

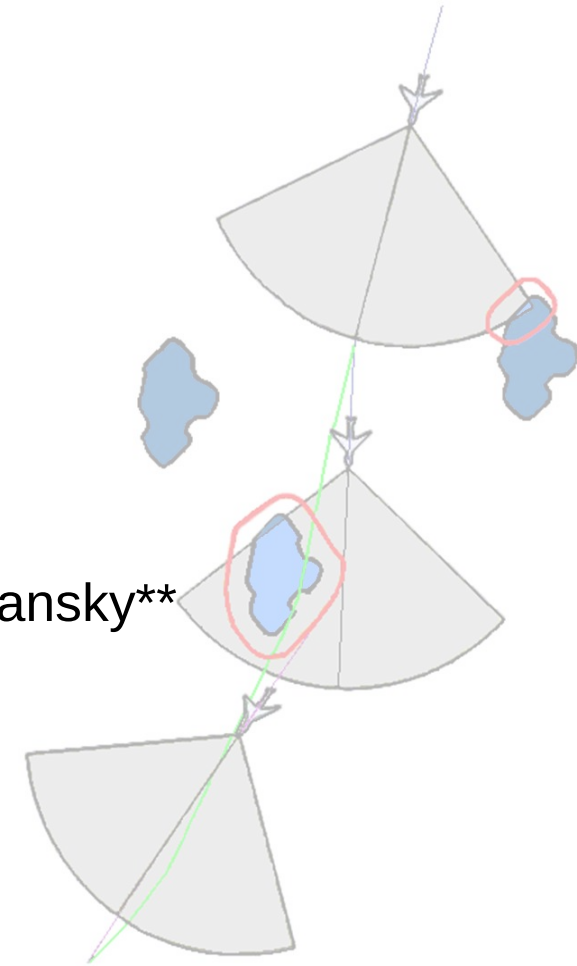
Case Study of Adverse Weather Avoidance Modelling

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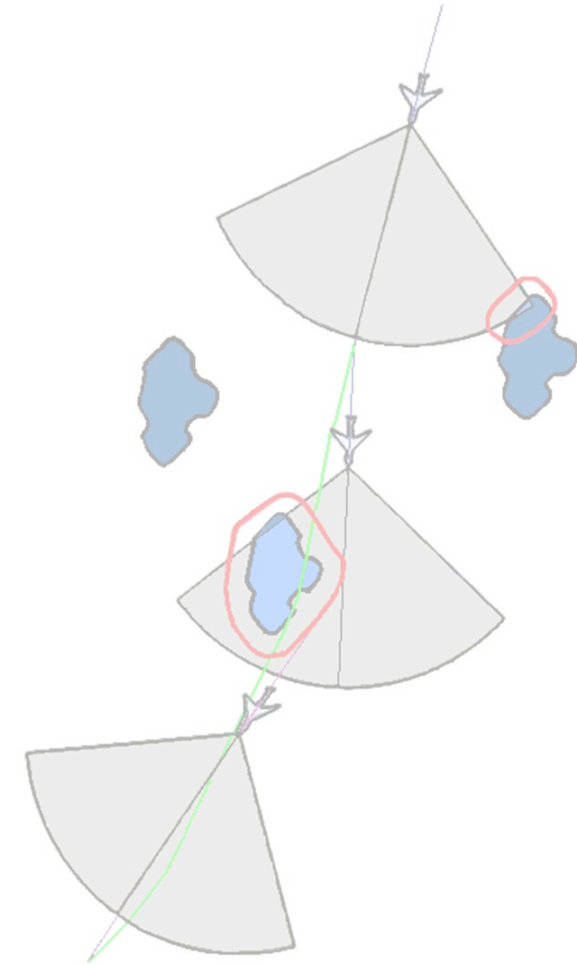
4th SESAR Innovation Days
Madrid, 25th November 2014



Case Study of Adverse Weather Avoidance Modelling

Outline

- Motivation and Objectives
- The weather diversion model DIVMET
- The air traffic simulation model NAVSIM
- Case Study: Air traffic over Austria during a squall-line passage
- Summary and Outlook



Motivation and Objectives

17th July 2010: Squall line over Austria and Czech Republic
extension: >500 km, durability: ~6 hrs

- Impact on air traffic
- Austro Control: Additional workload for air traffic controllers

 Can we predict the sector occupancy for various time scales by forecasting weather impacted flight trajectories?

Basic question: How accurately and realistically can we simulate trajectories in adverse weather situations?

Case study: thunderstorms, 1 hr time horizon (over Austria),
based on observations, but not yet on forecasts

THE WEATHER DIVERSION MODEL DIVMET

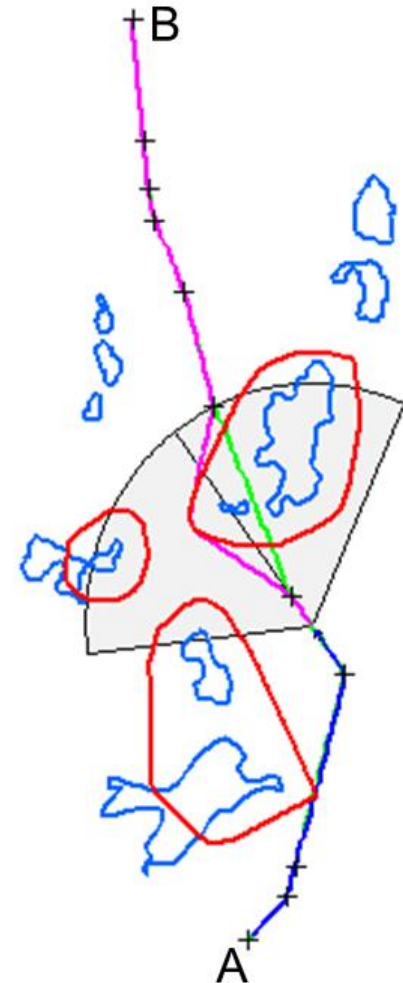
DIVMET

Input:

- Flight trajectories
- Weather situation

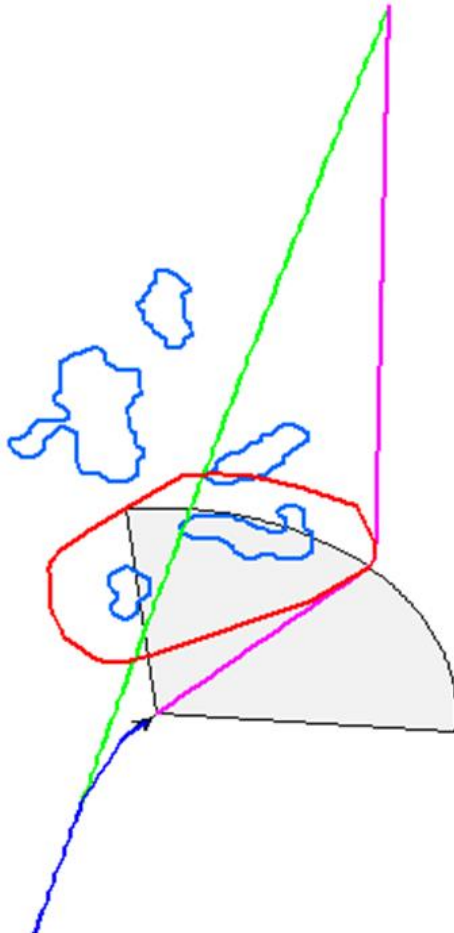
Parameters:

- Distance to CBs
- Field of view

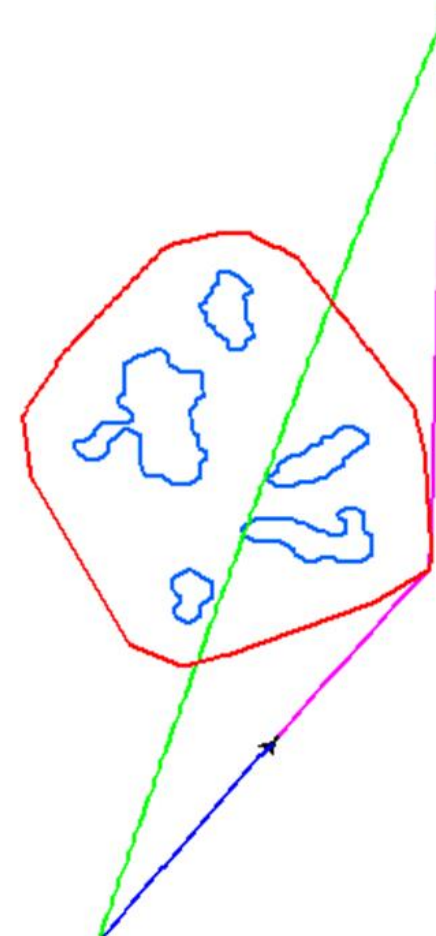


How much weather information is considered?

Limited view (business case: on-board radar at night)

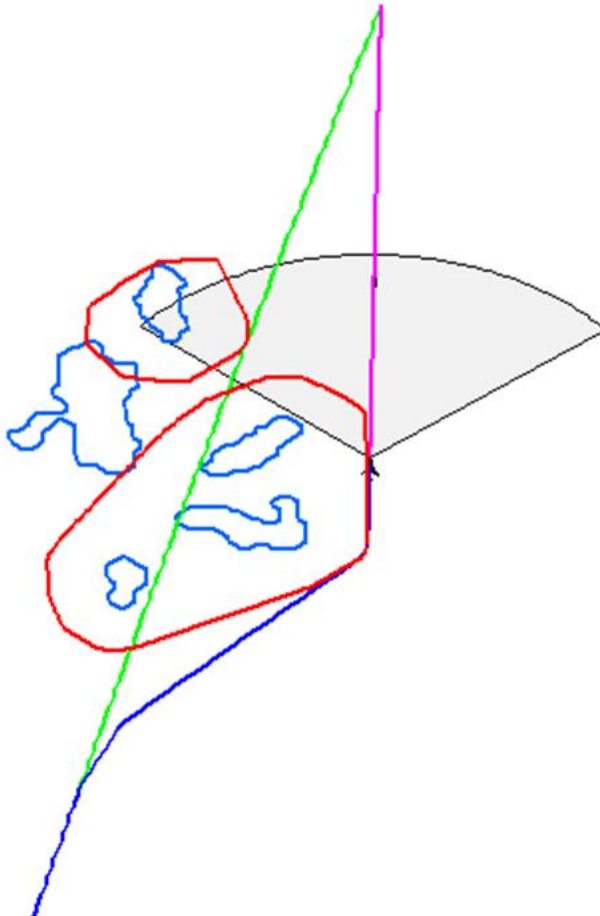


Full view (unlimited weather information in the cockpit)

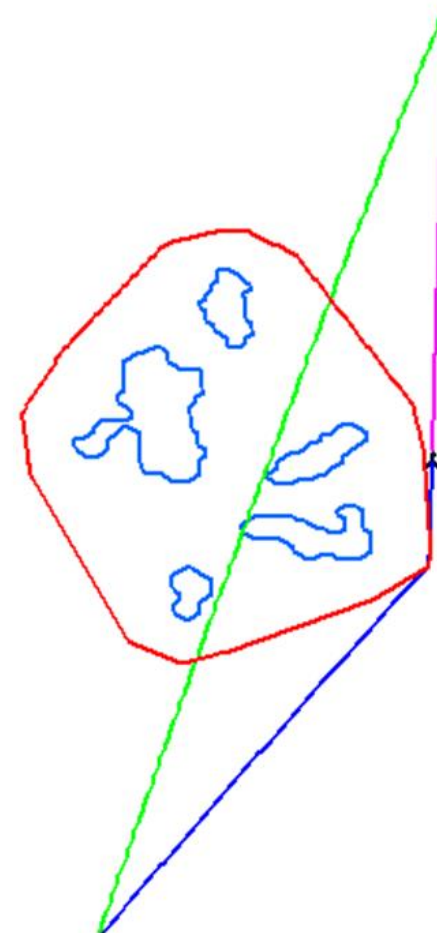


How much weather information is considered?

