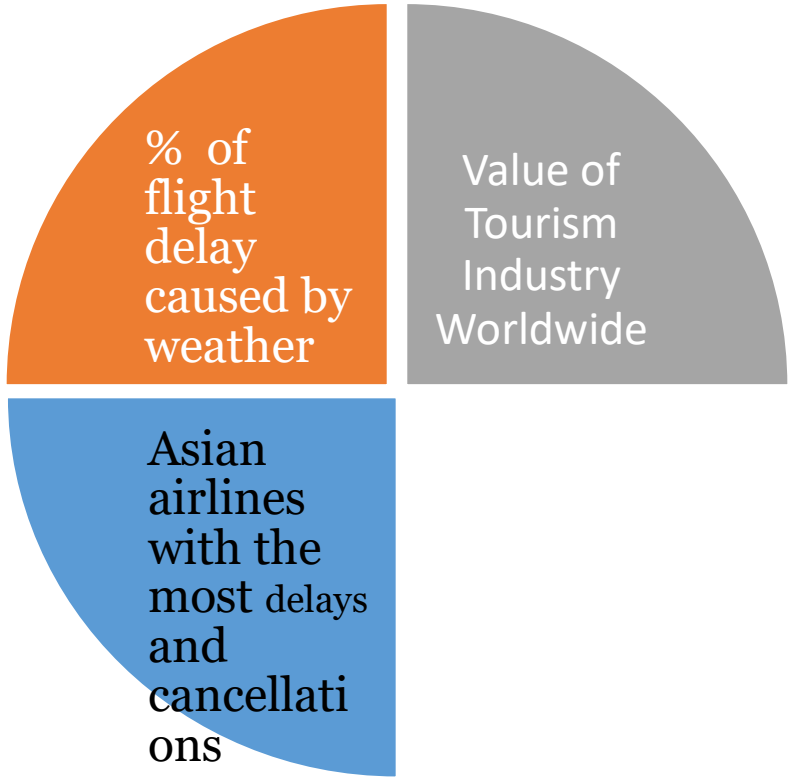
Problem Statement

- Should flights be reduced during heavy rainfall so as to avoid flight delay or flight cancellation as heavy rainfall reduces visibility

Significance of the study

- Annual analysis of flight delay causes shows that weather accounts for 6% of total aircraft operation delays

- Heavy rain, result in delayed or cancelled flight
  source:https://www.hindawi.com/journals/amete/2022/5356563/



- Air travel worldwide in 2021 was forecast to be $354 billion
- In 2022, $626 billion

Source: https://www.iata.org/en/iata-repository/publications/economic-reports/airline-industry-economic-performance---october-2021---report/

- Air India reported delay in 78% respondents
- Air China was 70%
- Cebu Pacific Air was 69%
- Singapore Airlines, reported delays in (38%)
- 1 to 3 hours of delay account for 40% of respondents. 38% of traveller reported experiencing delays exceeding 4 hours.

Source: These Asian airlines have the most delays and cancellations now: Travel Weekly Asia (travelweekly-asia.com)

Is rain the reason for cancellation of flight?

- The only real problem with heavy rainfall is the decrease in visibility for the pilots.
- But does rain delay flights?
- Generally, It is the temperature of the rain that can affect take-off and landing.
- If it is so cold that the rain turns into hail or snow, there could be a delayed or cancelled flight.
- Source: Does Rain Cancel Flights? | Sheffield School of Aeronautics

Hypothesis

Hypothesis:

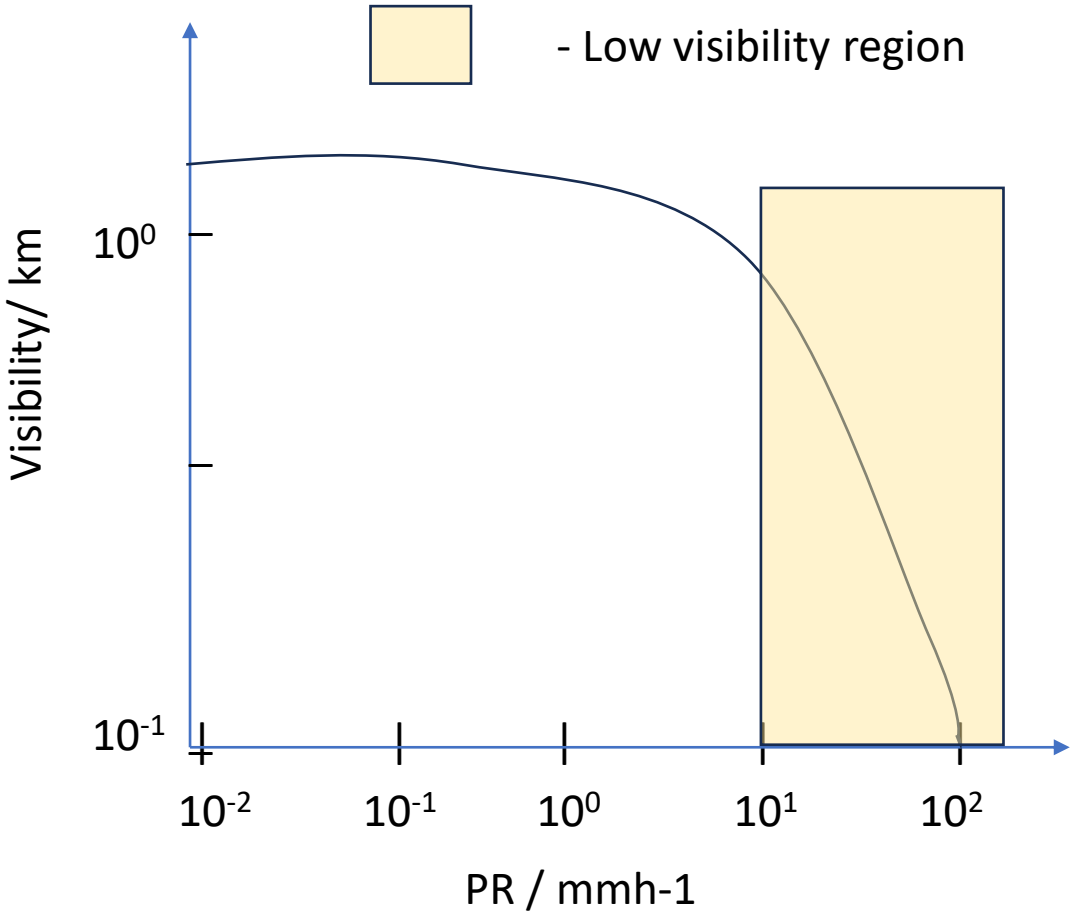
Visibility will be reduced during heavy rainfall.

Visibility is a measure of the distance at which an object or light can be clearly discerned.

(unit in km)

Rainfall intensity describes how fast the rain is falling.
(unit in mmh-1)

Visibility(km) vs Precipitation Rate(mmh-1)due to rain



PR – Precipitation Rate due to rain

Reference:

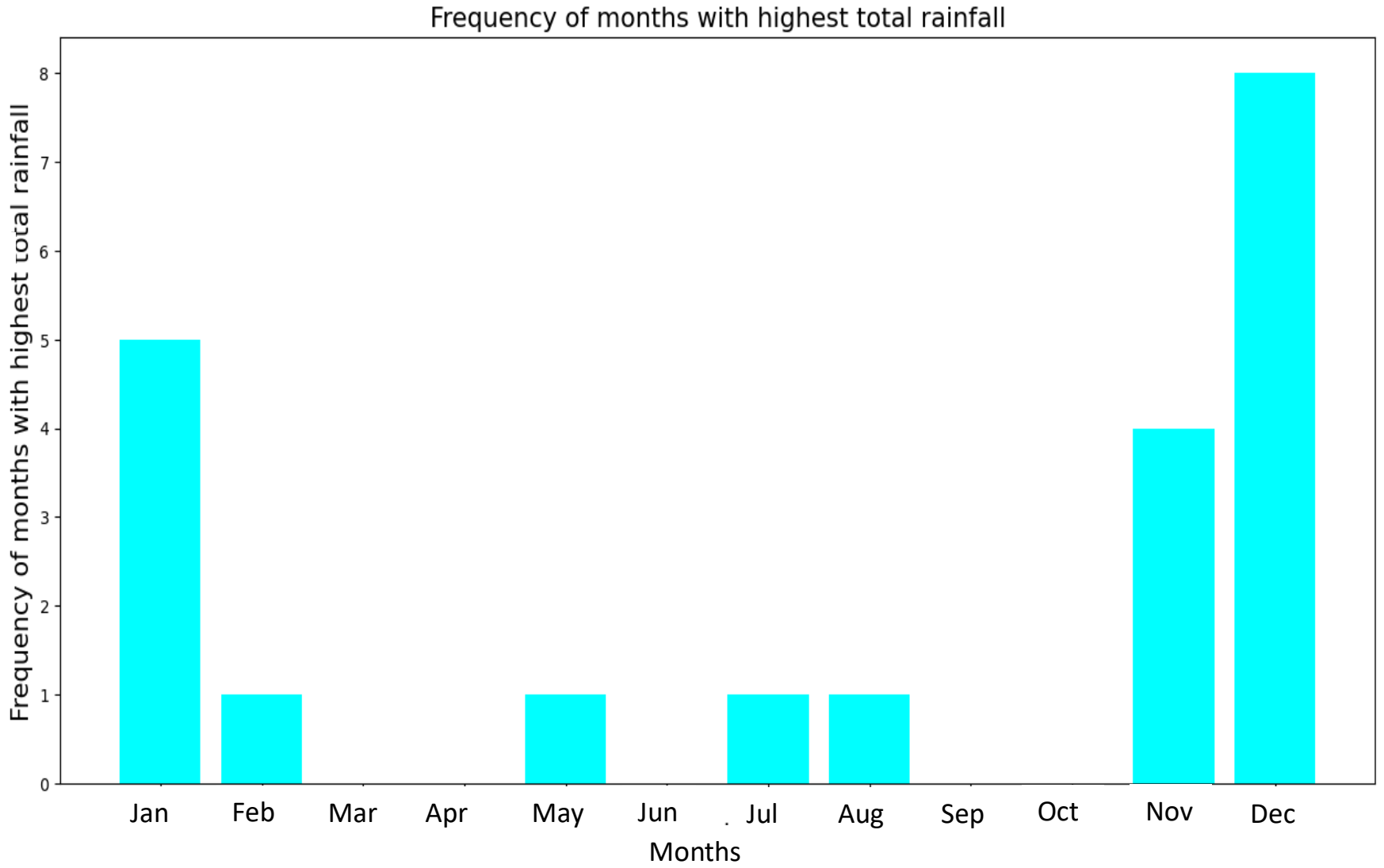
Visibility Parameterization For Forecasting Model Applications

