War impact
on
russian airways

Network Science Project
Zamengo Fulvio - 07/2022

Introduction: inspiring article

Introduction: informative background

- 24/02/22 Russia invasion of Ukraine [en wikipedia Russian invasion of Ukraine]

- 28/02/22 UK ban Russia from its airspace [gov.uk russian economic sanctions]:

  "We have banned Aeroflot and all other Russian commercial and private jets from UK airspace."

  UE follows [consilium.eu new set of measures]:

  "EU member states will deny permission to land in, take off from or overfly their territories to any aircraft operated by Russian air carriers, including as a marketing carrier, or to any Russian registered aircraft, or to non-Russian registered aircraft which are owned or chartered, or otherwise controlled by a Russian legal or natural person."

  Russia hits back [bloomberg russia bans in response to sanctions]

- 01/03/22 also US join the ban [transportation.gov us will block russian]

  "effectively closing U.S. air space to all Russian commercial air carriers and other Russian civil aircraft."

Introduction: goals

- General insights on the flights route network
- Focus on the russian situation
- Russian pre vs post war comparison

Content

Data description

Flights data: source

The data is provided by the OpenSky Network and can be directly downloaded from: https://zenodo.org/record/6797232.

The dataset contains many informations about air traffic, for our purposes only the origin and destination airports code of the tracked flights occurred during the periods of Apr, May and Aug 2021 and 2022 have been selected.

Note: origin and destination airports are computed online based on the ADS-B trajectories. They are left empty if no airport can be found and no further cross-checking has been done.

Flights data: final polished dataset

After polishing the collected data:

- 2021 keep track of almost 4M flights of nearly 500K different airlines

- 2022 keep track of 5M+ flights of 530K+ different airlines

Final 2021 (analog 2022) dataset sample:

origin	destination	cnt
LIPZ	LIRF	174

Airports-info data: source

The data have been downloaded from: https://ourairports.com/data.

The dataset contains mainly location descriptions on the worldwide airports, in particular code, name, continent, country, latitude and longitude.

Note: the dataset keep track of many more airports than the ones active in the flights datasets but a bunch of them are missing. These few missing airports info have been manually added.
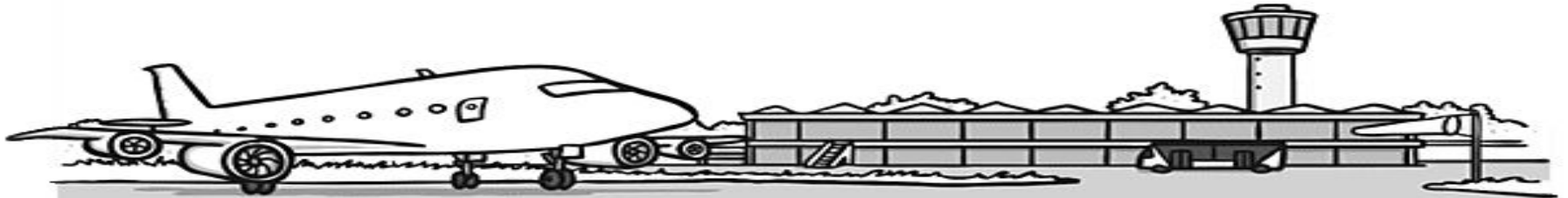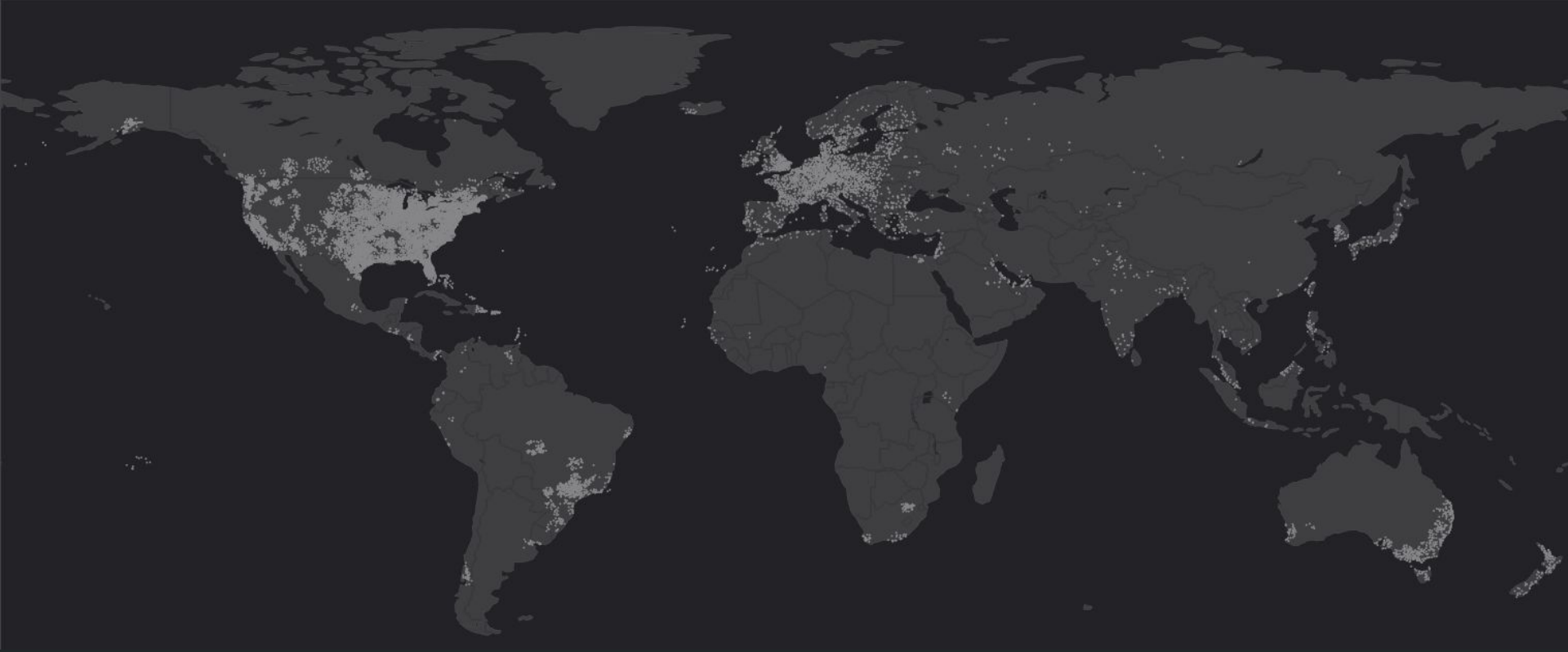
Airports-info data: final polished dataset

After polishing the data the 16K+ airports involved in the flights datasets are recorded (one still missing).

