A Century of Aviation Accidents: Trends, Risk Factors, and Insights

ECE 143 Final Project Presentation

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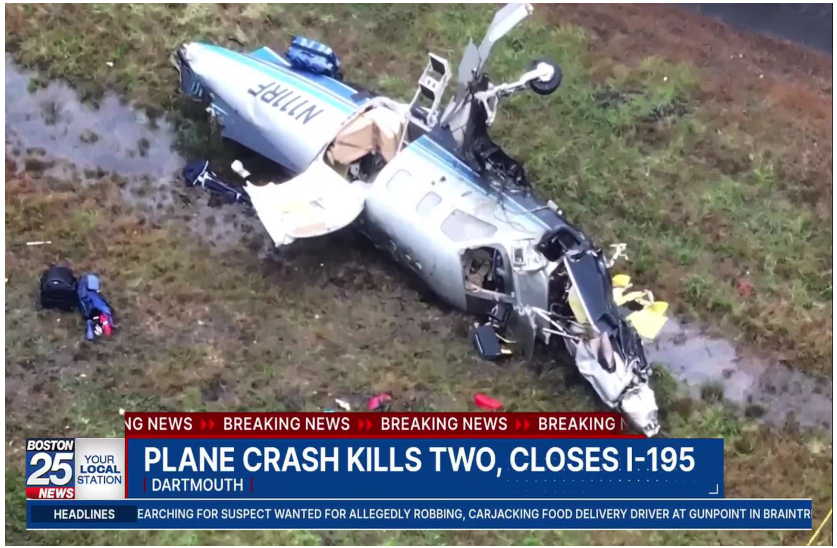
Motivation

- Even rare aviation accidents carry enormous human, economic, and regulatory consequences.
- A century of crash data provides a unique opportunity to uncover long-term risk patterns that are impossible to see in isolated reports.
- **Goal**: Identify which aircraft types, flight phases, and time periods exhibit elevated crash severity, and explore what these patterns reveal about changes in aviation safety over time.



Dataset

- **4,962** accident records spanning **1920–2024**
- Includes aircraft type, operator, location, fatalities, time, and summary text
- Contains both structured fields (year, operator, weather keywords) and unstructured text (summaries)
- Requires cleaning and parsing (dates, times, location fields, fatality extraction)


```
Data columns (total 25 columns):
 #   Column                 Non-Null Count  Dtype
---  ------                 --------------  -----
 0   aboard                 4952 non-null   object
 1   aircraft_type          4951 non-null   object
 2   cn_ln                  4951 non-null   object
 3   date                   4951 non-null   object
 4   detail_url             4961 non-null   object
 5   fatalities             4952 non-null   object
 6   flight_no              4951 non-null   object
 7   ground_fatalities      4907 non-null   float64
 8   location               4951 non-null   object
 9   operator               4951 non-null   object
 10  raw_text               10 non-null     object
 11  registration           4951 non-null   object
 12  route                  4950 non-null   object
 13  summary                4951 non-null   object
 14  time                   4951 non-null   object
 15  year_page_url          4960 non-null   object
 16  date_parsed            4951 non-null   object
 17  time_raw               4951 non-null   object
 18  time_hhmm              3498 non-null   object
 19  fatalities_total       4943 non-null   float64
 20  fatalities_passengers  4737 non-null   float64
 21  fatalities_crew        4737 non-null   float64
 22  location_city          4928 non-null   object
 23  location_state         3331 non-null   object
 24  location_country       2777 non-null   object
```

Data Processing

Scraping

- Python script pulled accident records from PlaneCrashInfo.com
- Parsed yearly pages + individual accident pages
- Extracted key fields (date, aircraft type, fatalities, summary)
- Combined everything into a single CSV

