

Supplementary materials for
Future risk evaluation of the global COVID-19 pandemic

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Text S Background of the COVID-19 pandemic

For the spatial diffusions of the COVID-19 pandemic, different countries have significant differences that mainly result from economic restart and increased testing capability (Figure S1). On April 3, 2020, the confirmed cases were mainly distributed over the NH, while the tropical regions of the NH and the SH had a small proportion of confirmed cases. In particular, the United States of America (America), Spain, and Italy had confirmed COVID-19 cases numbering greater than 100,000, i.e., 254,556, 117,710, and 115,242 cases, respectively. The countries with confirmed cases numbering between 80,000 and 100,000 were China (82,875) and Germany (85,122). The countries within Central Asia, Mongolia, and the countries in Africa (except south Africa) had confirmed cases numbering fewer than 1,000 (Figure S1A).

Except for America, Spain, and Italy, the new countries with numbers of confirmed cases greater than 100,000 on April 27, 2020 were Germany (increased from 85,122 to 159,103) and France (increased from 59,929 to 162,220), and the total number of confirmed cases worldwide (2,026,027) was larger than 2 million by the same date (Figure S1B). In fact, America (increased from 254,556 to 987,916), Germany, and France contributed to more than 90% of the increase in confirmed cases. There was no significant increase in South America and Africa at this time.

It only took 12 d for the number of worldwide confirmed cases to increase from 2 million to 4 million by May 9, 2020. The new countries with numbers of confirmed cases larger than 100,000 at this point were Russia (198,676), Turkey (135,569), Iran (106,220), and Brazil (147,003) (Figure S1C). America had the largest number of confirmed cases, i.e., 1,324,352 at this point.

Peru and India were the newest countries with confirmed cases numbering more than 100,000 on May 30, 2020, at which time the total number of confirmed cases worldwide was 6,069,385 (Figure S1D). On June 15 and 28, 2020, the total number of worldwide confirmed cases reached 8,035,398 and 10,138,506, respectively (Figures S1E and S1F, respectively). More than 15 countries had confirmed cases numbering greater than 100,000 at this point, including Brazil, Peru, and South Africa in the Southern Hemisphere (SH) (Figure S1F). America had the largest number of confirmed cases at this point, i.e., 2,597,742, followed by Brazil with 1,319,385 confirmed cases.

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Table Captions

Table S1 85 countries in the five climate regions: tropical climate, arid climate, temperate climate, cold climate and polar climate base on the Koppen-Geiger climate classification criteria.

Table S2 12 estimated parameters and 3 statistical metrics (CC: correlation coefficient, AE: absolute error, DISO: distance between indices of simulation and observation) of the 85 countries. Where N, S represent the northern hemisphere and southern hemisphere; A, B, C, D, E represent the tropical climate, arid climate, temperate climate, cold climate and polar climate.

35 Table S1 85 countries in the five climate regions: tropical climate, arid climate, temperate climate,
36 cold climate and polar climate base on the Koppen-Geiger climate classification criteria.

| Climate regions | Countries | | | | | |
|-------------------|----------------|--------------|------------------------|----------------|-------------|----------------------|
| Tropical climate | Bolivia | Brazil | Cameroon | Colombia | Cuba | Dominican Republic |
| | Ecuador | Ghana | India | Malaysia | Peru | Nigeria |
| | Panama | Philippines | Puerto Rico | Singapore | Thailand | |
| Arid climate | Afghanistan | Algeria | Argentina | Australia | Azerbaijan | Bahrain |
| | Chile | China | Djibouti | Egypt | Iran | Iraq |
| | Israel | Mexico | Kazakhstan | Kuwait | Morocco | Oman |
| | Qatar | Saudi Arabia | South Africa | Spain | Turkey | United Arab Emirates |
| | Uzbekistan | | | | | |
| Temperate climate | Austria | Bangladesh | Belgium | France | Germany | Greece |
| | Guinea | Indonesia | Ireland | Italy | Japan | Luxembourg |
| | Netherlands | New Zealand | Portugal | United Kingdom | Netherlands | New Zealand |
| Cold climate | Armenia | Belarus | Bosnia and Herzegovina | Bulgaria | Canada | Croatia |
| | Czech Republic | Denmark | Estonia | Finland | Hungary | Lithuania |
| | Moldova | Norway | Poland | Romania | Russia | Serbia |
| | Slovakia | Slovenia | South Korea | Sweden | Switzerland | Ukraine |
| Polar climate | Iceland | | | | | |

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Table S2 12 estimated parameters and 3 statistical metrics (CC: correlation coefficient, AE: absolute error, DISO: distance between indices of simulation and observation) of the 85 countries. Where N, S represent the northern hemisphere and southern hemisphere; A, B, C, D, E represent the tropical climate, arid climate, temperate climate, cold climate and polar climate.

| | NA | | | NB | |
|-------------------------|------------|----------|-------------|-------------|----------|
| | Cuba | India | Philippines | Afghanistan | Algeria |
| c0 | 6.473391 | 17.99993 | 17.99987 | 19.18607 | 11.83355 |
| delta0 | 0.023963 | 0.01 | 0.01 | 0.01 | 0.01 |
| alphaC | 0.003706 | 0.003571 | 0.004335 | 0.002948 | 0.014827 |
| gammaI | 0.105591 | 0.177656 | 0.199994 | 0.199996 | 0.199997 |
| gammaC | 0.032575 | 0.024361 | 0.006633 | 0.011508 | 0.045085 |
| cf | 1.74794 | 14.99993 | 14.99983 | 4.803405 | 1.230857 |
| rb | 0.39233 | 0.399998 | 0.39996 | 0.268468 | 0.18541 |
| deltaf | 0.668788 | 0.71 | 0.670747 | 0.110002 | 0.110001 |
| rd | 0.081773 | 0.062332 | 0.09073 | 0.05 | 0.05 |
| p | 0.069742 | 0.036635 | 0.03927 | 0.066569 | 0.151795 |
| R0 | 3.484791 | 3.514036 | 3.366098 | 6.081999 | 8.553778 |
| Rf | 0.318895 | 0.889606 | 0.710822 | 1.209116 | 0.714235 |
| relative bias | 0.122338 | 0.119231 | 0.692627 | 0.10073 | -0.15757 |
| Correlation coefficient | 0.999822 | 0.99982 | 0.998544 | 0.998266 | 0.998802 |
| DISO | 0.999997 | 1.000434 | 1.001528 | 1.001473 | 1.000313 |
| | NB | | | | |
| | Azerbaijan | Bahrain | China | Djibouti | Egypt |
| c0 | 8.006466 | 17.99999 | 5.268128 | 9.368391 | 12.4351 |
| delta0 | 0.010031 | 0.033129 | 0.01 | 0.01 | 0.021189 |
| alphaC | 0.001441 | 0.000373 | 0.002398 | 0.000261 | 0.006995 |
| gammaI | 0.188126 | 0.2 | 0.071429 | 0.071429 | 0.19998 |
| gammaC | 0.065094 | 0.049522 | 0.046451 | 0.049952 | 0.024218 |
| cf | 4.980231 | 14.99999 | 1.74408 | 0.100001 | 9.434349 |
| rb | 0.396904 | 0.399999 | 0.05 | 0.093453 | 0.399866 |
| deltaf | 0.546805 | 0.133129 | 0.71 | 0.71 | 0.121205 |
| rd | 0.200461 | 0.05 | 0.067832 | 0.249745 | 0.075996 |
| p | 0.096008 | 0.022816 | 0.139062 | 0.040303 | 0.038897 |
| R0 | 3.879173 | 1.761656 | 8.996824 | 4.636904 | 2.186956 |
| Rf | 0.651998 | 1.104982 | 0.312708 | 0.035328 | 1.172342 |
| relative bias | -0.27053 | -0.11486 | 2.678121 | -0.0136 | 1.361281 |
| Correlation coefficient | 0.999377 | 0.99596 | 0.993808 | 0.997008 | 0.999815 |
| DISO | 1.000388 | 1.000551 | 0.998805 | 1.001186 | 1.000124 |

| | NB | | | | |
|---------------------------|--------------|----------|----------|-------------------------|---------------|
| | Iran | Iraq | Israel | Kazakhstan | Kuwait |
| c0 | 11.48556 | 10.25557 | 9.496015 | 18.72308 | 14.99292 |
| delta0 | 0.167351 | 0.010042 | 0.011043 | 0.199857 | 0.060944 |
| alphaC | 0.006966 | 0.005787 | 0.000891 | 0.000909 | 0.000633 |
| gammaI | 0.071432 | 0.148548 | 0.072022 | 0.19259 | 0.199982 |
| gammaC | 0.074694 | 0.069057 | 0.025218 | 0.024088 | 0.034893 |
| cf | 8.437349 | 7.245433 | 6.441313 | 13.63191 | 11.99284 |
| rb | 0.399979 | 0.398494 | 0.125846 | 0.399953 | 0.399958 |
| deltaf | 0.867345 | 0.18063 | 0.429571 | 0.305528 | 0.160945 |
| rd | 0.05714 | 0.159471 | 0.215372 | 0.050011 | 0.07029 |
| p | 0.05573 | 0.032269 | 0.053925 | 0.04376 | 0.042885 |
| R0 | 2.680642 | 2.086739 | 6.164758 | 2.08774 | 2.464216 |
| Rf | 0.574508 | 0.711464 | 0.693061 | 1.262733 | 1.449582 |
| relative bias | 0.197539 | -0.11186 | -0.17356 | 0.060506 | -0.24035 |
| Correlation coefficent | 0.999093 | 0.998241 | 0.999837 | 0.999291 | 0.998857 |
| DISO | 0.999977 | 1.000209 | 1.000029 | 1.00006 | 1.001363 |
| | NB | | | | |
| | Mexico | Morocco | Oman | Pakistan | Qatar |
| c0 | 9.952451 | 5.36876 | 14.56819 | 4.971046 | 16.45529 |
| delta0 | 0.101969 | 0.01 | 0.010008 | 0.01 | 0.012526 |
| alphaC | 0.017626 | 0.003791 | 0.000467 | 0.002016 | 0.000105 |
| gammaI | 0.177966 | 0.071429 | 0.072039 | 0.199999 | 0.07151 |
| gammaC | 0.092334 | 0.013672 | 0.017411 | 0.02176 | 0.009826 |
| cf | 4.864495 | 1.591385 | 11.5562 | 1.573758 | 13.45325 |
| rb | 0.050027 | 0.4 | 0.396649 | 0.399993 | 0.399343 |
| deltaf | 0.210527 | 0.71 | 0.709219 | 0.110001 | 0.710101 |
| rd | 0.398634 | 0.083547 | 0.078516 | 0.05 | 0.050006 |
| p | 0.106124 | 0.069903 | 0.018064 | 0.185912 | 0.014681 |
| R0 | 3.773003 | 4.608804 | 3.207461 | 4.400865 | 2.874792 |
| Rf | 1.448607 | 0.325895 | 0.524922 | 1.117705 | 1.045745 |
| relative bias | -0.03705 | 0.472568 | -0.09072 | 0.461512 | 0.239072 |
| Correlation coefficent | 0.999702 | 0.999244 | 0.999438 | 0.999115 | 0.999178 |
| DISO | 1.000374 | 1.000225 | 1.000483 | 1.000489 | 1.000853 |
| | NB | | | | |
| | Saudi Arabia | Spain | Turkey | United Arab Emirates | United States |
| c0 | 14.47283 | 9.463395 | 11.3827 | 17.99957 | 9.709275 |
| delta0 | 0.016991 | 0.01 | 0.199988 | 0.01 | 0.01 |
| alphaC | 0.000881 | 0.008833 | 0.002233 | 0.000698 | 0.003983 |
| gammaI | 0.192148 | 0.071429 | 0.103888 | 0.19875 | 0.080743 |
| gammaC | 0.014987 | 0.036849 | 0.021394 | 0.018224 | 0.00822 |

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|----------------------------|------------|----------|-----------------------|----------|----------|
| cf | 11.45962 | 6.005123 | 0.100141 | 14.99954 | 6.70927 |
| rb | 0.399847 | 0.072505 | 0.055116 | 0.399981 | 0.05 |
| deltaf | 0.716722 | 0.71 | 0.299996 | 0.709996 | 0.704733 |
| rd | 0.059099 | 0.14808 | 0.399976 | 0.062419 | 0.073671 |
| p | 0.031719 | 0.099154 | 0.094762 | 0.036069 | 0.074129 |
| R0 | 2.194983 | 11.52337 | 3.549625 | 3.110051 | 7.931598 |
| Rf | 0.964744 | 0.765848 | 0.367956 | 0.831996 | 0.71783 |
| relative bias | 0.322516 | 0.191984 | 2.091825 | -0.05728 | 1.155269 |
| Correlation coefficient | 0.999093 | 0.999589 | 0.999823 | 0.99909 | 0.999556 |
| DISO | 1.000792 | 1.000182 | 1.000008 | 1.001999 | 1.000787 |
| | | | | | |
| | NB | | NC | | |
| | Uzbekistan | Austria | Bangladesh | Belgium | Brazil |
| c0 | 8.184808 | 7.340245 | 18.00005 | 10.06183 | 8.761158 |
| delta0 | 0.043367 | 0.028074 | 0.01 | 0.01 | 0.010046 |
| alphaC | 0.000401 | 0.002567 | 0.003281 | 0.011714 | 0.01082 |
| gammaI | 0.153218 | 0.072188 | 0.199957 | 0.19918 | 0.137728 |
| gammaC | 0.035533 | 0.053602 | 0.002955 | 0.018327 | 0.072269 |
| cf | 5.18463 | 3.723683 | 14.99997 | 7.061719 | 4.789163 |
| rb | 0.061691 | 0.396964 | 0.099771 | 0.050001 | 0.311581 |
| deltaf | 0.743336 | 0.663903 | 0.533082 | 0.677825 | 0.262098 |
| rd | 0.179193 | 0.219949 | 0.185108 | 0.121085 | 0.301128 |
| p | 0.050319 | 0.082193 | 0.052614 | 0.093473 | 0.126294 |
| R0 | 2.095041 | 6.017343 | 4.510695 | 4.496172 | 7.487622 |
| Rf | 0.324213 | 0.415882 | 1.105406 | 0.769077 | 1.512767 |
| relative bias | -0.0399 | 0.113345 | -0.34945 | 0.611867 | -0.2205 |
| Correlation coefficient | 0.998905 | 0.999824 | 0.999791 | 0.999844 | 0.999518 |
| DISO | 1.000014 | 0.999969 | 1.000353 | 1.000111 | 1.000522 |
| | | | | | |
| | NC | | | | |
| | Cameroon | Colombia | Dominican Republic | Ecuador | France |
| c0 | 9.492254 | 9.942427 | 10.69862 | 17.99999 | 12.79555 |
| delta0 | 0.01 | 0.092983 | 0.011912 | 0.2 | 0.01 |
| alphaC | 0.003343 | 0.003883 | 0.003811 | 0.003461 | 0.009272 |
| gammaI | 0.199996 | 0.130853 | 0.113308 | 0.2 | 0.071429 |
| gammaC | 0.04133 | 0.016915 | 0.01037 | 0.006984 | 0.018066 |
| cf | 0.9562 | 5.575623 | 1.477094 | 14.99999 | 4.673993 |
| rb | 0.399995 | 0.382788 | 0.393681 | 0.399999 | 0.05 |
| deltaf | 0.110023 | 0.197742 | 0.700477 | 0.3 | 0.71 |
| rd | 0.05 | 0.308576 | 0.071754 | 0.05 | 0.072445 |
| p | 0.199986 | 0.072646 | 0.094498 | 0.04898 | 0.06096 |
| R0 | 9.039745 | 3.226837 | 8.073767 | 2.204122 | 9.57908 |
| Rf | 0.766594 | 1.232673 | 0.414111 | 1.510668 | 0.436846 |