Limited view (business case: on-board radar at night)



Full view (unlimited weather information in the cockpit)



DIVMET

Input:

- Flight trajectories
- Weather situation

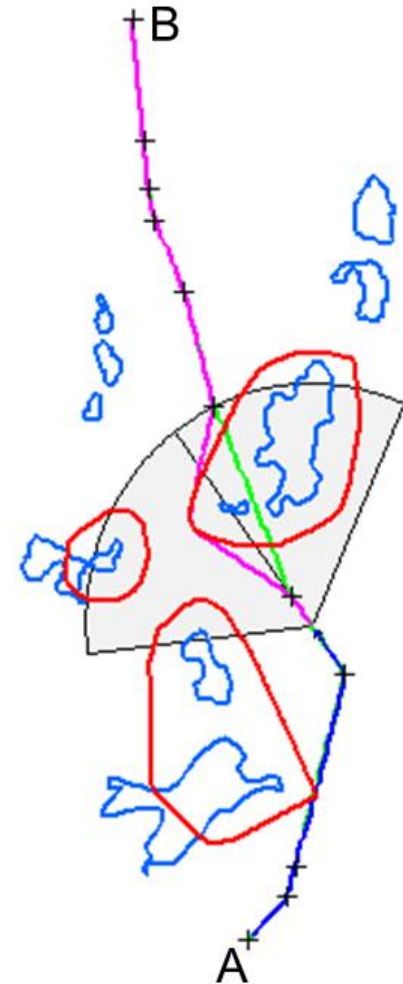
Parameters:

- Distance to CBs
- Field of view

- Realistic representation of diversion routes
- Diagnostics: Punctuality, distance, fuel consumption

Limitations:

- 2-dimensional
- Single AC with constant speed
- Without AC performance data



THE AIR TRAFFIC SIMULATION MODEL

NAVSIM

C.-H. Rokitansky

NAVSIM: Global air traffic simulation tool

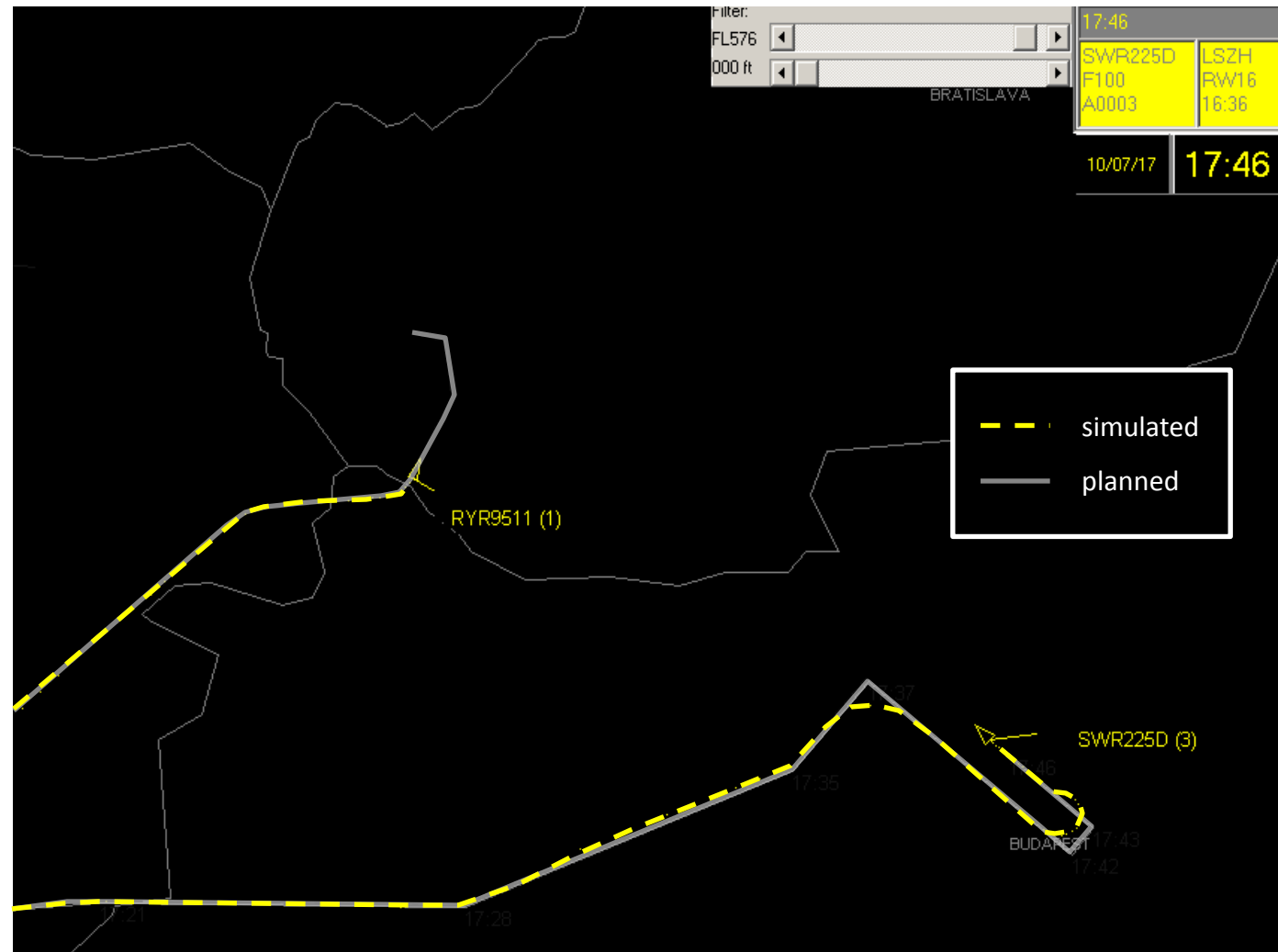
Up to 300.000
aircraft per day

Simulation:
real time and fast
time (up to 60x)

