Presentation of Historical Emissions Calculation Methodology

7 July 2009, Bruxelles

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Agenda

1. Welcome and background

2. Historical Emissions Calculation, roles and responsibilities

3. Eurocontrol detailed methodology to calculate CO_2 emissions

4. Discussion

5. Next steps

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Background – Cooperation Agreement

11 November 2008

Request for assistance from European Commission's Directorate-General Environment & Directorate-General Energy & Transport

24 December 2008

Approval of EUROCONTROL's Permanent Commission

31 December 2008

Cooperation Agreement signed between European Community and EUROCONTROL

- Interpretation of the aviation activities listed in Annex I to Directive 2003/87/EC
- Aircraft operators vs. competent authorities
- Historical aviation CO_2 emissions 2004-2006
- Monitoring and reporting guidelines for emissions and tonne-kilometre data from aviation activities (Decision 339/2009)

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Background – External Validation, Verification & Reconciliation Methodology

- Price enquiry launched on Monday 2 February
- Closing date Thursday 19 February
- Interviews 23 and 24 March (with air transport associations and DG ENV representatives as observers)
- Contract let to Innaxis/Polytechnic University Madrid on 6 April
  - D1 – Validation report
  - D2 – Verification report
  - D3 – Reconciliation Methodology
  - D4 – Verification report
- Draft D1, D2, D3 distributed on 29 April

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Background – Fuel Burn Data Acquisition

- Request for cooperation from EUROCONTROL's Director General on 11 February 2009 to Air Transport Associations
- First data set received in March
- Last data set received week of 2 June
- Most data received late May 2009

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Roles and Responsibilities

European Commission to decide on the historical aviation emissions by 2 August 2009 based on best available data, including estimates based on actual traffic information

EUROCONTROL to deliver, under the Cooperation Agreement, to the European Commission its calculation of the historical aviation CO_2 emissions for 2004, 2005, 2006 based on best available data

Innaxis to validate and verify EUROCONTROL's work and propose a reconciliation methodology

