Wind & Weather Avoidance Analysis at *Bangkok Airport* (VTBS)

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Final Presentation **Prof. Asei Tezuka Lab.**

Introduction

Thailand is one of Southeast Asia's major aviation hubs, with **Suvarnabhumi Airport (VTBS)** in Bangkok serving as the primary international gateway. Each day, VTBS handles hundreds of domestic and international flights.

However, Thailand's tropical climate often causes weather-related disruptions. Thunderstorms and heavy rainfall can significantly impact flight paths and air traffic flow.

(Bangkok Suvarnabhumi Airport (VTBS))

➢ This project explores how weather conditions influence flight routes around **VTBS** using real flight and weather data.

➢ **Suvarnabhumi Airport (VTBS)** is Thailand's main international gateway, handling over **800 flights daily**, both domestic and international.

➢ As Thailand continues to grow as a tourism and business hub, **air traffic congestion** has become more common—especially during peak hours.

➢ Weather conditions like storms and heavy rain often lead to **route changes**, **holding patterns**, or even **delays**, making air traffic management more complex.


(BKK Suvarnabhumi Airport (VTBS) Terminal Map)
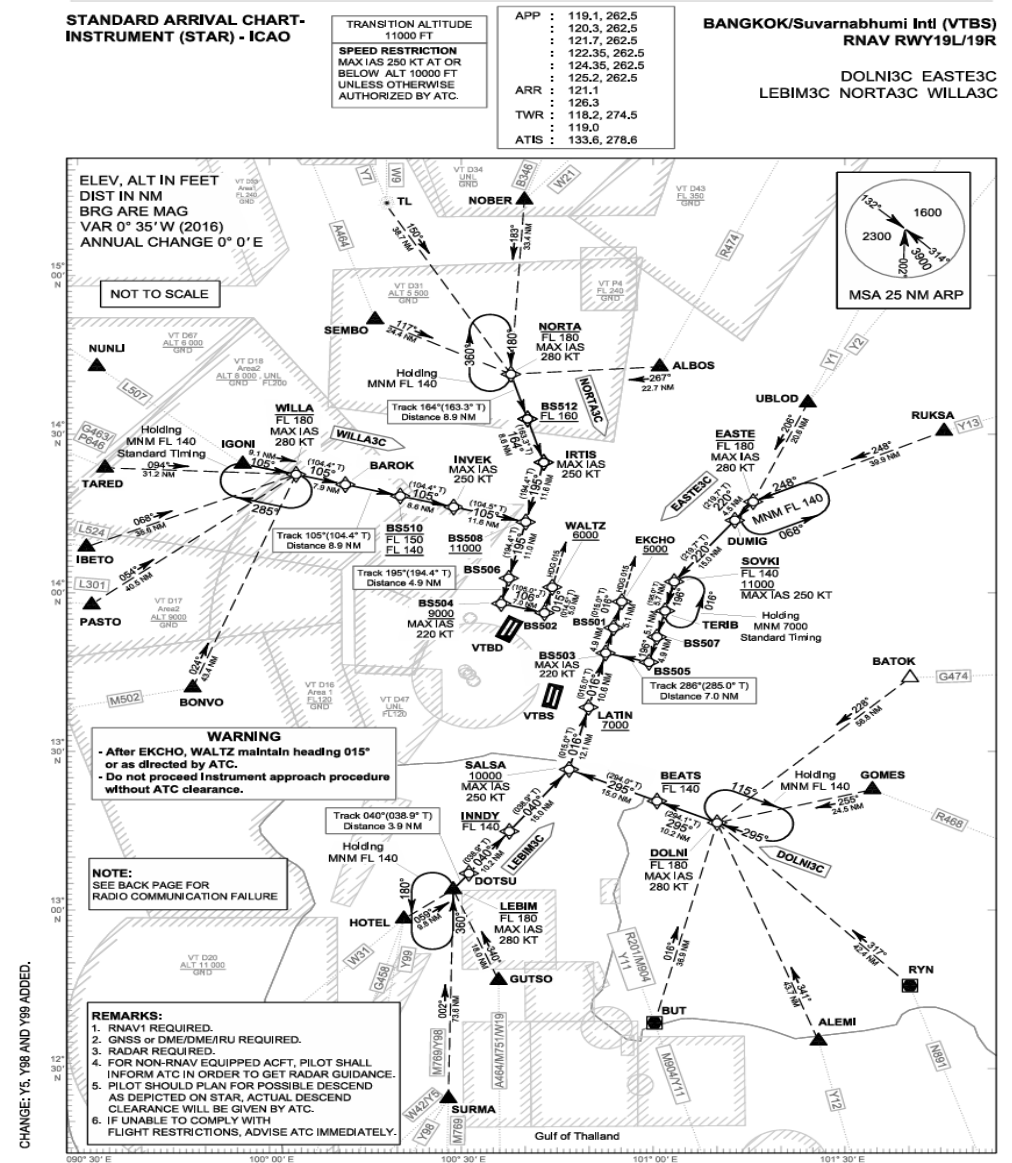
Problem

