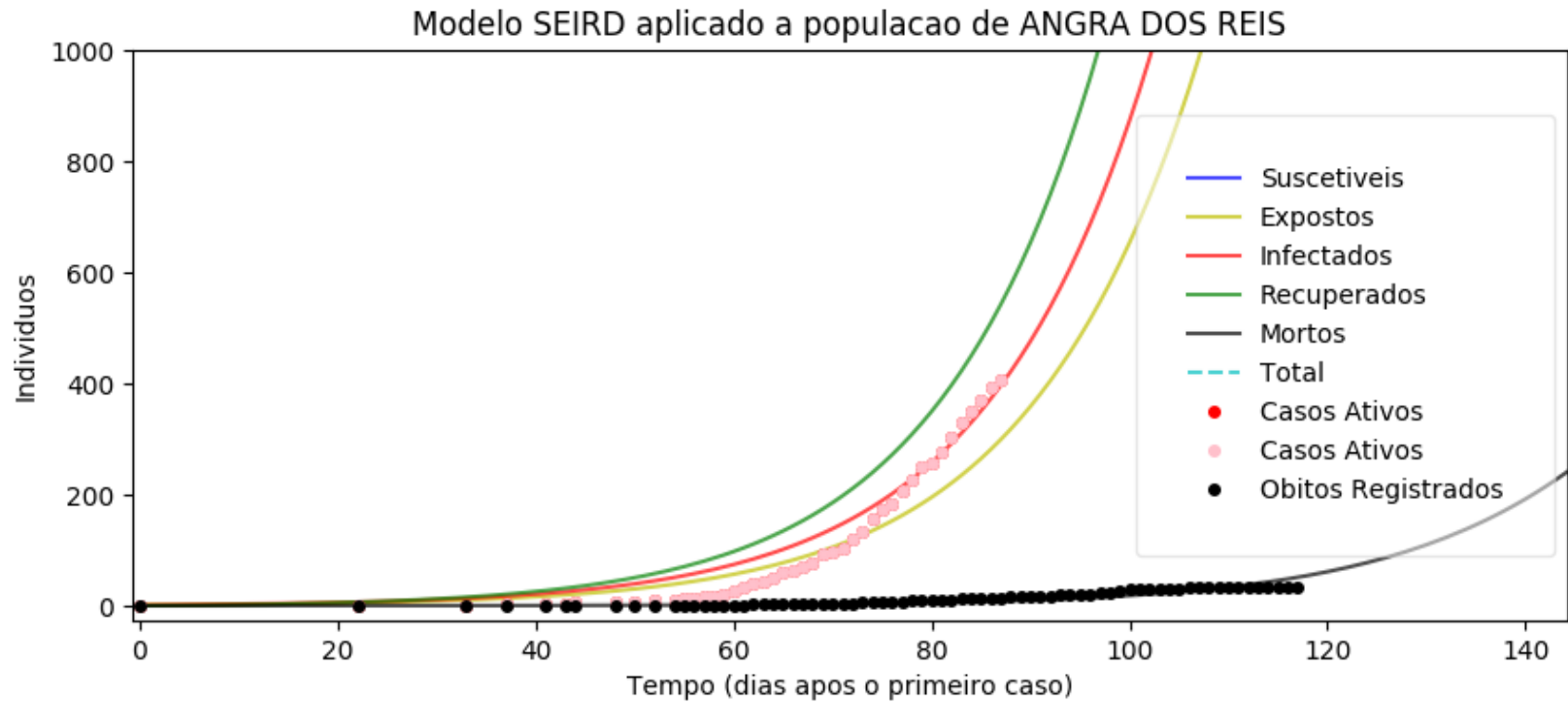


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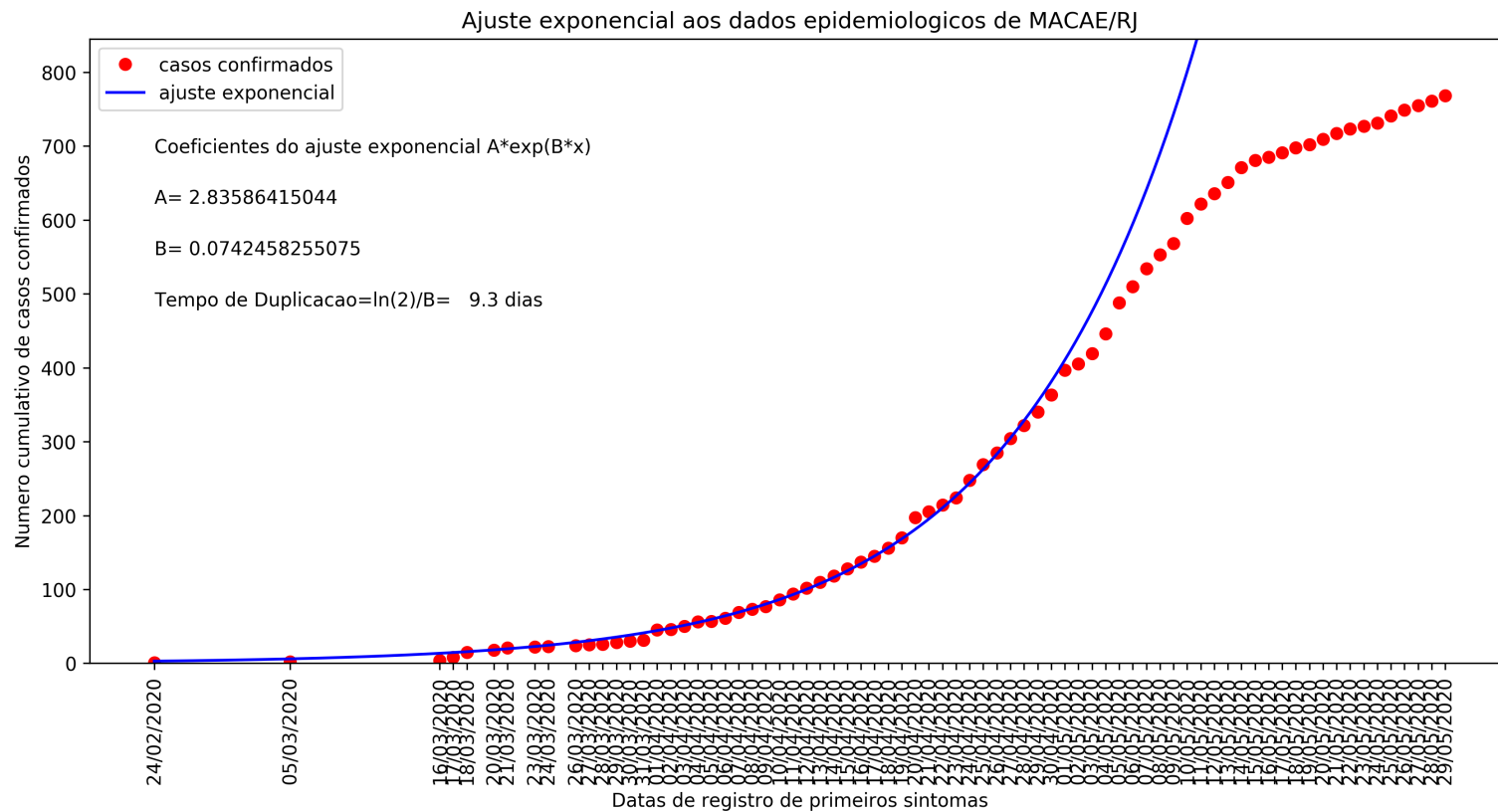
Modelo SEIRD aplicado a populacao de ANGRA DOS REIS



