Assessing the Global COVID19 Impact on Air Transport with Open Data

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This paper approaches the impact of the pandemic as a massive service disruption of the pre-pandemic global connectivity and regional air transport networks. In particular, the project aims to provide data analytical evidence for policy success and transformation of the air transportation system. As an aspirational goal, the industry aims to recover in a “greener” manner. The project builds on openly available data sets. The paper will be produced in a reproducible manner making the data, code, and its processing available to interested reseachers and practitioners. The open assessment will provide policy makers with a tool to assess the reaction to local or regional measures.

# 1 Introduction

This paper is heavily informed by the work of (Strohmeier et al. 2021).

For many years, many concerns of the global air traffic management community has been directed to the evident problem of imbalances between capacity and demand. The pressing, increasing demand for air transport registered in the last decade not only has already produced challenging delay management practices, but also fostered projections of even worse scenarios. EUROCONTROL (\_\_\_\_), for example, argued that delays in Europe could reach up to 20 minutes per flight in 2040, in stark contrast to the 12 minutes per flight, as registered in 2016.

In the above scenario, many disturbances on the air navigation system could represent a real threat to multiple stakeholders. Events such as extreme bad weather, unexpected interruptions of air navigation services, changes in regulatory framework and others: all of those inputs could promote even more delay and its propagation effects. That is why the concept of resilience in ATM system became similarly relevant in the agenda during the same period. Arguably, a resilient ATM system could mitigate the negative effects of excessive demands on insufficient capacity and their respective constraints and bottlenecks.

However, the recent COVID-19 crisis posed a completely different, unexpected, and inverted challenge. Demand for air transport dropped as low as 90% of the previous “normal” in many places. Where the lack of capacity was previously the issue, now the lack of demand threatened the ATM system stability. In the financial perspective, airlines and airports had to deal with an unprecedented decrease in incomes. As a result, air navigation providers collected less fees for their services, due to significantly fewer flights. In the operational perspective, pilots and air traffic controllers practiced less. The problems and obstacles developed into many other dimensions.

Hence, the current scenario is a proper moment to further investigate the concept of resilience.

This paper approaches the impact of the pandemic as a massive service disruption of the pre-pandemic global connectivity and regional air transport networks. In particular, the project aims to provide data analytical evidence for policy success and transformation of the air transportation system. As an aspirational goal, the industry aims to recover in a “greener” manner. To date, no assessment of this transformational aspects has been conducted.

* data-analytical approach - using open data / freely available (tbd: validated against organisational data)
* ???RQ1.1 = through a qualitative analysis of previous proposed models
* ???RQ1.2 = through a quantitative analysis of open data

The contribution of this paper are

* conceptualisation of the COVID-19 impact on air transportation as a resilience problem;
* assessing the impact on the basis of open data
* identification of patterns and/or measures to describe and quantify/evaluate the level of recovery (or disruption)

# 2 Background

## 2.1 COVID-19 & Air Transportation

On 11. March 2020, the World Health Organisation reacted to the steadily increasing of infections and global spreach of a newly detected Corona-Virus by declaring a pandemic.

## 2.2 Resilience

Resilience is a well-researched topic. The term is used by a diverse set of domains, communities, and research areas. In consequence there exists an abundance of theoretical definitions in the literature and numerous concepts that emerge from theses definitions and expert domains.

The term originates from physics and is nowadays used with reference to safety, security, environment and ecological systems, mental health/psychology, biological system, and others. Despite the varying contexts, across all of these disciplines the concept of resilience is closely related with the capability and ability of the focus of concern - typically the system or agent - to return to a stable state after a disruption impacted the original state.

Recently, the term is also used frequently on the political and strategic level. Policymakers, operational experts, and academes concur that the concept of resilience plays a major role when addressing and assessing the extent to which organisations and systems are prepared and capable to respond to and recover from disruptions.

Within air navigation, the term ‘resilience’ has been picked up by several communities, both operational and scientific.

