Sector Occupancy Analysis with the Adverse Weather Diversion Model DIVMET

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Motivation for model development

Adverse weather conditions, e.g. thunderstorms or icing, are responsible for:
- about 50% of all aircraft delays
- >10% of all accidents and incidents in aviation

Main objective of any future adverse weather solution for aviation is the reduction of delays and the increase of safety.

- Understanding the interaction of the two complex systems air traffic and adverse weather.
- Investigation, exploration and development of an adverse weather ATM solution model: DIVMET

Similar tools in the US developed at MIT-Lincoln Lab [1], at NCAR, Boulder [2] and by NASA [3]. Necessity of these developments results from increased weather related delays.

Note: Lack of equivalent tools to support ATM in adverse weather conditions in Europe.

Development of the DIVMET algorithm

- Simulates the collaborative decision making between pilot and ATC
- Proposes a short and safe route through a field of storms

Motivation & Objectives of the study

Squall line situation over Austria

Observations
- Nearly completely blocked air space over Czech Republic
- Highly blocked air space over Austria
- Unexpected shift of air traffic from Czech Republic to Austria
- Maximum workload for Austrian controllers due to increased airspace sector occupancy

Key questions
- Is it possible to predict the arising sector and work load using weather forecast and/or nowcast models?
- Can the shift of trajectories be simulated?
- Is, especially, DIVMET suitable for sector load shift analyses?

Benefits
- Ability to schedule resources (personnel, airspace sector distribution)
- Provision of diversion routes
- Avoidance of sector closing and holding patterns because of the overall traffic situation and sector occupancy

Setup for feasibility analysis & Basic results

Basic numerical experiment
- 1°x1° grid sectors
- Intended homogenous coverage of airspace by trajectories
- Approximated by 63 direct routes connecting all outer grid points except those on the same border
  - Flights only in one direction; no interaction and no conflicts considered
  - Main flow from the east and north
- Setting of route points (RP) every 15 s at a flight velocity of 280 m/s
  - Number of route points per sector, the sector route coverage density, is assumed as a measure for sector load

Further results

- 0.5°x0.5° grid sectors
- Total number of RP: 4477 (+12%)
- Compared to the unrestricted sector
- Smaller sectors show larger effects
- Main flow from west and north
- Main deviation to the south due to limited knowledge
- Total number of RP: 4701 (+202)
- Unlimited knowledge
- Balanced deviation to the north and south
- Shorter detour
- Total number of RP: 4564 (+142)

Conclusions
- Simulation of sector load shift and anticipated effects is possible
- More efficient routes and more balanced load of available sectors in case of an increased radar field of view
- DIVMET is suitable for this application
- Transfer to real conditions (airspaces, air traffic routes)

References & Additional information


Additional information

T. Hauf, L. Sakiew, and M. Sauer, Adverse weather diversion model DIVMET. Submitted to Journal of Aerospace Operations