Two general models for the analysis of the dynamics of COVID-19 in several countries

Results in May 31, 2020

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Two simple models (see Annex) were applied to various countries with data of daily new cases provided in: https://www.ecdc.europa.eu/en/publications-data/download-todays-data-geographic-distribution-covid-19-cases-worldwide.

Results for China, South Korea, Iran and Turkey show that for the first two countries the episodes are practically controlled, even if new episodes might always occur. For Iran the numbers are now increasing after a first decrease. The second model is not able to capture these two episodes. The values for Turkey show a decrease. The numbers are still increasing in Pakistan, India, and Ukraine and the curve seems already decreasing in Russia (Figure 1).

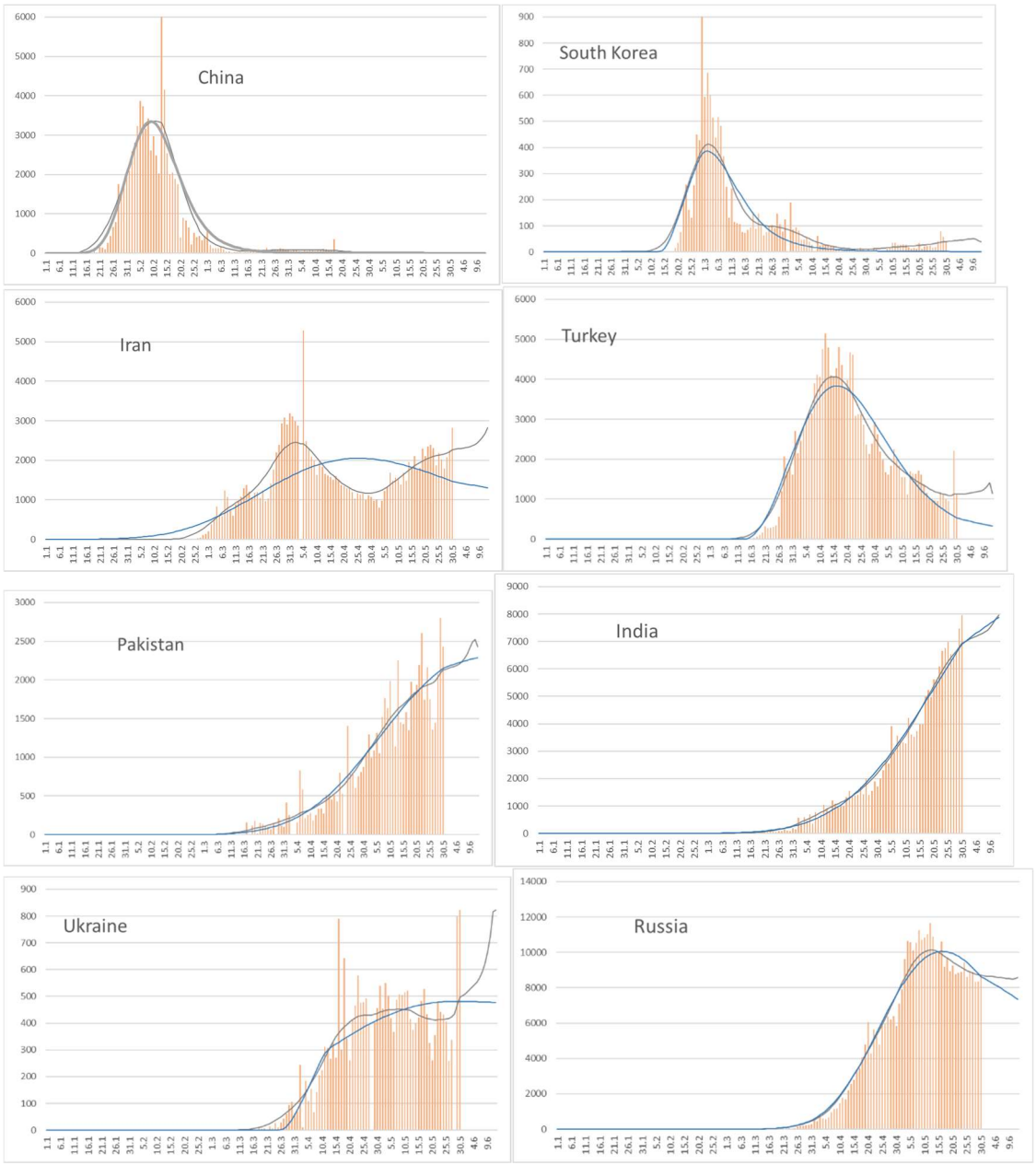

Figure 1. Observed and estimated cases in China, South Korea, Iran and Turkey.

The same analysis was done in other continents with more recent episodes, from North to South America and Australia. The numbers are not decreasing very rapidly in the USA and Canada, they are still increasing rapidly in Peru and Brasil, and show a certain tendency to slow down the increase in Mexico, Chile and Argentina. In Australia the decrease already occurred for a long time (Figure 2).

