How does the advancement of COVID-19 differ between the U.S, Canada, and India?

20 Pages

Appendix with data is after the reference page

Introduction/ Background Information

At the end of 2019, a new virus sprung up called coronavirus that was found in Wuhan, China. Coronavirus has occurred in the world before this on many occasions, however the specific type in 2019 that started this worldwide pandemic was called SARS- CoV- 2. This new type of coronavirus created a worldwide pandemic where many countries created new restrictive rules and measures to suppress the spread of COVID-19. Some of these restrictive measures include an at home lock down, face mask rules, and stay at home orders. Specifically in Washington, COVID-19 disrupted my life tremendously. My first year of high school got put on hold after only having one semester. After that, for the next year and a half my school remained online, and I had no social contact with my friends or family. Since I had so much time to myself, I became very interested in reading about what COVID-19 was and ways to prevent it. As someone who is pursuing a future career in the medical field, I also wanted to see how epidemiology works since it could be a possible career path. While reading up on COVID, I noticed how many covid cases there were and that they were increasing rapidly. This observation is what helped me choose this specific topic for my mathematical investigation. Therefore, I decided to figure out how to model Covid 19 in the United States, Canada, and India.

The SIR Model

The SIR model is a basic model that uses differential equations to model the spread of diseases. This model separates the entire population into 3 compartments: susceptible, infected, and recovered. This model helps to predict the number of infected, susceptible, and recovered people there are in the population over a specific period. The susceptible group is every person in the total population of each country that is not part of the infected or recovered group. The infected group is considered as people who currently have covid-19, and the recovered group are people that no longer have covid.

First, the independent variable of time is considered. In this model, time will be counted in days. When defining my variable T, I was initially considering a low number such as 10. However, I realized that having a larger number would be make my model more realistic and give me a greater understanding of the disease since it will show the growth and decline of covid for a longer period. Therefore, I selected the variable T to be 90 days or 3 months since this is a large enough amount of time for individuals to be susceptible, infected, and recovered. This time is also long enough to see how the disease can vary. I selected September 3rd, 2020, as the date that the data will start to be collected and the end date will be 3 months after or December 2nd, 2020. I selected the date September 3rd since I wanted to explore the growth and modelling of Covid at the beginning of my school year from 2020 to 2021.

After this, the population was split into 3 groups susceptible, infected, and recovered:

The variable S is used to represent the amount of susceptible individuals

$$S = S(t)$$

The variable I is used to represent the amount of infected individuals

$$I = I(t)$$

The variable R is used to represent the amount of recovered individuals

$$R = R(t)$$

These equations were modelled as $S(t)$, $R(t)$, and $I(t)$ since time is a necessary factor with each group to model how Covid will be spread over that time. Without time, the differential equations cannot be created.

Next, the variable N is used to represent the total population. This variable is important so that the fraction of the population that is either susceptible, infected, or recovered can be represented. Therefore, the equations become:

$$S(t) = \frac{S(t)}{N}$$

$$I(t) = \frac{I(t)}{N}$$

$$R(t) = \frac{R(t)}{N}$$

When defining these equations, I noticed that since there are only 3 groups considered in the entire population. This means that these values must add up to the entire population. Therefore, I can create the equation:

$$S + I + R = N$$

There are a few other variables that need to be considered as well such as the rate of infection and the rate of recovery. These two rates are necessary to model the spread of covid since each infected person can infect others and in order to move people from the infected to recovered group there needs to be an approximate recovery rate. The variable B will be used to represent the number of contacts per day that could spread COVID-19 and the variable K will be used to represent the fraction of infected people that can recover during the day.

The variable K was used to represent the recovery rate. At first, I was unsure how to calculate the recovery rate, but I realized that the recovery rate is inversely proportional to how long it takes to get recovered. Therefore, the recovery rate can equal to the reciprocal of the recovered days. The CDC claims that most individuals recover from covid within 3 to 14 days. I decided to select the median of these values, 8.5 days, since the median can be useful to provide a center value and to select a number that isn't affected by outliers. I had originally considered selecting a smaller or larger number such as 3 or 14 but realized that since not everyone recovers at the same rate that there would be more outliers with the values 3 and 14 then the value 8.5.

Therefore, K will be:

$$K = \frac{1}{8.5} \approx 0.118$$

When attempting to solve for the variable B, I had a lot of difficulty trying to create a value since there is no specific equation for the rate of infection for covid. However, while conducting my preliminary research I came across a value called R_0 , which is the amount of people who could get infected from one person currently infected with Covid. The equation used to represent R_0 is the $\frac{rate\ of\ infection}{rate\ of\ recovery}$. This is when I realized that I could use the R_0 value to calculate the rate of infection, B , since the rate of infection could equal $R_0 \times rate\ of\ recovery$. According to the MRC Centre for Global Infectious Disease Analysis, someone with COVID-19 could affect anywhere from 1.5 people to 3.5, which is the R_0 value. I decided on the value 2.6 to be used since this is the median of the two values.

Therefore, B is

$$B = 2.6 \times 0.118 \approx 0.306$$

Now that all the variables have been defined, the differential equations need to be created to model how covid spreads.

Therefore, the differential equations become:

$$\frac{ds}{dt} = -0.306\, s(t)i(t)$$

$$\frac{di}{dt} = 0.306\, s(t)i(t) - 0.118i(t)$$

$$\frac{dr}{dt} = 0.118i(t)$$

$\frac{ds}{dt}$ is used to represent the rate of the susceptible population. This was defined as $s(t)$

Euler's Method

When trying to solve for the 3 countries using the SIR differential equations, I came across a lot of difficulty with trying to calculate each value. Since this was so time consuming, I investigated various numerical methods to help me calculate the differential equations easier. This is where I came across Euler's method. Euler's Method can be used alongside the SIR Model to calculate the remaining values for the rest of the 3 months. This method is important to solving the equations since it can help calculate solutions based off one initial value. This can make the calculations more precise and more efficient.

Euler's method uses two main variables Y and T. These two variables are used to create these differential equations:

$$\frac{dy}{dt} = f(y, t) \text{ and } \Delta t = t_n - t_{n-1}$$

These differential equations then create Euler's equation which is:

$$Y_n = Y_{n-1} + F(X_{n-1}, Y_{n-1}) \times \Delta t$$

This method is used to calculate differential equations and can therefore be applied to the SIR model equations as well.

So, the equations can become:

$$S_t = s_{t-1} + \Delta s$$

$$I_t = i_{t-1} + \Delta i$$

$$R_t = r_{t-1} + \Delta r$$

Now to make this equation even simpler Δs, Δi, and Δr can be replaced with the equations that were deciphered in the SIR section since those differential equations represent the rates of change for S, I, and R.