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|----------------------------|----------|----------|----------|----------|----------|
| relative bias | -0.12169 | 0.250526 | 0.57464 | 1.478985 | 0.780343 |
| Correlation coefficient | 0.991382 | 0.999287 | 0.999611 | 0.979518 | 0.996487 |
| DISO | 1.001216 | 1.00005 | 1.000108 | 1.016614 | 1.003933 |

| | NC | | | | |
|----------------------------|----------|----------|----------|----------|-----------|
| | Germany | Ghana | Greece | Guinea | Indonesia |
| c0 | 18.81672 | 17.99728 | 7.138195 | 8.770922 | 6.777624 |
| delta0 | 0.01 | 0.015226 | 0.022894 | 0.010071 | 0.042376 |
| alphaC | 0.003444 | 0.000841 | 0.002706 | 0.000745 | 0.006817 |
| gammaI | 0.071429 | 0.071615 | 0.080468 | 0.198052 | 0.071481 |
| gammaC | 0.072925 | 0.009586 | 0.010581 | 0.026067 | 0.010164 |
| cf | 6.750704 | 14.99473 | 3.41983 | 1.540469 | 3.753583 |
| rb | 0.05 | 0.050044 | 0.386614 | 0.398491 | 0.053214 |
| deltaf | 0.71 | 0.11537 | 0.174496 | 0.607388 | 0.356422 |
| rd | 0.088863 | 0.050079 | 0.142307 | 0.05013 | 0.05001 |
| p | 0.044817 | 0.010122 | 0.035573 | 0.182876 | 0.044078 |
| R0 | 10.35633 | 2.097721 | 2.456706 | 7.706946 | 2.623829 |
| Rf | 0.425942 | 1.251073 | 0.478668 | 1.117939 | 0.641197 |
| relative bias | 0.205364 | 0.198528 | 0.206366 | 0.005824 | 0.751881 |
| Correlation coefficient | 0.999738 | 0.996198 | 0.999207 | 0.998703 | 0.999776 |
| DISO | 1.000168 | 1.000903 | 0.999736 | 1.000927 | 1.000049 |

| | NC | | | | |
|----------------------------|----------|----------|----------|------------|----------|
| | Ireland | Italy | Japan | Luxembourg | Malaysia |
| c0 | 6.128225 | 8.036487 | 18.00078 | 11.20151 | 12.5507 |
| delta0 | 0.017721 | 0.01 | 0.01 | 0.055575 | 0.01 |
| alphaC | 0.00534 | 0.008387 | 0.002033 | 0.001339 | 0.001384 |
| gammaI | 0.071554 | 0.074965 | 0.071431 | 0.173354 | 0.094522 |
| gammaC | 0.040518 | 0.017404 | 0.013883 | 0.025799 | 0.047609 |
| cf | 3.109068 | 4.436377 | 14.99857 | 0.835687 | 9.550633 |
| rb | 0.050172 | 0.399963 | 0.398578 | 0.399993 | 0.050002 |
| deltaf | 0.717106 | 0.453987 | 0.709996 | 0.155582 | 0.709997 |
| rd | 0.084532 | 0.163169 | 0.057109 | 0.097667 | 0.086095 |
| p | 0.043469 | 0.0956 | 0.022466 | 0.148512 | 0.038812 |
| R0 | 2.983888 | 9.042397 | 4.96613 | 7.266669 | 4.66044 |
| Rf | 0.305475 | 0.802095 | 0.624021 | 0.380534 | 0.489854 |
| relative bias | 0.721503 | 0.467122 | -0.38225 | 0.24839 | -0.10463 |
| Correlation coefficient | 0.999149 | 0.999944 | 0.998472 | 0.99965 | 0.99963 |
| DISO | 1.000315 | 1.000007 | 1.002438 | 0.999872 | 1.000169 |

| | NC | | | | |
|-------------------------|------------------------|----------|----------------|----------|----------------|
| | Netherlands | Nigeria | Panama | Portugal | Puerto Rico |
| c0 | 16.18329 | 16.86809 | 7.456741 | 6.046566 | 18.71613 |
| delta0 | 0.078154 | 0.010001 | 0.155537 | 0.126875 | 0.174435 |
| alphaC | 0.006923 | 0.003747 | 0.001946 | 0.002144 | 0.003704 |
| gammaI | 0.199996 | 0.199944 | 0.197588 | 0.088246 | 0.199994 |
| gammaC | 0.001 | 0.024218 | 0.003841 | 0.002673 | 0.001 |
| cf | 4.656963 | 13.86596 | 3.325681 | 3.038055 | 3.814382 |
| rb | 0.330706 | 0.399541 | 0.294889 | 0.074671 | 0.399988 |
| deltaf | 0.778153 | 0.110047 | 0.25605 | 0.528075 | 0.874398 |
| rd | 0.05 | 0.050001 | 0.050653 | 0.242884 | 0.058711 |
| p | 0.072154 | 0.027737 | 0.119637 | 0.143682 | 0.086611 |
| R0 | 4.198049 | 2.228556 | 2.526297 | 4.038582 | 4.329348 |
| Rf | 0.525921 | 1.484907 | 0.921922 | 0.73089 | 0.431355 |
| relative bias | 0.016501 | 0.789146 | 0.092852 | 0.290766 | 0.163482 |
| Correlation coefficient | 0.999856 | 0.996418 | 0.999579 | 0.999848 | 0.998105 |
| DISO | 0.999981 | 1.004192 | 0.999928 | 0.99998 | 0.999686 |
| | NC | | | ND | |
| | Singapore | Thailand | United Kingdom | Armenia | Belarus |
| c0 | 18 | 18 | 7.174881 | 9.349559 | 17.99991 |
| delta0 | 0.01 | 0.01 | 0.01 | 0.192244 | 0.01 |
| alphaC | 0.000107 | 0.001535 | 0.01029 | 0.001331 | 0.000852 |
| gammaI | 0.2 | 0.071429 | 0.071429 | 0.085355 | 0.199858 |
| gammaC | 0.008325 | 0.065163 | 0.001 | 0.034402 | 0.018949 |
| cf | 15 | 15 | 4.174201 | 5.159436 | 14.99986 |
| rb | 0.4 | 0.4 | 0.064296 | 0.398786 | 0.399936 |
| deltaf | 0.229108 | 0.71 | 0.556076 | 0.507335 | 0.382843 |
| rd | 0.05 | 0.070412 | 0.097263 | 0.399464 | 0.170297 |
| p | 0.034208 | 0.021002 | 0.104852 | 0.126457 | 0.051902 |
| R0 | 2.932092 | 4.64246 | 9.238751 | 4.259079 | 4.451748 |
| Rf | 1.385719 | 0.458404 | 0.736565 | 1.100821 | 1.343821 |
| relative bias | -0.42694 | -0.0288 | -0.1548 | 0.603834 | -0.2567 |
| Correlation coefficient | 0.993065 | 0.994608 | 0.999762 | 0.997592 | 0.999299 |
| DISO | 1.019029 | 1.003338 | 1.000251 | 0.999863 | 1.001087 |
| | ND | | | | |
| | Bosnia and Herzegovina | Bulgaria | Canada | Croatia | Czech Republic |
| c0 | 6.478302 | 17.99998 | 18 | 4.240905 | 10.50122 |
| delta0 | 0.028147 | 0.019695 | 0.01 | 0.010016 | 0.179312 |
| alphaC | 0.003179 | 0.003044 | 0.004967 | 0.001845 | 0.00166 |
| gammaI | 0.192389 | 0.130459 | 0.2 | 0.071807 | 0.098007 |

| | | | | | |
|---------------------------|----------|----------|----------|----------|-----------|
| gammaC | 0.027956 | 0.010958 | 0.035085 | 0.032247 | 0.015252 |
| cf | 3.179862 | 14.99993 | 15 | 0.141038 | 2.039459 |
| rb | 0.389094 | 0.050002 | 0.4 | 0.050038 | 0.15286 |
| deltaf | 0.132607 | 0.119698 | 0.577441 | 0.178246 | 0.28241 |
| rd | 0.296674 | 0.05 | 0.084935 | 0.370415 | 0.088892 |
| p | 0.092303 | 0.010188 | 0.043834 | 0.136164 | 0.095031 |
| R0 | 2.711418 | 1.221362 | 3.757167 | 7.057327 | 3.598522 |
| Rf | 0.903123 | 0.779341 | 0.888414 | 0.242291 | 0.514987 |
| relative bias | 0.019559 | 0.188882 | 0.221225 | -0.19582 | 0.108214 |
| Correlation coefficent | 0.999382 | 0.995255 | 0.999497 | 0.999697 | 0.99977 |
| DISO | 0.999925 | 0.9985 | 1.000785 | 1.000006 | 0.999929 |
| ND | | | | | |
| | Denmark | Estonia | Finland | Hungary | Lithuania |
| c0 | 6.107866 | 6.143929 | 14.34974 | 4.649406 | 6.149698 |
| delta0 | 0.04799 | 0.052792 | 0.010004 | 0.019767 | 0.017288 |
| alphaC | 0.004489 | 0.001348 | 0.002745 | 0.008434 | 0.001774 |
| gammaI | 0.072804 | 0.186411 | 0.198675 | 0.071833 | 0.17696 |
| gammaC | 0.054363 | 0.005906 | 0.03648 | 0.013828 | 0.016418 |
| cf | 3.098829 | 2.614569 | 10.83475 | 0.635325 | 1.517232 |
| rb | 0.052364 | 0.392527 | 0.063218 | 0.077137 | 0.050052 |
| deltaf | 0.213865 | 0.440529 | 0.426119 | 0.120369 | 0.344554 |
| rd | 0.084165 | 0.101748 | 0.099829 | 0.05005 | 0.399874 |
| p | 0.04477 | 0.108735 | 0.047487 | 0.067179 | 0.135536 |
| R0 | 2.263758 | 2.792857 | 3.265411 | 3.409875 | 4.290936 |
| Rf | 0.537845 | 0.467721 | 0.837468 | 0.355754 | 0.497941 |
| relative bias | 1.066476 | 0.850237 | 0.552484 | 0.103281 | 0.103745 |
| Correlation coefficent | 0.998746 | 0.998811 | 0.999651 | 0.999339 | 0.998679 |
| DISO | 0.999835 | 0.99964 | 1.000235 | 1.000002 | 0.999841 |
| ND | | | | | |
| | Moldova | Norway | Poland | Romania | Russia |
| c0 | 12.05996 | 7.368357 | 9.682529 | 11.13287 | 10.54204 |
| delta0 | 0.012808 | 0.178133 | 0.089174 | 0.010007 | 0.01 |
| alphaC | 0.00257 | 0.000977 | 0.003332 | 0.004484 | 0.001099 |
| gammaI | 0.073539 | 0.071429 | 0.071798 | 0.199817 | 0.190059 |
| gammaC | 0.02089 | 0.001 | 0.013673 | 0.021416 | 0.010975 |
| cf | 9.013071 | 1.864943 | 6.614747 | 0.955953 | 7.542038 |
| rb | 0.310429 | 0.145819 | 0.153558 | 0.182804 | 0.05 |
| deltaf | 0.117477 | 0.278133 | 0.326283 | 0.110057 | 0.709999 |
| rd | 0.275821 | 0.088392 | 0.144269 | 0.050004 | 0.061107 |
| p | 0.022077 | 0.090918 | 0.054082 | 0.173001 | 0.075265 |
| R0 | 3.083456 | 2.684387 | 3.25308 | 9.179138 | 3.966088 |
| Rf | 1.041785 | 0.488644 | 0.902577 | 0.636146 | 1.023346 |

| | | | | | |
|----------------------------|-------------|-----------|----------|--------------|-------------|
| relative bias | 0.149725 | 0.185195 | 0.271386 | -0.18828 | 0.396332 |
| Correlation coefficient | 0.999242 | 0.999406 | 0.999903 | 0.999734 | 0.999544 |
| DISO | 1.000153 | 0.99973 | 1.000002 | 1.000069 | 1.001501 |
| ND | | | | | |
| | Serbia | Slovakia | Slovenia | South Korea | Sweden |
| c0 | 4.086788 | 10.14991 | 6.900642 | 5.793026 | 10.64219 |
| delta0 | 0.052178 | 0.015447 | 0.08138 | 0.01 | 0.010024 |
| alphaC | 0.001632 | 0.000833 | 0.002568 | 0.000964 | 0.007685 |
| gammaI | 0.084019 | 0.071429 | 0.105732 | 0.071429 | 0.103098 |
| gammaC | 0.011131 | 0.017933 | 0.00684 | 0.031809 | 0.002888 |
| cf | 1.032082 | 7.149813 | 2.591537 | 2.739499 | 6.229471 |
| rb | 0.060297 | 0.050001 | 0.332845 | 0.086901 | 0.313593 |
| deltaf | 0.490176 | 0.715444 | 0.182539 | 0.709999 | 0.214989 |
| rd | 0.065146 | 0.085174 | 0.081802 | 0.1987 | 0.097353 |
| p | 0.121694 | 0.01 | 0.044453 | 0.14743 | 0.049685 |
| R0 | 3.65161 | 1.168347 | 1.639397 | 10.48842 | 4.67417 |
| Rf | 0.386431 | 0.19421 | 0.408836 | 0.517182 | 0.986335 |
| relative bias | 0.246419 | 0.224956 | 0.088009 | 0.147601 | 2.210679 |
| Correlation coefficient | 0.999301 | 0.997907 | 0.999488 | 0.99728 | 0.999683 |
| DISO | 1.000138 | 0.999494 | 0.999703 | 0.999014 | 1.000216 |
| ND NE SA | | | | | |
| | Switzerland | Ukraine | Iceland | Bolivia | Peru |
| c0 | 10.31769 | 10.22659 | 7.459023 | 10.01187 | 12.59996 |
| delta0 | 0.081772 | 0.010206 | 0.032352 | 0.01 | 0.01 |
| alphaC | 0.004267 | 0.002476 | 0.000402 | 0.00528 | 0.003876 |
| gammaI | 0.145388 | 0.073033 | 0.071598 | 0.199984 | 0.199998 |
| gammaC | 0.052118 | 0.009228 | 0.056206 | 0.007565 | 0.045943 |
| cf | 1.874143 | 2.441369 | 0.368887 | 6.090962 | 2.201096 |
| rb | 0.050066 | 0.380431 | 0.229365 | 0.399978 | 0.218712 |
| deltaf | 0.44988 | 0.218734 | 0.728983 | 0.709337 | 0.110001 |
| rd | 0.255594 | 0.099513 | 0.083182 | 0.050001 | 0.05 |
| p | 0.086883 | 0.075355 | 0.054769 | 0.042801 | 0.136258 |
| R0 | 3.946274 | 9.258054 | 3.929978 | 2.040719 | 8.175553 |
| Rf | 0.364765 | 0.734191 | 0.034062 | 1.006105 | 1.202916 |
| relative bias | 0.01713 | 0.499648 | -0.02387 | 0.129968 | -0.20721 |
| Correlation coefficient | 0.999809 | 0.999879 | 0.999092 | 0.999038 | 0.998669 |
| DISO | 0.999969 | 1.00009 | 0.999683 | 1.000201 | 1.001295 |
| SB SC | | | | | |
| | Argentina | Australia | Chile | South Africa | New Zealand |
| c0 | 10.11513 | 6.483388 | 17.05675 | 16.59293 | 7.523986 |
| delta0 | 0.199939 | 0.01 | 0.010001 | 0.2 | 0.010097 |

| | | | | | |
|---------------------------|----------|----------|----------|----------|----------|
| alphaC | 0.003851 | 0.000828 | 0.001486 | 0.0015 | 0.000765 |
| gammaI | 0.071534 | 0.071429 | 0.199987 | 0.2 | 0.17202 |
| gammaC | 0.021153 | 0.048676 | 0.051542 | 0.027286 | 0.055639 |
| cf | 7.111305 | 3.464129 | 2.168132 | 13.4288 | 0.101654 |
| rb | 0.399958 | 0.05 | 0.39998 | 0.399999 | 0.117325 |
| deltaf | 0.540229 | 0.71 | 0.11002 | 0.3 | 0.251505 |
| rd | 0.39999 | 0.084629 | 0.050001 | 0.05 | 0.217022 |
| p | 0.093931 | 0.080612 | 0.091104 | 0.041954 | 0.153375 |
| R0 | 3.49989 | 6.418324 | 7.400119 | 1.740335 | 6.336556 |
| Rf | 1.09188 | 0.386945 | 0.783284 | 1.165253 | 0.045393 |
| relative bias | 0.045542 | 0.196499 | -0.16595 | 1.048383 | -0.06725 |
| Correlation coefficent | 0.999734 | 0.993513 | 0.999147 | 0.994234 | 0.999802 |
| DISO | 0.999986 | 1.003262 | 1.000228 | 0.999523 | 0.999976 |

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Figure Captions

Figure S1: Spatial distributions of the cumulative confirmed COVID-19 cases over the world, for the numbers of 1 million cases (A), 2 millions cases (B), 4 millions cases (C), 6 millions cases (D), 8 millions cases (E), and 10 millions cases (F).

Figure S2: Simulation results of the cumulative confirmed cases, cumulative recovered cases, and cumulative deaths of Bolivia, Brazil, Cameroon, Colombia, Cuba, Dominican Republic, Ecuador, Ghana, India, Malaysia, Nigeria, Panama, Peru, Philippines, Puerto Rico, Singapore and Thailand in tropical region.

Figure S3: Simulation results of the cumulative confirmed cases, cumulative recovered cases, and cumulative deaths of Afghanistan, Algeria, Argentina, Australia, Azerbaijan, Bahrain, Chile, China, Djibouti, Egypt, Iran, Iraq, Israel, Kazakhstan, Kuwait, Mexico, Morocco, Oman, Pakistan, Qatar, Saudi Arabia, South Africa, Spain, Turkey, United Arab Emirates, United States and Uzbekistan in arid region.