Final dataset sample:

id	name	lat	lon	continent	country
LIPZ	Venice Marco Polo Airport	45.51	12.35	EU	IT

2021/22 Active airports location

2021 Flights routes

2022 Flights routes

# Some Basic analysis

Graph insights

2021:

- #Nodes (airports): 14147

- #Edges (routes): 484006

- #Flights: 3841760

- Density: 0.24%

- Giant strong cc size: 12099
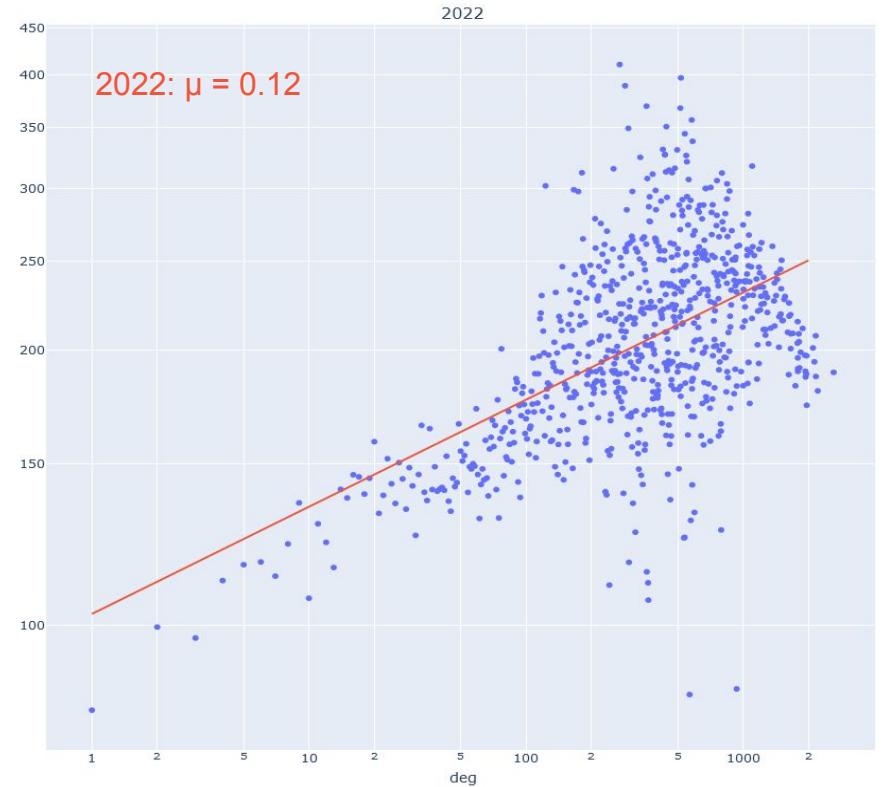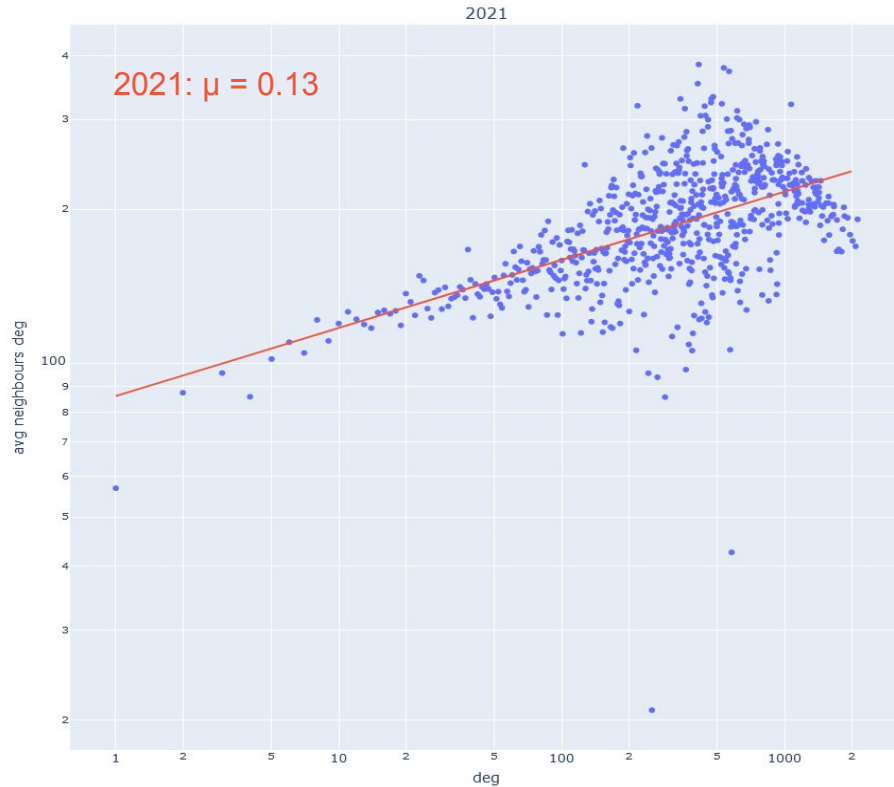
- Giant weak cc size: 14082

2022:

- #Nodes (airports): 14665

- #Edges (routes): 537845

- #Flights: 5112557

- Density: 0.25%

- Giant strong cc size: 12515

- Giant weak cc size: 14644

Degree distribution

2021 Arrivals · 2021 Departures · 2022 Arrivals · 2022 Departures
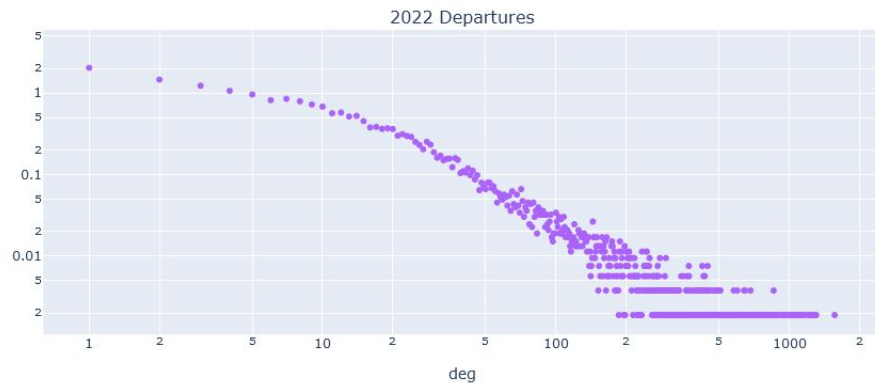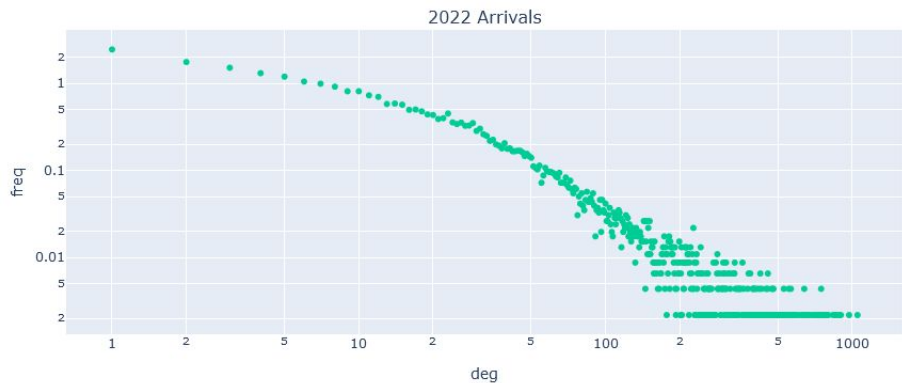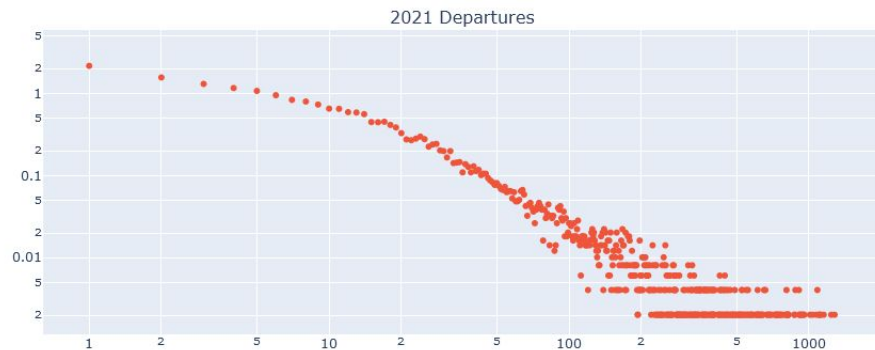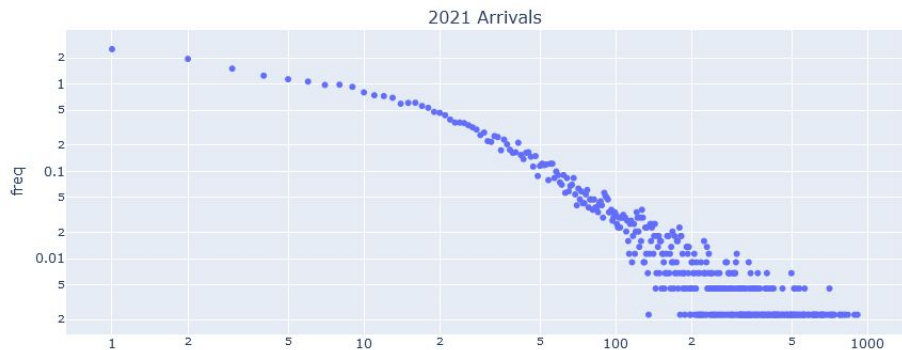
Power-law distribution: many low deg, some hubs

Assortativity: degree vs neighbours avg deg

2021: μ = 0.13

2022: μ = 0.12

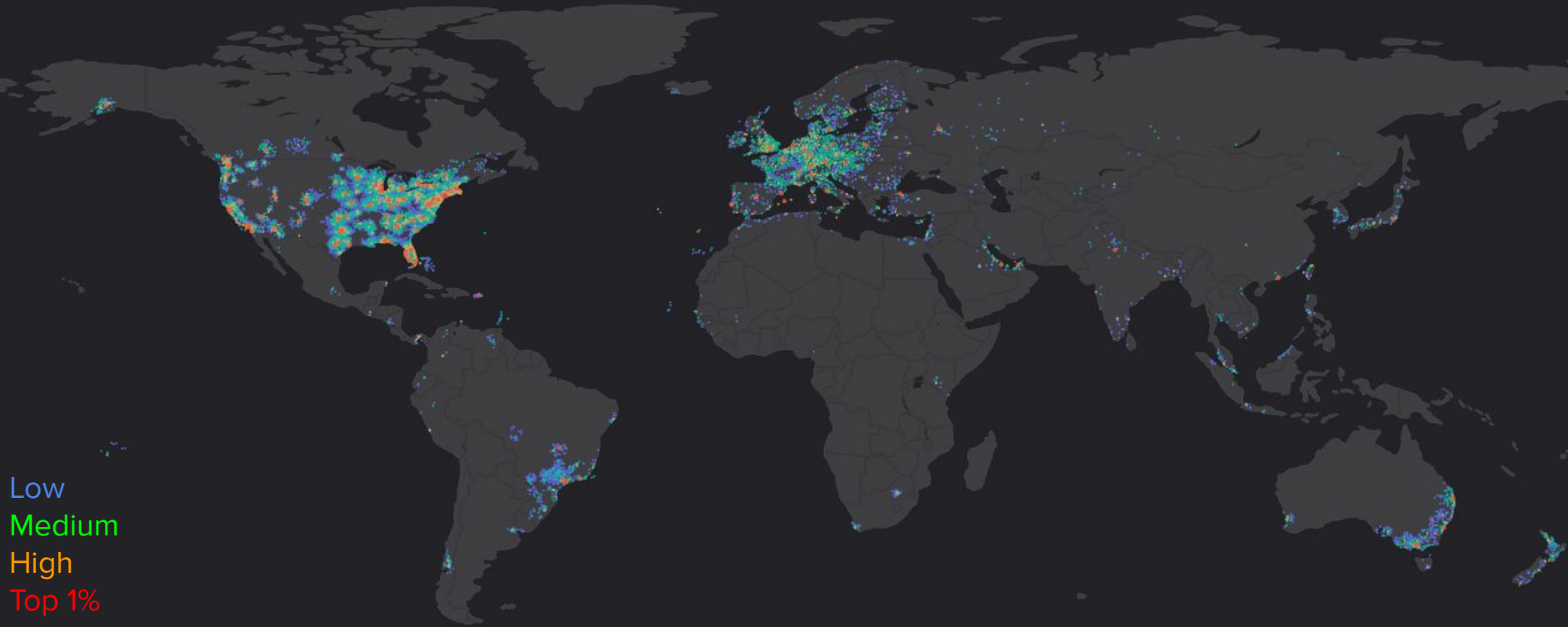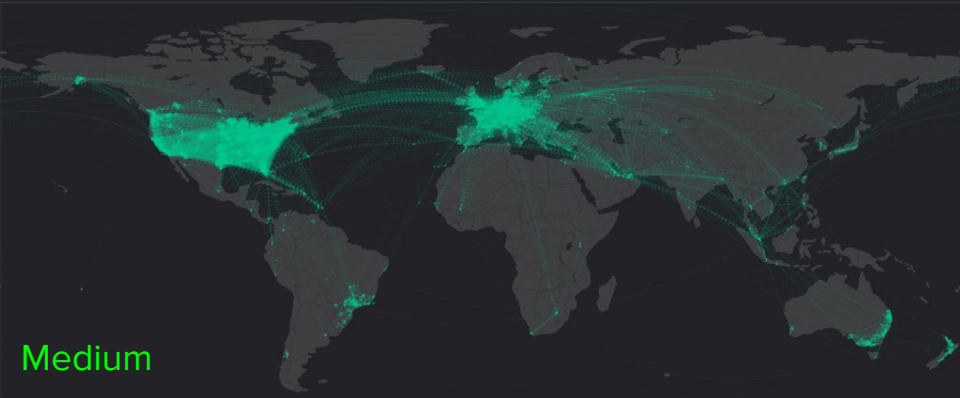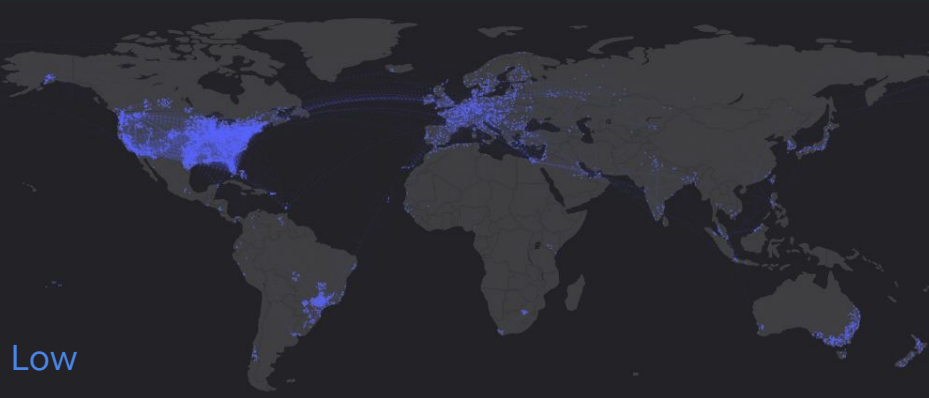Slightly Assortative network (μ > 0)

