International Civil Aviation Organization

INFORMATION PAPER

GIACC/2-IP/2
26/6/08
Revision No. 1
14/7/08
English only

GROUP ON INTERNATIONAL AVIATION AND CLIMATE CHANGE (GIACC)

SECOND MEETING

Montréal, 14 to 16 July 2008

Agenda Item 2: Review of aviation emissions-related activities within ICAO and internationally

AVIATION DATA

(Presented by the Secretariat)

1. INTRODUCTION

1.1 This paper responds to the GIACC/1 request (GIACC/1-SD/3) to prepare a working paper on data collection in the field of aviation greenhouse gas emissions. It presents data available on aviation fuel burn and aviation emissions of CO_2 in ICAO and from other sources, including CAEP.

1.2 This request was brought to the attention of CAEP members and rapporteurs through CAEP Memo 71. A special request was addressed to the CAEP Modelling and Databases Task Force (MODTF) and the CAEP Forecast and Economic Support Group (FESG).

1.3 Member States were also requested to provide data through a questionnaire attached to State letter ENV 1/1-08/44 dated 27 May 2008. No replies have yet been received as of the date of issuing this paper, and the results from this consultation will be brought to the attention of the group in due course.

1.4 The data presented in the Appendix is the result of a collection from many sources including: ICAO's Economic Analyses and Databases Section (EAD), the International Panel on Climate Change (IPCC), The United Nations Framework Convention on Climate Change (UNFCCC), and CAEP working groups.

1.5 The methodologies for ICAO and CAEP data estimation are described herein. Data from other sources is presented as available.

2. ICAO DATA

2.1 For several years now, ICAO has been conducting studies and analyses of regional differences in international airline operating economics with the aim of estimating and comparing airline costs in different regions of the world.

2.2 As part of these analyses, fuel consumption is estimated from each airline's information provided by OAG (scheduled operations) associated to a fuel consumption formula specific to each aircraft type. From these fuel consumption figures, it is possible to estimate emissions for any airline on each scheduled flight sector flown by taking into account the aircraft type operating the flight.

2.3 Accordingly, EAD has the ability to estimate fuel consumption (CO_2 emissions) on an annual basis, either by equipment type (aircraft model, jet/non-jet, passenger or cargo), by service category (international or domestic) or by origin/destination (route group, country or city) breakdown at different levels such as, by country of departure, by country pair or by country of airline registration.

2.4 The formula for fuel consumption calculation was developed in-house during the 1990s and uses the stage length (great circle distance) and airlines' block hour inputs. It takes into account the real route used by the airline, the total block time elapsed (i.e. from the moment the aircraft is pushed back until it arrives at the gate), as well as the differences in fuel consumption due to additional time required for circuitous routings or for prevailing winds. It is worthy of note that in other fuel consumption models this calculation is often left out.

2.5 Since its implementation, the fuel consumption database has been updated with fuel figures for new aircraft types based mostly on publicly-known manufacturers' material. However there are limitations with this procedure as it does not differentiate between the different fuel consumption resulting from flights at different altitudes.

2.6 Traffic data in the OAG database are based on a published timetable that does not reflect the actual operations performed due to cancellations and other operational irregularities. Additionally, non-scheduled and general aviation operations are not included in the database and regionally, there can be significant variations between timetabled and actual operations.

2.7 Despite the above shortcomings, the ICAO fuel consumption database is unique in terms of its coverage, as the published scheduled services represent about 64 per cent of total aviation traffic (measured in flight hours), leading to a 90 per cent estimation of the world jet fuel consumption. In terms of accuracy, comparisons with sample data available on the actual operations of some U.S. airlines indicate that the estimated differences are less than 5 per cent.

2.8 Finally, when compared to the results of other models like the ones from the FAA's AEDT SAGE or EUROCONTROL's AEM (based on CAEP/6 FESG inputs), the ICAO model is performing at around 4% below.

2.9 Bearing in mind this worldwide coverage, the models and the databases already in place have a great potential for various aviation environmental analyses, even with the shortcomings in respect of fuel consumption formulas and in terms of traffic coverage. However, resources are not provided for in the regular programme budget.

2.10 To date, the ICAO data has not been used as the basis for fuel consumption or CO_2 forecasts.

3. CAEP/7 DATA

3.1 CAEP/7 (2004-2007) has evaluated computer-based models used to estimate aviation Greenhouse Gases (GHG) and Local Air Quality (LAQ) emissions for possible future CAEP use. Four GHG models have been offered for evaluation: AEDT/SAGE (US FAA), AEM (EUROCONTROL), AERO2k (UK/QinetiQ) and FAST (UK/MMU[1]).

