I am not sure that another publication is necessary as we have already described our model twice and not sure what else we can add that would be new.

I am still keeping track each day. I could add other counties from the Worldometer site by coping and pasting numerical data without putting in the numbers manually.

We could use a modified version of the model in which we do not use the susceptible population S but rather a reproduction rate R_E parameter. The equations become

$$dR_E / dt = -a R_E I$$
$$dI / dt = b(R_E - 1) I$$
$$dR / dt = bI$$

It is obvious that

$$R_E = 1 \quad dI / dt = 0$$
$$R_E > 1 \quad dI / dt > 0$$
$$R_E < 1 \quad dI / dt < 0$$

This is a little different and may be a more interesting approach.

I have included all the graphs for each community. Some extra graphs such as R vs T and C vs t and dI/dt.

I calculate dI/dt using $dI/dt = aSI - bI$ and Maltab function gradient(I,h) but when I graph both of them they are sometimes different – not sure why.

If we do publish again we need to check my code for any errors.

One major problem is that the parameters to fit the model and data are a "bit" arbitrary. The more data makes it more difficult to select the best values. To fine tune the values, sometimes I use a least squares error check. It is of some help.

```
EI = 0; Edead = 0; ER = 0; EItot = 0;
  for c = 1 : Ndays
   z = find(t>c,1);
   EItot = EItot + (Itot(z) - Idtot(c))^2;
   EI = EI + (I(z) - Id(c))^2;
   ER = ER + (R(z) - Rd(c))^2;
   Edead = Edead + (D(z) - Dd(c))^2;
  end
  E = sqrt(EItot + EI + ER);
  EItot = sqrt(EItot);
  EI    = sqrt(EI);
  ER    = sqrt(ER);
  Edead    = sqrt(Edead);
  fprintf('EItot    = %2.2e \n',EItot)
  fprintf('EI       = %2.2e \n',EI)
  fprintf('ER       = %2.2e \n',ER)
  fprintf('Edead    = %2.2e \n',Edead)
  fprintf('E        = %2.2e \n',E)
```

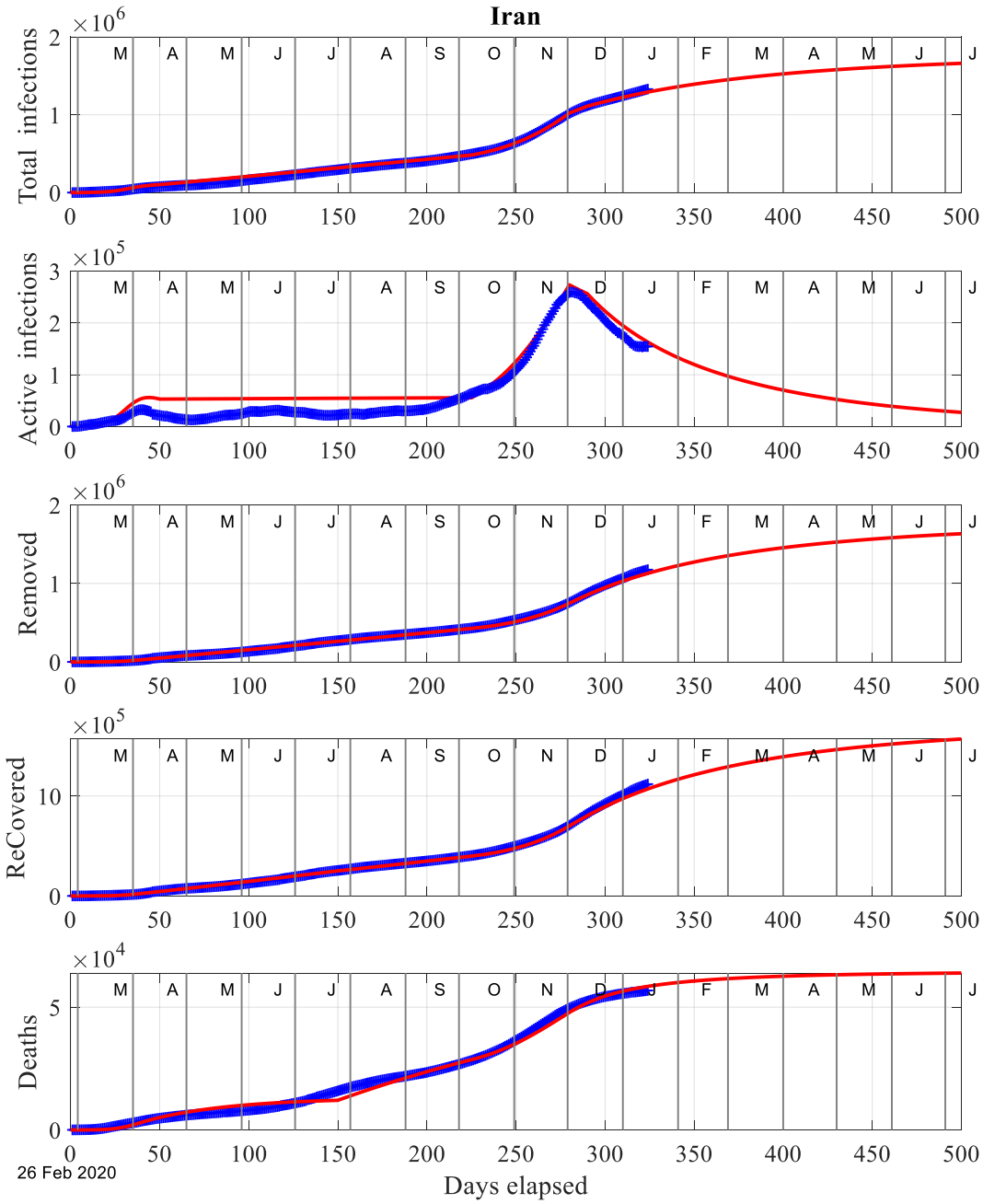
It may be possible to get better estimates by matching the ODEs to the data. Can consider it in more detail if think about another publication.

eg $b = dR/dt / I$ where dR/dt is slope of data curve for removals vs time. Not sure best way to do this as data jumps around a bit.

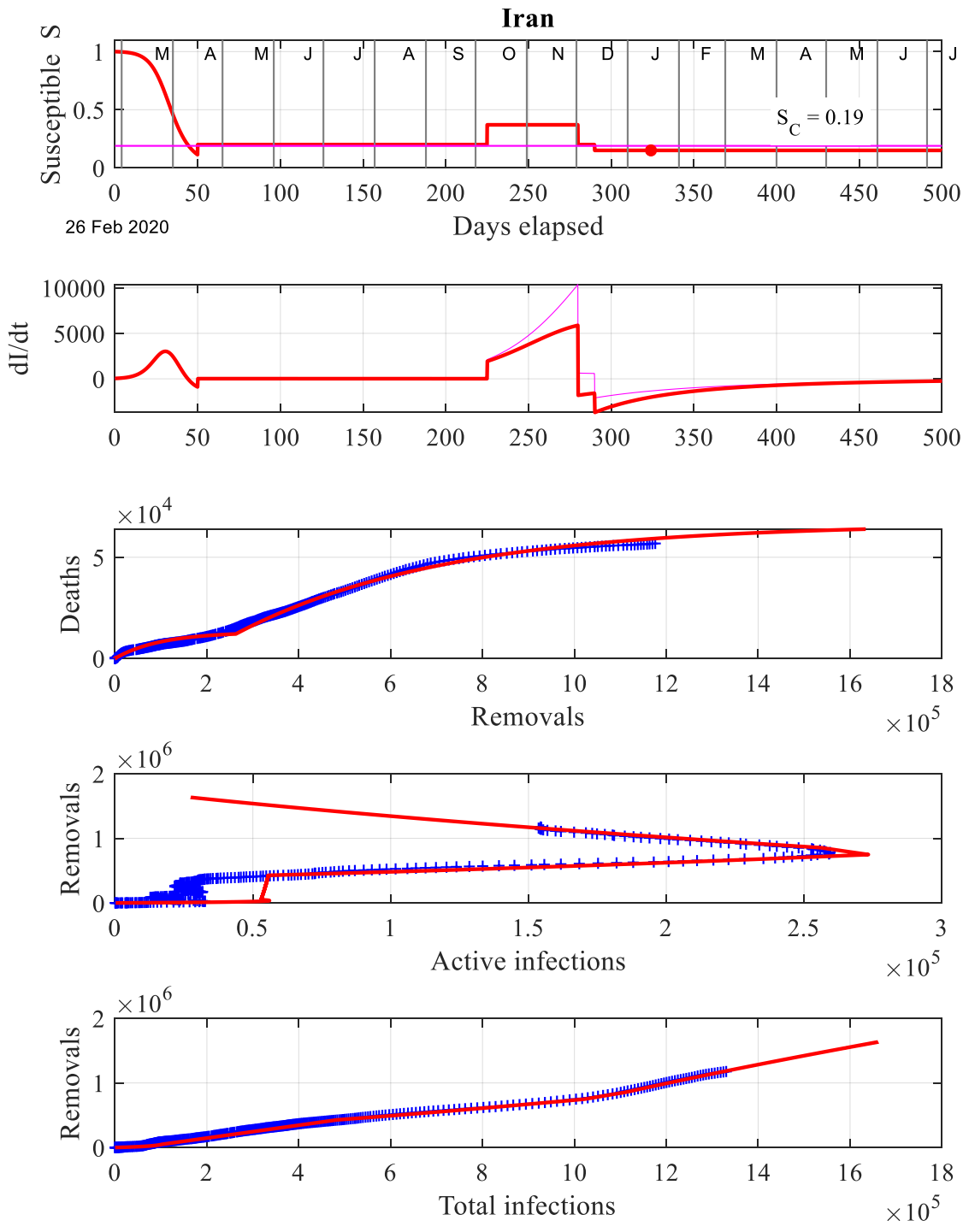
Also not sure about the model and my way of solving the equations – this would need to checked carefully if publishing again since I cannot fit my model to the World data (dI/dt saturates ???) and USA data could not set S = constant over a time span but had to used spikes ??? again not sure why.