Bangkok Air Traffic Challenge

➤ **Suvarnabhumi Airport (VTBS)**
  - 65 million passengers/year
  - 300,000++ flights annually

➤ **Weather Problems:**
  - Frequent Thunderstorms (May-October)
  - Sudden Weather Changes
  - Safety VS Efficiency Decisions

➤ **What we learn:**
  - How pilots avoid weather ?
  - Does wind direction affect decisions ?
  - When do pilot deviate ?

🛩️ **Bangkok & BKK Airport Weather Radar**
📅 2025-05-25 23:10:00
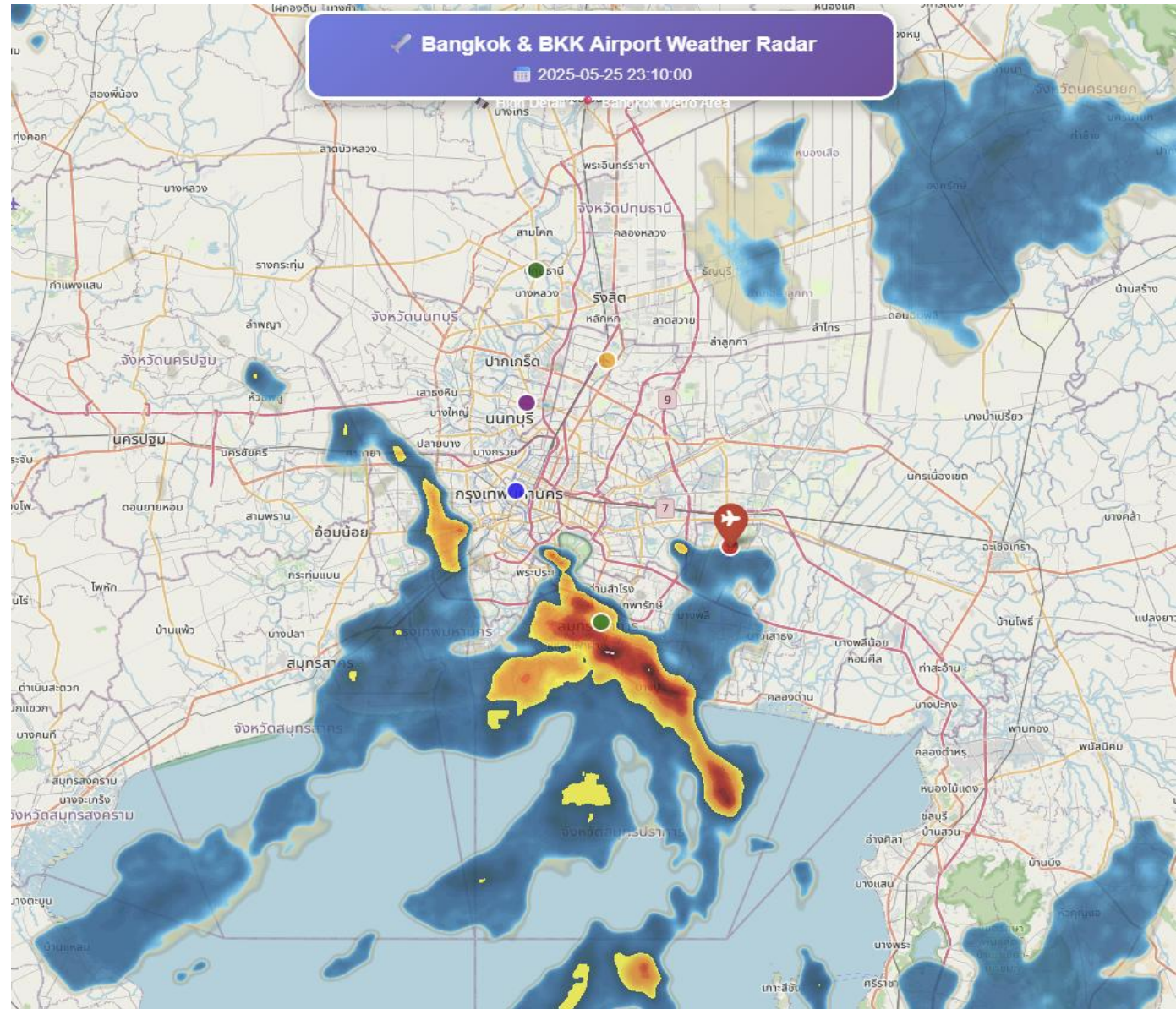
(Radar from previous progress at 2025/05/25 code detecting heavy rain)