Figure S4: Simulation results of the cumulative confirmed cases, cumulative recovered cases, and cumulative deaths of Austria, Bangladesh, Belgium, France, Germany, Greece, Guinea, Indonesia, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Portugal and United Kingdom in temperate region.

Figure S5: Simulation results of the cumulative confirmed cases, cumulative recovered cases, and cumulative deaths of Armenia, Belarus, Bosnia and Herzegovina, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, Hungary, Lithuania, Moldova, Norway, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, South Korea, Sweden, Switzerland and Ukraine in cold region.

Figure S6: Simulation results of the cumulative confirmed cases, cumulative recovered cases, and cumulative deaths of Iceland in polar region.

Figure S7: Distribution of the contact rates c_0 at early transmission period of the 85 countries.

Figure S8: Same as Figure S6, but for the minimum contact rates c_f .

Figure S9: Sensitivity analysis of the daily new confirmed cases of Cameroon, Cuba, Dominican Republic, Ecuador, Ghana, Malaysia, Nigeria, Panama, Puerto Rico, and Thailand in tropical region.

Figure S10: Sensitivity analysis of the daily new confirmed cases of Afghanistan, Algeria, Argentina, Australia, Azerbaijan, Bahrain, Djibouti, Iraq, Israel, Kazakhstan, Kuwait, Morocco, Oman, Qatar, United Arab Emirates and Uzbekistan in arid region.

Figure S11: Sensitivity analysis of the daily new confirmed cases of Austria, Belgium, Greece, Guinea, Indonesia, Ireland, Luxembourg, Netherlands, and Portugal in temperate region.

Figure S12: Sensitivity analysis of the daily new confirmed cases of Armenia, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, Hungary, Lithuania, Moldova, Norway, Poland, Romania, Serbia, Slovakia, Slovenia, Switzerland, and Ukraine in cold region.

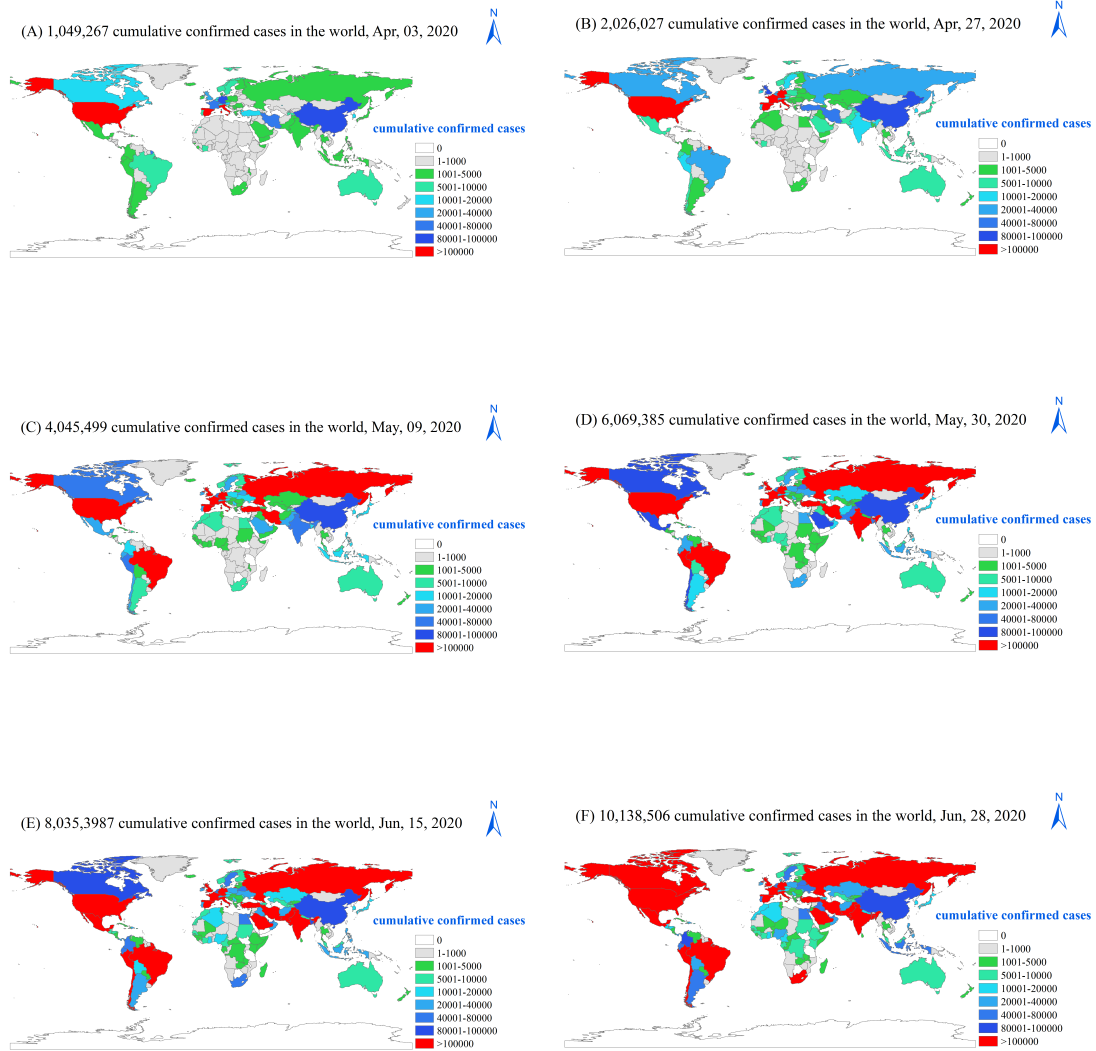
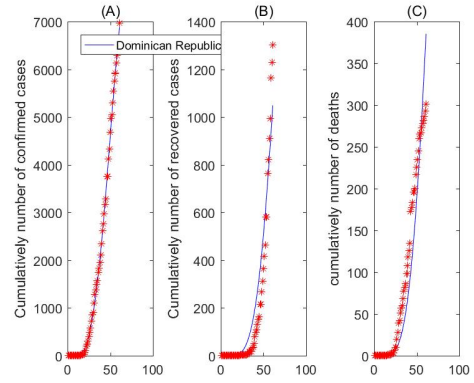
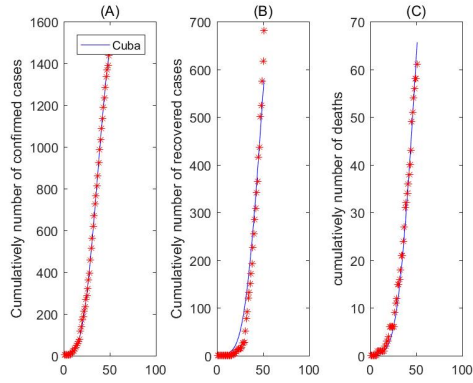
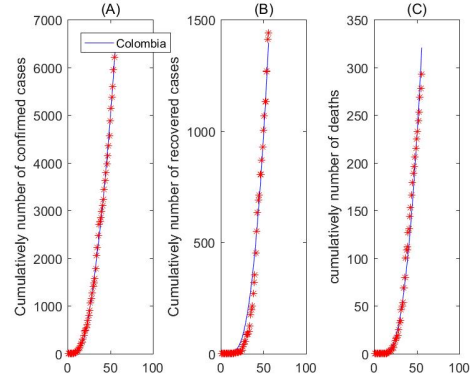
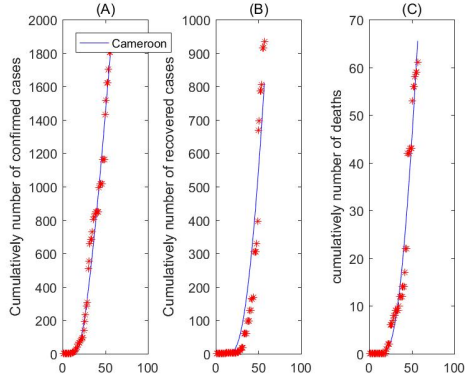
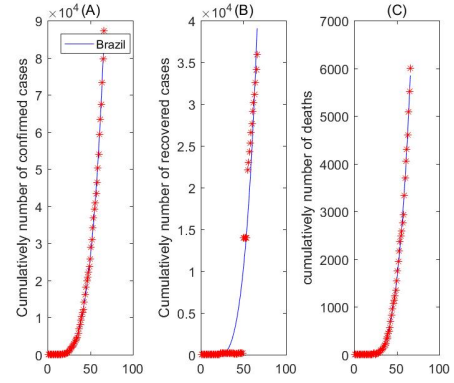
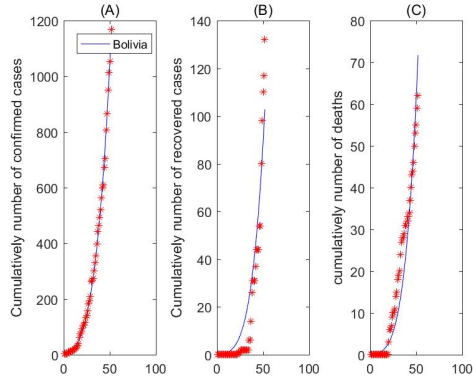
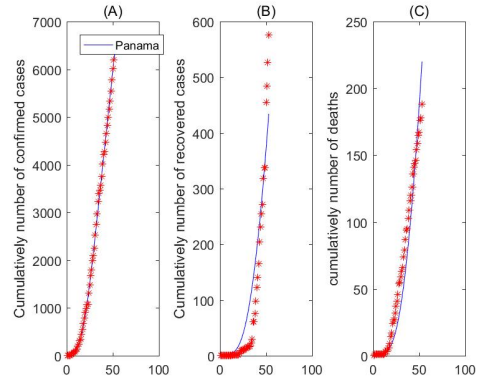
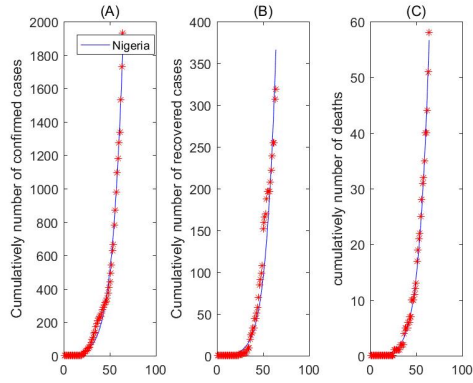
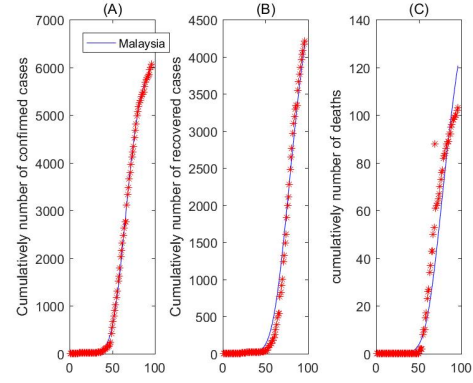
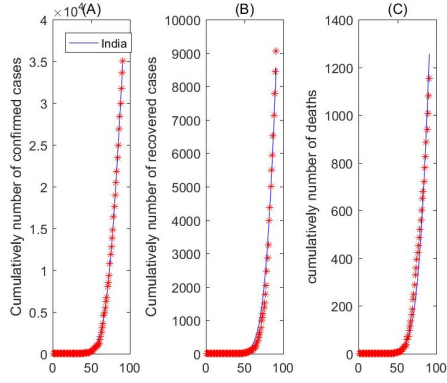
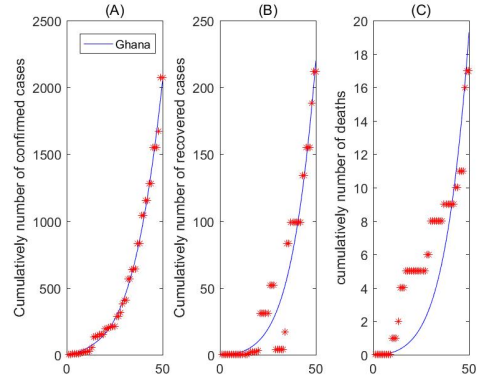
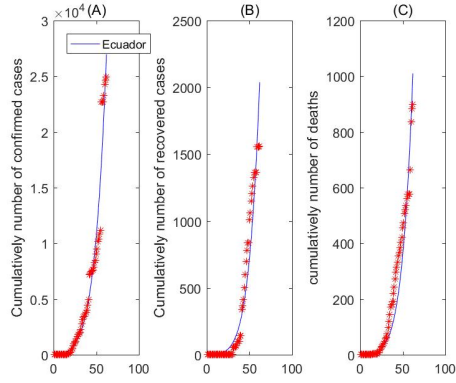


Figure S1: Spatial distributions of the cumulative confirmed COVID-19 cases over the world, for the numbers of 1 million cases (A), 2 millions cases (B), 4 millions cases (C), 6 millions cases (D), 8 millions cases (E), and 10 millions cases (F).