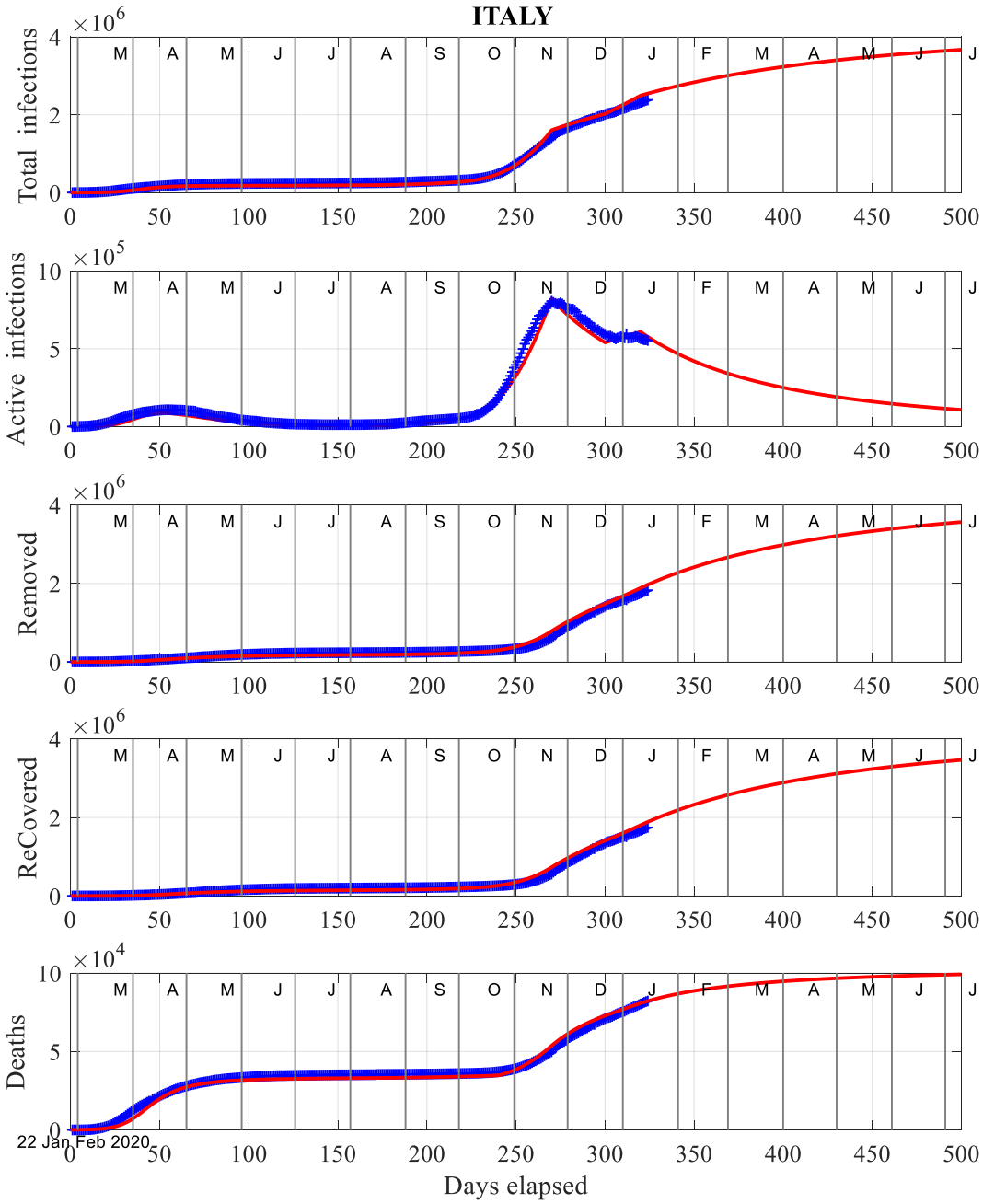
In the SIR model $S \rightarrow 0$ but in describing the data this is not true, S often set to a small number where $S > 0$.

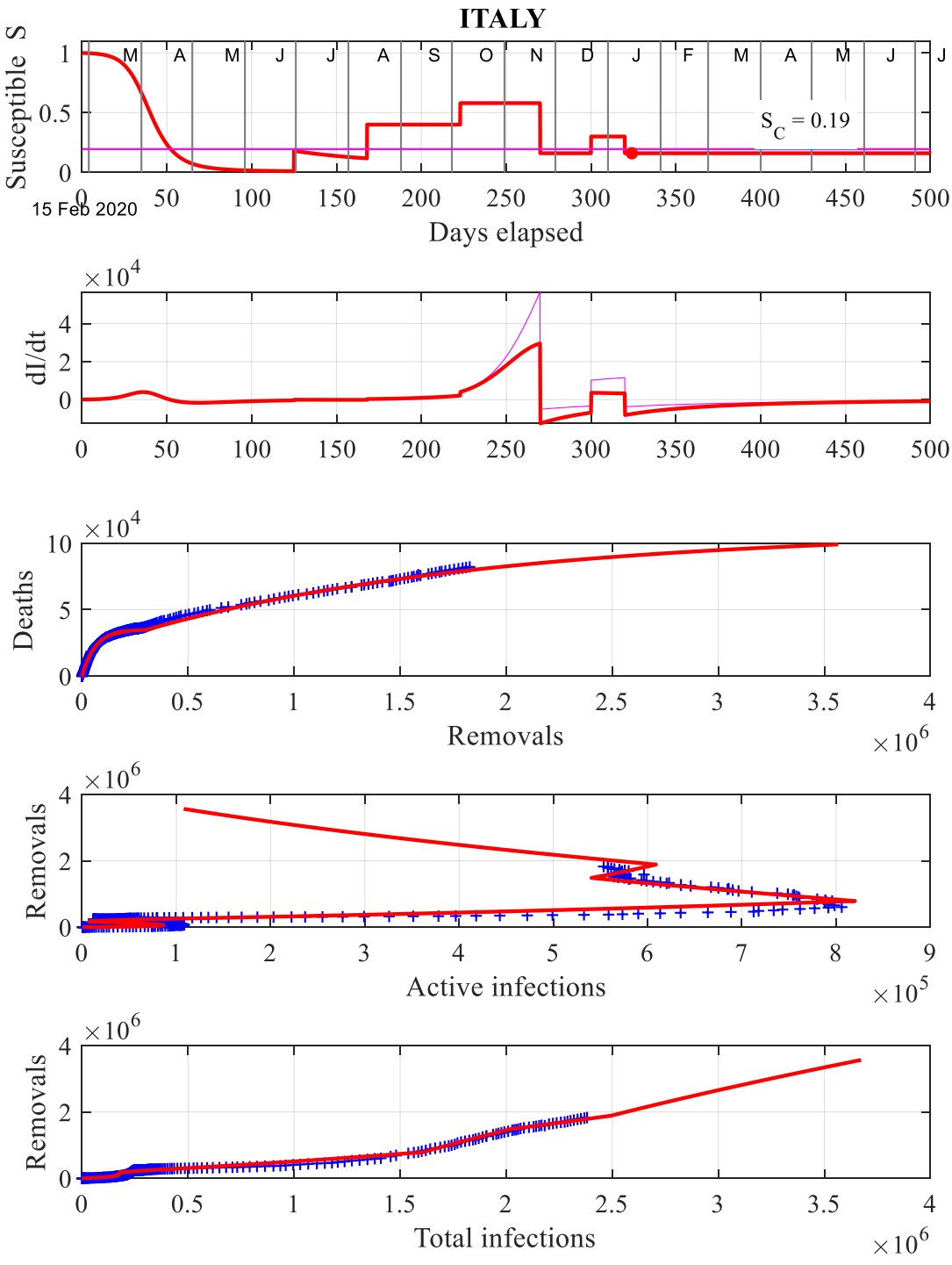
Below are my graphs.

