

# Impact of COVID-19 on Air Traffic in the United States

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Week 5/6 Group Project

**Abstract**—This project focuses on the impact that the COVID-19 pandemic has had on the domain of human mobility and revenue generation specific to the aviation industry in the USA. Both airspace and aerodrome densities were chosen as a metric to analyze the impact the pandemic has had, and a collection of both federal and state mandates were examined to identify a point of decline in air transport over three major regions that contain hubs that are crucial to both air transport and the supply chain in the United States. Air traffic was found to decrease significantly following the outbreak of the pandemic, specifically coinciding with the WHO declaring COVID-19 a pandemic, the US President declaring a National Emergency and imposing a travel ban on flights from Europe, and the enacting of stay-at-home orders by US states.

## I. DESCRIPTION OF THE DATASETS

This work analyzes and visualizes the trends of air traffic in the United States before and after the COVID-19 pandemic struck. This project is focused on regional airspaces (Chicago, New York, and Los Angeles) that have historically contained the densest and busiest air traffic. The data used is historical data from the year 2019 to 2020. Specific dates were chosen to generate heatmaps that visualize the density of the airspace over a specific area, defined by bounding box coordinates. The dates used are 'February 25th, 2020' for pre-COVID, and 'April 7th, 2020' for post-COVID. All aircrafts logged over the specified coordinates are filtered to be aircrafts flying above or equal to 10,000 ft AGL regardless of aircraft type, operator, or type of flight. Commercial scheduled, commercial non-scheduled, cargo, and general aviation flights are also recorded.

Data was obtained from three separate sources. Airport data was collected from a crowdsourced dataset [26] and joined with a secondary dataset containing flight data and air traffic data sourced from OpenSky, using the 'traffic' toolkit available to Python via Conda [25], [27]. Additional flight data and aggregations were obtained by interfacing with the database using a python script for each extract and transform action using OpenSky's Impala and Hadoop shell.

The main data frame with a concatenated form of all flight data from 2019 to 2020, named ‘flightlist,’ contains 16 columns and approximately 53.5 million rows. Table 1 below outlines this information.

TABLE 1: AIR TRAFFIC VARIABLES

Variable	Data Type	Description
callsign	String	Flight identifier on ATC screens.
number	String	Commercial flight number, when available.
icao24	String	Unique transponder ID.
registration	String	Aircraft tail number (Unique).
typecode	String	Aircraft model type and number.
origin	String	Four letter ICAO airport identification.
destination	String	Four letter ICAO airport identification.
firstseen	Datetime	UTC timestamp of the time when the OpenSky network first received a squawk code from the transponder.
lastseen	Datetime	UTC timestamp of the time when the OpenSky network last received a squawk code from the transponder.
day	Datetime	UTC day of the last squawk received by OpenSky.
latitude_1	Integer (Latitude)	Location latitude when first squawk was received.
longitude_1	Integer (Longitude)	Location longitude when first squawk was received.
altitude_1	Integer	Location height when first

		squawk was received.
latitude_2	Integer (Latitude)	Location latitude when last squawk was received.
longitude_2	Integer (Longitude)	Location longitude when last squawk was received.
altitude_2	Integer	Location altitude when last squawk was received.

## II. DATA PROCESSING

A count aggregation was performed on this data frame to produce the number of flights flying into and departing from 5 different major airports by year - KATL (Atlanta), KDFW (Dallas Fort Worth), KORD (Chicago O'Hare), KLGA (New York LaGuardia), and KEWR (Newark), and a trend line was plotted using this extracted data. This plot can be found in Figure 1, where it is elaborated on in more detail. The heatmaps depicting airspace density were produced by filtering all unique flight IDs by their altitude - leaving only flights above an altitude of 10,000 feet AGL as logged information. Any flights below that specified altitude and flights which are awaiting landing and departure at airports were removed and are labelled in the OpenSky dataset as 'onground'. Coordinates of these flights were aggregated together using the 'agg\_latlon()' function defined in the traffic class.