Airports relevance ranking

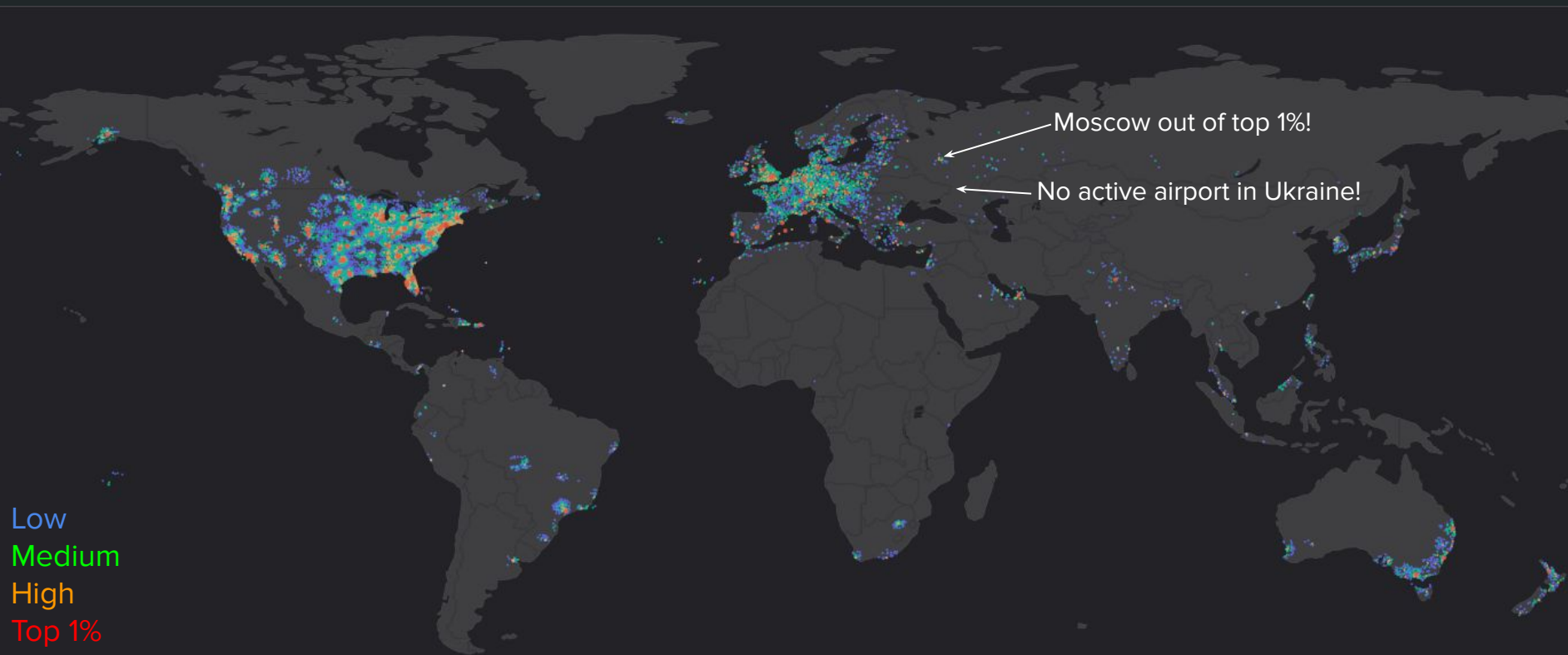# 2021 Active airports relevance

Low
Medium
High
Top 1%

2021 Active airports relevance

Low

Medium

High

Top 1%

2022 Active airports relevance

Moscow out of top 1%!

No active airport in Ukraine!

