Assessing trends in aviation noise and emissions in Europe using advanced modelling capabilities – IMPACT & AAT

2nd ECATS Conference
Athens - 9 November 2016
Introduction

**IMPACT** and the Aircraft Assignment Tool - **AAT** – were first introduced at the 1st ECATS Conference

- In 2013
- Tools at the very early stage of their development...

**Three years later…**

- IMPACT and AAT have become mature tools
- These have been effectively combined and used to support the European Aviation Environmental Report 2016
IMPACT overview

A modelling platform to perform both noise and fuel/emission assessments of aviation

- Accessible via a secured web portal

Developed and maintained by EUROCONTROL

- Initially to support SESAR-related environmental assessment needs

A CAEP-approved tool having successfully contributed to the CO$_2$ Standard analysis in CAEP/10
IMPACT overview

Built from the already existing **STAPES** and **AEM** environmental models:

<table>
<thead>
<tr>
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<th>STAPES</th>
<th>AEM</th>
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</thead>
<tbody>
<tr>
<td><strong>Scope</strong></td>
<td>Noise (multi-airport)</td>
<td>Fuel burn &amp; emissions (global)</td>
</tr>
<tr>
<td>**Development &amp;</td>
<td>Software: ECTL</td>
<td>ECTL</td>
</tr>
<tr>
<td>maintenance**</td>
<td>Airport database: EASA &amp; ECTL</td>
<td></td>
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<tr>
<td><strong>Calculation</strong></td>
<td>ECAC Doc.29 3rd Ed. ICAO Doc 9911</td>
<td>Fuel: tabulated BADA FF data</td>
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<tr>
<td>methods</td>
<td></td>
<td>Emissions: BFFM2</td>
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<tr>
<td><strong>CAEP-approved</strong></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Distributed</strong></td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
IMPACT overview

Robust interdependency analyses
  • Noise vs fuel & emissions in the vicinity of airports

Through the use of common and consistent input data
  • Aircraft & engine types
  • Trajectories

IMPACT features a detailed aircraft trajectory calculator
  • Total Energy Model (TEM) using BADA 4 data
  • Use of ANP + BADA in the vicinity of airports
IMPACT modelling workflow
IMPACT common trajectory calculator

Complete trajectory from DEP to ARR airports
BADA Total Energy model

\[(\text{Thr} - \text{D}) \cdot V_{\text{TAS}} = mg_0 \frac{dh}{dt} + mV_{\text{TAS}} \frac{dV_{\text{TAS}}}{dt}\]

BADA Fuel Flow

\[
\frac{FF}{\delta \sqrt{\theta}} = \frac{W_{\text{TOW}}a_0}{L_{\text{HV}}} f_1 \left( M, \frac{\text{Thr}}{\delta} \right)
\]

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IMPACT common trajectory calculator

Trajectory & Thrust using the ECAC Doc.29 / ICAO Doc 9911 aircraft performance modelling method

Rated_Thr = E + F \cdot V_{CAS} + G_A \cdot h + G_B \cdot h^2 + H \cdot T

Adapted_Thr = W \cdot \frac{R \cdot \cos\gamma + \sin\gamma + a/g}{N}

BADA Fuel Flow

\[
\frac{FF}{\delta \sqrt{\theta}} = \frac{W_{TOW}a_0}{L_{HV}} f_1 \left( M, \frac{Thr}{\delta} \right)
\]

IMPACT trajectory calculator

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The main results produced by IMPACT include:

- noise contours (shapefiles), surface and population count
  - Use of the European Environment Agency (EEA) population database

- fuel burn and emission masses of a wide range of pollutants
  - Aggregated by phase of flight, etc.

- gridded (i.e. geo-referenced) emission inventories within the LTO portion
  - as an introduction to further – more detailed – Local Air Quality (LAQ) assessments
IMPACT - benefits of the web approach...

No installation issues

No need for powerful computers…
   Any machine with a web browser

Centralized models & databases management

Easy user licence management
   User accounts

Protection of sensitive reference information
   Ex: BADA data
AAT Overview

The Aircraft Assignment Tool (AAT) is a fleet and operations forecasting capability jointly developed by EUROCONTROL and EASA

- a generic tool that takes as input an existing demand and fleet forecast and converts it into a forecast of movements by particular aircraft types on specific airport pairs
- Assumptions (aircraft transport and range capability categories, market share, retirement curves, etc.) are defined by the user
- The geographical scope depends on the forecast (from a single airport pair to full global operations)

AAT was reviewed by the CAEP Forecasting and Economic Analysis Support Group (FESG) and was used in the CO₂ standard’s cost-effectiveness analysis (CAEP/10)
AAT Principle

AIRCRAFT ASSIGNMENT TOOL

- Aircraft/Engine Types Mapping
- Geographical Reference

Operations Database

Traffic Forecast

Utilisation

Base Operations (by AP2, ACType)

Load base operations data

Distribute forecast over baseline

Free capacity of current airframes

Retire & phase-out current airframes

Retirements & phase-outs

Future Flights (by AP2)

With ACType

Without ACType

Free Aircraft Capacity

Available free aircraft

Future Fleet

Available Fleet

Choice of replacement aircraft

Future Ops (by AP2, ACType)

Replacements
IMPACT and AAT have been combined to produce the environmental results of the *Sector Overview* section of the European Aviation Environmental (EAER) Report 2016.

- Trends in noise and emissions in Europe until 2035 under various traffic forecasts and aircraft technology scenarios
- AAT was integrated into the EUROCONTROL/STATFOR 20-year forecast toolset for the passenger market segment
- Output from AAT (a/c operations by city-pairs) were used by IMPACT to perform the environmental analysis
- IMPACT used the PRISME operation database for the “historical” portion of the analysis (2005-2014)
EAER Report 2016

For each traffic forecast, 'advanced' and 'low' technology improvements rates are applied to new aircraft deliveries from 2015 onwards. The upper bound of the range reflects the 'low' technology improvement rate, and the lower bound is the 'advanced' technology improvement rate.

$L_{den}$ 55 dB population exposure
Full-flight CO2 emissions for all departures from EU+EFTA

For each traffic forecast, 'advanced' and 'low' technology improvements rates are applied to new aircraft deliveries from 2015 onwards. The upper bound of the range reflects the 'low' technology improvement rate, and the lower bound is the 'advanced' technology improvement rate.
Thank you!
Any questions?

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EAER report 2016: www.easa.europa.eu/eaer/