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Scheduled Civil Aircraft Emission Inventories for 1976 and 1984: Database Development and Analysis

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Executive Summary

This report describes the development of a database of aircraft fuel burned and emissions from scheduled air traffic for four months (February, May, August, and November) of 1976 and 1984. These emission inventories were developed under the NASA High Speed Research Systems Studies (HSRSS) contract NAS1-19360, Task Assignment 55. They will be available for use by atmospheric scientists conducting the Atmospheric Effects of Aviation Project (AEAP) modeling studies.

A detailed database of fuel burned and emissions [NOx, carbon monoxide(CO), and hydrocarbons (HC)] for scheduled air traffic has been calculated for selected months of 1976 and 1984. The data are on a 1° latitude x 1° longitude x 1 km altitude grid. The datafiles were delivered to NASA Langley Research Center electronically.

Global fuel use by scheduled air traffic was calculated to be 1.26×10^8 kg/day during May 1976 and 1.66×10^8 kg/day during May 1984. Global NOx emissions increased from 1.36×10^6 kg/day in May 1976 to 2.15×10^6 kg/day in May 1984.

Using this data combined with earlier results [NASA CR-4700] for May 1990 and for each month of 1992, trends in emissions from scheduled air traffic have been calculated globally and for selected geographical regions. The results show that calculated fuel use by scheduled air traffic has been increasing at a rate of 4.6 %/year over the 1976 to 1992 time period. NOx emissions in the 9-13 kilometer band due to scheduled air traffic were calculated to have increased globally at 6.9%/year over that time period. The rate of increase in specific areas depended both on increases in passenger demand and the introduction of new, more efficient aircraft into the fleet.

Global emissions of carbon monoxide decreased in many regions between 1976 and 1984 and then increased between 1984 and 1992. Similarly, hydrocarbon emissions from scheduled air traffic decreased in globally and in most regions analyzed between 1976 and 1992, with the largest drop occurring between 1976 and 1984.

The fleet average effective EI(NOx) was calculated to have increased at about 1%/year over the 1976 to 1992 time period. Over the same time period, the fleet average effective EI(CO) and EI(HC) decreased significantly as more efficient combustors came into service.

An analysis of the trend in revenue passenger miles indicated a growth rate of 5.6%/year which was faster than the average annual rate of increase of calculated fuel consumption.

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GLOSSARY

AEAP	Atmospheric Effects of Aviation Project
AESA	Atmospheric Effects of Stratospheric Aircraft
APU	Auxiliary power unit
ASM	Available seat mile (the number of seats an airline provides times the number of miles they are flown)
ATC	Air traffic control
ATM	Available ton-miles (the number of tons capable of being carried times the number of miles flown)
BCAG	Boeing Commercial Airplane Group
BMAP	Boeing Mission Analysis Process
CAEP	ICAO Committee on Aviation Environmental Protection
CIAP	Climatic Impact Assessment Program (US Dept. of Transportation program in the early 1970s)
CO	Carbon Monoxide
CO_2	Carbon Dioxide
EI(CO)	Emission Index (grams CO/kg fuel burn)
EI(HC)	Emission Index [grams hydrocarbon (as CH_4)/kg fuel burn]
EI(NOx)	Emission Index (grams NOx (as NO_2)/kg fuel burn)
ESAD	Equivalent Still Air Distance
FAA	Federal Aviation Administration
GAEC	Global Atmospheric Emissions Code
GCD	Great circle distance
GE	General Electric
gm	gram
HC	Unburned hydrocarbon
H_2O	Water
HSCT	High Speed Civil Transport
HSRP	High Speed Research Program (NASA)
ICAO	International Civil Aviation Organization
ISA	International standard atmosphere
kg	kilogram
lb	pound
Load Factor	Percentage of an airplane's seat capacity occupied by passengers on a given flight
LTO cycle	Landing takeoff cycle
M	Mach number
MDC	McDonnell Douglas Corporation
MTOW	Maximum takeoff weight
NASA	National Aeronautics and Space Administration
nmi	Nautical mile
NOx	Oxides of nitrogen (NO + NO_2) in units of gram equivalent NO_2
OAG	Official Airline Guide
OEW	Operating Empty Weight
P&W	Pratt & Whitney
PAX	passengers

RAM	Revenue air mile
RPM	Revenue passenger miles (the number of paying passengers times the number of miles they fly)
RTM	Revenue ton-miles (number of tons carried times the number of miles flown)
SO_2	Sulfur dioxide
TBE	Turbine bypass engine
TOGW	Takeoff gross weight
ton	2000 pounds
3D	Three dimensional

1. Introduction

The NASA Atmospheric Effects of Aviation Project (AEAP) has been initiated to evaluate the effects of aircraft emissions on the atmosphere. For this assessment, inventories of aircraft emissions as a function of altitude and geographical position are required. These inventories can then be used as the input to three-dimensional chemical transport models in order to evaluate the effect of aircraft emissions, how long they persist in the atmosphere, how much they perturb the chemistry or microphysics of the upper troposphere, and how they compare with other sources of NOx, water, soot, and condensation nuclei in the upper troposphere.