Thus, Euler's method and the SIR model together create these differential equations:

$$s_{t+1} = s_t - bs_t i_t \times \Delta t$$

$$i_{t+1} = i_t + (bs_t i_t - ki_t) \times \Delta t$$

$$r_{t+1} = r_t + ki_t \times \Delta t$$

Modelling COVID-19 in the United States

The first country I selected was the United States. I decided the United States since this is where I'm currently living, and I wanted to understand how the disease works here. When covid originally started spreading in the United States, I never thought it would affect my life tremendously. Not just that, in 2021 at the beginning of my school year I did not know anyone who had gotten covid yet, so I wanted to understand how many people it's been affecting since I no one I knew had gotten it yet. The process of collecting data for the United States was not difficult since the U.S has excellent data collected for COVID-19 in 2020. I chose to proceed with Worldometers statistics regarding COVID-19 since this organization had the most data collected on their website, and it was organized well.

To begin modelling for COVID-19 I first collected data regarding covid. After doing some more research on the United States specifically, I defined my variable S, I, R, and N.

$$N = 329,500,000$$

$$I = 2{,}435{,}327$$

$$R = 2{,}785{,}745$$

$$S = (329{,}500{,}000 - 2{,}785{,}745 - 2{,}435{,}327) = \ 324,278{,}928$$

Using each of these variables, I can now use my differential equations to calculate for S(t), R(t), and I(t) when T = 0.

I(0) will be the current number of people infected on September 3rd divided by the total population:

$$I(0) = \frac{2{,}435{,}327}{329{,}500{,}000} \approx 0.00739$$

To solve for R(0), the total amount of people who have recovered and died on September 3rd 2020 will be divided by the total population again.

$$R(0) = \frac{2{,}785{,}745}{329{,}500{,}000} \approx 0.00845$$

To solve for S(0) the equation S + I + R = N can be used. Since R and I have been found, S will equal the total population minus the infected amount and the recovered amount. Therefore, the equation for S will be the total susceptible or remaining people divided by the entire population of the United States.

$$S(0) = \frac{324{,}278{,}928}{329{,}500{,}000} \approx 0.984$$

To double check that all these calculations are correct, S + I + R should be equal to the total population N. Here N will equal 1 since S(0), I(0), and R(0) values are percentages of the population that are either susceptible, infected, or recovered. Therefore, all the percentages should add up to 100% or 1.

$$0.984 + 0.00845 + 0.00739 \approx 1.0$$

Since each value of S(0), R(0), and I(0) have been found there is one more step necessary to do before being able to use Euler's method: $\Delta s, \Delta i,$ and Δr must be calculated.

Now, the differential equations for the SIR model can be used to solve for the first day or T = 1.

$$\frac{ds}{dt} or\ \Delta s = -bs(t)i(t) = \ -0.306(0.984)(0.00739) \approx \ -0.00222$$

$$\frac{di}{dt} or\ \Delta i = bs(t)i(t) - ki(t) = \ 0.00222 - 0.118(0.00739) \approx 0.00135$$

$$\frac{dr}{dt} or\ \Delta r = ki(t) = \ 0.118(0.00739) \approx 0.000869$$

Now that all the rates for the 3 groups have been defined, the Euler differential equations created can be used. So, using the equations stated above in the Euler's method section and plugging in values I can now find the values of S(1), I(1), and R(1).

$$s_1 = \ 0.984 - 1(-0.00222) \approx 0.986$$

$$i_1 = \ 0.00739 + 1(-0.00222) - 1(0.000869) \approx 0.00429$$

$$r_1 = 0.00845 + 1(0.000869) \approx 0.00932$$

To double check that these equations are correct, s_1+ i_1+r_1 must equal to the entire population or 1 again.

$$0.986 + 0.00429 + \ 0.00932 \approx 1.0$$

Using Euler's method for the rest of the values up till 90, the graph becomes:

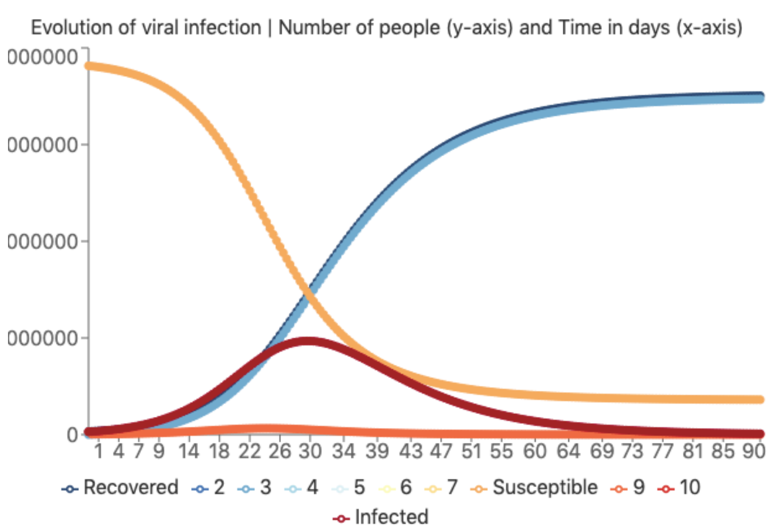


Figure 1. The SIR Model for Covid 19 for The United States

As shown in Figure 1, there is a drastic drop in the number of susceptible people around day 14. Initially, the number of susceptible people started out at 329,500,000 however around day 14 there is a massive dip in the amount of susceptible people. Around day 43 the susceptible amount of people drops to less than half of the amount at T = 0. However, the number of recovered people grew drastically unlike the susceptible people. This is because the number of infected individuals is also gradually rising. The amount of recovered people is relatively small around day 14 but lengthens from day 18 till around day 60 then flattens out. When looking at the amount of infected people, there is a spike shown in the graph. At around day 14 till day 30 there is an increase of infected people. However, after day 30 the infected people are shown to decrease. After looking at this graph, I realized that the peak in the infected group represented spikes that have occurred in the variations of covid. It was interesting to me to see how even though the infected population had grown tremendously during its spike around day 30, that the infected population ended up reducing. This shows that less people were getting infected by people in the infected group although the infected group is rising.

Modelling COVID-19 in Canada

The next country I selected was Canada. I selected Canada since it is the next largest country in North America. I wanted to explore a nearby country as well since people who are infected with covid in Canada can easily travel or be connected to the United States since they are so close by. Canada was more difficult to collect data on than the United States since I'm not familiar with the Canadian sites. However, I used Worldometers again since the data was organized and collected similarly to the United States. Canada also had a lot of data that was collected regarding COVID-19 so it was a little difficult to find the pieces I really needed. Canada's differential equations can be calculated following the same steps as done above for the United States.