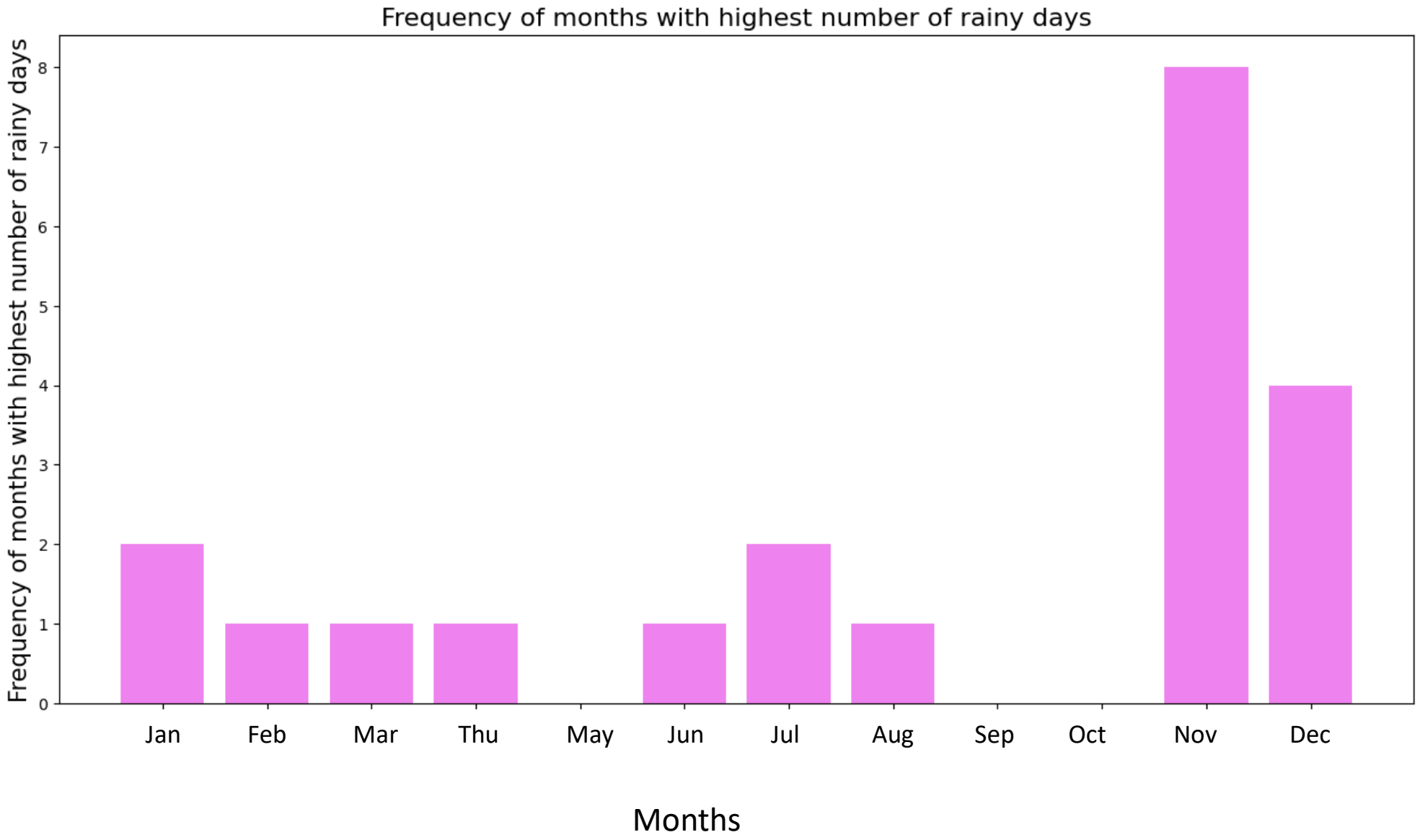
- 5th International Conference on Fog, Fog Collection and Dew
- Munster, Germany,25-30 Jul 2010

- Conducted in central and eastern Canada, and Barrow, Alaska
- Observations were obtained using a fog measuring device(FMD) for fog parameterization and a Vaisala all-weather precipitation instrument called FD12P

Steps to finding days with heavy rainfall

- Analyze data from 2001 to 2021
- For each year, the month with highest total rainfall are obtained.
- The months with highest number of rainy days are also obtained
- Data is downloaded from Meteorological Service Singapore to get the rainfall intensity for months corresponding to months with highest total rainfall and highest number of rainy days from 2004 to 2022
- Data is in the form of Rainfall in 60 min
- Days with rainfall intensity larger than 10 mmh-1 are subsetted for the chosen months


Frequency of months with highest total rainfall
Frequency of months with highest total rainfall
0
1
2
3
4
5
6
7
8
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Months

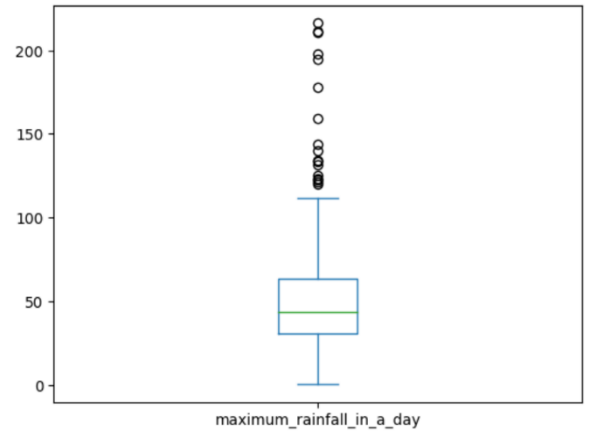

Frequency of months with highest number of rainy days
Frequency of months with highest number of rainy days
0
1
2
3
4
5
6
7
8
Jan
Feb
Mar
Thu
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Months

