



Analyzing Seasonal Fog Variability at North Dakota Airports and its Impact on Flight Delays

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ATSC 493 – Senior Project
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Introduction

- General impacts of fog
 - The Midwest is prone to seasonal meteorological impacts (Goodman and Small Griswold, 2019).
 - In North Dakota, topography and climate show a seasonal variability of fog (Willette, 2023).



Aircraft landing in fog conditions

Adapted from The Sydney Herald

Introduction

- Visibility Challenges:
 - Fog significantly impacts visibility, complicating airport operations (Gultepe et al., 2007).
 - Pilots must rely on Instrument Flight Rules (IFR) when visibility drops to 1-3 miles, and Low Instrument Flight Rules (LIFR) for visibility below 1 mile (Herman and Schumacher, 2016).
- Operational Challenges:
 - Reduced visibility disrupts take offs and landings.
 - Delay defined as detainment of IFR traffic by air traffic control (ATC) for 15 minutes or more (FAA).
 - This disrupts the overall flow of air traffic, causing widespread delay and cancellations.

Efforts to Reduce Impacts

- Localized Aviation MOS Program (LAMP)
 - Use of METAR, TAF, radar, NWP, and climatology.
 - Proved accurate for predicting ceiling trends, loss of accuracy for fog (Boyd and Guinn 2019).
- High frequency ASOS data
 - More frequent than the standard hourly ASOS observations.
 - Proved beneficial for fog events since conditions change rapidly (Leyton and Fritsch 2004).



ASOS at BIS

Adapted from the National Weather Service

Motivation and Objectives

- Research Gap:
 - Limited research exists of how fog affects airports in North Dakota.
- Study Objectives:
 - What is the probability of flight delays due to fog by season at North Dakota airports?
 - How has the probability changed over time from 2000 to 2023?
 - How have flight delays due to weather changed over time from 2000 to 2023?

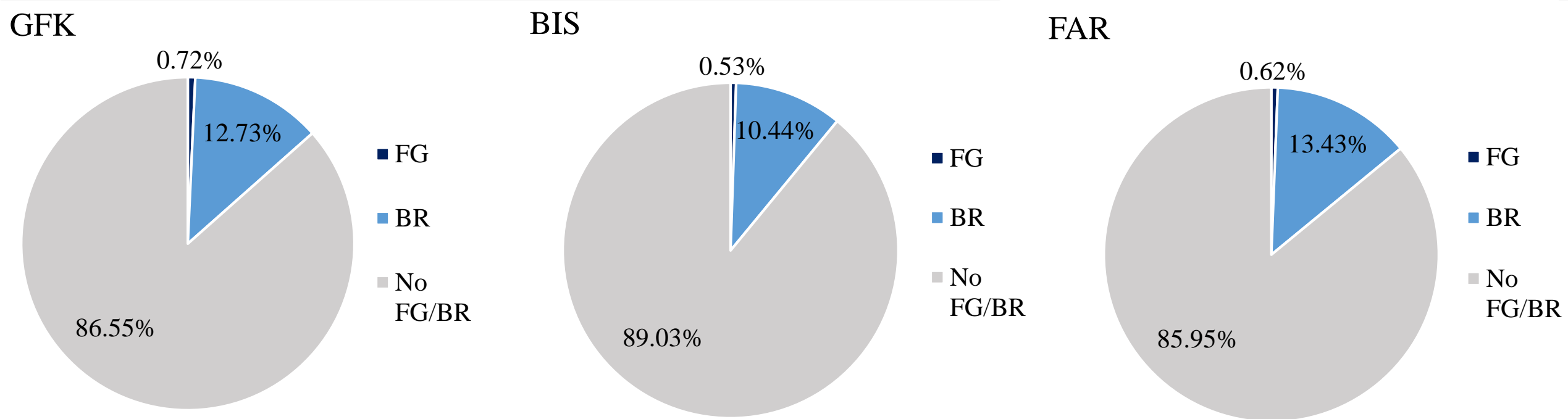
Methodology

- METARs and flight delay statistics are examined for three North Dakota airports:
 - Grand Forks International Airport (GFK)
 - Hector International Airport (FAR)
 - Bismarck Municipal Airport (BIS)
- 1 January 2000 to 31 December 2023
- METAR data from Iowa Environmental Mesonet
- Delay information from the OPSNET