Three-dimensional inventories of aircraft emissions for May 1990 have previously been developed as part of the NASA program, and projections were made to the year 2015 for both subsonic and high speed civil transport fleets. [Wuebbles, *et. al.*, 1993; Baughcum, *et. al.*, 1994, Landau, *et. al.*, 1994; Baughcum and Henderson, 1995]. The basic approach of the NASA-funded work has been a "bottoms-up" approach in which aircraft schedules are estimated, the aircraft/engine combinations identified, and then detailed calculations of fuel burned and emissions are done along each flight path. Other studies have used a mixture of a "bottoms-up" approach to account for scheduled air traffic and a "top-down" approach to account for military and non-scheduled traffic [McInnes and Walker, 1992; Schumann, 1995].

In a recent study, we have reported on the development of aircraft emission inventories for each month of 1992 for scheduled air traffic, including turboprops, passenger jets, and jet cargo aircraft. [Baughcum, et. al., 1996]. These inventories were calculated using the Official Airline Guide (OAG) as the source of air traffic. In a parallel study, McDonnell Douglas Aerospace has calculated emission inventories for military aircraft, charter airlines, and flights in the former Soviet Union and China that were not listed in the OAG. [Metwally, 1995]

In this study, we report the development of aircraft emission inventories for scheduled air traffic for 1976 and 1984. These inventories have been developed to assess the trend in aircraft emissions. Calculations were done for four months (February, May, August, and November) of each year. To calculate these inventories, flight schedule data (number of departures for each city pair, airplane type, engine type) from the Official Airline Guide have been combined with performance and emissions data to calculate the fuel burned, emissions, and altitude along each route. Fuel burned, oxides of nitrogen (NOx), carbon monoxide (CO), and total hydrocarbons (HC) have been calculated on a 1° longitude x 1° latitude x 1 kilometer altitude grid. The results for all the different routes and airplane/engine combinations were summed to produce the total inventory.

In Section 2, the methodology is briefly described. Results for the 1976 and 1984 emission inventories are summarized in Section 3. A trend analysis for fuel burned, NOx, carbon monoxide (CO), hydrocarbons, and revenue passenger miles is presented in Section 4. In Section 5, sulfur emissions from aircraft fleets are discussed. Conclusions are presented in Section 6. Numerous appendices are provided to document details of the calculations and analyses.

The work described in this report was conducted under NASA Langley Contract NAS1-19360, Task 55. The NASA Langley Task Manager was Donald L. Maiden.

The principal investigator was Steven L. Baughcum. Extraction and validation of aircraft departure data from the Official Airline Guide was done by Wes Banning and Stephen C. Henderson. Terrance G. Tritz collected the data set and calculated the 3-dimensional aircraft emission inventories using the Boeing proprietary Global Aircraft Emissions Code (GAEC). The GAEC code used to calculate the aircraft emission inventories was written by Peter S. Hertel. The analysis of the results was done by Steven L. Baughcum. The program manager for the work described in this task was initially John D. Vachal and later Philip F. Sweetland. The final report was reviewed internally by Douglas P. Dubois and Rebel R. Nichols.

2. Emissions Inventory Methodology

The calculation of aircraft emission inventories has been described in detail in our earlier work. [Baughcum, *et. al.*, 1994; Baughcum, *et. al.*, 1996] The overall process is shown schematically in Figure 2-1.