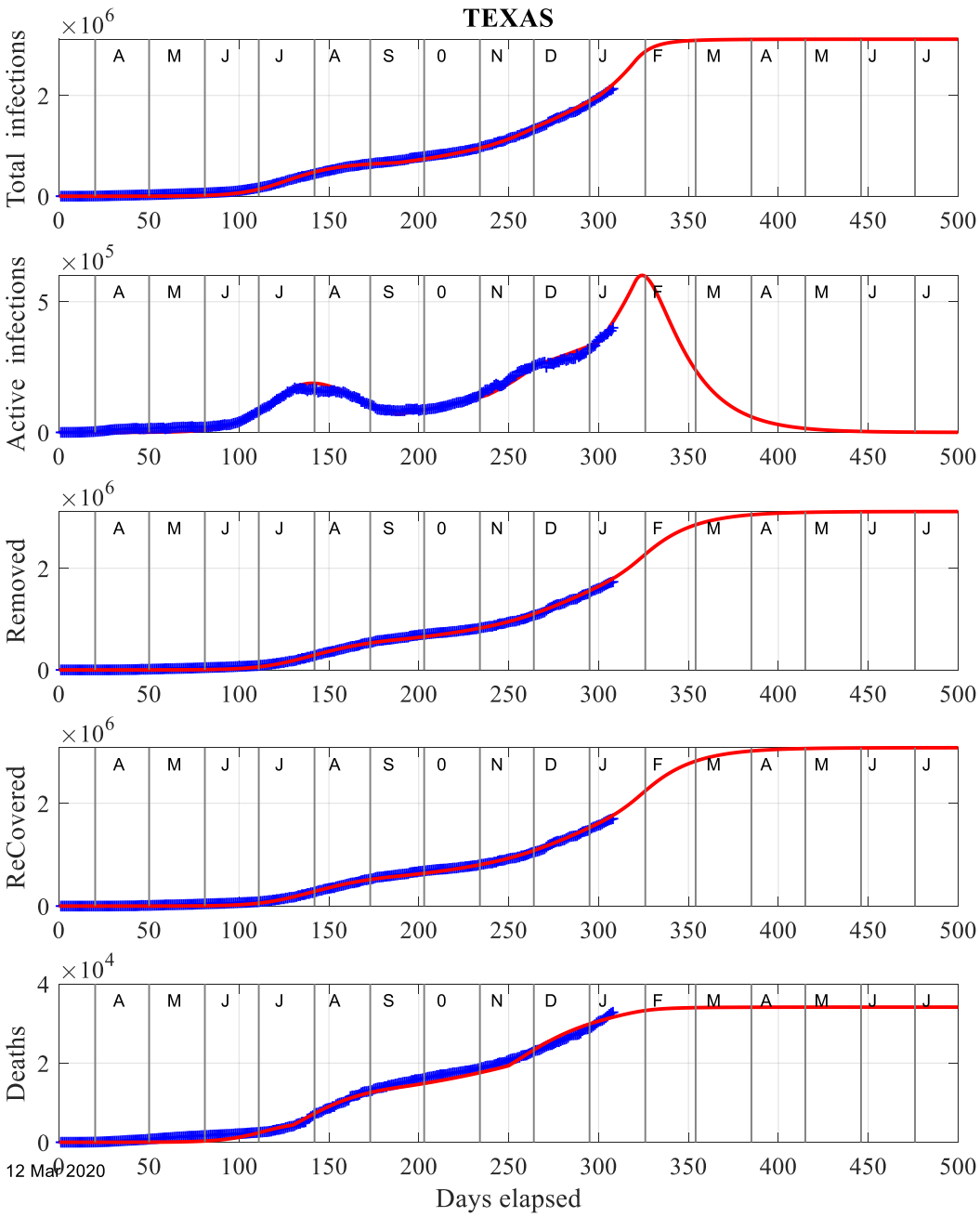


Not a good fit for 50 to 200 days for I

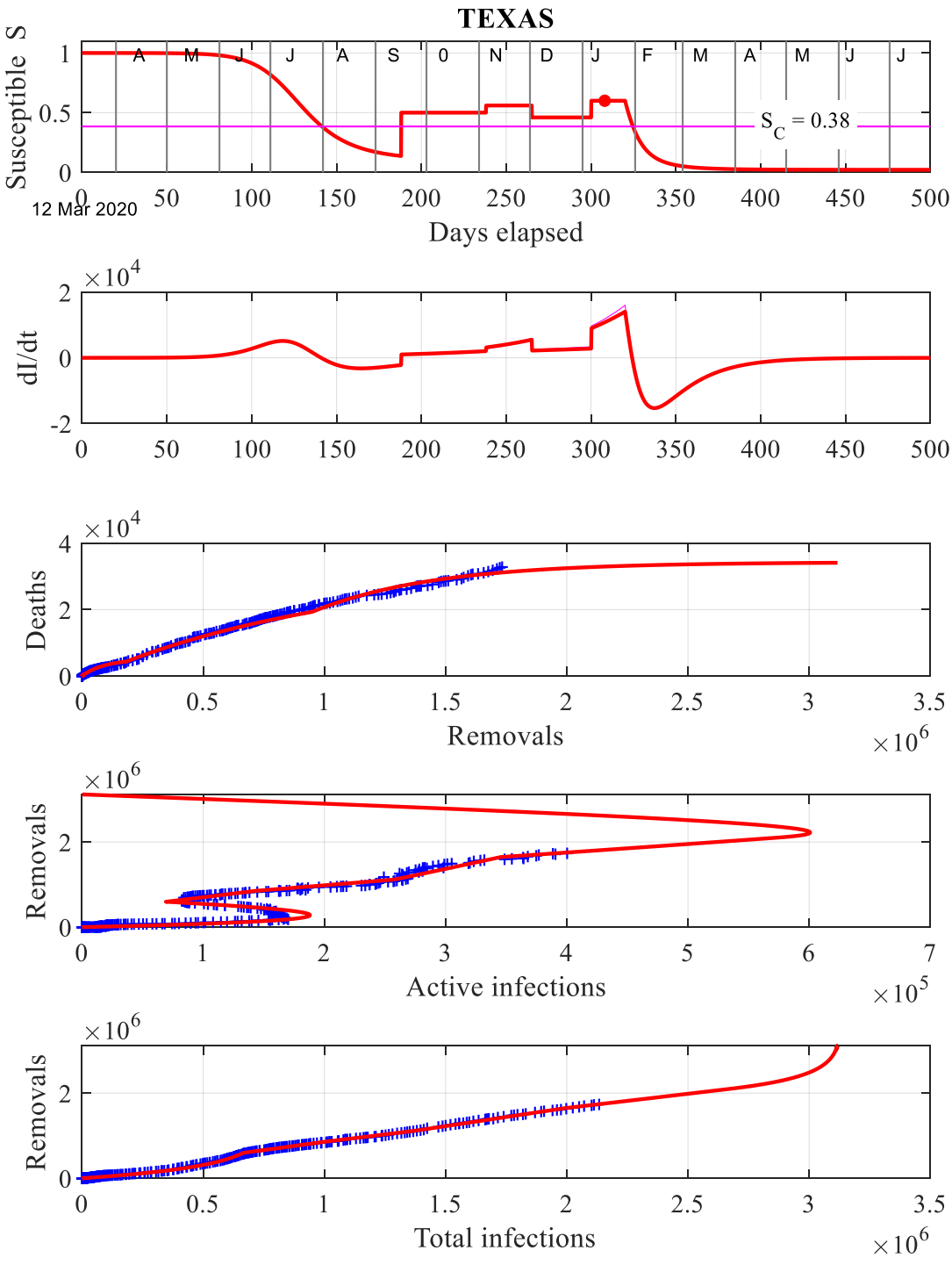

Iran
Susceptible S
M A M J J A S O N D J F M A M J J
$S_C = 0.19$
26 Feb 2020
Days elapsed
dI/dt
Deaths
Removals
Active infections
Total infections

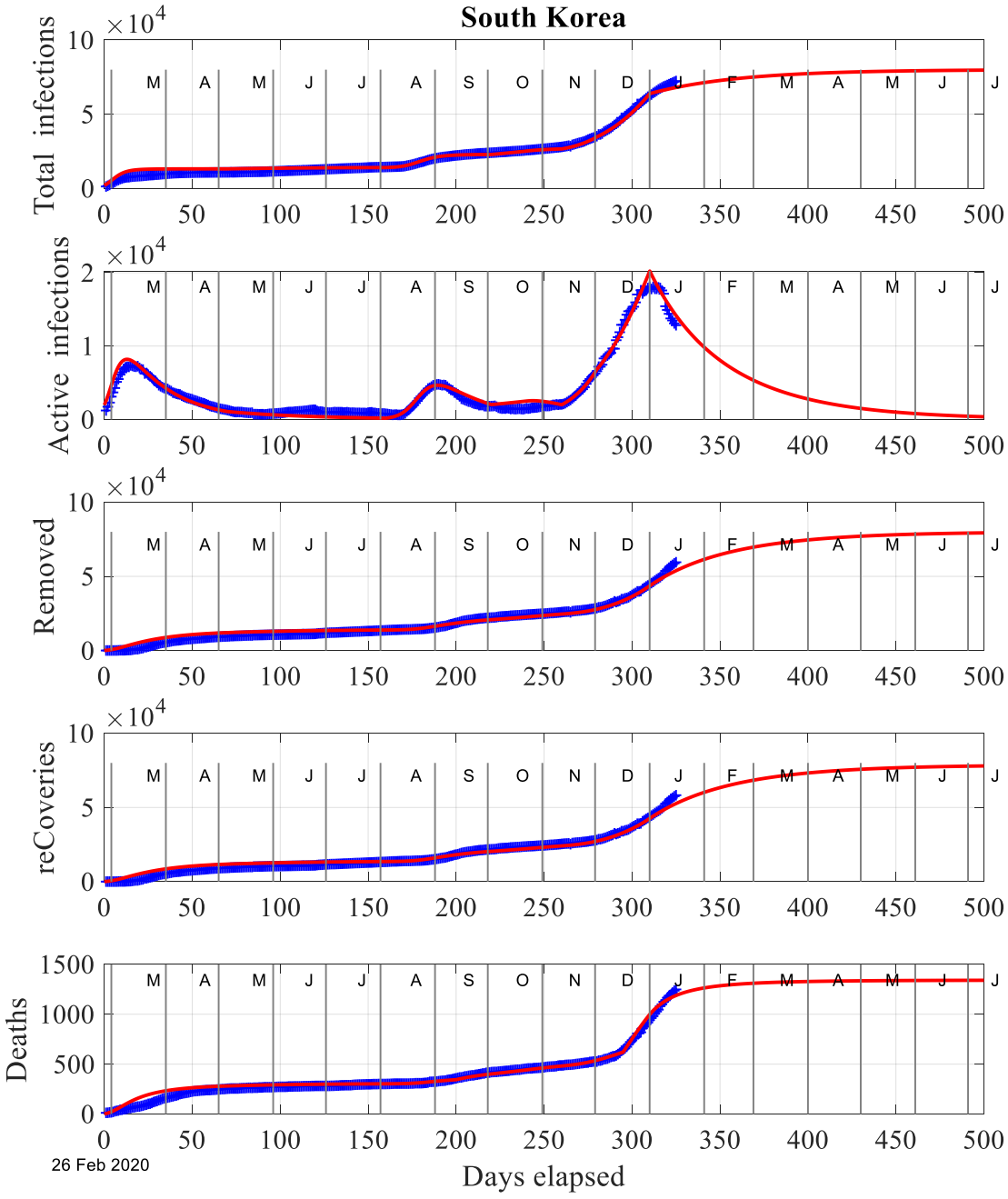

ITALY
Total infections
Active infections
Removed
ReCovered
Deaths
M A M J J A S O N D J F M A M J J
22 Jan Feb 2020
Days elapsed

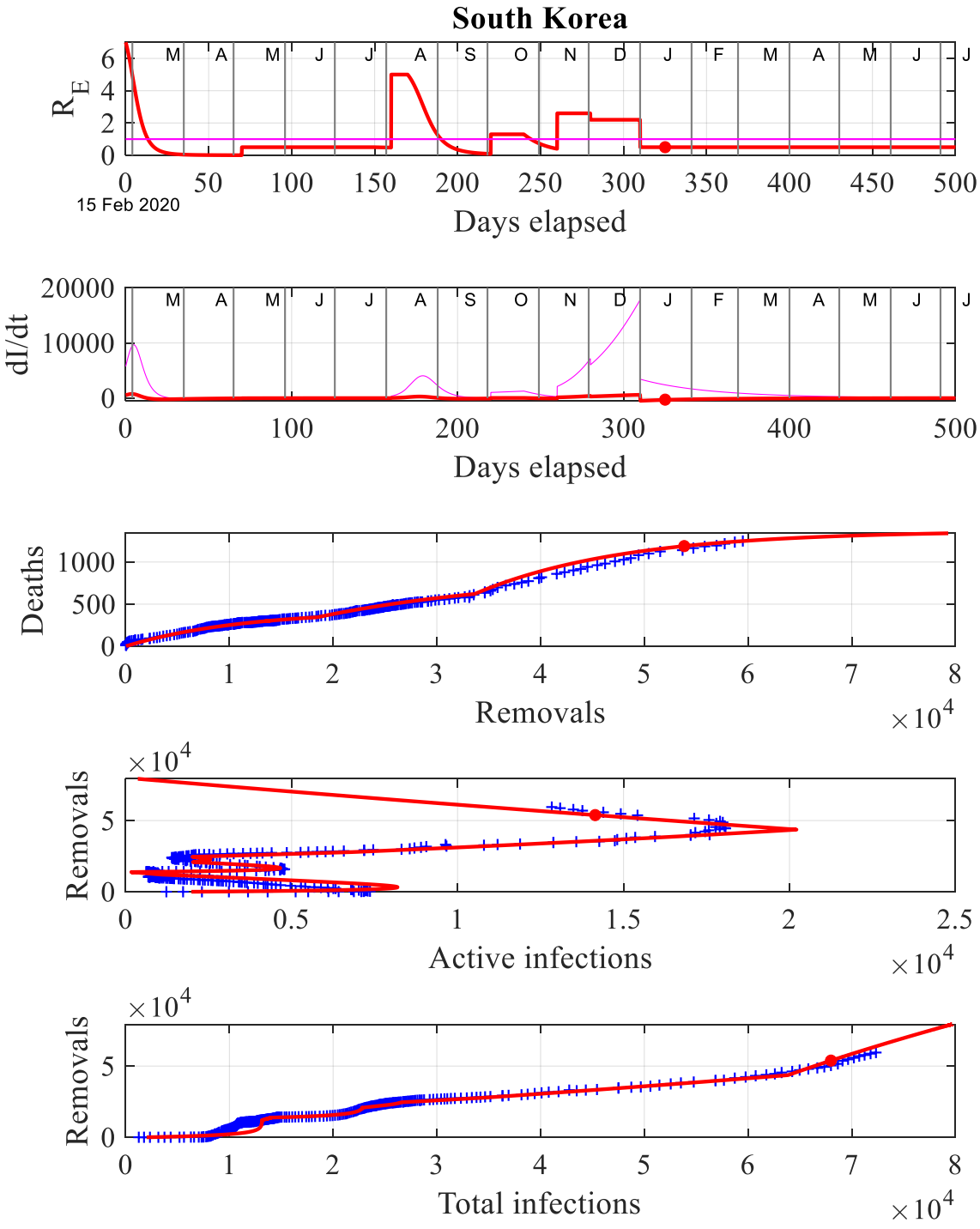

ITALY
Susceptible S
M A M J J A S O N D J F M A M J J
$S_C = 0.19$
15 Feb 2020
Days elapsed
$\times 10^4$
dI/dt
$\times 10^4$
Deaths
Removals
$\times 10^6$
$\times 10^6$
Removals
Active infections
$\times 10^5$
$\times 10^6$
Removals
Total infections
$\times 10^6$