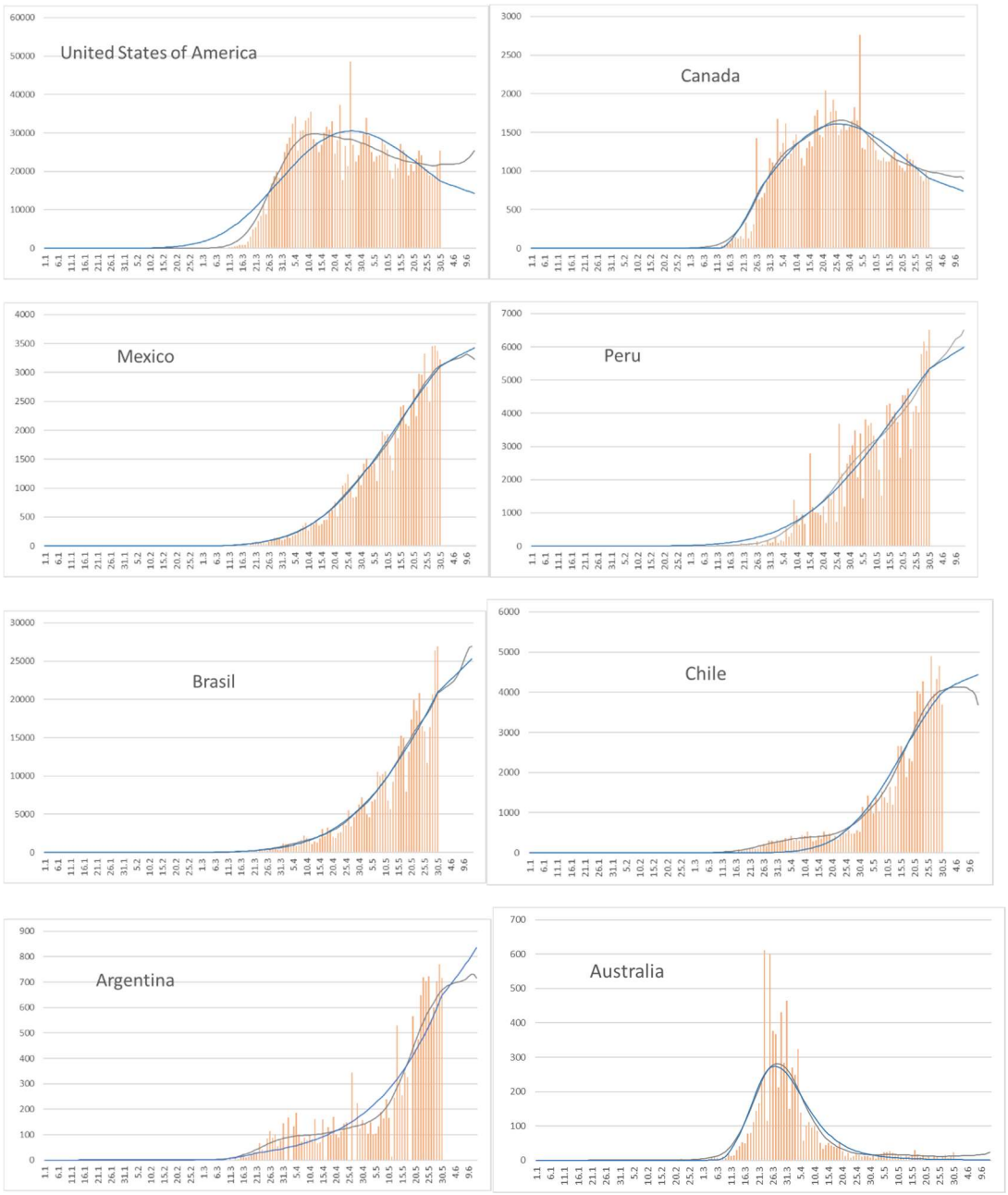

Figure 2. Observed and estimated cases in some countries from North to South America and Australia.

In Western Europe, the number of cases decreased significantly in most countries at various rates, with the exception for Sweden where the two models indicate different trends (Figure 3).