3.2 In carrying out the modelling of emissions, the aircraft replacement data used for LAQ and GHG modelling were derived from a 2006 version of the CAEP In-Production aircraft database. Projections of future technology or operational developments were not included in the assessment. Guidance for taking into account technology or operational advances was not available in time for consideration by CAEP/7.

3.3 An estimation using the four-model average fuel burn for each future year with an indication of the range of forecast results is presented for total aviation fuel burn model results (2000-2025) and total aviation CO_2 emissions model results (2000-2025). The best available, but older 2002 FESG demand and traffic forecast was used to generate future aircraft fleets for input to the models. Projections of future technology developments and operational improvements were not included in the estimation. As a result, only currently available aircraft were used to generate future fleets and the consequent fuel consumption and CO_2 results.

4. DATA PRESENTATION

4.1 Data is presented for CAEP/7 total aviation fuel burn model results, CAEP/7 total aviation CO_2 emissions model results, ICAO regions global estimates, for Annex I and non Annex I countries, and top 10 countries and airlines that have the highest aviation fuel consumption and thus emit more CO_2 from aviation. Current estimates and future projections are included.

4.2 Graphs are presented for each data source in the Appendix.

5. CONCLUSIONS

5.1 The Secretariat is working towards improving its State-level data by encouraging better participation from Contracting States. Until more complete and reliable data is received, model estimations are the best option to reliable estimates of CO_2 emissions on a global basis and are the basis for CAEP's work. Comparison with other entities' data also demonstrates that ICAO's and CAEP's data are reasonably consistent.

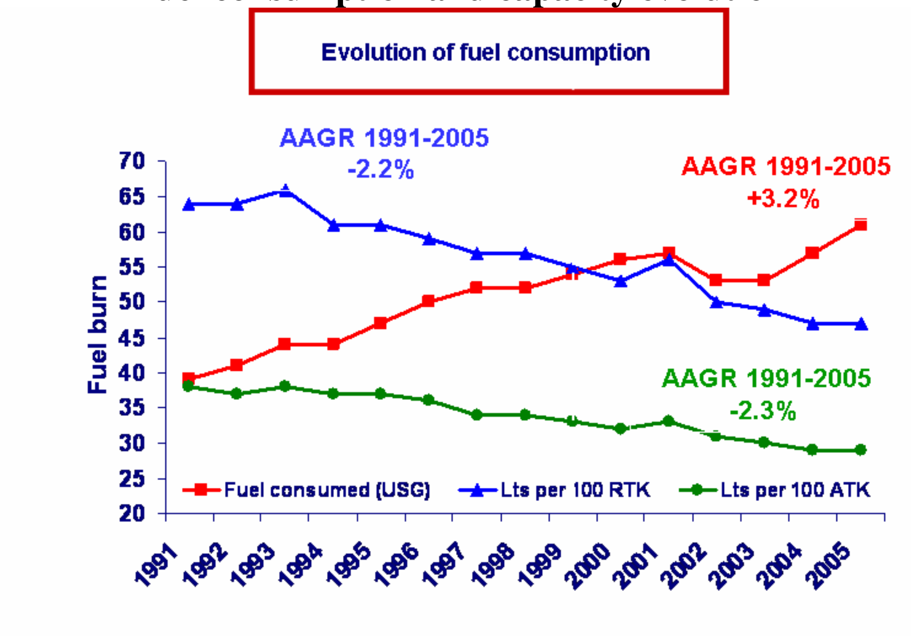
— — — — — — — — —

[1] Manchester Metropolitan University

APPENDIX

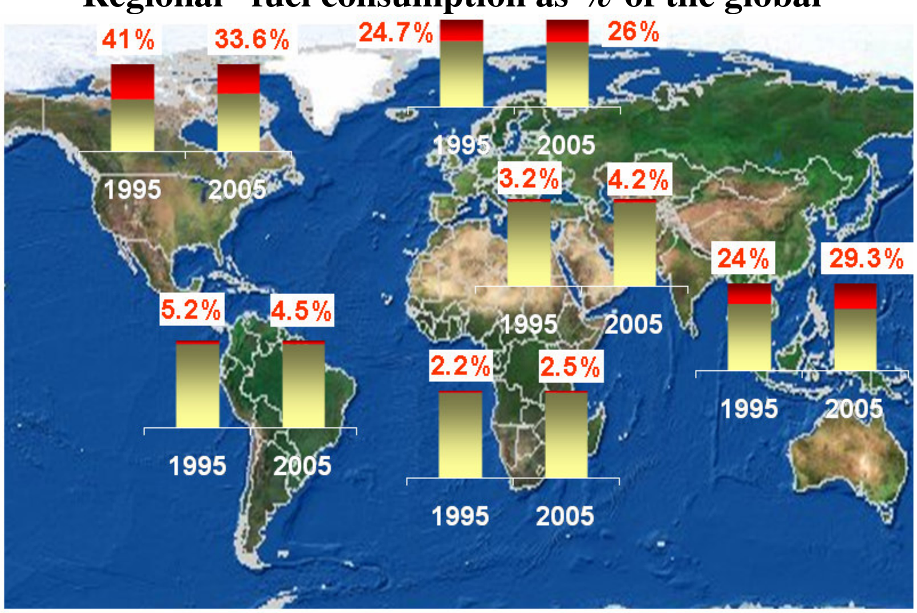
GLOBAL EMISSIONS ESTIMATES
Source :ICAO data