Low
Medium
High
Top 1%

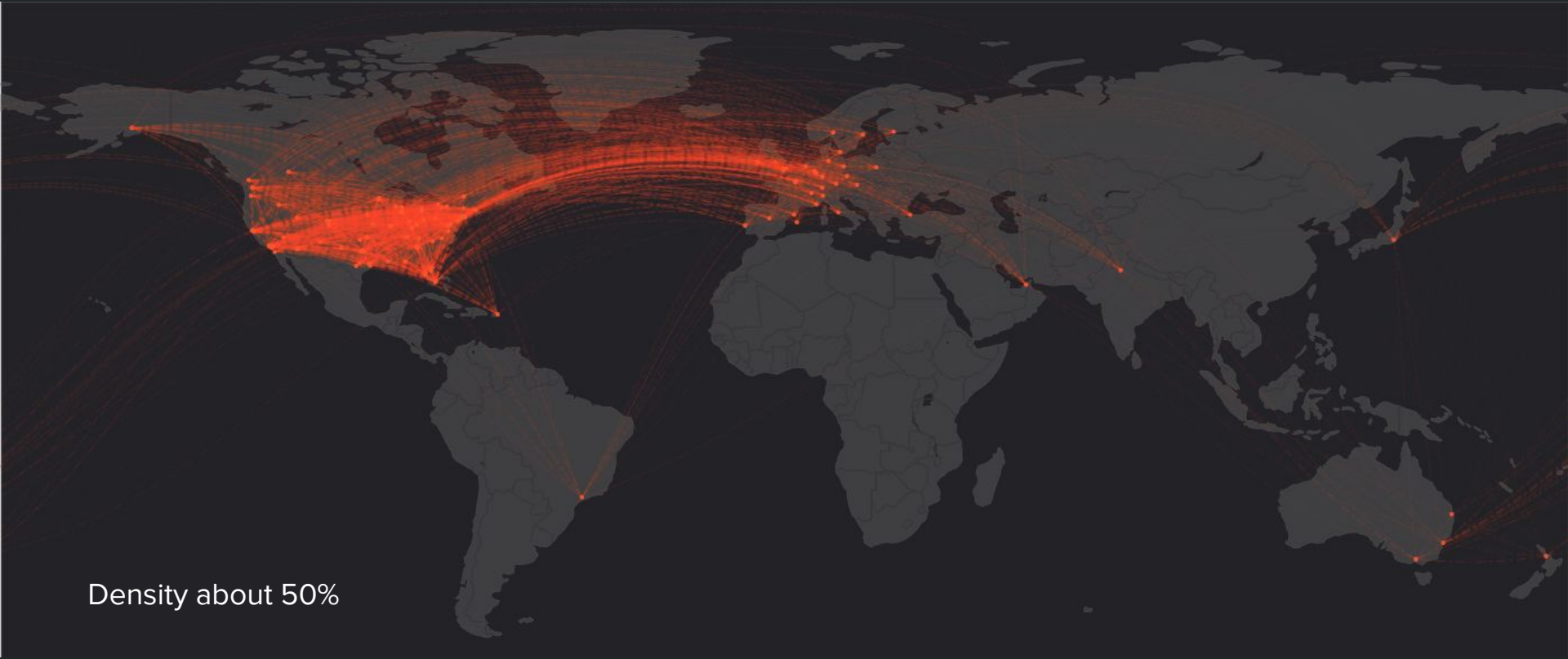# 2022 Active airports relevance

Low

Medium

High
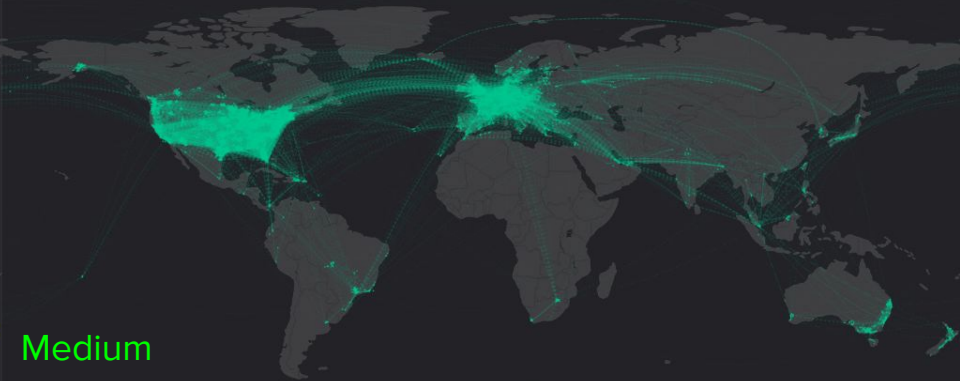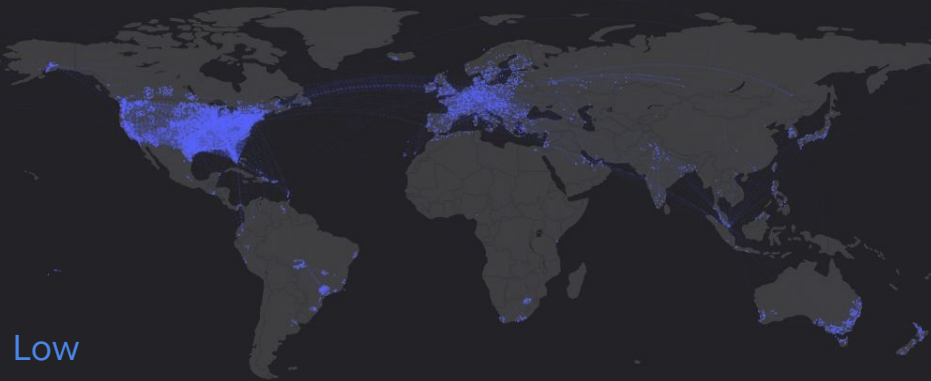
Top 1%

2021 Top 1% "dense sub-network"

Density about 50%

2022 Top 1% "dense sub-network"

Density about 50%

Airports relevance insights

- Relevant airports are much more connected.

- The majority of the airports are in the US and EU and so are many of the most important ones.

- The airports ranking doesn't change significantly between 2021 and 2022.
  Nevertheless It's worth noting that Moscow goes out of the Top 1% club.

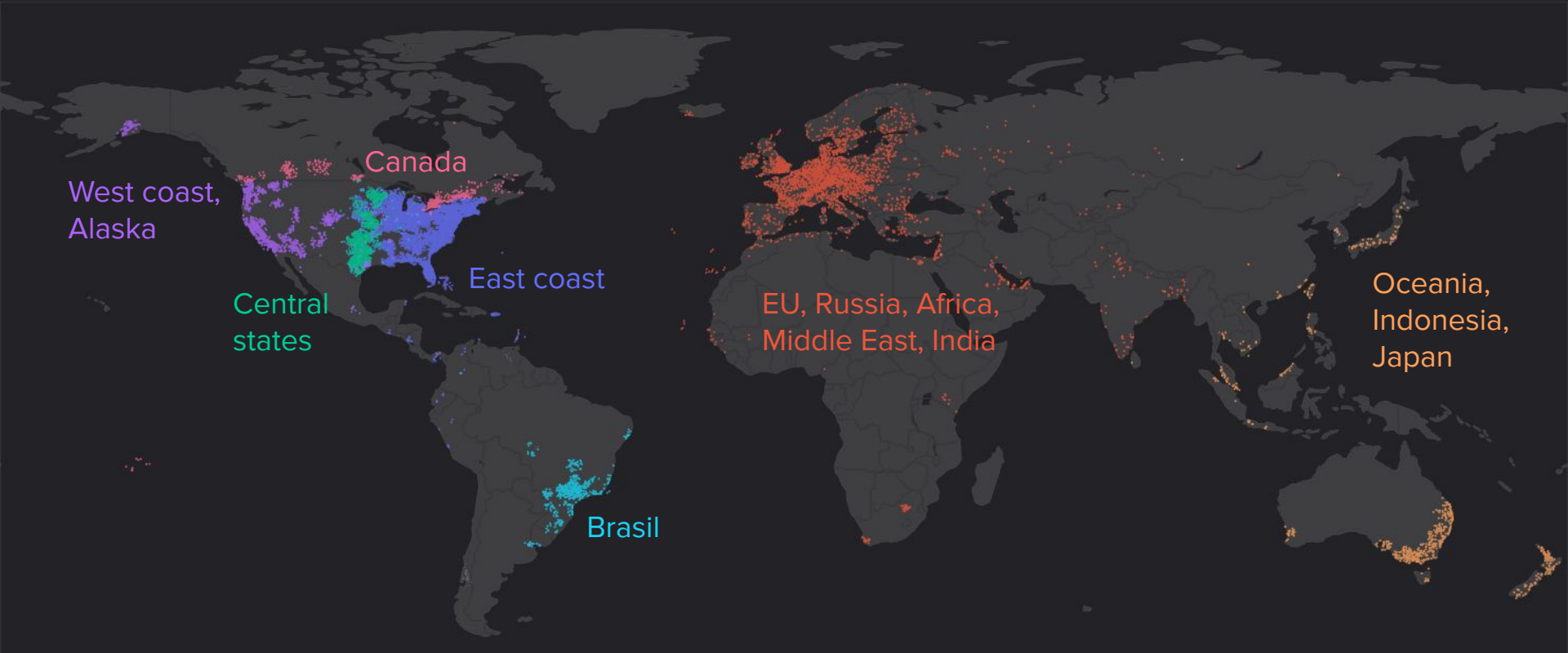- In 2022 all Ukraine airports have suffered a complete shut off.