## III. RESULTS

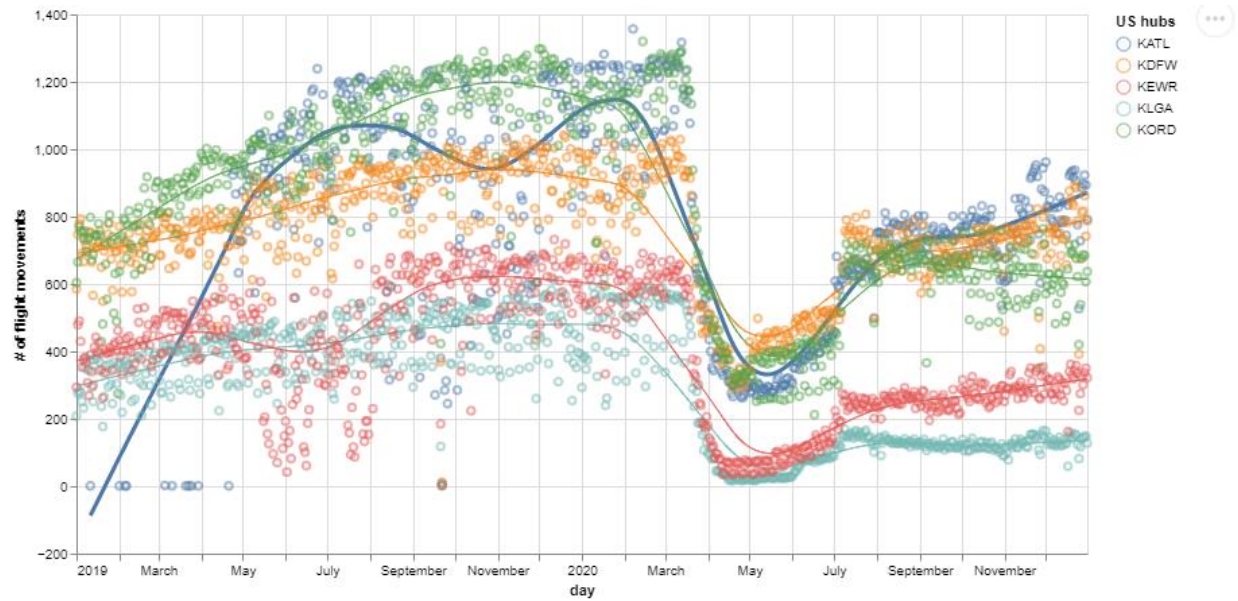


Figure 1: Trend and scatter plot depicting the number of flight movements at 5 major US airports

#### A. Overview

Air traffic patterns appear to be relatively consistent from the beginning of 2019 until February 2020. A steep decline in air travel is noted during the month of February 2020, which is consistent with the timeline presented in Table 2 below. This decline reaches its minimum in May 2020. Air traffic then begins to increase steadily however, each of the five hubs show very different recovery rates. One factor that would play a role in these differences in recovery would likely be the differing mandates and stay-at-home orders issued by state governments and port authorities that govern the operation of these airports. New York City had many strict regulations as COVID-19 broke out and this is reflected by the slow recovery of the Newark (EWR) and LaGuardia (LGA) airports.

#### B. Chicago Area

Governor J. B. Pritzker of Illinois declared a state of disaster for all counties in the state on March 9th, 2020 [7]. Shortly after, on March 20th, Governor Pritzker announced a stay-at-home order for all non-essential individuals, temporary closings of non-essential businesses, and

temporarily prohibiting certain activities such as sports and gatherings [8]. In the same executive order, he called for all travel, “except Essential Travel and Essential Activities,” to be prohibited.

The executive order that stopped travel had an immense effect on flights in and out of Illinois’ largest airport, O’Hare International Airport (KORD). The daily changes in air traffic are displayed in Figure 1. In February 2019, there were approximately 64,000 total flights (arrivals and departures) [10] at KORD, while in February 2020 there were around 68,500 [9]. March 2019 saw over 76,000 flights [11], compared to 65,600 in March 2020 [12]. April is when the two years drastically vary in total flights. There were 74,500 in April 2019 [13], but only 24,300 in April 2020 [14].

Chicago Midway International Airport (MDW) was also heavily affected by Governor Pritzker’s order. MDW had approximately 14,500 flights in February of 2019 [15], 19,100 in March [16], and 19,300 in April [17]. In the beginning of 2020, the flight totals were similar, as February had 15,300 [18]. However, March had just 12,400 flights [19], far less than the 19,000 from the previous year. April 2020 saw the most dramatic decrease, which again is in direct relation to the travel mandate, with approximately 6,700 flights [20].

The difference in total flights before and after the COVID-19 outbreak is displayed in Figures 2 and 3 below. Figure 2 shows the route density for Chicago area airports on February 25, 2020, while Figure 3 shows the same for April 7, 2020, after the executive orders took effect.