EUROCONTROL (2009): first definition of resilience in ATM context – “Resilience is the intrinsic ability of a system to adjust its functioning prior to, during, or following changes and disturbances, so that it can sustain required operations under both expected and unexpected conditions.”

Gluchshenko (2012):

Definitions for Resilience, robustness, disturbance, stress, and perturbation Proposition for a framework of different levels of stress/perturbations Proposition of metrics for resilience (both quantitative and qualitative)

Gluchshenko (2013): repeats the previous ideas and adds a performance-based approach as well as an algorithm to investigate resilience

Project Resilience 2050 (Jun/2012 + 43 months) – includes the previous definitions and other technical tasks. However, it evolves the way to measure resilience. Now, not only the time of deviation and time of recovery is considered. The project measures it as the relative difference of rate of delays correlation, or R = (ax1 – dx1)/dx1 – it has no unit, it’s the difference between two pearson correlations.

Koelle (2015): proposes to address resilience as a situation management and state-oriented problem. Through two case studies, argued that “there is a lack of fit of the current operational ANS performance indicators to address impact of disruptions as they are primarily based on actual timestamps or transition times.”

The unprecedented decline in air transportation since March 2020 has triggered an increased interest in the topic. For example under the umbrella of the ICAO Global Air Navigation Plan Study Group, an expert team is currently working on refining the performance framework with a view to resilience. With a view to COVID, there is a dual interest in understanding resilience in air navigation/transportation:

* political level: ADD SOME DESCRIPTION
* operational level: ADD SOME DESCRIPTION

This paper addresses the operational dimension. Being able to characterise resilience within the operational domain will enable to address the more strategic and political decision-making.

## 2.3 <if we need to fill space> Crowd-Sourced Data Collection

# 3 Method/Materials

A mixed-method approach, based on:

1. to answer RQ1.1, a qualitative analysis of previous models to develop acute low-demand as a disturbance
2. to answer RQ1.2, a quantitative analysis of open data, to observe (or not) different levels/stages of stress/recovery, which could indicate different “more” or “less” resilience to the disturbances

## 3.1 Open-source Data

This study builds on publicly available data. Opensky Network collects crowdsourced air traffic data from more than 2500 feeders (sensor stations). To support the process of illustrating and studying the impact of the COVID pandemic on air traffic demand, a flight-by-flight dataset is provided on a monthly basis (Olive, Strohmeier, and Lübbe 2021). The data spans the period since 1. January 2019. Fig. 3.1 shows the number of daily flights tracked by Opensky Network globally.