Technical Note: the relevance class thresholds have been chosen as follows:
Low: 50%, Medium: 90%, High: 99%, Top 1% that correspond to about 140 airports.

Community detection

2021 Communities

West coast, Alaska

Canada

Central states

East coast

Brasil

EU, Russia, Africa, Middle East, India

Oceania, Indonesia, Japan

2021 Communities

West coast, Alaska

Canada

Oceania, Indonesia, Japan

EU, Russia, Africa, Middle East, India

East coast

Central states

Brasil

2022 Communities

West coast

East coast

EU, Africa,
Middle East

Russia

Russia is on its own!

Japan, India,
Indonesia,
Alaska
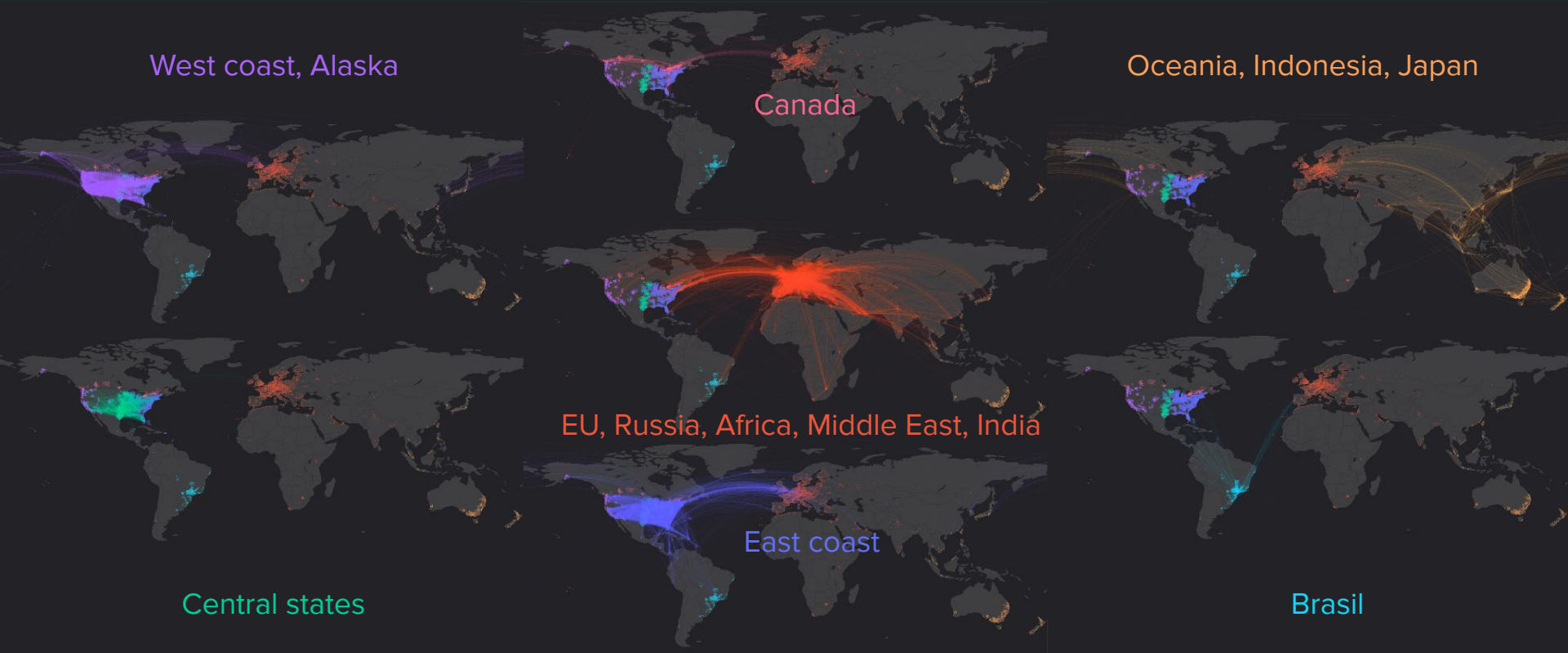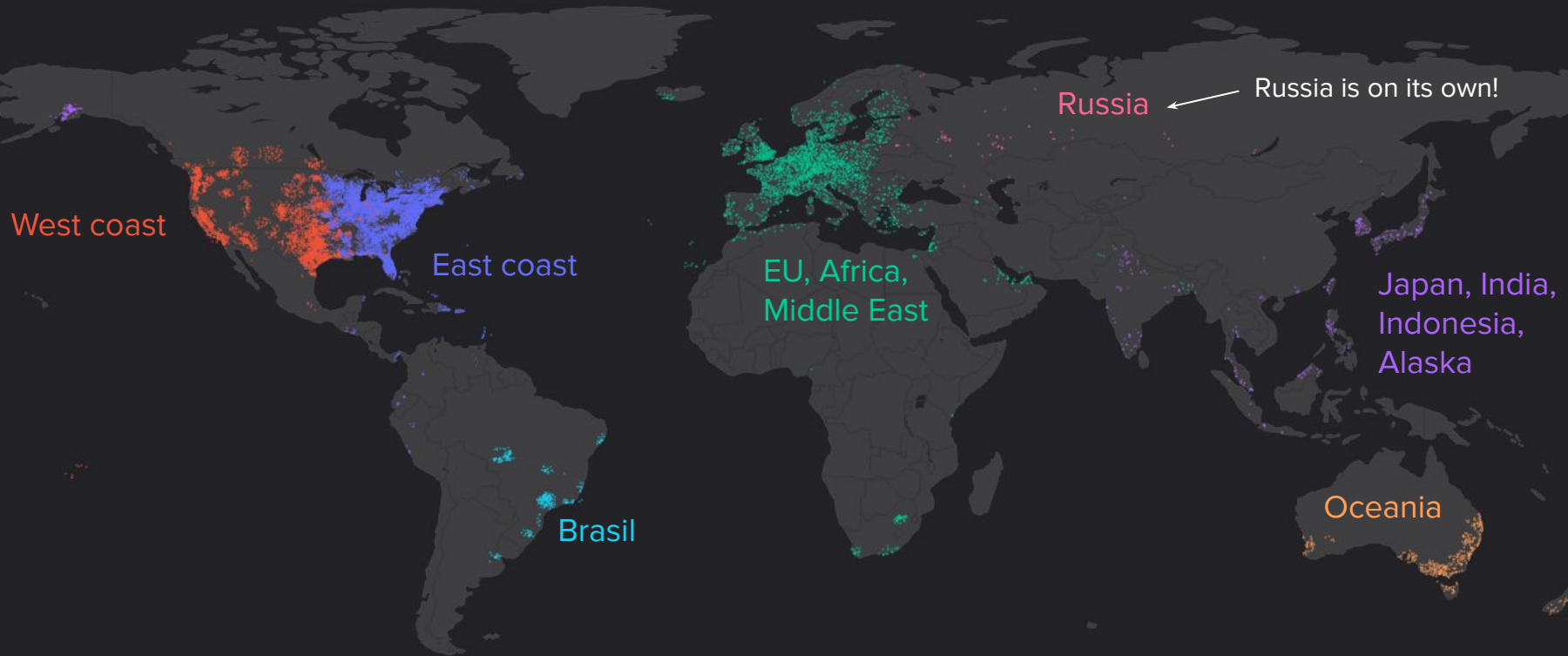
Brasil