First, defining the variables:

$$N = 38{,}010{,}000$$

$$I = 5908$$

$$R = (9141 + 2983) = 12124$$

$$S = (38010000 - 5908 - 12124) = 37991968$$

Now to solve for T = 0:

I(0) will be the current number of people infected on September 3rd divided by the total population:

$$I(0) = \frac{5908}{38010000} \approx 0.000155$$

To solve for R(0), the total people who have recovered and died on September 3rd 2020 will be divided by the total population again.

$$R(0) = \frac{12124}{38010000} \approx 0.000319$$

$$S(0) = \frac{37991968}{38010000} \approx 0.999$$

To double check that all these calculations are correct, S + I + R should be equal to the total population N or 1.

$$0.999 + 0.000319 + 0.000155 \approx 1.0$$

Now, the differential equations for the SIR model can be used to solve for the first day.

$$\frac{ds}{dt} = -0.306(0.999)(0.000155) \approx -0.0000475$$

$$\frac{di}{dt} = 0.0000475 - 0.118(0.000155) \approx 0.0000292$$

$$\frac{dr}{dt} = 0.118(0.000155) \approx 0.0000183$$

Then using Euler's method to calculate the next value of S, I, and R

$$s_1 = 0.999 - 1(-0.0000475) \approx 0.999$$

$$i_1 = 0.000155 + 1(-0.0000475) - 1(0.0000182) \approx 0.0000896$$

$$r_1 = 0.000319 + 1(0.0000182) \approx 0.000337$$

To double check that these equations are correct, s_1+ i_1+r_1 must equal to the entire population

$$0.000337 + 0.0000897 + 0.999 \approx 1.0$$

Using Euler's method again to define the rest of the values for S, I, and R, the graph becomes:

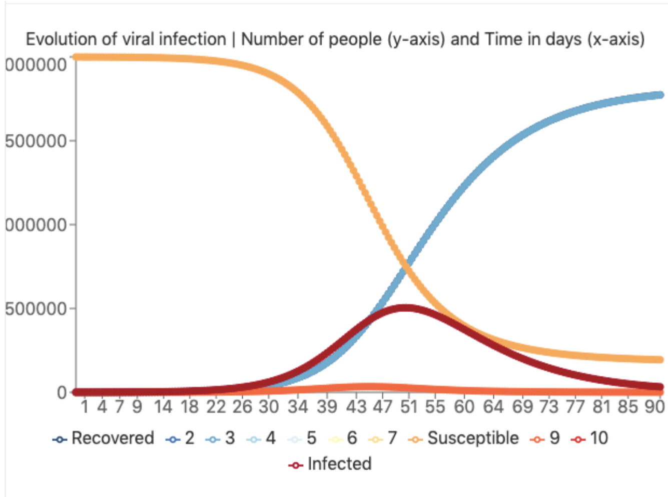


Figure 2. The SIR Model for Covid 19 for Canada

As shown in Figure 2, on day 0 till around 30 the number of susceptible people stays around the same. However there comes a drastic drop in the number of susceptible people around day 34. Initially, the number of susceptible people started out at 38,010,000 however around day 60 it decreases to over three quarters of the original susceptible amount. As this drop in the susceptible population occurs the number of recovered individuals increases. The number of recovered individuals grew drastically unlike the susceptible people. The amount of infected people has an increase at around 30 days and decreases again around day 60. This one was interesting since there seemed to be no growth till around day 30. This was odd to me since even though the infection period of 8.5 days had passed, people still weren't getting infected till almost 3 times the infection period.

Modelling COVID-19 in India

The final country that was selected was India. I selected the country India since most of my extended family lives here. I had already explored about covid close to me in Canada and the

United States, but I also wanted to see how covid has been affecting my family. India's data was found on the same statistics site Worldometers. I was particularly interested in trying to see the spread of COVID in India since some of my relatives live there and I wanted to see how Covid was there.

The next steps will be repeating the steps above as done with U.S and Canada to use the SIR model for India.

The variables defined are:

$$N = 1,380{,}000{,}000$$

$$R = (67491 + 69451) = 136{,}942$$

$$I = 828{,}786$$

$$S = (1380000000 - 136942 - 828786) = 1{,}379{,}034{,}252$$

I(0) will be the current number of people infected on September 3rd divided by the total population:

$$I(0) = \frac{828{,}786}{1,380{,}000{,}000} \approx 0.000601$$

To solve for R(0), the total people who have recovered and died on September 3rd 2020 will be divided by the total population again.

$$R(0) = \frac{136{,}942}{1,380{,}000{,}000} \approx 0.0000992$$

$$S(0) = \frac{1{,}379{,}034{,}252}{1,380{,}000{,}000} \approx 0.999$$

To double check that all these calculations are correct, S + I + R should be equal to the total population N or 1.

$$0.999 + 0.0000992 + 0.000601 \approx 1$$

Now, the differential equations for the SIR model can be used to solve for the first day.

$$\frac{ds}{dt} = -0.306(0.999)(0.000601) \approx -0.000184$$

$$\frac{di}{dt} = 0.000184 - 0.118(0.000601) \approx 0.000113$$

$$\frac{dr}{dt} = 0.118(0.000601) \approx 0.0000706$$

Then using Euler's method

$$s_1 = 0.999 - 1(-0.000184) \approx 0.999$$

$$i_1 = 0.000601 + 1(-0.000184) - 1(0.0000706) \approx 0.000346$$

$$r_1 = 0.0000992 + 1(0.0000706) \approx 0.000169$$

To double check that these equations are correct, $s_1 + i_1 + r_1$ must equal to the entire population

$$0.000169 + 0.000346 + 0.999 \approx 1.0$$

After using Euler's method for the rest of the values the graph becomes:

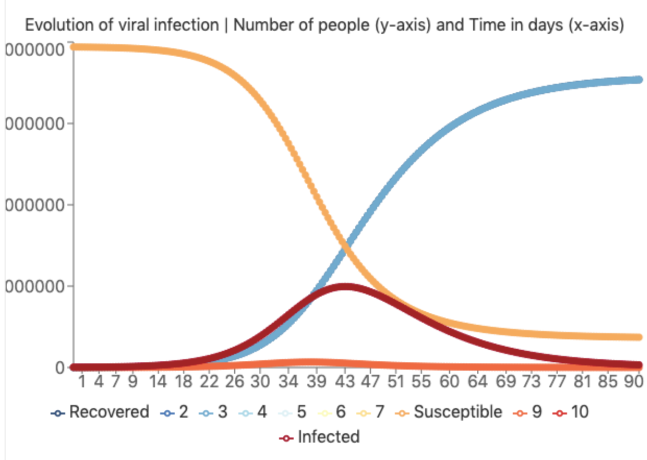


Figure 3. The SIR Model for Covid 19 for India

As shown in Figure 3, on day 0 till around 26 the number of susceptible people stays around the same. Then this amount drops around day 26 and decreases to less than half the original susceptible population. The recovered population increases at around day 26 and stabilizes around day 70. The infected individuals start to increase around day 26, peaks at day 43, and then decreases around 55.

Optimization

After establishing the three diagrams representing the Covid disease, I noticed that in all 3 diagrams the susceptible population is decreasing and towards the end in all the diagrams the infected group was decreasing as well. After this realization, I started to wonder about how long it would take based on the diagrams for the curve to flatten. When the curve flattens or reaches 0 it means that covid would no longer exist anymore. Therefore, I decided to use optimization to discover when the curve would flatten.