Global Emissions Database Calculation Schematic

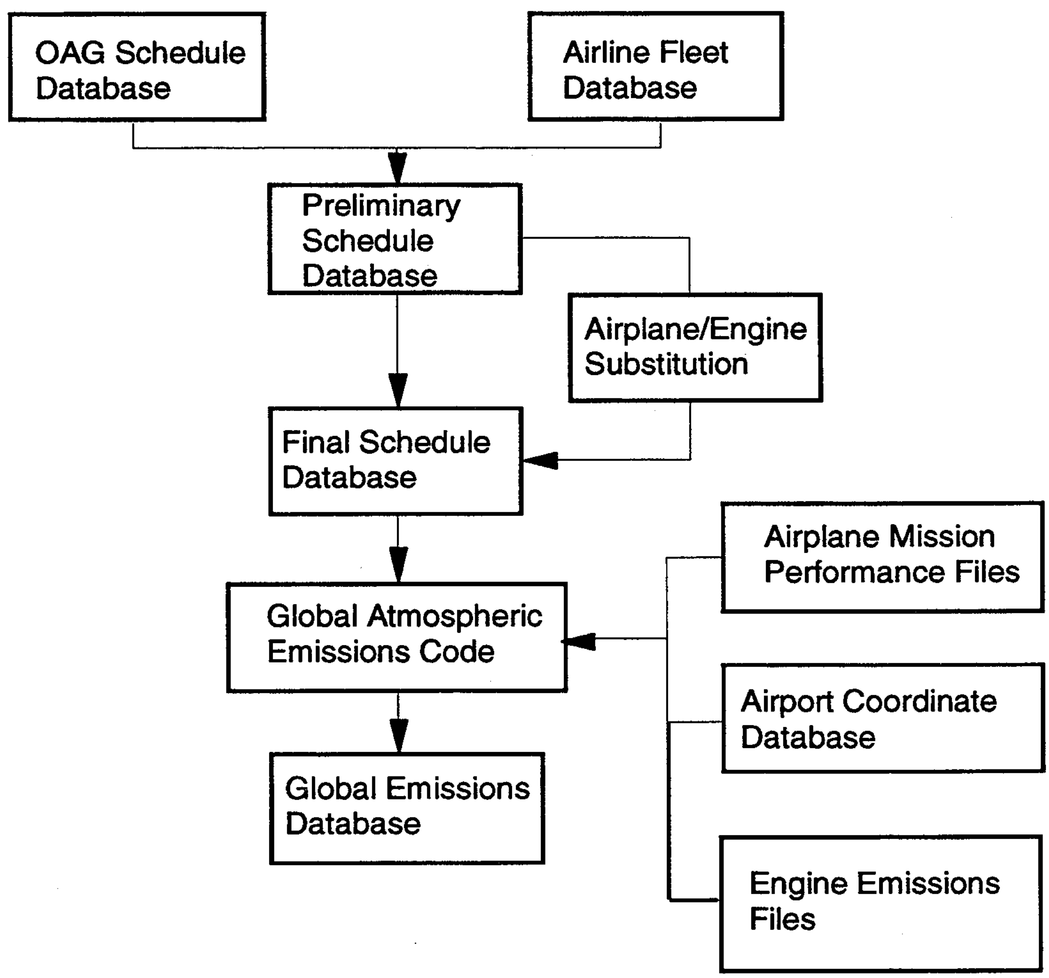

Figure 2-1. Schematic of emission inventory calculation.

Data on aircraft departure frequencies was extracted from the Official Airline Guide (OAG) (Oakbrook, IL), a subsidiary of the Reed Travel Group. The database contains listings of every scheduled jet and turboprop flight listed by city-pair and airline, and includes departure and arrival times, airplane code, and trip frequency.

The coverage of the OAG database depends on schedule data submitted by the individual airlines, and is based on the airlines' forecast of their operations for the next month. While it is quite accurate overall, changes in airline planned operations during any month, or operations not reported by the airline as part of their schedule are not included. The OAG offered little coverage of flights within the former Soviet Union or the Peoples Republic of China in 1976 and 1984, but contained fairly complete coverage of flights between these regions and the rest of the world.

Boeing normally purchases tapes containing the schedule data for five months of any year: February, May, August, September and November. These tapes are then processed and the data considerably "enriched" to create standard databases that are used in a variety of airline and airplane studies within Boeing. These data tapes were used for our analyses of emissions in 1976 and 1984.

For data generated in any given year, an airport listing is needed for that year. Separate listings are needed for each year due to the addition and subtraction of airports around the world and to changes in the airport codes used in the OAG. Airport codes for airports removed are re-used which is the main reason for using the appropriate year's airport listing. This is of particular concern when historical databases, such as those for 1976 and 1984, are generated.