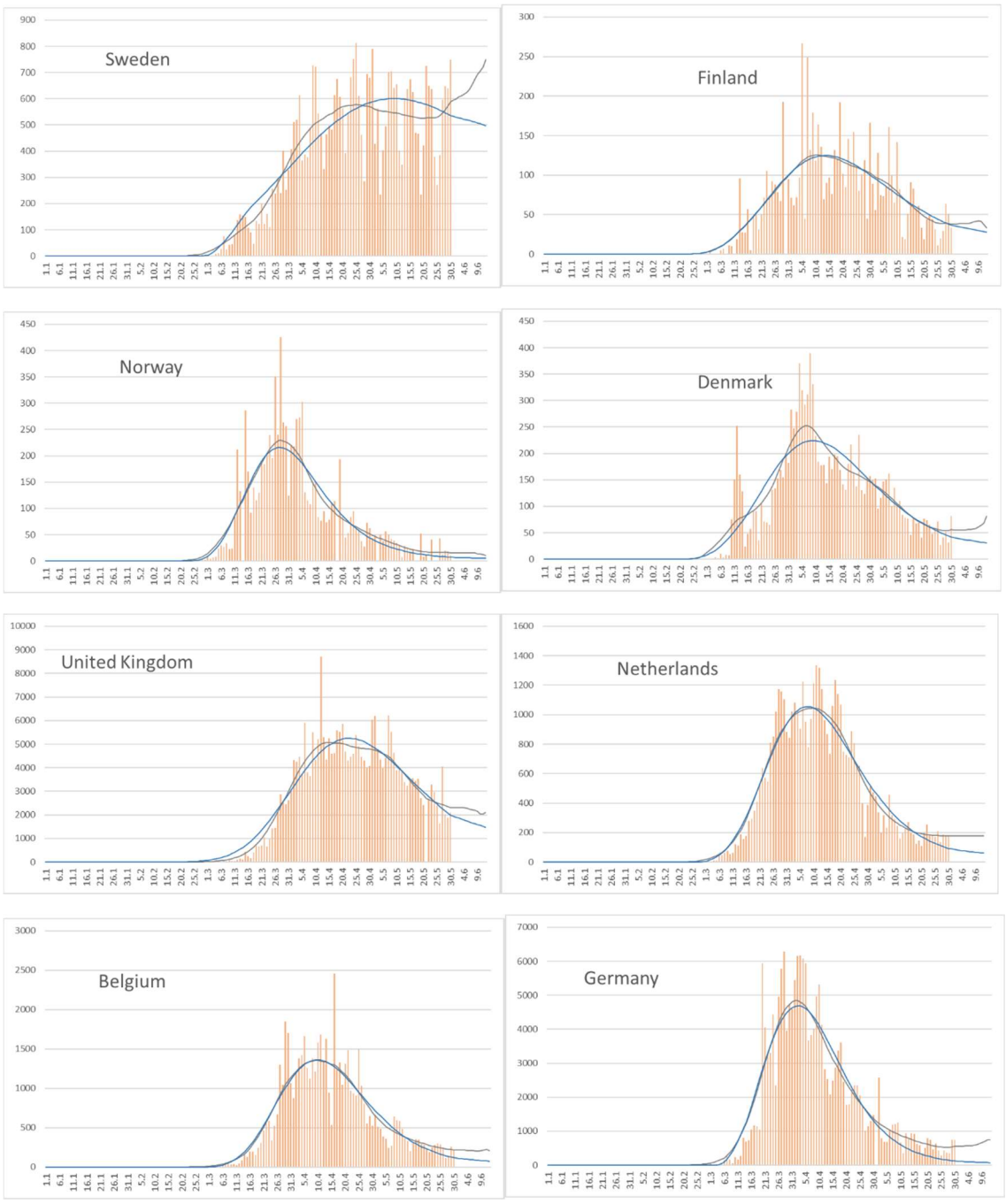

Figure 3. Observed and estimated cases in North and Central Europe.

Finally, the analysis of the situations in Southern Europe including Switzerland. The number of cases already decreased significantly in all cases but less clearly in France and Portugal where the two models diverge (Figure 4).