Optimization is the optimal solution when finding the maximum or minimum of a function. There are a couple ways to find the optimal solution, one of the ways being setting your equation to 0. I decided to select the infected differential equation and see when it reaches 0 first since this equation includes both S and I. Using this equation will allow me to define some of my variables and use those values to solve the other equations. Using the infected equation will show how many people will be left who aren't/haven't been infected for the disease to die out.

As derived earlier, the infected differential equation is:

$$\frac{di}{dt} = 0.306\, s(t)i(t) - 0.118i(t)$$

To find the optimal solution this equation must be set equal to 0:

$$0.306\, s(t)i(t) - 0.118i(t) = 0$$

Since both parts of the equation contain I, I can be factored out:

$$0.306I(\ S\ - 0.386) = 0$$

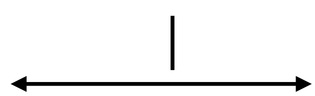
Therefore,

$$s(t) \approx 0.386 \text{ and } i(t) = 0$$

$$i(t) = 0\,, s(t) = 0.386$$

This shows that the curve of I is flattening and optimizing when the susceptible population of the country is at 38.6%. When putting S back into the equation as less than 0.386, it can be found that there is a local maximum at this point.

So, a sign diagram can be drawn for a visual understanding



\+ -

. 0.386

<u>Comparing and contrasting amongst 3 countries</u>

After solving for the differential equations through 90 days, I noticed trends with the graphs for the United States, Canada, and India. Each of the 3 countries had an increase and quick decrease with the infected population. This represents how there have been many different peaks of Covid-19 since it began. For example, a new variant of Covid-19, Omicron, came out recently and had a peak in covid cases till the beginning of February of 2022. The susceptible and recovered populations for the 3 countries all follow the same pattern. After looking at all 3 models, I noticed that the day that the susceptible population starts decreasing tremendously that the recovered population starts increasing at that same rate. COVID-19 didn't differ as much between all 3 countries other than the days the susceptible, infected, and recovered population started to change were different.

<u>Limitations and Advantages of the SIR model</u>

After exploring the SIR model and modelling COVID-19 I noticed a lot of limitations this model had with infectious diseases.

- The first major limitation I noticed was that this model had the population remain constant the entire time. This doesn't work in real life, since there are constantly people coming and leaving and the population doesn't stay the same.
- The SIR model also doesn't consider that other factors could play a role. For example, regarding COVID-19, vaccinations now would dramatically change the modelling of covid-19. Also, lockdown and quarantine should also be taken into consideration when modelling the data since there is no homogeneous mixing of the population during quarantine. The model would most likely change drastically as the susceptible group wouldn't be the entire population since vaccinations lower the rate of infection per person.
- The SIR model also doesn't consider for some infectious diseases that there is a period where someone can be exposed and then become infectious. For example, regarding

COVID-19 the CDC says to get tested 3-5 days after being exposed to someone with COVID-19.

- The SIR model also assumes homogeneous mixing which is when all 3 compartments have the same probability of mixing with the others. This isn't true since everyone in the world doesn't have the same probability of interacting with someone who could have Covid-19.

However, while using the SIR model there were also some advantages to this model. Since the SIR model is not as complicated and only has 3 groups, it does a simple job of showing the trend between Susceptible, Individual, and Recovered individuals and can be used by researchers when someone needs an approximate model of Covid rather than an intricate one.

Conclusion

The SIR model is a basic infectious disease model that was primarily used for the influenza pandemic, measles, mumps, and rubella. This is a model that divides the entire population into 3 groups and then predicts the trends of each group and what will happen. This model has a real-life application since epidemiologists can use this model if there were to be a worldwide pandemic such as currently with the Covid-19 epidemic. After modelling COVID-19 for different countries, I learned how to find data online and make sure it is accurate. I also learned about other models such as the SEIR model, SEIS, SIS, SIRD, and others that are all used as a more advanced infectious disease model. If there was more time, I would want to create a model specifically for covid to represent all the factors such as vaccinations, new variants, and no homogenous mixing. This would allow for a better understanding of covid.

This investigation was also beneficial for me since it allowed me to learn more about the pandemic that's on going. As a student who is very interested in the medical field, this model allowed for me to understand infectious diseases even better. Hopefully, I will be able to use this knowledge and apply it to my future career in the medical field. Overall, this exploration answered a lot of questions that I had developing regarding COVID-19 and how it spreads. I learned about how the disease grows and thrives and how each group plays its role in COVID developing. This project helped me answer questions that I had developed over quarantine and lockdown. I was also able to explore Euler's method and optimization more in this exploration. This was very beneficial to me since I realized how a small number change in any of these methods results in such a large difference. The numbers in the United States, Canada, and India differed at maybe 0.1-0.2 and yet there was a large difference in the curves and models for each country.

Works Cited

By. "Coronavirus in the U.S.: Latest Map and Case Count." *The New York Times*, The New York Times, 3 Mar. 2020, www.nytimes.com/interactive/2021/us/covid-cases.html.

"CDC Covid Data Tracker." *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, covid.cdc.gov/covid-data-tracker/#datatracker-home.

"Covid-19 Government Response Tracker." *Blavatnik School of Government*, www.bsg.ox.ac.uk/research/research-projects/covid-19-government-response-tracker.

FT Visual & Data Journalism team. "Free to Read: Coronavirus Tracked: Has the Epidemic Peaked near You?" *Coronavirus Chart: See How Your Country Compares | Free to Read | Financial Times*, 31 Dec. 1969, ig.ft.com/coronavirus-chart/?areas=rou&areasRegional=usmi&cumulative=0&logScale=0&per100K=1&startDate=2021-01-01&values=deaths.

FT Visual & Data Journalism team. "The Global Race to Vaccinate." *Covid-19 Vaccine Tracker*, 22 Sept. 2021, ig.ft.com/coronavirus-vaccine-tracker/?areas=ind&cumulative=1&doses=total&populationAdjusted=0.

Published: Nov 30, 2021. "Global Covid-19 Tracker – Updated as of November 30." *KFF*, 30 Nov. 2021, www.kff.org/coronavirus-covid-19/issue-brief/global-covid-19-tracker/.

"The Sir Model for Spread of Disease - the Differential Equation Model." *The SIR Model for Spread of Disease - The Differential Equation Model | Mathematical Association of America*, www.maa.org/press/periodicals/loci/joma/the-sir-model-for-spread-of-disease-the-differential-equation-model.