4D trajectories

Input:

- Traffic Demand
- Base-of-Aircraft-Data (BADA)
- Navigation data



NAVSIM

Output:

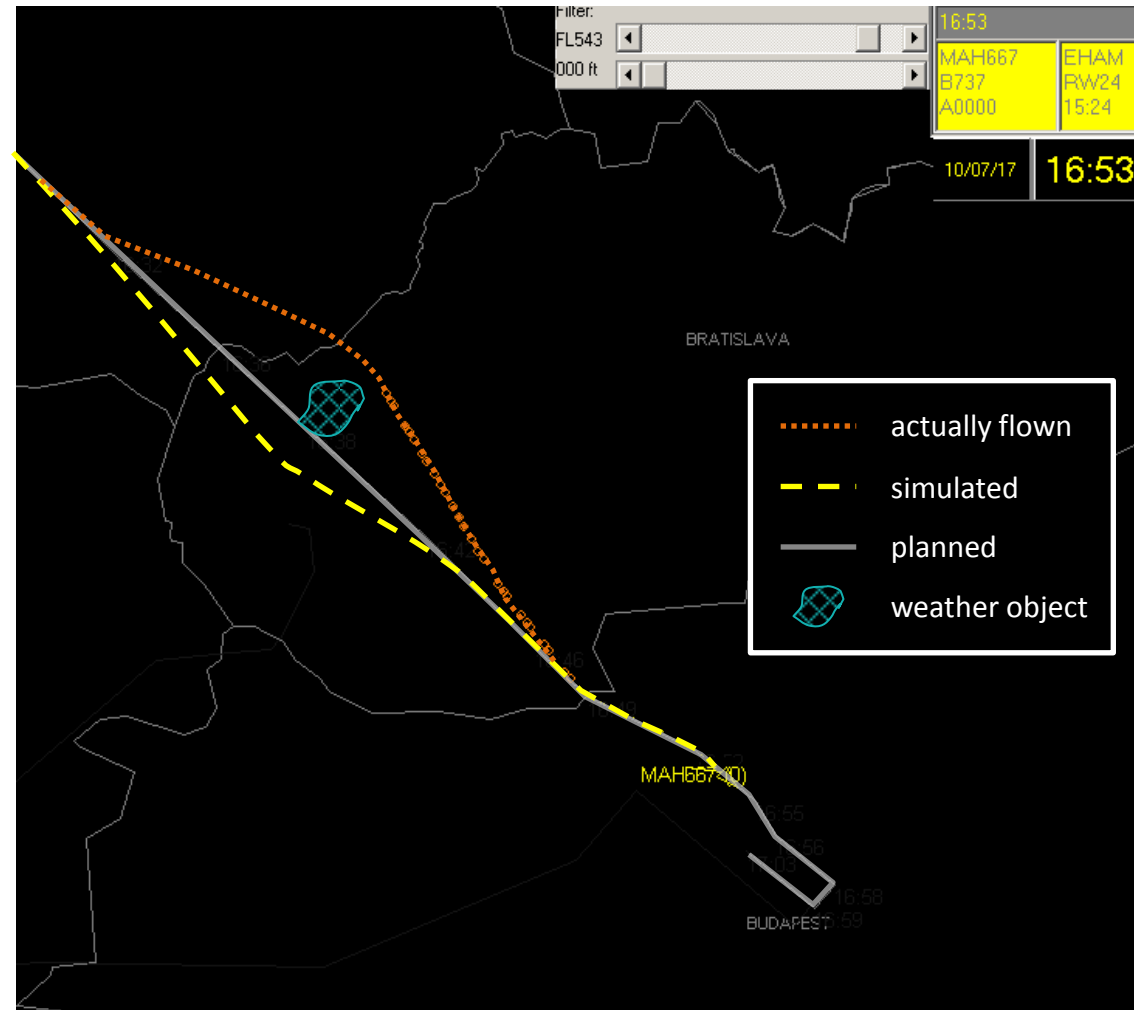
- Position recording

Display (radar-like screen):

- Weather polygons
- FPL route (planned)
- CPR route (actually flown)
- POS route (NAVSIM simulated)

AC-AC conflict detection

→ Realistic representation of the entire air traffic from gate to gate!