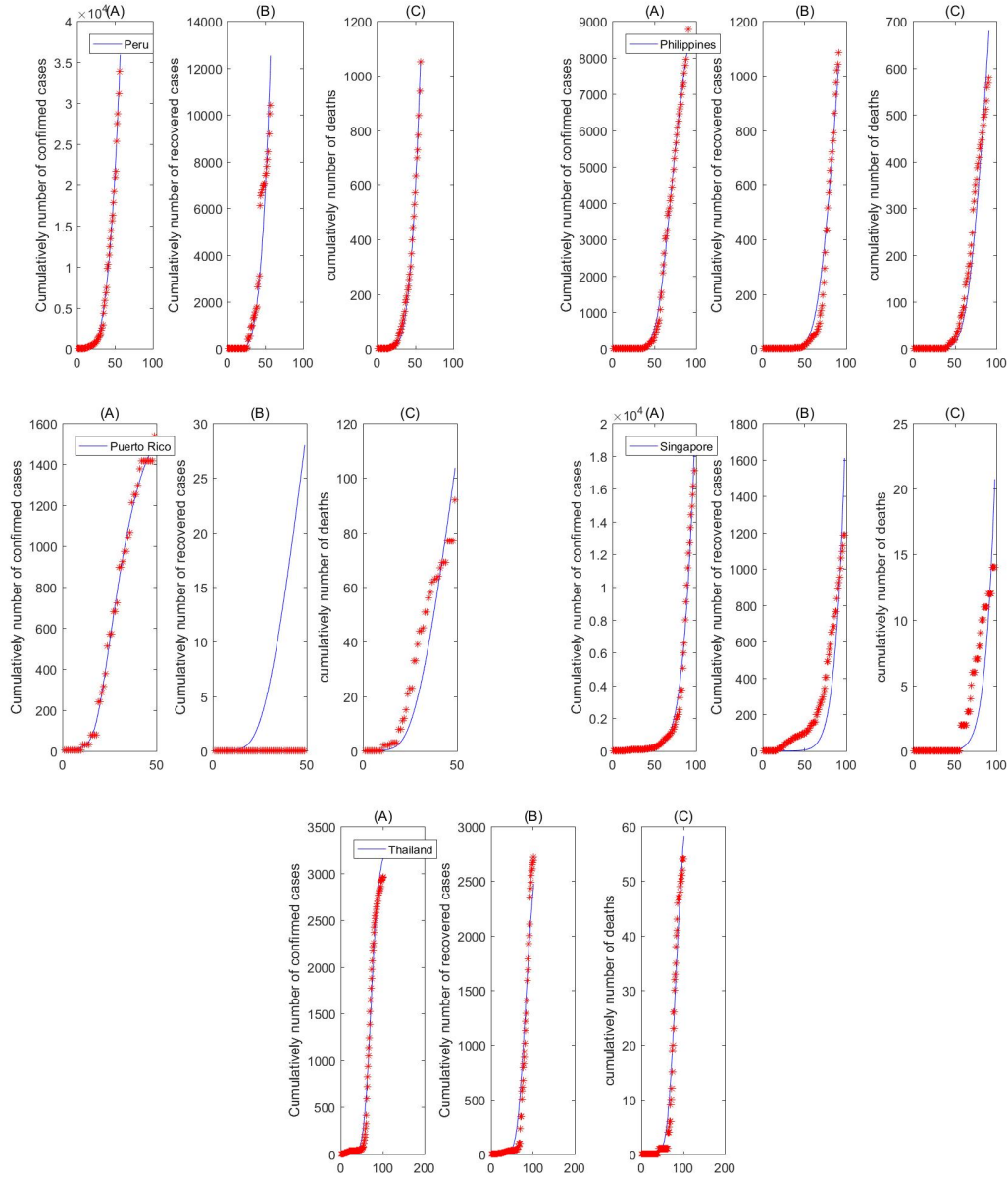
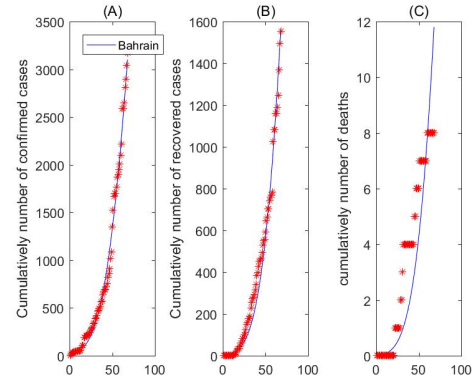
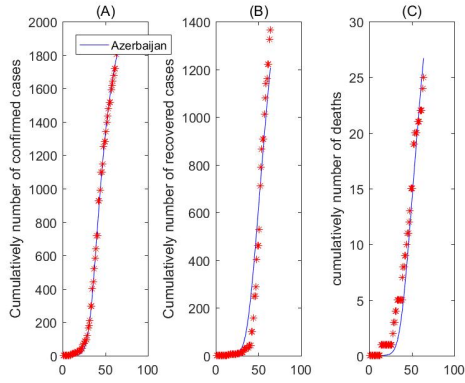
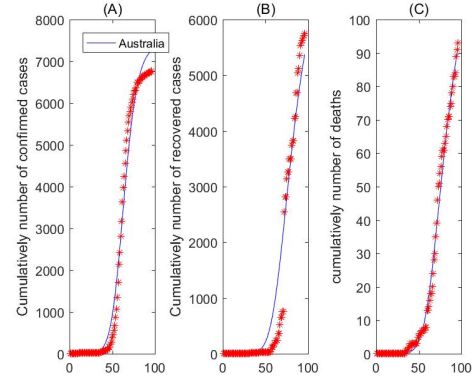
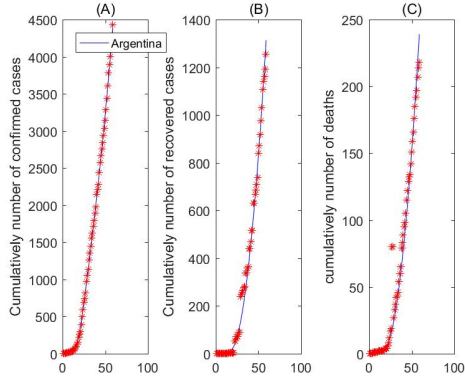
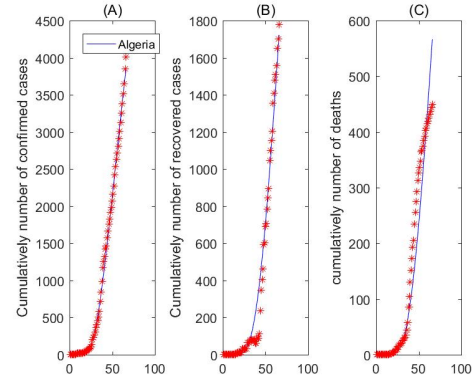
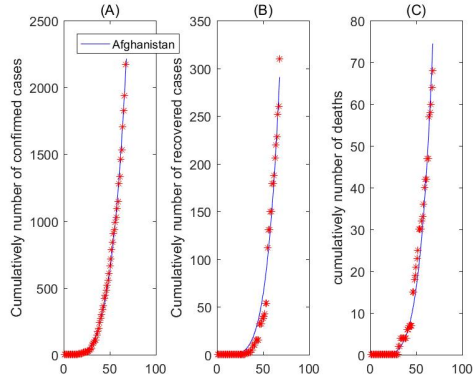
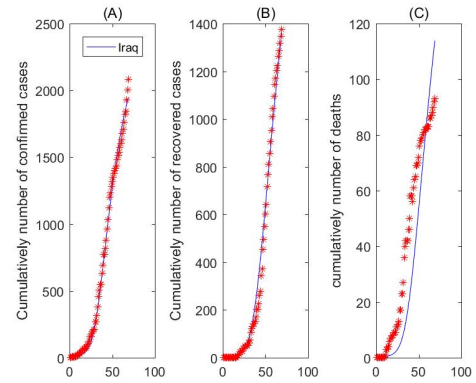
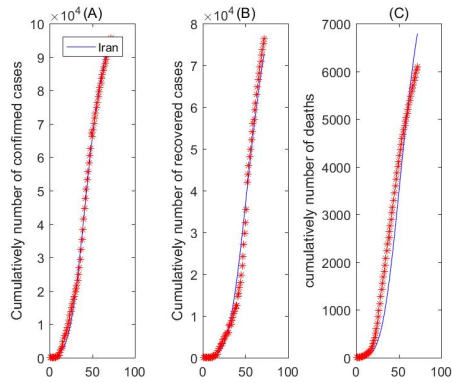
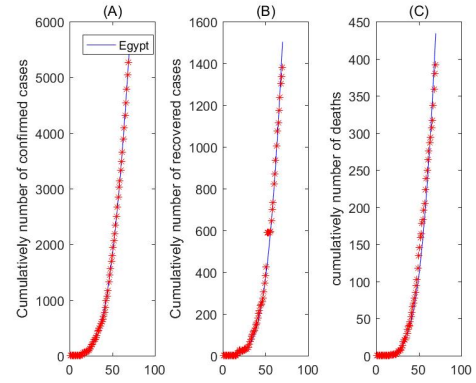
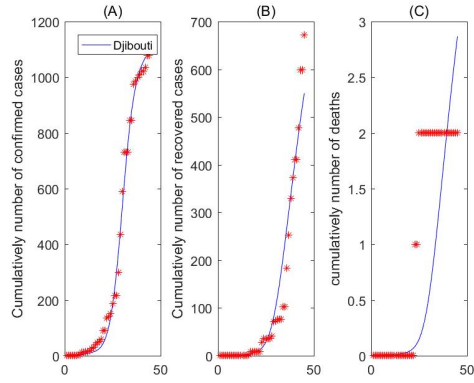
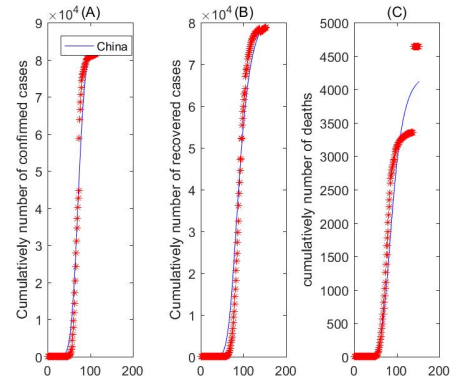
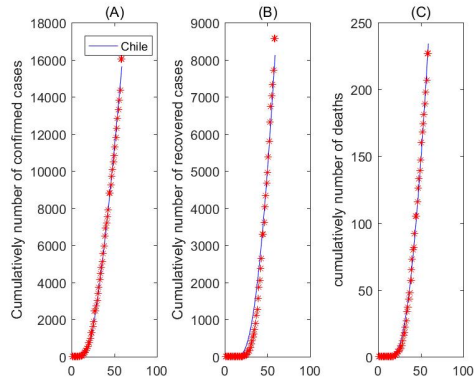
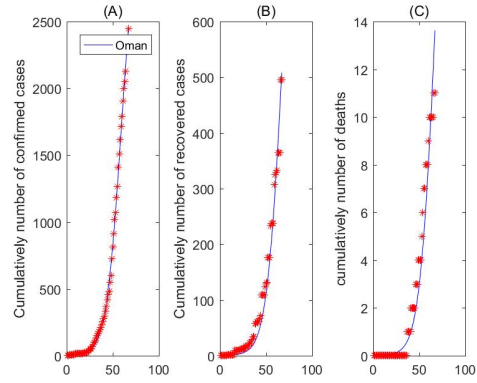
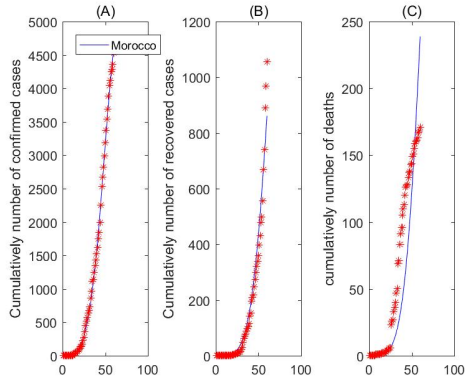
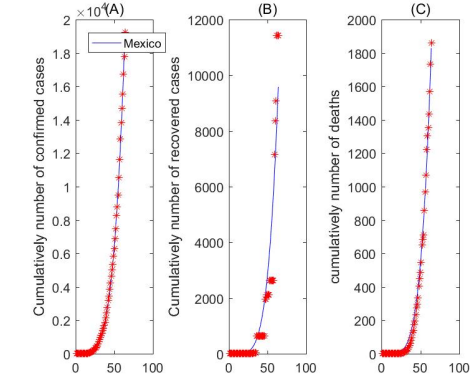
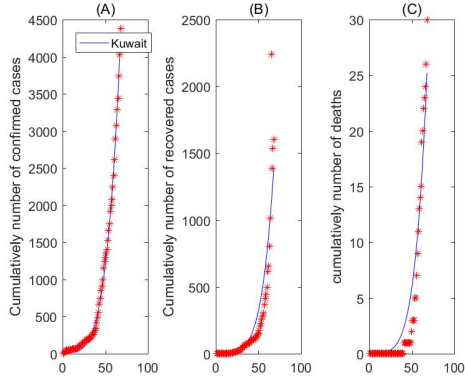
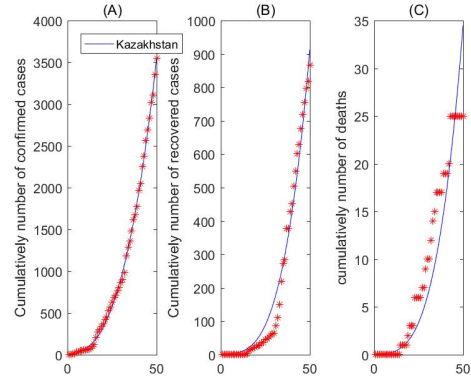
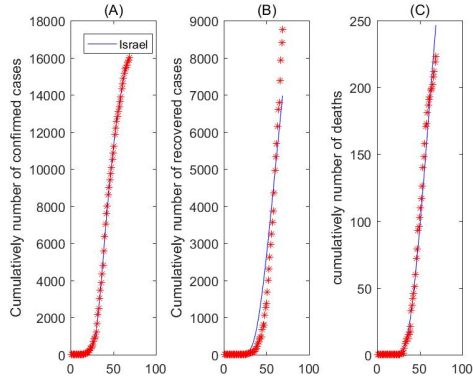
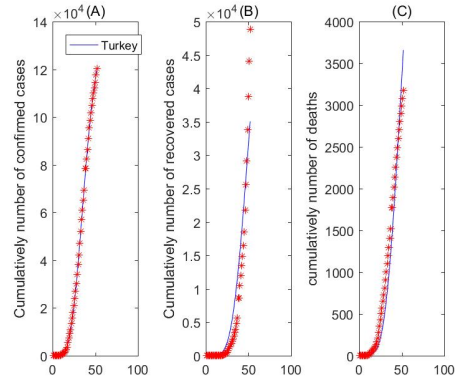
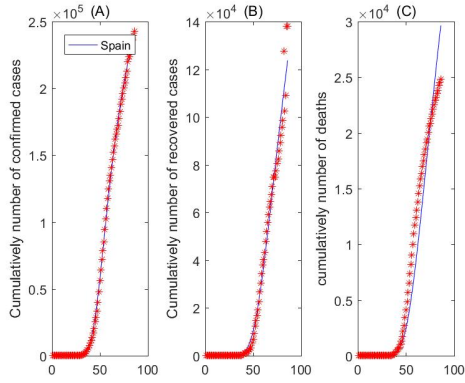
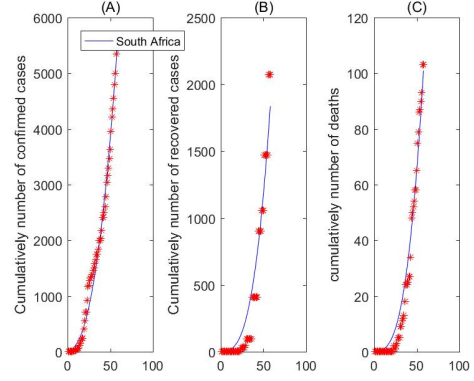
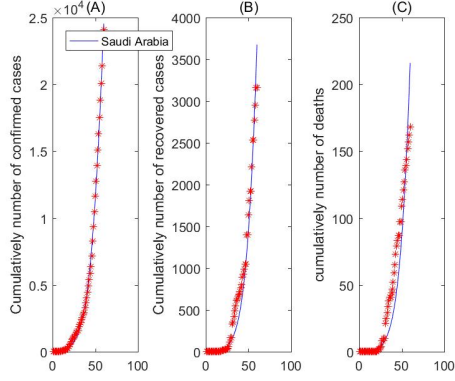
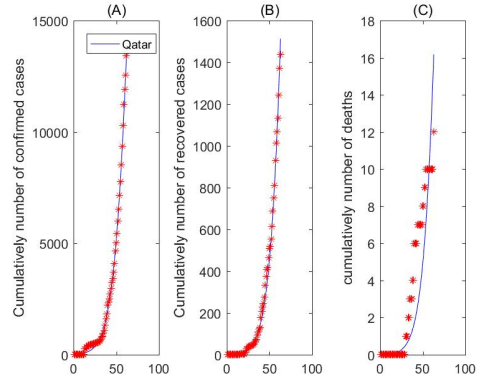
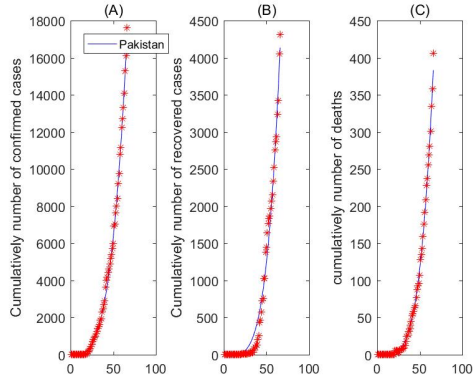


Figure S2: Simulation results of the cumulative confirmed cases, cumulative recovered cases, and cumulative deaths of Bolivia, Brazil, Cameroon, Colombia, Cuba, Dominican Republic, Ecuador, Ghana, India, Malaysia, Nigeria, Panama, Peru, Philippines, Puerto Rico, Singapore and Thailand in tropical region.