Appendix 1 U.S calculations

T	S(t)	S'(t)	I(t)	I'(t)	R(t)	R'(t)
0	0.984154561	-0.002224064	0.00739098	0.001354883	0.00845446	0.000869181
1	0.986378625	-0.001296176	0.004297735	0.000714204	0.009323641	0.000505414
2	0.987674801	-0.000753814	0.002496144	0.000460267	0.009829055	0.000293547
3	0.988428615	-0.000437854	0.001448783	0.000267477	0.010122601	0.000170377
4	0.98886647	-0.000254146	0.000840552	0.000339005	0.010292978	9.8849E-05
5	0.989120615	-0.000147454	0.000487558	0.000196809	0.010391827	5.73368E-05
6	0.989268069	-8.5531E-05	0.000282767	0.0001142	0.010449164	3.32534E-05
7	0.9893536	-4.96055E-05	0.000163983	6.62466E-05	0.010482417	1.92844E-05
8	0.989403206	-2.87675E-05	9.50928E-05	3.84226E-05	0.010501702	1.11829E-05
9	0.989431973	-1.66822E-05	5.51424E-05	2.22827E-05	0.010512884	6.48475E-06
10	0.989448655	-9.67367E-06	3.19755E-05	1.29218E-05	0.010519369	3.76032E-06
11	0.989458329	-5.60949E-06	1.85415E-05	7.49319E-06	0.01052313	2.18048E-06
12	0.989463938	-3.25275E-06	1.07515E-05	4.34511E-06	0.01052531	1.26438E-06
13	0.989467191	-1.88615E-06	6.2344E-06	2.51959E-06	0.010526574	7.33166E-07
14	0.989469077	-1.09371E-06	3.61508E-06	1.46102E-06	0.010527308	4.25134E-07
15	0.989470171	-6.34198E-07	2.09624E-06	8.4719E-07	0.010527733	2.46518E-07
16	0.989470805	-3.67746E-07	1.21553E-06	4.91252E-07	0.010527979	1.42946E-07
17	0.989471173	-2.13241E-07	7.04834E-07	2.84858E-07	0.010528122	8.28885E-08
18	0.989471386	-1.2365E-07	4.08705E-07	1.65177E-07	0.010528205	4.80637E-08
19	0.98947151	-7.16995E-08	2.36991E-07	9.57797E-08	0.010528253	2.78702E-08
20	0.989471582	-4.15756E-08	1.37422E-07	5.55387E-08	0.010528281	1.61608E-08
21	0.989471623	-2.4108E-08	7.96851E-08	3.22047E-08	0.010528297	9.37097E-09
22	0.989471647	-1.39792E-08	4.62062E-08	1.86742E-08	0.010528306	5.43384E-09
23	0.989471661	-8.106E-09	2.67931E-08	1.08284E-08	0.010528312	3.15086E-09
24	0.989471669	-4.70034E-09	1.55362E-08	6.27894E-09	0.010528315	1.82706E-09
25	0.989471674	-2.72553E-09	9.00881E-09	3.6409E-09	0.010528317	1.05944E-09
26	0.989471677	-1.58043E-09	5.22384E-09	2.11121E-09	0.010528318	6.14324E-10
27	0.989471678	-9.16424E-10	3.02909E-09	1.2242E-09	0.010528319	3.56221E-10
28	0.989471679	-5.31397E-10	1.75645E-09	7.09866E-10	0.010528319	2.06558E-10
29	0.98947168	-3.08135E-10	1.01849E-09	4.11622E-10	0.010528319	1.19775E-10
30	0.98947168	-1.78675E-10	5.90581E-10	2.38683E-10	0.010528319	6.94524E-11
31	0.98947168	-1.03606E-10	3.42454E-10	1.38402E-10	0.010528319	4.02726E-11
32	0.98947168	-6.00771E-11	1.98575E-10	8.02539E-11	0.010528319	2.33524E-11
33	0.98947168	-3.48363E-11	1.15146E-10	4.6536E-11	0.010528319	1.35411E-11
34	0.989471681	-2.02001E-11	6.67682E-11	2.69843E-11	0.010528319	7.85195E-12
35	0.989471681	-1.17132E-11	3.87161E-11	1.56471E-11	0.010528319	4.55302E-12
36	0.989471681	-6.79202E-12	2.24499E-11	9.0731E-12	0.010528319	2.64011E-12
37	0.989471681	-3.93842E-12	1.30178E-11	5.26113E-12	0.010528319	1.53089E-12
38	0.989471681	-2.28373E-12	7.5485E-12	3.05071E-12	0.010528319	8.87704E-13

39	0.989471681	-1.32424E-12	4.37707E-12	1.76899E-12	0.010528319	5.14743E-13
40	0.989471681	-7.67865E-13	2.53805E-12	1.02577E-12	0.010528319	2.98475E-13
41	0.989471681	-4.45264E-13	1.47175E-12	5.94787E-13	0.010528319	1.73078E-13
42	0.989471681	-2.58177E-13	8.53361E-13	3.44909E-13	0.010528319	1.00355E-13
43	0.989471681	-1.49721E-13	4.94878E-13	1.99979E-13	0.010528319	5.81977E-14
44	0.989471681	-8.68023E-14	2.86911E-13	1.1598E-13	0.010528319	3.37407E-14
45	0.989471681	-5.03281E-14	1.66351E-13	6.72394E-14	0.010528319	1.95629E-14
46	0.989471681	-2.91939E-14	9.64957E-14	3.89802E-14	0.010528319	1.13479E-14
47	0.989471681	-1.69266E-14	5.59483E-14	2.26144E-14	0.010528319	6.57952E-15
48	0.989471681	-9.83049E-15	3.24931E-14	1.31055E-14	0.010528319	3.82119E-15
49	0.989471681	-5.6849E-15	1.87905E-14	7.62073E-15	0.010528319	2.20977E-15
50	0.989471681	-3.30325E-15	1.09183E-14	4.4009E-15	0.010528319	1.284E-15
51	0.989471681	-1.90721E-15	6.30399E-15	2.5619E-15	0.010528319	7.41349E-16
52	0.989471681	-1.1121E-15	3.67588E-15	1.47493E-15	0.010528319	4.32283E-16
53	0.989471681	-6.45534E-16	2.13371E-15	8.61179E-16	0.010528319	2.50924E-16
54	0.989471681	-3.67902E-16	1.21604E-15	5.02528E-16	0.010528319	1.43006E-16
55	0.989471681	-2.241E-16	7.40727E-16	2.80793E-16	0.010528319	8.71095E-17
56	0.989471681	-1.30681E-16	4.31946E-16	1.73303E-16	0.010528319	5.07969E-17
57	0.989471681	-8.18727E-17	2.70617E-16	9.88568E-17	0.010528319	3.18245E-17
58	0.989471681	-3.8837E-17	1.2837E-16	6.67764E-17	0.010528319	1.50963E-17
59	0.989471681	-3.41136E-17	1.12757E-16	2.55768E-17	0.010528319	1.32602E-17
60	0.989471681	-2.9915E-17	9.88792E-17	2.24854E-17	0.010528319	1.16282E-17
61	0.989471681	-2.62412E-17	8.67362E-17	1.97148E-17	0.010528319	1.02002E-17
62	0.989471681	-2.30923E-17	7.63278E-17	1.72651E-17	0.010528319	8.97615E-18
63	0.989471681	-2.04682E-17	6.76542E-17	1.51362E-17	0.010528319	7.95614E-18
64	0.989471681	-1.7844E-17	5.89806E-17	1.3532E-17	0.010528319	6.93612E-18
65	0.989471681	-1.57447E-17	5.20417E-17	1.17239E-17	0.010528319	6.1201E-18
66	0.989471681	-1.36454E-17	4.51028E-17	1.04407E-17	0.010528319	5.30409E-18
67	0.989471681	-1.2071E-17	3.98986E-17	8.95336E-18	0.010528319	4.69208E-18
68	0.989471681	-1.04965E-17	3.46945E-17	7.9909E-18	0.010528319	4.08007E-18
69	0.989471681	-9.44685E-18	3.1225E-17	6.82443E-18	0.010528319	3.67206E-18
70	0.989471681	-8.3972E-18	2.77556E-17	6.18279E-18	0.010528319	3.26406E-18
71	0.989471681	-7.34755E-18	2.42861E-17	5.54115E-18	0.010528319	2.85605E-18
72	0.989471681	-6.2979E-18	2.08167E-17	4.8995E-18	0.010528319	2.44804E-18
73	0.989471681	-5.77307E-18	1.9082E-17	4.05386E-18	0.010528319	2.24404E-18
74	0.989471681	-5.24825E-18	1.73472E-17	3.73304E-18	0.010528319	2.04003E-18
75	0.989471681	-4.72342E-18	1.56125E-17	3.41222E-18	0.010528319	1.83603E-18
76	0.989471681	-4.1986E-18	1.38778E-17	3.09139E-18	0.010528319	1.63203E-18

