Modeling Convective Weather Avoidance of Arrivals in Terminal Airspace

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**Goal**
Adapt the Convective Weather Avoidance Model (CWAM) for the terminal airspace with a focus on arrival decision making

**Motivation**
Operational Deviation Error (DOE) for Automation Project

**Challenges**
- Flexibility in arrival airspace makes it difficult to identify potential trajectories
- Trajectory from cornerpost dependent on many factors
  - Runway configuration
  - Extension of downward leg due to winds, traffic volume, etc.
- Potential interactions with operations of nearby airports

**Typical Cornerpost Impacts**

- **Classical Deviations**
  - Arriving aircraft deviating to avoid a storm near the arrival cornerpost (flight plan changes made)

- **Arboreal Holding**
  - Airborne holding in response to weather at cornerpost

- **Arboreal Reroute**
  - Airborne reroute to alternate cornerpost to avoid weather

- **Pathfind**
  - Pilot-planned typical route to avoid weather impacting cornerpost at departure time

- **Diversion**
  - Diversion to avoid cornerpost weather

- **Planning**
  - Aircraft maneuvers to avoid weather inside terminal

**Typical Airport Impacts**

- **Diversion**
  - Aircraft maneuvers to avoid weather impacting cornerpost at departure time

- **Holding**
  - Airport closed — aircraft enter holding patterns to wait out storms

**Analysis Database**

- Analyzed five days from 2009 for four metro regions
  - DFW, ORD, BWI, and RDU
  - 17,000 impacts
  - 12,000 weather impact decisions

- Identified weather impact decisions:
  - Prolonged
  - Rerouted
  - Avoided

- Cornerpost: Most common weather impact decisions are planning, rerouting, and deviation
- Airport: Most common weather impact decision is to hold

**CWAM Modeling**

- Modify core CWAM for terminal application:
  - Identify impacts that are specific to terminal operations (manually)
  - “Classical” Deviation
  - Arboreal Holding
  - Arboreal Reroute
  - Avoided
  - Diversion
  - Planning
  - Identify nonimpacted flights (automated)
  - Create Terminal Weather Avoidance Field (TWAF) from probability of weather impact decisions

**Cornerpost Impacts**
A correlation exists between pilot behavior and the storm intensity and echo top height. Pilots are likely to avoid storms with tops greater than 30,000 feet, greater than level three. However, pilots will penetrate storms with level one. Physicians are likely to avoid storms with tops greater than 30,000 feet. Physicians are likely to avoid storms with tops greater than 30,000 feet.

**Airport Impacts**
Airport closures are likely to occur when precipitation with intensity greater than level three and/or echo tops are greater than 40,000 feet.

**Conclusions**

- Terminal weather avoidance is highly correlated with precipitation intensity (50% of the storm vertical extent above max)
- Pilots will fly in close proximity to storms within the terminal airspace suggesting that large spatial filters are not appropriate