Route Density (Chicagoland) Pre COVID19

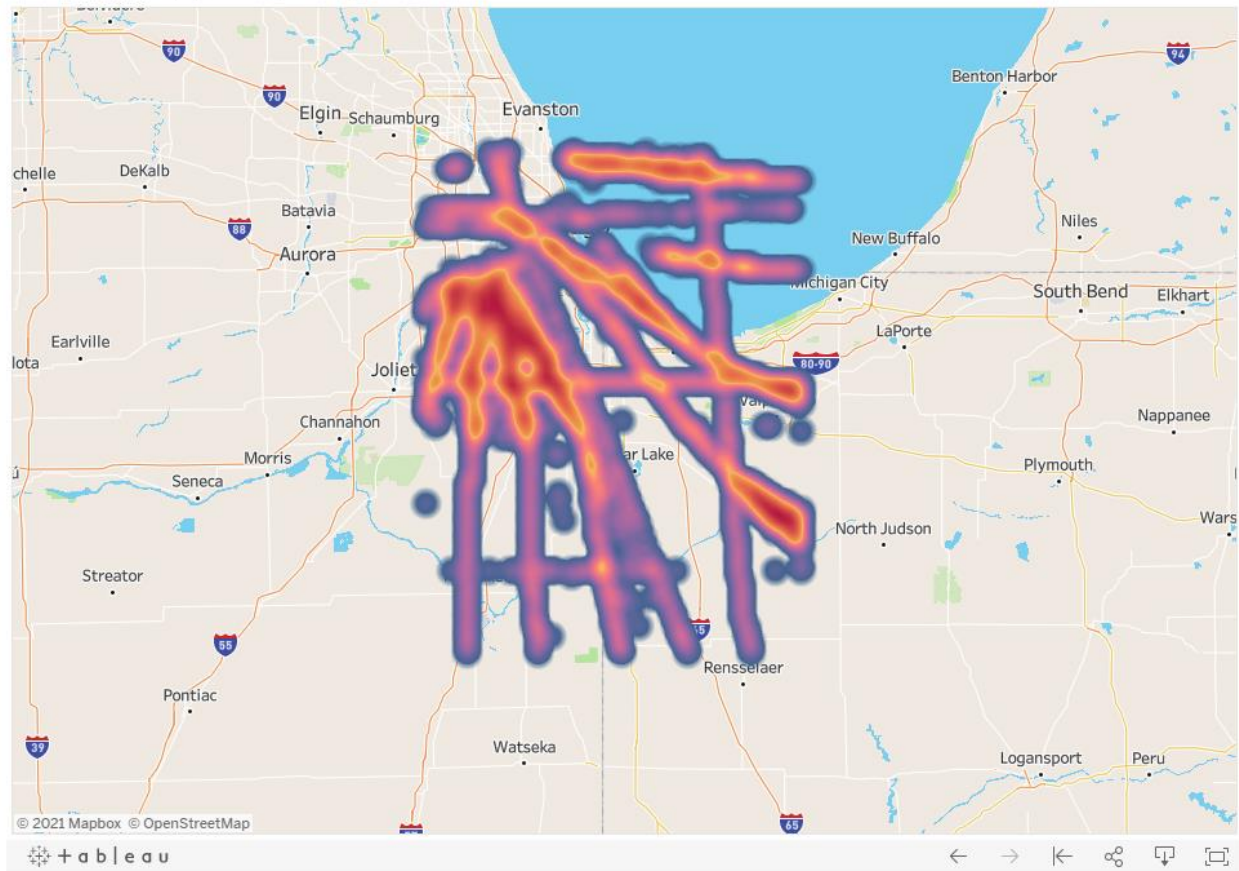


Figure 2: Chicago-area airspace density before COVID-19

Route Density (Chicagoland) Post COVID19

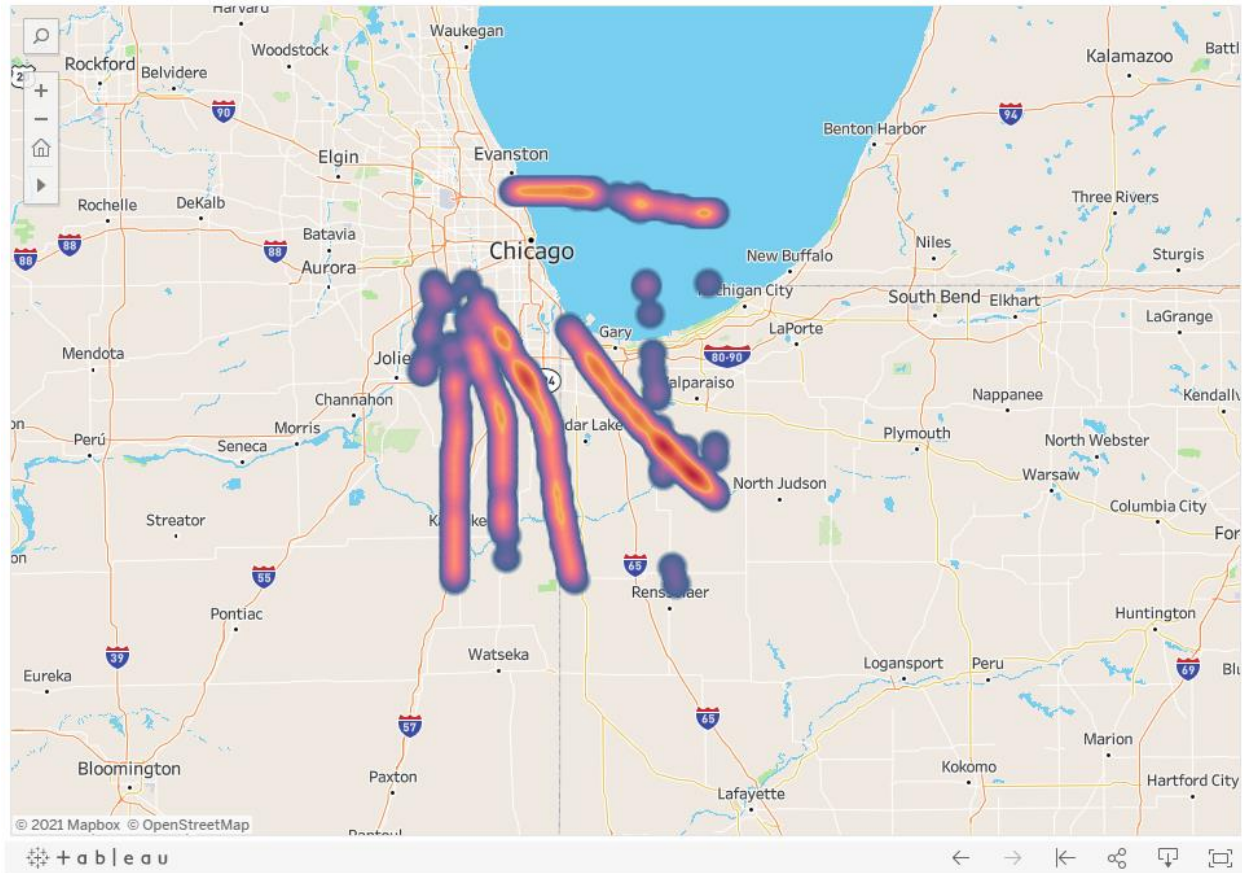


Figure 3: Chicago-area airspace density after COVID-19

### *C. Los Angeles Area*

Due to the COVID-19 pandemic, Governor Gavin Newsome of the state of California declared a State of Emergency on March 4, 2020 [2]. This declaration cited a government code that waived the 30-day limit of such orders [3], thus there was no set end date to the mandate. Restriction of movement orders in California were implemented on March 19, 2020 [1].

Los Angeles International Airport (LAX) is one of the busiest airports in the country. In February 2019, there were around 50,900 flights. In the same month of 2020, there were approximately the same amount [6]. Figure 4 exhibits the density of flights in the Los Angeles area airports. Owing to the mandates that started in March of 2020 there was a large decrease in flights, approximately 20% from March 2019 [5]. In April the stay-at-home orders were in full



effect and that is apparent in both the data and the graphs. In April 2019 there were approximately 56,900 flights, both domestic and international [4]. There was approximately a 72% decrease in flights in April 2020, from the almost 57,000 previously mentioned to approximately 15,500. Figure 5 shows the dramatic decrease in flights from LAX after his proclamation.