Appendix 2 India Calculations

T	S(t)	S'(t)	I(t)	I'(t)	R(t)	R'(t)
0	0.9993	-0.0001835	0.000601	0.000113	0.000099233	7.0627E-05
1	0.999484	-0.00010587	0.000346	0.001179	0.00016986	4.0741E-05
2	0.99959	-6.1074E-05	0.0002	0.00073	0.000210601	2.35E-05
3	0.999651	-3.5228E-05	0.000115	0.000424	0.000234101	1.3554E-05
4	0.999686	-2.0318E-05	6.65E-05	2.74E-05	0.000247655	7.8171E-06
5	0.999706	-1.1718E-05	3.83E-05	1.58E-05	0.000255472	4.5084E-06
6	0.999718	-6.7584E-06	2.21E-05	9.12E-06	0.00025998	2.6001E-06
7	0.999725	-3.8978E-06	1.28E-05	5.26E-06	0.00026258	1.4996E-06
8	0.999729	-2.248E-06	7.35E-06	3.03E-06	0.00026408	8.6483E-07
9	0.999731	-1.2965E-06	4.24E-06	1.75E-06	0.000264945	4.9877E-07
10	0.999732	-7.4769E-07	2.45E-06	1.01E-06	0.000265444	2.8765E-07
11	0.999733	-4.3121E-07	1.41E-06	5.82E-07	0.000265731	1.659E-07
12	0.999733	-2.4869E-07	8.14E-07	3.36E-07	0.000265897	9.5675E-08
13	0.999734	-1.4342E-07	4.69E-07	1.94E-07	0.000265993	5.5178E-08
14	0.999734	-8.2716E-08	2.71E-07	1.12E-07	0.000266048	3.1822E-08
15	0.999734	-4.7704E-08	1.56E-07	6.44E-08	0.00026608	1.8353E-08
16	0.999734	-2.7512E-08	9E-08	3.71E-08	0.000266098	1.0584E-08
17	0.999734	-1.5867E-08	5.19E-08	2.14E-08	0.000266109	6.1042E-09
18	0.999734	-9.1507E-09	2.99E-08	1.23E-08	0.000266115	3.5204E-09
19	0.999734	-5.2774E-09	1.73E-08	7.12E-09	0.000266118	2.0303E-09
20	0.999734	-3.0436E-09	9.96E-09	4.11E-09	0.00026612	1.1709E-09
21	0.999734	-1.7553E-09	5.74E-09	2.37E-09	0.000266122	6.753E-10
22	0.999734	-1.0123E-09	3.31E-09	1.37E-09	0.000266122	3.8946E-10
23	0.999734	-5.8383E-10	1.91E-09	7.88E-10	0.000266123	2.2461E-10
24	0.999734	-3.3671E-10	1.1E-09	4.54E-10	0.000266123	1.2954E-10
25	0.999734	-1.9419E-10	6.35E-10	2.62E-10	0.000266123	7.4707E-11
26	0.999734	-1.1199E-10	3.66E-10	1.51E-10	0.000266123	4.3085E-11
27	0.999734	-6.4588E-11	2.11E-10	8.71E-11	0.000266123	2.4848E-11
28	0.999734	-3.7249E-11	1.22E-10	5.03E-11	0.000266123	1.433E-11
29	0.999734	-2.1482E-11	7.03E-11	2.9E-11	0.000266123	8.2646E-12
30	0.999734	-1.2389E-11	4.05E-11	1.67E-11	0.000266123	4.7664E-12
31	0.999734	-7.1452E-12	2.34E-11	9.64E-12	0.000266123	2.7489E-12
32	0.999734	-4.1208E-12	1.35E-11	5.56E-12	0.000266123	1.5853E-12
33	0.999734	-2.3765E-12	7.77E-12	3.21E-12	0.000266123	9.1429E-13
34	0.999734	-1.3706E-12	4.48E-12	1.85E-12	0.000266123	5.2729E-13
35	0.999734	-7.9046E-13	2.59E-12	1.07E-12	0.000266123	3.041E-13
36	0.999734	-4.5587E-13	1.49E-12	6.15E-13	0.000266123	1.7538E-13
37	0.999734	-2.6291E-13	8.6E-13	3.55E-13	0.000266123	1.0115E-13