CASE STUDY: AIR TRAFFIC OVER AUSTRIA DURING A SQUALL LINE PASSAGE

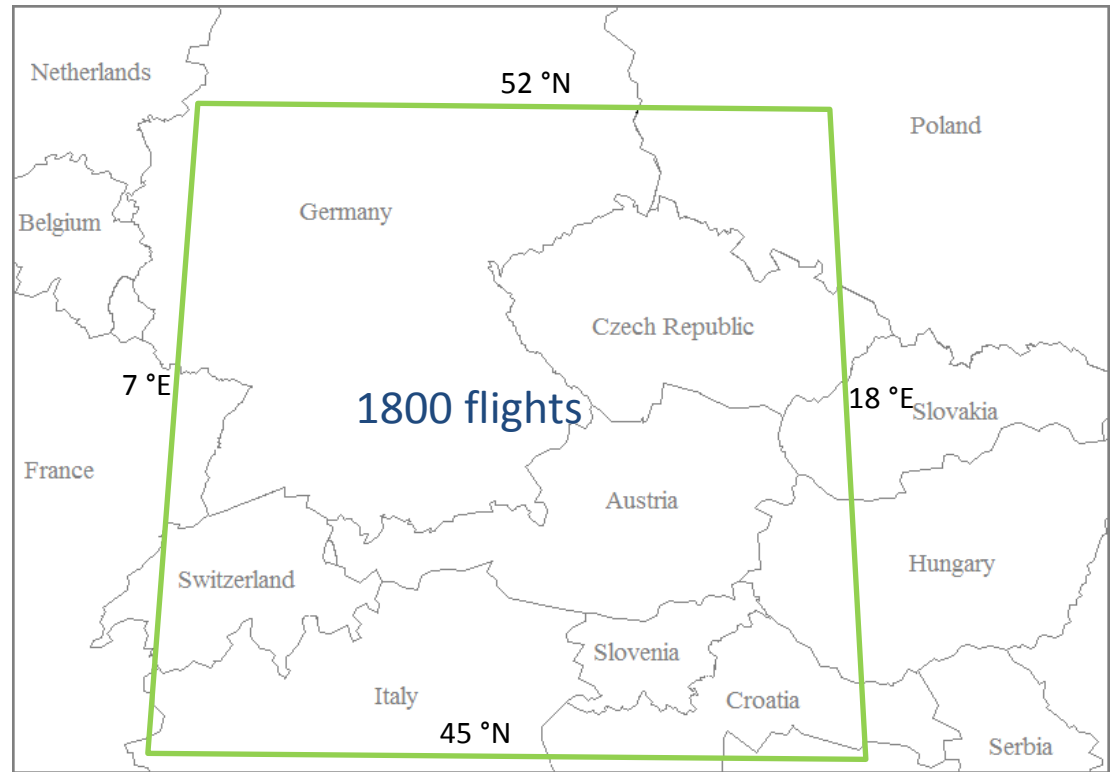
17th July 2010, 12:30 UTC – 18:00 UTC

>26.000 flights over Europe
(Traffic Demand)

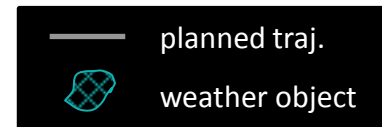
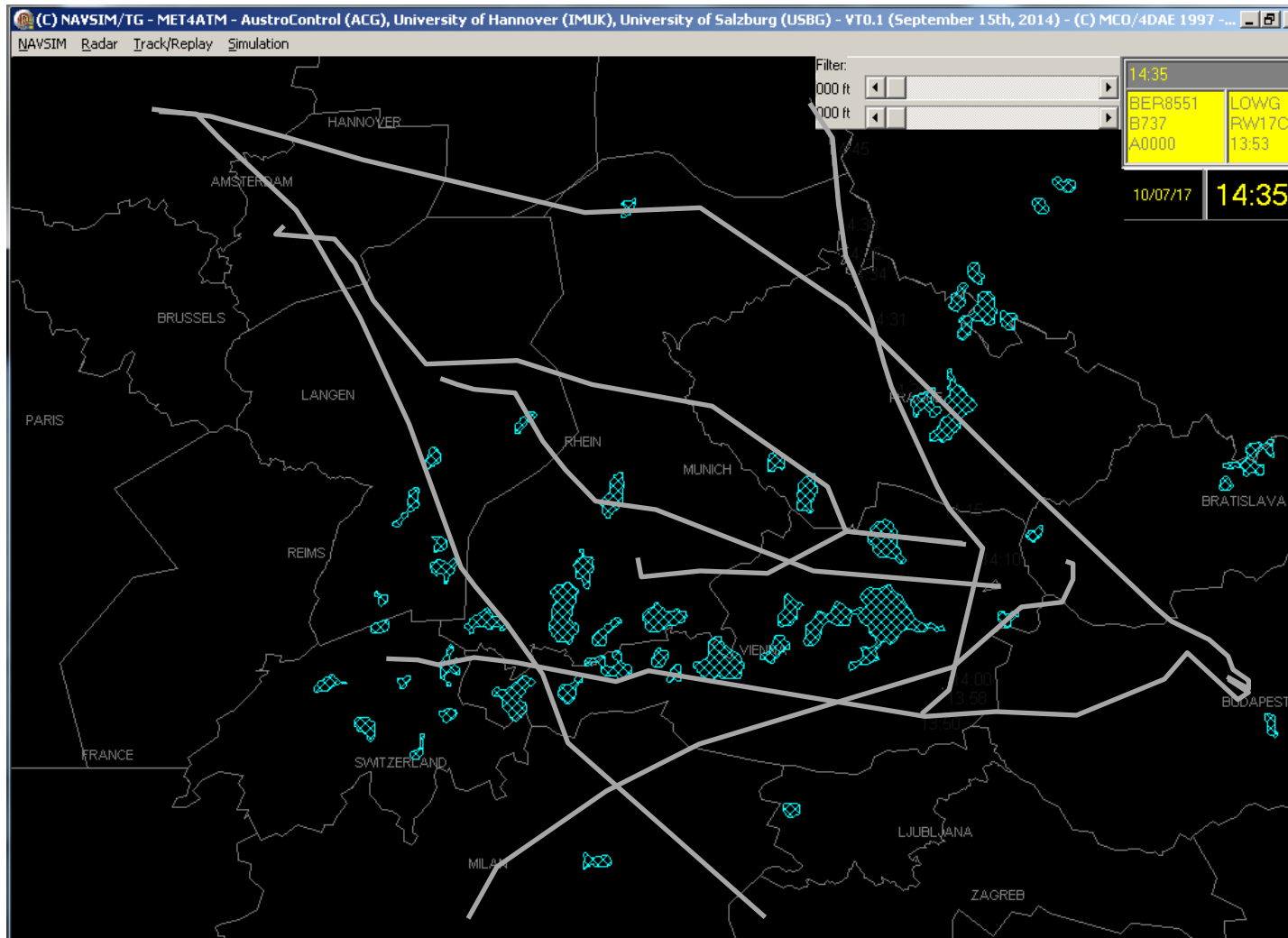
Weather radar data: CERAD

