

SUPPLEMENTARY INFORMATION

Deep Learning-derived Optimal Aviation Strategies to Control Pandemics

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I. Dataset Figures

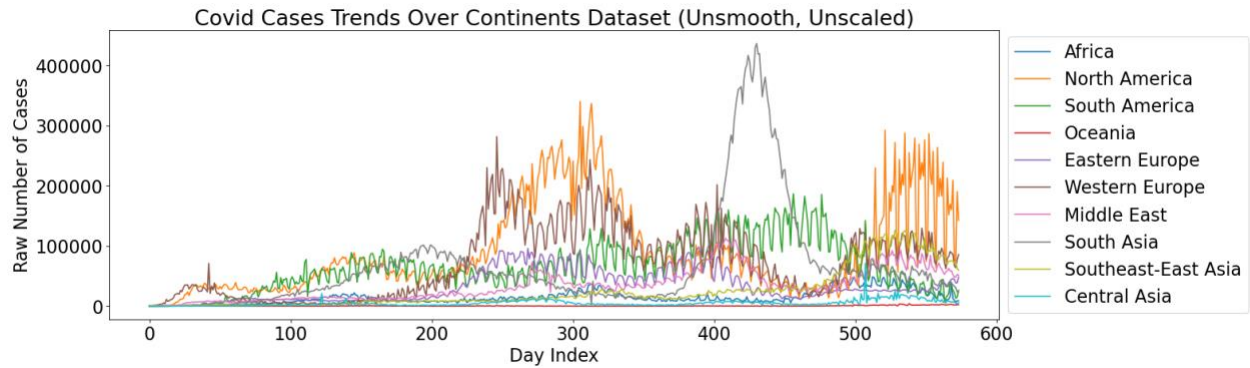


Figure S1. COVID-19 cases per day. Daily COVID-19 infections trend for each geographical region plotted across the dataset.

