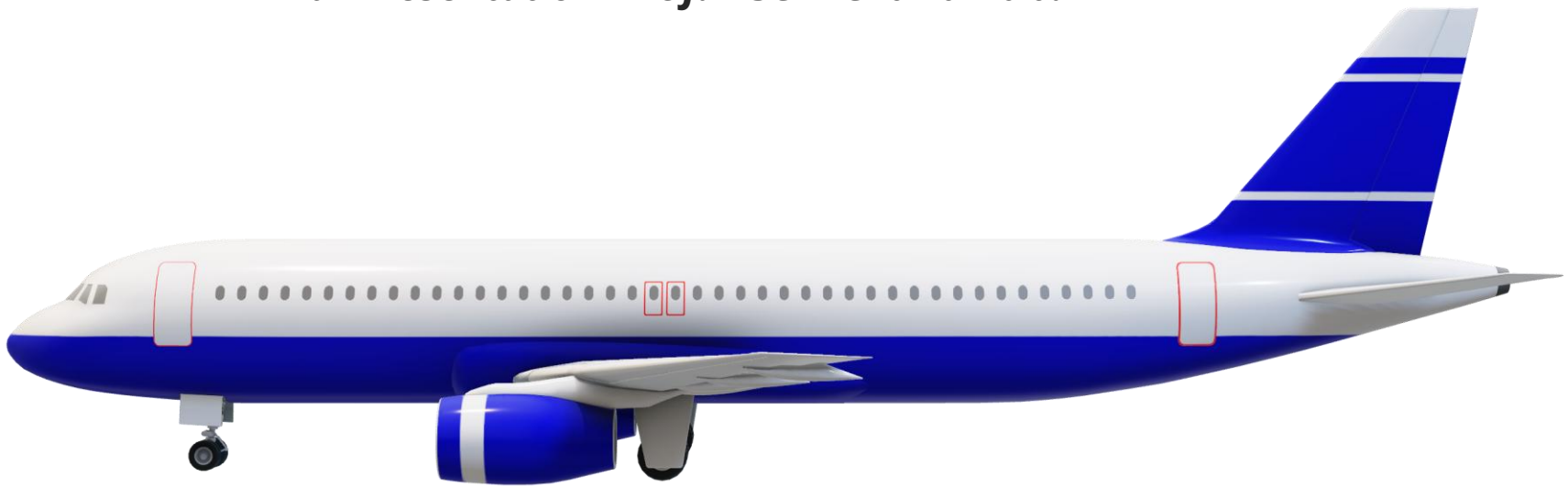
Wind & Weather Avoidance Analysis at *Bangkok Airport* (VTBS)

Krit Ittisomboon 2025/06/26 WasedaUniversity/KMITL

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.

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

(Bangkok Suvarnabhumi Airport (VTBS))

Background

- **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)