Cleaning

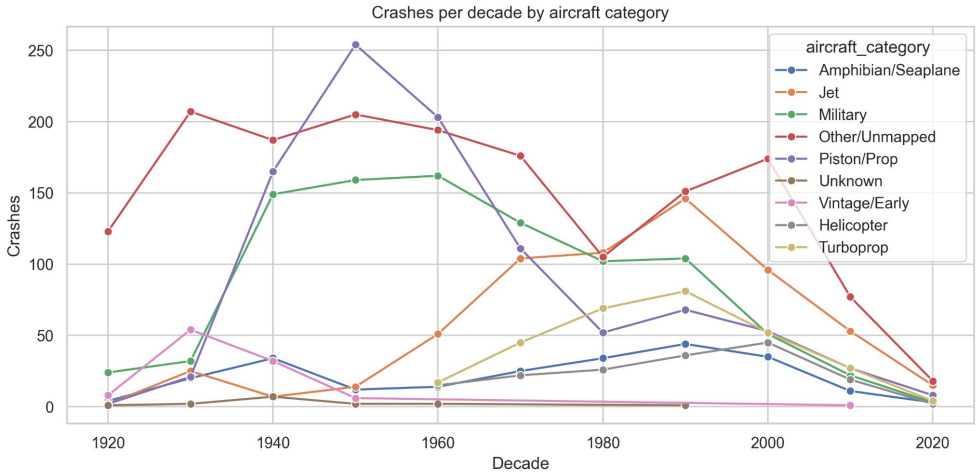
- Standardized aircraft types and flight phases
- Fixed inconsistent dates and missing numeric fields
- Removed unusable or duplicate entries

Feature Engineering

- Added decade, hour, and fatality ratio
- Categorized aircraft (Jet, Prop, Turboprop, Helicopter, Military)

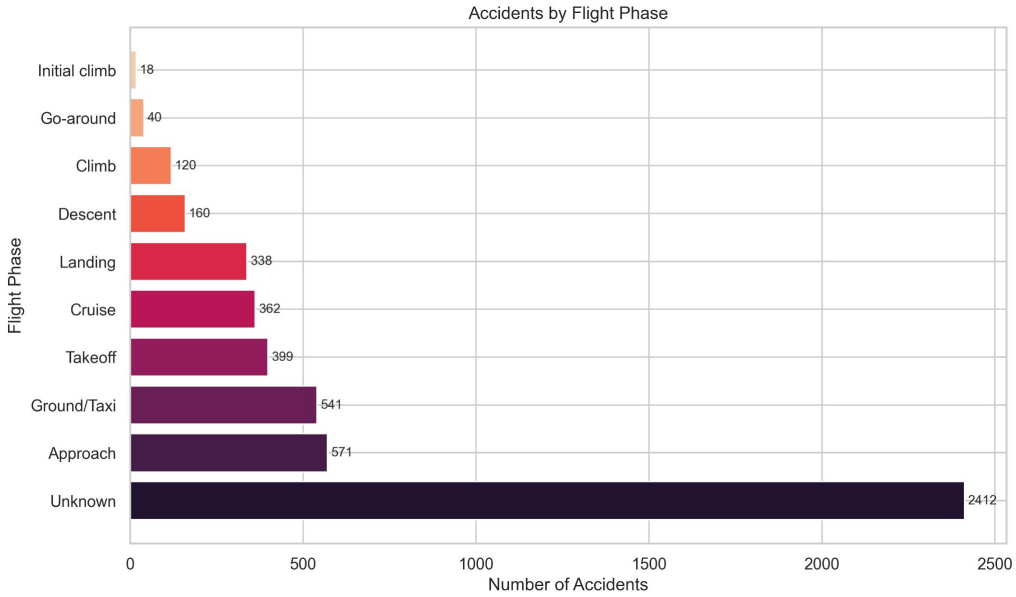
Aircraft Category

- Piston/prop crashes dominate early decades due to immature technology and minimal regulation.
- Jet crashes rise after the 1950s because jet travel expands globally (higher exposure, not lower safety).
- Military and piston crashes peak mid-century, reflecting WWII/Cold War activity, then decline with better standards.
- Helicopter and turboprop crashes increase in recent decades as their operational use expands.



Flight Phase

- Most crashes occur during takeoff, approach, and landing → highest workload + least margin for error.
- Cruise accidents are fewer but often more catastrophic due to altitude and speed.
- Large “Unknown” category comes from older reports lacking detailed phase information.