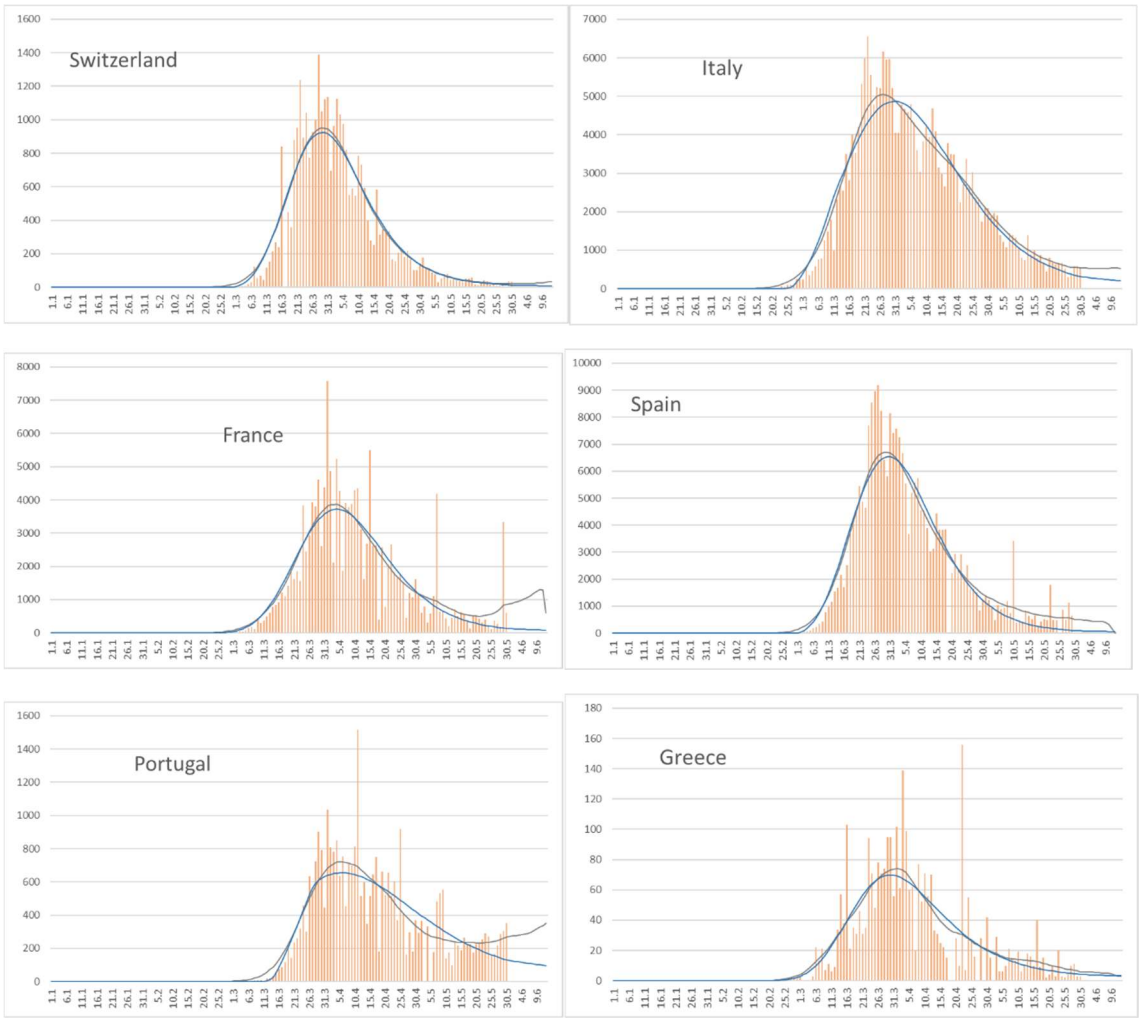

Figure 4. Observed and estimated symptomatic cases and number of infections in Southern Europe.

Annex: The two models

1. The first model is simply a reciprocal averaging system. The number of infections is estimated from the number of new cases by the moving average of the cases of the following 14 days. Then, the number of estimated cases, including the projection, is estimated from the moving average of estimated infections of the previous 14 days. This is a special smoothing procedure. The model is sensitive to changes in the trends and it is more adjusted when there are multiple episodes, as in Iran, or in general when the conditions are greatly changing through time;

2. The second model adjusts a global equation to the whole episode from the estimated number of infections (N) calculated as in model 1 from the moving average of the number of cases of following 14 days.

The equation used was of the form:

$$N = (a)^{(t-i)\,(b\,)^{t-j}}$$

The coefficients are interpreted as the initial infection rate (a) starting in time t=i, and a reaction rate (b where 1 represents no reaction) starting at time t=j. This equation implies that t>i and j>i. The values of the coefficients a, b, i, and j, together with the coefficient of determination R^2 are presented for various countries in the table below. After adjusting the estimated number of infections, the number of cases is obtained from the moving average of the estimated number of infections of the previous 14 days.