Solution

We created ***Automated Weather Avoidance Analysis System***

➢ **What does it do ?:**
  - ✓ Track all flight arriving at Suvarnabhumi Airport (VTBS)
  - ✓ Analyzes real weather radar data
  - ✓ Measures avoidance behavior
  - ✓ Correlates with wind conditions

➢ **Key Features Combining:**
  - • Real-Flight Positions
  - • Actual Weather Data
  - • Wind Conditions
  - • Automated 24/7 analysis

```
Report Generated: 2025-06-24 16:32:07
Analysis Type: Real Weather Radar Data (No Simulated Zones)

DATA SOURCES
------------------------------------------
METAR Station: VTBS
METAR Time: 2025-06-24 07:00:00
Wind: 11 kt from 180°
Full METAR: VTBS 240700Z 18011KT 150V220 9999 FEW020 32/23 Q1006 NOSIG

Weather Radar: 2025-06-24 16:30:00 (2.0 min ago)
Radar Source: Rain Viewer API

ALTITUDE FILTERING
------------------------------------------
Maximum Altitude for Analysis: 10,000 ft
Final Approach Altitude: 3,000 ft
Only analyzing arrival flights below threshold

EXECUTIVE SUMMARY
------------------------------------------
Total Arrival Flights Analyzed: 15
Flights Avoiding Weather: 0 (0.0%)
Flights in Real Weather: 0 (0.0%)
Average Confidence Score: 93.0%
High Confidence Analyses: 14 (93.3%)

ALTITUDE DISTRIBUTION
------------------------------------------
0-3,000 ft: 5 flights
3,000-5,000 ft: 2 flights
5,000-7,000 ft: 5 flights
7,000-10,000 ft: 3 flights
```

```
AVOIDANCE BY WIND CONDITION
------------------------------------------

HEADWIND:
    Total Flights: 15
    Avoiding Weather: 0 (0.0%)
    In Real Weather: 0 (0.0%)


CONFIDENCE ANALYSIS
------------------------------------------

HIGH Confidence (14 flights):
    Average Score: 94.3%
    Common Issues:
      - High altitude (8700ft, -15%): 1 flights
      - Medium altitude (5250ft, -10%): 1 flights
      - Medium altitude (6700ft, -10%): 1 flights
      - High altitude (8400ft, -15%): 1 flights
      - Medium altitude (6475ft, -10%): 1 flights
      - Medium altitude (5575ft, -10%): 1 flights
      - Medium altitude (6200ft, -10%): 1 flights

MEDIUM Confidence (1 flights):
    Average Score: 75.0%
    Common Issues:
      - High altitude (8350ft, -15%): 1 flights
      - Far from airport (65km, -10%): 1 flights
```