Fuel consumption and capacity evolution



Source: ICAO based on OAG timetable

Regional* fuel consumption as % of the global



Source: ICAO based on OAG timetable

*By region of registration

Fuel consumption by top twenty countries of departure

	Country of departure	Fuel*		Country of departure	Fuel*
1.	United States	74 584	11.	United Arab Emirates	4 038
2.	China	18 282	12.	Korea	4 037
3.	United Kingdom	11 804	13.	Netherland	3 983
4.	Japan	11 678	14.	Italy	3 974
5.	Germany	8 611	15.	Thailand	3 966
6.	France	6 715	16.	Singapore	3 889
7.	Australia	5 354	17.	Brazil	3 642
8.	Canada	5 121	18.	India	3 556
9.	Spain	4 953	19.	Mexico	3 054
10.	Russia	4 635	20.	Malaysia	2 374

Source: ICAO based on OAG timetable

*Fuel consumption expressed in millions liters

Fuel consumption by top ten countries of airlines' registration

	Country of registration	Fuel*
1.	United States	72 102
2.	China	20 684
3.	United Kingdom	11 764
4.	Japan	10 407
5.	Germany	9 995
6.	France	7 326
7.	Korea	6 214
8.	Singapore	5 625
9.	Netherland	5 196
10.	Russia	5 094

*Fuel consumption expressed in millions liters

Source: ICAO based on OAG timetable

Fuel consumption for the top ten countries by category of service (by country of departure)

PASSENGER SERVICES

	Cargo Services	Fuel*		International**	Fuel*		Domestic	Fuel*
1.	United States	7 750	1.	United States	20 220	1.	United States	46 613
2.	China	2 956	2.	United Kingdom	10 611	2.	China	6 979
3.	United Arab Emirates	1 611	3.	China	8 346	3.	Japan	3 910
4.	Korea	1 111	4.	Germany	7 088	4.	Russia	3 006
5.	Japan	994	5.	Japan	6 774	5.	Australia	1 930
6.	Germany	812	6.	France	5 412	6.	Canada	1 918
7.	Netherland	725	7.	Spain	3 693	7.	Brazil	1 672
8.	France	605	8.	Singapore	3 531	8.	Indonesia	1 257
9.	India	481	9.	Thailand	3 255	9.	Mexico	1 232
10	Luxemburg	457	10	Netherland	3 249	10	Spain	1 209