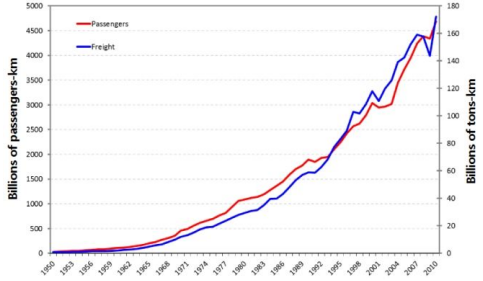


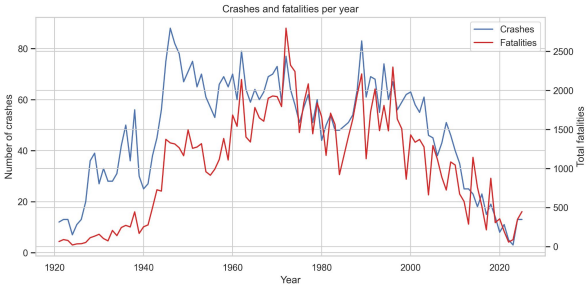
Safety Over Time

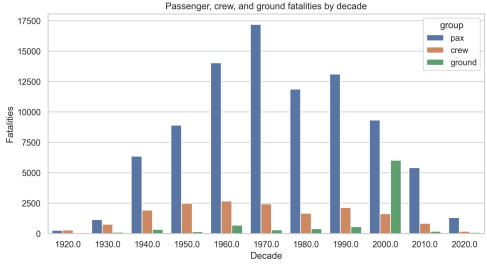
Despite exponential growth in flight volume from the early 1900s

- Total crashes increased from 1910s and peaked in 1970s
- Decreased since 1970s until modern day
- **Modern aviation significantly safer**

Interesting datapoint in 2000s that breaks this trend: isolated 9/11 incident





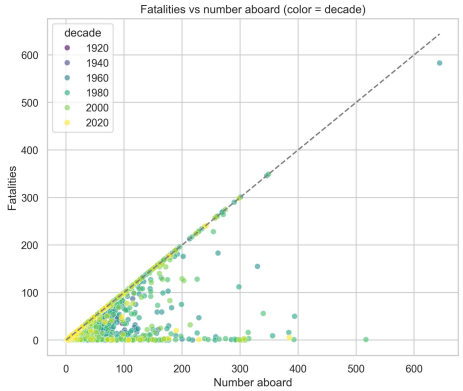


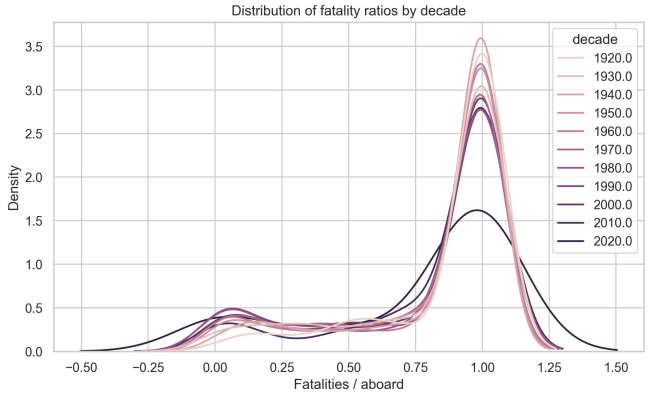
ACCIDENT DETAILS	
Date:	September 11, 2001
Time:	0847
Location:	New York City, New York
Operator:	American Airlines
Flight #:	11
Route:	Boston - Los Angeles
AC Type:	Boeing 767-223ER
Registration:	N334AA
cn / ln:	22332/169
Aboard:	92 (passengers:81 crew:11)
Fatalities:	92 (passengers:81 crew:11)
Ground:	2750
Summary:	The aircraft was hijacked shortly after it left Logan International Airport in Boston. The hijackers took control of the aircraft and deliberately crashed it into the north tower of the World Trade Center between the 94th and 99th floors at approximately 450 mph. After 102 minutes, the building collapsed. It was one of four planes that were hijacked the same day.

Safety Over Time (continued)

Fatality ratio is measured as total fatalities divided by total passengers aboard. Observations include

- Latest data points (yellow dots and dark line) show how in recent years, airplanes have become much safer
- This is likely a downstream effect of tighter regulations, increased safety standards, innovation in aircraft technology, and commercialization of passenger aircraft.