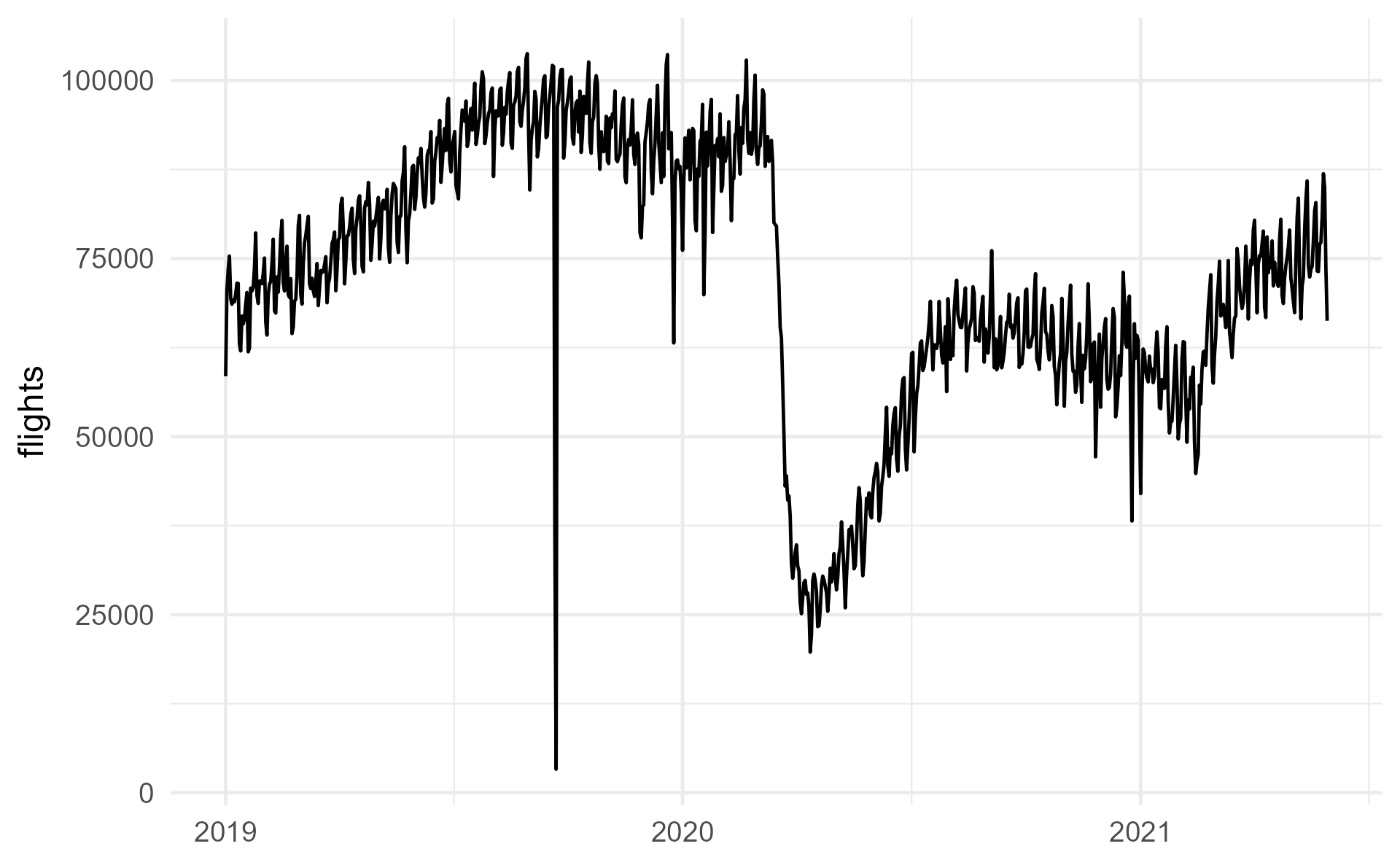


Figure 3.1: Daily flights tracked by Opensky Network

## 3.2 Measuring Resilience

The concept of resilience (and robustness) is intimately linked with the construct of disruptions.