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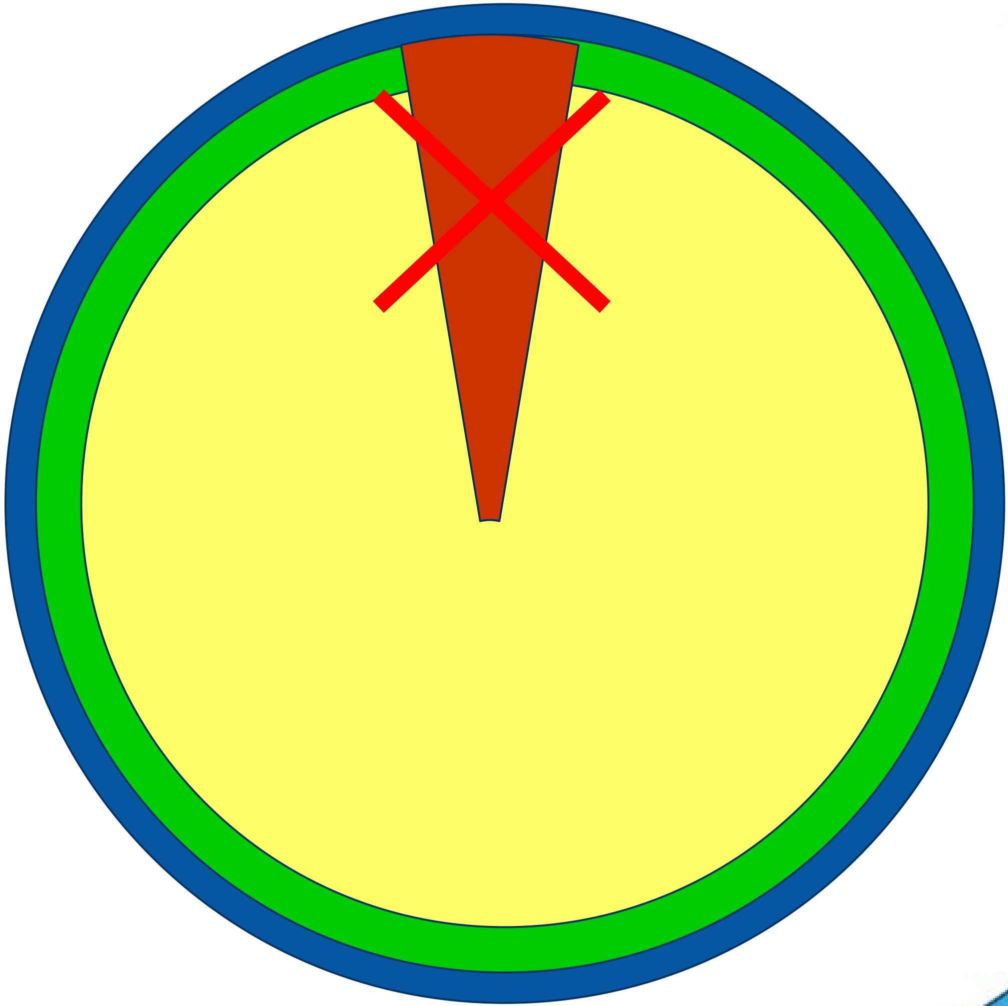
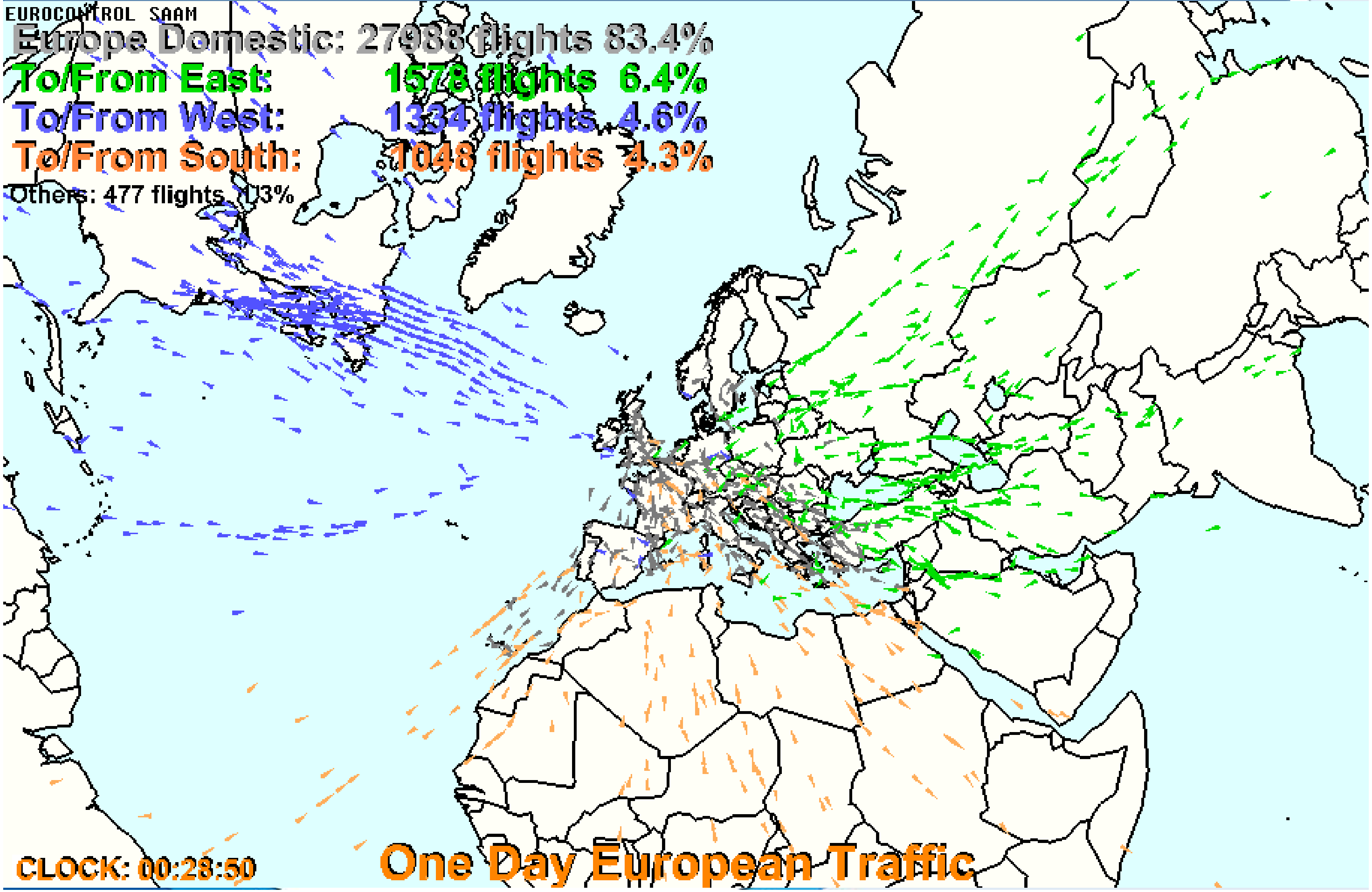
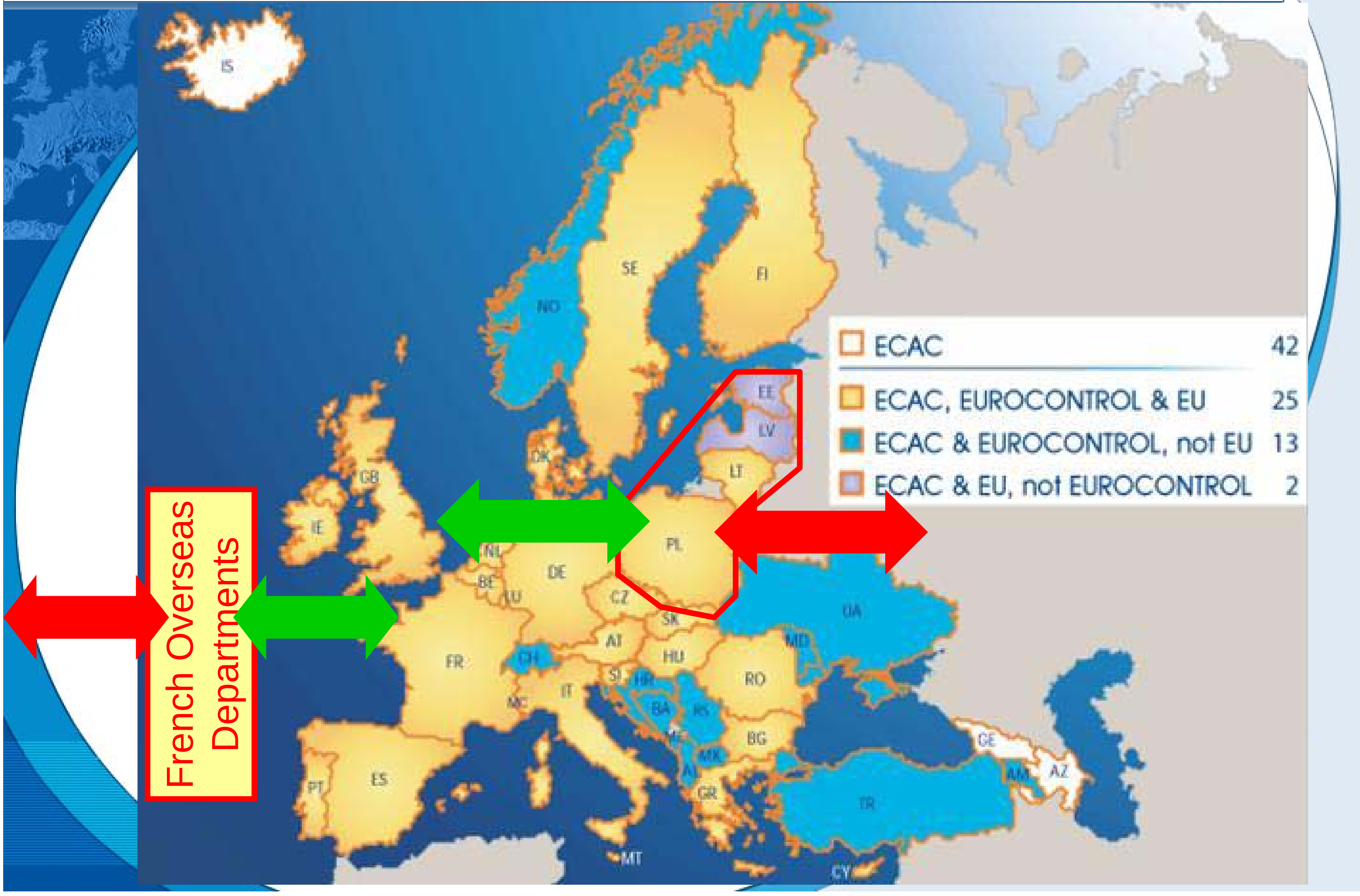
Objective of the Calculation



One day of traffic



Traffic Sources and Coverage (1)



Traffic Sources and Coverage (2)

Estonia, French Overseas Departments, Latvia

- Received traffic data
- Gap represented 0.01%, 0.15%, 0.01% w.r.t. total CO_2

Lithuania

- CRCO since 1 Jan 2008
- Extrapolation back to cover 2004, 2005 and 2006
- Gap represented 0.01% w.r.t. total CO_2

Poland

- CFMU
- Gap represented 0.07% w.r.t. total CO_2

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Directive Annex I Exemptions

Not applied for:

- State flights
- Public Service Obligations
- Traffic from non-CRCO sources

(CO_2 Emissions included in calculation)

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Emissions Estimation Methodology