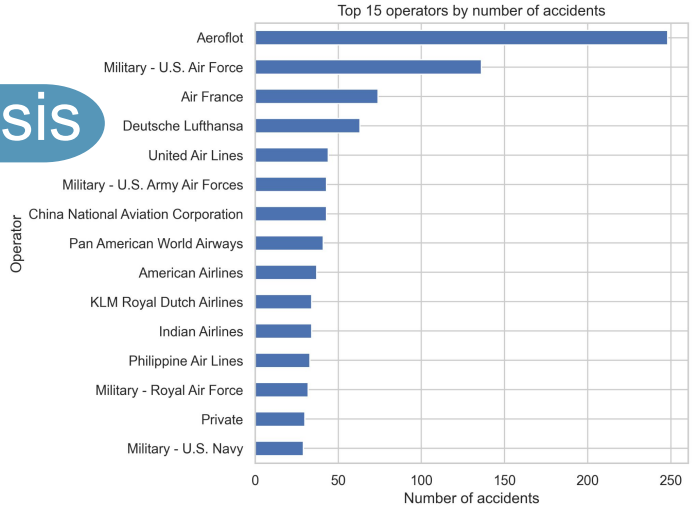


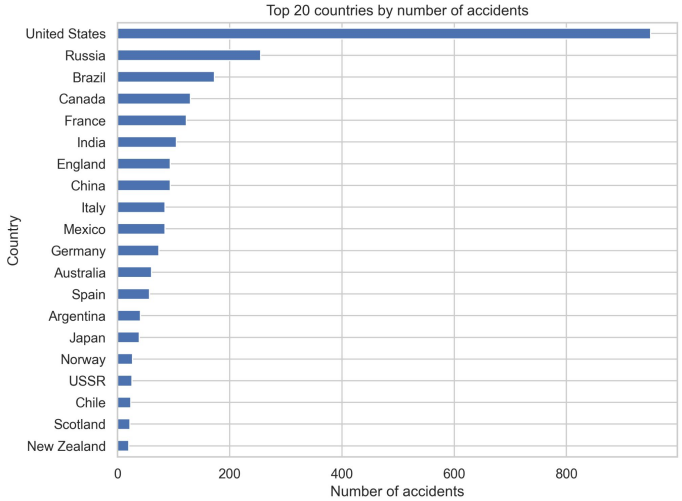


Airline/Country of Origin Analysis

Data clearly dominated/skewed towards the United States. Likely for several reasons

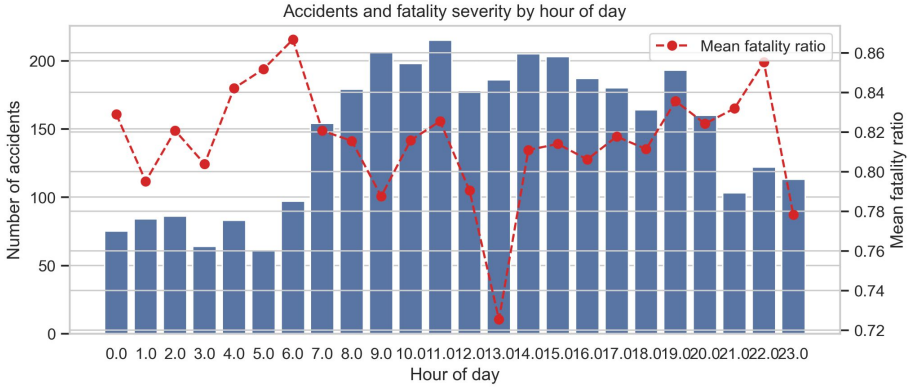
- The U.S. were leaders in aircraft innovation, leading to larger number of casualties as the technology matured. Other countries likely adopted aircraft after maturity.
- Aeroflot (Russian) also experienced many accidents. This is likely an effect of the Cold War where the U.S. and Soviet Union were competing in technology and sacrificing safety standards in the process. This agrees with our previous data where most accidents happened around ~1970s which is around the peak of the Cold War.