The OAG database is designed for the purpose of flight itinerary planning by airline passengers and travel agents. As a result, certain duplicate listings of the same actual flight segment may occur in the schedule data. These duplications are not noted in the database, and logic must be built into the extract code to eliminate these duplications as much as possible. Much of the time on this task was spent in the process of discovering and eliminating these duplications. The processing of OAG data normally done within Boeing was inadequate for the purposes of this work and improvements were developed as described earlier. [Baughcum, *et. al.*, 1996]

Once the logic required to remove these duplicate flights was in place and tested, a complete set of schedules was extracted for the four months (February, May, August, and November) analyzed for 1976 and 1984.

The monthly airline schedules extracted from the OAG database do not in themselves contain enough information to allow calculation of emissions for a given flight. The specific airplane and engine type must be identified based on the aircraft that an airline operates. This, in turn, must be matched with available aircraft performance and engine datafiles.

The aircraft and engines used in the performance calculations are shown in Tables 2-1 and 2-2, for 1976 and 1984, respectively. Appendices A and B contain matchup tables correlating the airplane types obtained from the schedule data translation with the airplanes actually used in the emissions calculations, showing the matchup for 1976 and 1984, respectively. For 1976, the number of different airplane types listed in the OAG data files was 66-79, varying between months, while for 1984 there were 97-103 types listed.

Table 2-1. List of aircraft and engines used in the performance and emissions calculations for the 1976 emission inventory calculations.

Airplane	Engine	Airplane	Engine
707-320B-C	JT3D-3B	DC-10-30	CF6-50C2
720	JT3C-7	DC-8-21-31-33	JT4A-9
727-100	JT8D-7	DC-8-63-63CF	JT3D-7
727-200	JT8D-15-15A	DC-8-71-71CF	CFM56-1B
727-200	JT8D-9	DC10-40	JT9D-20
737-200	JT8D-15	DC8-55-55CF	JT3D-3B
737-200	JT8D-7	DC9-30	JT8D-7
737-200ADV	JT8D-9-9A	DC9-50	JT8D-15
747-100-200	JT9D-7A	F-28-4000	MK555-15H
747SP	JT9D-7A	L-1011-1-100	RB211-22B
A300-B2-B4	CF6-50C2	Large Turboprop	PW125
BAC111-500	MK512-14	Medium Turboprop	PW120
Caravelle-10B	JT8D-1	Small Turboprop	PT6A
Concorde	Olympus 593		

Table 2-2. List of aircraft and engines used in the performance and emissions calculations for the 1984 emission inventory calculations.

Airplane	Engine	Airplane	Engine
707-320B-C	JT3D-3B	Caravelle-10B	JT8D-1
720	JT3C-7	Concorde	Olympus 593
727-100	JT8D-7	DC-10-30	CF6-50C2
727-200	JT8D-15-15A	DC-8-21-31-33	JT4A-9
737-200	JT8D-15	DC-8-63-63CF	JT3D-7
737-200	JT8D-7	DC-8-71-71CF	CFM56-1B
747-100-100SR	CF6-45A2	DC10-10	CF6-6D
747-100-200	CF6-50E2	DC10-40	JT9D-20
747-100-200	JT9D-7A	DC8-55-55CF	JT3D-3B
747-300	CF6-50E2	DC9-30	JT8D-7
747-300	JT9D-7R4G2	DC9-50	JT8D-15
747SP	JT9D-7A	F-28-4000	MK555-15H
757-200	RB211-535C	L-1011-1-100	RB211-22B
767-200	JT9D-7R4D	L1011-500AC	RB211-524B4
A300-B2-B4	CF6-50C2	MD-82	JT8D-217A
A310-300	CF6-80A3	Large Turboprop	PW125
BAC111-500	MK512-14	Medium Turboprop	PW120
BAE146-300	ALF502R-5	Small Turboprop	PT6A

Airplane performance data files were generated for all the airplane/engine combinations shown in Tables 2-1 and 2-2. These data files provide time, fuel burned and distance flown as a function of aircraft gross weight and altitude for climbout, climb, and descent conditions. They also provide tables of fuel mileage (nautical miles per pound of fuel burned) as a function of gross weight, cruise Mach number and altitude for cruise conditions. These performance data files were generated using the proprietary Boeing Mission Analysis Program (BMAP), and each file covered the whole operating envelope of the airplane. This allowed simple interpolation routines to be used by the Global Atmospheric Emissions Code (GAEC), a proprietary program created for these calculation tasks. Aircraft performance calculations were done assuming 70% load factors.

For purposes of the emissions calculations, the Earth's atmosphere was divided into a grid of three dimensional cells with dimensions of 1° of latitude by 1° of longitude by 1 kilometer in altitude, up to 22 kilometers.