Oceania

2022 Communities

East coast

Russia

Japan, India,
Indonesia, Alaska

EU, Africa, Middle East

West coast

Brasil

Oceania

Communities insights

- North America is splitted into 2 different but both quite reasonable ways.

  For both of them the partition is not clear-cut but still fairly decent.

- In 2022 Russia is no more in the EU community* and form a community on its own!
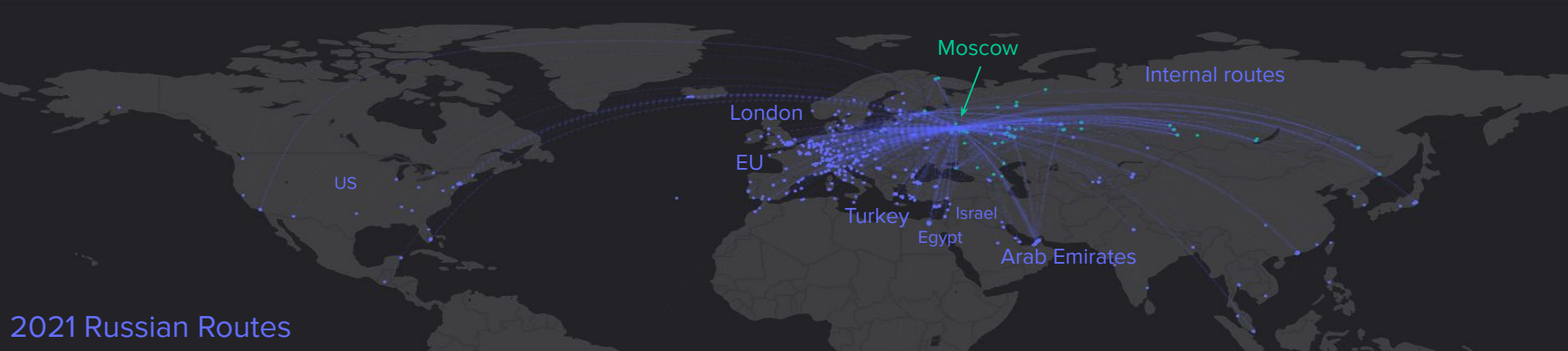
Technical note: the algorithm has been calibrated to look for "macro communities", that in this case are of more interest, but It's possible to look also for finer partitions.

*EU community meaning, in this contest, the EU-UAE-Africa group

Focus on russian airways

2021 vs 2022 russian routes

2021 Russian Routes

2022 Russian Routes
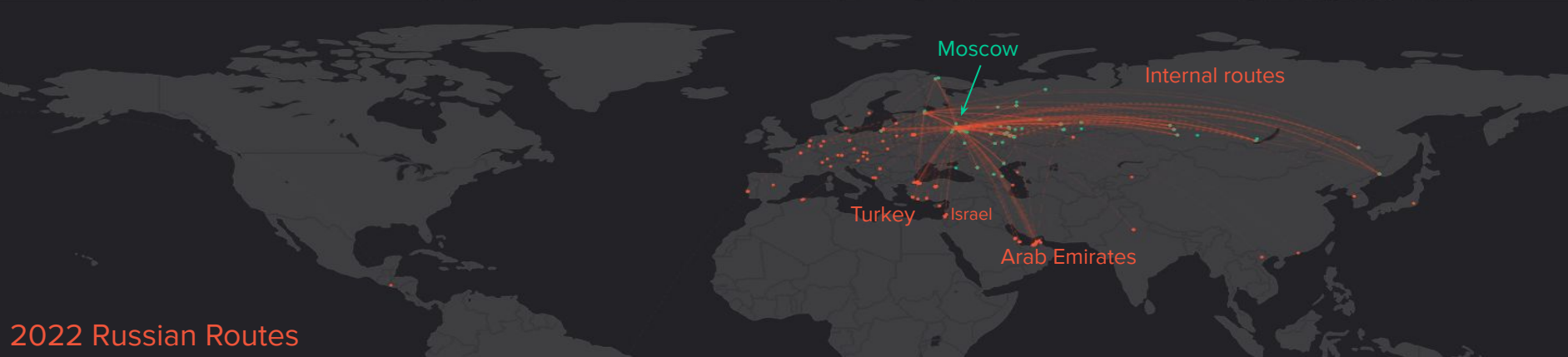
Russian airways insights

- The main center of russian routes is clearly Moscow.

- In 2021 the external connections are mainly with: (central) EU, London, Arab Emirates and Turkey, less relevant but still active are also US, Egypt and Israel.

- In 2022 the connections balance change drastically with Arab Emirates and Turkey strengthening their role and becoming clearly dominant, Israel slightly relevant while EU has only a few (noisy) weak links registered and London is completely absent.