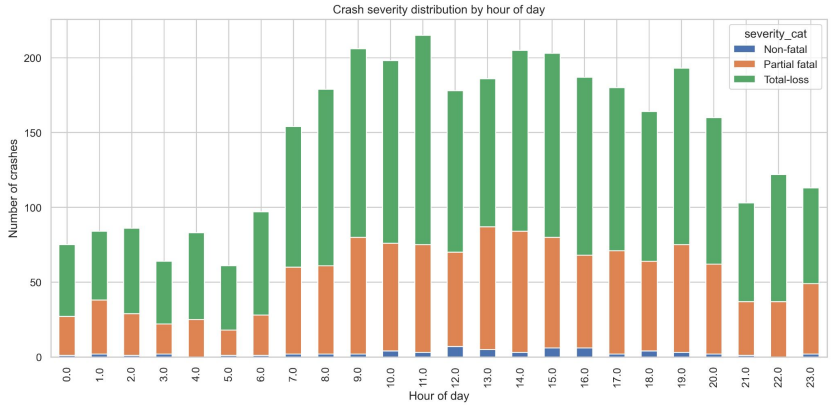


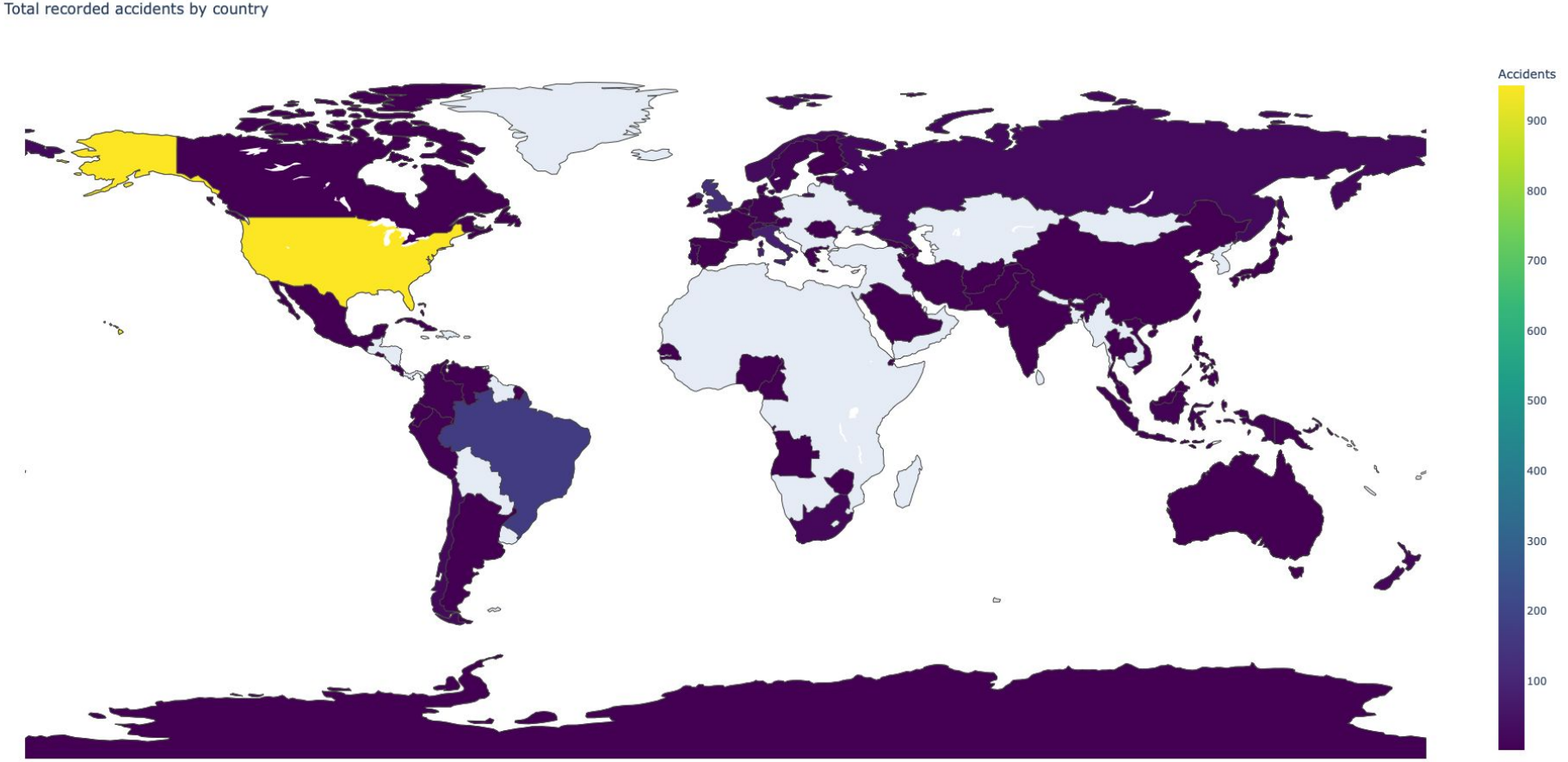


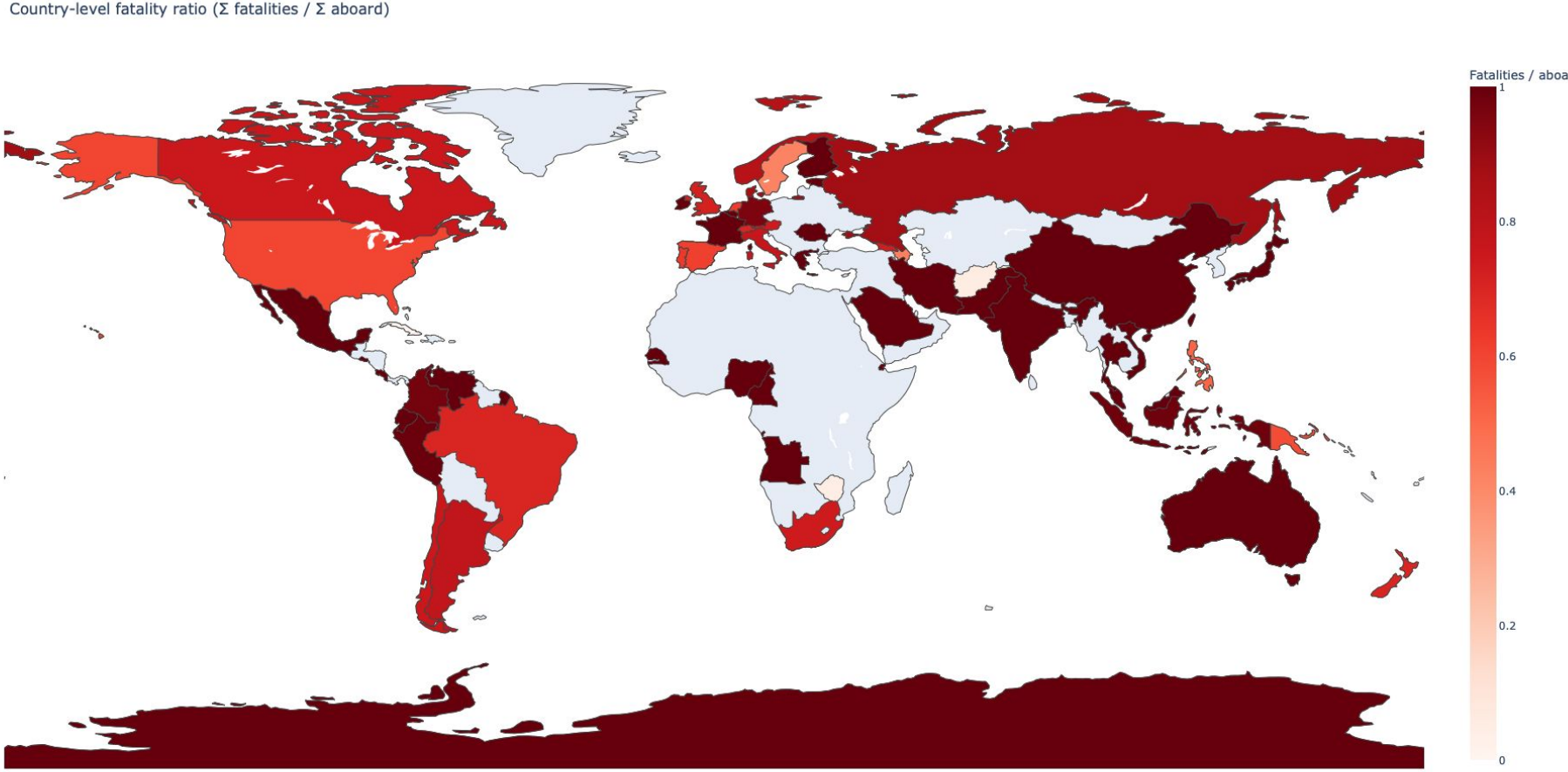
Hours-of-Day

- Crash frequency strongly follows global flight schedules
- Severity is not highest when frequency is highest
- Nighttime accidents are deadlier because “total-loss” crashes are more common






Total recorded accidents by country
Accidents
900
800
700
600
500
400
300
200
100


Country-level fatality ratio (Σ fatalities / Σ aboard)
Fatalities / aboa
1
0.8
0.6
0.4
0.2
0

Conclusion

- **Safety Trends**
  - Accident counts peak mid-century
  - Fatality severity steadily declines after the 1980s

- **Risk Contexts**
  - Certain conditions consistently elevate risk:
  - Approach/Landing phases,
  - Night operations,
  - Military and early piston/prop aircraft,

- **Severity Predictors**
  - Aircraft category
  - Flight phase
  - Visibility-related hours of day

Aviation safety is improving
But specific risk factors remain consistently dangerous across history

THANK YOU FOR ATTENTION