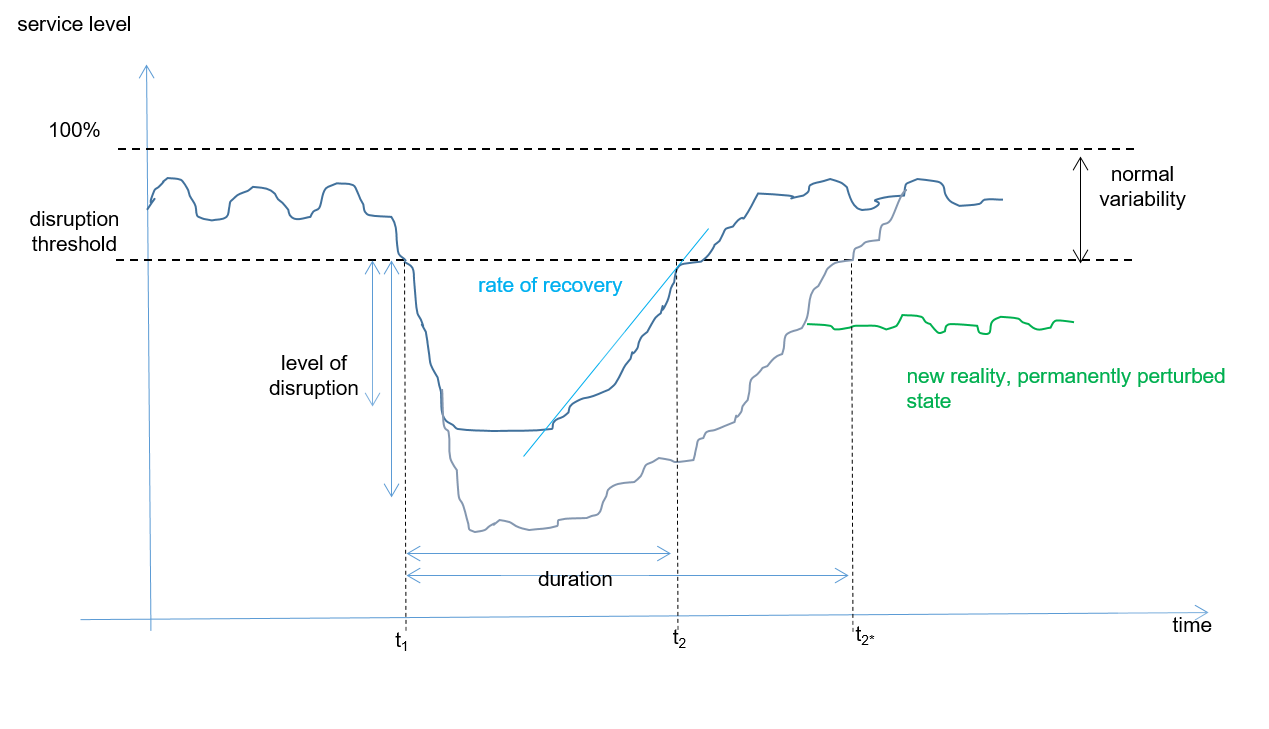


Figure 3.2: Resilience as a function of disturbance impact

Conceptually, resilience R can be measured as the observed loss in quality of service (performance) over the time to recovery, t1-t2, for a certain level of disruption. Thus, mathematically, this represents the area covered by

as presented in Fig. 3.2 (LOS: loss of service / performance, THR: associated threshold).

# 4 Results/Discussion

1.1

1. Resilience can be measured as a function of time - the smaller the relationship between time of stress and the time of recovery, more resilient a system is.

1.2 how to use open data to “see” resilience?

1.2.1 Gather and prepare data

## # A tibble: 6 x 9  
## ADEP ADEP\_CTRY ADEP\_REG ADES ADES\_CTRY ADES\_REG TYPE DATE CALL   
## <chr> <chr> <chr> <chr> <chr> <chr> <chr> <date> <chr>   
## 1 YSSY AU Other EDDF DE EU A332 2019-01-01 CES219  
## 2 LEMD ES EU LEMD ES EU A332 2019-01-01 AEA040  
## 3 YSSY AU Other LFPG FR EU B788 2019-01-01 CXA825  
## 4 UUEE RU EU EDDF DE EU B744 2019-01-01 CLU211  
## 5 KLDJ US US LFPG FR EU B788 2019-01-01 ETH704  
## 6 WIII ID Other RPLL PH Other B77W 2019-01-01 SVA872