2021 vs 2022 main links summary
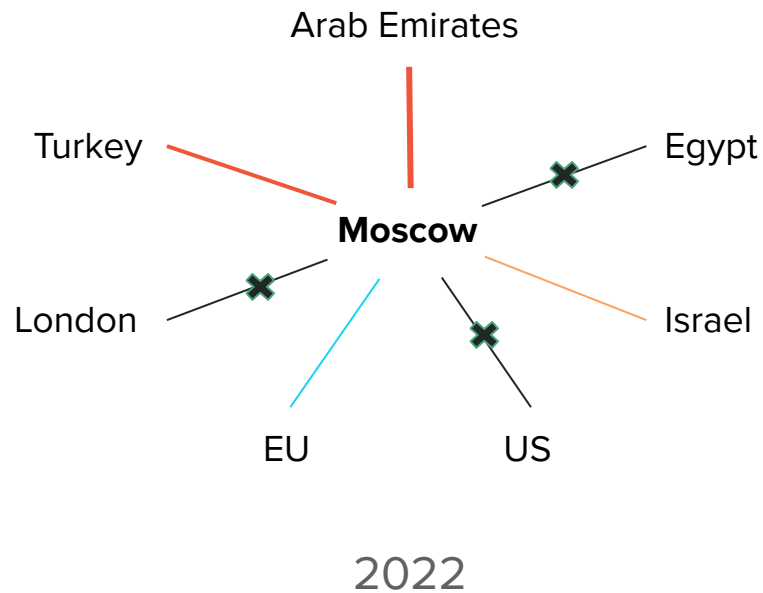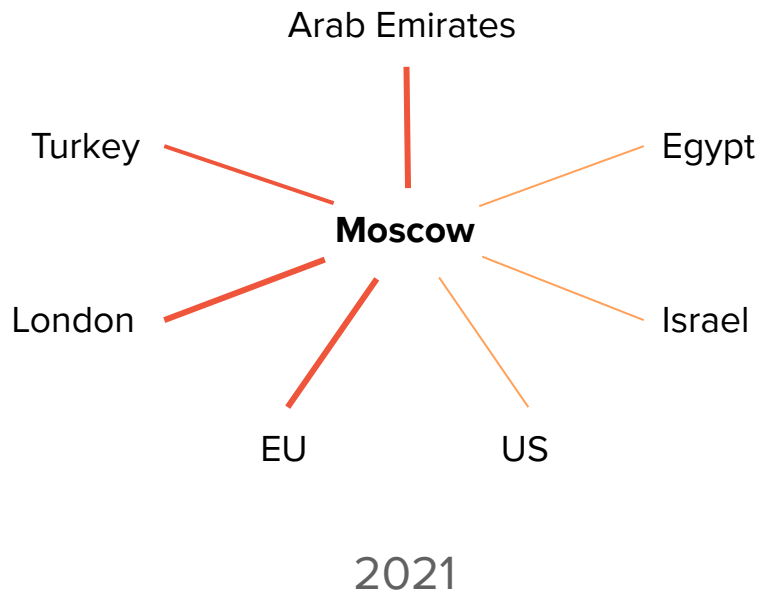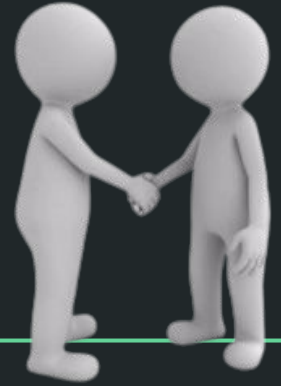
2021

2022

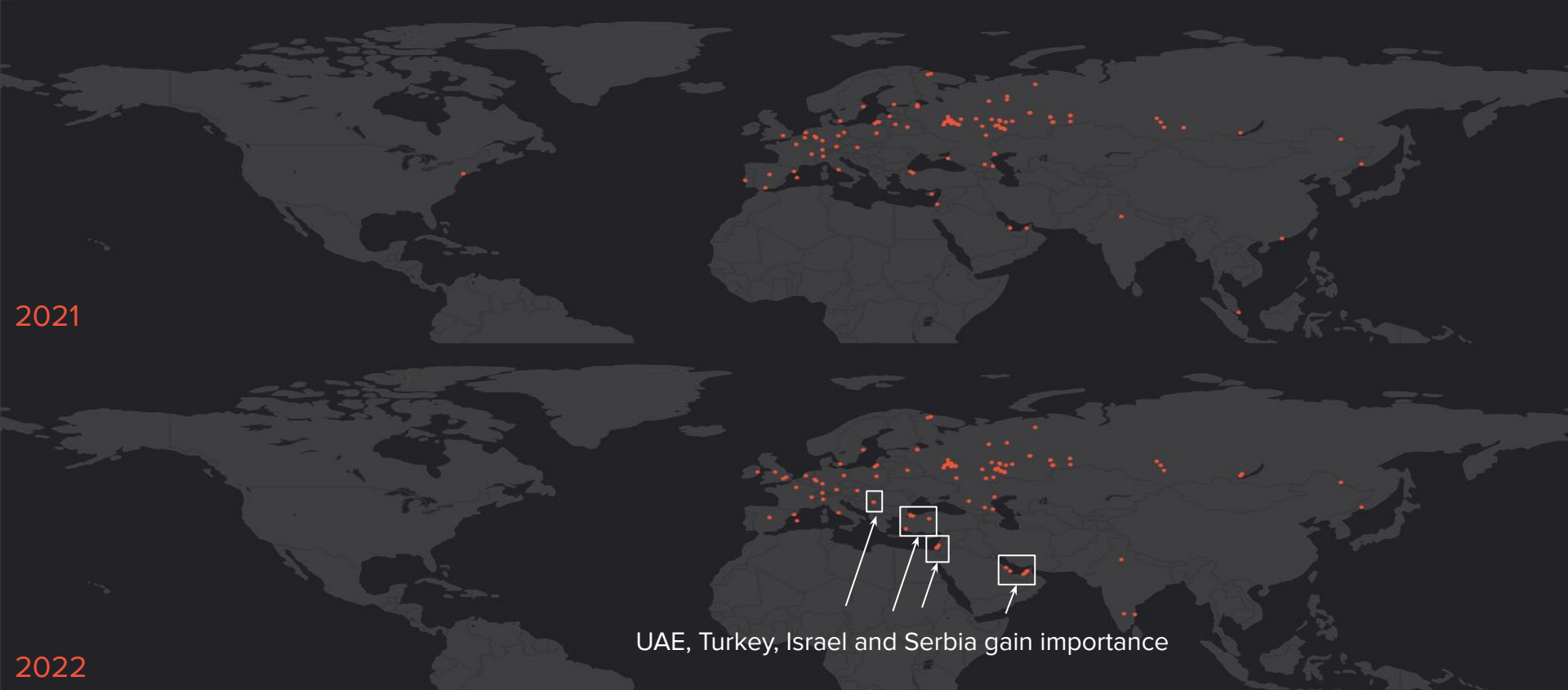# Closeness to russian airports

2021 vs 2022 top 100 relevant airports from a russian perspective

2021

2022

UAE, Turkey, Israel and Serbia gain importance

2021 vs 2022 top 100 relevant airports from a russian perspective

2021

2022

No direct London/EU links

Closeness to russian airports insights

- Both in 2021 and 2022 the most relevant airports are situated in EU, London, UAE and Turkey.

- While in 2021 there is a direct link between russian and London/EU airports, in 2022 these ties are broken.

- Due to this fact, UAE and Turkey strength their influence becoming the leading centers.
  Furthermore Serbia became a quite significant node as bridge to London and EU airports.

UAE
Turkey
Israel
Serbia
EU
London

Final conclusions summary

Final conclusions summary

- The majority of the airports are located in US and EU and so are the most important ones.

- The key center of the russian subnetwork is Moscow.

- Ukraine has suffered (also) an air traffic shut off as a direct consequence of the war.

- Due to airspace ban acts, Russia has left the EU community to give rise at one of its own.

- In 2021 Russia main destinations were EU, London, UAE and Turkey, all directly connected.

- In 2022 the airspace bans have left (and strength) only UAE and Turkey as key direct destinations.
  Moreover, as a side effect, Serbia has became an important bridge for the paths to west countries that are still quite influential.