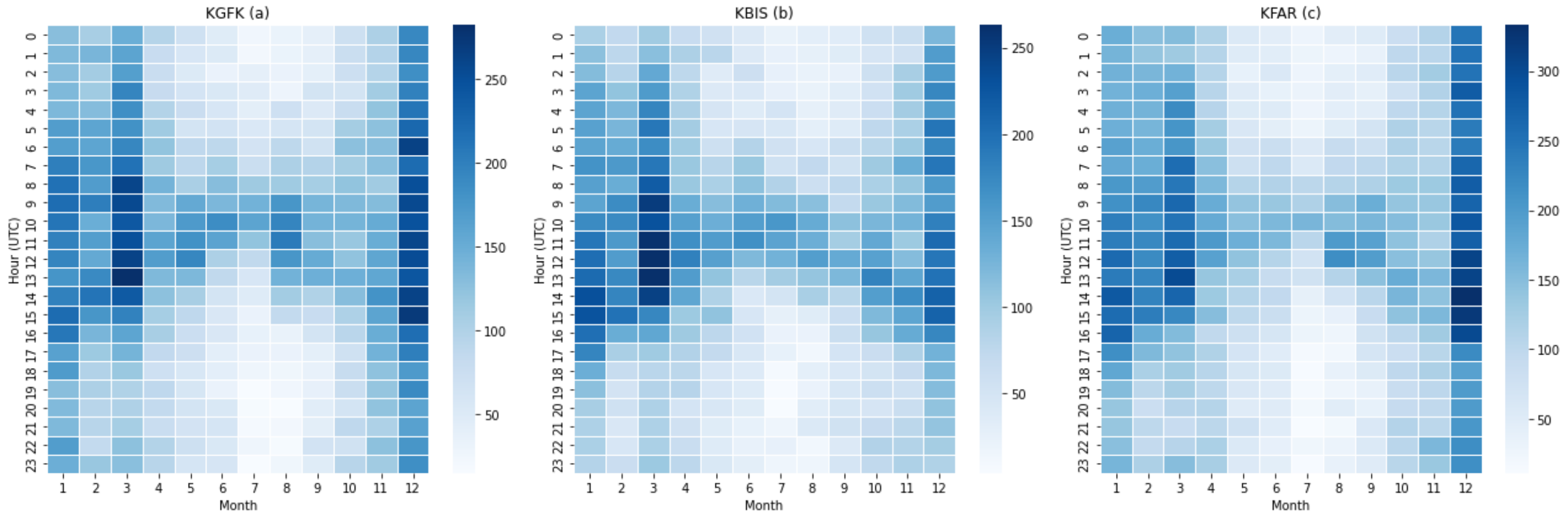
Adapted from ND Aeronautics Commission

Results – Low Visibility Occurrences (2000—2023)



- Low visibility is caused by fog and mist.
- Mist reports occurred more frequent than fog reports.