Route Density (Los Angeles) Pre COVID19

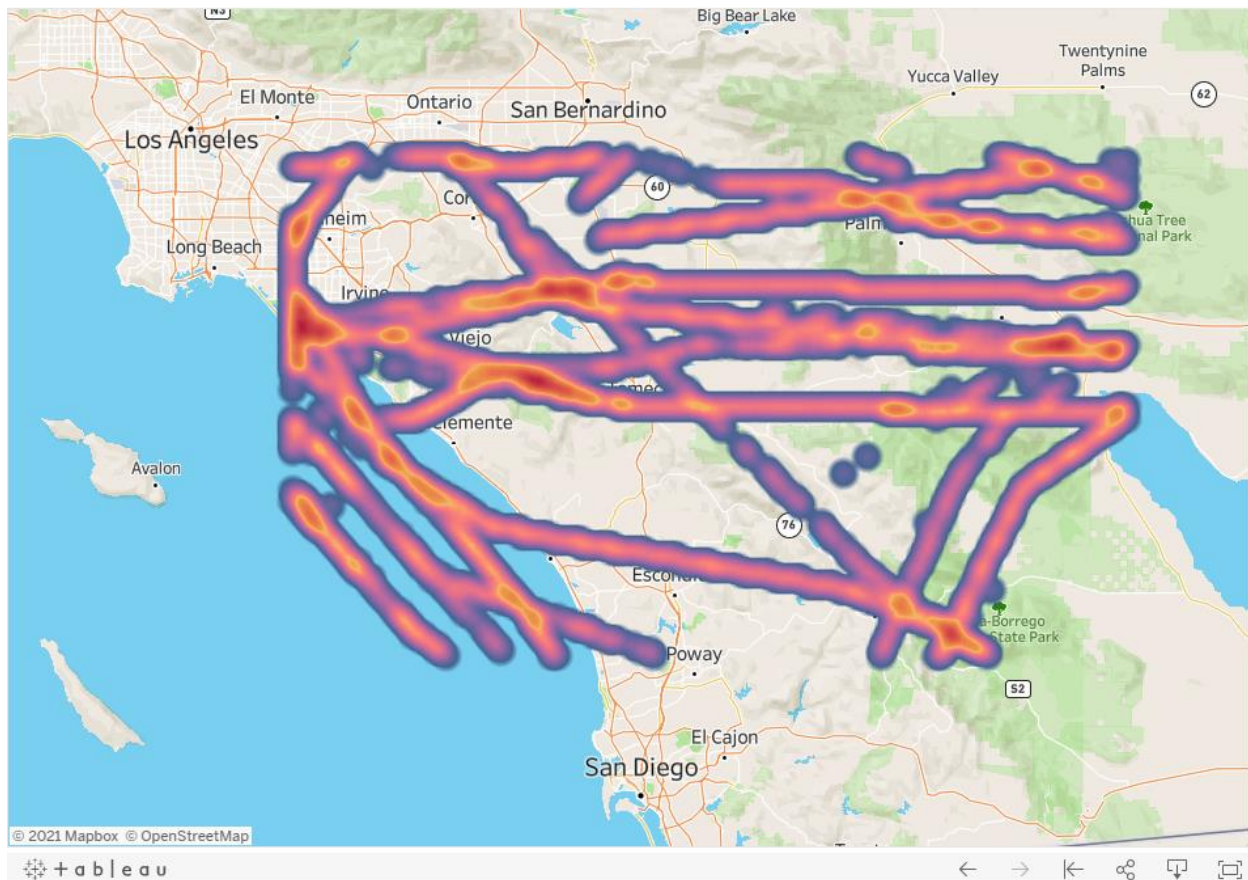


Figure 4: Los Angeles-area airspace density before-COVID-19



Route Density (Los Angeles) Post COVID19

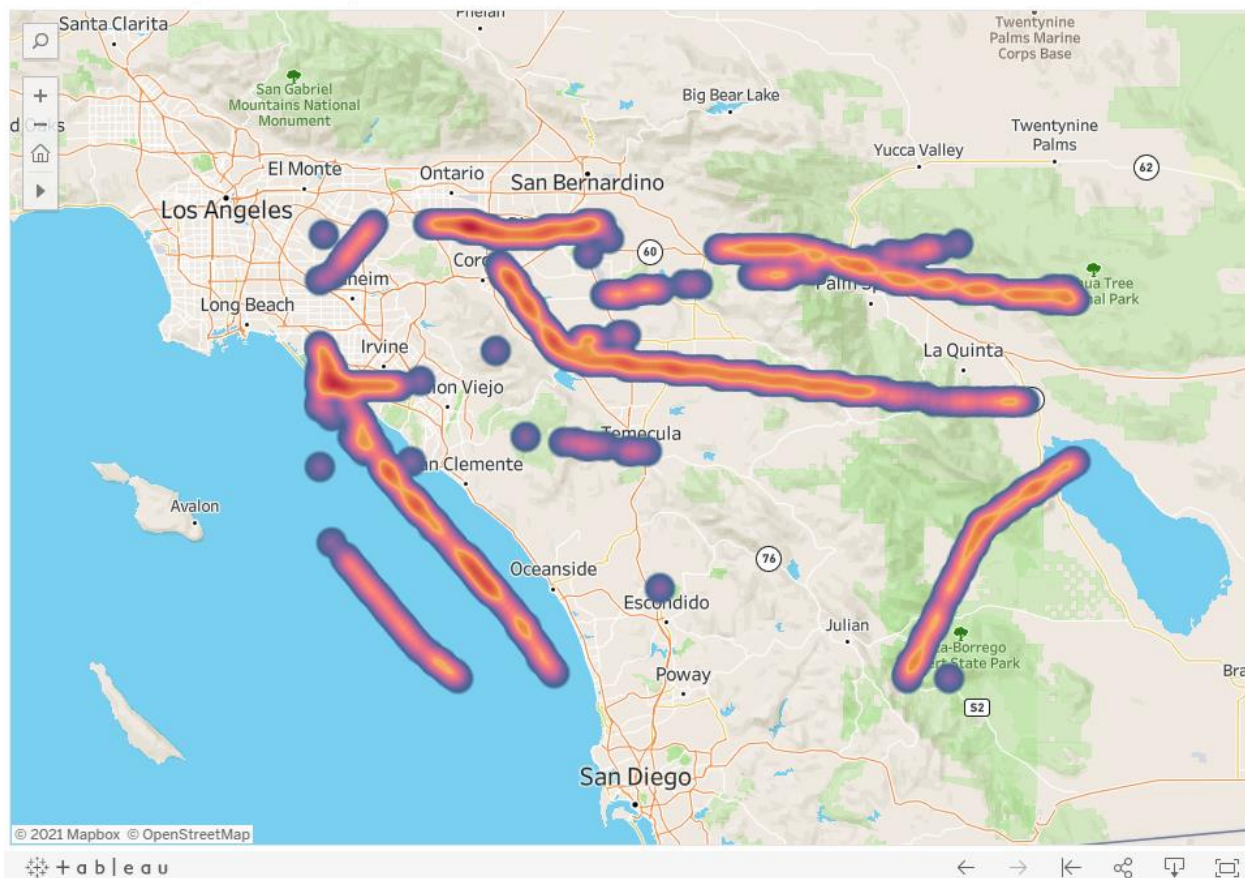


Figure 5: Los Angeles-area airspace density after COVID-19

#### *D. New York City Area*

New York has always had one of the busiest airport systems in the country, in 2019 there were over 1.3 million flights [24]. On March 7, 2020, New York Governor Andrew Cuomo declared a disaster emergency for the state [21]. Soon after on March 20 he mandated the state to be ‘on pause’ [22]. Part of these mandate proclamations stated that New York residents should stay at home as much as possible and included a ban on non-essential travel [23]. Just as with California and Illinois, these mandates impacted all travel in and out of the state.

Per the Port Authority of New York and New Jersey, February 2019 saw around 94,000 flights in the New York airport hub. That same year in March there were over 112,500 flights and April had almost 109,000. The travel restrictions for the state were reflected in the data starting in

March. February of 2020 had almost 100,500 flights while March had around 86,000. The most drastic difference appeared in April of 2020 however, there were a total of 13,320 flights for the New York hub [24]. Figures 6 and 7 display the disparity in flights during these time periods.