Source: ICAO based on OAG timetable

*Fuel consumption expressed in millions liters

**Including Domestic legs of International Services

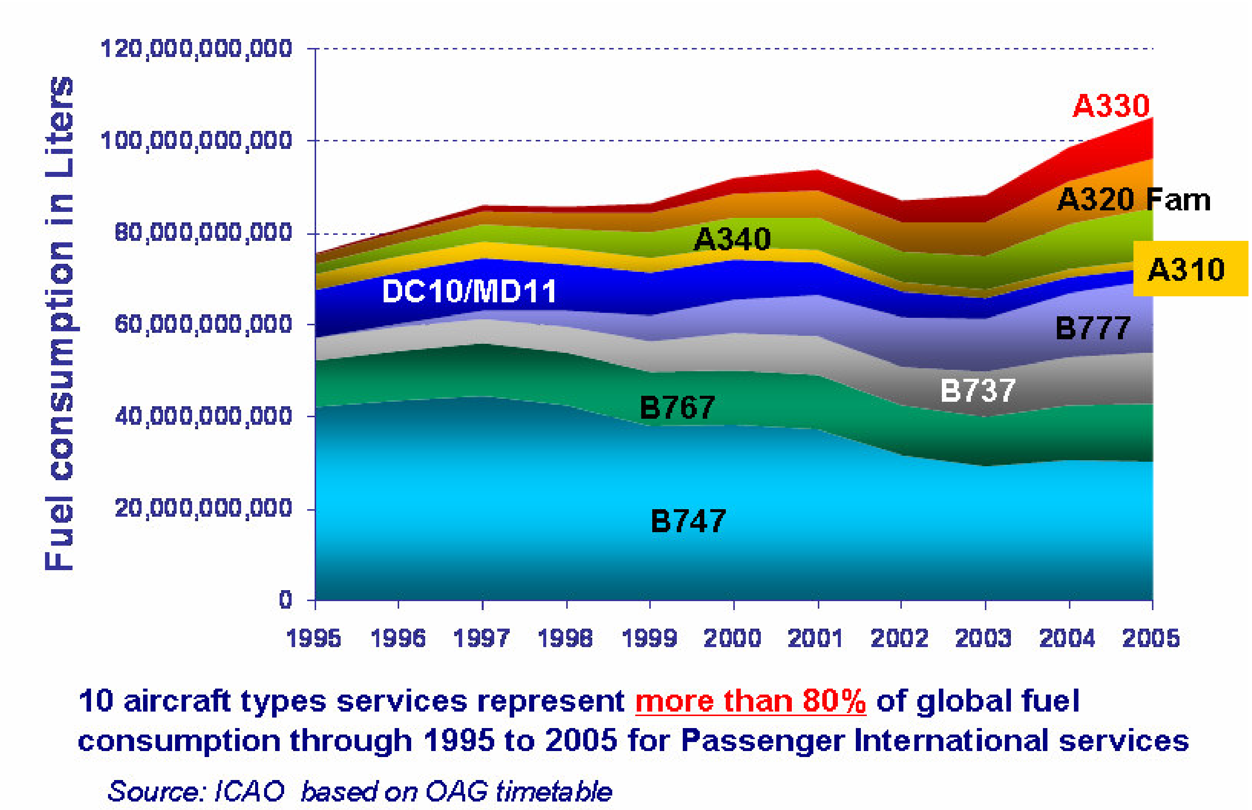
Fuel consumption by top ten airlines

	AIRLINE	Fuel*
1.	American Airlines	11 490
2.	United Airlines	9 086
3.	Delta Airlines	8 465
4.	British Airways	7 172
5.	Northwest Airline	6 731
6.	Lufthansa	6 565
7.	Air France	6 167
8.	Southwest	5 412
9.	Singapore Airline	5 386
10.	Continental	5 263

*Fuel consumption expressed in millions liters

Source: ICAO based on OAG timetable

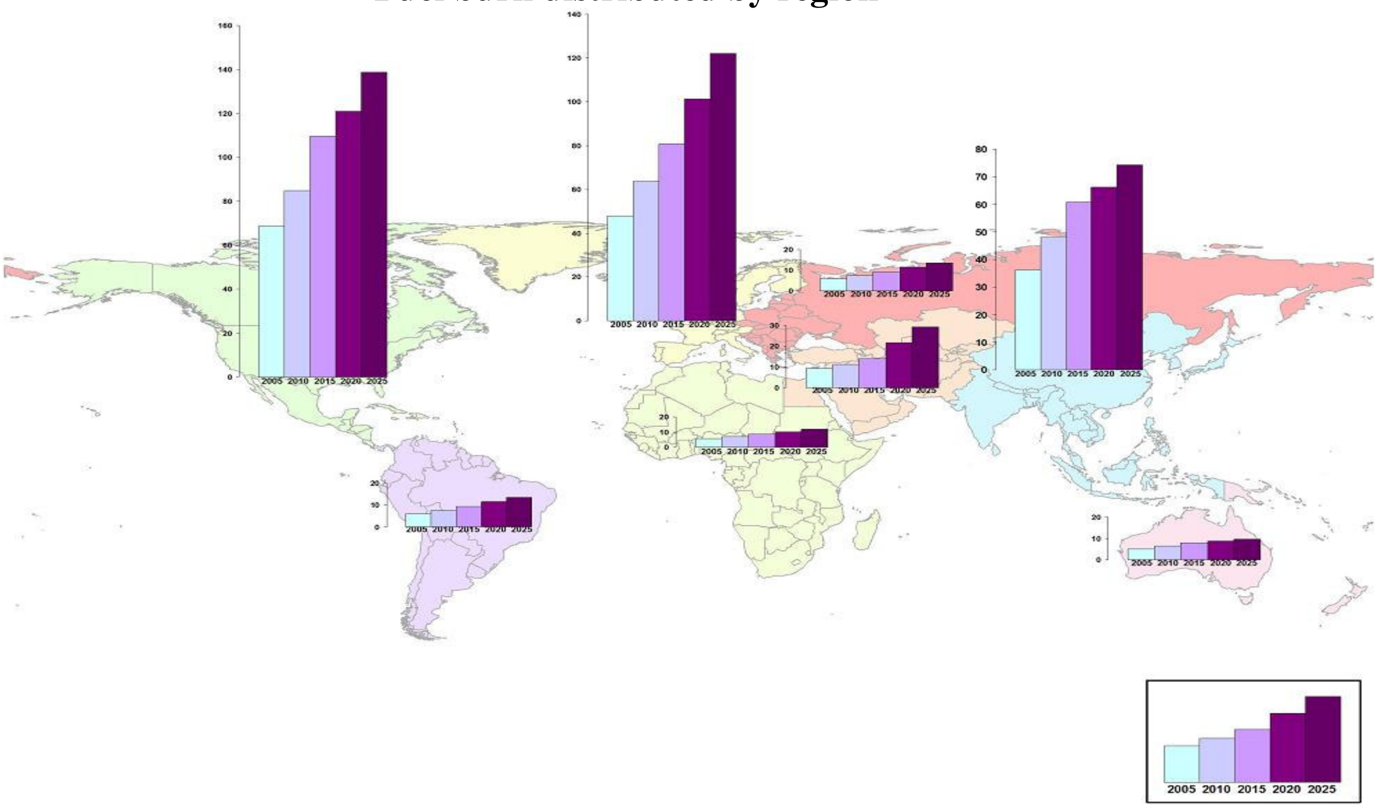
Fuel consumption evolution by major aircraft type on international Passenger Services