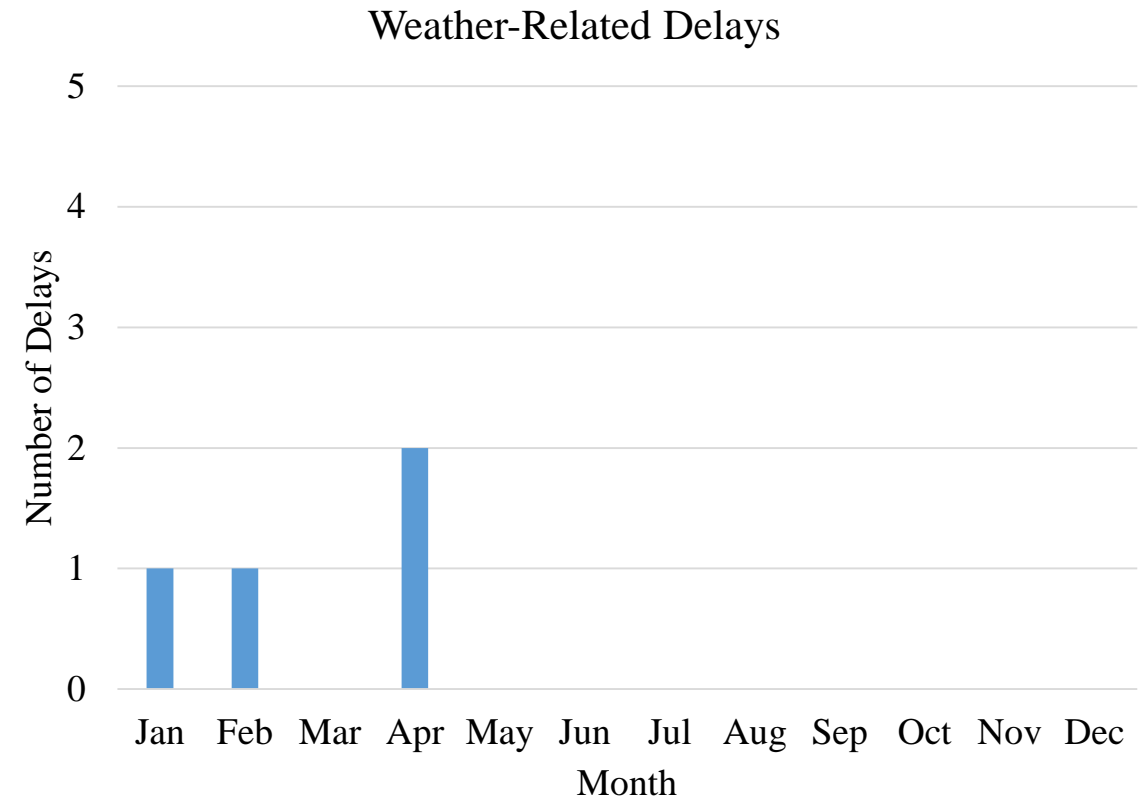
Results – Hourly Fog and Mist (2000—2023)



Morning fog more frequent in winter months; earlier in summer and later in winter.

Results – Flight Delays at GFK (2000—2023)

- 4 weather-related delays recorded.
- Low number of delays aligns with low traffic volume (~2 departures per day).
- Aligns with seasonal fog occurrences.
 - 2 delays recorded 7 April 2001
 - 1 delays recorded 22 January 2009
 - 1 delays recorded 17 February 2010
- Historical decrease in delays, last weather-related delay was in 2010.

