

Climatic influences on the worldwide spread of SARS-CoV-2

Michail Bariotakis¹, George Sourvinos², Elias Castanas³, Stergios A. Pirintzos^{4*}

¹Institute of Biological and Medical Imaging, Helmholtz Zentrum München, Neuherberg, Germany

²Laboratory of Clinical Virology, School of Medicine, University of Crete, Heraklion, Crete, Greece

³Laboratory of Experimental Endocrinology, School of Medicine, University of Crete, Heraklion, Greece

⁴Department of Biology, University of Crete, Heraklion, Greece

*Corresponding author – pirintzos@uoc.gr

Supplementary Material

eMethods - The maximum-entropy approach

eTable 1 – Bioclimatic variables

eFigure 1 - Sensitivity of model predictions

Supplementary Material

eMethods

The maximum-entropy approach

In total, we used data from seven WHO Coronavirus Disease -2019 Reports (Situation Report -8, -13, -18, -23, -28, -33, -39, and -44), which spanned the period from 02/02/2020 to 04/03/2020 on a regular interval of five days. The countries with at least one confirmed incident in each Situation Report or any of the previous ones were used as “presence records” of the virus.

We also employed the widely used bioclimatic data from WorldClim.org¹ in 10 minutes (corresponding to approximately 18.5 km) resolution for the whole world map. WorldClim is a set of global climate layers (gridded climate data), which can be used for mapping and spatial modeling. These data represent variables derived from climatic data, which are considered to have an important effect on biological entities (see Table S1).

To correlate the virus presence records given by WHO with the bioclimatic variables, we applied a machine-learning technique called maximum entropy modeling, employing Maxent² version 3.4.1. Maxent was initially designed to model the potential niche of species, given a set of presence records and a set of environmental predictors. The model expresses a probability distribution where each grid cell has a predicted suitability of conditions for the species, with the underlying assumption that the species relates to the employed variables, in our case to the bioclimatic variables.

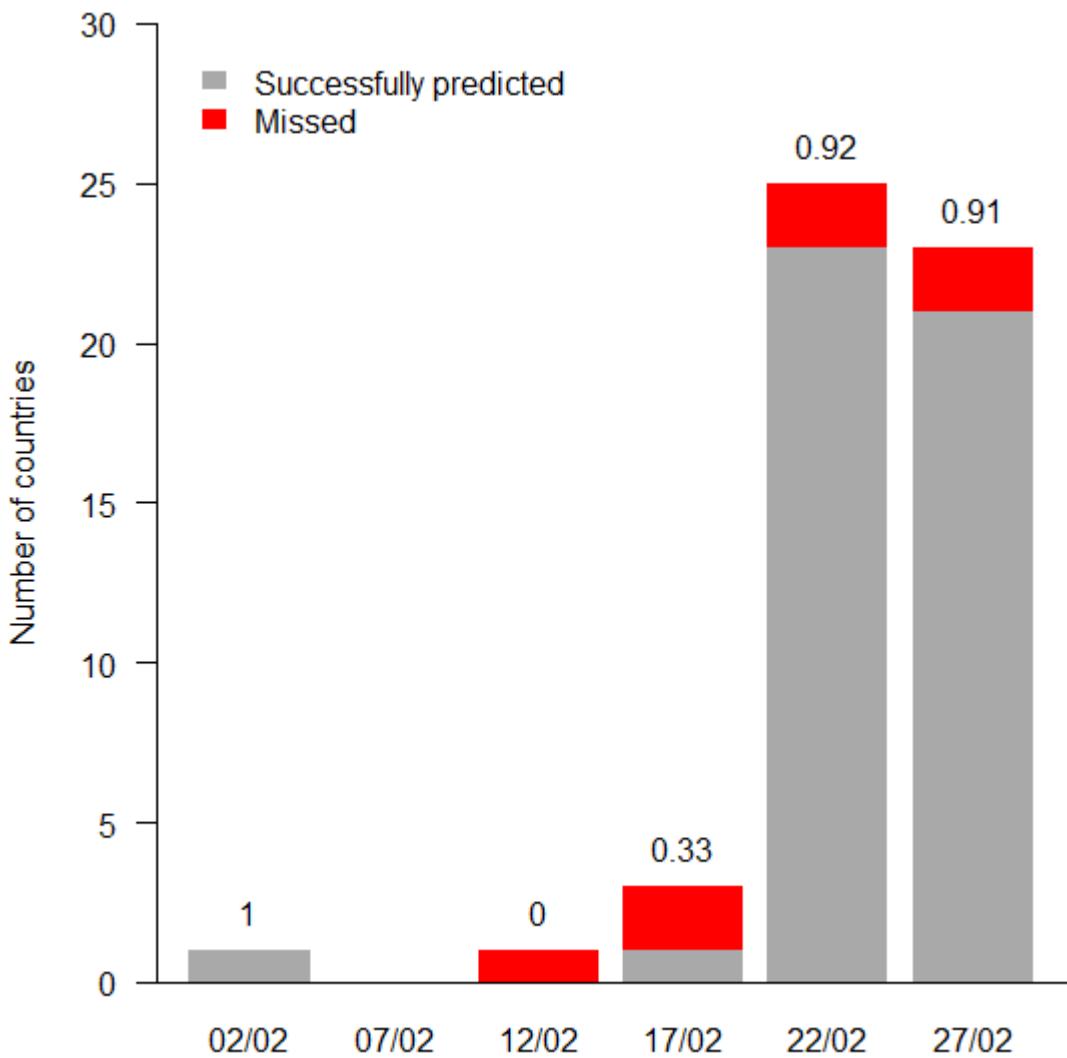
Analysis was performed in R version 3.6.0³, which was also used for the creation of the Figures and Maps.