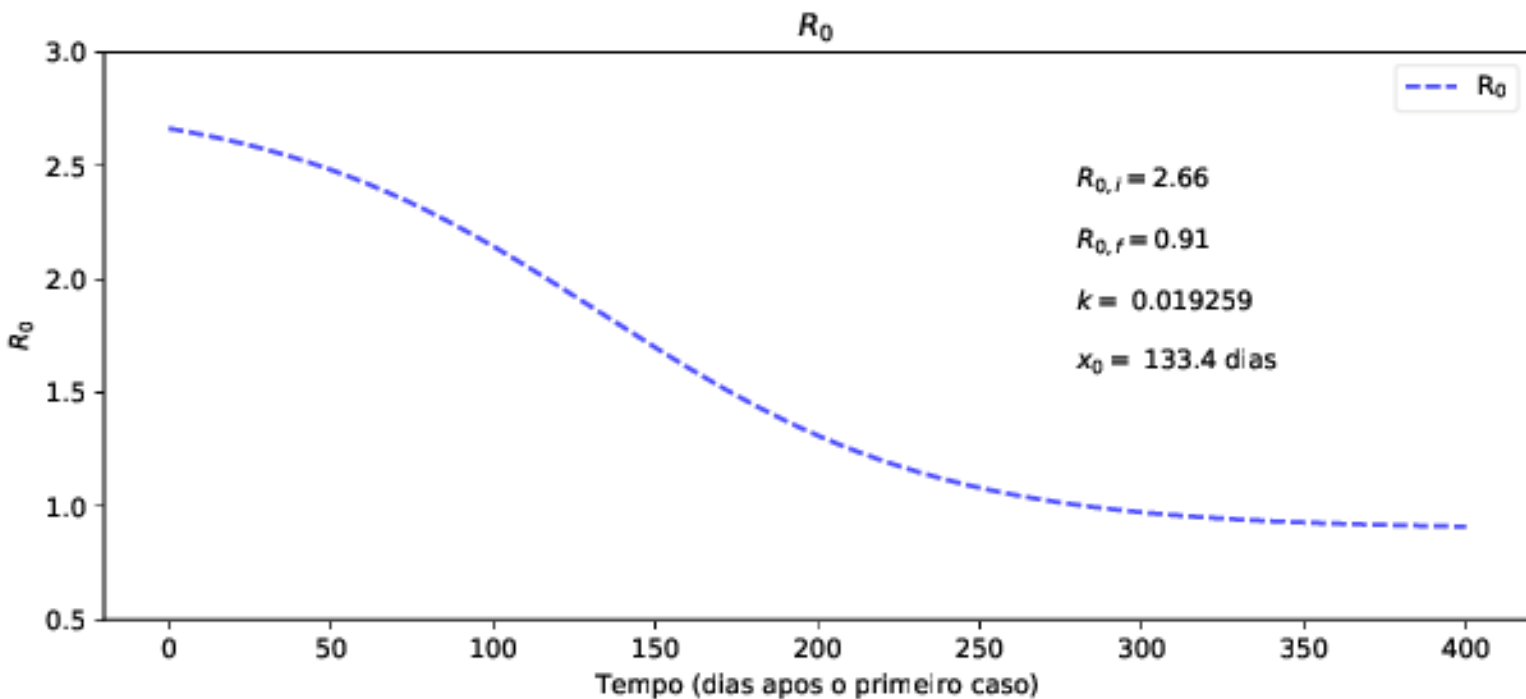
# Angra dos Reis/RJ



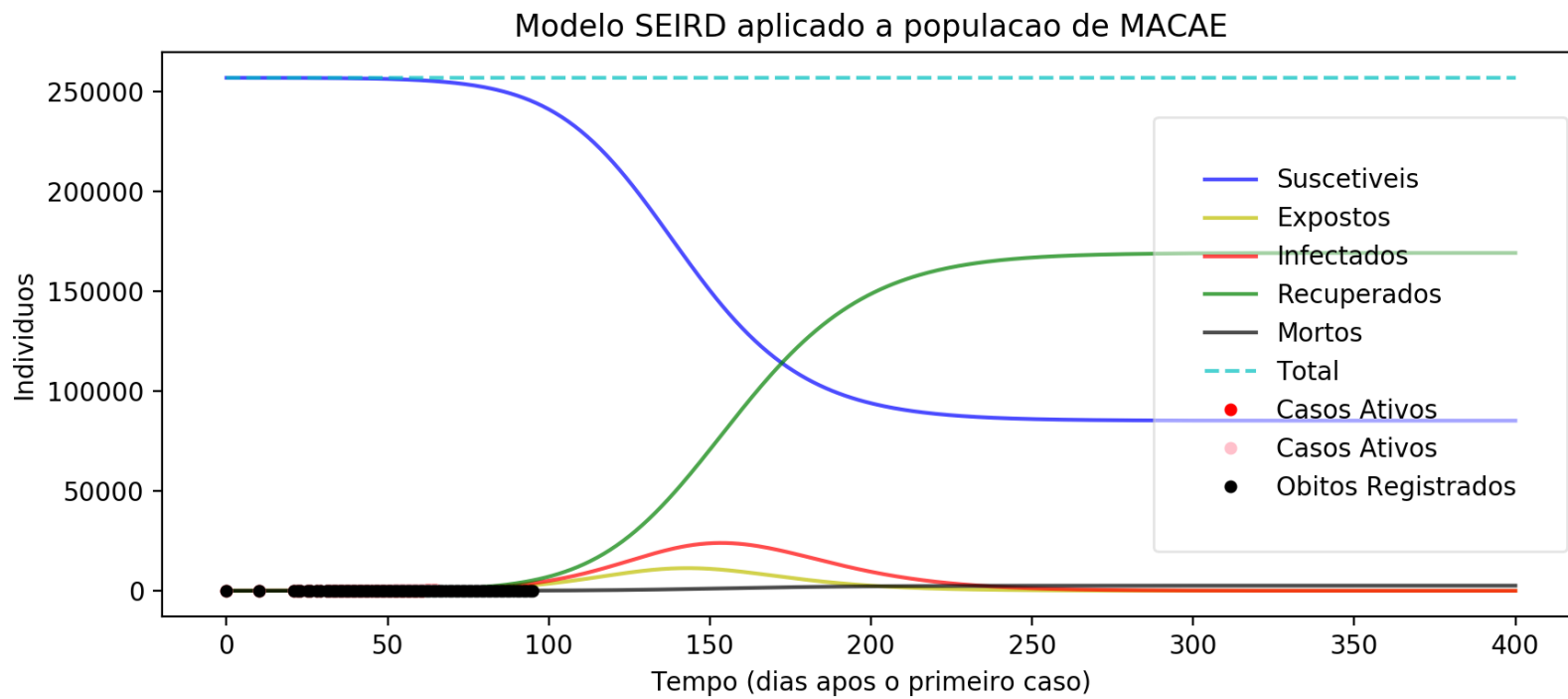
# Macaé/RJ



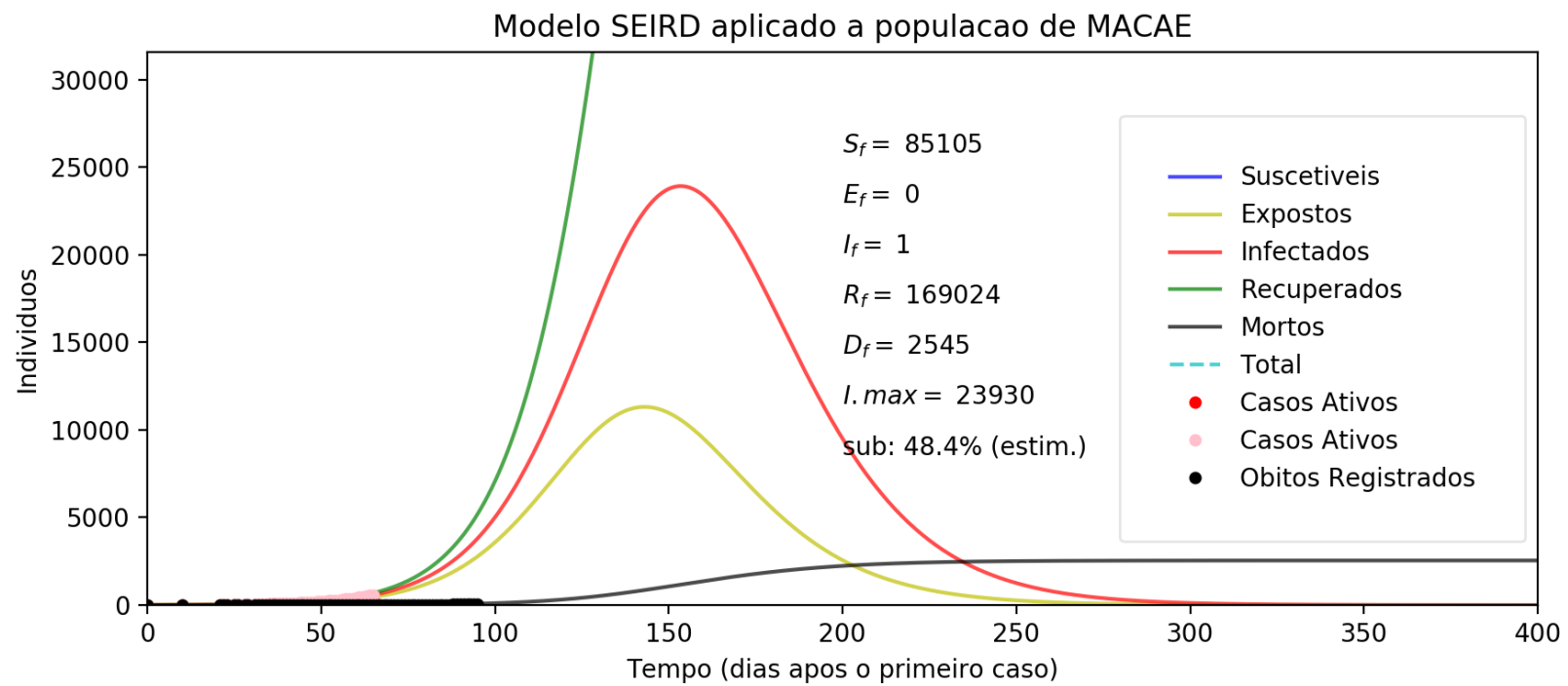
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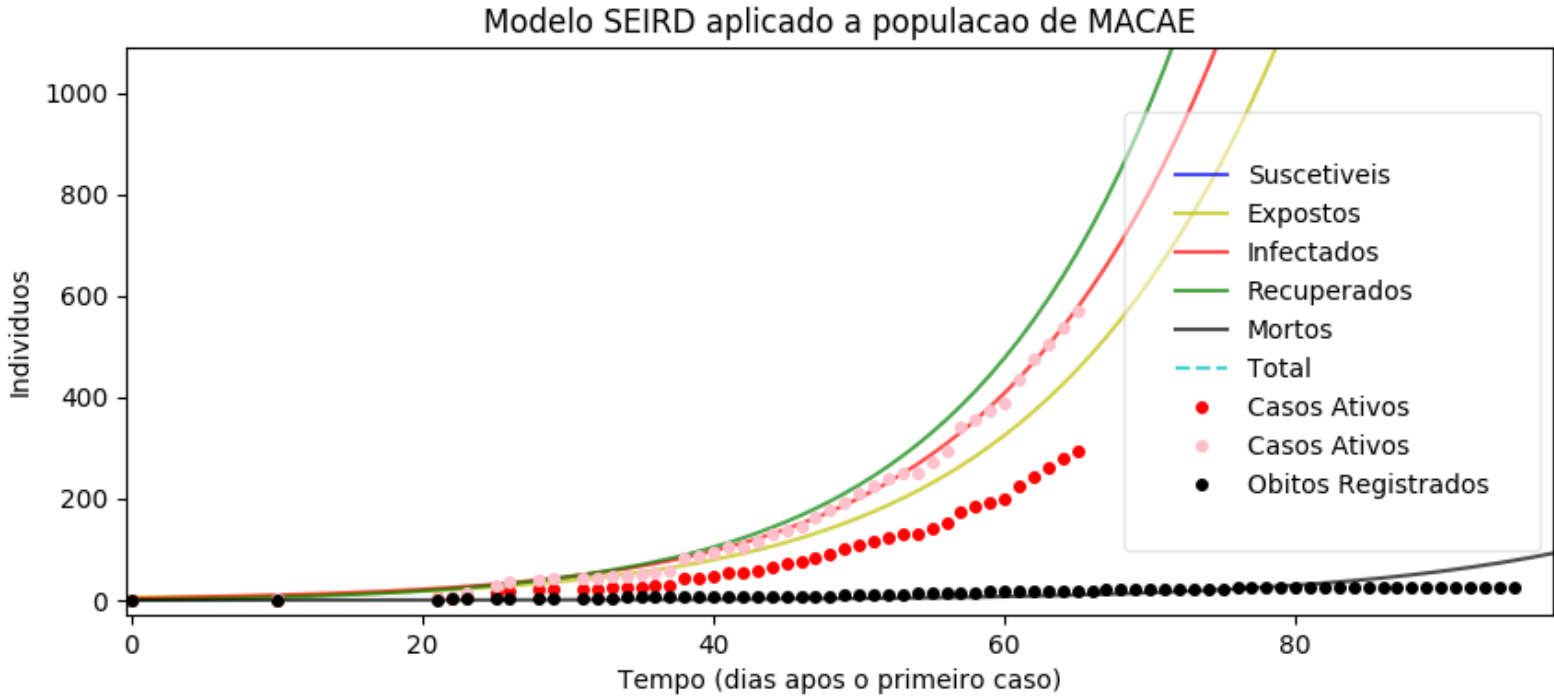
# Macaé/RJ