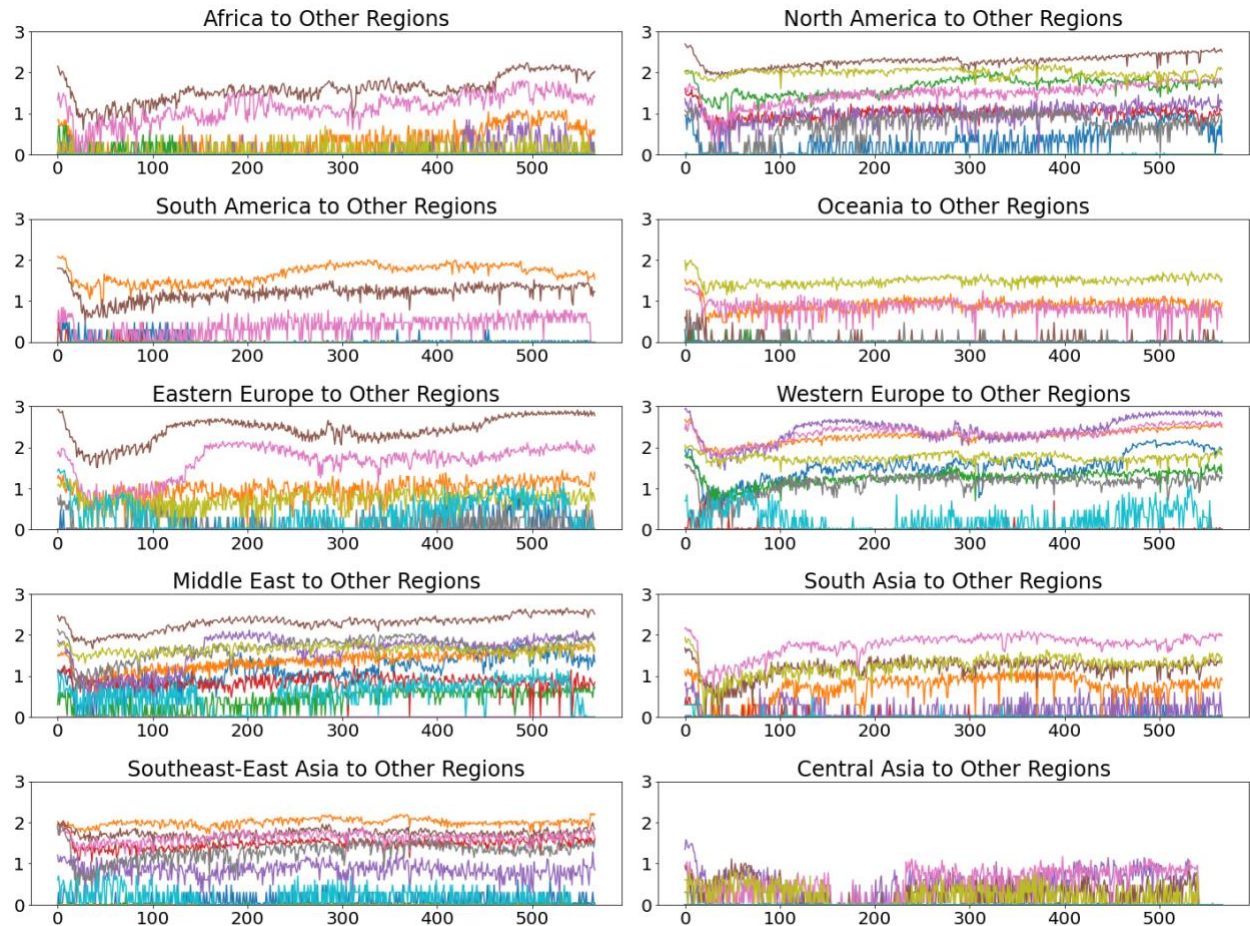


Figure S2. Outgoing flights per geographical region. Outgoing international flights plotted for each geographical region across the dataset. Each subplot depicts each of the 9 other destination regions color coded.

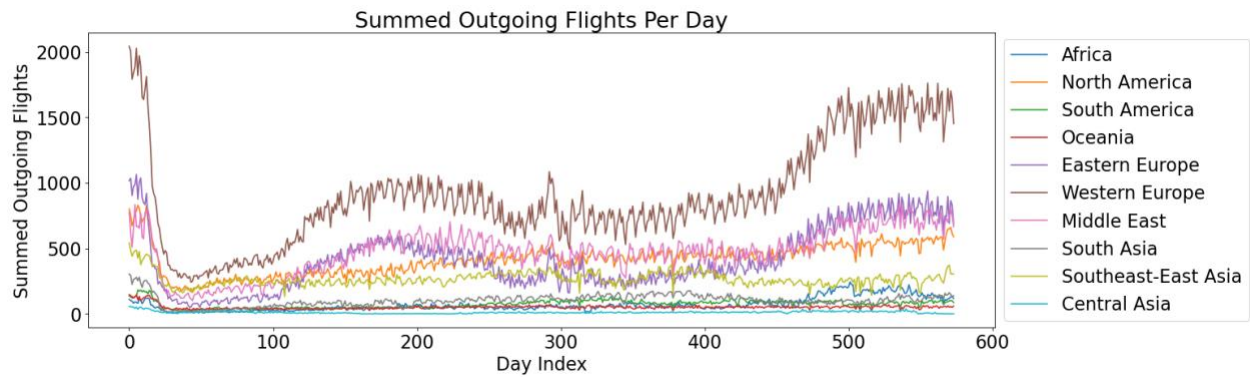


Figure S3. Total outgoing flights per day. Outgoing total international flights of each geographical region plotted across the dataset.