(Text Result from our code showing all information we've taken at 2025/06/24, 16:30)

Data Sources

✈️ FLIGHT DATA	🌧️ WEATHER RADAR	🗨️ WIND DATA
OpenSky Network	RainViewer API	METAR (VTBS)
• Position	• Precipitation	• Speed
• Altitude	• Intensity (dBZ)	• Direction
• Heading	• Coverage Area	• Gusts
➢ Real-Time	➢ Every 5-10 min	➢ Hourly

Coverage Area: 80km radius around Airport (VTBS)
Collection Time: Automated every 10 minutes

How It Works

1. Filter Arrival Flights
- Altitude ≤ 10,000ft
- Within 80Km of VTBS
- Descending Aircraft Only
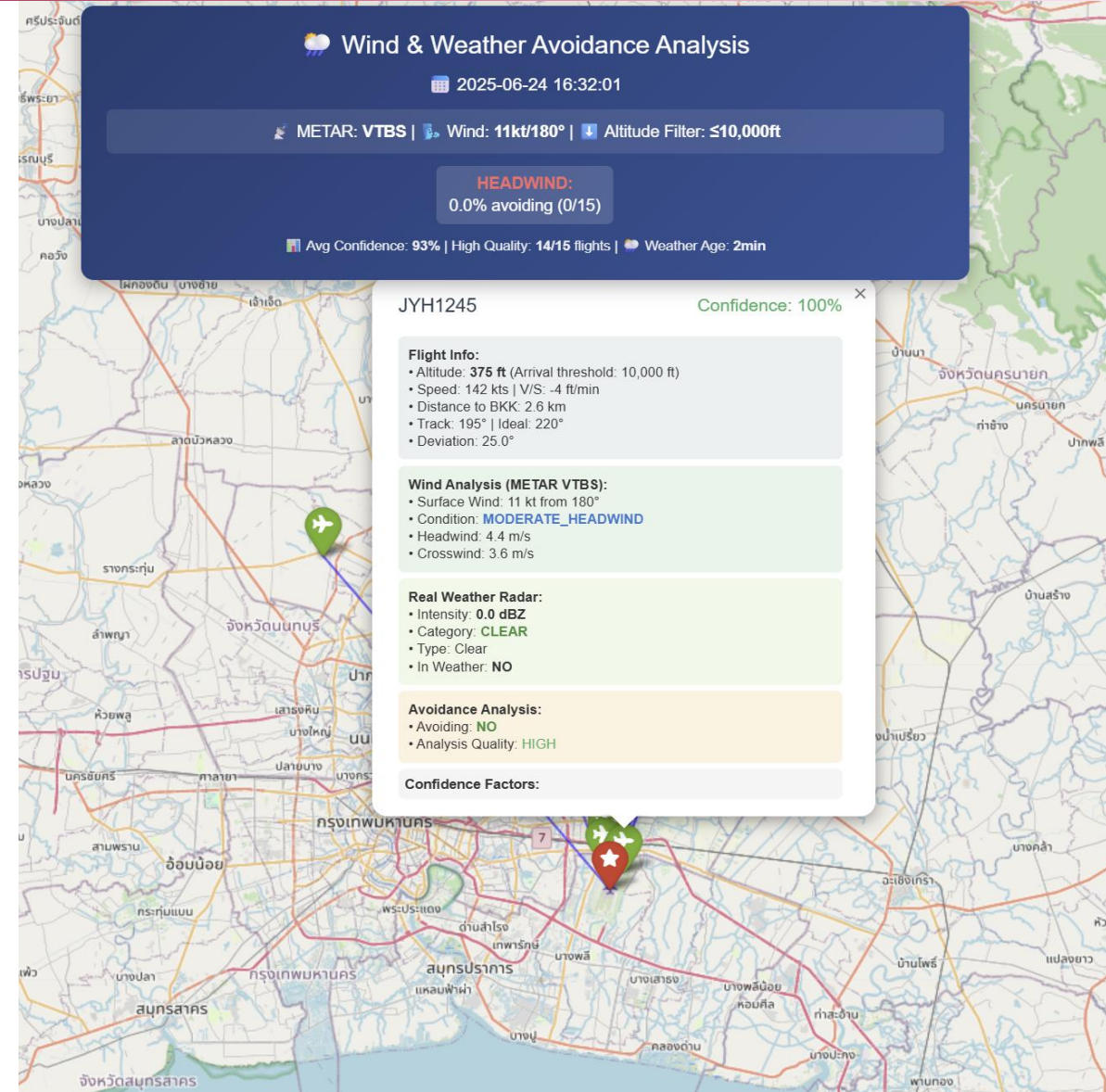
2. Classify Wind Exposure
- Calculate wind relative to approach
- Categorize: HEADWIND | TAILWIND | CROSSWIND | CALM