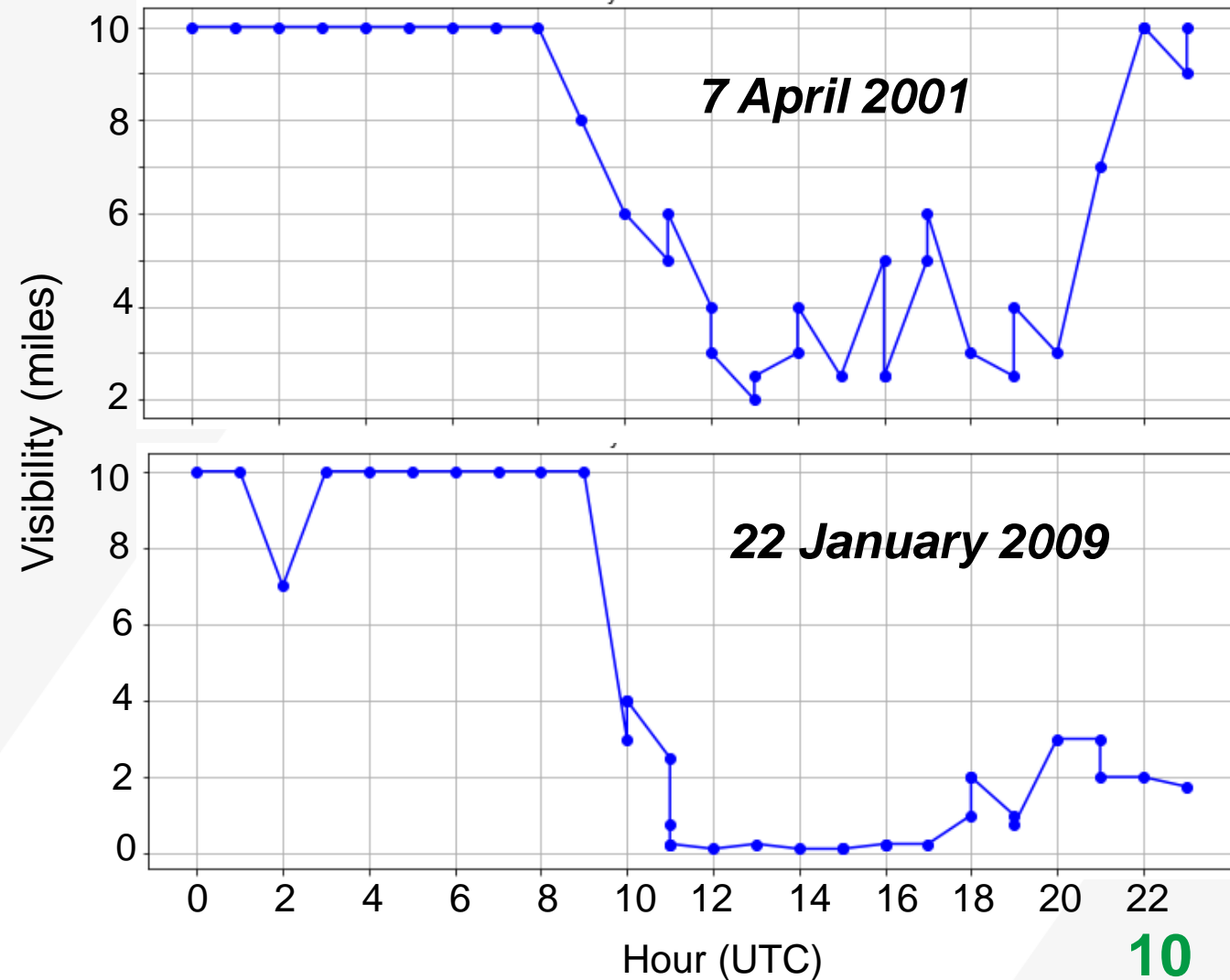


Weather-related delay frequency by month at GFK

Results – Low Visibility Impact at GFK

- Two dates show evidence of low visibility contributing to the delays.

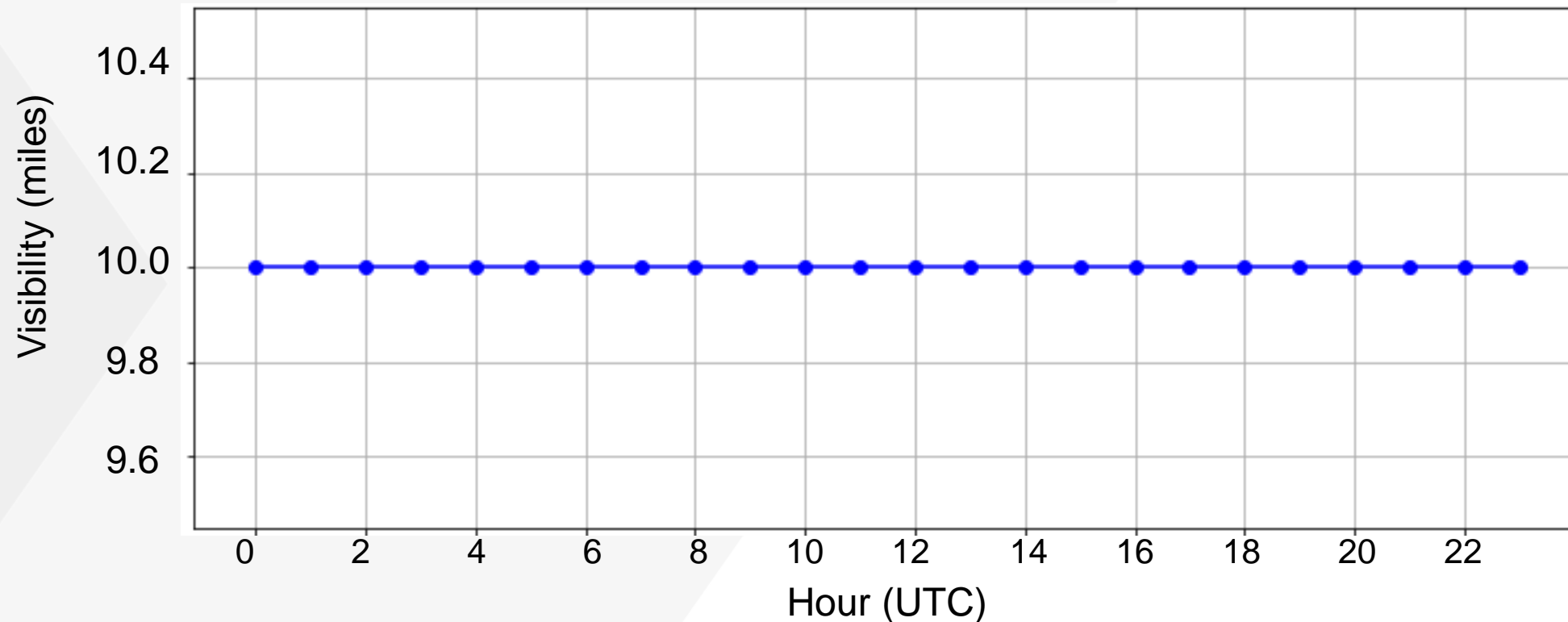
- 7 April 2001 reported mist, rain, and overcast skies.
- 22 January 2009 reported freezing fog (FZFG) resulting in a major drop in visibility.