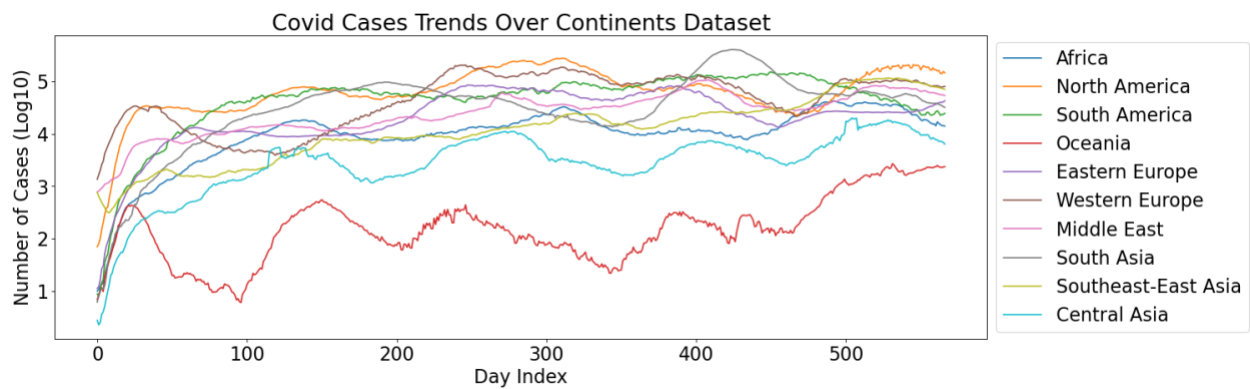


Figure S4. Smoothened and $\log_{10}$ transformed COVID-19 cases. Daily COVID-19 infections trend for each geographical region after smoothing with a 7-day moving average and $\log_{10}$ transformation.

II. Additional DCSAGE Results

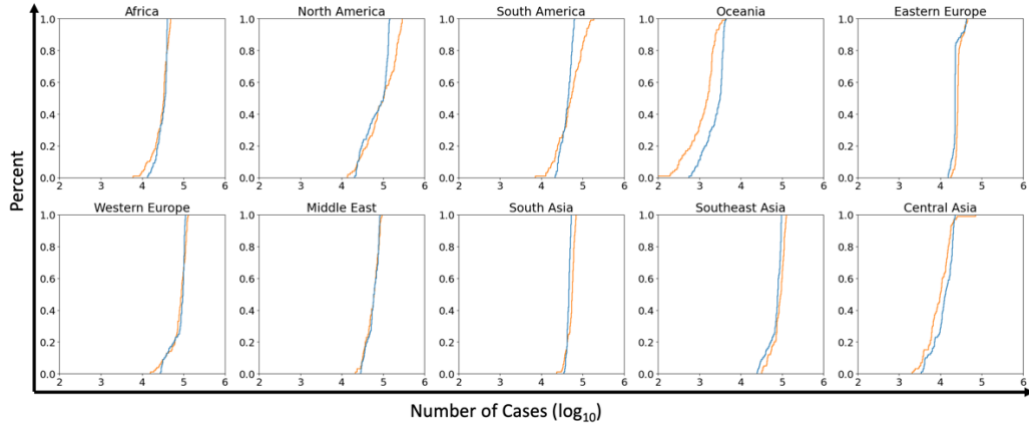


Figure S5. DCSAGE prediction cumulative distribution plots. Cumulative distribution plots of DCSAGE predictions on test set data. Blue represents model predictions, with orange representing ground truth cases.