3. Analyze Weather Position
- Extract radar intensity at aircraft location
- Measure: Clear | Light | Moderate | Heavy

4. Detect Avoidance
- Compare Actual VS Ideal Heading
- If deviation >20° + in Weather = AVOIDING
- Assign Confidence Score (0-100%)

Wind & Weather Avoidance Analysis
📅 2025-06-24 16:32:01

METAR: **VTBS** | Wind: **11kt/180°** | Altitude Filter: **≤10,000ft**

HEADWIND:
0.0% avoiding (0/15)

📊 Avg Confidence: **93%** | High Quality: **14/15** flights | Weather Age: **2min**

JYH1245 — Confidence: 100%

Flight Info:
- Altitude: **375 ft** (Arrival threshold: 10,000 ft)
- Speed: 142 kts | V/S: -4 ft/min
- Distance to BKK: 2.6 km
- Track: 195° | Ideal: 220°
- Deviation: 25.0°

Wind Analysis (METAR VTBS):
- Surface Wind: 11 kt from 180°
- Condition: MODERATE_HEADWIND
- Headwind: 4.4 m/s
- Crosswind: 3.6 m/s

Real Weather Radar:
- Intensity: **0.0 dBZ**
- Category: CLEAR
- Type: Clear
- In Weather: NO

Avoidance Analysis:
- Avoiding: NO
- Analysis Quality: HIGH

Confidence Factors:

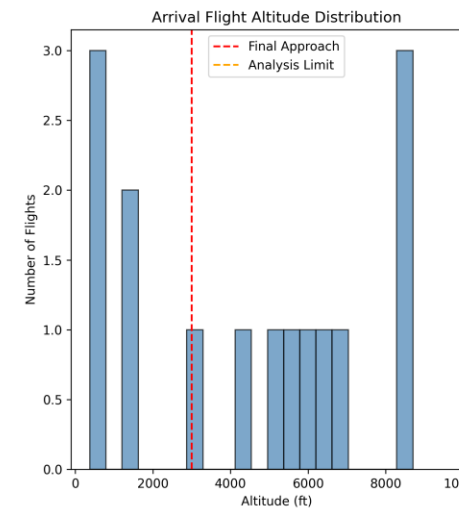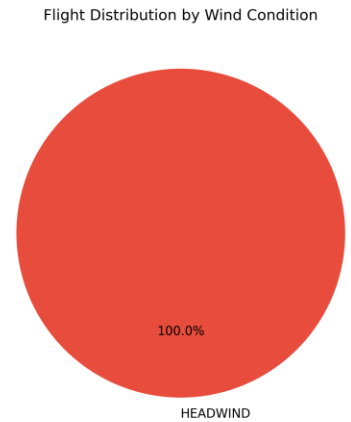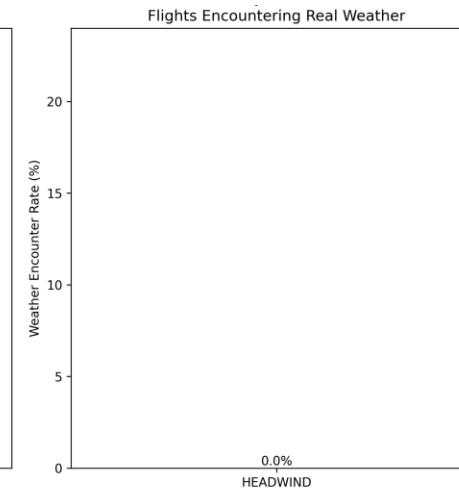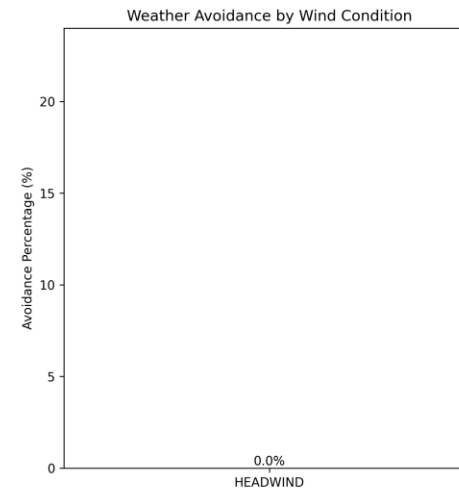*(Result of our map showing flight data and Airport at 2025/06/24 16:30)*