CAEP Data

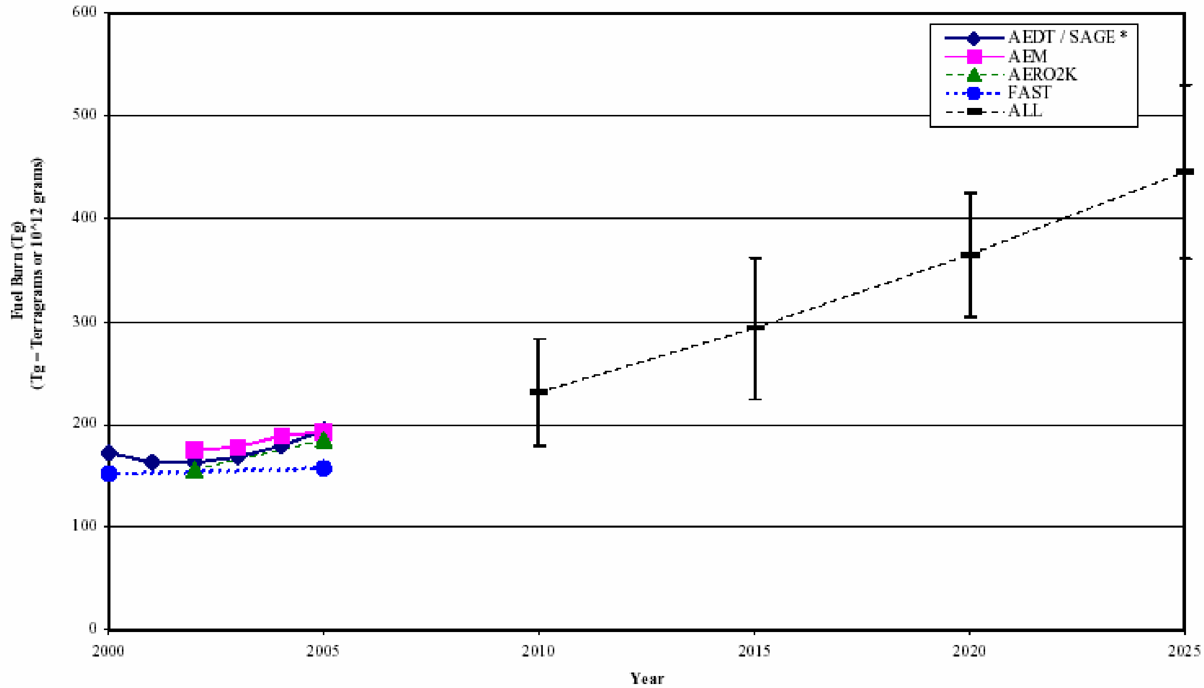
The CAEP data presented herein is from CAEP/7 based on the 2002 forecast. Work is currently underway within the CAEP/8 work cycle to update this information. The CAEP/8 data will be based on an updated FESG forecast (but one that does not consider the recent increase in fuel prices), and will include projections of future aircraft technology developments and operational improvements, e.g, direct routing. Some initial results are expected to be available in February 2009. Pre-final results are scheduled for May 2009, with final results in September 2009.