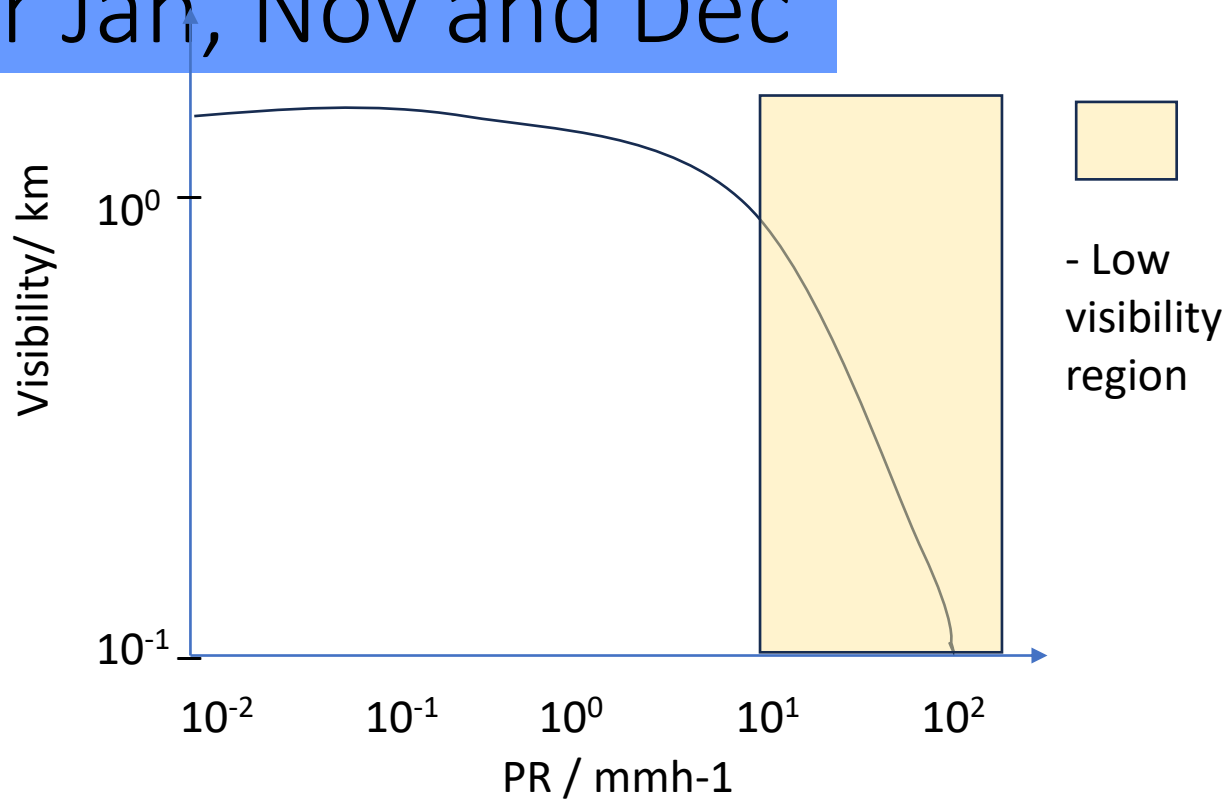
Rain Classification	Rainfall Intensity / mmh-1
No rain	< 0.5 mm/h
Weak rain	0.5–2 mm/h
Moderate rain	2–6 mm/h
Heavy rain	6–10 mm/h
Very heavy rain	10–18 mm/h
Shower	18–30 mm/h
Cloudburst	>30 mm/h

