Real-time Wind Uplinks for Predication of the Arrival Time and Optimization of the Descent Profile

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1 Status quo
2 Concept „Realtime Wind Uplinks“ & Testing
3 Theoretical Analysis of gained Wind Data
4 Results from Data Evaluation & Testing
5 Conclusion & Outlook
Wind information at short and middle range flights

FPL system → Lido/Flight

-1.5 h  0 h  Up to 5 h
Wind information on short and middle range flights

WAFC forecast (UTC +6, +12, +18, +24, +30, +36 h) every 6 hours

FPL system → Lido/Flight

Up to 12,5 hours old

-1.5 h 0 h bis zu 5 h
Aircraft Meteorological Data Relay (AMDar)
→ Predicted Wind Information (PWI) - automated wind uplink for long range flights
Conditions

- airport → Frankfurt/Main (Germany)
- aircraft type → A320 fleet (short and mid range flights)
- 6 test pilots

Testing

- working schedule of test pilots
- similar arrival direction for prior a/c → wind fields, jet streams
- briefing, test protocol, debriefing
  → output different wind forecast data for this arrival route
3 Theoretical Analysis

Enhanced Jet Performance Model (EJPM)

Flight planning system Lido/Flight

- 1) No winds
- 2) OFP forecast
- 3) Predicated Wind Info
- 4) Real-time wind data
- 5) Real wind data

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Theoretical Analysis

Diagram showing absolute deviation of the head and tail wind component (real wind wind data) in [kn].

- OFP forecast
- PWI
- Real-time wind uplink

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a) EJPM calculation (example MXP-FRA)

- high precision fuel calculation and time prediction based on measured flight data (database OFP and measured a/c-positions)

<table>
<thead>
<tr>
<th>scenario</th>
<th>time [min]</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPF forecast</td>
<td>50:47</td>
</tr>
<tr>
<td><strong>PWI uplink</strong></td>
<td><strong>51:37</strong></td>
</tr>
<tr>
<td>Real-time wind uplink</td>
<td>52:37</td>
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<tr>
<td>Real wind data</td>
<td>51:51</td>
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*Increase of speed to reduce delay costs!!!*
4 Results

b) Lido/Flight (example)

- profile with real wind data
- real head wind
- uplink wind data

- displacement ToD around 7 NM
  - increased fuel consumption 6.1 kg
  - 19 kg CO$_2$

- displacement ToD around 3 NM
  - increased fuel consumption 2.6 kg
  - 8 kg CO$_2$
b) Lido/Flight calculation

- test trail of 10 flights
  - OFP forecast: 79.9kg jet fuel
  - PWI: 93.2kg jet fuel
  - real-time wind data: 36.1kg jet fuel
4 Results

🌟) Testing

- high failure rate → 10 out of 67 data sets were 100% complete

Introduce an automation with smart algorithm and request real-time wind data from more (prior) aircraft!
5 Conclusion

- Enhanced Jet Performance Model (TU Dresden)
  - ETA could be predicted more accurate → adjustments of Cost Index possible to avoid delay costs in case of more tail wind or saving fuel in case of more tail wind

- flight planning system Lido/Flight (Lufthansa Systems)
  - displacement of T/D results in significant fuel savings for both wind cases

- test findings from flight trails could be used for developing automation

Direct achievements of this study:
→ technical issues got solved
→ enabling of PWI requests/uplinks for A320-fleet of Lufthansa
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