38	0.999734	-1.5163E-13	4.96E-13	2.05E-13	0.000266123	5.8335E-14
39	0.999734	-8.7441E-14	2.86E-13	1.18E-13	0.000266123	3.364E-14
40	0.999734	-5.0416E-14	1.65E-13	6.8E-14	0.000266123	1.9396E-14
41	0.999734	-2.9079E-14	9.51E-14	3.92E-14	0.000266123	1.1187E-14
42	0.999734	-1.6768E-14	5.49E-14	2.26E-14	0.000266123	6.4509E-15
43	0.999734	-9.6715E-15	3.16E-14	1.3E-14	0.000266123	3.7208E-15
44	0.999734	-5.5816E-15	1.83E-14	7.52E-15	0.000266123	2.1474E-15
45	0.999734	-3.2284E-15	1.06E-14	4.34E-15	0.000266123	1.242E-15
46	0.999734	-1.8645E-15	6.1E-15	2.51E-15	0.000266123	7.1732E-16
47	0.999734	-1.0683E-15	3.49E-15	1.45E-15	0.000266123	4.1101E-16
48	0.999734	-6.0333E-16	1.97E-15	8.36E-16	0.000266123	2.3211E-16
49	0.999734	-3.6269E-16	1.19E-15	4.64E-16	0.000266123	1.3953E-16
50	0.999734	-2.1822E-16	7.14E-16	2.79E-16	0.000266123	8.3954E-17
51	0.999734	-1.2468E-16	4.08E-16	1.7E-16	0.000266123	4.7966E-17
52	0.999734	-7.6077E-17	2.49E-16	9.54E-17	0.000266123	2.9268E-17
53	0.999734	-3.3191E-17	1.09E-16	6.33E-17	0.000266123	1.2769E-17
54	0.999734	-2.9281E-17	9.58E-17	2.19E-17	0.000266123	1.1265E-17
55	0.999734	-2.5834E-17	8.45E-17	1.93E-17	0.000266123	9.9388E-18
56	0.999734	-2.2802E-17	7.46E-17	1.71E-17	0.000266123	8.7721E-18
57	0.999734	-2.0117E-17	6.58E-17	1.51E-17	0.000266123	7.7394E-18
58	0.999734	-1.7747E-17	5.81E-17	1.33E-17	0.000266123	6.8277E-18
59	0.999734	-1.5659E-17	5.12E-17	1.17E-17	0.000266123	6.0245E-18
60	0.999734	-1.382E-17	4.52E-17	1.03E-17	0.000266123	5.3168E-18
61	0.999734	-1.2196E-17	3.99E-17	9.13E-18	0.000266123	4.6921E-18
62	0.999734	-1.0754E-17	3.52E-17	8.06E-18	0.000266123	4.1374E-18
63	0.999734	-9.4951E-18	3.11E-17	7.1E-18	0.000266123	3.6529E-18
64	0.999734	-8.3849E-18	2.74E-17	6.27E-18	0.000266123	3.2258E-18
65	0.999734	-7.3906E-18	2.42E-17	5.54E-18	0.000266123	2.8433E-18
66	0.999734	-6.5289E-18	2.14E-17	4.88E-18	0.000266123	2.5118E-18
67	0.999734	-5.7667E-18	1.89E-17	4.31E-18	0.000266123	2.2185E-18
68	0.999734	-5.0873E-18	1.66E-17	3.81E-18	0.000266123	1.9572E-18
69	0.999734	-4.4907E-18	1.47E-17	3.36E-18	0.000266123	1.7277E-18
70	0.999734	-3.9604E-18	1.3E-17	2.97E-18	0.000266123	1.5237E-18
71	0.999734	-3.4965E-18	1.14E-17	2.62E-18	0.000266123	1.3451E-18
72	0.999734	-3.0822E-18	1.01E-17	2.31E-18	0.000266123	1.1858E-18
73	0.999734	-2.7176E-18	8.89E-18	2.04E-18	0.000266123	1.0455E-18
74	0.999734	-2.4028E-18	7.86E-18	1.79E-18	0.000266123	9.2439E-19
75	0.999734	-2.1211E-18	6.94E-18	1.59E-18	0.000266123	8.1601E-19
76	0.999734	-1.8725E-18	6.13E-18	1.4E-18	0.000266123	7.2039E-19
77	0.999734	-1.6571E-18	5.42E-18	1.23E-18	0.000266123	6.3751E-19
78	0.999734	-1.4582E-18	4.77E-18	1.1E-18	0.000266123	5.6101E-19

79	0.999734	-1.2925E-18	4.23E-18	9.61E-19	0.000266123	4.9726E-19
80	0.999734	-1.1434E-18	3.74E-18	8.53E-19	0.000266123	4.3988E-19
81	0.999734	-1.0108E-18	3.31E-18	7.55E-19	0.000266123	3.8888E-19
82	0.999734	-8.9483E-19	2.93E-18	6.67E-19	0.000266123	3.4426E-19
83	0.999734	-7.954E-19	2.6E-18	5.89E-19	0.000266123	3.0601E-19
84	0.999734	-6.9598E-19	2.28E-18	5.28E-19	0.000266123	2.6775E-19
85	0.999734	-6.1312E-19	2.01E-18	4.6E-19	0.000266123	2.3588E-19
86	0.999734	-5.4684E-19	1.79E-18	4.03E-19	0.000266123	2.1038E-19
87	0.999734	-4.8056E-19	1.57E-18	3.62E-19	0.000266123	1.8488E-19
88	0.999734	-4.3084E-19	1.41E-18	3.15E-19	0.000266123	1.6575E-19
89	0.999734	-3.8113E-19	1.25E-18	2.84E-19	0.000266123	1.4663E-19
90	0.999734	-3.3142E-19	1.08E-18	2.54E-19	0.000266123	1.275E-19

Appendix 3 Canada Calculations

T	S(t)	S'(t)	I(t)	I'(t)	R(t)	R'(t)
0	0.99953	-4.75025E-05	0.0001554	2.922E-05	0.000319	1.827E-05
1	0.99957	-2.74028E-05	8.966E-05	0.0012091	0.000337	1.054E-05
2	0.9996	-1.5827E-05	5.178E-05	0.0007477	0.000348	6.09E-06
3	0.99962	-9.12854E-06	2.987E-05	0.0004343	0.000354	3.512E-06
4	0.99963	-5.265E-06	1.723E-05	7.103E-06	0.000357	2.026E-06
5	0.99963	-3.03663E-06	9.935E-06	4.097E-06	0.000359	1.168E-06
6	0.99963	-1.75139E-06	5.73E-06	2.363E-06	0.000361	6.739E-07
7	0.99964	-1.01012E-06	3.305E-06	1.363E-06	0.000361	3.886E-07
8	0.99964	-5.82589E-07	1.906E-06	7.86E-07	0.000362	2.242E-07
9	0.99964	-3.36009E-07	1.099E-06	4.533E-07	0.000362	1.293E-07
10	0.99964	-1.93793E-07	6.34E-07	2.614E-07	0.000362	7.456E-08
11	0.99964	-1.11771E-07	3.657E-07	1.508E-07	0.000362	4.3E-08
12	0.99964	-6.44638E-08	2.109E-07	8.697E-08	0.000362	2.48E-08
13	0.99964	-3.71795E-08	1.216E-07	5.016E-08	0.000362	1.431E-08
14	0.99964	-2.14433E-08	7.016E-08	2.893E-08	0.000362	8.25E-09
15	0.99964	-1.23675E-08	4.046E-08	1.668E-08	0.000362	4.758E-09
16	0.99964	-7.13294E-09	2.334E-08	9.623E-09	0.000362	2.744E-09
17	0.99964	-4.11393E-09	1.346E-08	5.55E-09	0.000362	1.583E-09
18	0.99964	-2.37271E-09	7.763E-09	3.201E-09	0.000362	9.129E-10
19	0.99964	-1.36846E-09	4.477E-09	1.846E-09	0.000362	5.265E-10
20	0.99964	-7.89262E-10	2.582E-09	1.065E-09	0.000362	3.037E-10
21	0.99964	-4.55207E-10	1.489E-09	6.141E-10	0.000362	1.751E-10
22	0.99964	-2.62541E-10	8.59E-10	3.542E-10	0.000362	1.01E-10