- 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)
    - *http://reports.eea.europa.eu/EMEPCORINAIR5/en/page002.html*

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ANCAT 3 – EMEP/CORINAIR
Input & Output Data

A320		Standard flight distances (nm) [1nm = 1.852 km]							
		125	250	500	750	1000	1500	2000	2500
Distance (km)									
	Climb/cruise/descent	232	463.048	926	1389	1852	2778	3704	4630
Fuel (kg)									
	Flight total	1644.4	2497.3	3660.6	4705.0	6027.2	8332.0	10865.9	13441.3
	LTO	802.3	802.3	802.3	802.3	802.3	802.3	802.3	802.3
	Taxi out	*167.3*	*167.3*	*167.3*	*167.3*	*167.3*	*167.3*	*167.3*	*167.3*
	Take off	*89.9*	*89.9*	*89.9*	*89.9*	*89.9*	*89.9*	*89.9*	*89.9*
	Climb out	*232.5*	*232.5*	*232.5*	*232.5*	*232.5*	*232.5*	*232.5*	*232.5*
	Approach landing	*145.4*	*145.4*	*145.4*	*145.4*	*145.4*	*145.4*	*145.4*	*145.4*
	Taxi in	*167.3*	*167.3*	*167.3*	*167.3*	*167.3*	*167.3*	*167.3*	*167.3*
	Climb/cruise/descent	842.1	1695.0	2858.3	3902.7	5224.9	7529.7	10063.6	12638.9

Emissions = f**(Generic Aircraft Type , Flown Distance)**

CFMU Based Actual Route Length

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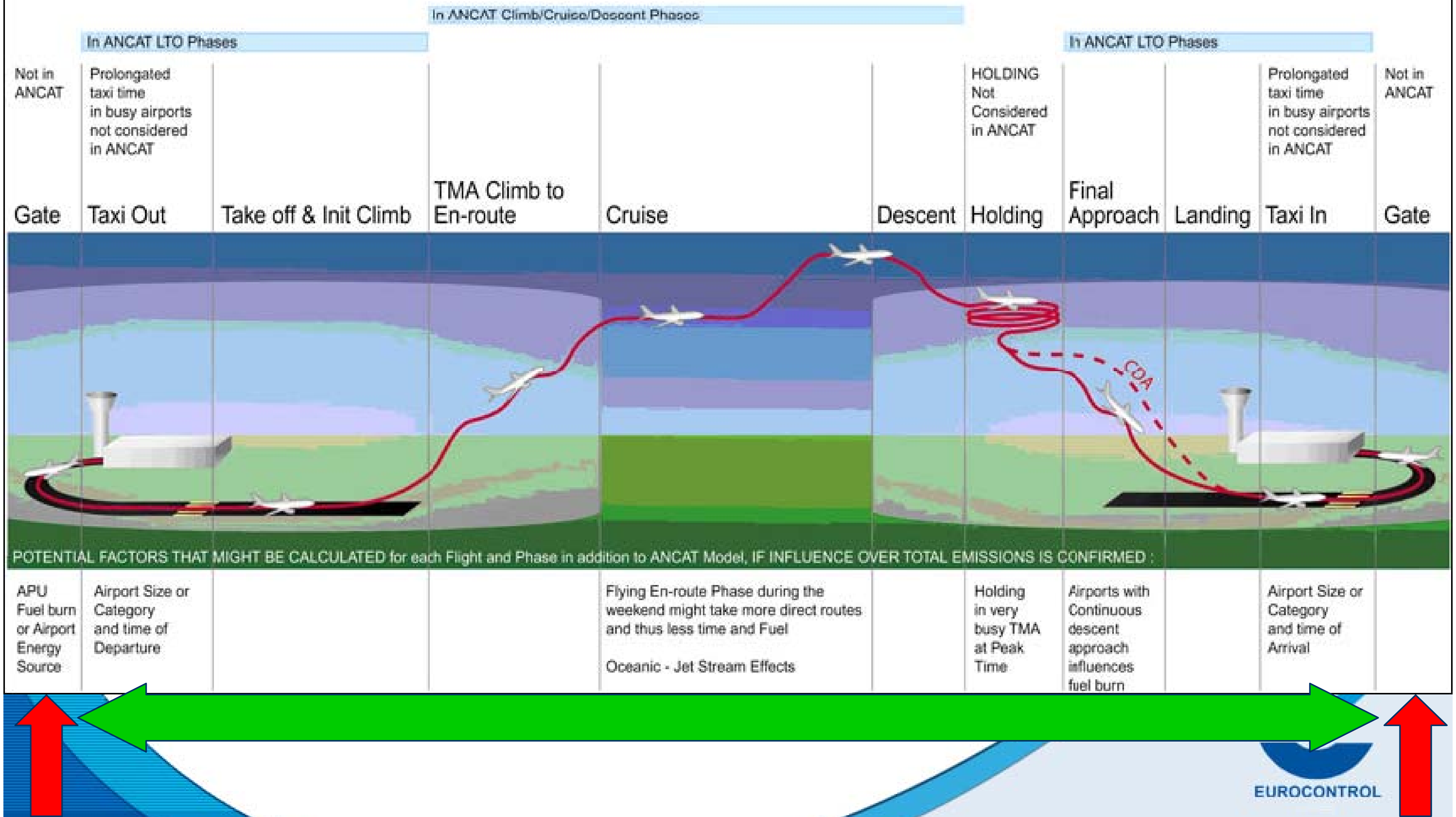
Fuel Burn Influencing Factors, ANCAT, Best Available Data



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Fuel Burn Data Samples (1)

- 23 aircraft operators:
  - European business aviation
  - European legacy carriers
  - European leisure carriers
  - European low fares carriers
  - European regional carriers
  - Non-European legacy carriers from the following continents: Africa, Asia, and North America

- 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

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Fuel Burn Data Samples (2)

- Data for 59 aircraft types, covering both jet and turbo-prop aircraft.
- For 54 of them, the sample data has been deemed valid.