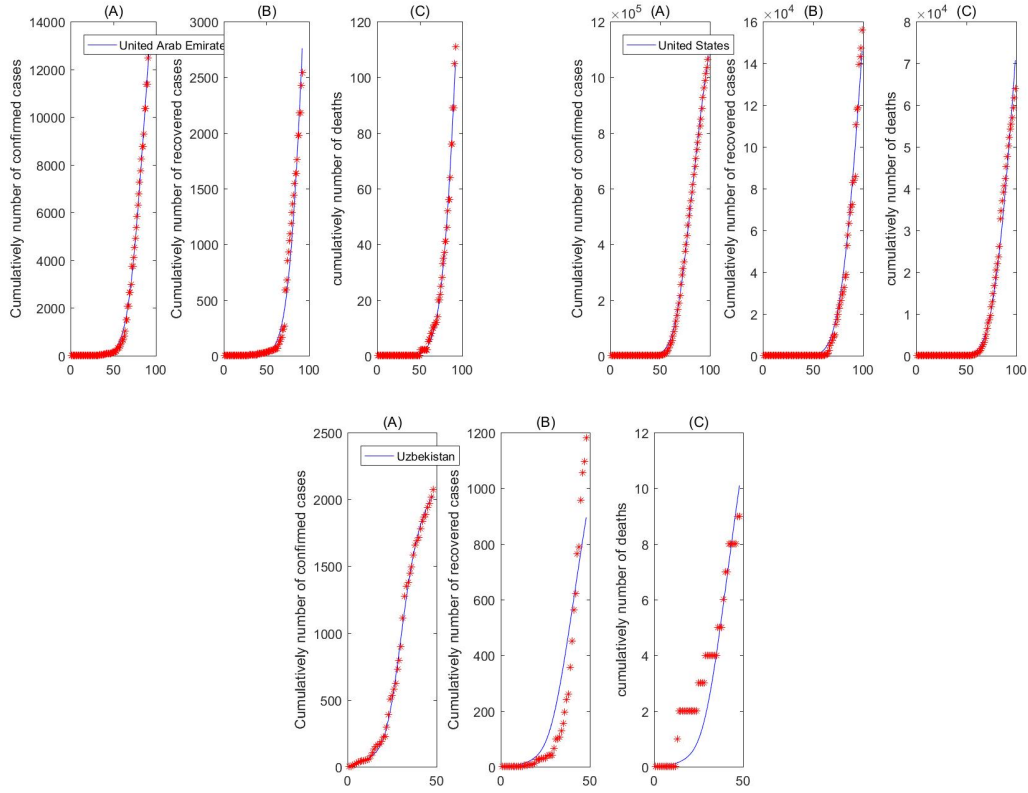
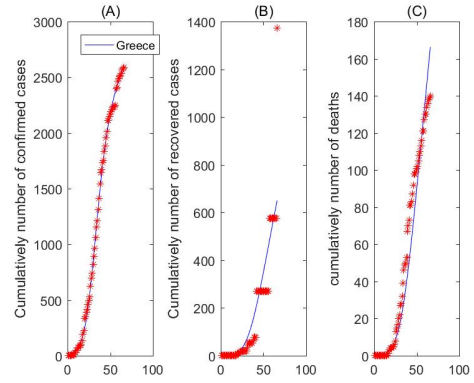
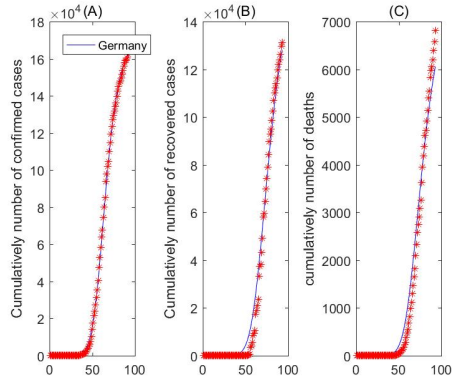
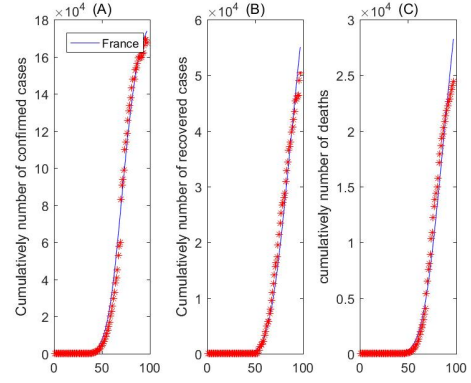
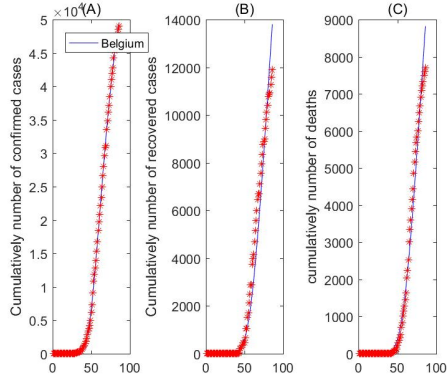
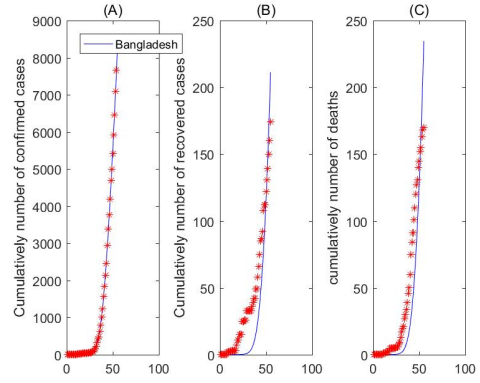
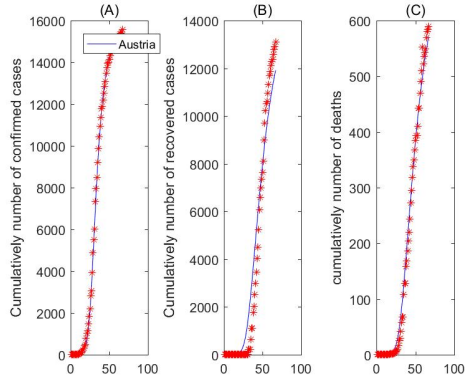
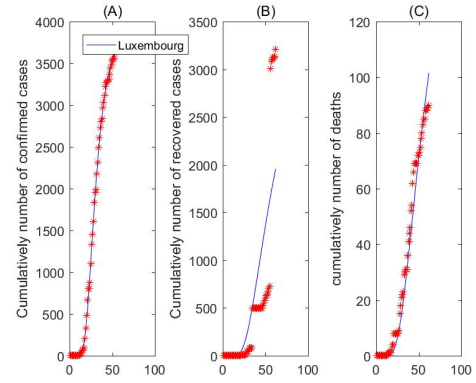
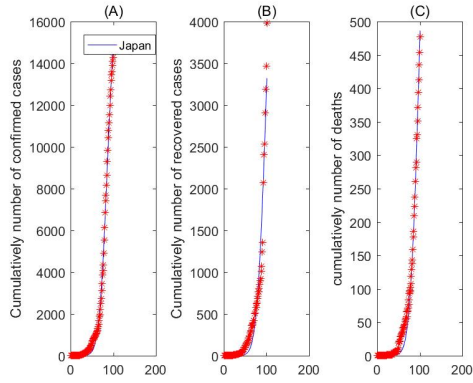
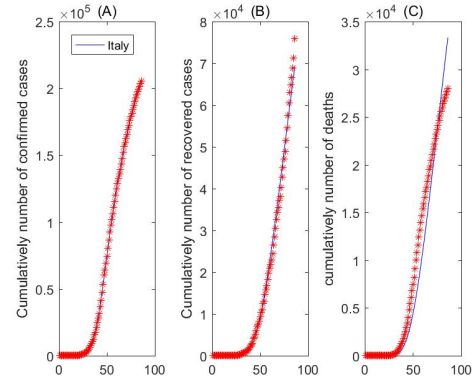
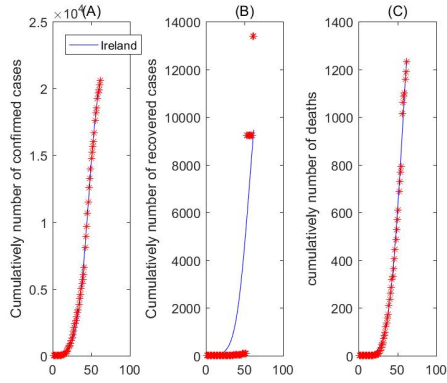
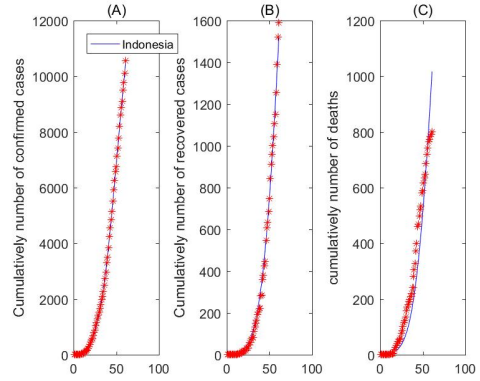
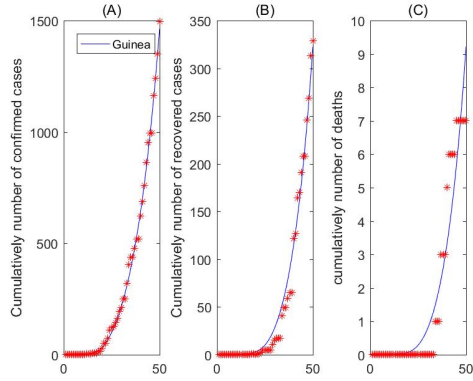


Figure S3: Simulation results of the cumulative confirmed cases, cumulative recovered cases, and cumulative deaths of Afghanistan, Algeria, Argentina, Australia, Azerbaijan, Bahrain, Chile, China, Djibouti, Egypt, Iran, Iraq, Israel, Kazakhstan, Kuwait, Mexico, Morocco, Oman, Pakistan, Qatar, Saudi Arabia, South Africa, Spain, Turkey, United Arab Emirates, United States and Uzbekistan in arid region.





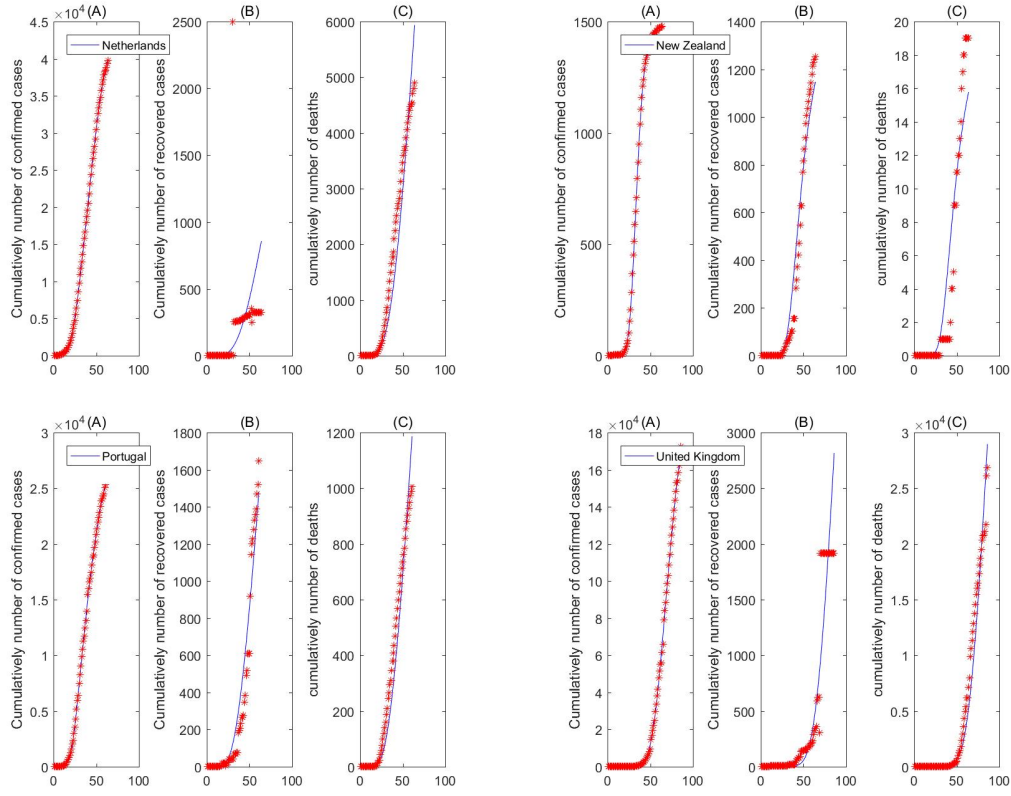
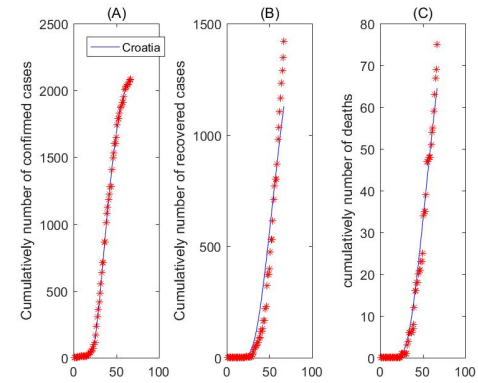
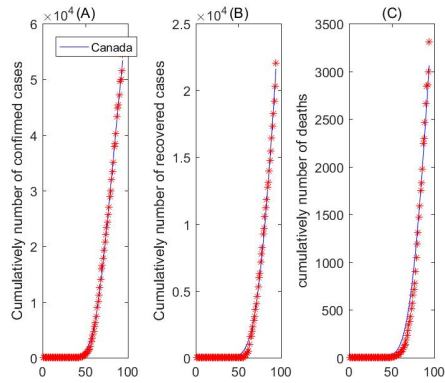
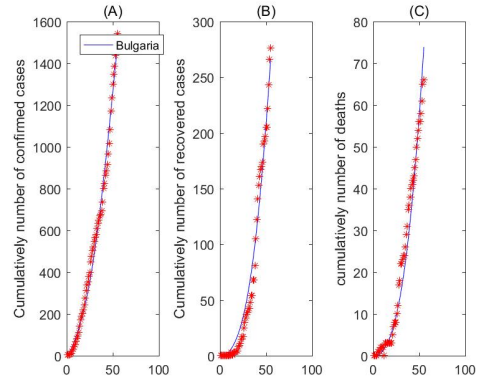
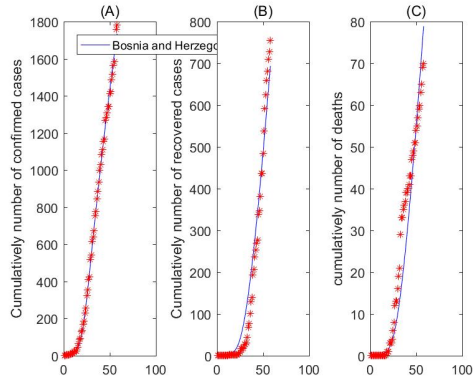
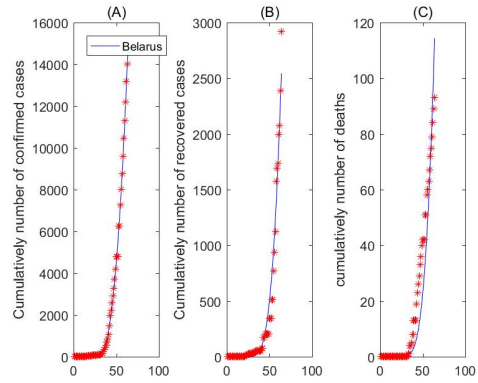
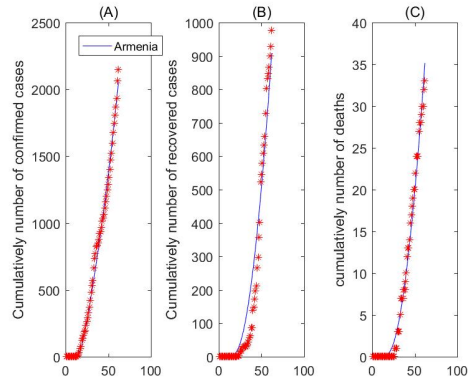
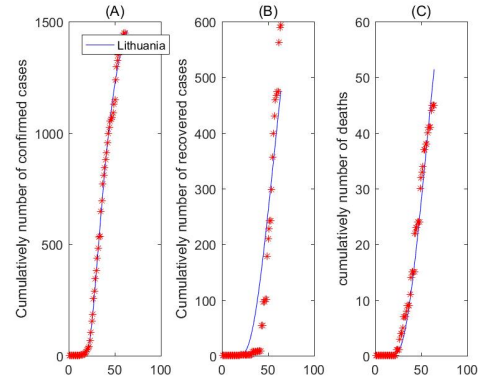
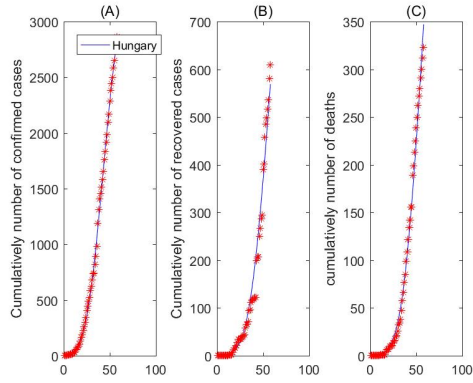
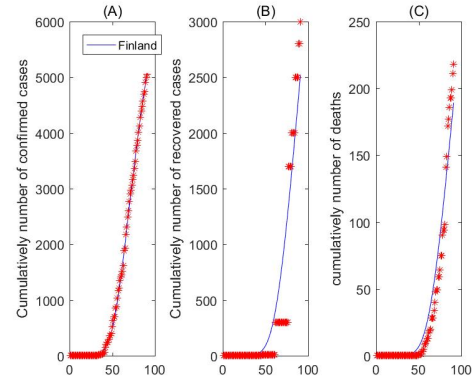
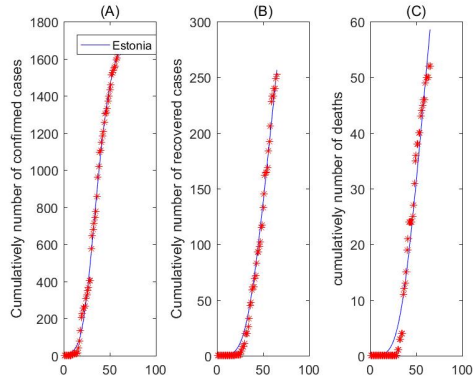
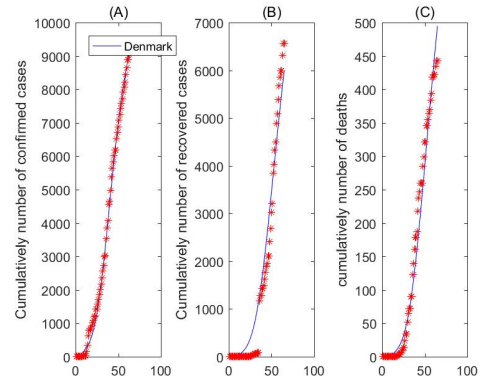
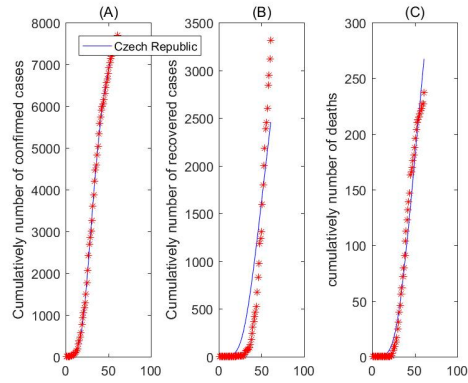
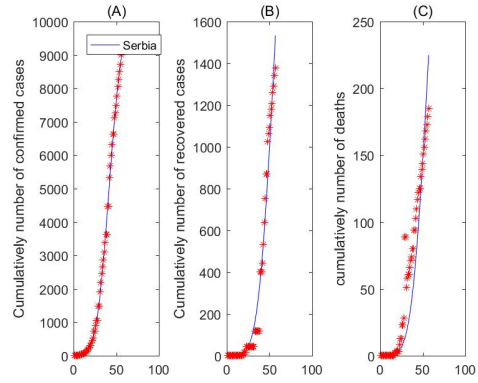
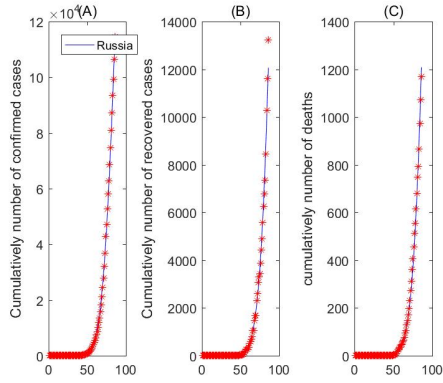
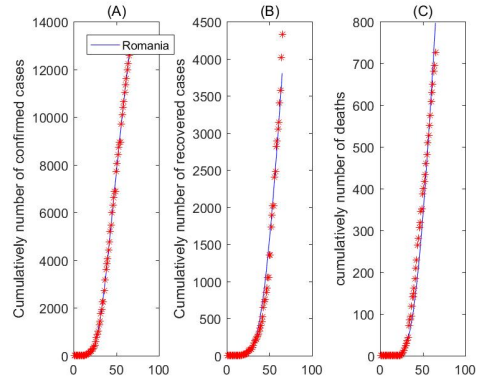
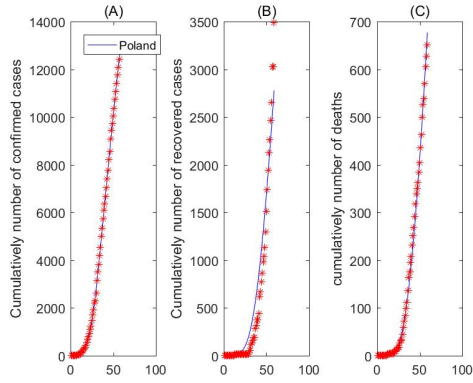
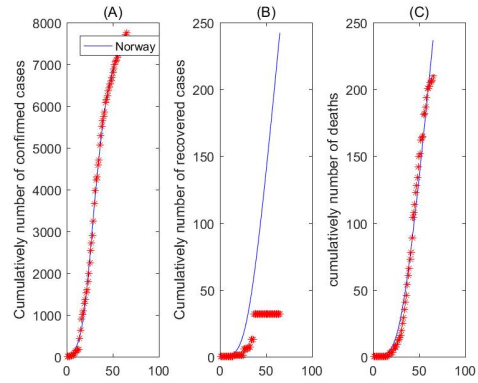
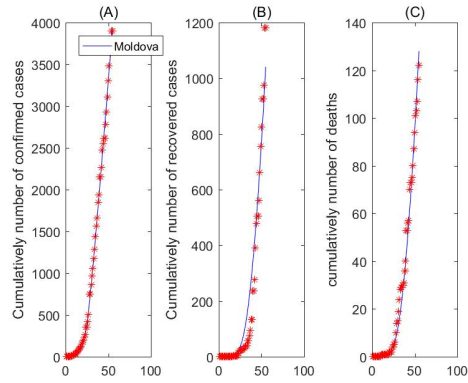