- Threshold for polygons:
37 dBZ ↔ 8 mm/h
- Time interval: 15 min

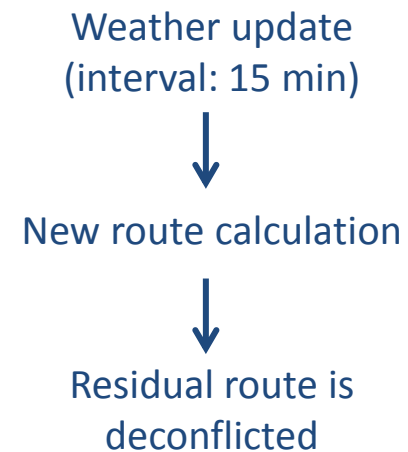
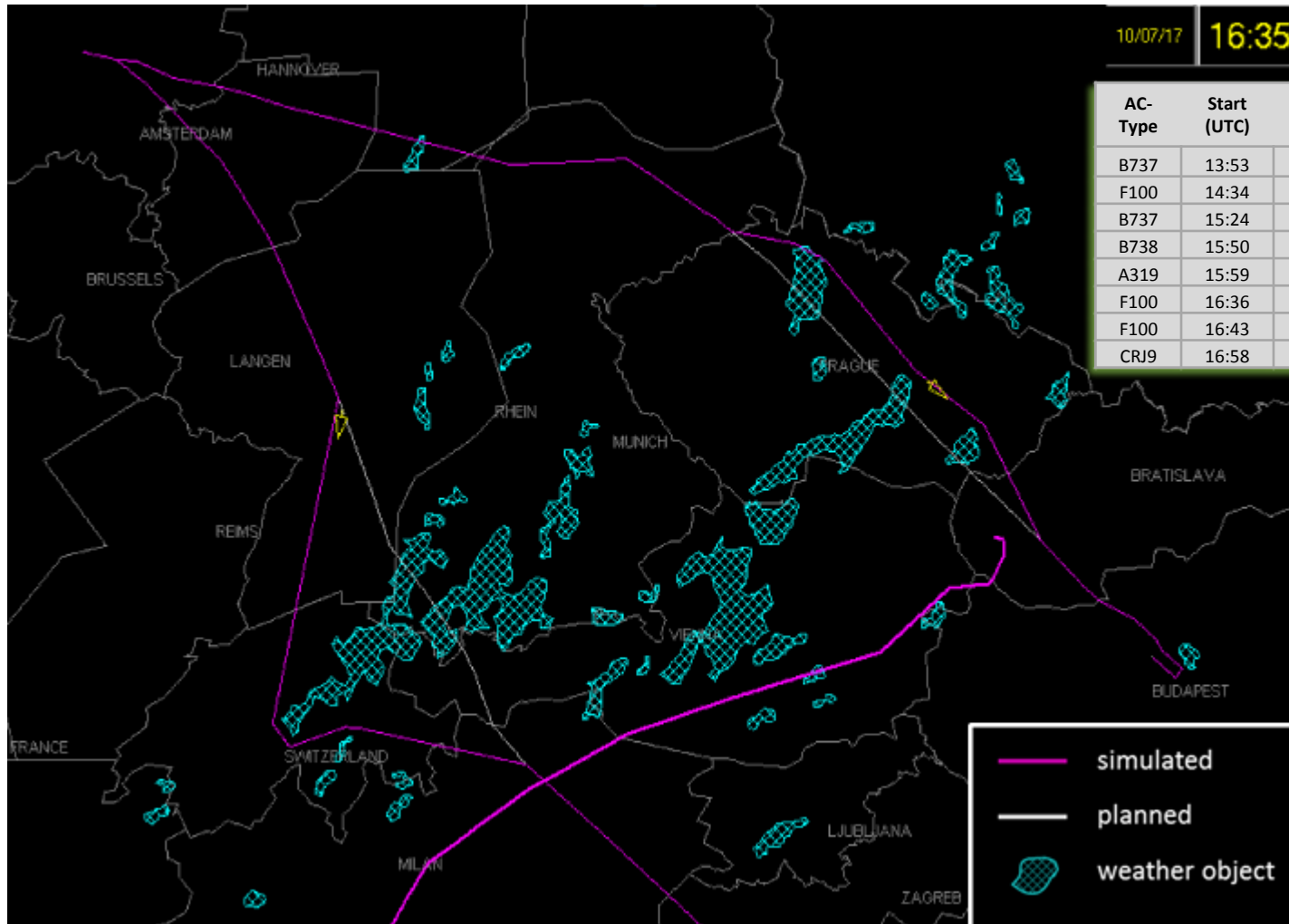
„Area of relevance“



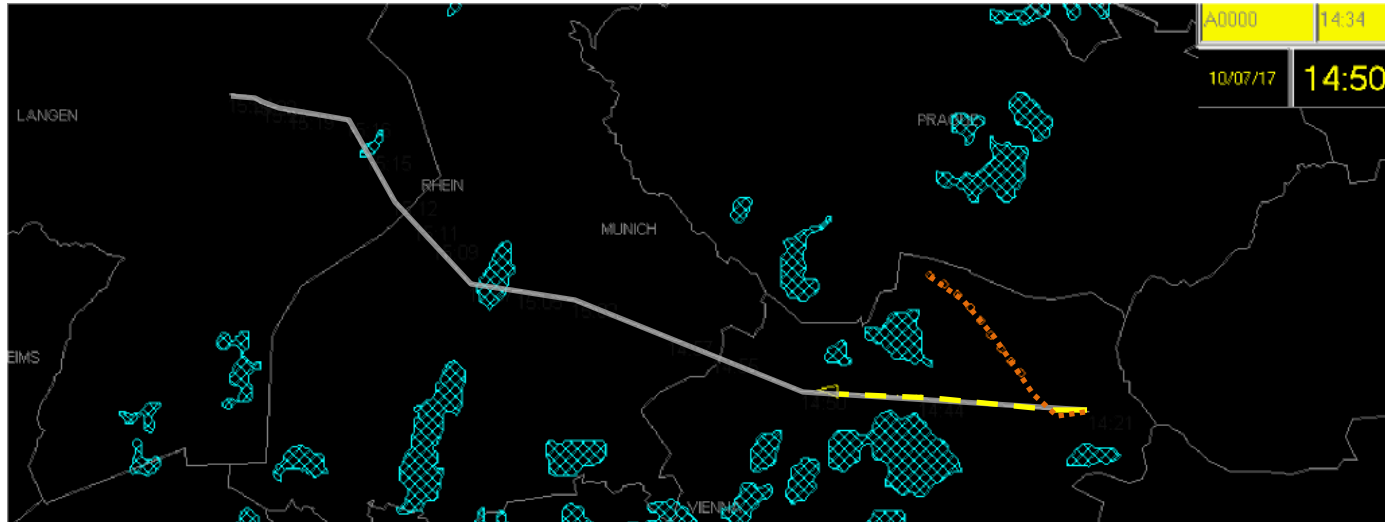
Scenario: 8 flights in the area of relevance