Source: researchgate.net

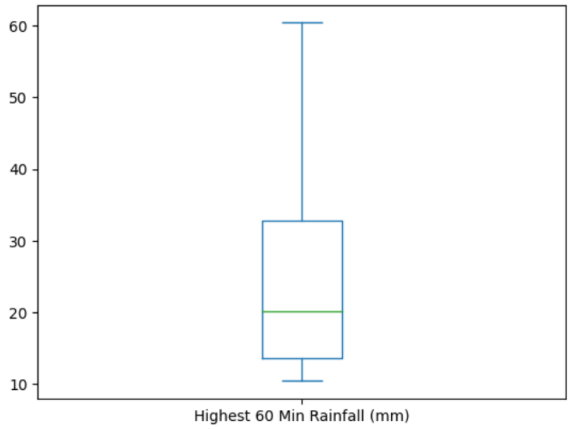
Boxplot diagrams for Jan, Nov and Dec

Jan
Highest 60 min Rainfall (mm)
count 31.000000
mean 20.458065
std 9.297339
min 10.600000
25% 11.800000
50% 18.200000
75% 28.800000
max 40.200000

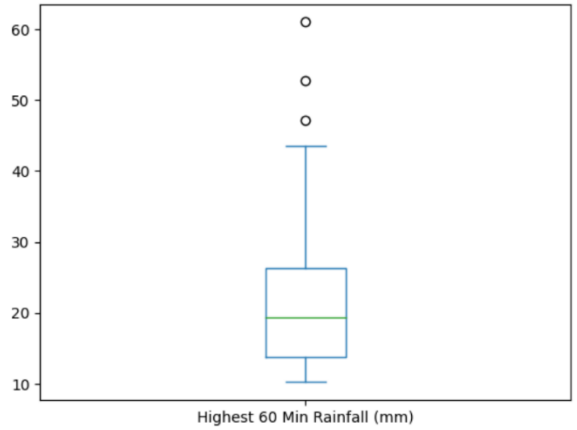




Nov
Highest 60 min Rainfall (mm)
count 48.000000
mean 24.795833
std 13.349093
min 10.400000
25% 13.550000
50% 20.100000
75% 32.850000
max 60.400000

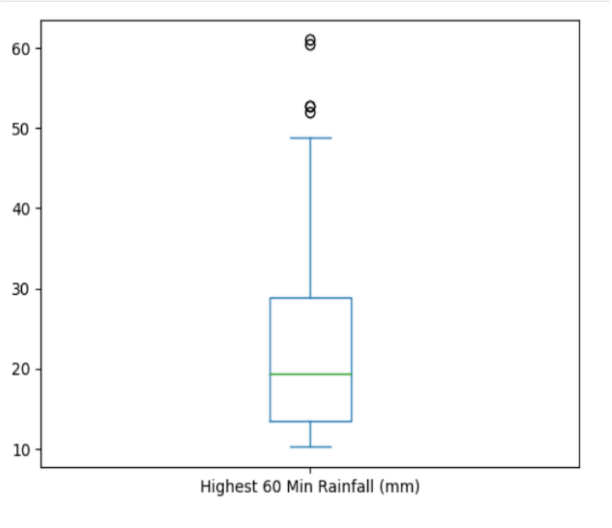


Dec
Highest 60 min Rainfall (mm)
count 56.000000
mean 22.728571
Std 11.468434
Min 10.200000
25% 13.800000
50% 19.300000
75% 26.300000
max 61.000000



Jan/ Nov / Dec

count	56.000000
mean	22.728571
Std	11.468434
min	10.200000
25%	13.800000
50%	19.300000
75%	26.300000
max	61.000000



Conclusion and Proposal

- November is the month which is likely to have the highest rainfall intensity and therefore lower visibility hence most likely to result in flight delays and cancellations
- This is followed by the months of December and January
- An alert could be set for poor visibility at the 50% or 75% mark of the rainfall intensity which could result in flight delay
- Customers-service officers in airline could get prepared or inform passengers in later flights if there is a delay or cancellation
- For the 3 months data, they are 19 mmh^{-1} and 26 mmh^{-1} at the 50% and 75% mark respectively.