Results – Low Visibility Impact at GFK

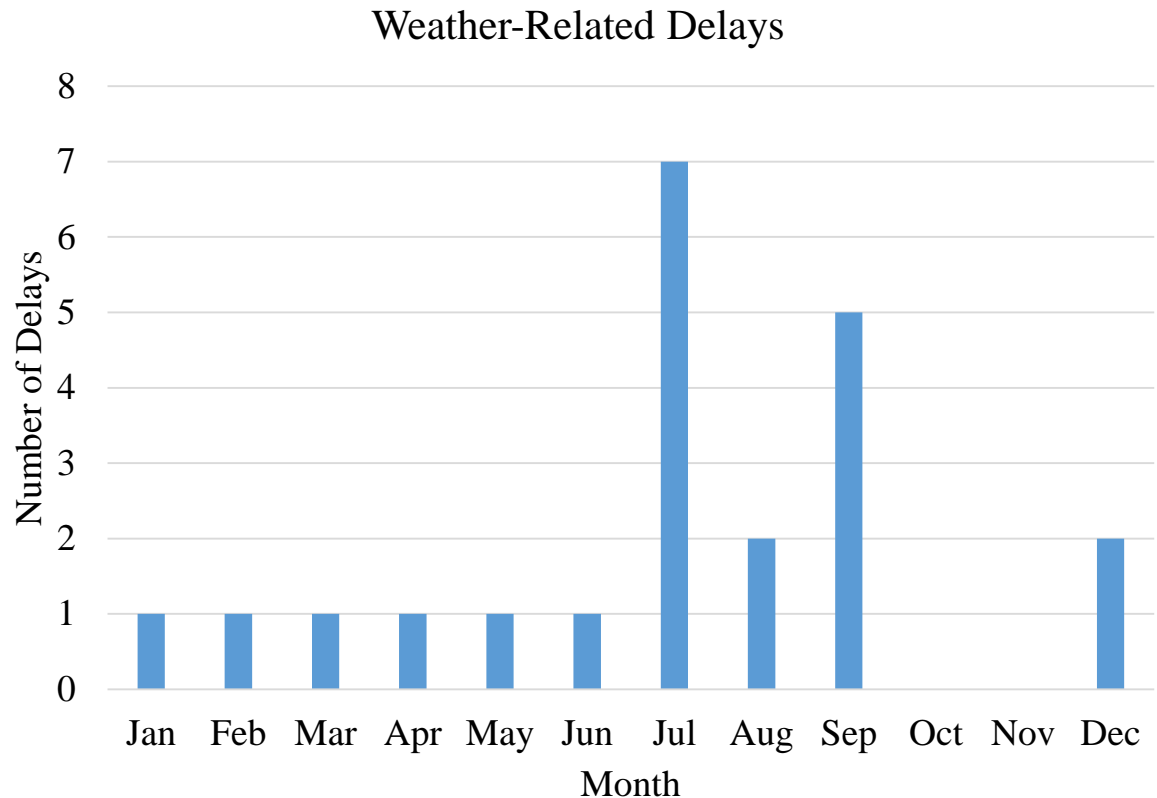
- Delay on 17 February 2010 shows no evidence of fog impact.