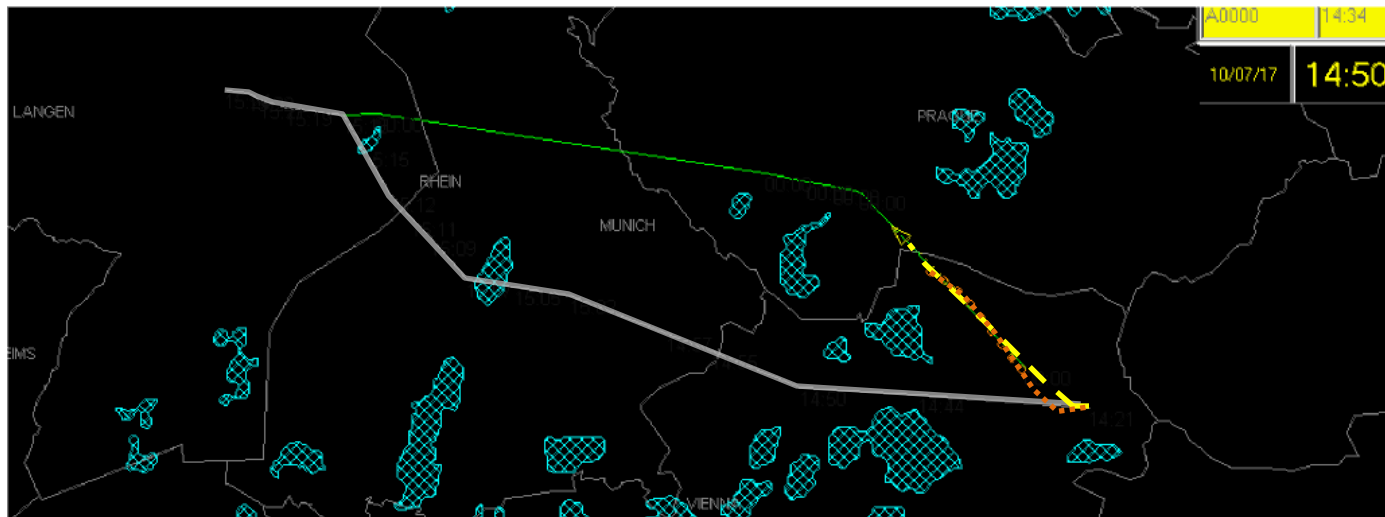
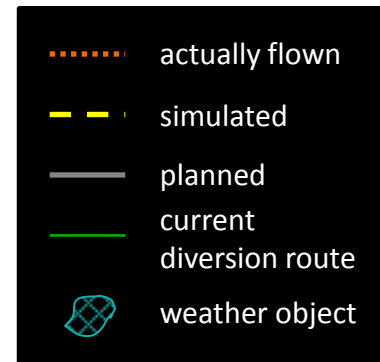
Scenario: 8 flights in the area of relevance