# Macaé/RJ

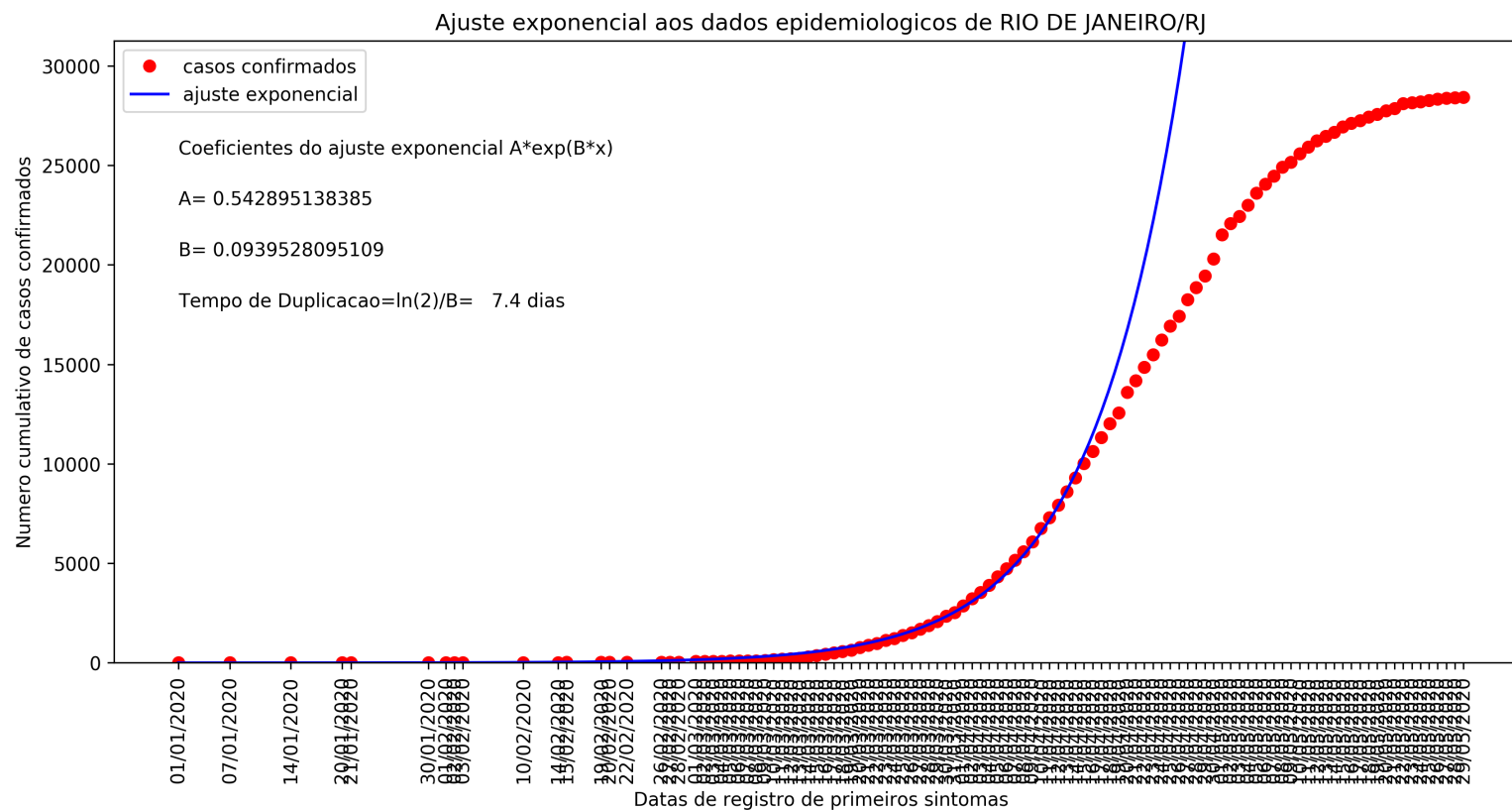


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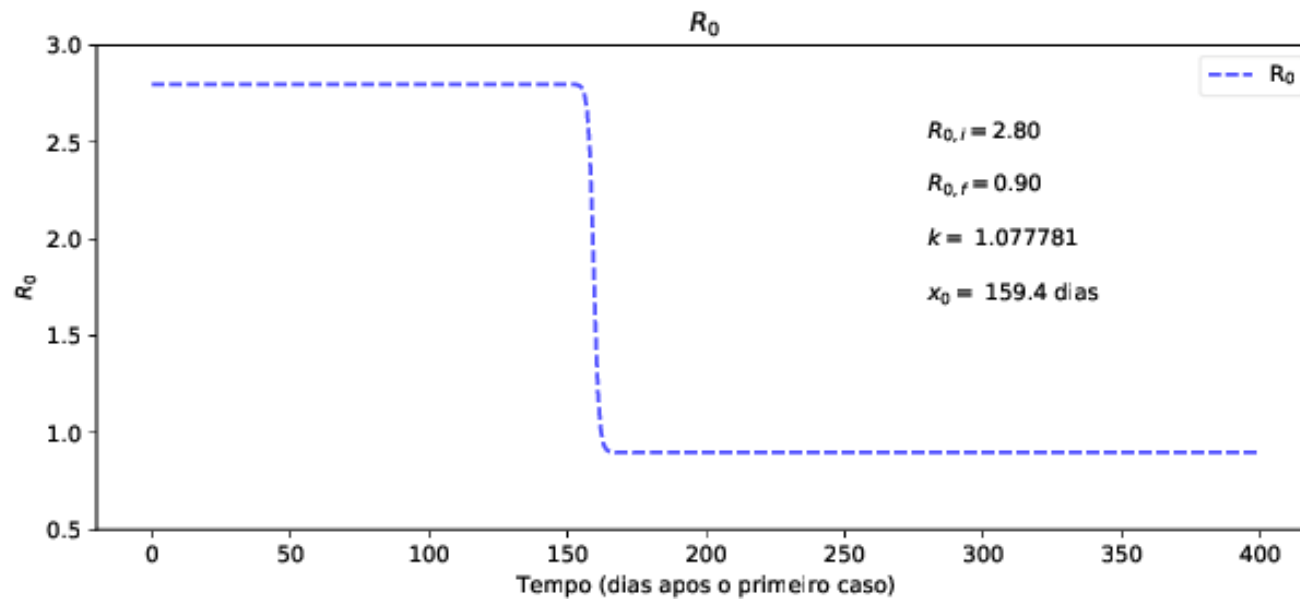




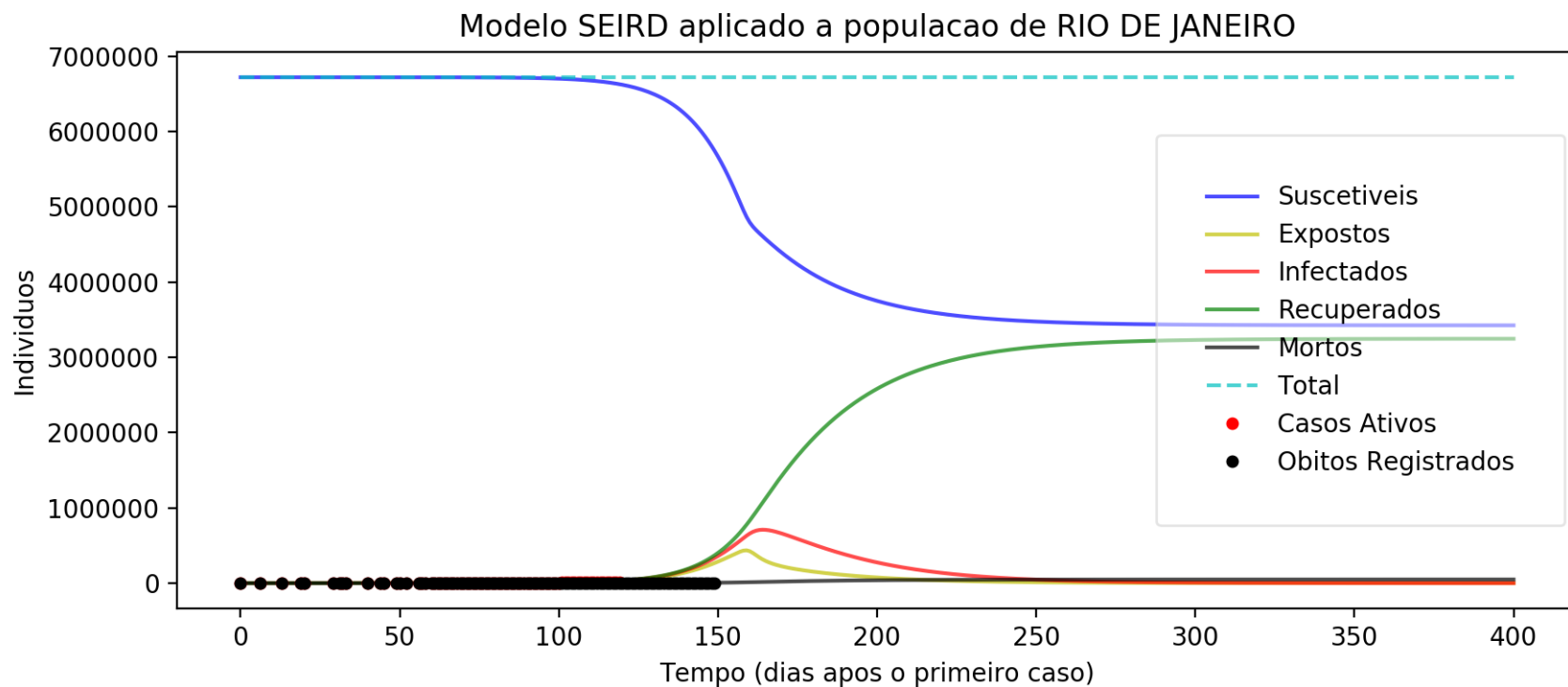
# Rio de Janeiro/RJ



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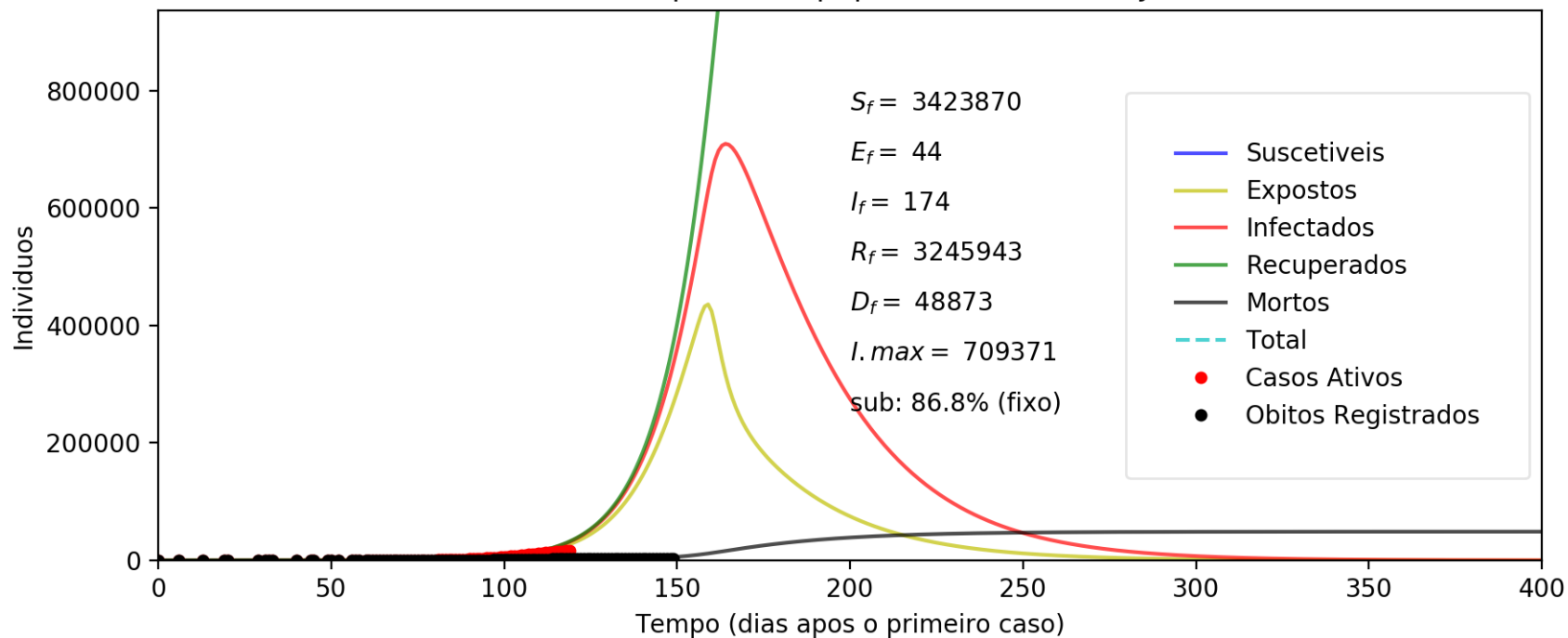