Fuel burn distributed by region



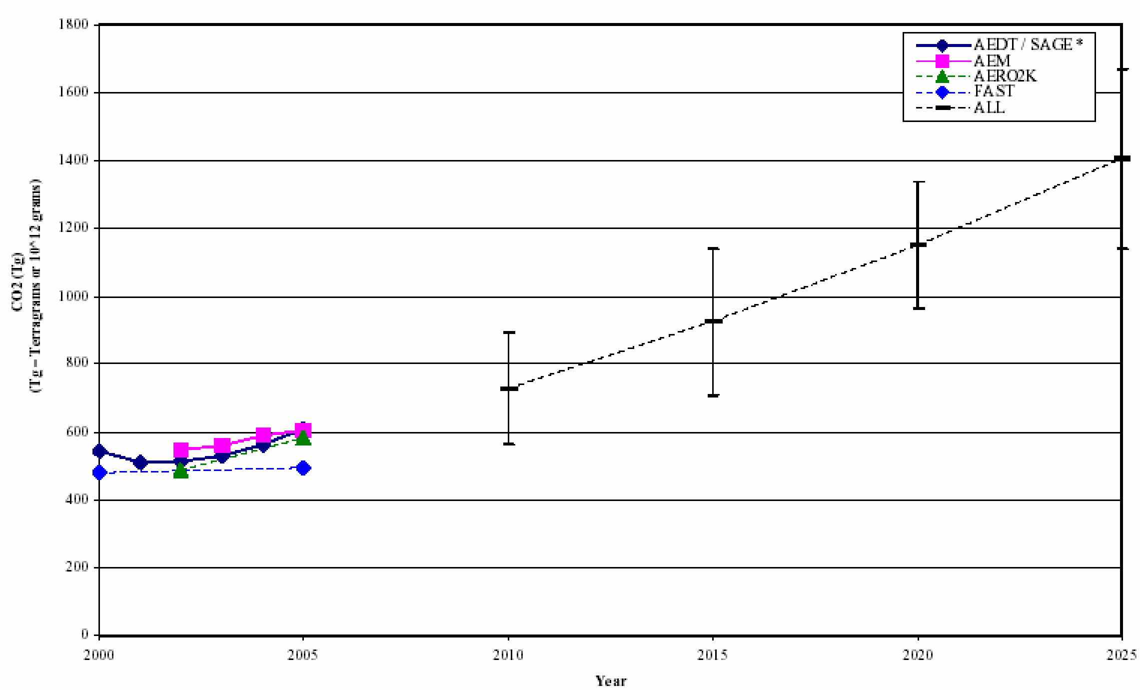
The following graphs are for the base-year 2000 to 2005 presenting actual modelled fuel burn data. For future data, the average fuel burn for each future year using the four models is presented with an indication of the range of results Projections of future technology developments and operational improvements were not included in these assessments.

Total aviation fuel burn model results (2000-2025)



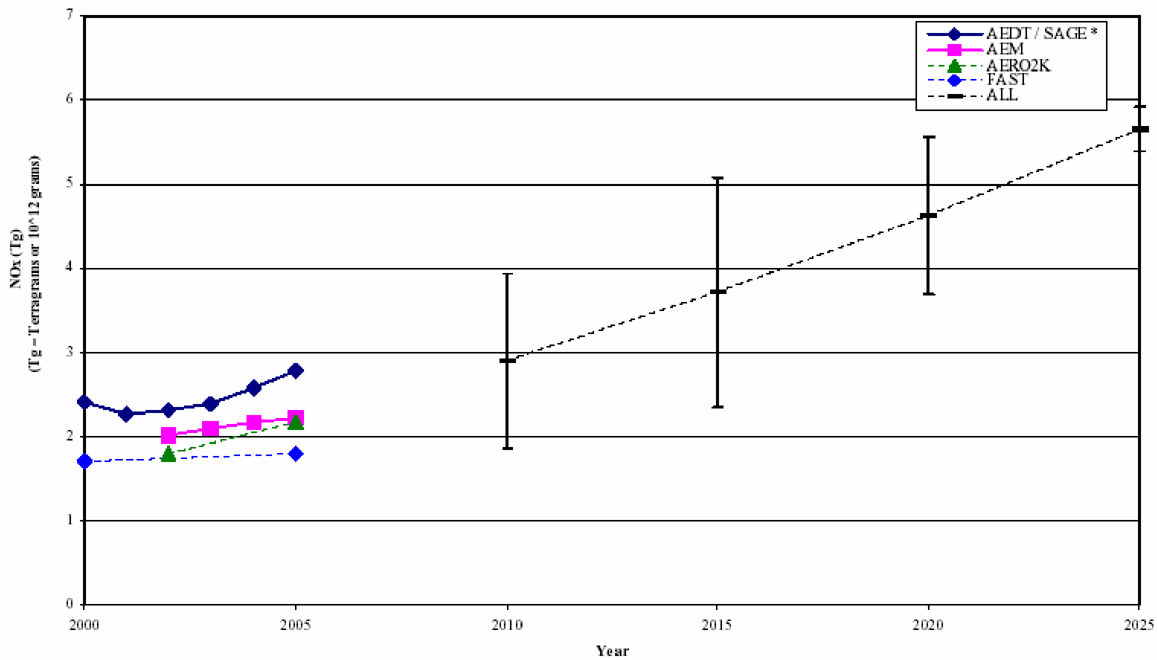
* Note: AEDT / SAGE (2000-2004) results have been adjusted down by 5% to account for the revised modelling assumptions resulting from migration from SAGE Version 1.5 to AEDT / SAGE in 2005.