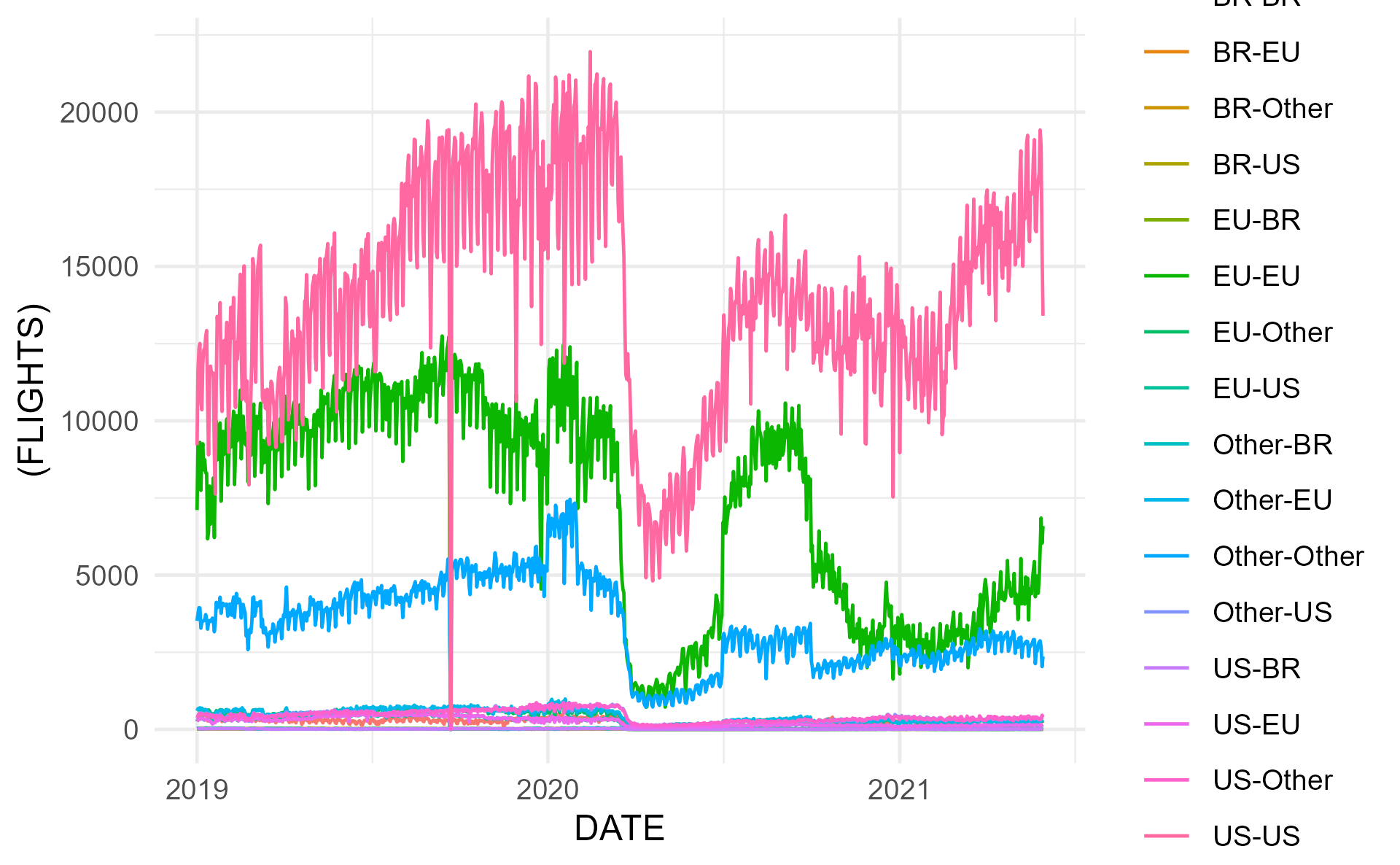


Figure 4.1: test

# 5 Conclusion

# Acknowledgment

# References

Olive, Xavier, Martin Strohmeier, and Jannis Lübbe. 2021. “Crowdsourced air traffic data from The OpenSky Network 2020.” Zenodo. <https://doi.org/10.5281/zenodo.4893103>.

Strohmeier, Martin, Xavier Olive, Jannis Lübbe, Matthias Schäfer, and Vincent Lenders. 2021. “Crowdsourced Air Traffic Data from OpenSky Network 2019-2020.” *Earth Systems Science Data* 13: 357–66. <https://doi.org/10.5194/essd-13-357-2021>.