# Rio de Janeiro/RJ

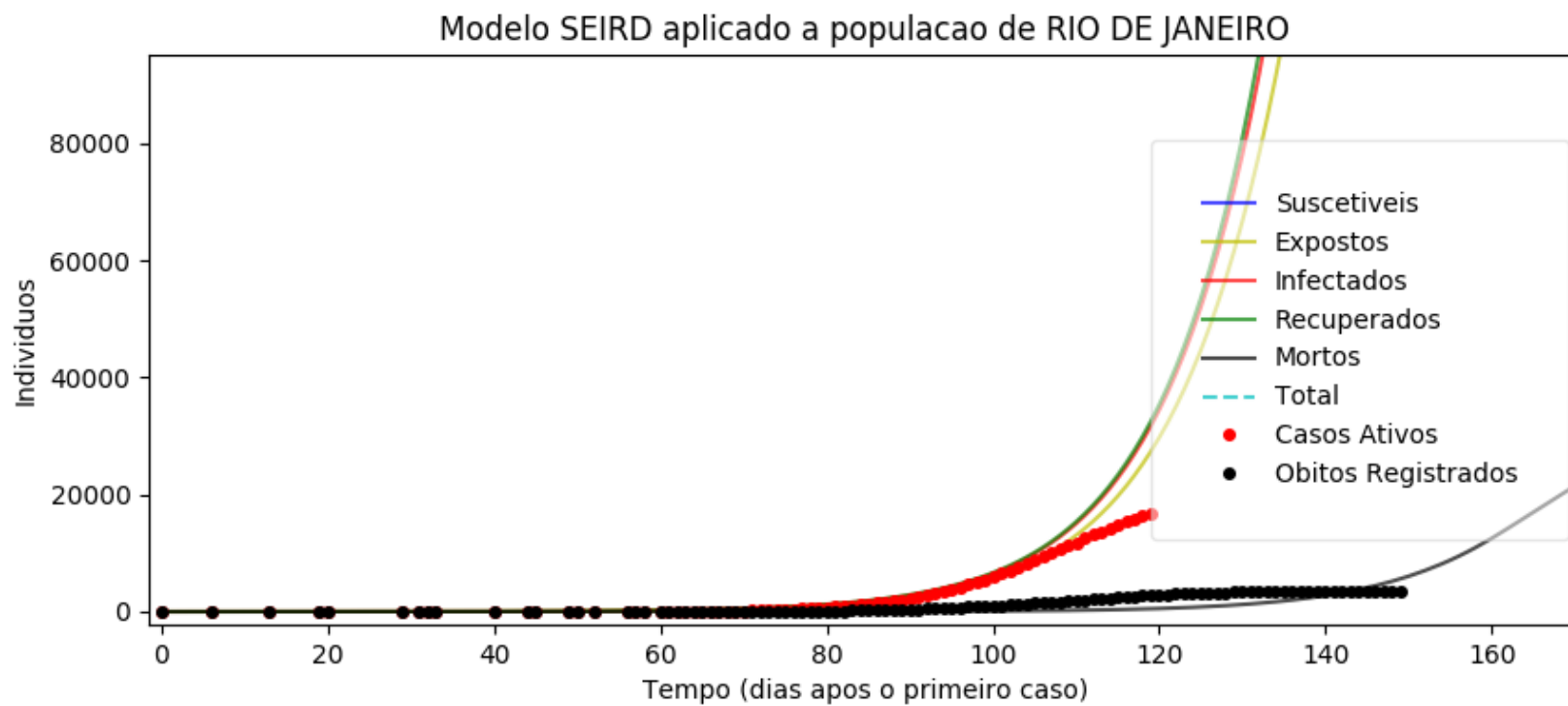


# Rio de Janeiro/RJ

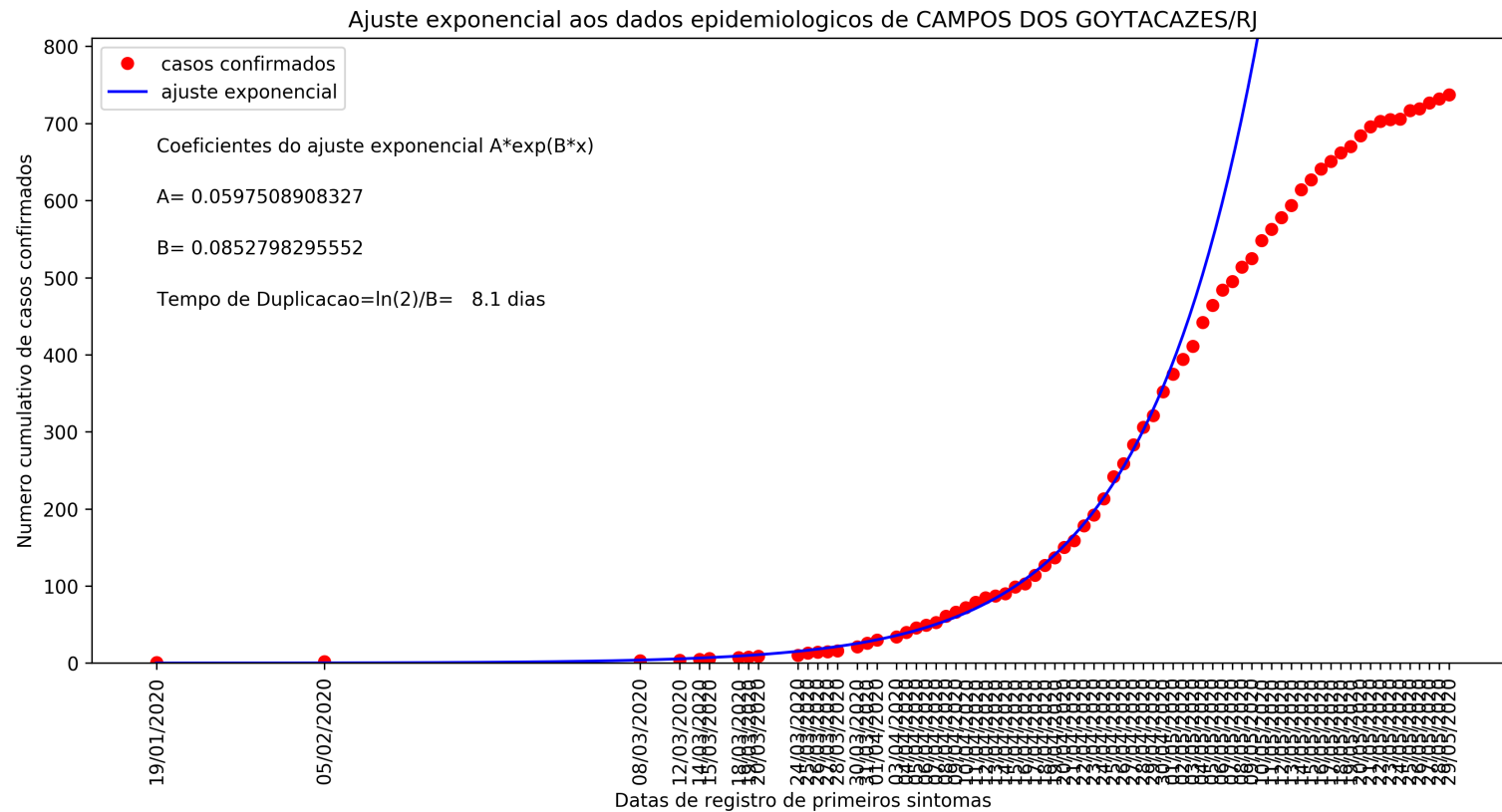
Modelo SEIRD aplicado a população de RIO DE JANEIRO