17 February 2010



Results – Flight Delays at BIS (2000—2023)

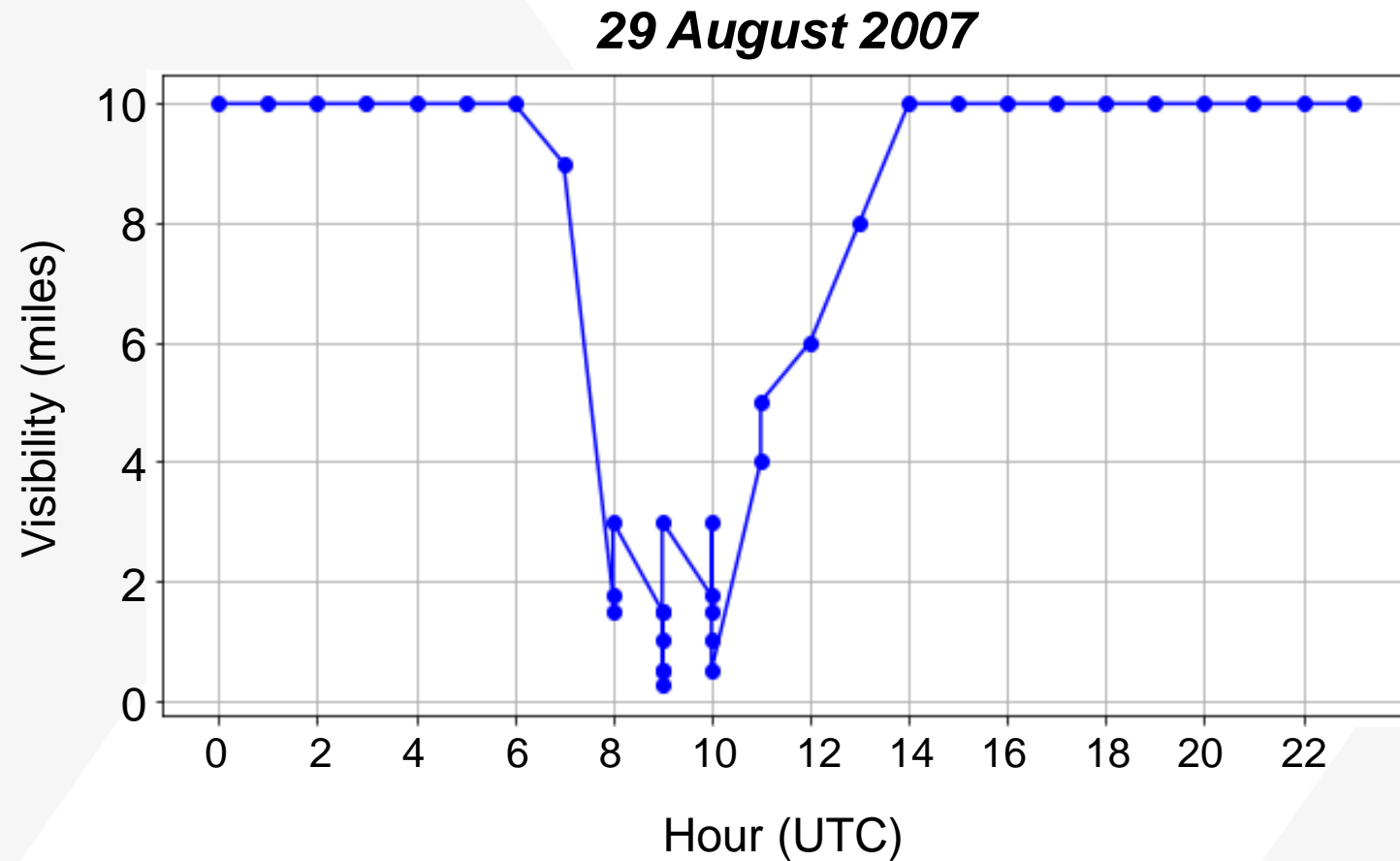
- 25 weather-related delays.
- BIS has ~9 departures per day.
- Somewhat aligns with seasonal fog occurrences.
 - Most delays occurred in July, not likely linked to fog.
- Historical decrease in delays, last weather-related delay was in 2009.