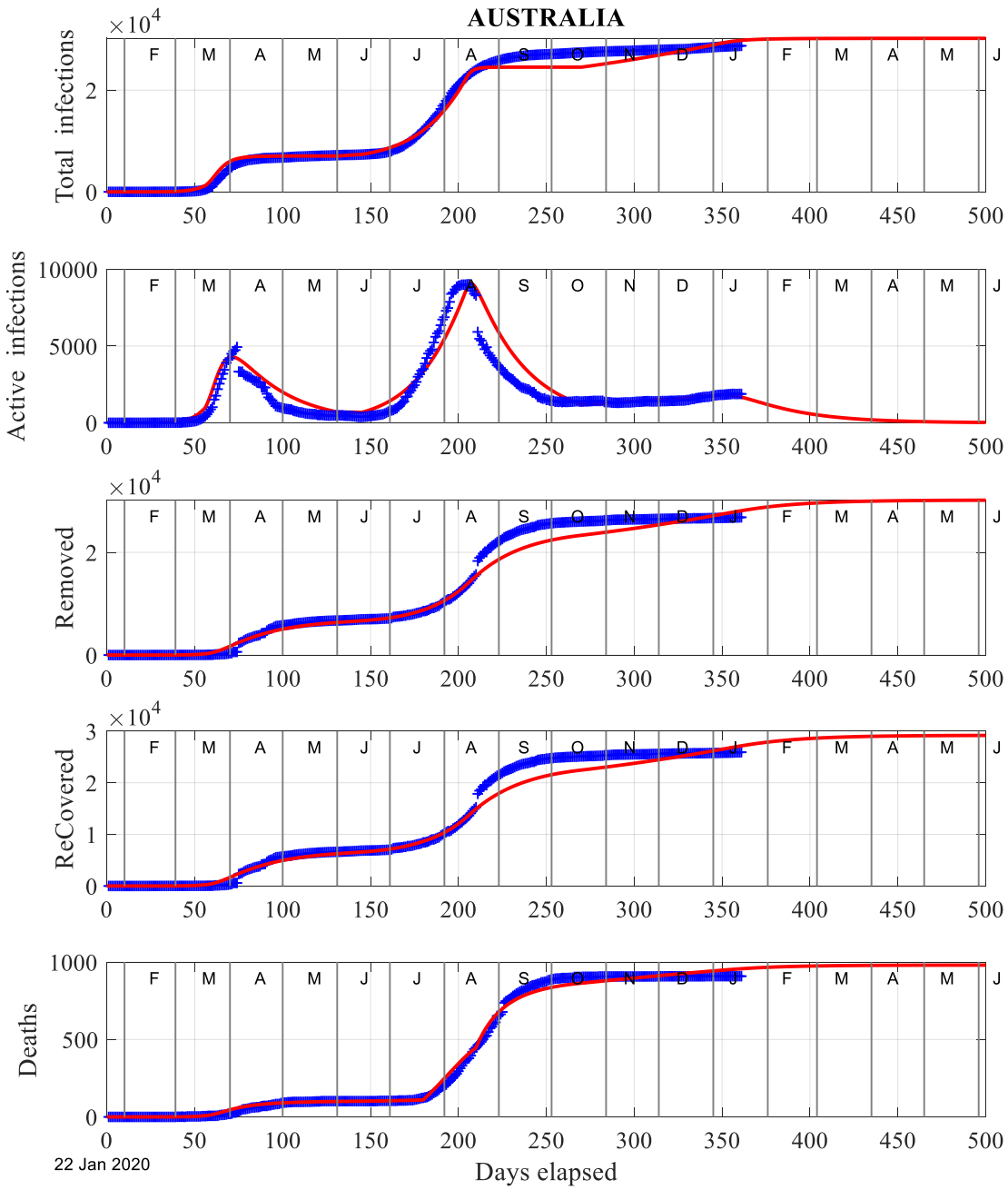


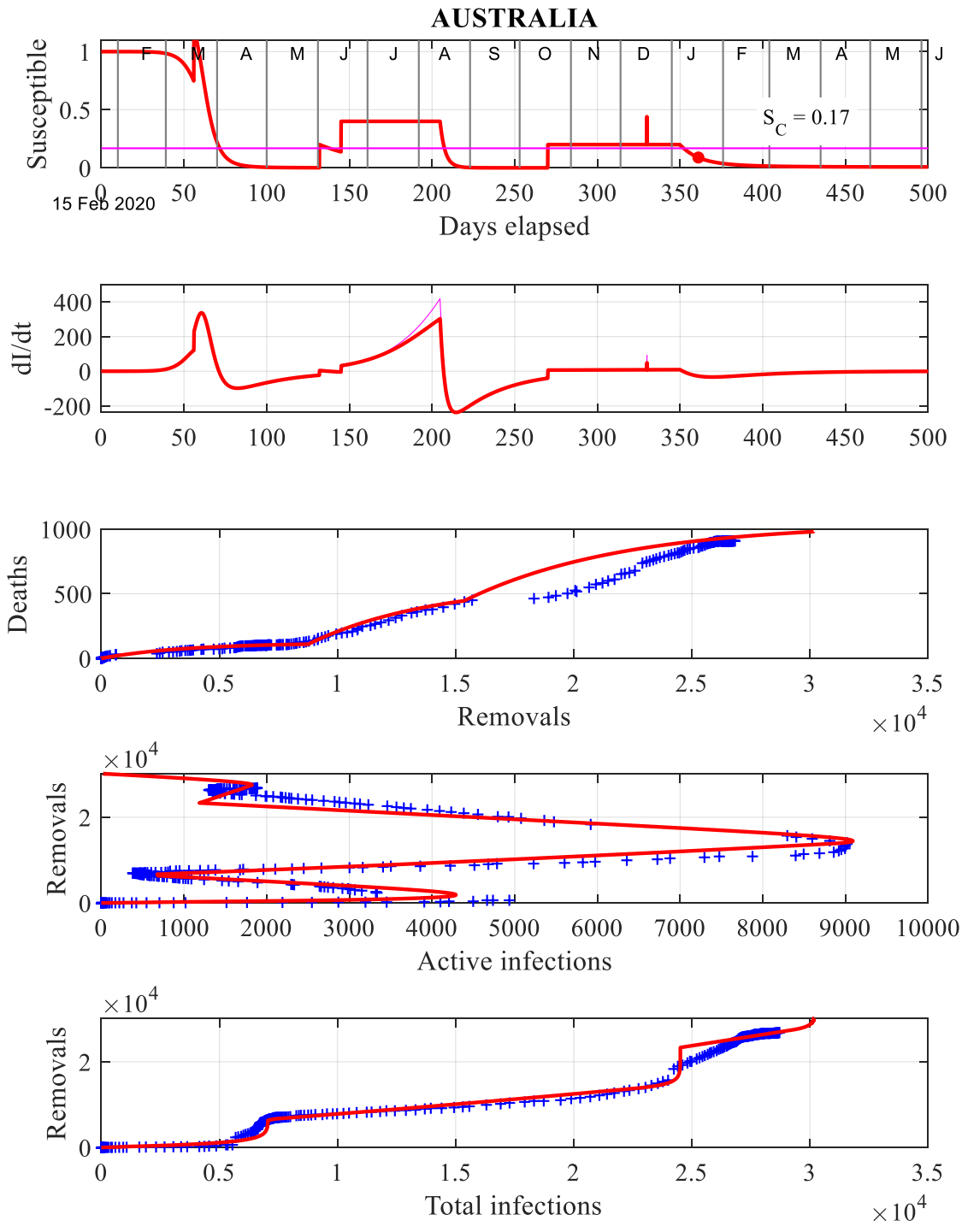
Could add California

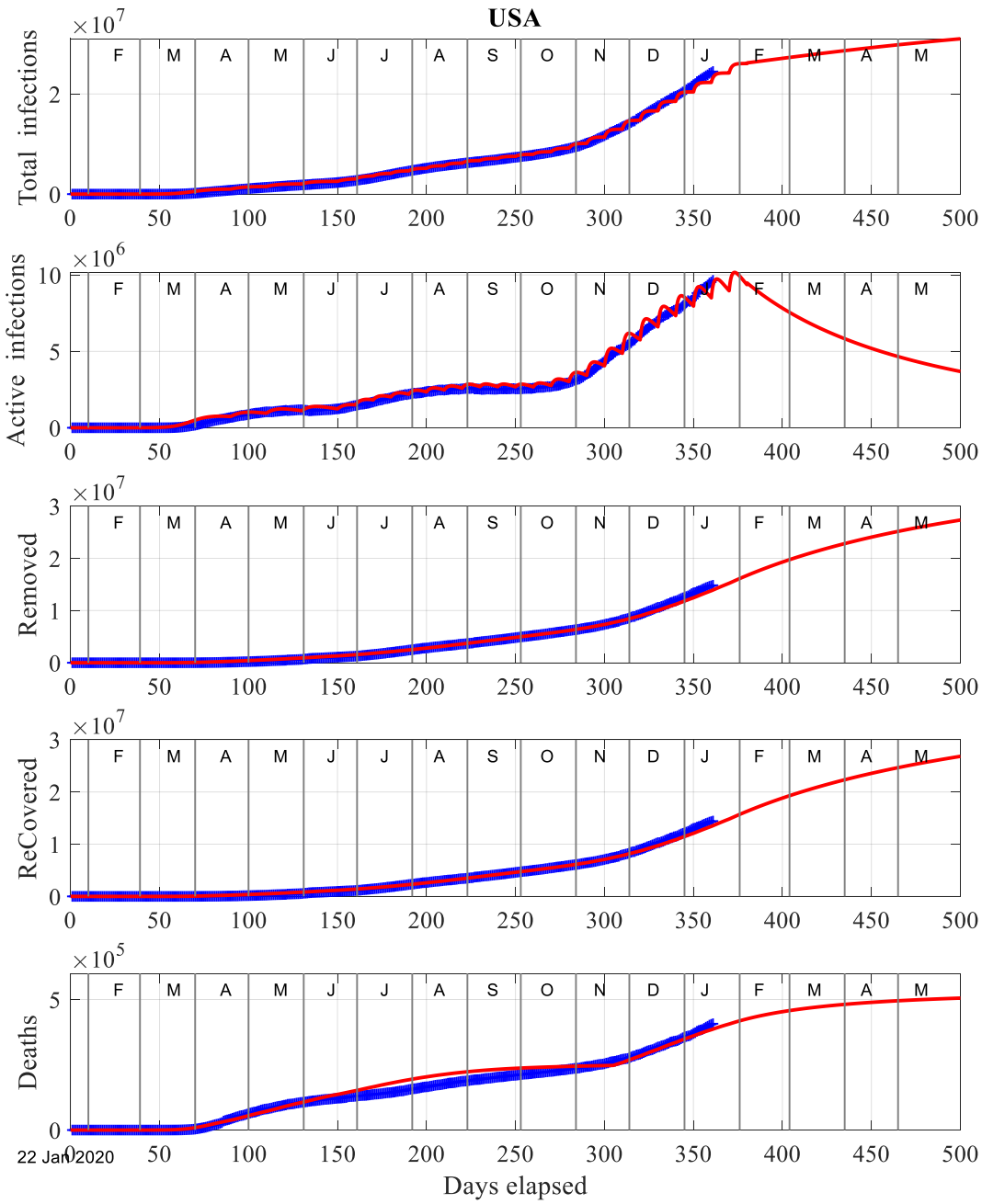

TEXAS
Susceptible S
A M J J A S O N D J F M A M J J
$S_C = 0.38$
12 Mar 2020
Days elapsed
$\times 10^4$
dI/dt
$\times 10^4$
Deaths
Removals
$\times 10^6$
$\times 10^6$
Removals
Active infections
$\times 10^5$
$\times 10^6$
Removals
Total infections
$\times 10^6$