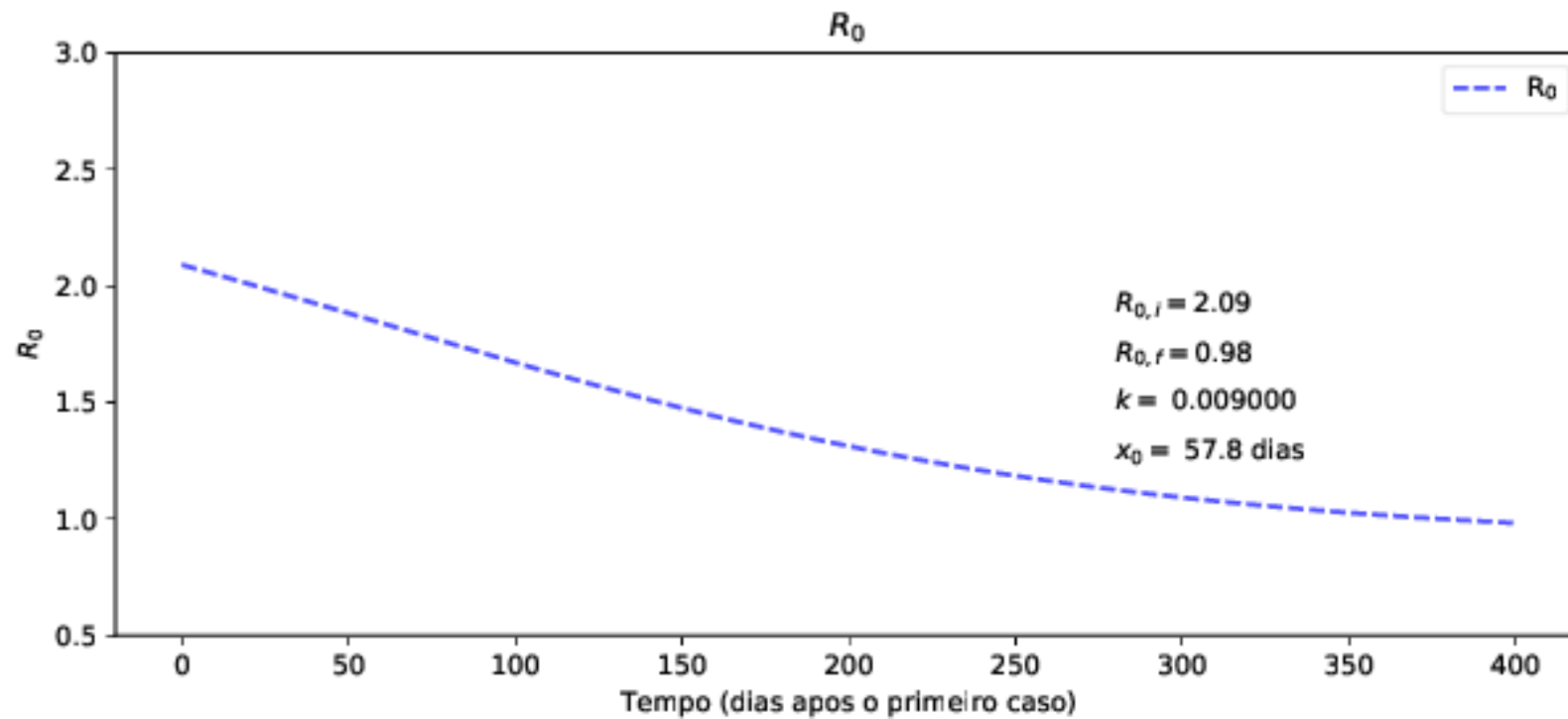
# Rio de Janeiro/RJ



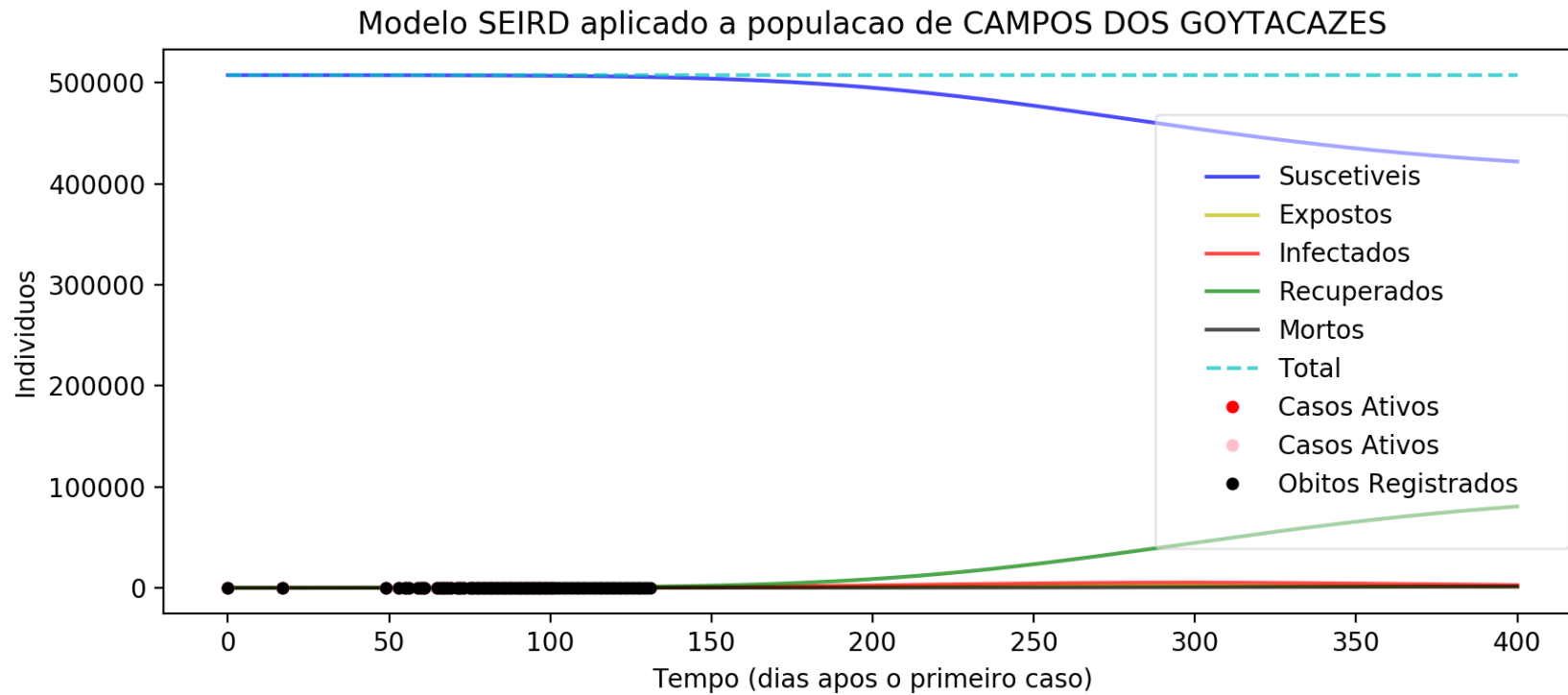
# Campos dos Goytacazes/RJ



# Campos dos Goytacazes/RJ

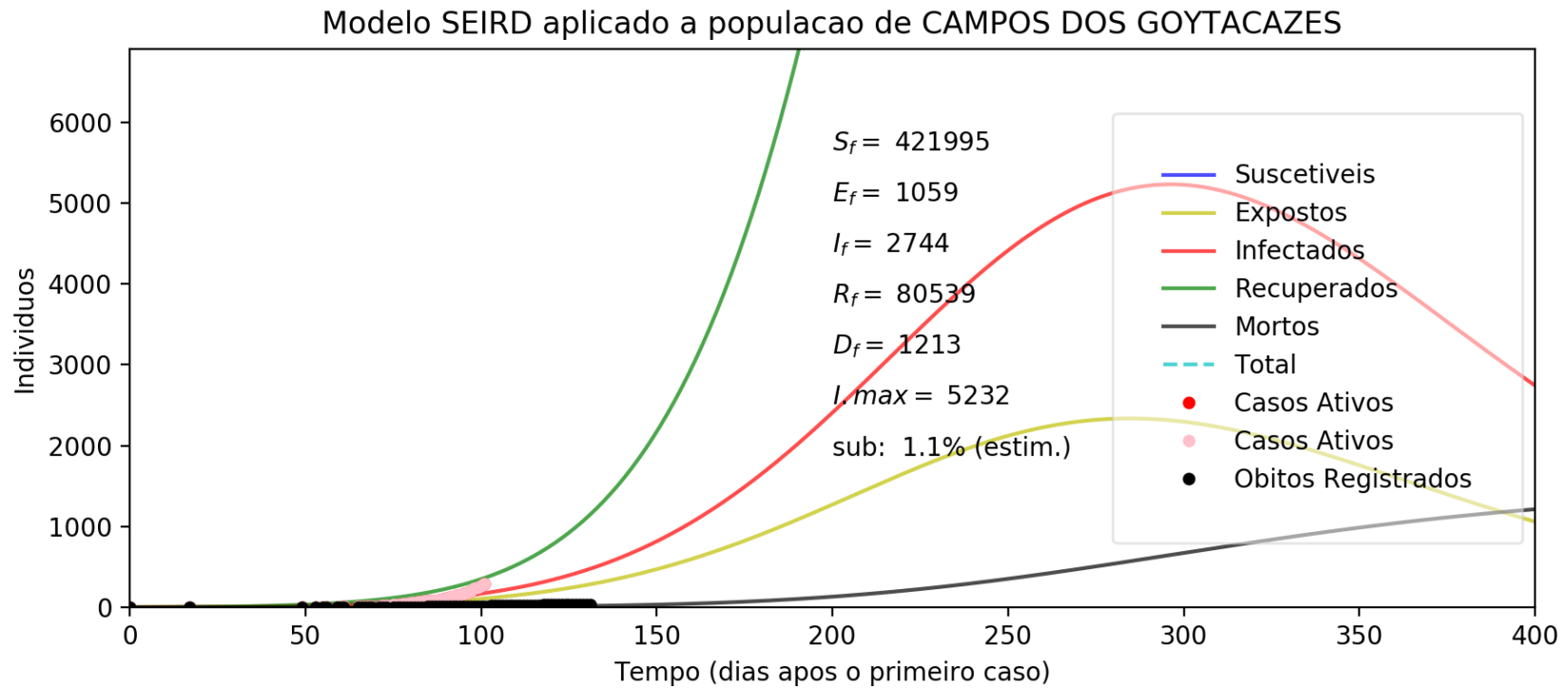


# Campos dos Goytacazes/RJ

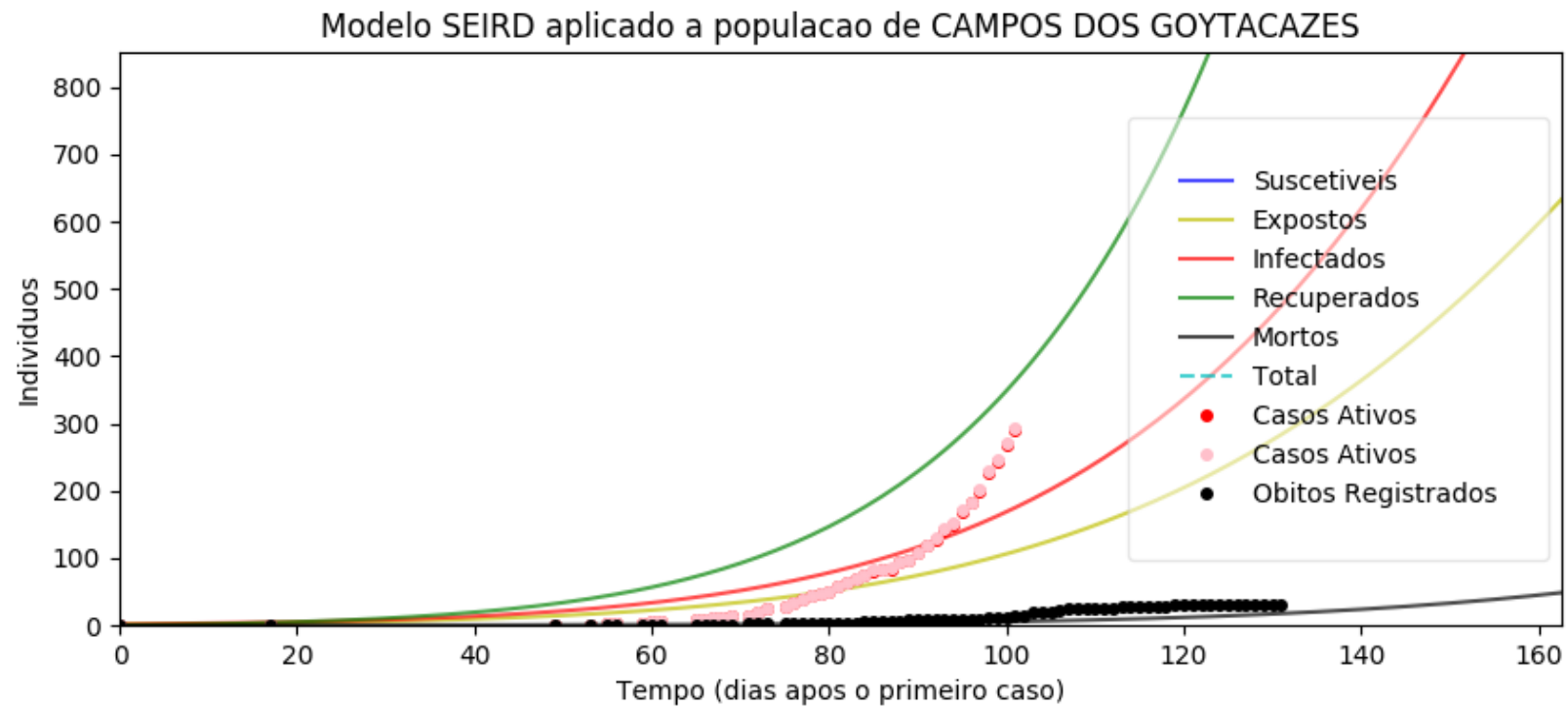




# Campos dos Goytacazes/RJ

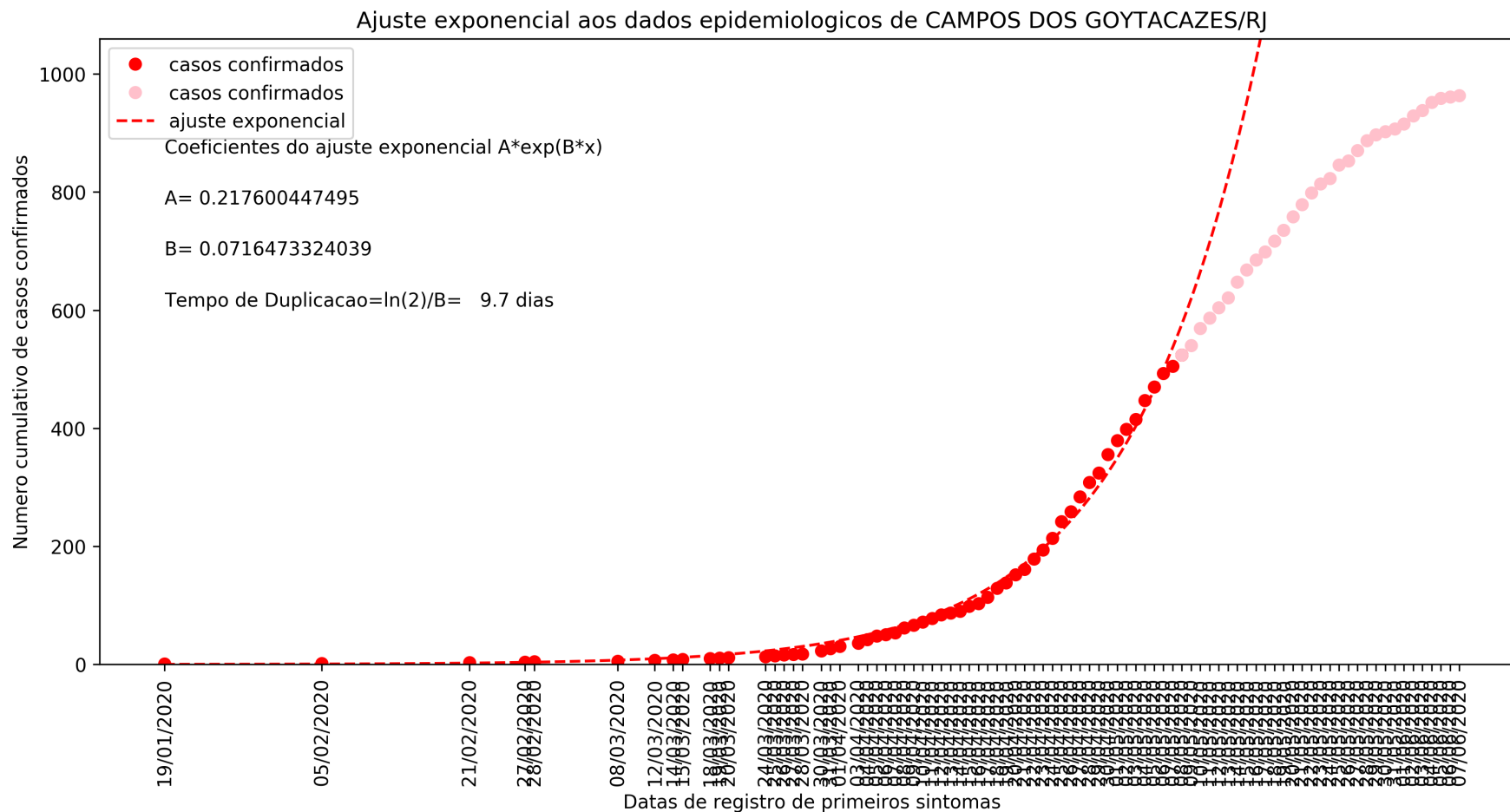