23	0.99964	-1.51421E-10	4.954E-10	2.043E-10	0.000362	5.826E-11
24	0.99964	-8.73321E-11	2.857E-10	1.178E-10	0.000362	3.36E-11
25	0.99964	-5.03688E-11	1.648E-10	6.795E-11	0.000362	1.938E-11
26	0.99964	-2.90503E-11	9.504E-11	3.919E-11	0.000362	1.118E-11
27	0.99964	-1.67547E-11	5.482E-11	2.26E-11	0.000362	6.446E-12
28	0.99964	-9.66332E-12	3.162E-11	1.304E-11	0.000362	3.718E-12
29	0.99964	-5.57335E-12	1.823E-11	7.519E-12	0.000362	2.144E-12
30	0.99964	-3.21444E-12	1.052E-11	4.337E-12	0.000362	1.237E-12
31	0.99964	-1.85393E-12	6.066E-12	2.501E-12	0.000362	7.133E-13
32	0.99964	-1.06925E-12	3.498E-12	1.443E-12	0.000362	4.114E-13
33	0.99964	-6.16688E-13	2.018E-12	8.32E-13	0.000362	2.373E-13
34	0.99964	-3.55662E-13	1.164E-12	4.798E-13	0.000362	1.368E-13
35	0.99964	-2.05112E-13	6.711E-13	2.767E-13	0.000362	7.892E-14
36	0.99964	-1.18315E-13	3.871E-13	1.596E-13	0.000362	4.552E-14
37	0.99964	-6.82278E-14	2.232E-13	9.206E-14	0.000362	2.625E-14
38	0.99964	-3.93348E-14	1.287E-13	5.309E-14	0.000362	1.513E-14
39	0.99964	-2.26965E-14	7.426E-14	3.06E-14	0.000362	8.733E-15
40	0.99964	-1.31048E-14	4.288E-14	1.765E-14	0.000362	5.042E-15
41	0.99964	-7.55952E-15	2.473E-14	1.02E-14	0.000362	2.909E-15
42	0.99964	-4.36302E-15	1.427E-14	5.881E-15	0.000362	1.679E-15
43	0.99964	-2.52652E-15	8.266E-15	3.391E-15	0.000362	9.721E-16
44	0.99964	-1.44892E-15	4.74E-15	1.969E-15	0.000362	5.575E-16

45	0.99964	-8.37378E-16	2.74E-15	1.127E-15	0.000362	3.222E-16
46	0.99964	-4.67436E-16	1.529E-15	6.575E-16	0.000362	1.798E-16
47	0.99964	-2.76724E-16	9.054E-16	3.61E-16	0.000362	1.065E-16
48	0.99964	-1.76314E-16	5.768E-16	2.089E-16	0.000362	6.784E-17
49	0.99964	-8.77178E-17	2.87E-16	1.426E-16	0.000362	3.375E-17
50	0.99964	-4.34612E-17	1.422E-16	7.1E-17	0.000362	1.672E-17
51	0.99964	-3.83579E-17	1.255E-16	2.87E-17	0.000362	1.476E-17
52	0.99964	-3.3851E-17	1.108E-16	2.533E-17	0.000362	1.302E-17
53	0.99964	-2.98744E-17	9.774E-17	2.236E-17	0.000362	1.149E-17
54	0.99964	-2.63617E-17	8.625E-17	1.973E-17	0.000362	1.014E-17
55	0.99964	-2.32633E-17	7.611E-17	1.741E-17	0.000362	8.951E-18
56	0.99964	-2.05293E-17	6.717E-17	1.536E-17	0.000362	7.899E-18
57	0.99964	-1.81102E-17	5.925E-17	1.356E-17	0.000362	6.968E-18
58	0.99964	-1.59728E-17	5.226E-17	1.196E-17	0.000362	6.146E-18
59	0.99964	-1.41005E-17	4.613E-17	1.055E-17	0.000362	5.425E-18
60	0.99964	-1.24435E-17	4.071E-17	9.313E-18	0.000362	4.788E-18
61	0.99964	-1.09854E-17	3.594E-17	8.217E-18	0.000362	4.227E-18
62	0.99964	-9.69303E-18	3.171E-17	7.256E-18	0.000362	3.729E-18
63	0.99964	-8.54975E-18	2.797E-17	6.403E-18	0.000362	3.29E-18
64	0.99964	-7.53902E-18	2.467E-17	5.649E-18	0.000362	2.901E-18
65	0.99964	-6.64428E-18	2.174E-17	4.983E-18	0.000362	2.556E-18
66	0.99964	-5.86553E-18	1.919E-17	4.387E-18	0.000362	2.257E-18

67	0.99964	-5.16962E-18	1.691E-17	3.876E-18	0.000362	1.989E-18
68	0.99964	-4.55655E-18	1.491E-17	3.416E-18	0.000362	1.753E-18
69	0.99964	-4.02634E-18	1.317E-17	3.007E-18	0.000362	1.549E-18
70	0.99964	-3.54583E-18	1.16E-17	2.662E-18	0.000362	1.364E-18
71	0.99964	-3.13159E-18	1.025E-17	2.341E-18	0.000362	1.205E-18
72	0.99964	-2.76707E-18	9.053E-18	2.067E-18	0.000362	1.065E-18
73	0.99964	-2.43568E-18	7.969E-18	1.83E-18	0.000362	9.371E-19
74	0.99964	-2.15401E-18	7.047E-18	1.607E-18	0.000362	8.288E-19
75	0.99964	-1.90547E-18	6.234E-18	1.421E-18	0.000362	7.331E-19
76	0.99964	-1.6735E-18	5.475E-18	1.262E-18	0.000362	6.439E-19
77	0.99964	-1.47467E-18	4.825E-18	1.106E-18	0.000362	5.674E-19
78	0.99964	-1.30897E-18	4.283E-18	9.71E-19	0.000362	5.036E-19
79	0.99964	-1.15985E-18	3.795E-18	8.627E-19	0.000362	4.463E-19
80	0.99964	-1.0273E-18	3.361E-18	7.646E-19	0.000362	3.953E-19
81	0.99964	-9.1131E-19	2.982E-18	6.767E-19	0.000362	3.506E-19
82	0.99964	-8.11895E-19	2.656E-18	5.989E-19	0.000362	3.124E-19
83	0.99964	-7.12479E-19	2.331E-18	5.378E-19	0.000362	2.741E-19
84	0.99964	-6.29633E-19	2.06E-18	4.702E-19	0.000362	2.423E-19
85	0.99964	-5.63356E-19	1.843E-18	4.129E-19	0.000362	2.168E-19
86	0.99964	-4.97078E-19	1.626E-18	3.721E-19	0.000362	1.913E-19
87	0.99964	-4.30801E-19	1.409E-18	3.313E-19	0.000362	1.658E-19
88	0.99964	-3.81093E-19	1.247E-18	2.842E-19	0.000362	1.466E-19

89	0.99964	-3.31386E-19	1.084E-18	2.536E-19	0.000362	1.275E-19
90	0.99964	-2.98247E-19	9.758E-19	2.166E-19	0.000362	1.148E-19