2004	2005	2006
92.2%	92.6%	93.0%

- The remaining 5 aircraft types were discarded because of insufficient sample data

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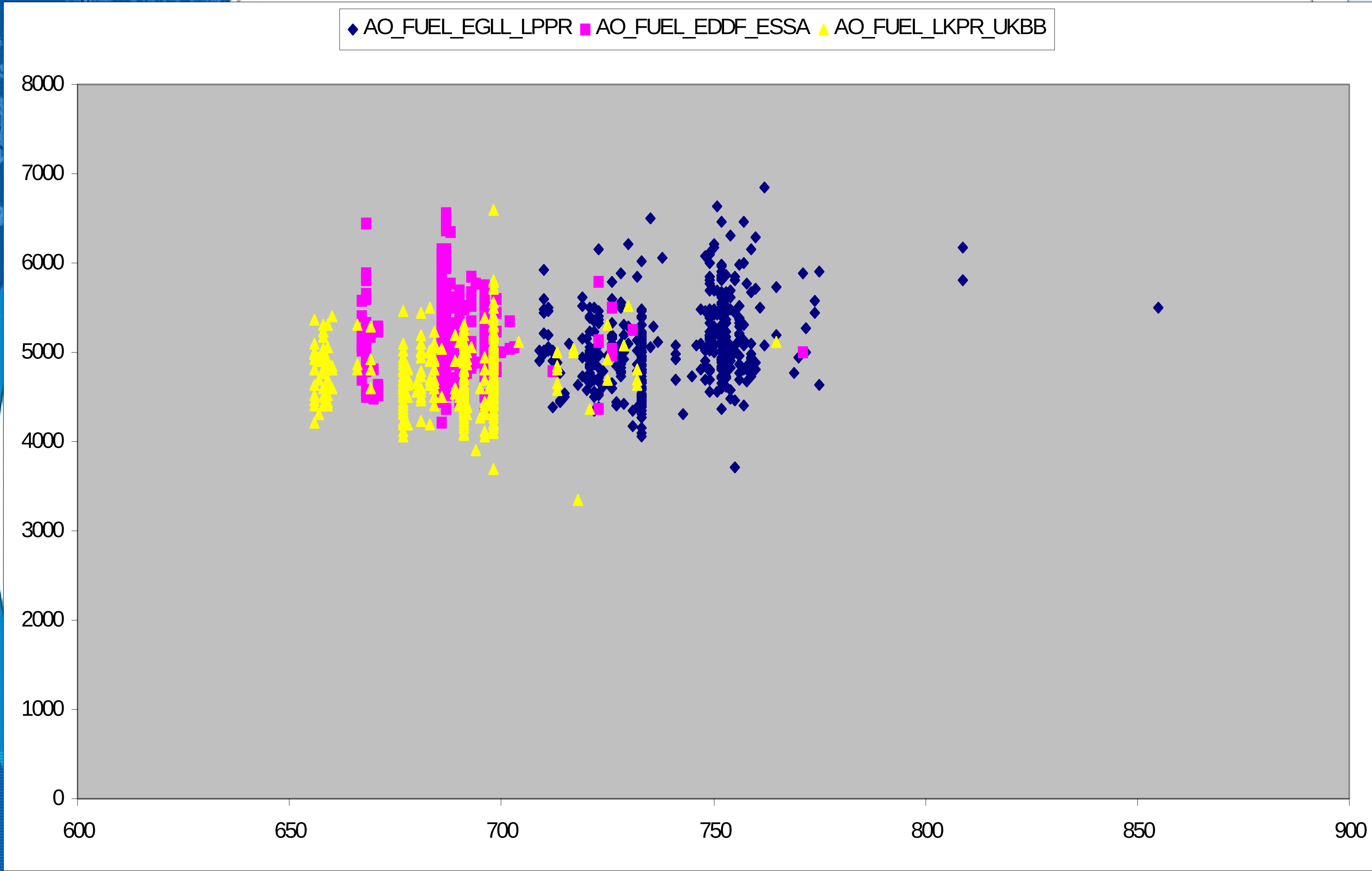
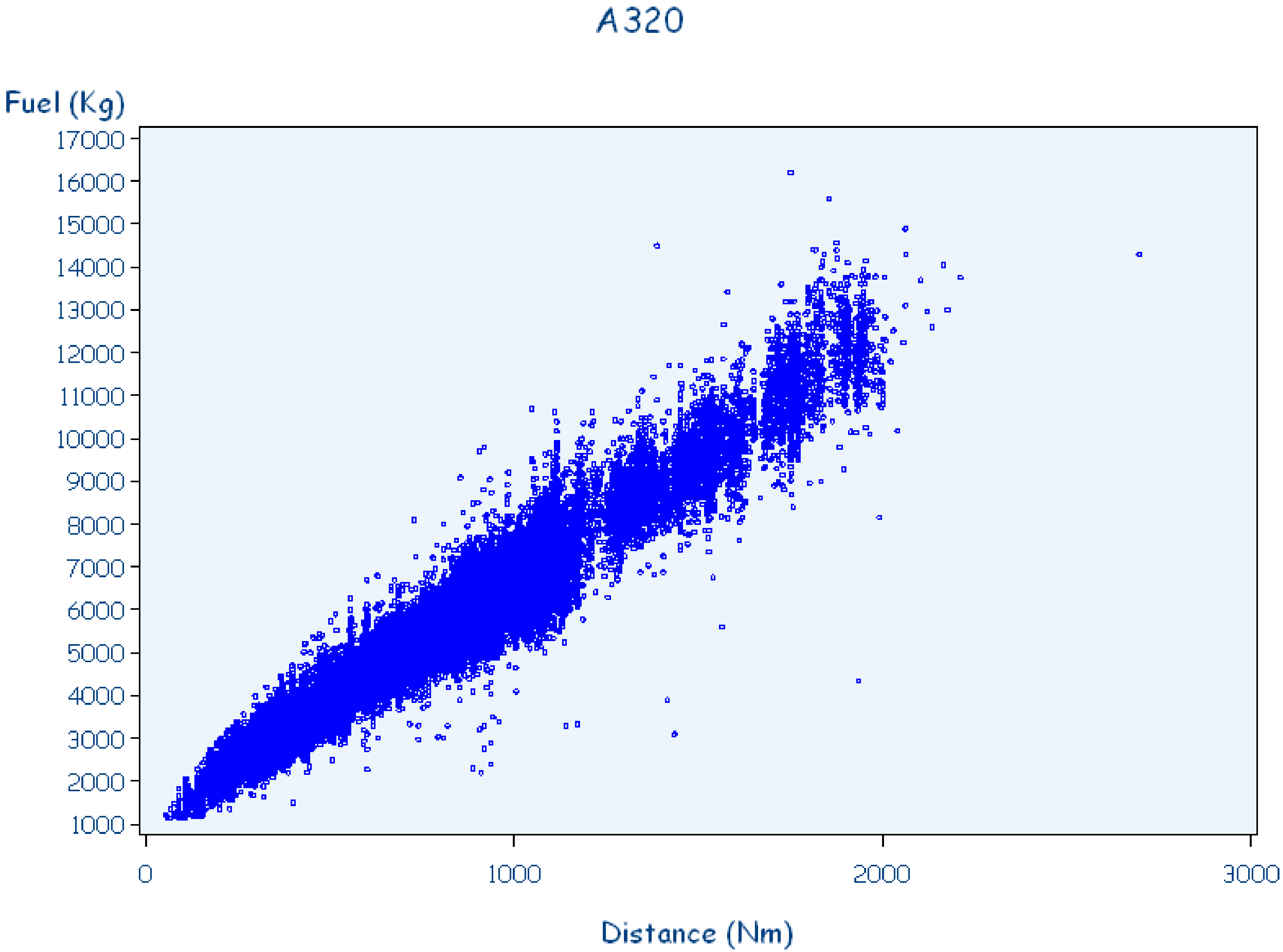
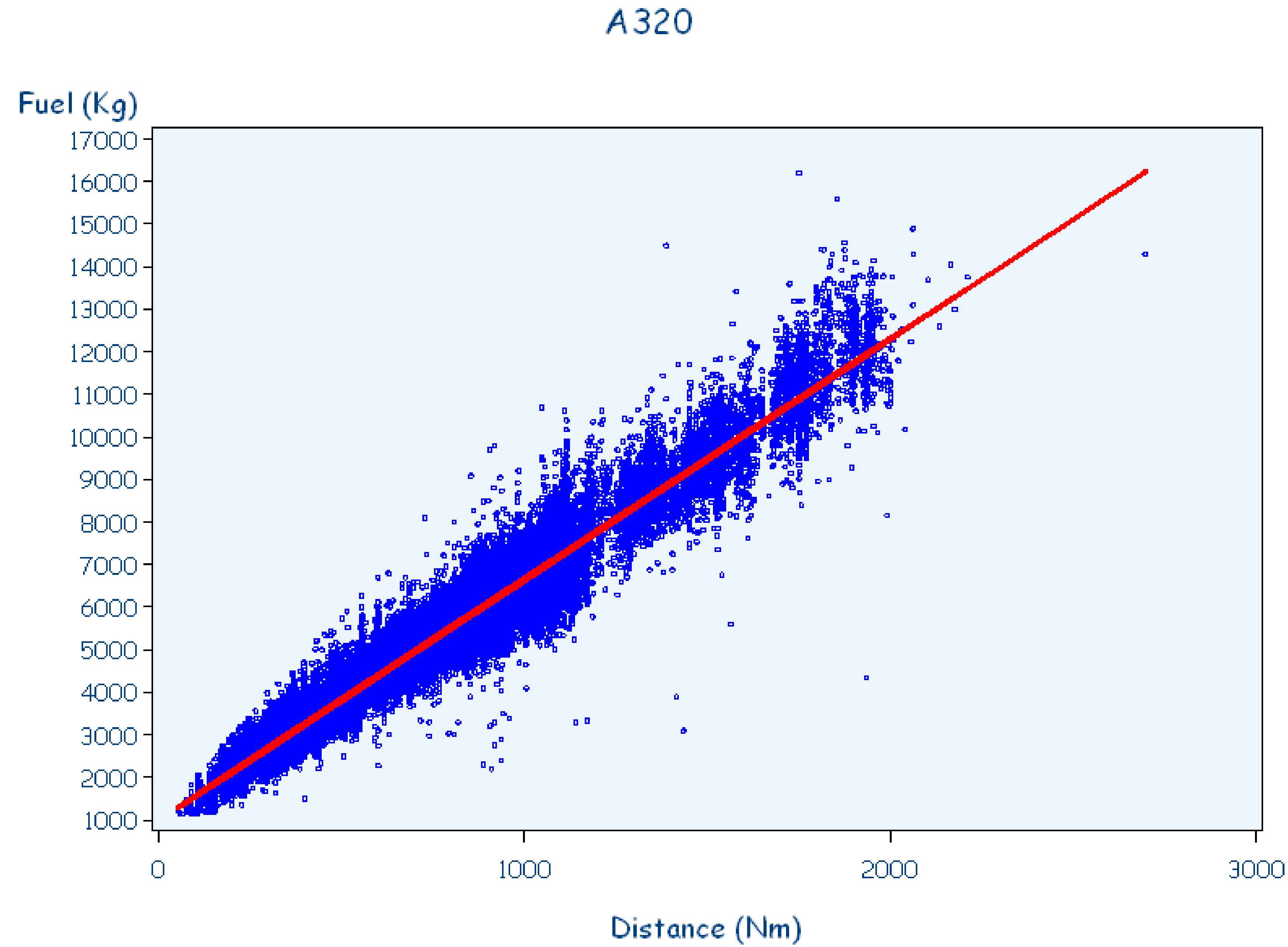
Fuel Burn Dispersion