South Korea
Total infections
Active infections
Removed
reCoveries
Deaths
×10^4
M A M J J A S O N D J F M A M J J
0 50 100 150 200 250 300 350 400 450 500
26 Feb 2020
Days elapsed

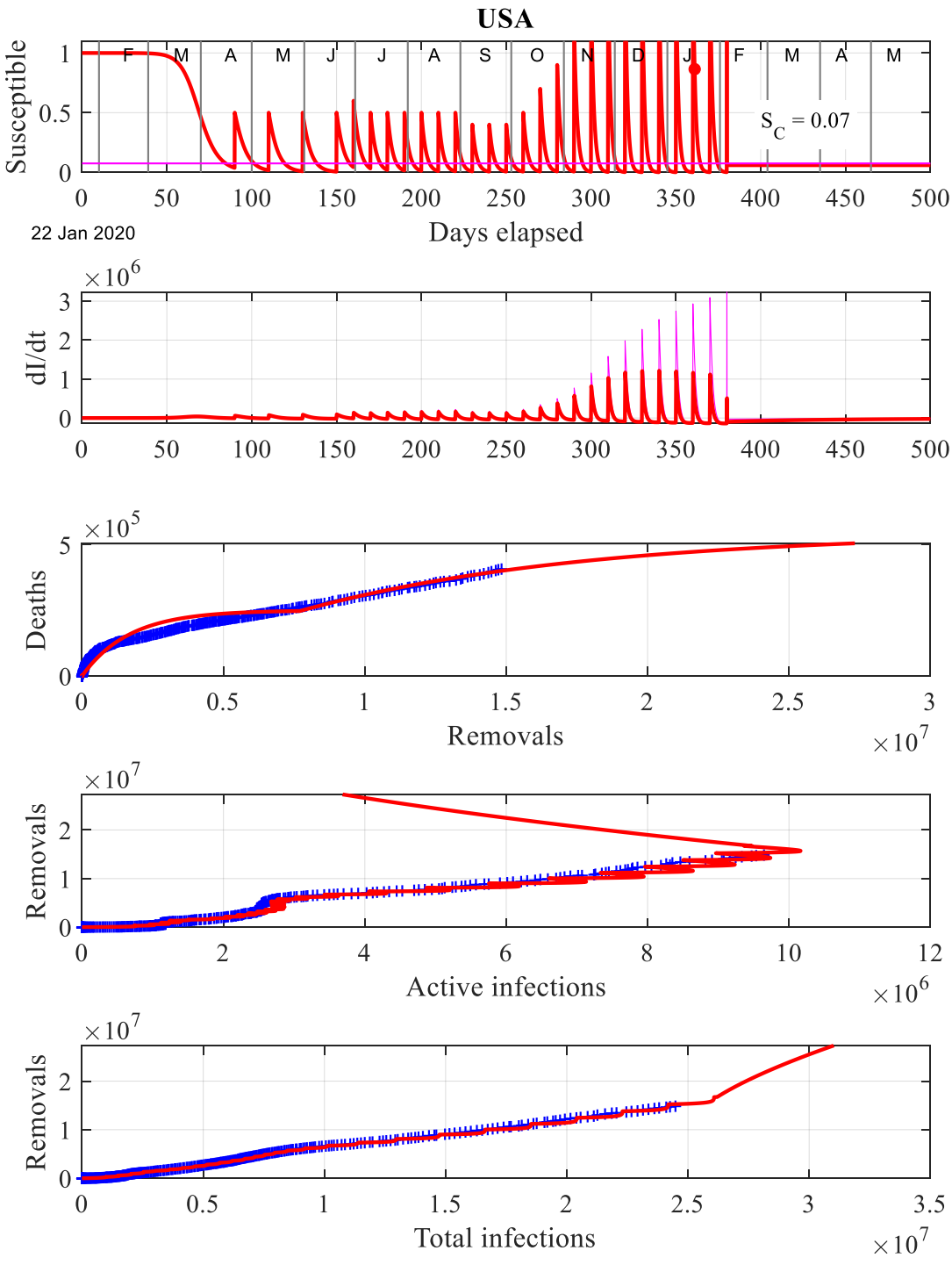

South Korea
R_E
M A M J J A S O N D J F M A M J J
0 50 100 150 200 250 300 350 400 450 500
15 Feb 2020
Days elapsed
dI/dt
20000
10000
0
Days elapsed
Deaths
1000
500
Removals
$\times 10^4$
Removals
Active infections
$\times 10^4$
Removals
Total infections
$\times 10^4$

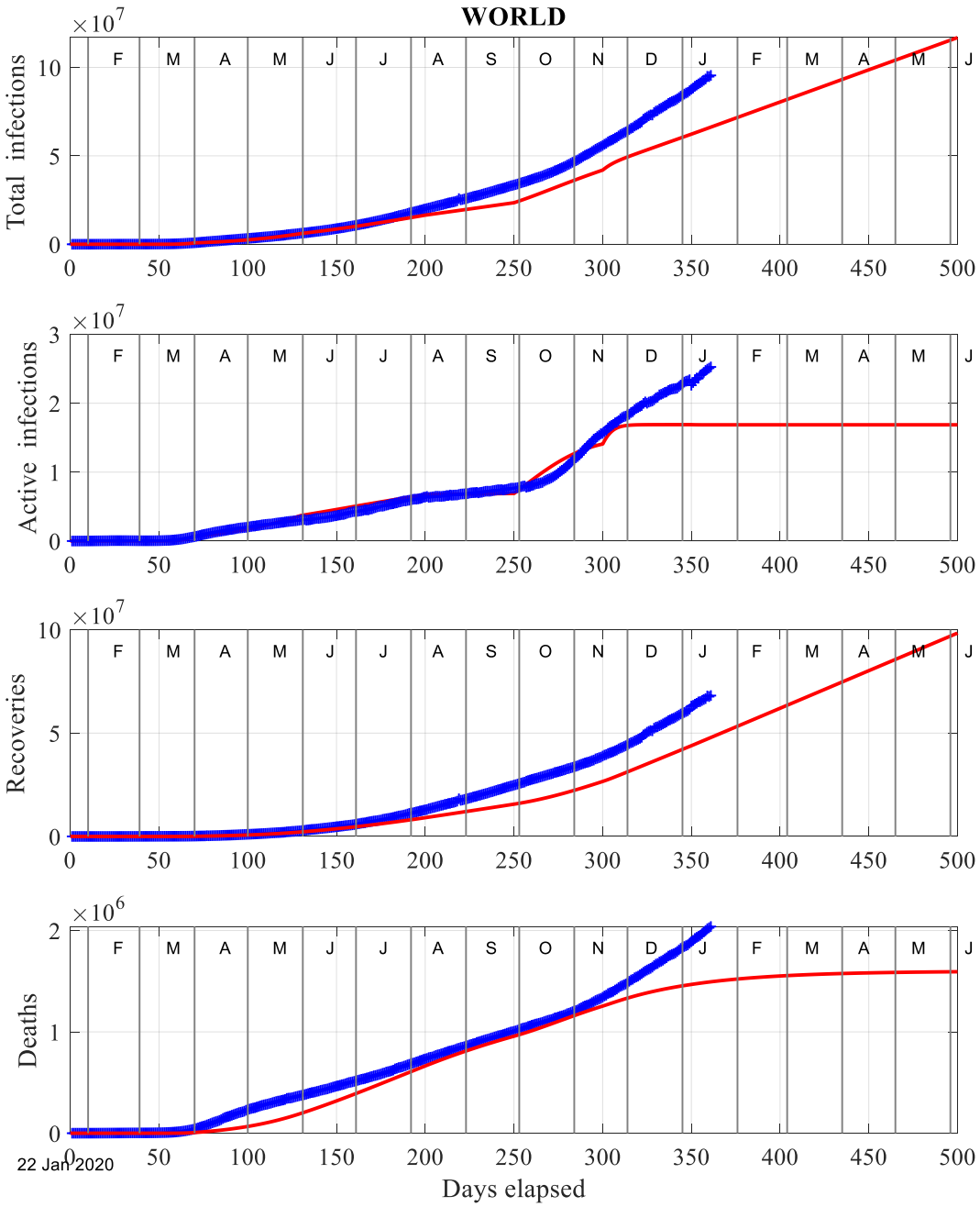

AUSTRALIA
Total infections
Active infections
Removed
ReCovered
Deaths
×10^4
F M A M J J A S O N D J F M A M J
0 50 100 150 200 250 300 350 400 450 500
22 Jan 2020
Days elapsed


AUSTRALIA
Susceptible
F M A M J J A S O N D J F M A M J
$S_C = 0.17$
15 Feb 2020
Days elapsed
dI/dt
Deaths
Removals
$\times 10^4$
Active infections
Total infections