Figure S4: Simulation results of the cumulative confirmed cases, cumulative recovered cases, and cumulative deaths of Austria, Bangladesh, Belgium, France, Germany, Greece, Guinea, Indonesia, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Portugal and United Kingdom in temperate region.







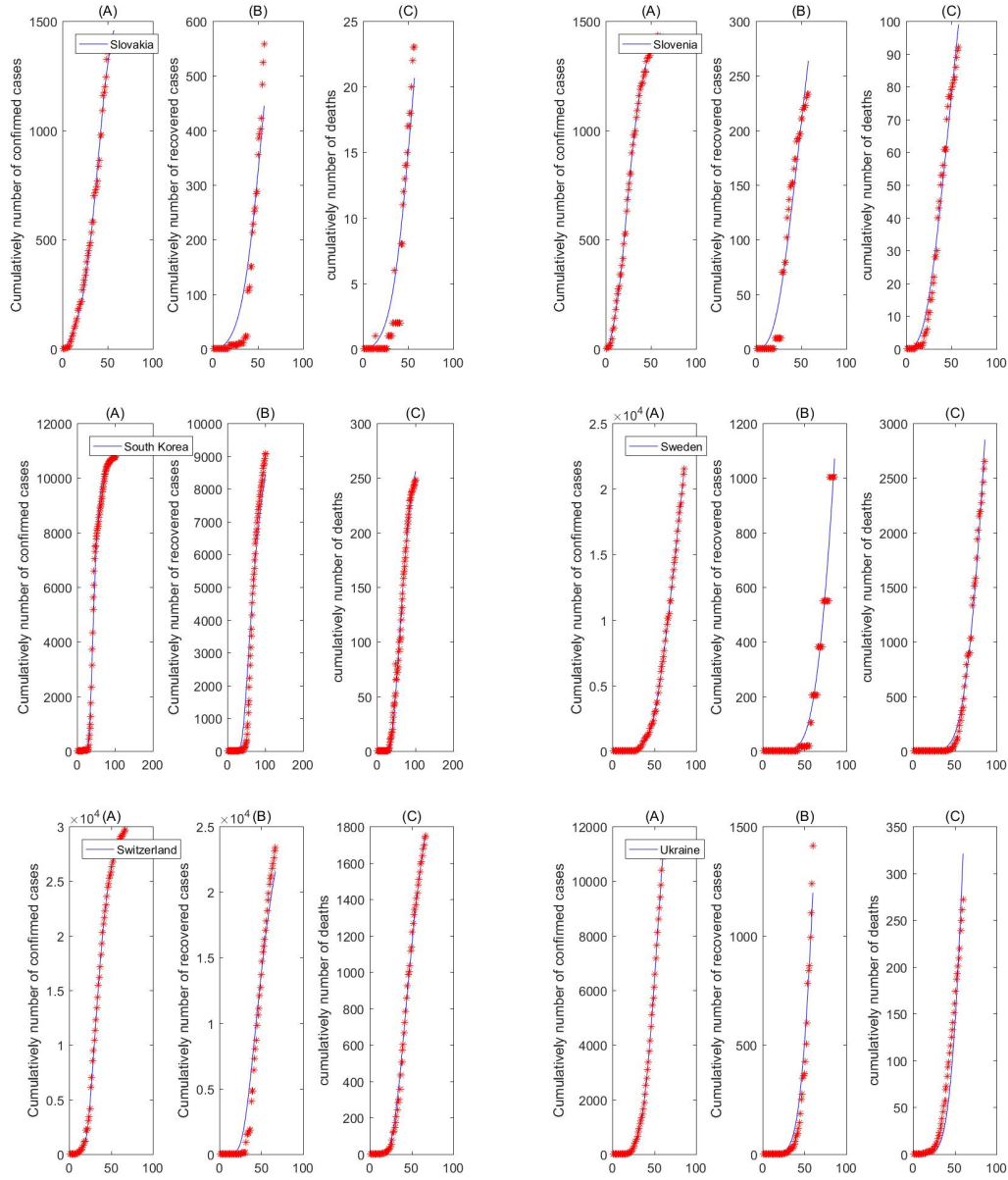


Figure S5: Simulation results of the cumulative confirmed cases, cumulative recovered cases, and cumulative deaths of Armenia, Belarus, Bosnia and Herzegovina, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, Hungary, Lithuania, Moldova, Norway, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, South Korea, Sweden, Switzerland and Ukraine in cold region.

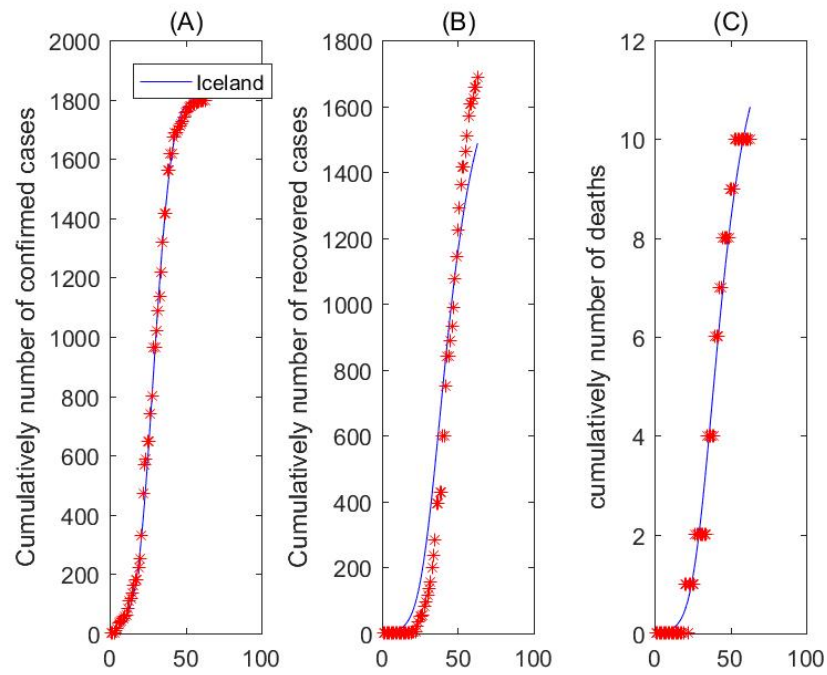


Figure S6: Simulation results of the cumulative confirmed cases, cumulative recovered cases, and cumulative deaths of Iceland in polar region.

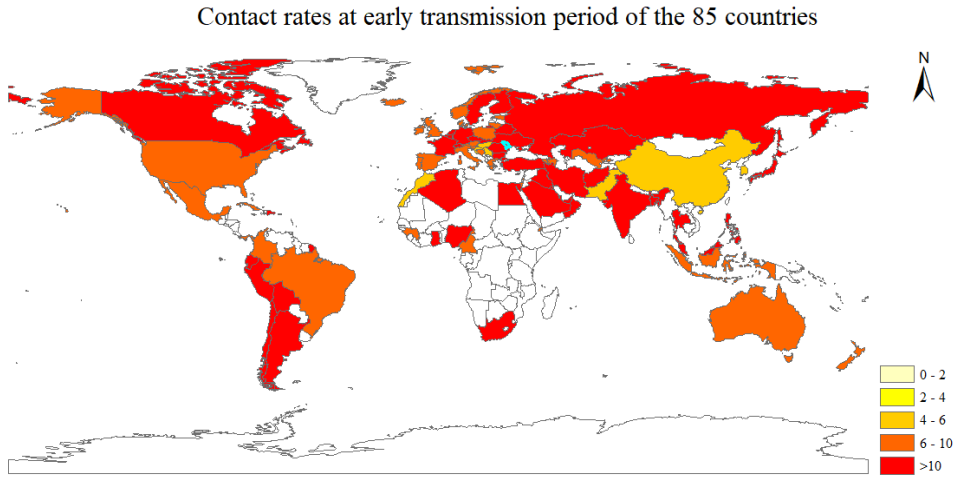


Figure S7: Distribution of the contact rates c_0 at early transmission period of the 85 countries.

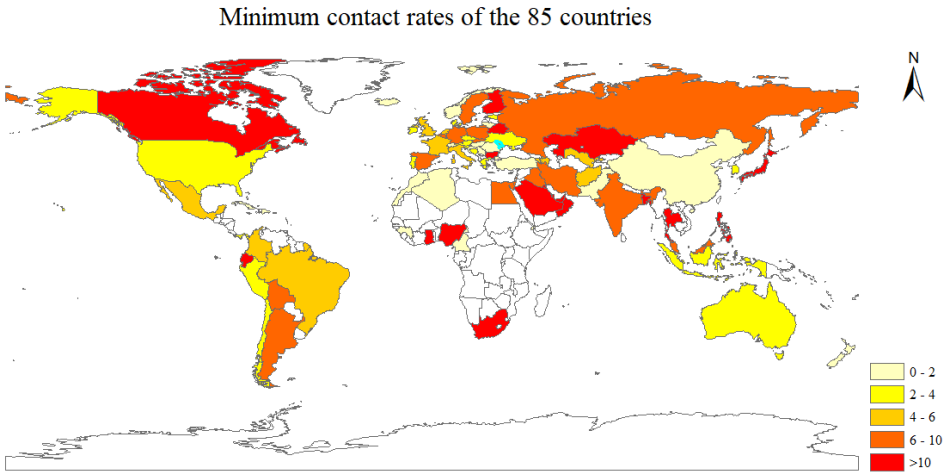
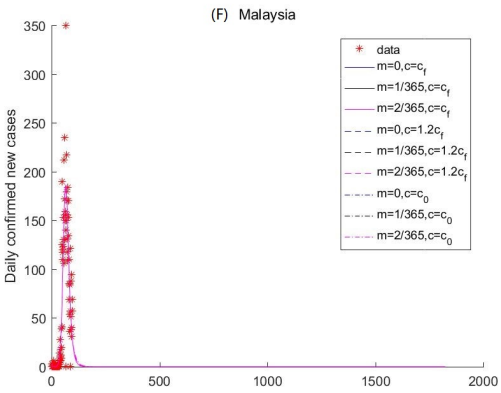
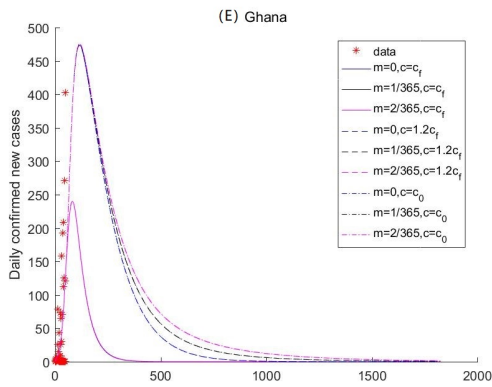
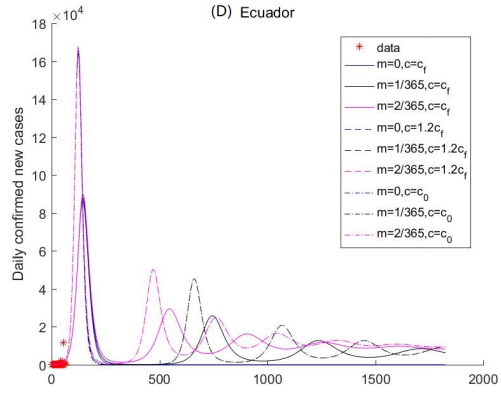
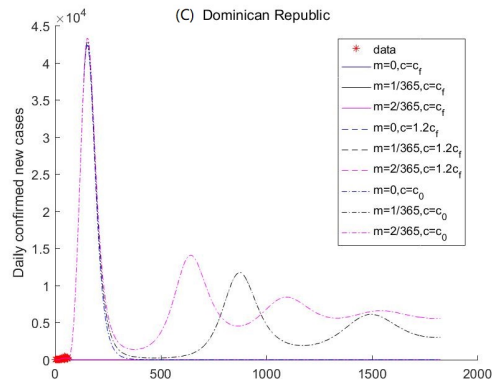
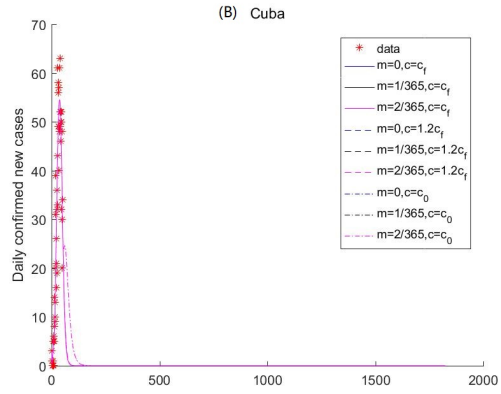
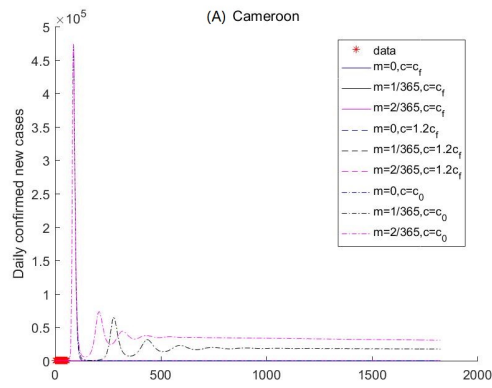


Figure S8: Same as Figure S5, but for the minimum contact rates c_f .