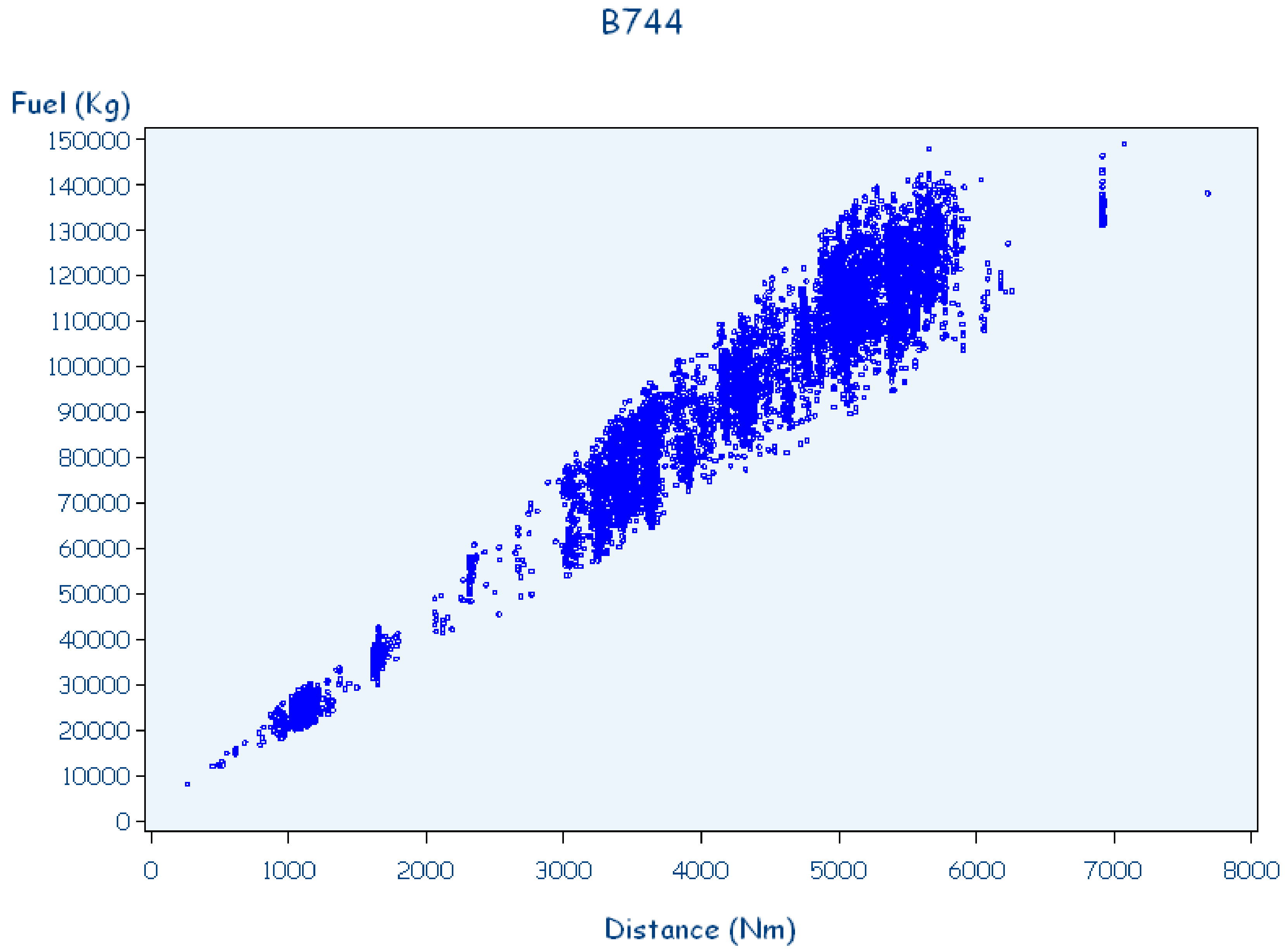
A320 Fuel Burn Distribution



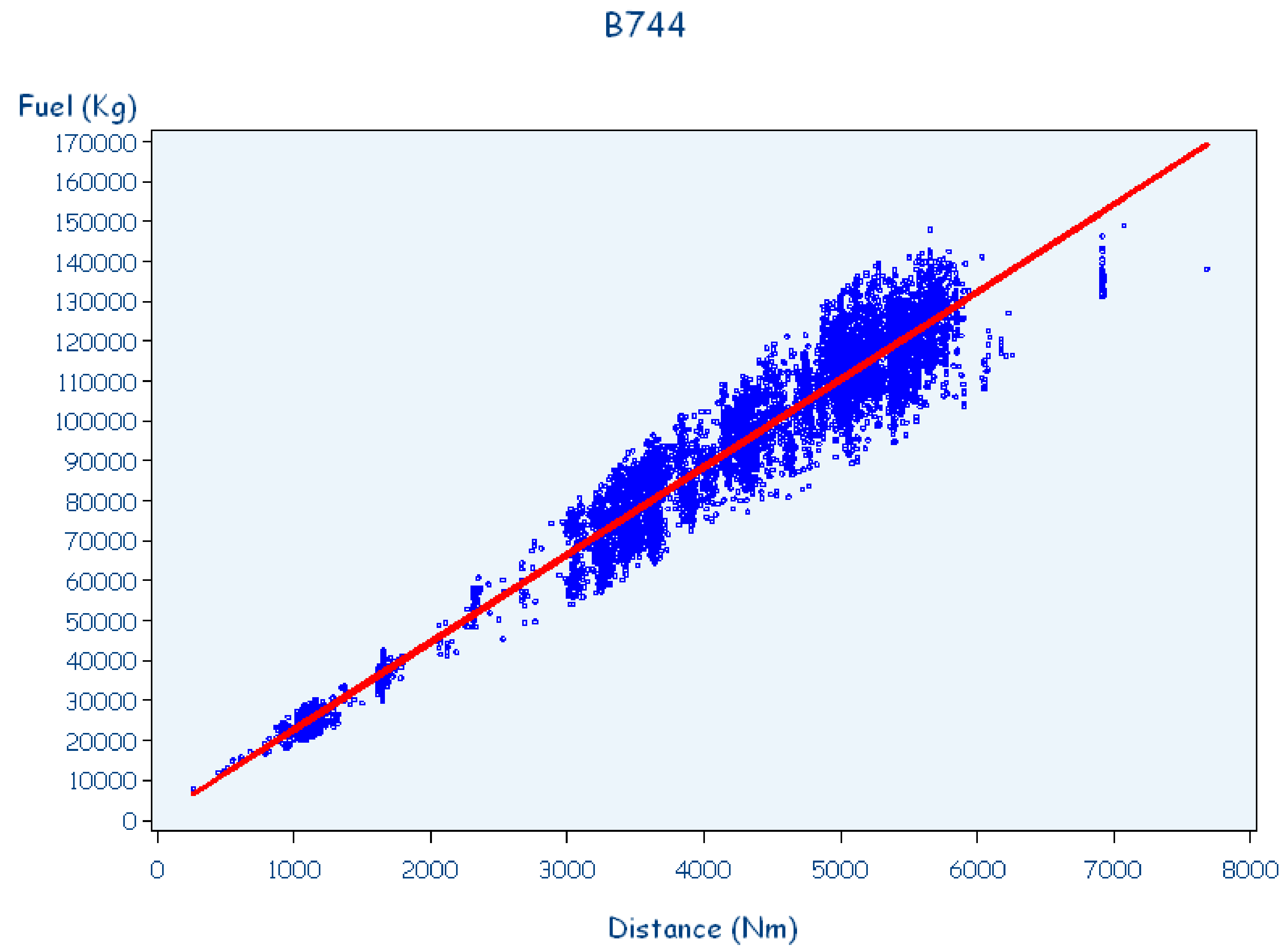
A320 Fuel Burn Distribution with Fit



B744 Fuel Burn Distribution



B744 Fuel Burn Distribution with Fit



Methodology after Reconciliation (1)

AO SAMPLE

- If sample data then use new fit

AO EQV

- If aircraft of same type of a sample (e.g. RJ70 vs. RJ1H) then use sample new fit with correction factor based on MTOW ratio