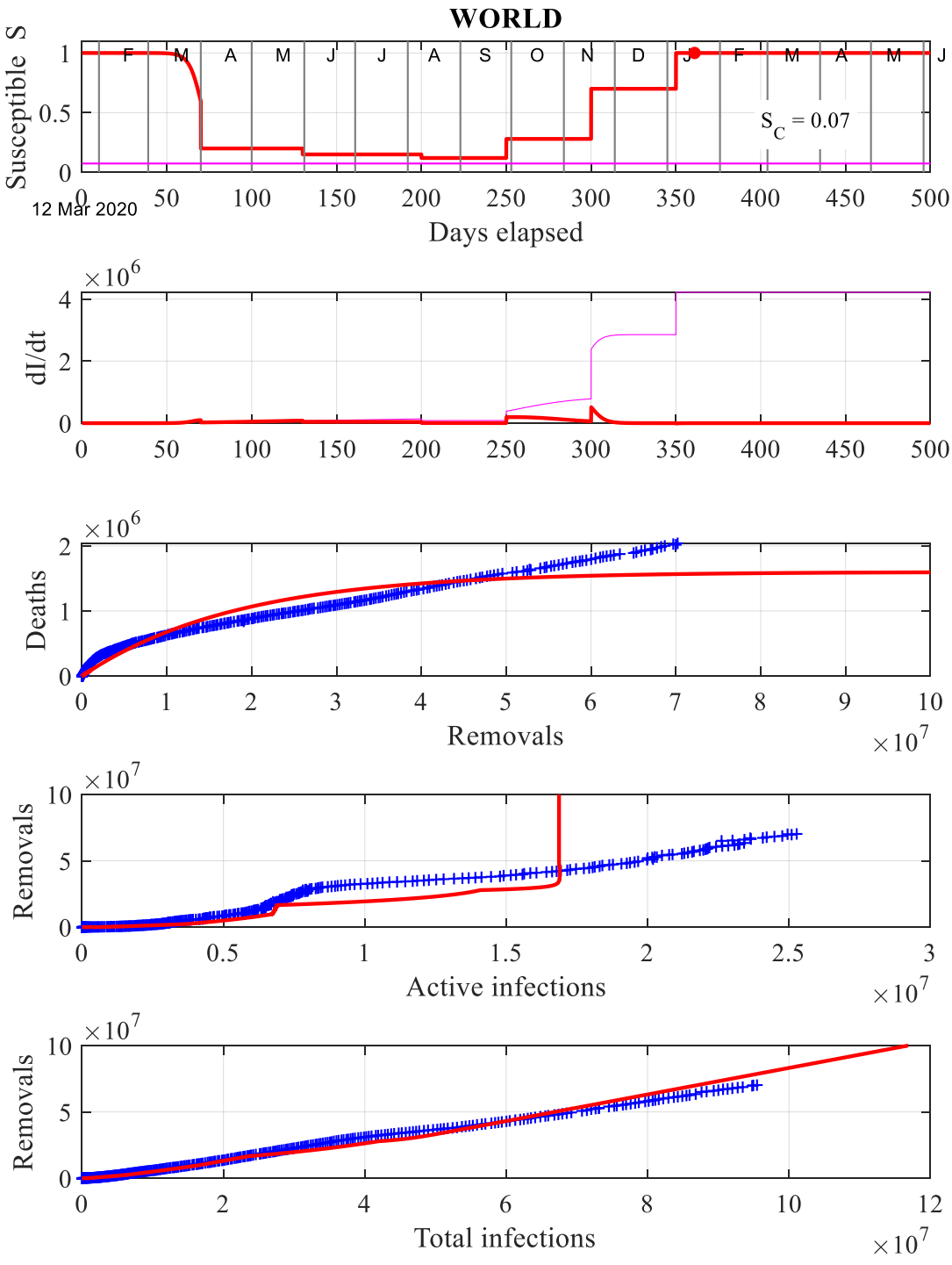


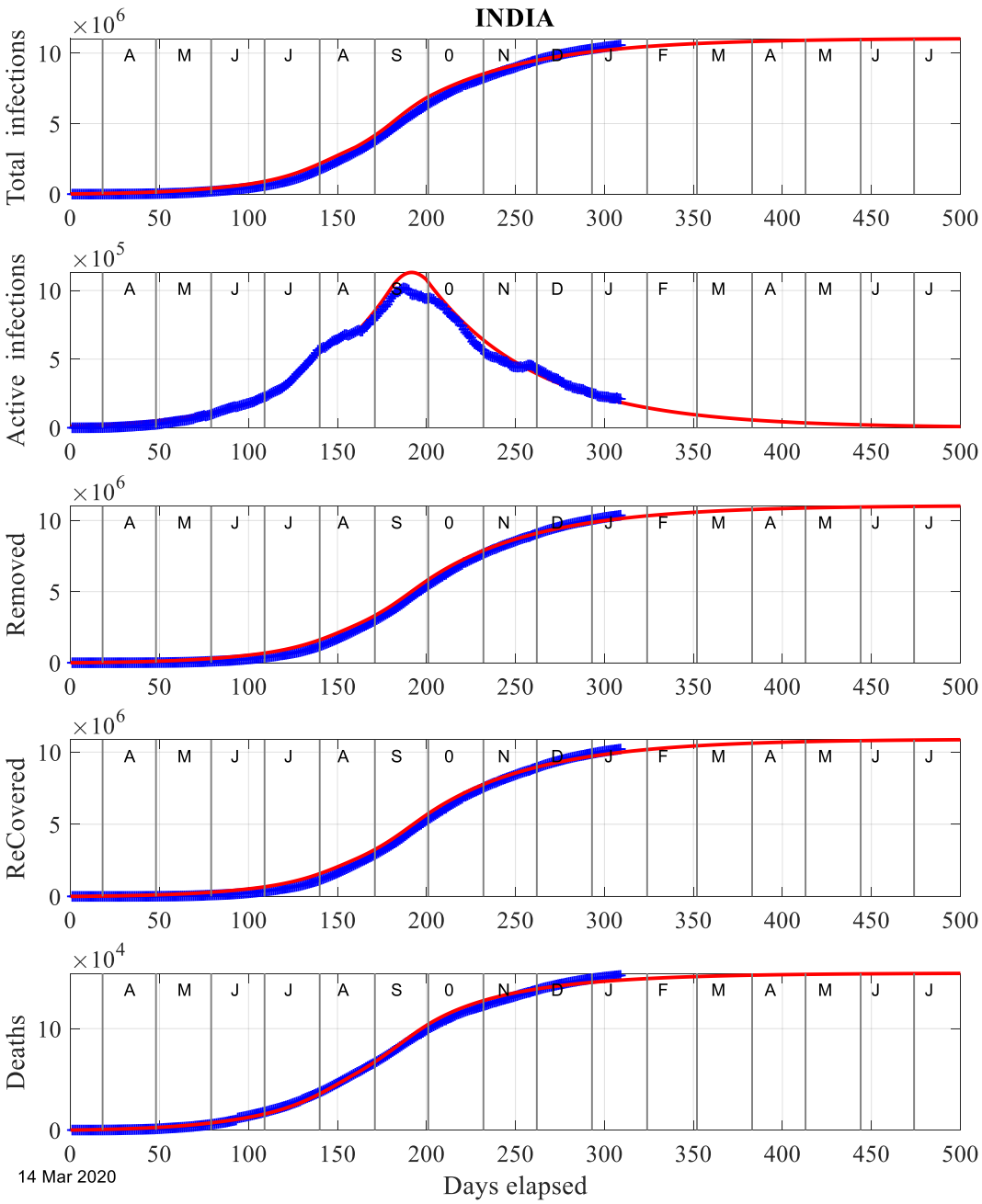
Had to use spikes in S and not S = constant for some time span ???


USA
Susceptible
F M A M J J A S O N D J F M A M
$S_C = 0.07$
22 Jan 2020
Days elapsed
$\times 10^6$
dI/dt
$\times 10^5$
Deaths
Removals
$\times 10^7$
Removals
Active infections
$\times 10^6$
Removals
Total infections
$\times 10^7$

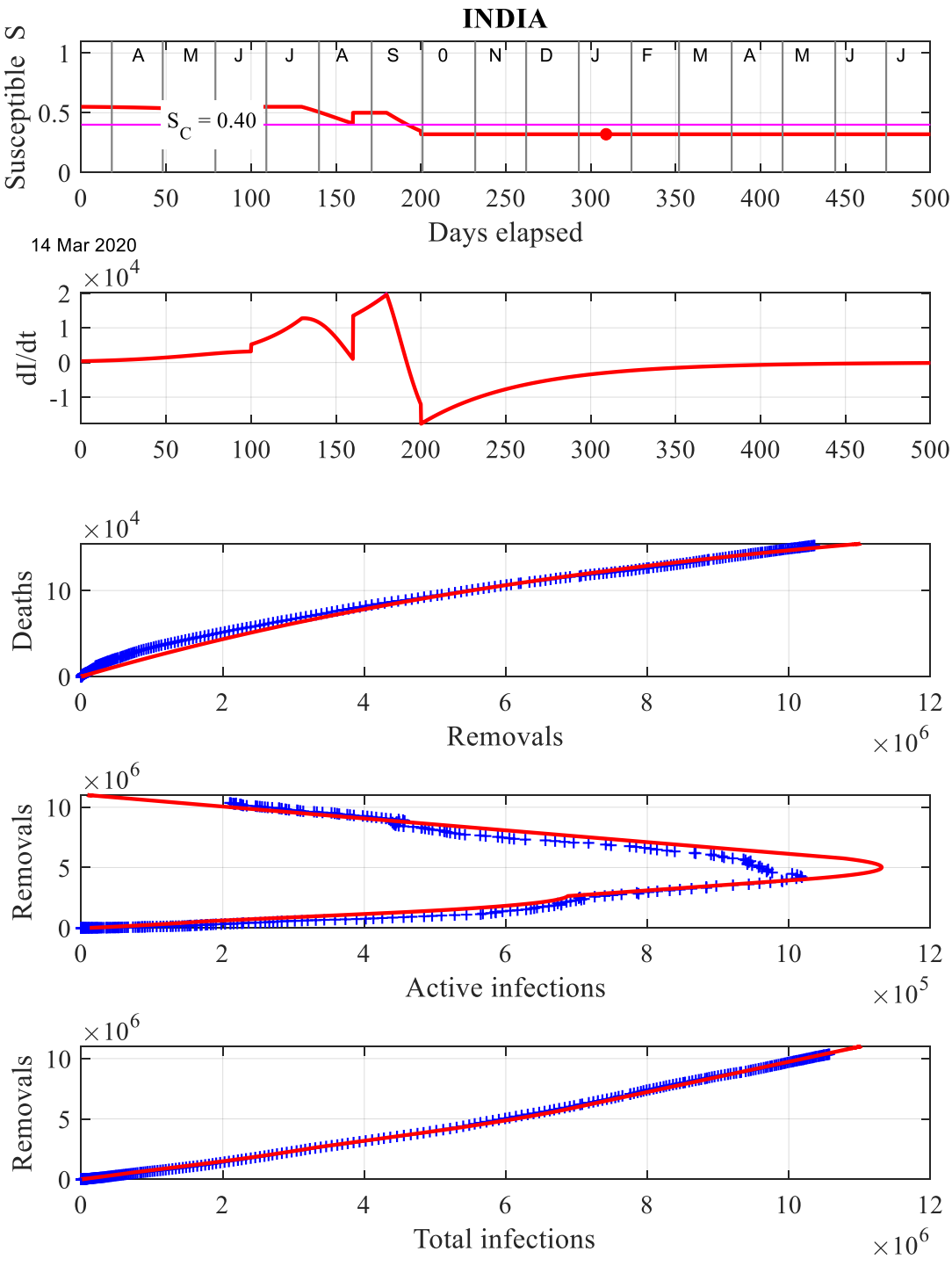


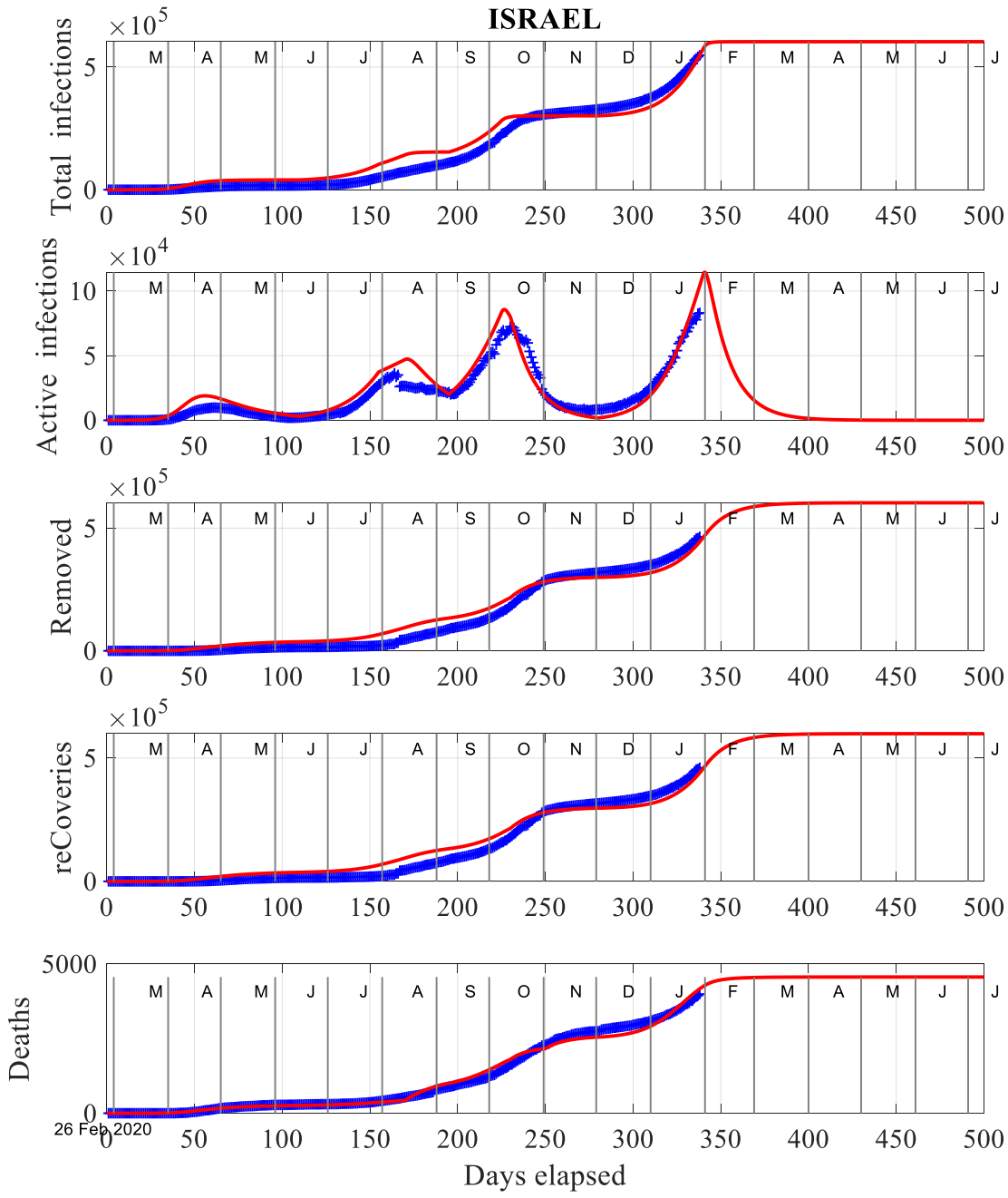
Tried a few times but could never get a good fit – I values seem to saturate – checked but no success – not sure of model or my solution method.