Weather-related delay frequency by month at BIS (2000—2023)

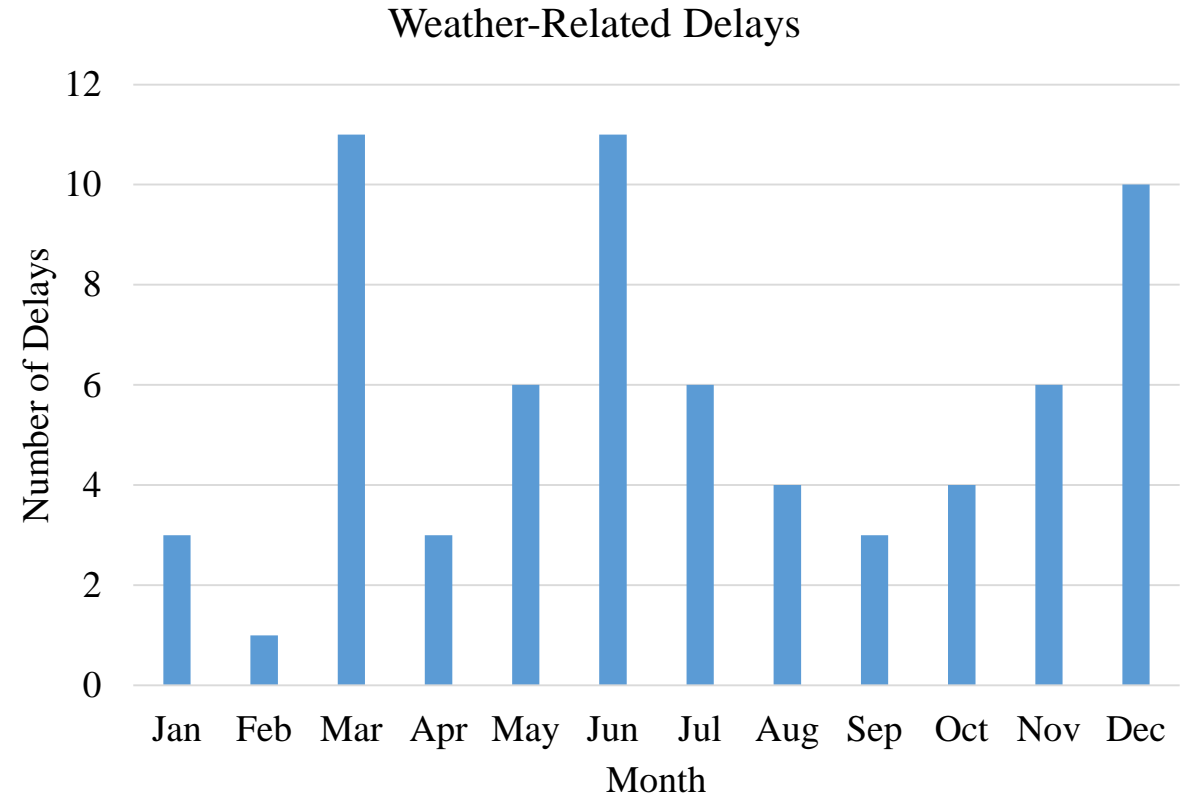
Results – Low Visibility Impact at BIS

- FG observations reported on 29 August 2007.
 - BR reported from 08:47Z to 12:52Z, FG reported from 09:17Z to 09:40Z.
- Lowest visibility associated with second report of FG.
- One delay logged, likely influenced by this event.
 - No other significant weather codes reported.



Results – Flight Delays at FAR (2000—2023)

- 68 weather-related delays.
 - Delay peaks in March and June.
- FAR has ~12 departures per day.
- FAR had the highest amount of delays, suggests greater sensitivity to weather or higher traffic volume.
- Continued relevance: FAR experienced delays 2021-2023.