Table 1. Coefficients of the equation for model 2 for various countries.

País	**a**	**b**	**i**	**j**	**R^2**
Argentina	1,056	0,999	0,0	65,9	0,972
Australia	1,702	0,956	57,4	66,1	0,978
Belgium	1,460	0,978	49,5	60,7	0,990
Brazil	1,194	0,994	31,9	37,7	0,996
Canada	1,184	0,987	31,9	71,7	0,990
Chile	1,304	0,988	72,9	81,1	0,984
China	2,570	0,960	8,2	9,3	0,972
Denmark	1,317	0,980	44,0	54,3	0,954
Finland	1,262	0,981	45,9	57,3	0,991
France	1,574	0,977	45,9	55,9	0,951
Germany	1,475	0,976	44,7	62,8	0,982
Greece	1,505	0,969	51,2	52,6	0,976
India	1,209	0,993	41,6	47,3	0,998
Iran	1,227	0,991	0,0	1,0	0,704
Italy	1,328	0,982	29,0	55,0	0,982
Mexico	1,185	0,992	45,4	63,9	0,999
Netherlands	1,428	0,978	46,7	58,5	0,989
Norway	1,481	0,970	47,6	55,7	0,983
Pakistan	1,186	0,991	44,3	61,5	0,994
Peru	1,179	0,993	28,9	35,0	0,993
Portugal	1,176	0,984	29,8	71,8	0,926
Russia	1,412	0,986	58,4	64,2	0,995
South Korea	1,492	0,961	28,9	43,9	0,938
Spain	1,559	0,975	44,3	59,8	0,984
Sweden	1,124	0,991	14,8	59,9	0,963
Switzerland	1,632	0,969	50,1	58,9	0,997
Turkey	1,378	0,980	51,5	73,0	0,964
Ukraine	1,077	0,993	3,8	86,1	0,935
United Kingdom	1,416	0,985	38,4	42,5	0,983
United States of America	1,355	0,989	16,9	21,7	0,942