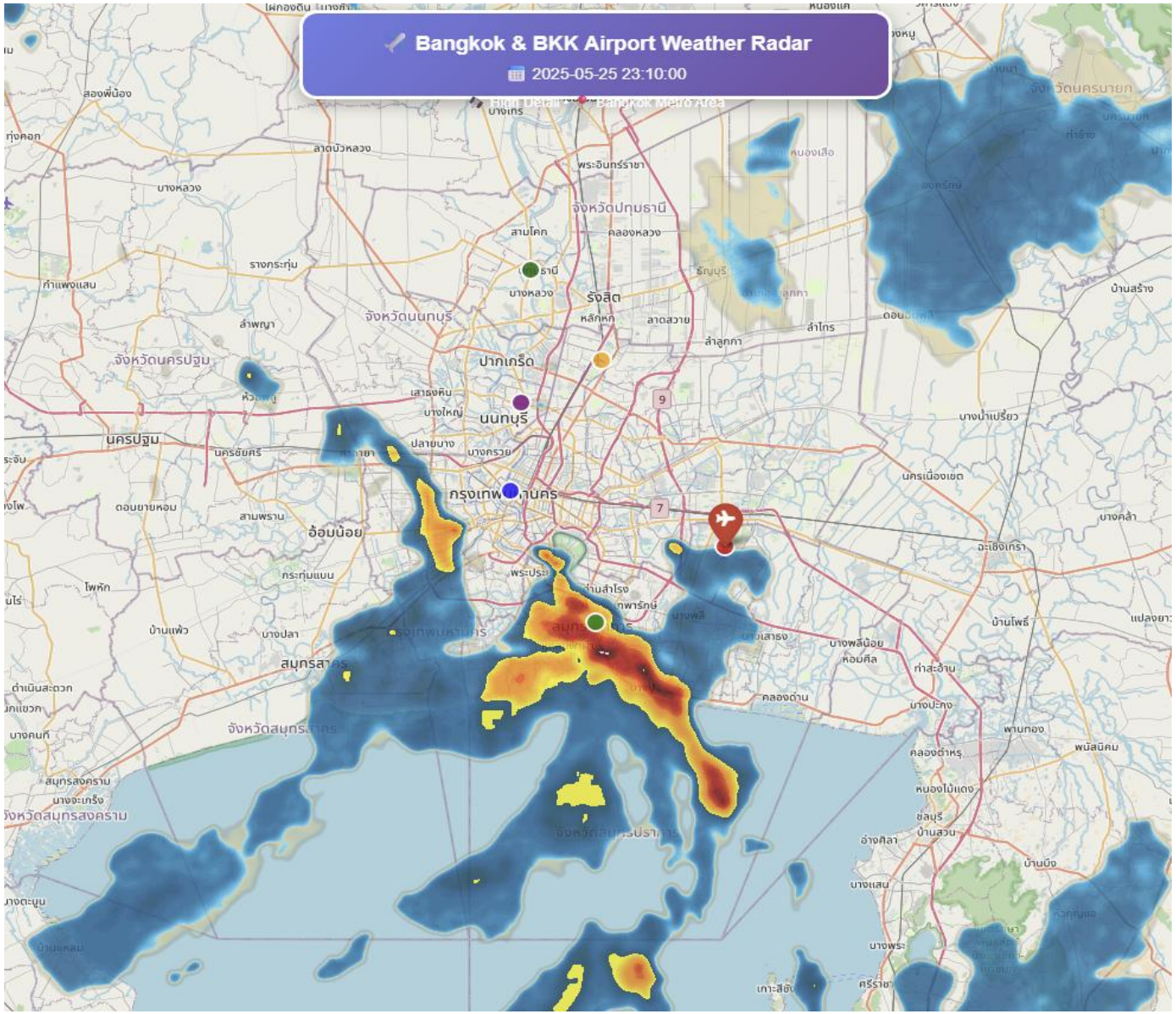
Problem

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 ?



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


CONFIDENCE ANALYSIS
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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

