ASSESSING VERTICAL FLIGHT PROFILES DURING CLIMB AND DESCENT IN THE US AND EUROPE

US/Europe Comparison Studies

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The research leading to the results presented in this paper was carried out in the context of a Memorandum of Cooperation between the United States of America and the European Union on the promotion and development of civil aviation research and development, specifically its Annex I - Appendix 2 on air traffic management performance measurement.
Overview

- Background
- Method
- Results
- Conclusions
- Future Work
Background (1)

- **US-Europe Comparison Study**
  - Early work as of 2003
  - Since 2009 FAA and EUROCONTROL have produced joint comparisons of operational performance (**)
  - Focusing on harmonizing data and common metrics
    - Accompanied by supporting studies to progress state of the art, i.e. on benchmarking of ATFM and vertical flight efficiency

(**) As of the 4th edition (2013 report), the comparison report is prepared under a Memorandum of Cooperation between the United States of America and the European Union.
### ICAO GANP 2019 Key Performance Indicators (KPIs)

<table>
<thead>
<tr>
<th>KPA</th>
<th>Efficiency</th>
<th>Capacity</th>
<th>Predictability</th>
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<tbody>
<tr>
<td><strong>Focus Area(s)</strong></td>
<td>Additional flight time &amp; distance</td>
<td>Vertical flight efficiency</td>
<td>Additional fuel burn</td>
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<td><strong>Core KPIs</strong></td>
<td>KPI02 Taxi-out additional time</td>
<td>KPI13 Taxi-in additional time</td>
<td>KPI09 Airport peak capacity</td>
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<td><strong>Additional KPIs</strong></td>
<td>KPI04 Filed flight plan en-route extension</td>
<td>KPI17 Level-off during climb</td>
<td>KPI16 Additional fuel burn</td>
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<td>KPI05 Actual en-route extension</td>
<td>KPI18 Level capping during cruise</td>
<td>KPI11 Airport throughput efficiency</td>
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Vertical Flight Profile: Terminology

- Top of Climb
- Top of Descent
- Departure Airport
- Arrival Airport
- Level Segment
- Level Segment
Method

- Level segment detection
  - 200 ft altitude band
  - 300 ft/minute vertical speed
- Determination of Top of Climb (ToC) & Top of Descent (ToD)
  - Equals last point in climb/first point in descent within 200NM around the airport
  - Extra filter for level segments >5 minutes and at or above 90% of ToC/ToD altitude
- Metrics
  - Average distance flown level per flight
  - Median altitude of
    - Continuous Climb Operations (CCO)
    - Continuous Descent Operations (CDO)
  - Share of unimpeded (CCO/CDO) flights
Results: Level distance

- More level flight during descent
- More level flight in the US (especially in descent)
- No relation to number of flights

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<tr>
<th>Region</th>
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<th>Climb (NM)</th>
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Results: Median CDO/CCO Altitude

- Similar median CCO altitudes close to cruising altitudes
- Higher median CDO altitudes in Europe
- Number of airports with median CDO/CCO altitude ≥ 10,000 feet

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Region | Descent | Climb
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Europe | 25/34 | 34/34
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Results: Share of unimpeded flights

- More CCO flights than CDO flights
- Similar share of CCO flights in US and Europe
- Higher share of CDO flights in Europe

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Results: Level flight change

Change of average distance flown level (2017 vs. 2015)

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Results: Median CDO/CCO altitude change

Change of median CDO/CCO altitude (2017 vs. 2015)

- **Descent**
  - Europe
  - US

- **Climb**
  - Europe
  - US

Change of median CDO/CCO altitude (feet)

- **Descent**
- **Climb**
- 2016 vs. 2015
Results: Share of unimpeded flights change

Change of share of CDO/CCO flights (2017 vs. 2015)

Change of share of CDO/CCO flights (pp)

- Descent
- Climb

2016 vs. 2015
Case study: Rome Fiumicino (1)

- Continuous degradation since beginning 2017
- More pronounced change for arrivals
- Increase of level flight within 40NM radius (68,300 NM)
- Possible change of approach procedures
Case study: Rome Fiumicino (2)
Case study: Rome Fiumicino (3)
Case study: Rome Fiumicino (4)
Case study: Rome Fiumicino (5)
Case study: Rome Fiumicino (6)

2017

Total level distance (1000's of NM)

Distance of level segment to airport (NM)

Altitude (100's of ft.)
- [0,50)
- [50,100)
- [100,150)
- [150,200)
- [200,250)
- [250,Inf)

Assessing Vertical Flight Profiles During Climb and Descent in the US and Europe
Case study: Los Angeles Intl (1)

- Redesign of the southern California airspace
- RNAV procedures from November 2016
- Improvement of VFE performance, especially for arrivals
- Significant decrease of level flight within 70NM radius
Case study: Los Angeles Intl (2)
Case study: Los Angeles Intl (3)
Case study: Los Angeles Intl (4)

Graph showing the share of unimpeded flights in Climb and Descent from 2015 to 2018.
Case study: Los Angeles Intl (5)

2016

Total level distance (10,000's of NM)

Distance of level segment to airport (NM)

Altitude (100's of ft.)
- [0,50)
- [50,100)
- [100,150)
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Case study: Los Angeles Intl (6)

2017

Total level distance (1000's of NM)

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- [0,50)
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Conclusions

- Methodology validated
- Less level flight during climb
- Less level flight in Europe than in the US (2017)

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- Level flight trends (2016 vs. 2017)
  - Europe: Relatively stable
  - US: Reduction of level flight during descent
Future Work

- Mapping between VFE performance trends and operational changes
- Further analyses of individual airports
- Input to ICAO GANP
- New version of US/Europe Comparison Study by end 2018
Thank you for your attention!