# Campos dos Goytacazes/RJ



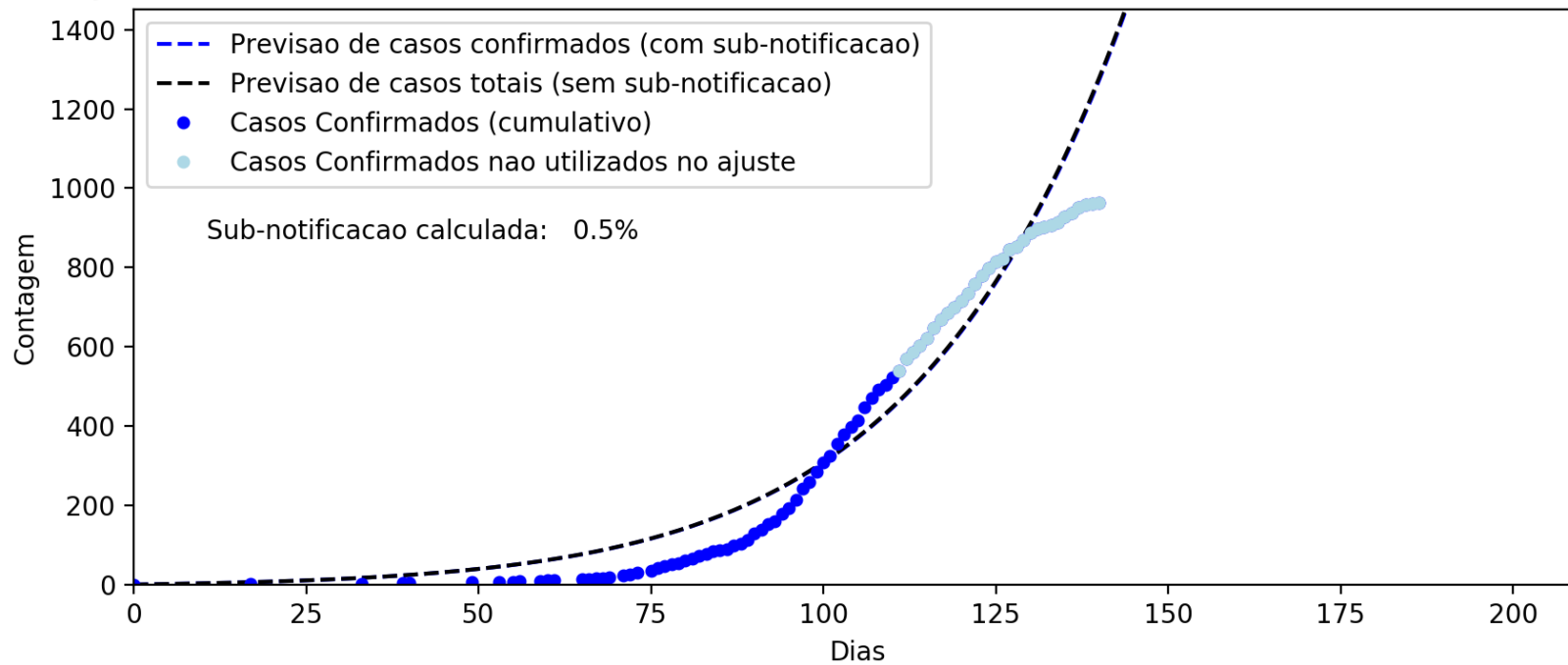
# Campos dos Goytacazes/RJ cenário antes do Lockdown

- Lockdown de 18/05 a 01/06 e alta testagem

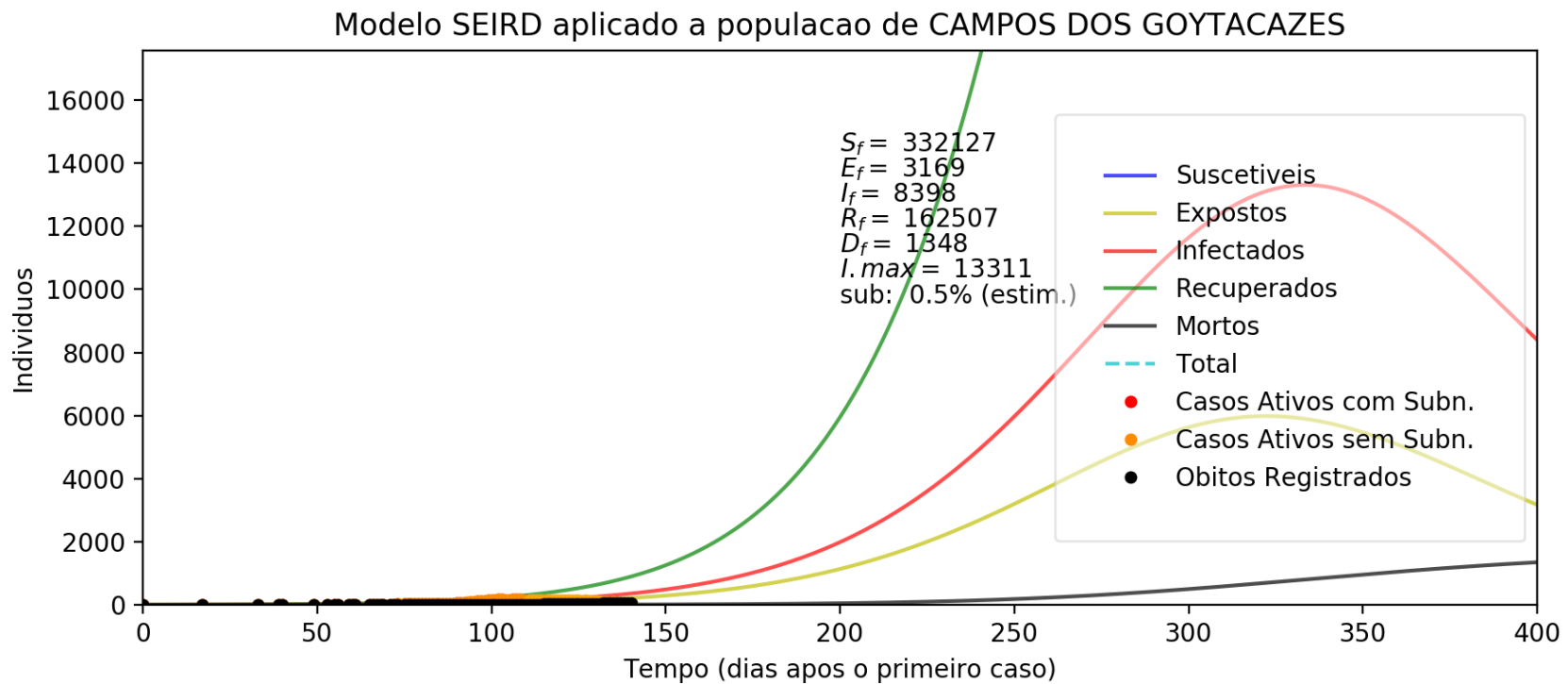


# Campos dos Goytacazes/RJ

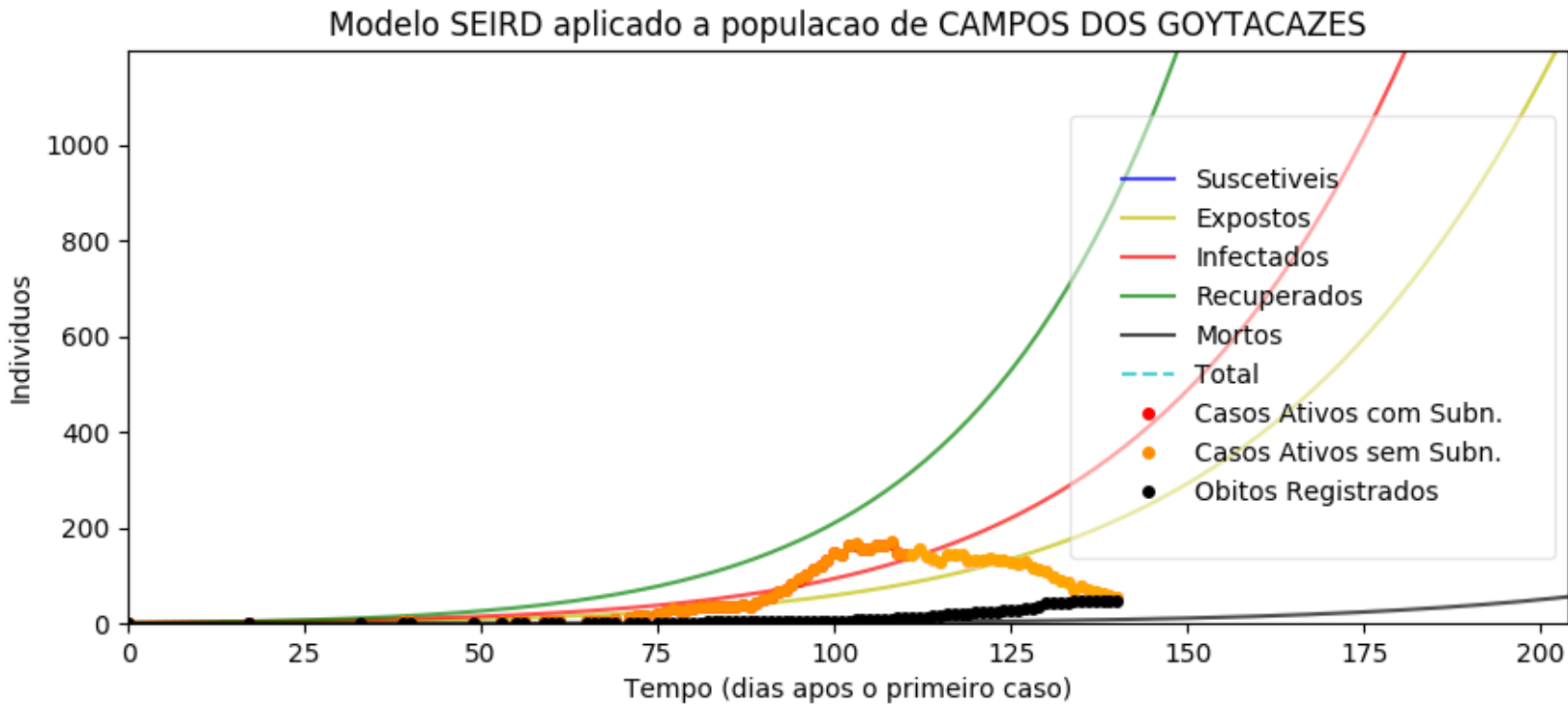
Ajuste do modelo aos Casos Confirmados de CAMPOS DOS GOYTACAZES com dados ate 07/06/2020