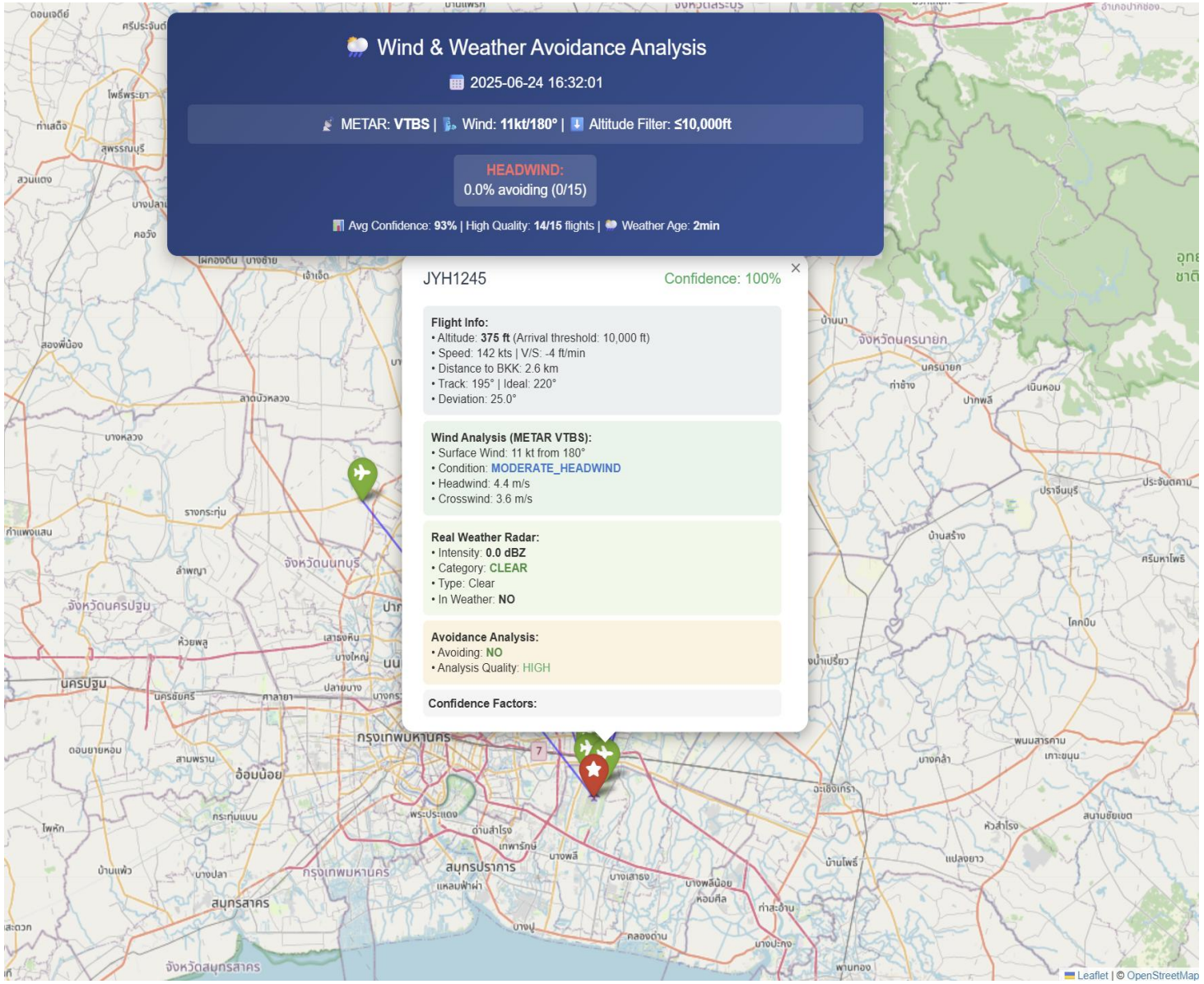
How It Works

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%)