The primary emissions are water vapor (H_2O) and carbon dioxide (CO_2) produced by the combustion of jet fuel. The emission levels are determined by the fuel consumption and the fraction of hydrogen and carbon contained in the fuel. Results from a Boeing study of jet fuel properties measured from samples taken from airports around the world yielded an average hydrogen content of 13.8% [Hadaller and Momenthy, 1989].

Current emission indices (in units of grams of emissions per kilogram of fuel burned) are summarized in Table 2-3, based on the analyses of Hadaller and Momenthy for commercial Jet A fuel.

Table 2-3. Recommended emission indices (in units of grams emission/kilogram fuel).

Emission	Emission Index
Carbon Dioxide (CO_2)	3155
Water (H_2O)	1237

Nitrogen oxides (NO_x), carbon monoxide (CO) and hydrocarbons (HC) are produced within the combustors and vary in quantity according to the combustor conditions. Nitrogen oxides are produced in the high temperature regions of the combustor primarily through the oxidation of atmospheric nitrogen. Thus, the NO_x produced by an aircraft engine is sensitive to the pressure, temperature, flow rate, and geometry of the combustor. The emissions vary with the power setting of the engine, being highest at high thrust conditions. By contrast, carbon monoxide and hydrocarbon emissions are highest at low power settings where the temperature of the engine is low and combustion is less efficient.

The emissions are characterized in terms of an emission index in units of grams of emission per kilogram of fuel burned. Nitrogen oxides consist of both nitric oxide (NO) and nitrogen dioxides(NO_2). For NO_X, the emission index [EI(NO_X)] is given as gram equivalent NO_2 to avoid ambiguity. Although hydrocarbon measurements of aircraft emissions by species have been made [Spicer *et al.,* 1992], only total hydrocarbon emissions are considered in this work.

For the engines considered in this study, emissions data from the engine certification measurements were used. [ICAO, 1995] In these measurements, emissions of nitrogen oxides (NOx), carbon monoxide (CO) and total hydrocarbons (HC) are measured at standard day sea level conditions at four power settings [7%(idle), 30%(approach), 85%(climbout) and 100% (takeoff)]. If the ICAO database did not have a particular engine, the data for that engine were obtained from the engine manufacturer. This was done for the three sizes of turboprops considered. If a source could not be found (e.g., JT3C and JT4A), engines with a similar combustor core were used with an adjustment for different fuel flow rates.

Emissions data is available from the certification measurements for a larger number of engines than we include in the performance calculations. In the calculations, the OAG airplane/engine combination is matched to both a performance engine and an emissions engine. (see Appendices A and B for the matchup tables) Fuel flow is calculated using the performance data. Then the emissions are calculated using a fuel flow technique described below. In most cases, the emissions engine is the same as that used to calculate the performance. If the OAG engine was similar to the performance engine, the emissions engine was matched to the OAG engine. If the OAG engine is significantly different from the performance engine, the emissions engine was matched to the performance engine.

Boeing has developed empirical methods which allow the calculation of emissions for a wide variety of aircraft and a large number of missions. These methods are described in detail in Appendices C and D of our previous contractor report [Baughcum, *et. al.* 1996]. Using these methods, emission indices measured during engine certification tests are correlated with the fuel flow and then scaled for ambient temperature, pressure, and humidity. For the work presented here, the Boeing Method 2 fuel flow correlation method is used (see Appendix D of [Baughcum, *et. al.,* 1996] for a complete description).

All global emissions calculations were done using GAEC (Global Atmospheric Emissions Code) described previously. [Baughcum, *et. al.,* 1994]

3. Results

3.1 Summary of 1976 Results

The daily fuel burned and emissions for the four months evaluated for 1976 are summarized in Table 3-1. The seasonal variation of the global totals is similar to that reported earlier [Baughcum, *et. al.*; 1996] with a maximum during the summer and a minimum in winter.

Table 3-1. Fuel burned and emissions for scheduled air traffic for selected months of 1976.

Month	Fuel (kg/day)	NOx (kg/day)	HC (kg/day)	CO (kg/day)
February	1.17E+08	1.28E+06	6.67E+05	1.04E+06
May	1.26E+08	1.36E+06	7.56E+05	1.13E+06
August	1.35E+08	1.49E+06	7.86E+05	1.19E+06
November	1.22E+08	1.33E+06	7.03E+05	1.08E+06

The fuel burned, emissions, and effective emission indices as a function of altitude for each month of data are provided as tables in Appendix C. For each OAG airplane/engine type, Appendices D-I summarize the fuel burned (Appendix D), NOx (Appendix E), hydrocarbons (Appendix F), carbon monoxide (Appendix G), distance flown (Appendix H), and number of departures (Appendix I).