Total aviation CO2 emissions model results (2000-2025)



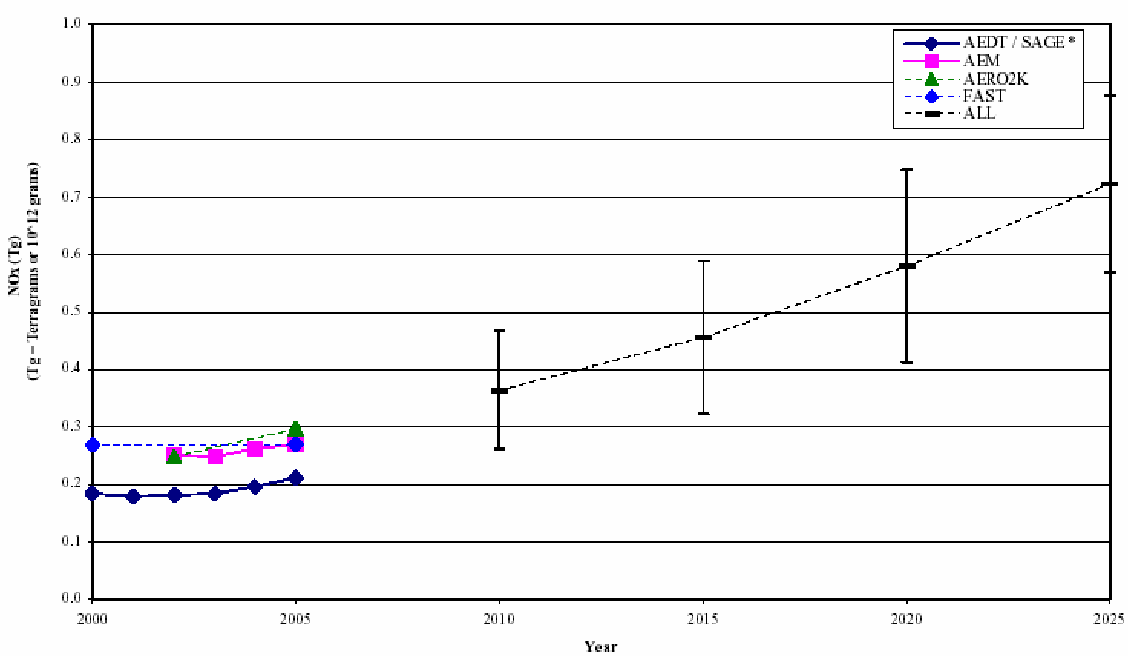
* Note: AEDT / SAGE (2000-2004) results have been adjusted down by 5% to account for the revised modelling assumptions resulting from migration from SAGE Version 1.5 to AEDT / SAGE in 2005.

Global aviation NOx emissions > 3000 ft (Global Greenhouse Gases)



* Note: AEDT / SAGE (2000-2004) results have been adjusted up by 4% to account for the revised modelling assumptions resulting from migration from SAGE Version 1.5 to AEDT / SAGE in 2005.