Wind & Weather Avoidance Analysis
METAR VTBS: 11kt/180°| Altitude Filter ≤ 10,000ft

Analysis Results (June 24, 2025 16:30)

Total Arrival Flights:	15
Wind Condition:	HEADWIND
Current Wind:	11kt/180°
Weather Activity:	MINIMAL

Key Observations:
- No weather encounters (clear conditions)
- No avoidance behavior detected
- High confidence: 93% average
- 14/15 flights with HIGH confidence

Weather Avoidance by Wind Condition

Flights Encountering Real Weather

Flight Distribution by Wind Condition

100.0%

HEADWIND

Arrival Flight Altitude Distribution

Weather Intensity vs Confidence

No Weather Encounters
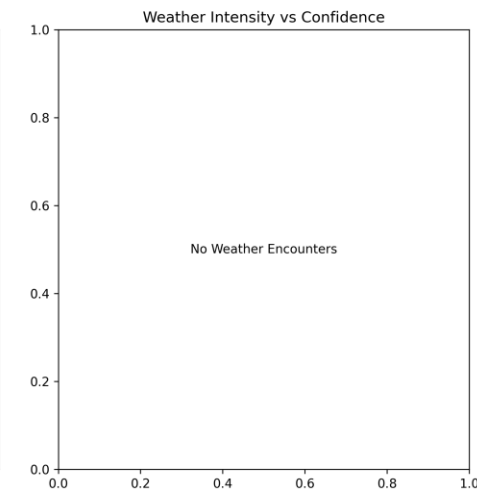
**(All data shown taken at 2025-06-24, 16:30)

What Our System Can Detect During Active Weather:

- ✓ Avoidance patterns by wind type
- ✓ Critical decision zones (40-60km)
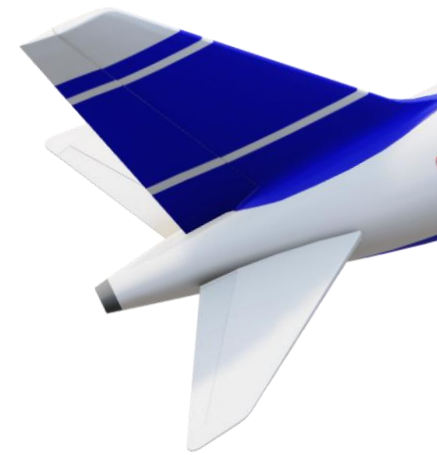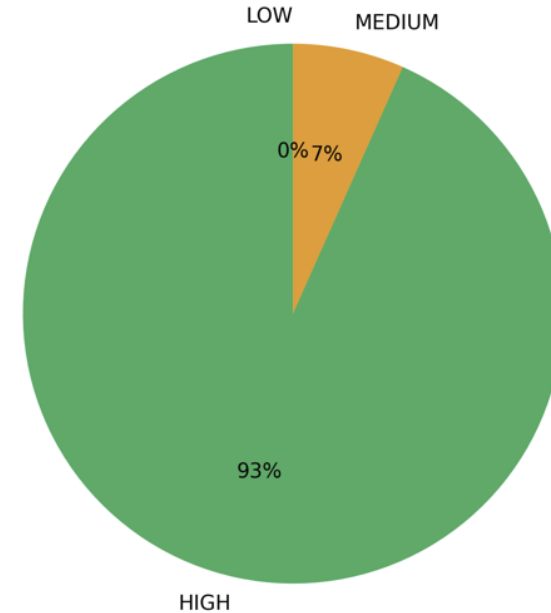- ✓ Altitude-dependent behavior
- ✓ Real-time deviations