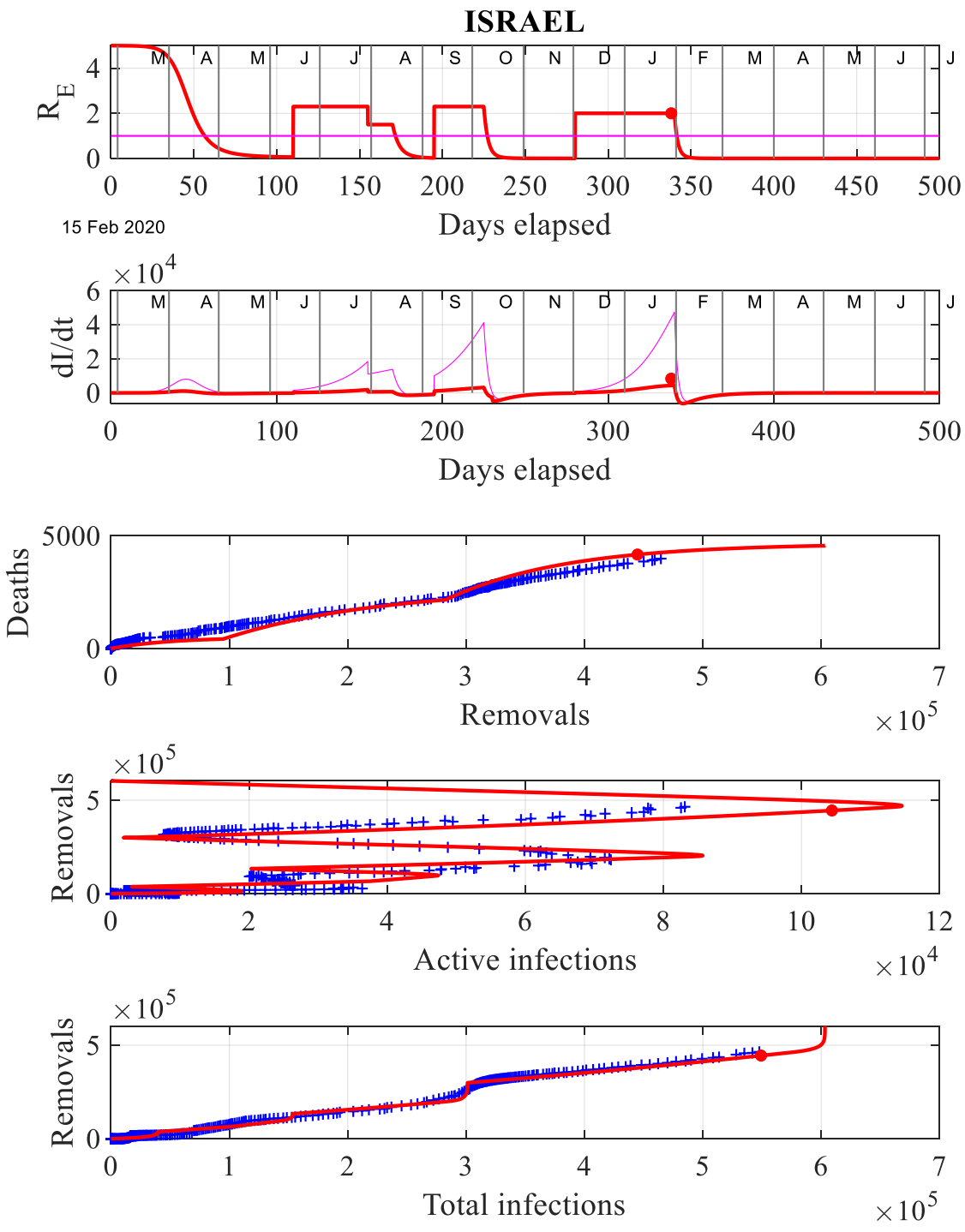

WORLD
Susceptible S
F M A M J J A S O N D J F M A M J
$S_C = 0.07$
12 Mar 2020
Days elapsed
$\times 10^6$
dI/dt
$\times 10^6$
Deaths
Removals
$\times 10^7$
$\times 10^7$
Removals
Active infections
$\times 10^7$
$\times 10^7$
Removals
Total infections
$\times 10^7$