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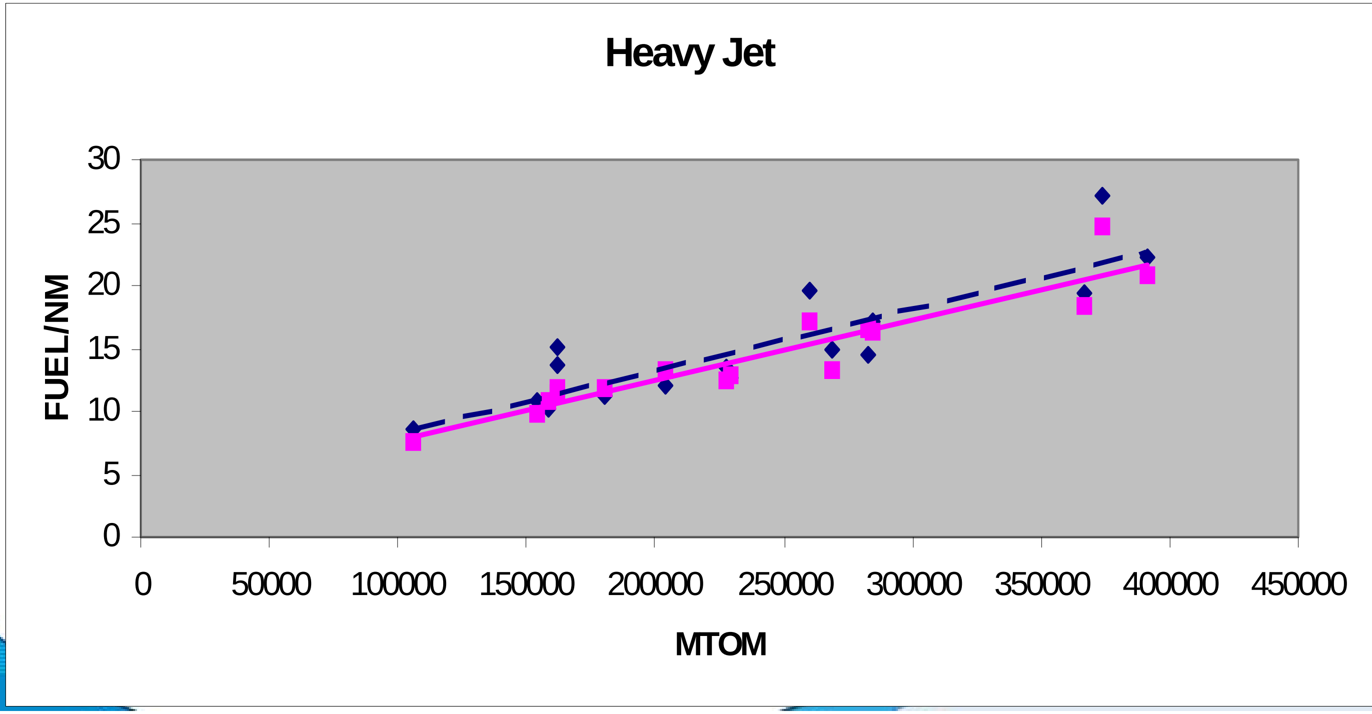
Methodology after Reconciliation (2)

ANCAT with new delta factor

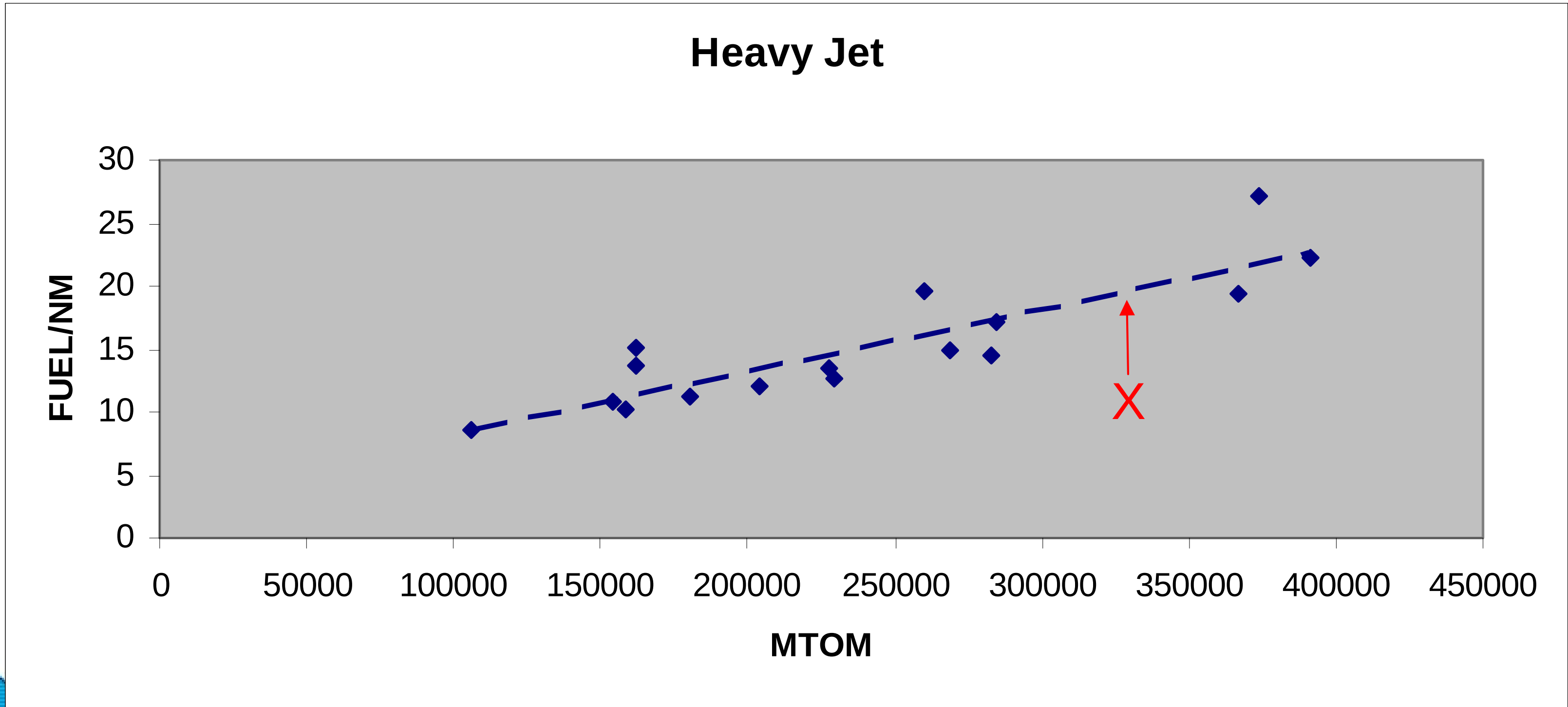
- If aircraft in ANCAT but not in sample, use ANCAT data with a delta factor based on difference between ANCAT aircraft family regression and sample aircraft family regression



Methodology after Reconciliation (3)

REGRESSION

- If neither of the previous, then use average fuel per nautical mile based on model from sample aircraft family regression



Fuel Burn Statistics

	Intra EU27	Non Intra EU27	Total
Distance: Actual VS Great Circle	10.6%	5.0%	7.4%
ANCAT Fuel: Actual VS Great Circle	7.6%	4.9%	5.7%
AO Based Model Fuel: Actual VS ANCAT GC	9.0%	7.6%	8.0%
AO Based Model Fuel: Actual VS ANCAT Actual	1.3%	2.6%	2.2%
AO Based Model Fuel: Actual VS Great Circle	7.7%	4.4%	5.4%