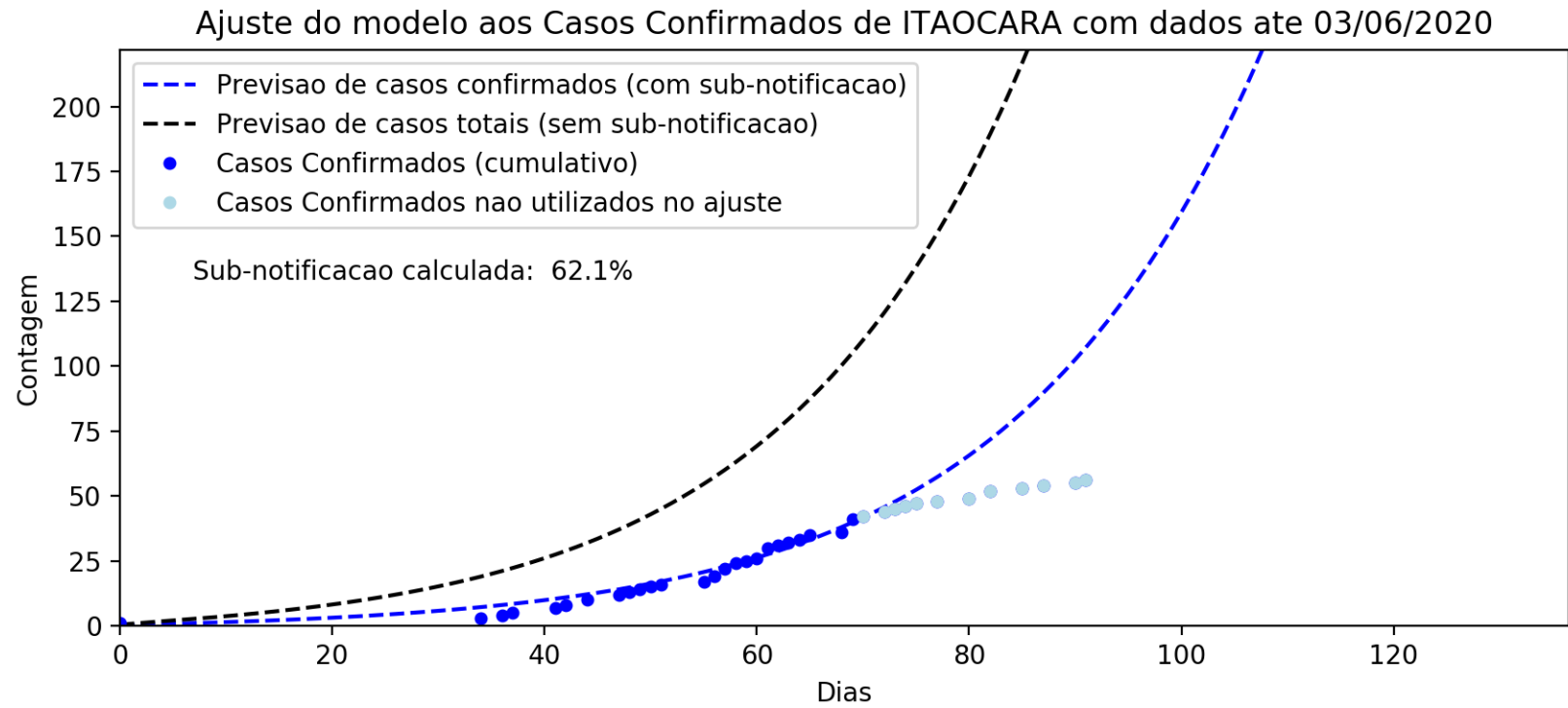
# Campos dos Goytacazes/RJ cenário antes do lockdown



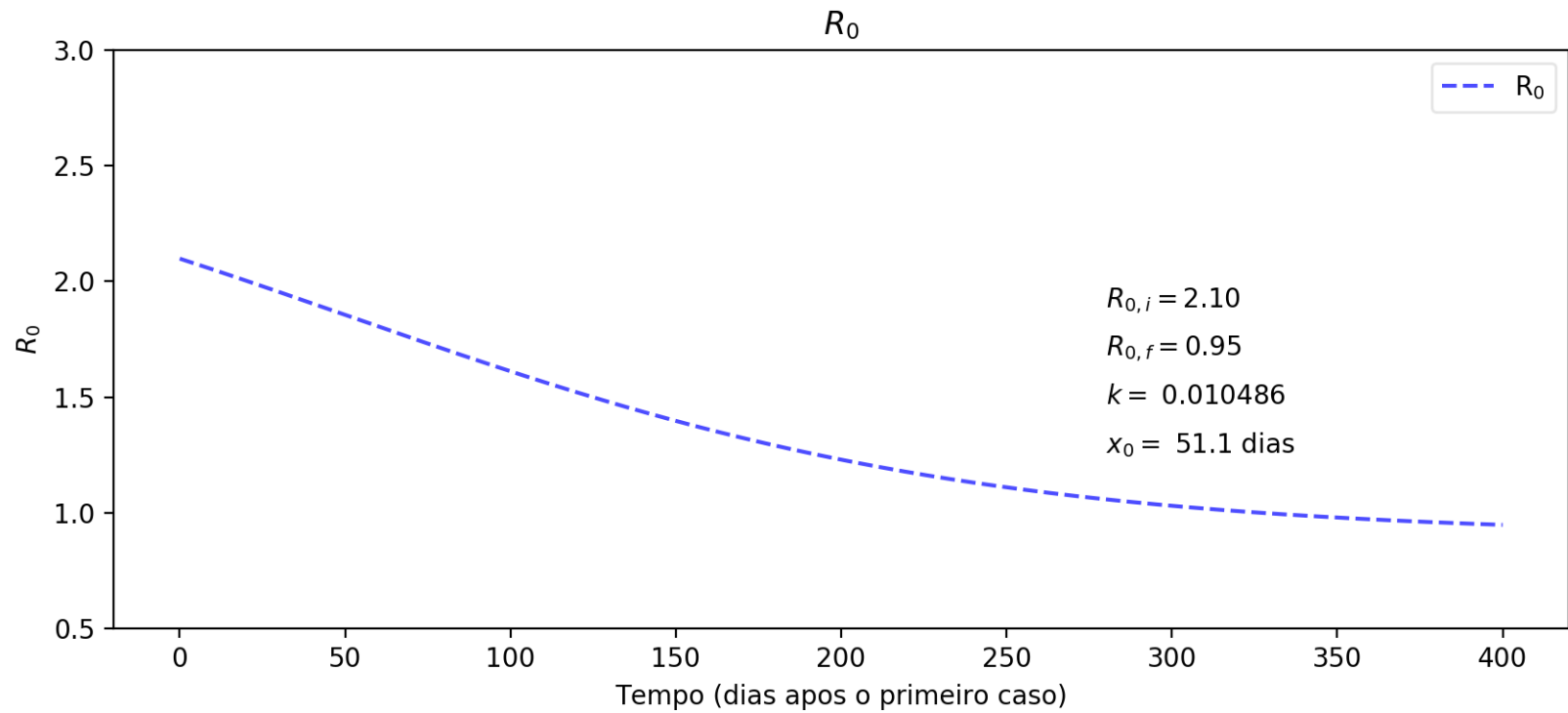
# Campos dos Goytacazes/RJ cenário antes do lockdown