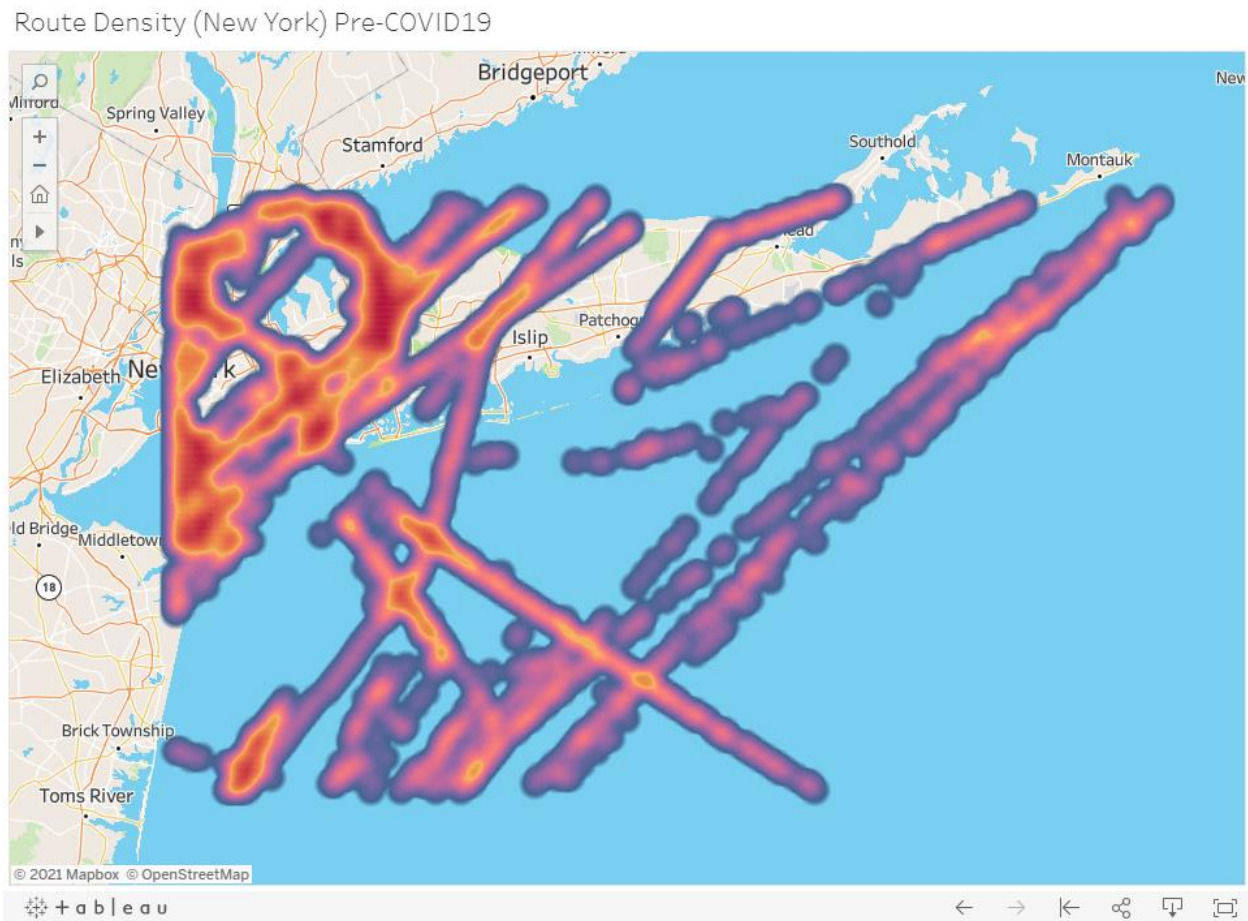


Figure 6: New York-area airspace density before COVID-19

Route Density (New York) Post-COVID

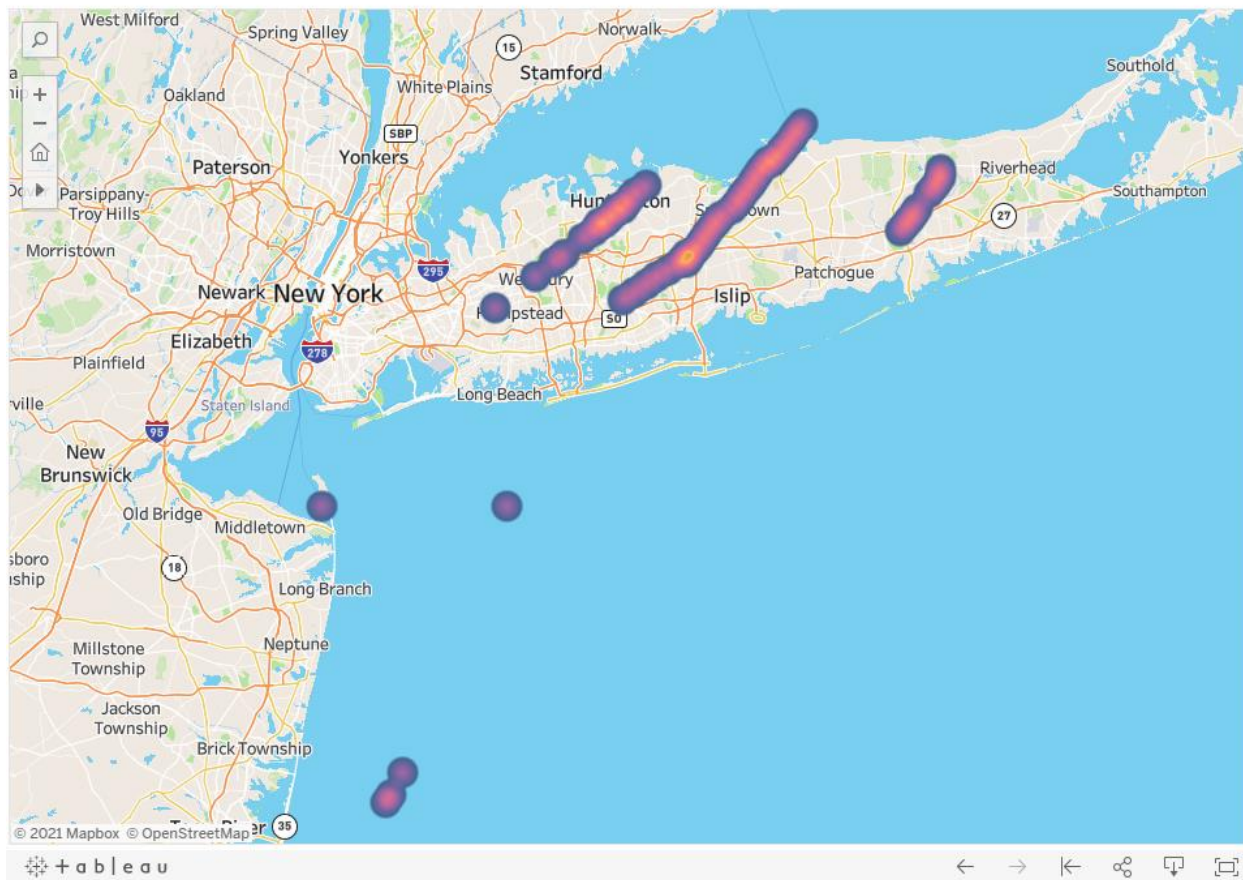


Figure 7: New York-area airspace density after COVID-19

#### IV. CONCLUSIONS / HYPOTHESIS

First of all, the data and figures clearly demonstrate a significant correlation between air traffic and the time period (before or after the outbreak). This should definitely allow us to refer to this relationship as causation. There are many factors that should be considered when looking at these results. As mentioned above, the air traffic data used includes all types of flights. The number of commercial passenger flights definitely decreased dramatically however there were still a fair number of flights that continued to run. Many of these flights may have been non-commercial or cargo flights, but these specific figures are unknown.

The next factors to consider are the events that transpired as the effects of the pandemic spread. The major drop in flights, as seen in Figure 1, happens in the middle of March 2020. This