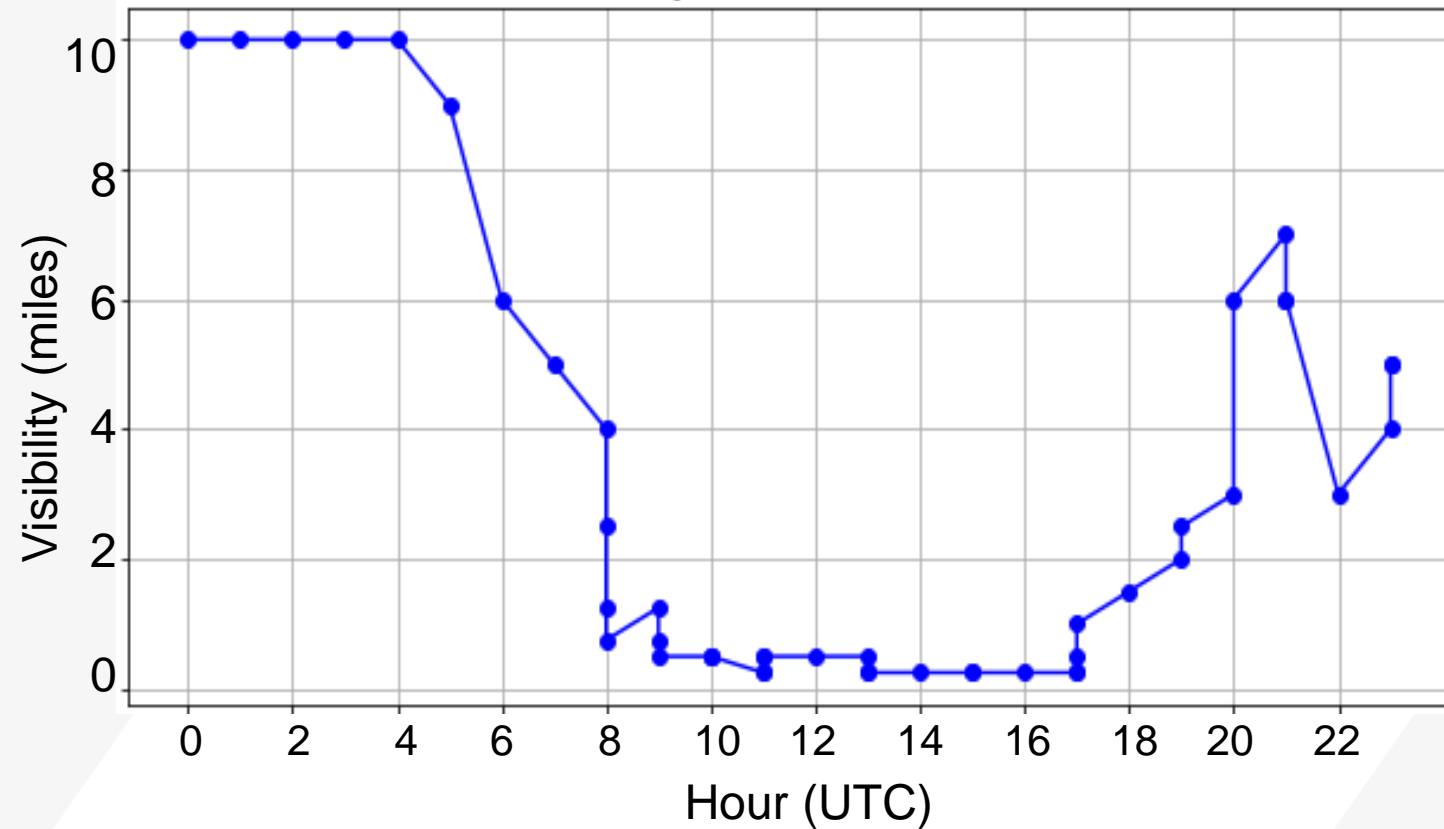


Weather-related delay frequency by month at FAR (2000—2023)

Results – Low Visibility Impact at FAR

22 December 2023

- FAR experienced a major fog event on 22 December 2023.
 - BR reported continuously from 06:53Z, FG reported from 09:53Z to 17:42Z
- Large drop in visibility associated with FG reports.
- One delay logged, likely influenced by this event.



Conclusions

- Seasonal fog trends present.
 - Winter months see more fog occurrences.
 - Diurnal fluctuation by season.
- Weather-related delays varied by airport, GFK showed the least.
 - Weather delays have overall decreased in the last two decades, possibly due to better forecasting and operational changes.
- Difficult to pinpoint exact cause of flight delays.
 - Flight delay reports lack timestamps for individual delays.

Future Work

- Include data from general aviation activity.
 - Utilize UND's high-volume flight program.
- Analyze taxiing, ground delays, and cancellations.
 - These may be more affected by fog than records show.



Aircraft used by UND's flight program

Adapted from the University of North Dakota

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Questions?

Thank you!