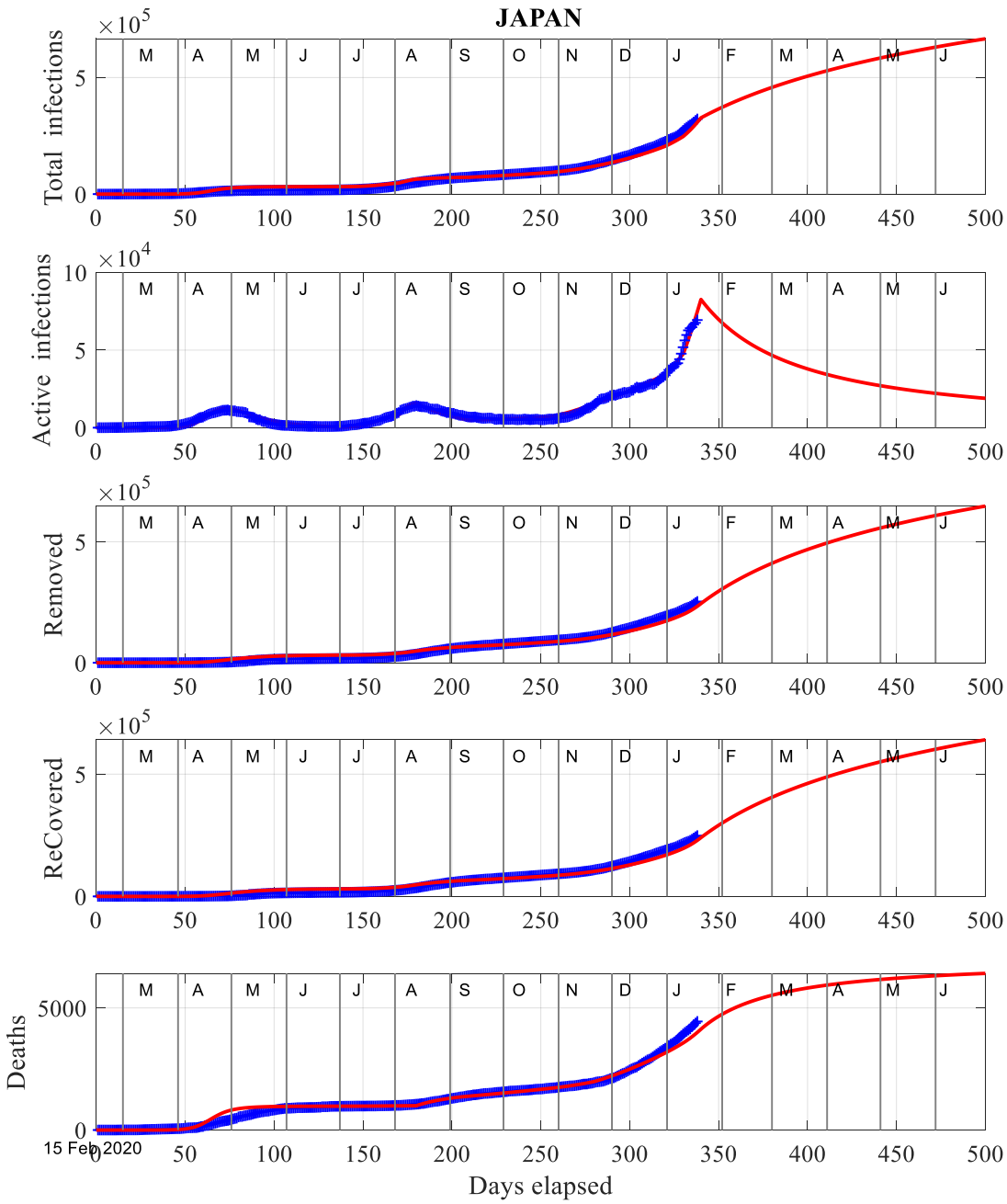


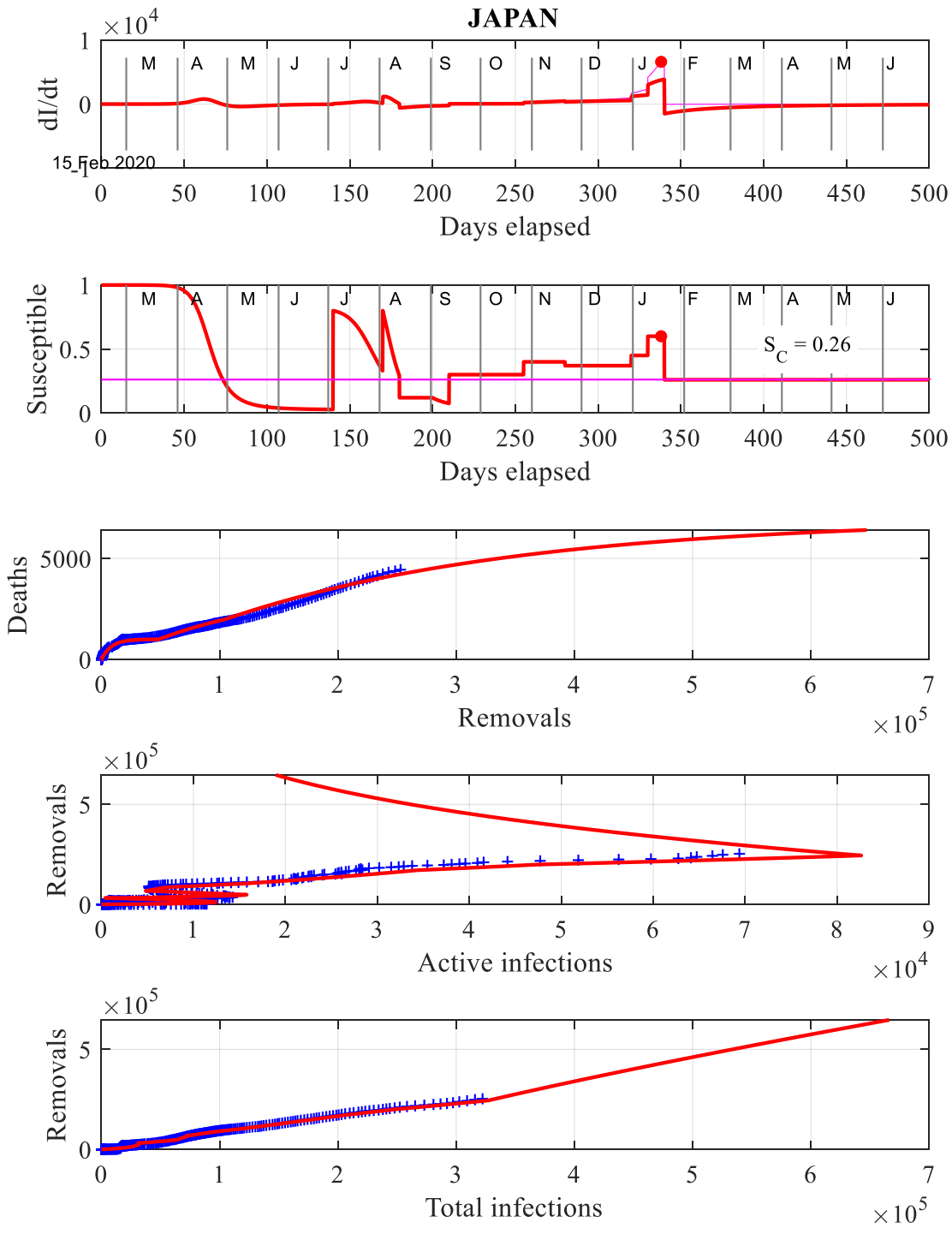
Amazing – a single peak

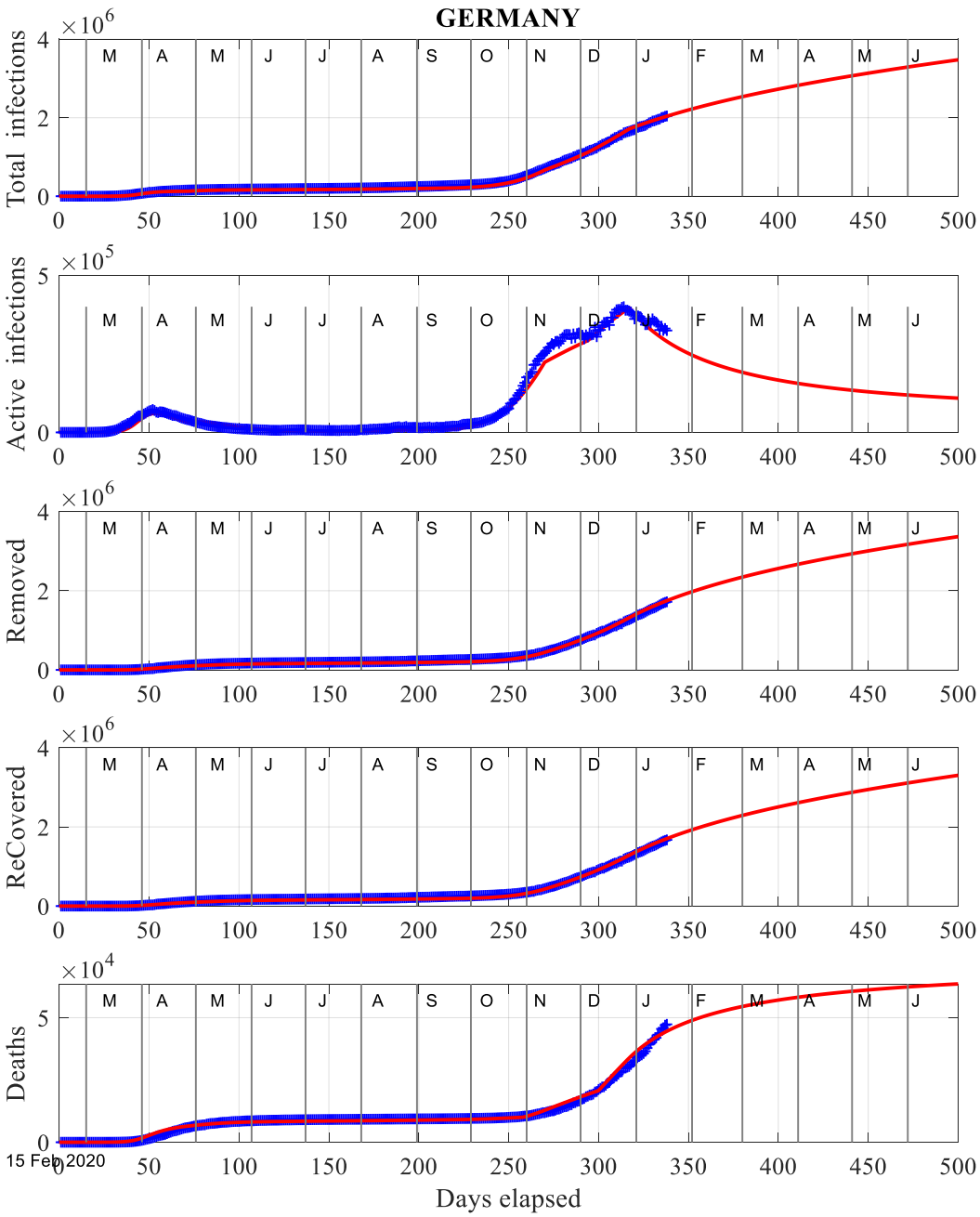

INDIA
Susceptible S
A M J J A S O N D J F M A M J J
$S_C = 0.40$
Days elapsed
14 Mar 2020
$\times 10^4$
dI/dt
Deaths
Removals
$\times 10^6$
Removals
Active infections
$\times 10^5$
Removals
Total infections
$\times 10^6$

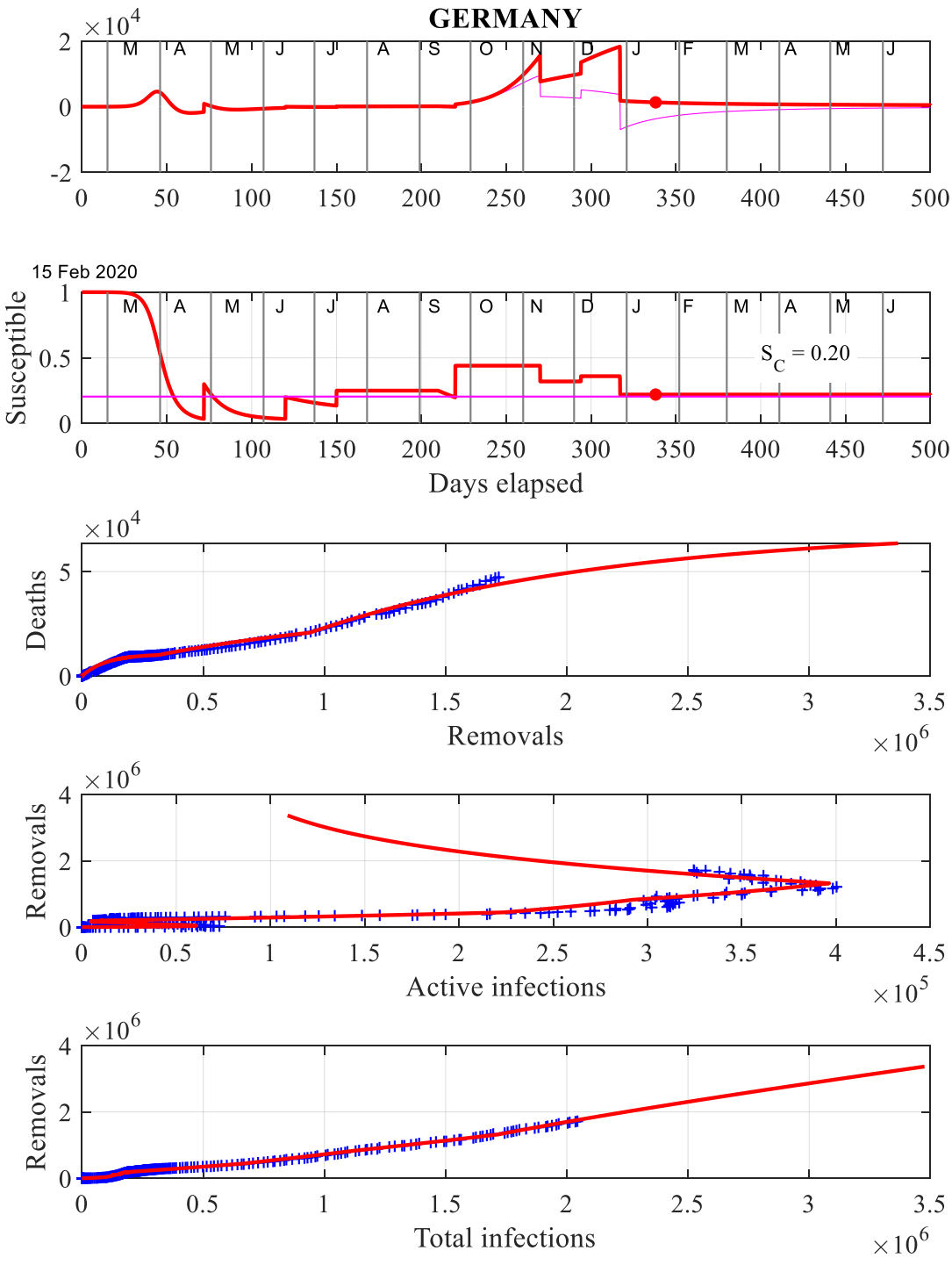

ISRAEL
Total infections
Active infections
Removed
reCoveries
Deaths
M A M J J A S O N D J F M A M J J
0 50 100 150 200 250 300 350 400 450 500
Days elapsed
26 Feb 2020


ISRAEL
R_E
M A M J J A S O N D J F M A M J J
0 50 100 150 200 250 300 350 400 450 500
Days elapsed
15 Feb 2020
$\times 10^4$
dI/dt
Days elapsed
Deaths
Removals
$\times 10^5$
Removals
Active infections
$\times 10^4$
Removals
Total infections
$\times 10^5$


JAPAN
Total infections
Active infections
Removed
ReCovered
Deaths
M A M J J A S O N D J F M A M J
15 Feb 2020
Days elapsed


JAPAN
×10^4
dI/dt
M A M J J A S O N D J F M A M J
15 Feb 2020
Days elapsed
Susceptible
S_C = 0.26
Days elapsed
Deaths
Removals
×10^5
Removals
Active infections
×10^4
Removals
Total infections
×10^5


GERMANY
Total infections
Active infections
Removed
ReCovered
Deaths
M A M J J A S O N D J F M A M J
0 50 100 150 200 250 300 350 400 450 500
15 Feb 2020
Days elapsed


GERMANY
×10^4
2
0
-2
M A M J J A S O N D J F M A M J
0 50 100 150 200 250 300 350 400 450 500
15 Feb 2020
Susceptible
1
0.5
0
S_C = 0.20
Days elapsed
Deaths
5
0 0.5 1 1.5 2 2.5 3 3.5
Removals
×10^6
Removals
4
2
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5
Active infections
×10^5
Total infections