Background

**European Commission** to decide on the historical aviation emissions based on best available data, including estimates based on actual traffic information.

**EUROCONTROL** to deliver, under a Cooperation Agreement, to the European Commission its **calculation of the historical aviation CO₂** emissions for 2004, 2005, 2006 based on best available data.

**Innaxis** to validate and verify EUROCONTROL’s work and propose a reconciliation methodology.
Fuel Burn Estimator for the EU ETS

- Initially based on ANCAT/EMEP-CORINAIR
- Collected fuel burn data to:
  - cater for influencing factors not covered by ANCAT
  - cover a wider range of aircraft types
- Reviewed fuel performance of aircraft types for which fuel data has been received
- Established methodologies for other aircraft types for which no fuel data has been received
ANCAT (Abatement of Nuisances Caused by Air Transport) also known as EMEP/CORINAIR

Recommended by ECAC: “ECAC Member States should calculate the emissions of aviation as accurately as possible using ANCAT method number three as described in the Guidance Material” (ECAC 27/3, 8-9 July 2003)

## A320 – EMEP/CORINAIR

### Input & Output Data

#### Emissions

- **EINOx (g/kg fuel):**
  - Flight total: 28.0, 37.9, 56.0, 66.8, 83.9, 109.4, 141.1, 169.9
  - LTO: 10.8, 10.8, 10.8, 10.8, 10.8, 10.8, 10.8, 10.8
- **HC (g):**
  - Taxi out: 0.775, 0.775, 0.775, 0.775, 0.775, 0.775, 0.775, 0.775
- **EIHC (g/kg fuel):**
  - Take off: 2.491, 2.491, 2.491, 2.491, 2.491, 2.491, 2.491, 2.491
- **CO (g):**
- **EICO (g/kg fuel):**

#### Flight distances (nm) [1nm = 1.852 km]

<table>
<thead>
<tr>
<th>Distance (km)</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>750</th>
<th>1000</th>
<th>1500</th>
<th>2000</th>
<th>2500</th>
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</thead>
<tbody>
<tr>
<td>Climb/cruise/descent</td>
<td>232</td>
<td>463.048</td>
<td>926</td>
<td>1389</td>
<td>1852</td>
<td>2778</td>
<td>3704</td>
<td>4630</td>
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<tr>
<td>Flight total</td>
<td><strong>1644.4</strong></td>
<td>2497.3</td>
<td><strong>3660.6</strong></td>
<td><strong>4705.0</strong></td>
<td><strong>6027.2</strong></td>
<td><strong>8332.0</strong></td>
<td><strong>10865.9</strong></td>
<td><strong>13441.3</strong></td>
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<tr>
<td>LTO</td>
<td>802.3</td>
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<td>802.3</td>
<td>802.3</td>
<td>802.3</td>
<td>802.3</td>
<td>802.3</td>
</tr>
<tr>
<td>Taxi out</td>
<td>167.3</td>
<td>167.3</td>
<td>167.3</td>
<td>167.3</td>
<td>167.3</td>
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<tr>
<td>Take off</td>
<td>89.9</td>
<td>89.9</td>
<td>89.9</td>
<td>89.9</td>
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<td>89.9</td>
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<tr>
<td>Climb out</td>
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<td>232.5</td>
<td>232.5</td>
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<td>232.5</td>
<td>232.5</td>
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<tr>
<td>Approach landing</td>
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<td>145.4</td>
<td>145.4</td>
<td>145.4</td>
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</tr>
<tr>
<td>Taxi in</td>
<td>167.3</td>
<td>167.3</td>
<td>167.3</td>
<td>167.3</td>
<td>167.3</td>
<td>167.3</td>
<td>167.3</td>
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</tr>
<tr>
<td>Climb/cruise/descent</td>
<td>842.1</td>
<td>1695.0</td>
<td>2858.3</td>
<td>3902.7</td>
<td>5224.9</td>
<td>7529.7</td>
<td>10063.6</td>
<td>12638.9</td>
</tr>
</tbody>
</table>

**Emissions** = \( \int (\text{Generic Aircraft Type}, \text{Flown Distance}) \)

**CFMU Based Actual Route Length**

(source: EMEP/CORINAIR)
Fuel Burn Data Acquisition

- Request for cooperation from EUROCONTROL’s Director General in February 2009 to Air Transport Associations
- First data set received in March
- Last data set received week of 2 June
Fuel Burn Data Samples (1)

- More than 20 aircraft operators (legacy, leisure, low fares carriers and business aviation)

- Each aircraft operator provided data for one or more months for 2004, 2005 and/or 2006. Few provided data for periods relating to 2007 or 2008

- About 700,000 flights
• Data for 59 aircraft types, covering both jet and turbo-prop aircraft.

• For 54 of them, the sample data has been deemed valid, representing the following share of CO₂ emissions under the EU ETS.

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
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<tr>
<td>Share</td>
<td>92.2%</td>
<td>92.6%</td>
<td>93.0%</td>
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</tbody>
</table>

• The remaining 5 aircraft types were discarded because of insufficient sample data.
Airport Pairs from Sample
A320 Fuel Burn Distribution
B744 Fuel Burn Distribution

Distance (Nm)

Fuel (Kg)
For the 54 aircraft types for which sufficient fuel burn data samples have been received a linear estimator has been defined.
B744 Fuel Burn Distribution with Fit

B744

Fuel (Kg)

Distance (Nm)
Methodologies for aircraft types not covered EQUIVALENT

If aircraft of same type of a sample (e.g. RJ70 vs. RJ1H) then use sample new (linear) fit with correction factor based on Maximum Take-Off Weight ratio
Methodologies for aircraft types not covered
ANCAT CORRECTED

If aircraft in ANCAT but not in sample, use ANCAT data with a delta factor based on difference between ANCAT aircraft family regression and sample aircraft family regression.
Methodologies for aircraft types not covered

REGRESSION

If neither of the previous, then use average fuel burn per nautical mile based on model from sample aircraft family regression (three families: heavy jet, light jet, turbo-prop)
The methodology:

• models the average fuel burn for traffic covered by EU ETS, thus reflects characteristics of this specific air traffic

• addresses only fuel burn and thus greenhouse gasses linear related to this, such as CO$_2$

• does not segregate fuel burn for the different flight phases, such as for the LTO
AEM – Advanced Emission Model

- Result of EUROCONTROL’s Experimental Centre research work
- Undergone several validation exercises
- Endorsed by ICAO/CAEP as a valid methodology for the estimation of aviation’s greenhouse gas emissions
AEM – Fuel Burn & GHG Emissions Estimation

A/C performance data bank (BADA) provides Fuel burn rates

Aircraft 4-D Profiles

Fuel burn calculation

Fuel consumed

Coefficients for Fuel burn proportional Pollutants

H2O, CO2, SOx, NOx, CO, HC

Emission calculation

ICAO Exhaust Emissions Data Bank

Boeing Fuel Flow Method2

VOC and TOG (EPA method)
• Above 3000 ft, the fuel burn calculation is based on the “Base of Aircraft Data“ (BADA).

• Its current version provides altitude & attitude dependent performance and fuel burn data for about 300 different aircraft types.

• For the directly supported aircraft types this data has been developed using reference sources such as Flight Manuals, Operating Manuals etc.

• For the other types, the data is specified to be the same as one of the directly supported aircraft.

• When taking into account both the directly and indirectly supported aircraft, BADA then covers over 99% of European air traffic.