# Itaocara/RJ

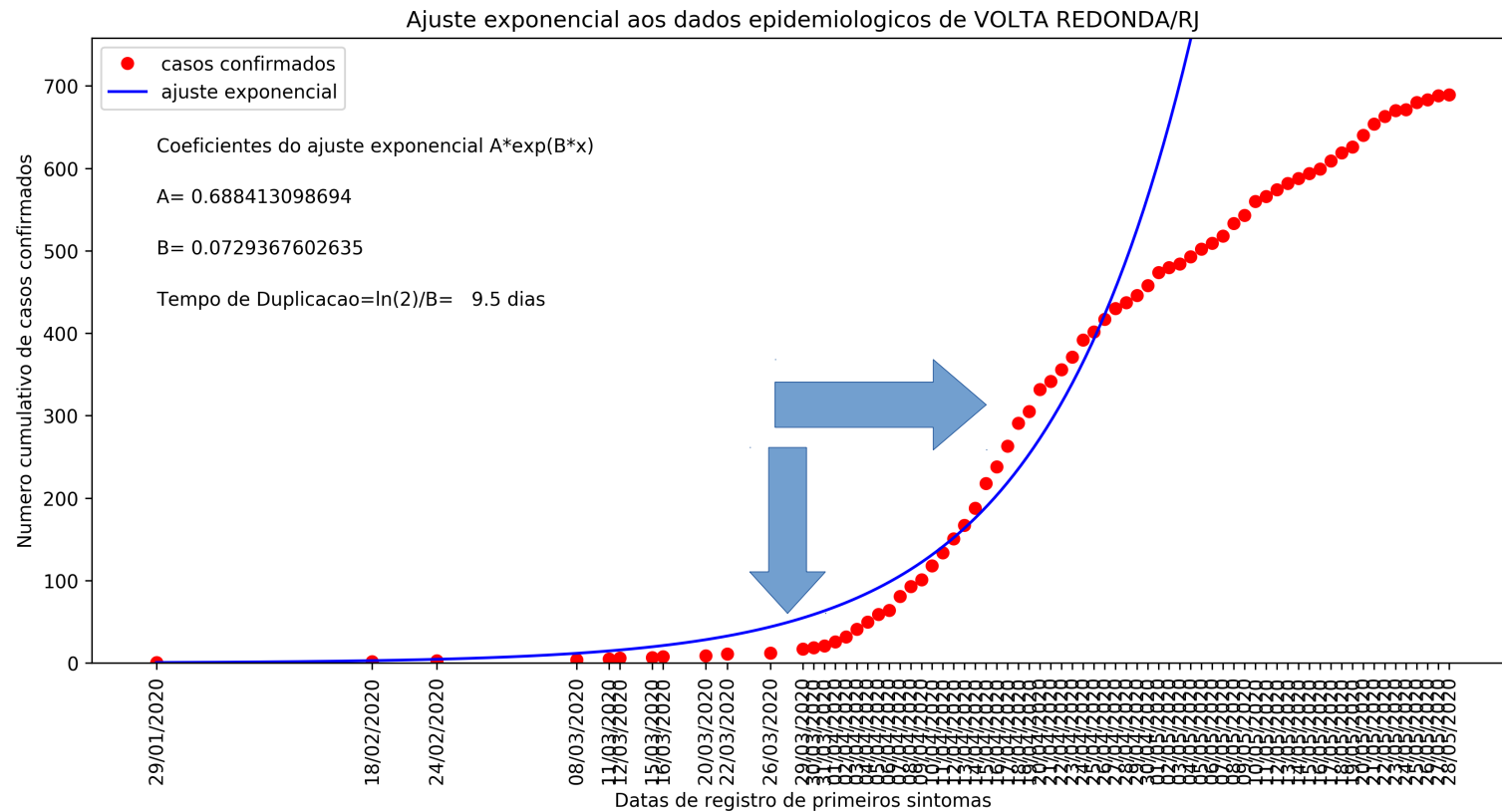


# Itaocara/RJ

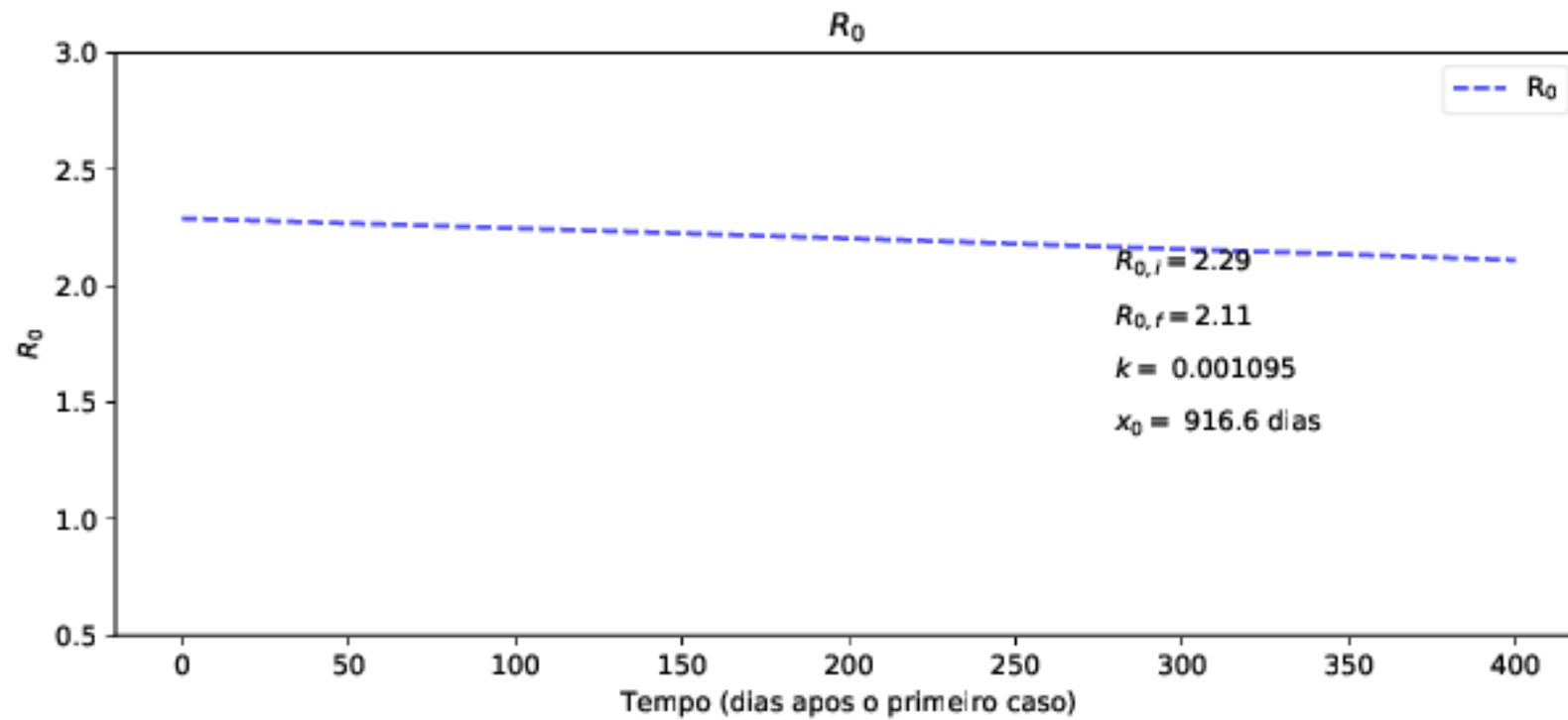




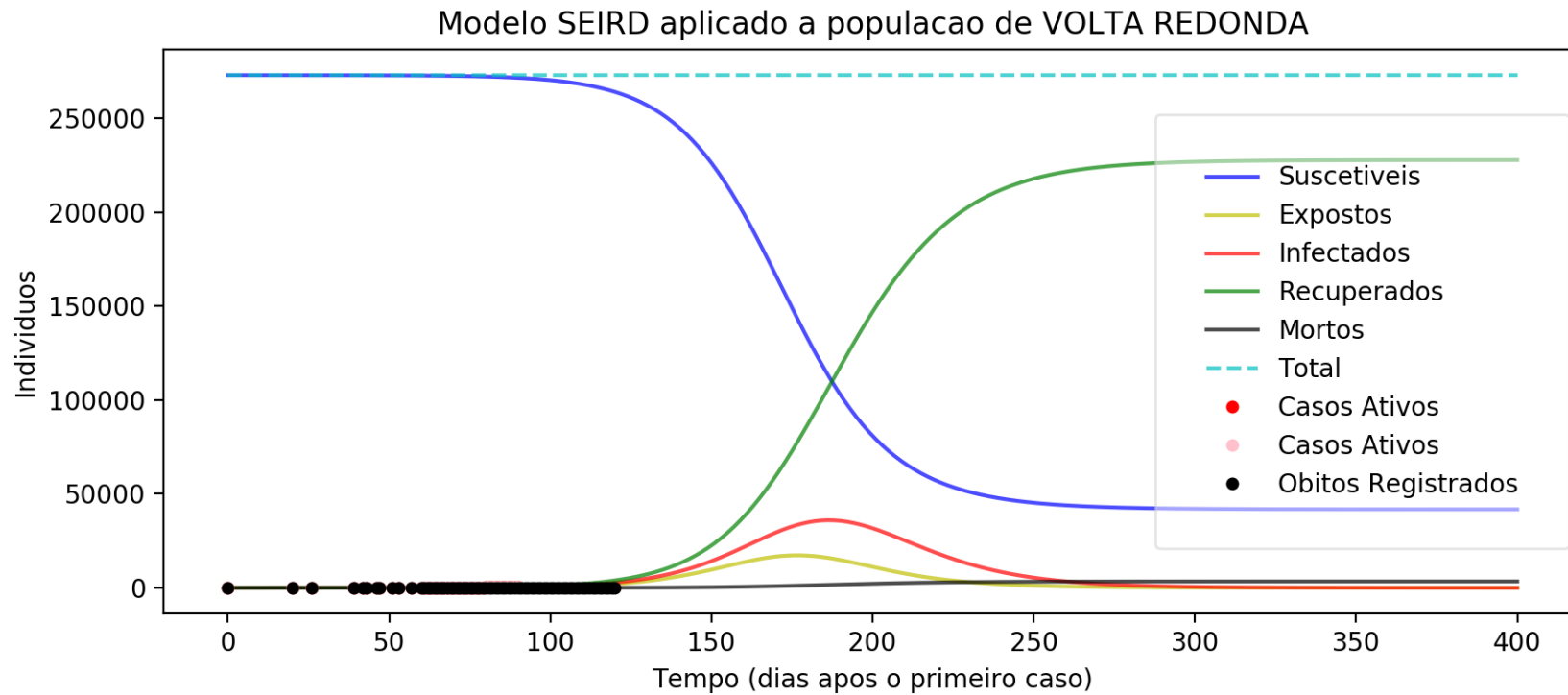
# Volta Redonda/RJ



# Volta Redonda/RJ

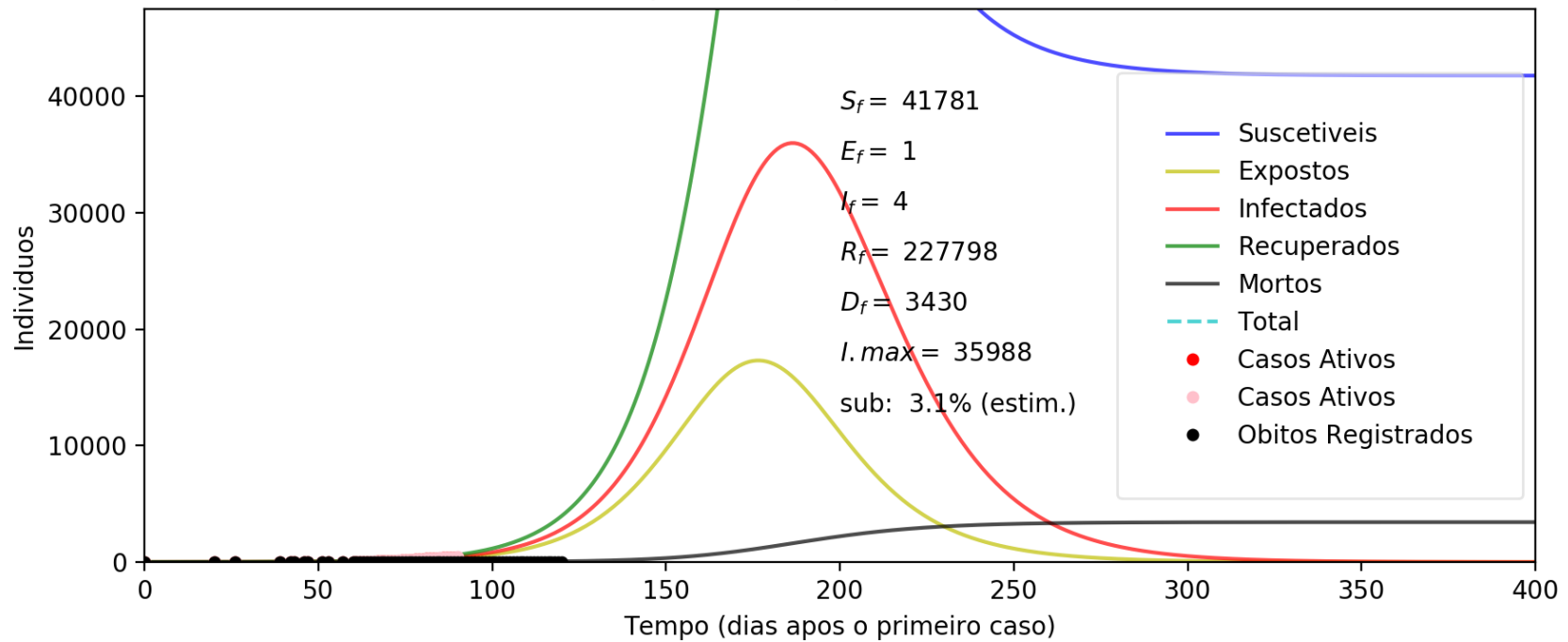


# Volta Redonda/RJ



# Volta Redonda/RJ

Modelo SEIRD aplicado a populacao de VOLTA REDONDA



# Volta Redonda/RJ