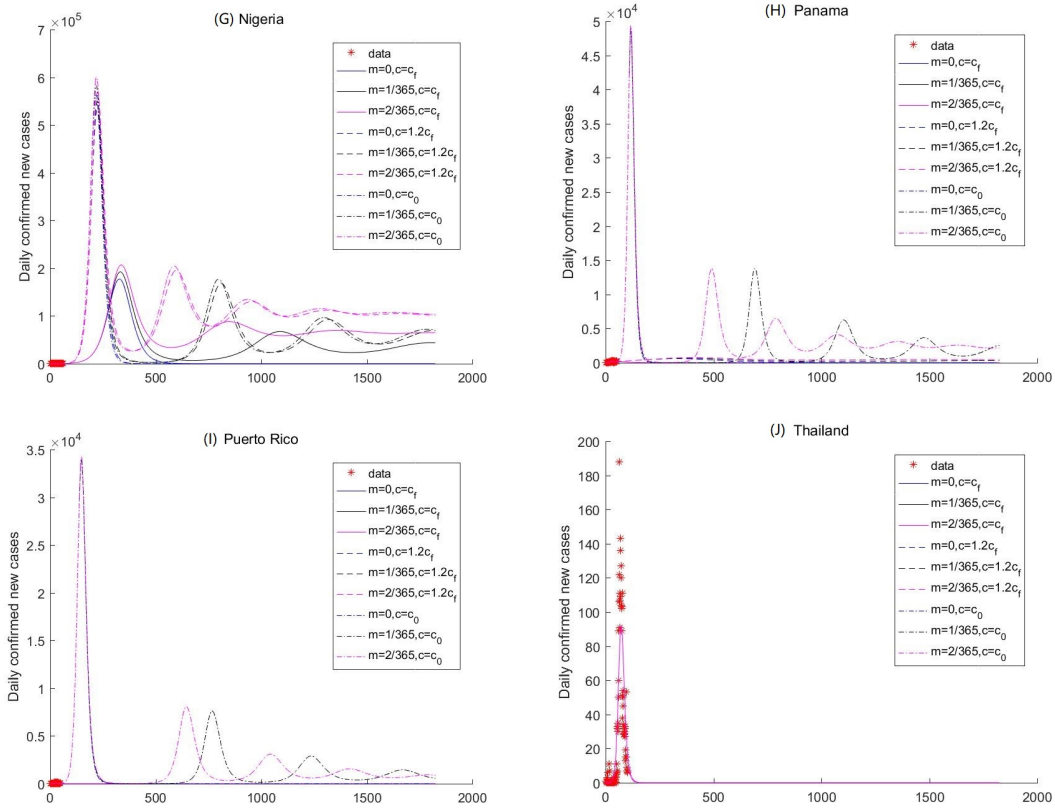
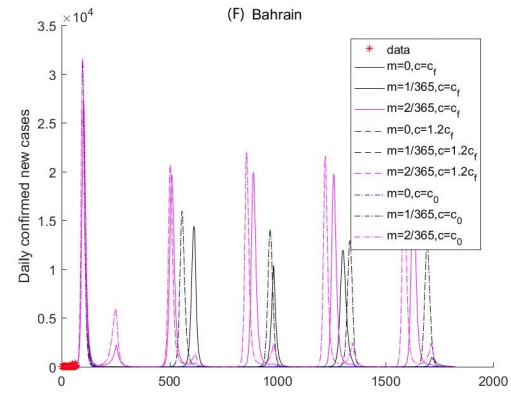
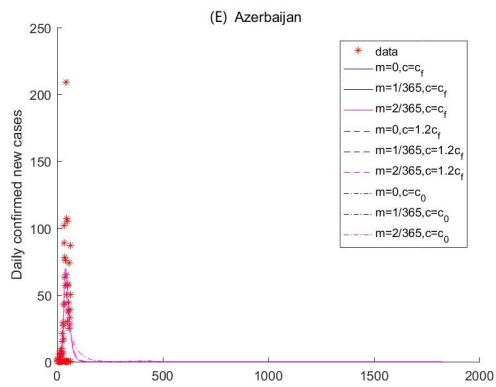
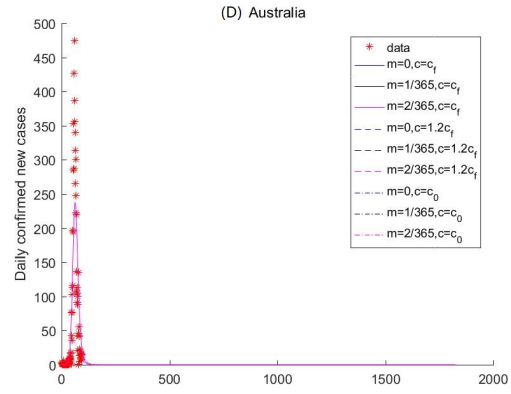
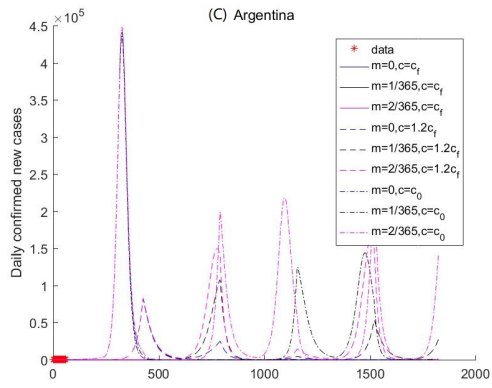
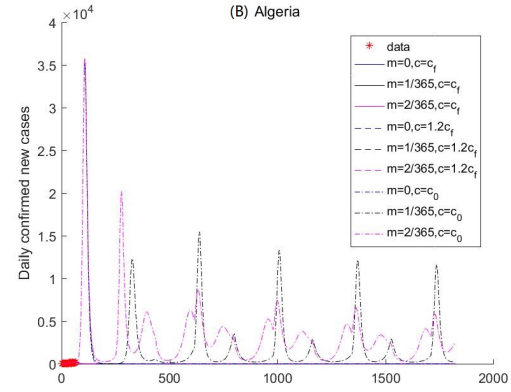
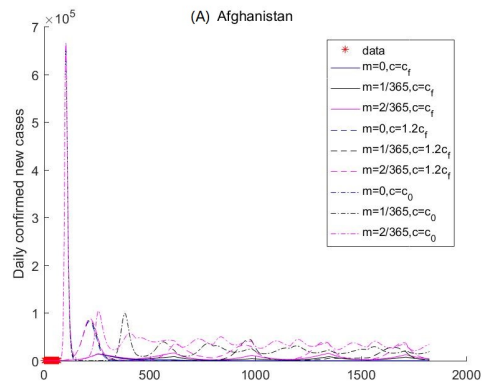
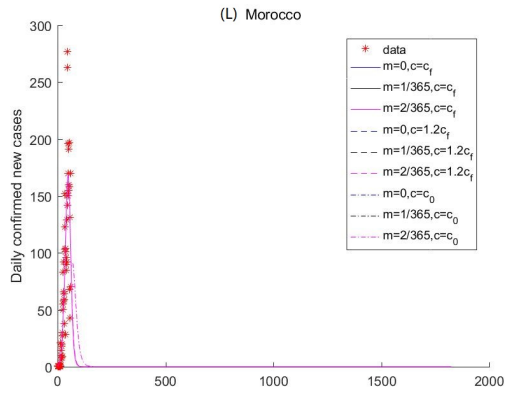
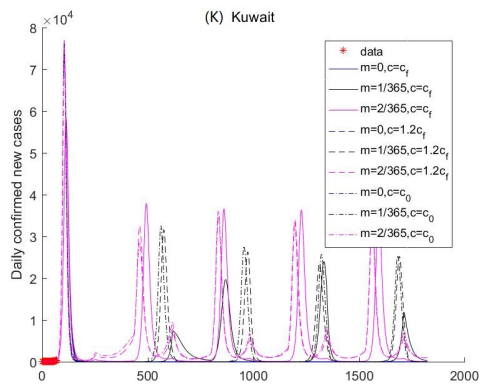
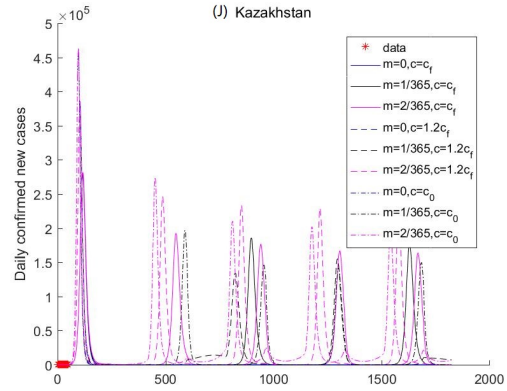
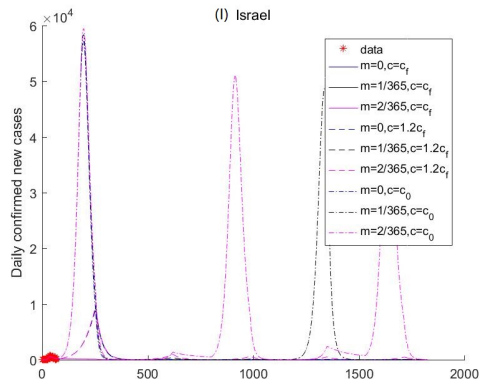
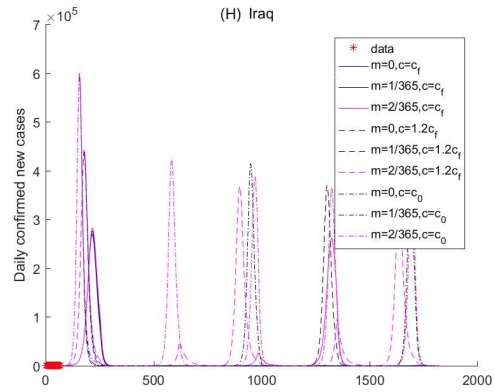
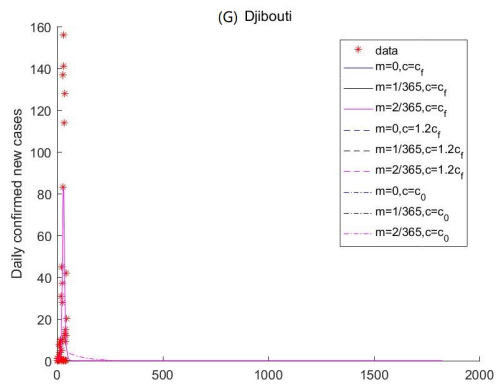


Figure S9: Sensitivity analysis of the daily new confirmed cases of Cameroon, Cuba, Dominican Republic, Ecuador, Ghana, Malaysia, Nigeria, Panama, Puerto Rico, and Thailand in tropical region.





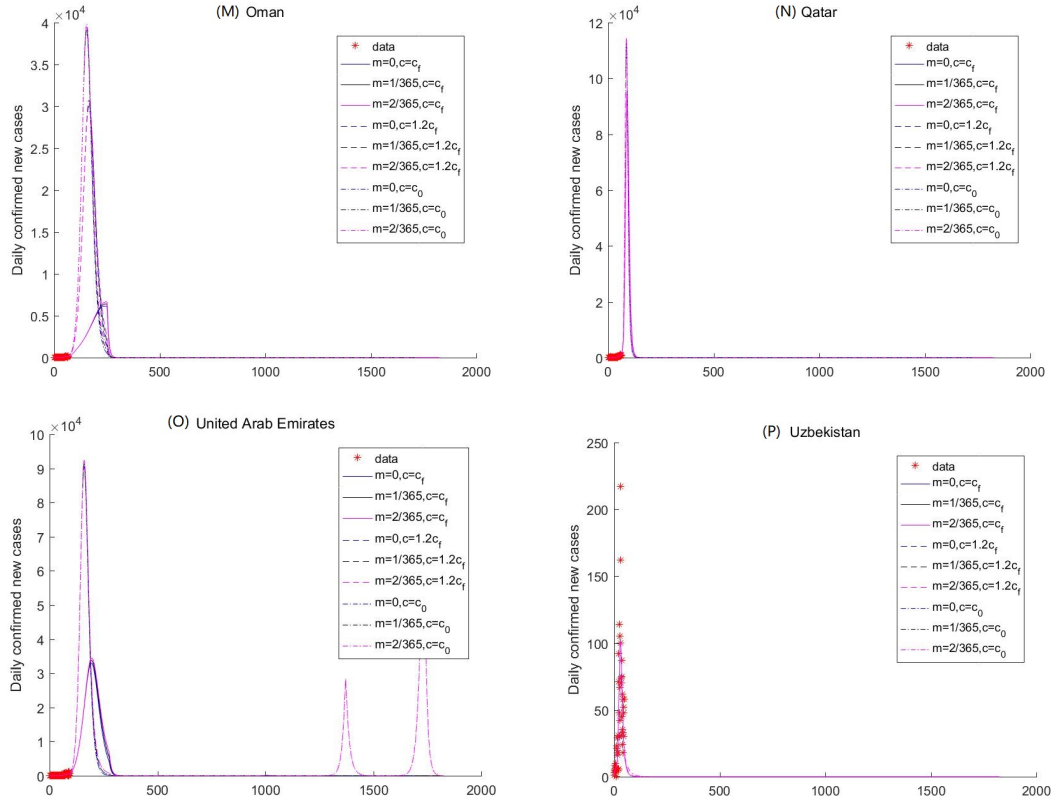
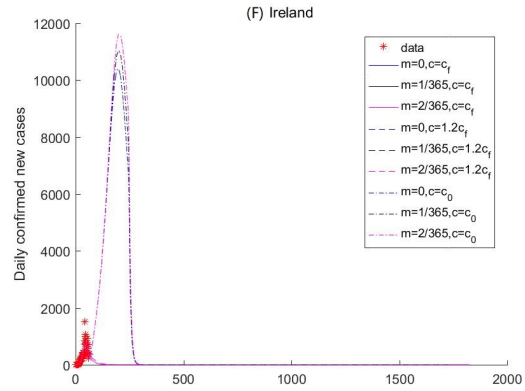
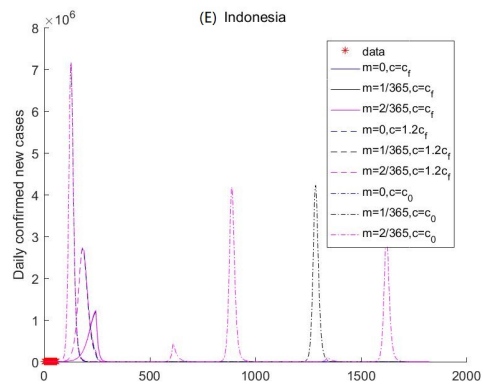
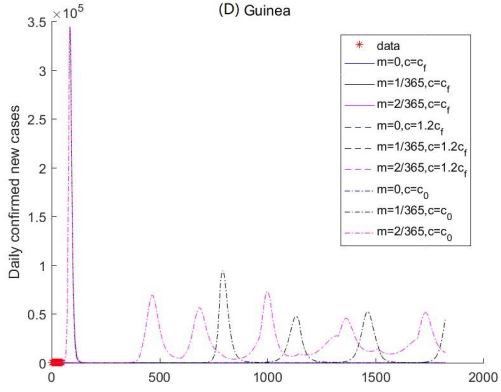
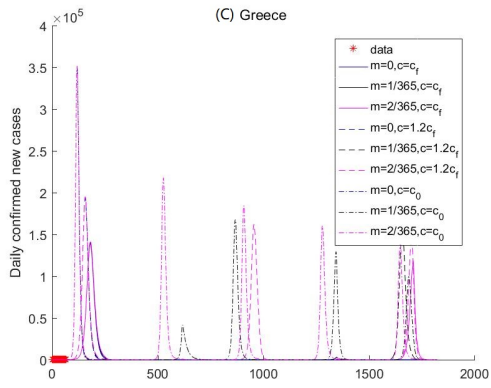
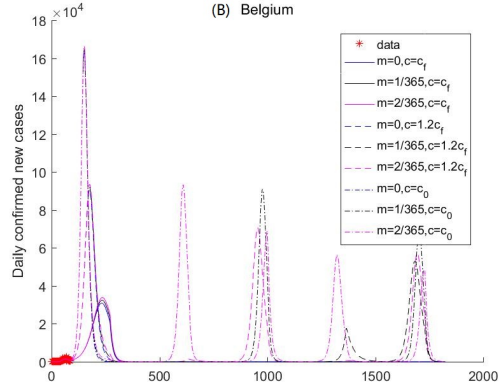
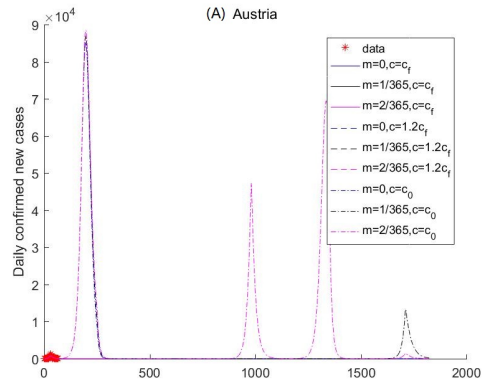


Figure S10: Sensitivity analysis of the daily new confirmed cases of Afghanistan, Algeria, Argentina, Australia, Azerbaijan, Bahrain, Djibouti, Iraq, Israel, Kazakhstan, Kuwait, Morocco, Oman, Qatar, United Arab Emirates and Uzbekistan in arid region.