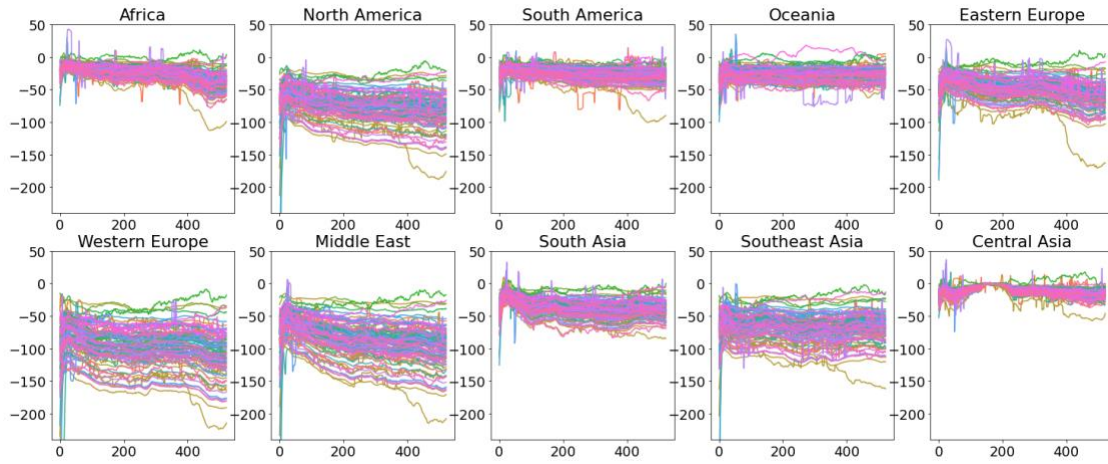


Figure S6. DCSAGE sensitivity score trends. Sensitivity score trends from 100 DCSAGE models across all 7-day data input windows in our dataset. Each subplot represents sensitivity scores for one geographical region.

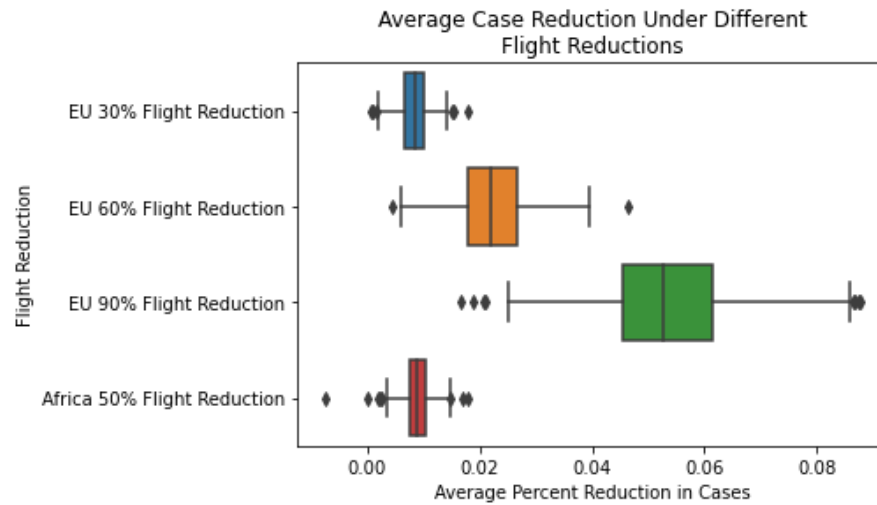


Figure S7. DCSAGE Perturbation Steps. Distribution of percent reductions in cases when increasingly large flight reductions are applied to Western Europe on a random test set window. A 50% flight reduction in Africa is shown for comparison to a larger reduction in the 2nd-least sensitive region.