aligns with a number of notable events as listed in Table 2 below. Some occurrences with the highest significance in terms of US air traffic would include the WHO declaring a pandemic, the US President declaring a National Emergency and instilling a travel ban on non-US citizens traveling from Europe, and the first US states enacting stay-at-home orders. These proceedings themselves limited a number of people from traveling, but even more significantly they alerted the public of the gravity and seriousness of the situation. These mandates and messages certainly had a massive impact on people choosing not to travel or being impeded to do so.

TABLE 2: TIMELINE OF EVENTS

<b>Date</b>	<b>Event</b>
January 9, 2020	WHO Announces Mysterious Coronavirus-Related Pneumonia in Wuhan, China
January 20, 2020	CDC Says 3 US Airports Will Begin Screening for Coronavirus
January 21, 2020	CDC Confirms First US Coronavirus Case
January 31, 2020	WHO Issues Global Health Emergency
February 2, 2020	Global Air Travel Is Restricted
February 3, 2020	US Declares Public Health Emergency
March 11, 2020	WHO Declares COVID-19 a Pandemic
March 13, 2020	President of the United States Declares COVID-19 a National Emergency

March 13, 2020	Travel Ban on Non-US Citizens Traveling from Europe Goes Into Effect
March 19, 2020	California Issues Statewide Stay-at-Home Order (first state to do so)

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