References

1. Fick SE, Hijmans RJ. Worldclim 2: new 1-km spatial resolution climate surfaces for global land areas. *Int J Climatol* 2017; 37: 4302–4315. <https://doi.org/10.1002/joc.5086>
2. Phillips SJ, Anderson RP, Dudík M, Schapire RE, Blair ME. Opening the black box: an open-source release of Maxent. *Ecography* 2017; 40: 887-893. doi:10.1111/ecog.03049
3. R Core Team (2019). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/>.

eTable 1. Bioclimatic variables

| Variable | Description | Temporal Scale |
|----------|--|----------------|
| BIO1 | Annual Mean Temperature | Annual |
| BIO2 | Mean Diurnal Range (Mean of monthly (max temp - min temp)) | Variation |
| BIO3 | Isothermality (BIO2/BIO7) (* 100) | Variation |
| BIO4 | Temperature Seasonality (standard deviation *100) | Variation |
| BIO5 | Max Temperature of Warmest Month | Month |
| BIO6 | Min Temperature of Coldest Month | Month |
| BIO7 | Temperature Annual Range (BIO5-BIO6) | Annual |
| BIO8 | Mean Temperature of Wettest Quarter | Quarter |
| BIO9 | Mean Temperature of Driest Quarter | Quarter |
| BIO10 | Mean Temperature of Warmest Quarter | Quarter |
| BIO11 | Mean Temperature of Coldest Quarter | Quarter |
| BIO12 | Annual Precipitation | Annual |
| BIO13 | Precipitation of Wettest Month | Month |
| BIO14 | Precipitation of Driest Month | Month |
| BIO15 | Precipitation Seasonality (Coefficient of Variation) | Variation |
| BIO16 | Precipitation of Wettest Quarter | Quarter |
| BIO17 | Precipitation of Driest Quarter | Quarter |
| BIO18 | Precipitation of Warmest Quarter | Quarter |
| BIO19 | Precipitation of Coldest Quarter | Quarter |



eFigure 1. Sensitivity of model predictions. Each bar represents the count of new infected countries of the report coming after each model.