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

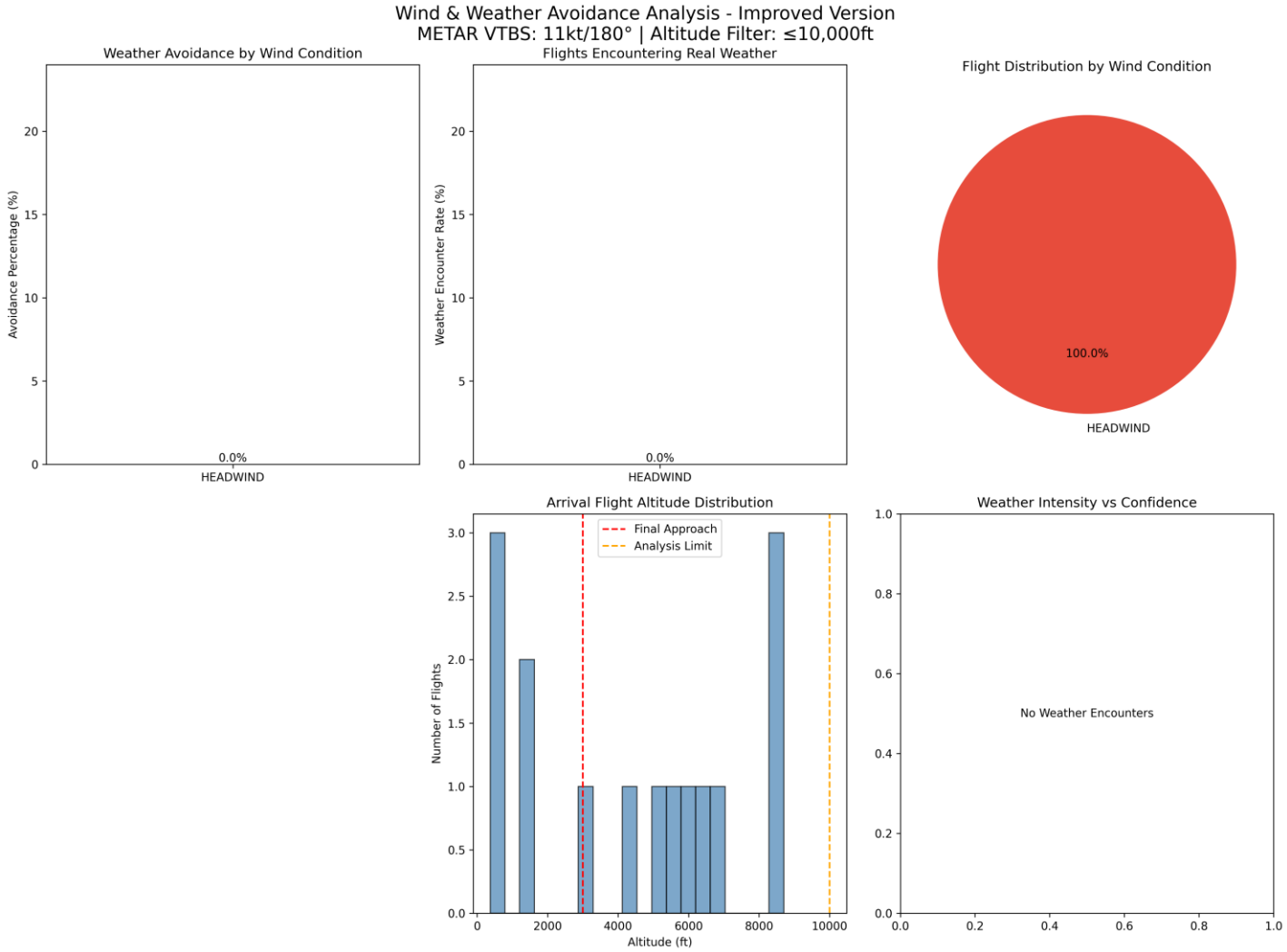
Results

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



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

System Capabilities

What Our System Can Detect During Active Weather:

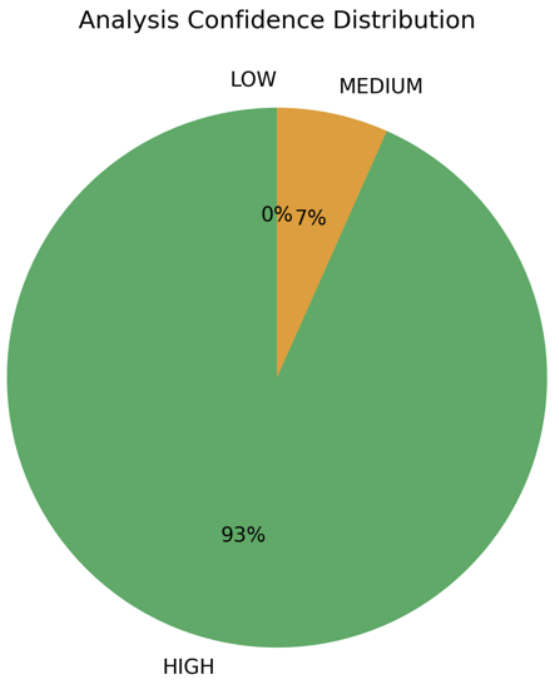
- ✓ Avoidance patterns by wind type
- ✓ Critical decision zones (40-60km)
- ✓ Altitude-dependent behavior
- ✓ Real-time deviations

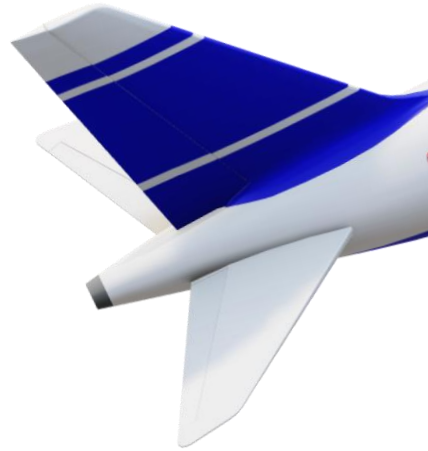
Quality Metrics:

- 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





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

Expected Patterns

Expected During Weather Events:

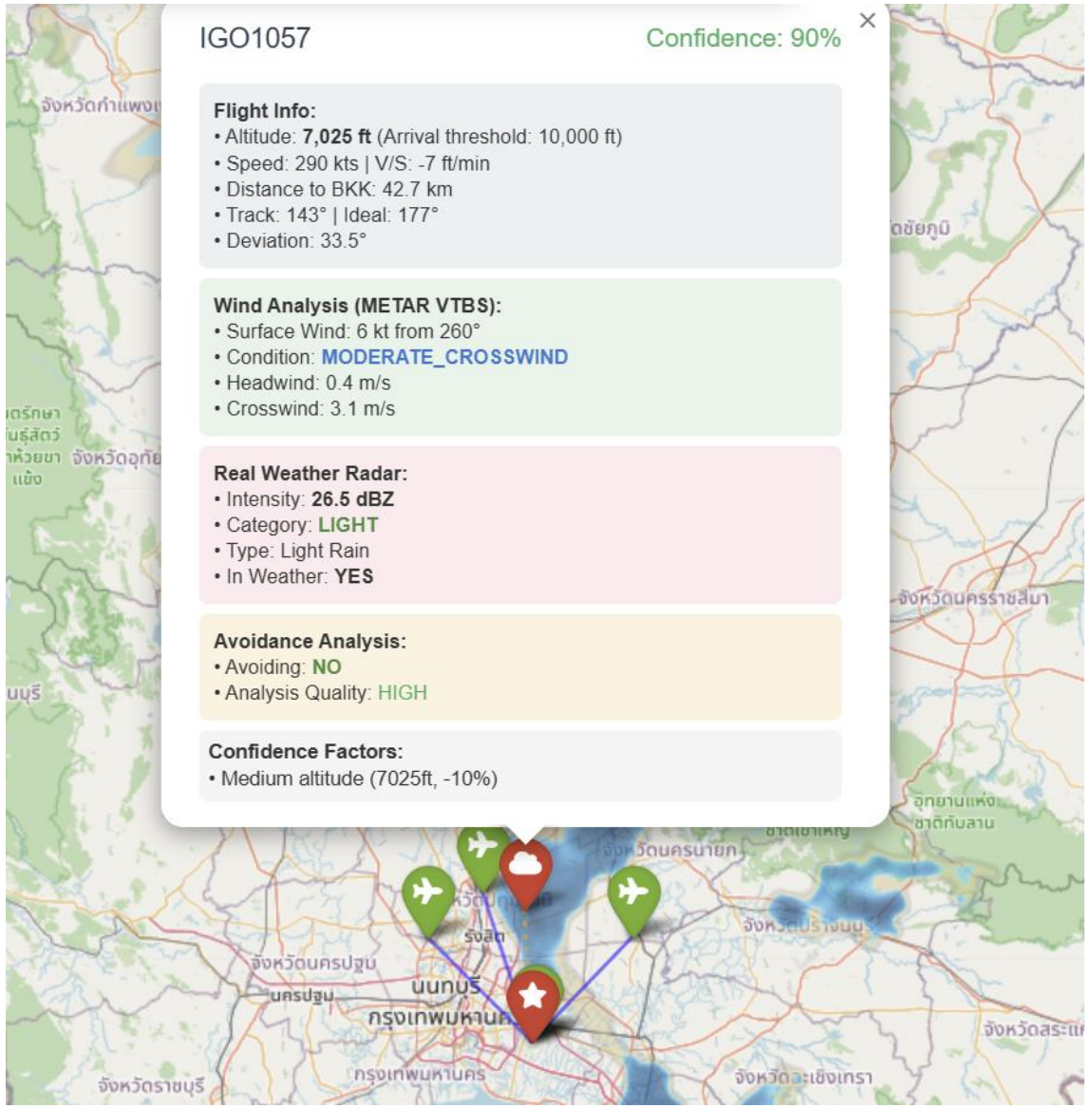
Wind Type	Expected Behavior
CROSSWIND	Highest caution
HEADWIND	Moderate avoid
TAILWIND	Least avoidance
CALM	Minimal changes

Decision Zones:

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

Altitude Factor:

- >5,000 ft: More Likely to avoid
- <3,000 ft: Committed to Landing



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

Future Development

Current System (60-70% Accuracy):

- OpenSky Network Data
- Real Weather Data
- Surface Wind (METAR)
- Basic Pattern Decision

flightradar24
LIVE AIR TRAFFIC

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

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Thank You !