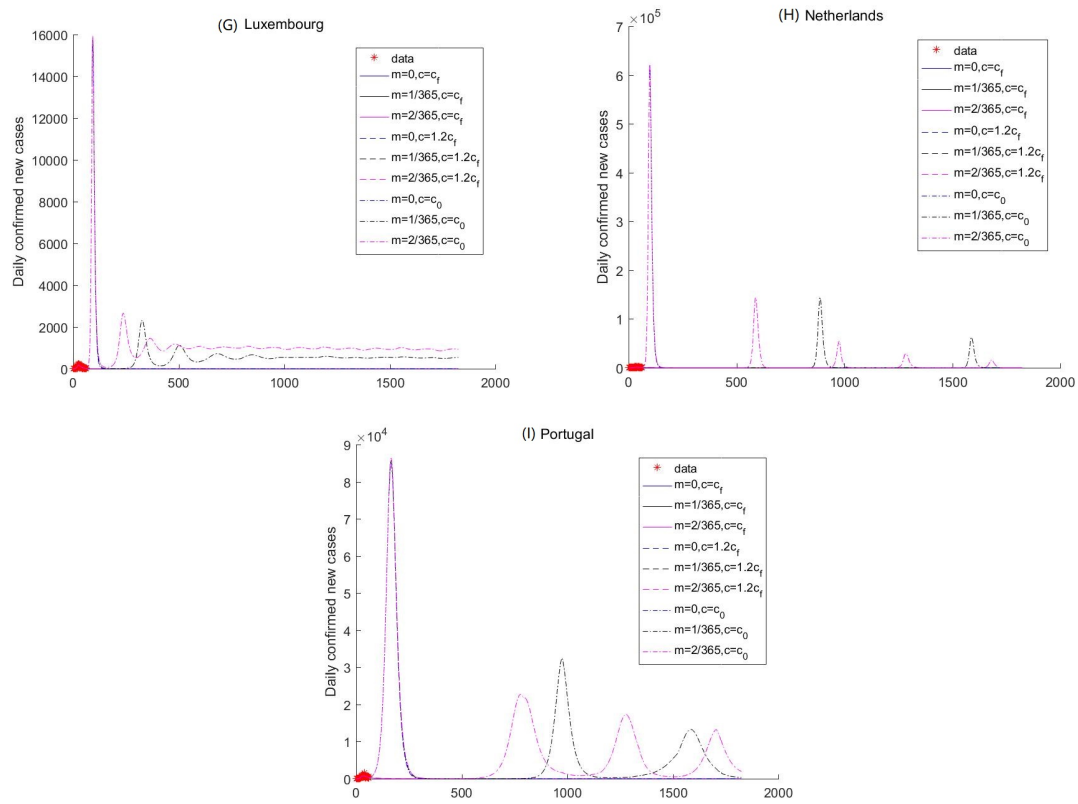
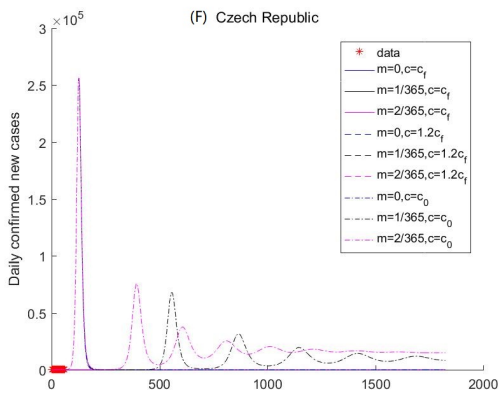
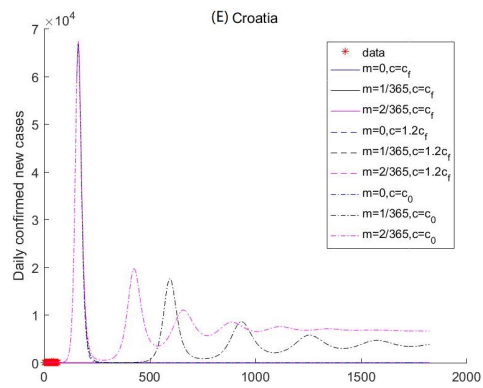
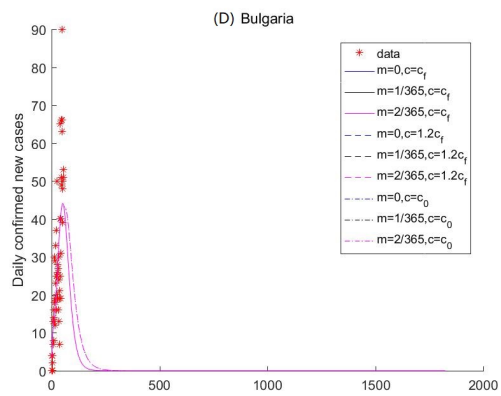
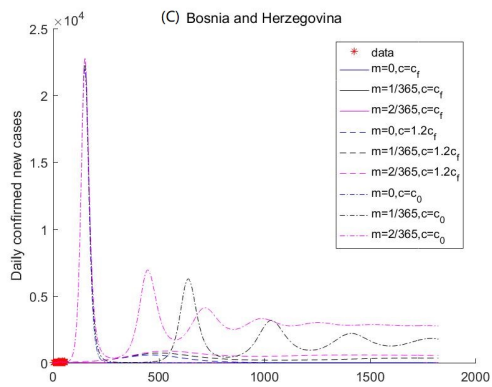
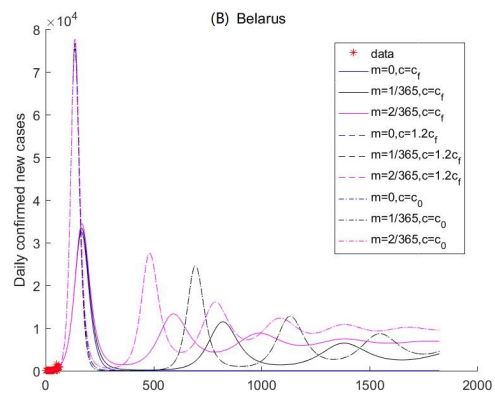
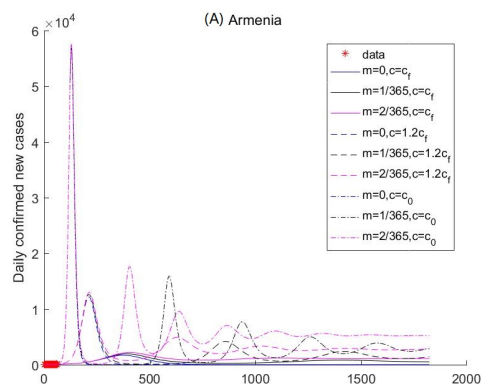
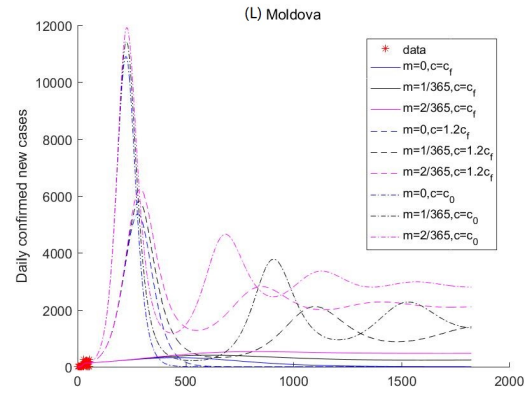
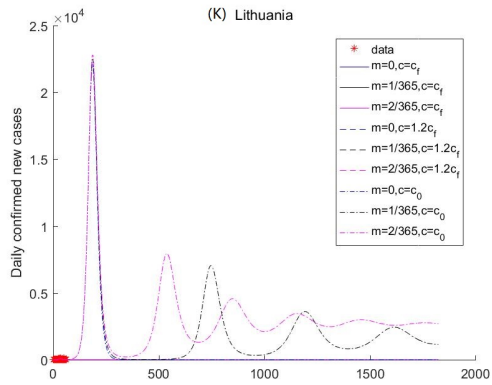
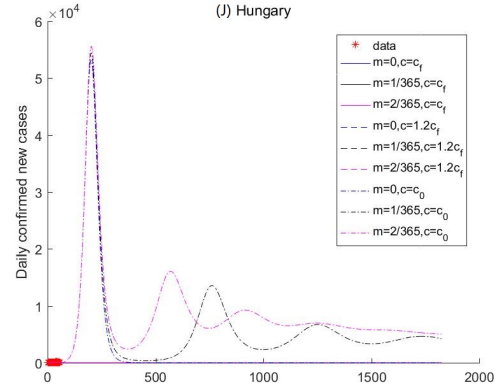
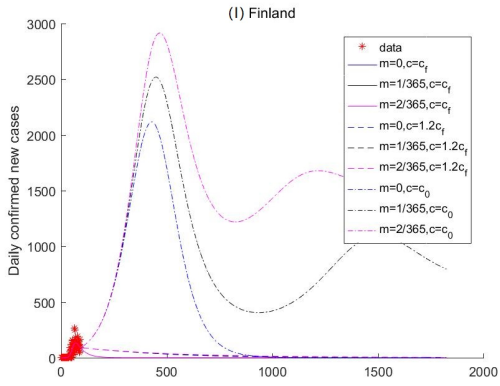
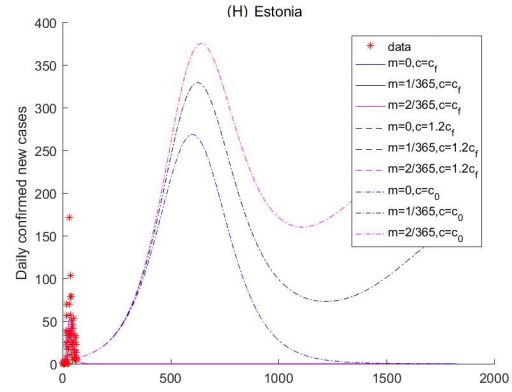
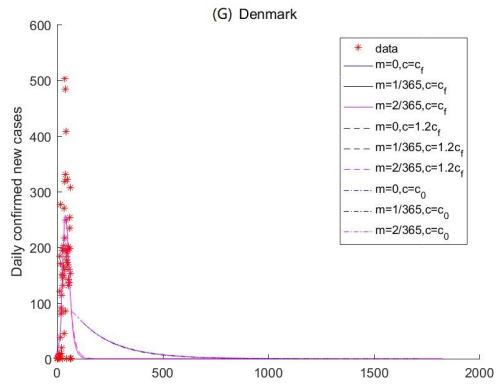
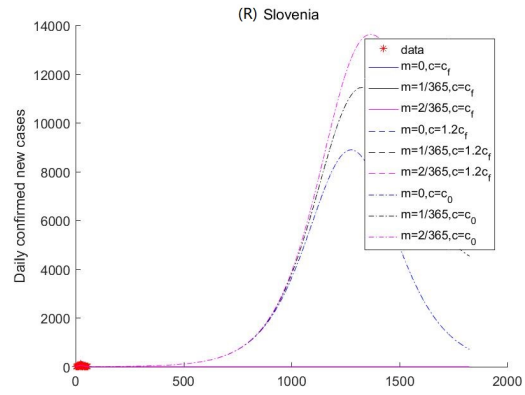
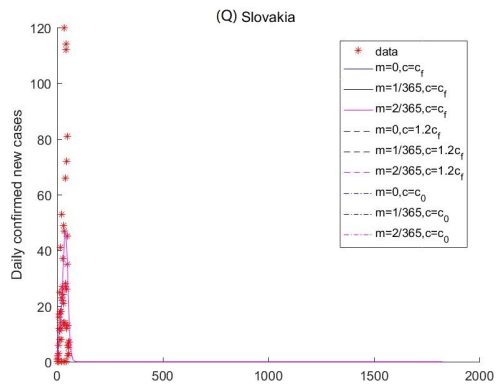
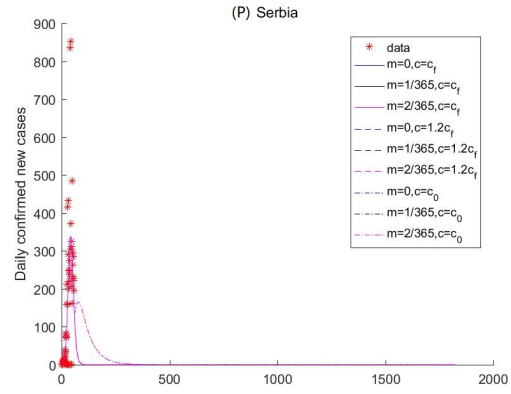
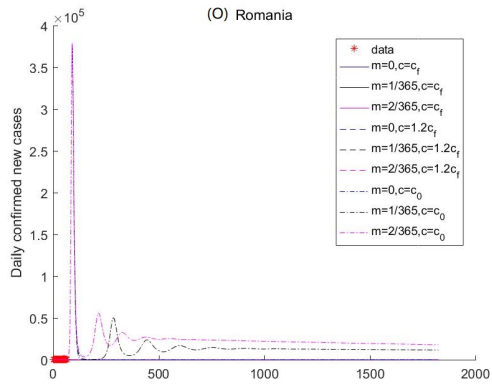
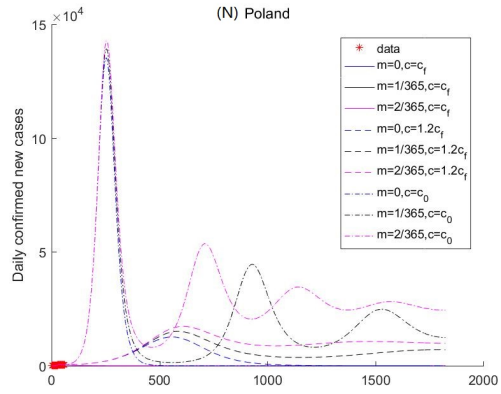
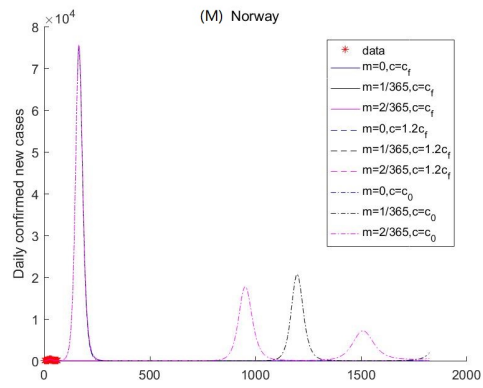


Figure S11: Sensitivity analysis of the daily new confirmed cases of Austria, Belgium, Greece, Guinea, Indonesia, Ireland, Luxembourg, Netherlands, and Portugal in temperate region.







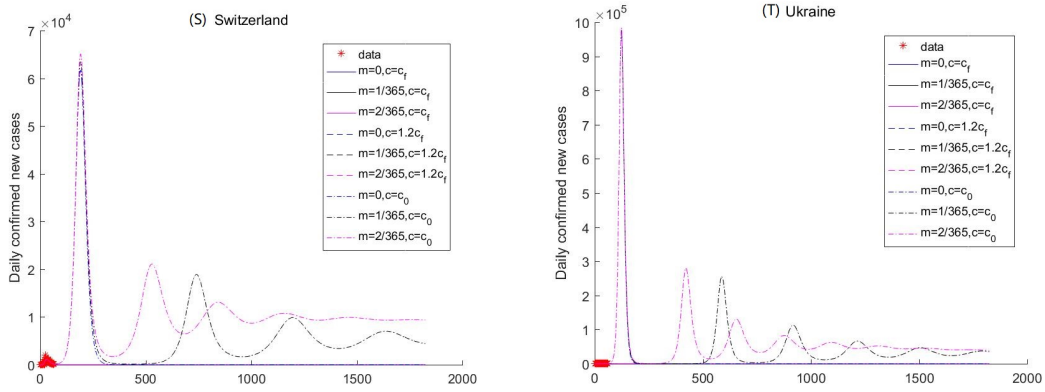


Figure S12: Sensitivity analysis of the daily new confirmed cases of Armenia, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, Hungary, Lithuania, Moldova, Norway, Poland, Romania, Serbia, Slovakia, Slovenia, Switzerland, and Ukraine in cold region.