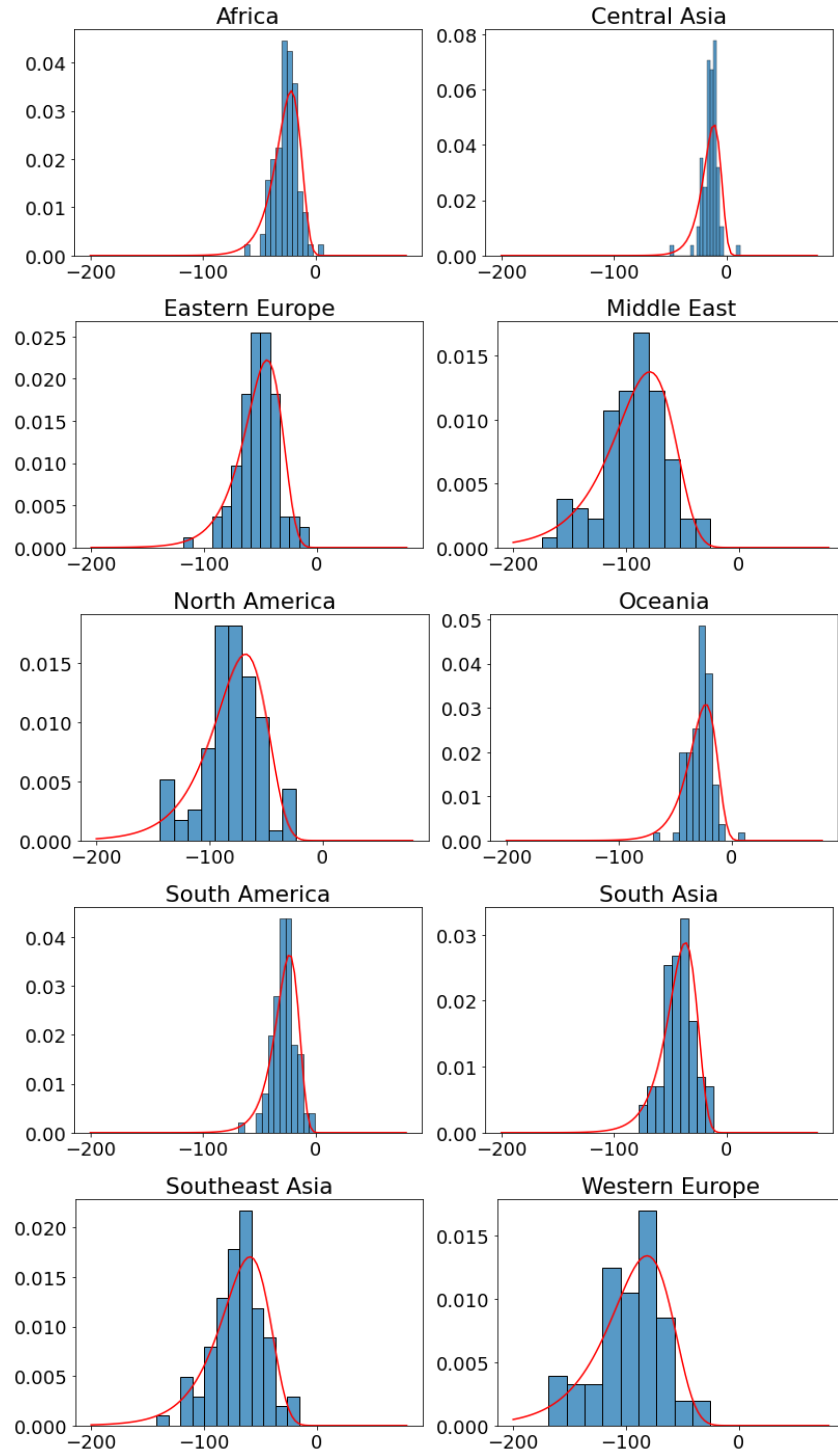


Figure S8. DCSAGE Extreme Value distribution fits. Gumbel distribution (Extreme Value Type I) distributions fitted on sensitivity score distributions for each geographical region on the first window of the dataset. Sensitivity score is plotted along the x-axis, and probability is shown on the y-axis. Sensitivity score distributions comprise of sensitivity scores for 100 DCSAGE models on the given window of the dataset.