Quality Metrics:

- Confidence: 93% Average
- Quality: 14/15 (93%)
- Data Age: 2 minutes

Altitude Distribution:

- 0 - 3,000 ft : 5 flights
- 3,000 - 7,000 ft : 7 flights
- 7,000 - 10,000 ft : 3 flights

Analysis Confidence Distribution

LOW   MEDIUM

0% 7%

93%

HIGH

🌧️ Wind & Weather Avoidance Analysis

📅 2025-06-24 16:32:01

🌡️ METAR: **VTBS** | 🧭 Wind: **11kt/180°** | ⬇️ Altitude Filter: **≤10,000ft**

HEADWIND:
0.0% avoiding (0/15)

📊 Avg Confidence: **93%** | High Quality: **14/15** flights | 🌧️ Weather Age: **2min**

**All data shown taken at 2025-06-24, 16:30

Expected Patterns

Expected During Weather Events:

Wind Type	Expected Behavior
🔁 CROSSWIND	Highest caution
⬅️ HEADWIND	Moderate avoid
➡️ TAILWIND	Least avoidance
⬜ CALM	Minimal changes

Decision Zones:
o > 60 Km: Free Maneuvering – Large deviations possible
o 40 – 60 Km: Critical Decisions – Most avoidance here
o 20 – 40Km: Limited Options – Minor adjustment only
o < 20 KM: Must Continue – Too close to deviate

Altitude Factor:
o >5,000 ft: More Likely to avoid
o <3,000 ft: Committed to Landing

IGO1057   Confidence: 90%

Flight Info:
• Altitude: **7,025 ft** (Arrival threshold: 10,000 ft)
• Speed: 290 kts | V/S: -7 ft/min
• Distance to BKK: 42.7 km
• Track: 143° | Ideal: 177°
• Deviation: 33.5°

Wind Analysis (METAR VTBS):
• Surface Wind: 6 kt from 260°
• Condition: MODERATE_CROSSWIND
• Headwind: 0.4 m/s
• Crosswind: 3.1 m/s

Real Weather Radar:
• Intensity: **26.5 dBZ**
• Category: LIGHT
• Type: Light Rain
• In Weather: **YES**

Avoidance Analysis:
• Avoiding: NO
• Analysis Quality: HIGH

Confidence Factors:
• Medium altitude (7025ft, -10%)

(Example Data from 2025/06/23 01:40 Data When Rain Occurs)

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Future Development

Current System (60-70% Accuracy):
- OpenSky Network Data
- Real Weather Data
- Surface Wind (METAR)
- Basic Pattern Decision

Future Develop -> (90%++ Accuracy):
- FlightRadar24 integration (better tracking and more information)
- Upper-Level Wind data (Full 3D analysis)
- Machine Learning model create for greater predictions
- Create Historical Pattern database
- Continuous Monitoring (24/7)

Applications:
- Air Traffic Control – Anticipate deviations
- Airlines – Optimize Approach
- Research – Safety Studies

Conclusion

What we Achieved:
- ✓ Automated avoidance analysis for VTBS
- ✓ Real-Time monitoring system operational
- ✓ Discovered wind-dependent patterns

Current Status:
- ✓ 📍 System validated during clear conditions
- ✓ 📊 Baseline behavior established
- ✓ 🎯 Prepared for weather analysis

Contact:
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GitHub: https://github.com/krithymn/ATMCODE.git

Thank You !