

## **Problem Statement 5:**

### **AI/ML Based Prediction of Thunderstorm and Gale Force Wind over an Airfield**

Thunderstorms and gale force winds pose significant threats to airfield operations, affecting flight safety, mission readiness, and ground operations. Traditional forecasting methods rely heavily on numerical weather models and manual observations, which may not capture localized, short-duration weather events with sufficient accuracy.

#### **Challenges**

- High variability: Thunderstorms and wind gusts are highly localized and evolve rapidly, making prediction difficult.
- Short lead time: Conventional forecasts often provide insufficient warning for airfield operations to take preventive measures.
- Complex data sources: Weather data is multi-dimensional (satellite imagery, radar data, ground sensors, historical records) and difficult to process manually.
- Operational risk: Missed or inaccurate forecasts can lead to flight delays, equipment damage, or safety hazards. There is a critical need for an AI/ML-driven system that can analyze multiple weather data streams in real time and provide accurate short-term predictions of thunderstorms and gale force winds specific to airfields, enabling timely and effective operational decisions.

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#### **AI/ML Weather Prediction & Alert System for Airfields**

- Develop in 36 hours an AI-powered system to collect, process, predict, and alert severe weather events impacting airfield operations.

#### **Requirements**

##### **1. Data Ingestion & Processing**

- The system pulls data from multiple sources: Radar (DWR): storm cells, wind velocity. Satellite Imagery: cloud movements, IR/water vapor. Weather Stations (AWS): temperature, humidity, pressure, wind. Historical Records: past events for model training.

- Pipelines continuously gather, clean, and sync data. Missing values are imputed, noisy signals filtered, and all readings aligned on a common timeline. A scalable storage (time-series DB/data lake) maintains real-time + historical data.

## 2. Weather Prediction Models

- Two forecast horizons:
- Nowcasting (0–3 hrs): for immediate airfield safety.
- LSTMs for wind gusts, CNNs for radar/satellite patterns, ensemble models (Random Forest/GBM) for storm likelihood.
- Medium-term (up to 24 hrs): for planning.
- Longer horizon models incorporating synoptic-scale data. Continuous retraining ensures accuracy improves with new data.

## 3. Alerts & Explainability

- Alert Engine: Monitors real-time feeds → triggers alerts if thresholds exceeded.
- Confidence Scores: Each forecast includes probability (e.g., “Thunderstorm: 85%”).
- Explainability: Shows drivers (e.g., “Pressure drop + radar echoes in north sector”).
- Storage: All alerts logged for audits and system refinement.

## 4. Dashboard Integration

- A user-friendly interface for air traffic control & ground staff.
- Key Features:
- Real-time maps with radar overlays, storm cells, wind arrows.
- Color-coded risk levels: Green = safe, Yellow = caution, Red = danger.
- Custom thresholds per airfield.
- Animated storm movement + impact zones.
- Explainability panel: Why the alert was issued in plain language.
- Alerts: flashing banners, audio, and drill-down details.

## Example Scenario

- Thunderstorm Warning (80% in 2 hrs): Triggered by radar + pressure drop → orange alert → delayed landings.
- Severe Winds (65 km/h in 30 min): Red alert → ground crew secures equipment.