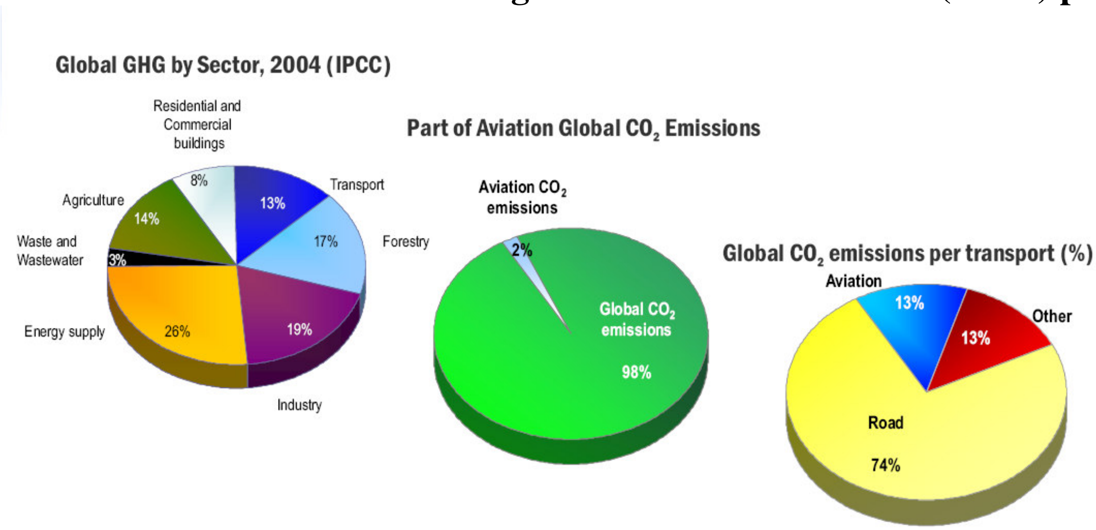
Summary of CAEP/7 NOx < 3000 ft (Local Air Quality)



* Note: AEDT / SAGE (2000-2004) results have been adjusted down by 7% to account for the revised modelling assumptions resulting from migration from SAGE Version 1.5 to AEDT / SAGE in 2005.

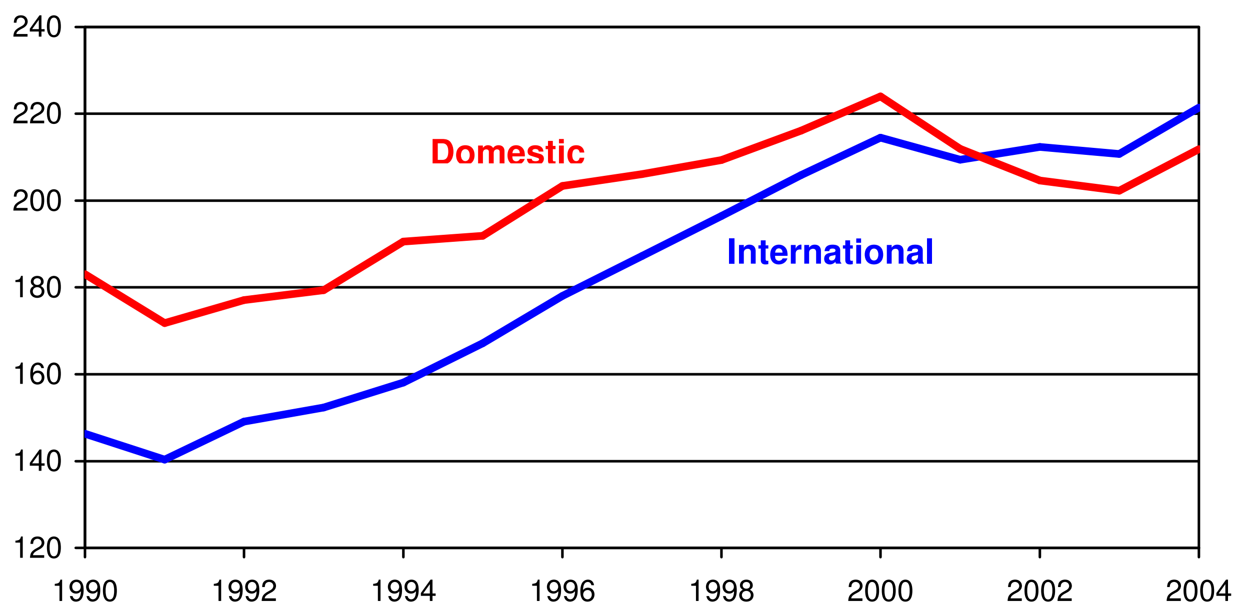
Intergovernmental Panel on Climate Change - IPCC

Global CO2 emissions and global Green House Gases (GHG) per sector



United Nations Framework Convention on Climate Change - UNFCCC

International aviation emissions of CO2 grew by 52% over 1990 to 2004 (Annex I countries)



Source: UNFCCC (excludes the Russian Federation)

— END —