Flight from Vienna to Frankfurt



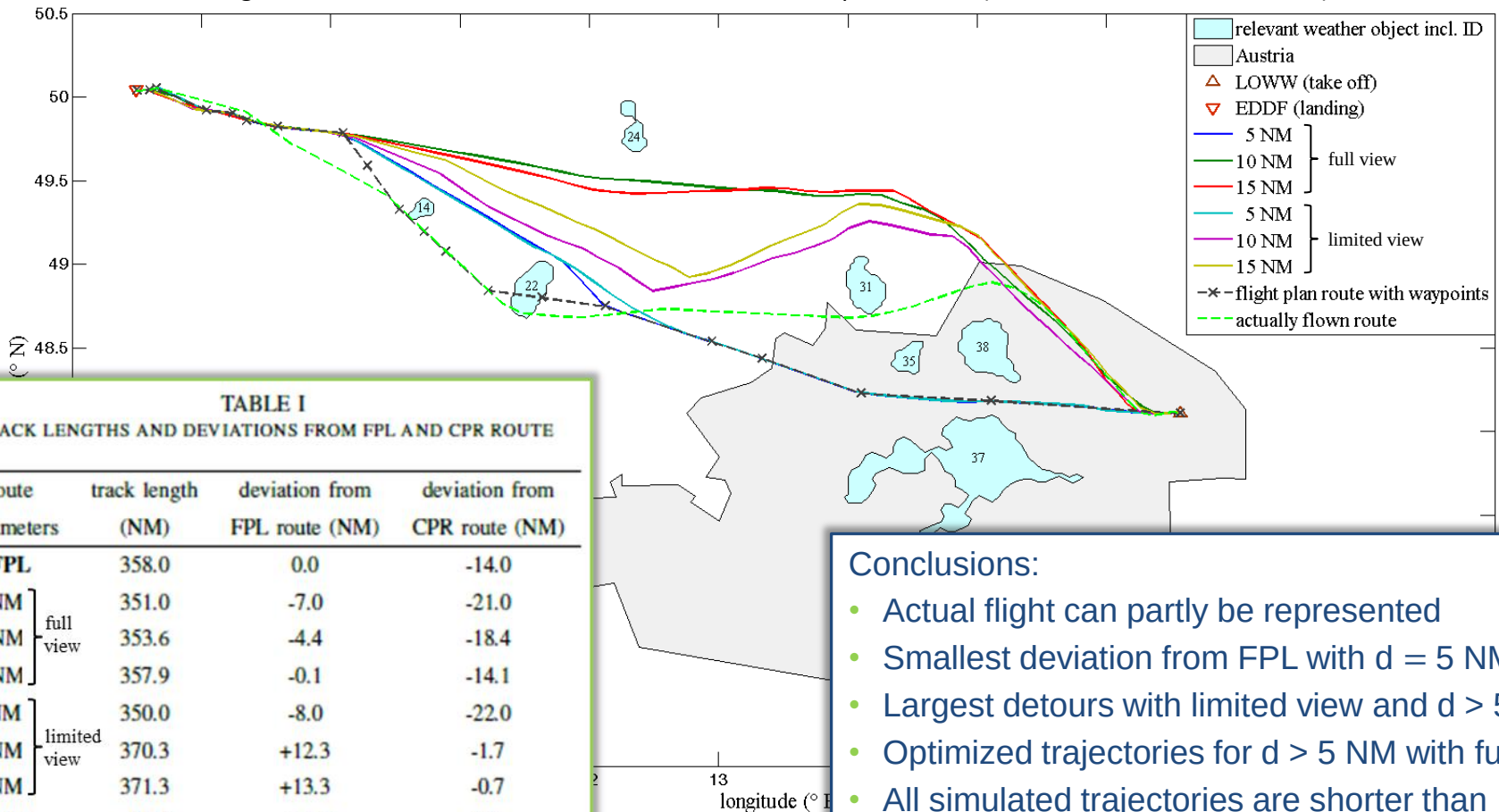
Distance to CBs:
5 NM



Distance to CBs:
10 NM

Flight from Vienna to Frankfurt

Flight from Vienna to Frankfurt, simulated with varied parameters (distance to CBs, field of view)



Conclusions:

- Actual flight can partly be represented
- Smallest deviation from FPL with $d = 5$ NM
- Largest detours with limited view and $d > 5$ NM
- Optimized trajectories for $d > 5$ NM with full view
- All simulated trajectories are shorter than actually flown route (up to 6 %)

SUMMARY AND OUTLOOK

Summary

17th July 2010: Squall line over Austria and Czech Republic

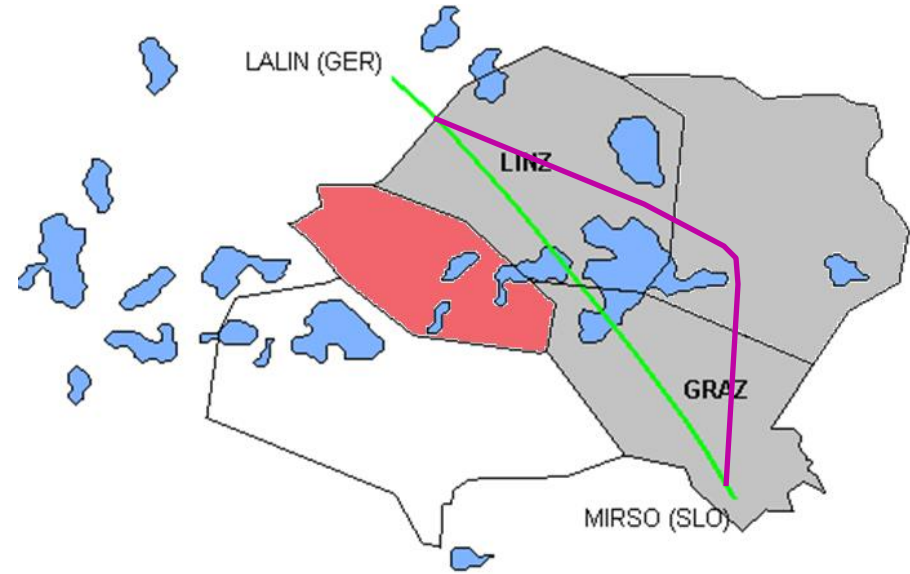
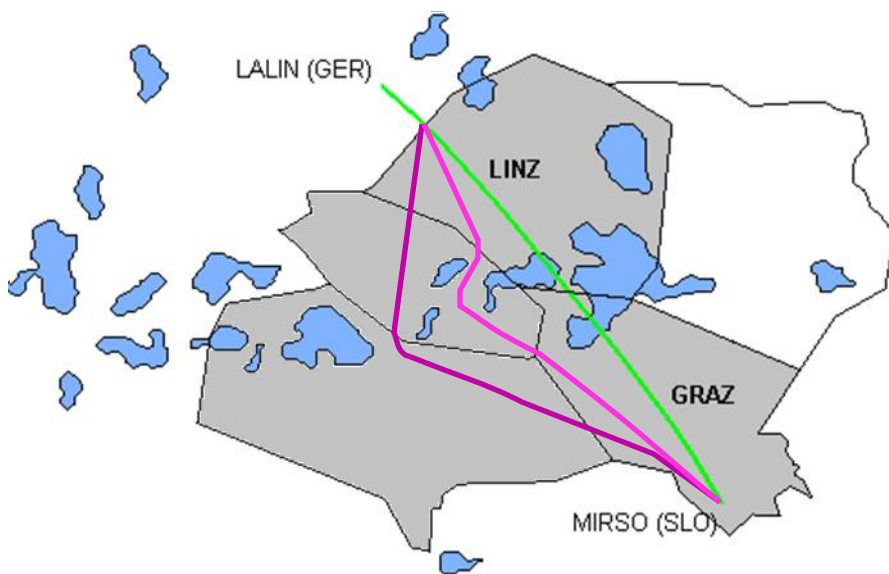
→ Austro Control: Additional workload for air traffic controllers

How accurately and realistically can we simulate trajectories in thunderstorm situations?

- Comparison of simulated trajectories with planned and actually flown routes
- Deconflicted realistic routes using DIVMET and NAVSIM
- More efficient routes in case of an increased field of view
- Limitation: Special flight manoeuvres (e.g. directs)
- Decision support for pilots in case of adverse weather

Outlook

Key question: Can we predict the sector occupancy for various time scales by forecasting weather impacted flight trajectories?



Prediction of sector occupancies will be possible at least for up to 1 hr!



Leibniz
Universität
Hannover

Thank you!

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