III. MPNN Results

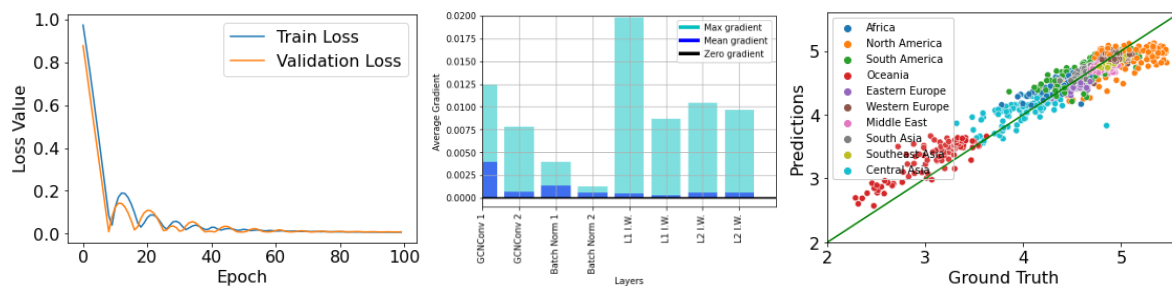


Figure S9. MPNN Training Figures. Loss curves (left), gradient flow plot (middle) and test set ground truth vs prediction correlation plot.

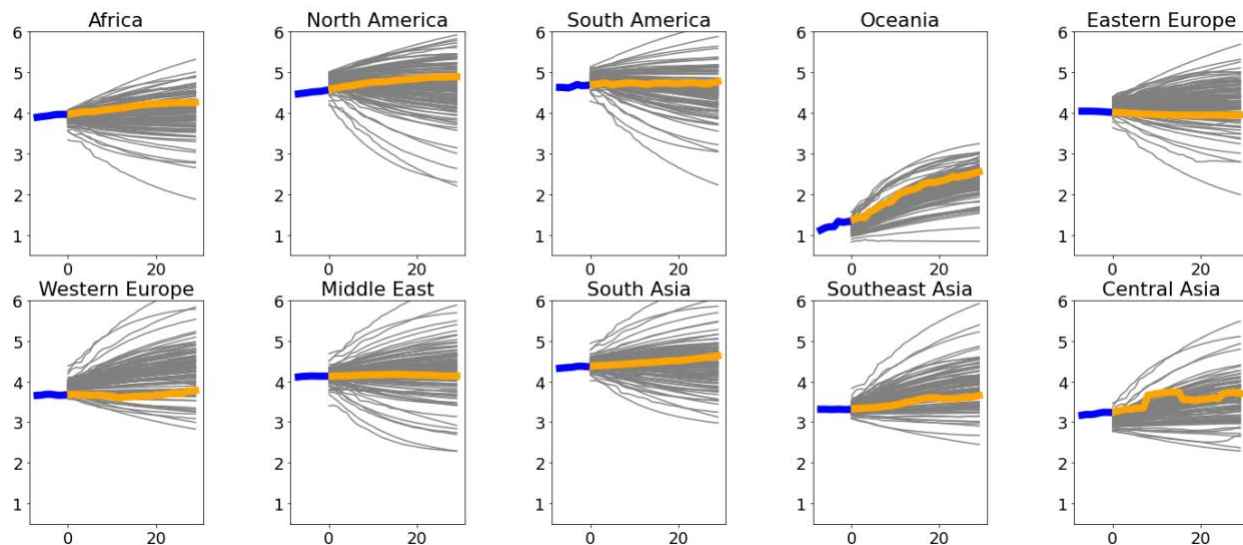


Figure S10. MPNN Bias corrected predictions. Recursive predictions of 100 MPNN models on the first dataset window after bias corrections.

IV. Bias Correction Factors

Table S1. Bias correction factors. Bias correction factors calculated for DCSAGE and MPNN across the entire dataset.

	DCSAGE	MPNN
Africa	1.027	0.969
North America	1.089	1.066
South America	1.185	1.064
Oceania	0.563	0.687
Eastern Europe	1.048	1.028
Western Europe	0.998	1.023

Middle East	0.975	1.003
South Asia	1.116	1.021
Southeast Asia	0.935	0.964
Central Asia	0.926	0.889