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Airport Coverage Representativeness

	in Sample						Sep-05				
Weigth	AC_TYPE	ARR in TOP10 EU27 AP	ARR in OTHER AP	MVTS	% Busy	% Non Busy	% Busy	% Non Busy	ARR in TOP10 EU27 AP	ARR in OTHER AP	Mvt
19.8%	B744	3,409	3,954	7,363	46%	54%	43%	57%	5,497	7,236	12,733
8.3%	B772	4,557	4,853	9,410	48%	52%	45%	55%	4,163	5,007	9,170
6.9%	B763	1,809	2,941	4,750	38%	62%	35%	65%	4,445	8,242	12,687
6.2%	A320	20,506	35,352	55,858	37%	63%	33%	67%	24,951	50,052	75,003
5.7%	A343	2,626	4,367	6,993	38%	62%	46%	54%	2,803	3,336	6,139
4.9%	B738	1,656	13,487	15,143	11%	89%	14%	86%	7,188	45,040	52,228
3.5%	A332	883	1,589	2,472	36%	64%	29%	71%	1,800	4,319	6,119
3.5%	B752	1,425	11,710	13,135	11%	89%	24%	76%	5,141	15,955	21,096
3.2%	MD11	647	3,055	3,702	17%	83%	33%	67%	1,231	2,450	3,681
3.0%	B742	159	164	323	49%	51%	26%	74%	673	1,916	2,589
2.7%	A321	12,654	22,030	34,684	36%	64%	37%	63%	10,333	17,353	27,686
2.6%	A319	27,822	83,492	111,314	25%	75%	30%	70%	13,007	30,557	43,564
2.4%	B733	7,230	10,522	17,752	41%	59%	23%	77%	8,497	28,516	37,013
2.4%	A333	565	563	1,128	50%	50%	31%	69%	1,139	2,505	3,644
1.9%	A346	600	594	1,194	50%	50%	50%	50%	677	674	1,351
1.8%	B734	6,684	28,848	35,532	19%	81%	25%	75%	5,694	17,399	23,093
1.5%	MD82	19	5,195	5,214	0%	100%	31%	69%	7,325	16,128	23,453
1.4%	B735	12,670	46,768	59,438	21%	79%	32%	68%	7,305	15,749	23,054
1.3%	B737	2,268	7,281	9,549	24%	76%	17%	83%	2,910	14,106	17,016
1.3%	A310	267	5,710	5,977	4%	96%	22%	78%	828	2,984	3,812
1.2%	B762	402	821	1,223	33%	67%	22%	78%	657	2,364	3,021

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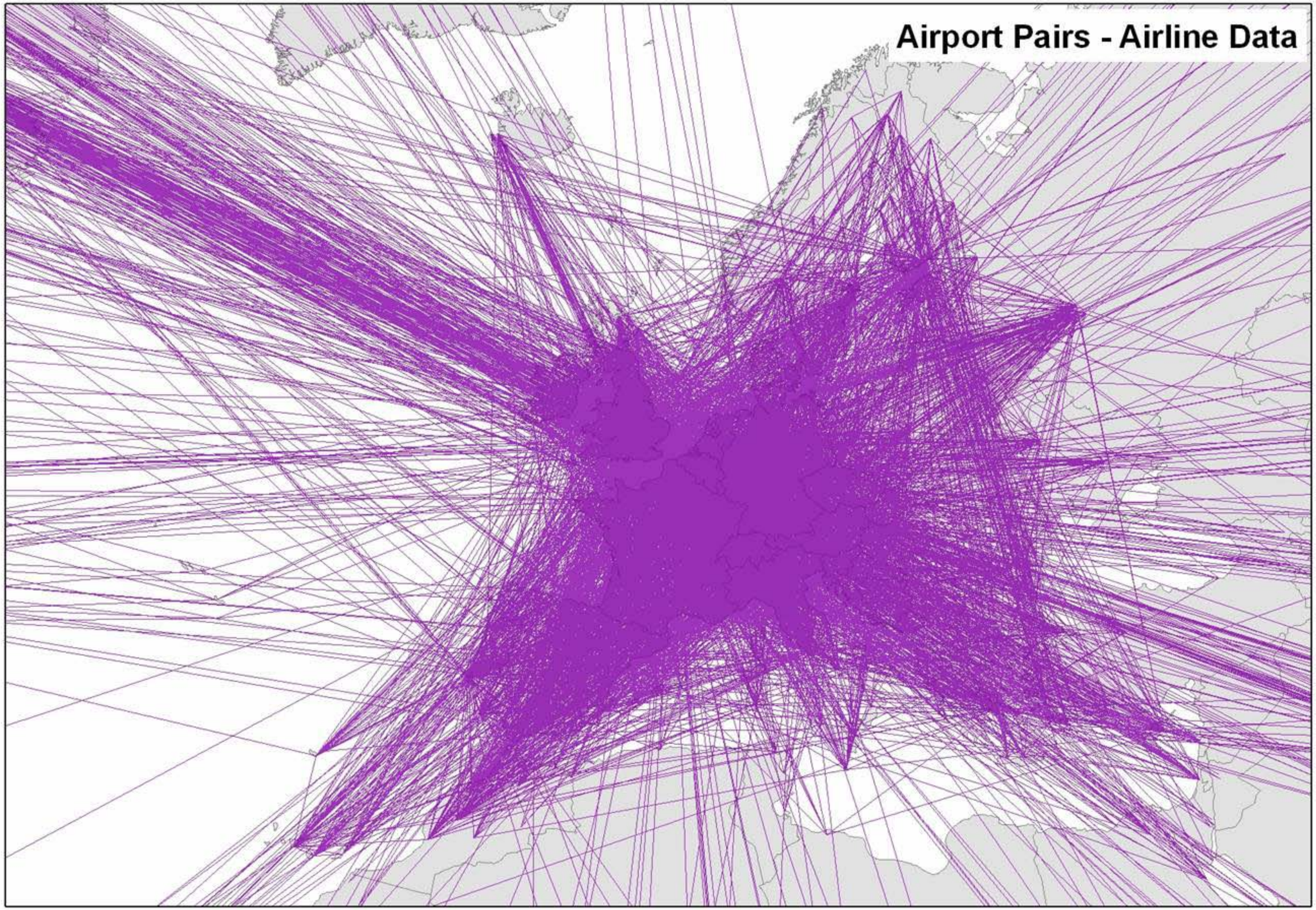
Airport Pairs from AO Sample



Confidence Intervals
(Based on a confidence level of 99.5%)

	2004		2005		2006	
Cluster	CO_2 share	Confidence Interval	CO_2 share	Confidence Interval	CO_2 share	Confidence Interval
SAMPLE	92.2%	0.02%	92.6%	0.02%	93.0%	0.02%
EQV	4.6%	0.10%	4.6%	0.10%	4.8%	0.10%
ANCAT	1.6%	0.29%	1.5%	0.30%	1.0%	0.33%
REGRESSION	1.5%	26.49%	1.3%	25.36%	1.2%	21.87%
TOTAL	100.0%	0.41%	100.0%	0.34%	100.0%	0.27%

$$\sqrt{\sum err_{sample}^2 + \sum err_{eqv}^2 + \sum err_{ancat}^2 + \sum_i \left(\sum \left| err_{reg-type\,i} \right|\right)^2}$$

A confidence level of 99.5% with a confidence interval of 1.5% means that by estimating the CO_2 emissions using another data sample of the same size, there is a probability of 99.5% that the newly estimated CO_2 emissions are within ±1.5% of the previously calculated CO_2 emissions

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