The global effective emission indices (summed over latitude, longitude, and altitude) are given in Table 3-2. Only very small seasonal variations in the global emission indices are calculated.

Table 3-2. Global effective emission indices for scheduled air traffic for selected months of 1976. (averaged over latitude, longitude, and altitude)

Month	Global EI(NOx)	Global EI(HC)	Global EI(CO)
February	10.88	5.68	8.86
May	10.85	6.01	9.03
August	11.03	5.81	8.80
November	10.97	5.78	8.85

A summary of fuel burned by generic airplane type during May 1976 is provided in Table 3-3. The table shows the daily fuel burned by each airplane and the fraction of the global total fuel use by scheduled air traffic that this represents. Also shown are the average effective emission indices for NOx, CO, and hydrocarbons in the 0-9 kilometer altitude band (consisting of landing, takeoff, climbout, climb to cruise, and descent) and in the 9-13 kilometer altitude band (corresponding mostly to cruise but also including some initial climb and the beginning of descent). A more detailed table showing these results for each individual aircraft/engine combination is included as Appendix Q.

For 1976, 9 aircraft types accounted for 89% of the global jet fuel burned by scheduled air traffic with the Boeing 747-100/200 making the largest single contribution.

Table 3-3. Summary of fuel burned and effective emission indices for different aircraft in May 1976.

			0-9 km Altitude Band			9-13 km Altitude Band		
Generic Airplane Type	Fuel (1000 kg/day)	% of Global Fuel Burned	EI (NOx)	EI (CO)	EI (HC)	EI (NOx)	EI (CO)	EI (HC)
Boeing 747-100/200	18,941	15.10%	23.5	23.3	12.2	13.5	0.5	0.7
Boeing 707	18,017	14.30%	15.1	38.8	44.7	5.9	7.6	7.5
Boeing 727-100	14,894	11.90%	10.8	7.4	2.2	7.7	3.5	1
Boeing 727-200	14,485	11.50%	11.6	5	0.8	8.6	2.4	0.5
DC-8	12,193	9.70%	8.7	33.9	25.7	7.1	5.6	1.3
DC-9	11,724	9.30%	9.4	9.5	2.9	8.1	2.1	0.5
DC-10	10,849	8.60%	20.2	18.5	6.8	12.6	2.3	1.4
Boeing 737-200	5,659	4.50%	9	10	3	7.8	2.1	0.5
Lockheed 1011	5,256	4.20%	17.8	25.5	18.8	14.5	3.2	1.1
Miscellaneous	4,635	3.70%	13.6	22.6	18.2	7.4	5.6	4.8
Boeing 720	1,443	1.10%	15.3	40.9	46.6	6	9.5	9.4
Large Turboprops	1,339	1.10%	12.8	4.3	0			
BAC111	1,205	1.00%	11.7	32.5	18.6	10.2	7.6	4.8
Caravelle	1,176	0.90%	8.3	14.7	4.5	6.8	6.2	1.2
Small Turboprops	766	0.60%	8	4.1	0.2			
Tupolev 134	723	0.60%	9.4	9.3	2.9	8	2.1	0.5
Tupolev 154	680	0.50%	11.8	4.8	0.7	8.6	2.3	0.5
Fokker 28	666	0.50%	10.2	5.7	0.5	8.4	1.7	0.4
Medium Turboprops	394	0.30%	11.9	5	0.6			
Boeing 747-SP	392	0.30%	24.3	26.4	16.1	14.1	0.4	0.6
YAK 40	112	0.10%	10.8	7.4	2.2	8	6.8	2.3
Concorde	67	0.10%	10.5	28.3	5.9	10.6	23.2	1.5
Convair	51	0.00%	15.4	41.7	47.8	6.3	13.2	12.8

3.2 Summary of 1984 Results

The daily fuel burned and emissions for the four months evaluated for 1984 are summarized in Table 3-4.

Table 3-4. Fuel burned and emissions for scheduled air traffic for selected months of 1984.

Month	Fuel (kg/day)	NOx (kg/day)	HC (kg/day)	CO (kg/day)
February	1.66E+08	2.04E+06	5.42E+05	1.08E+06
May	1.74E+08	2.15E+06	5.59E+05	1.11E+06
August	1.86E+08	2.31E+06	5.74E+05	1.16E+06
November	1.74E+08	2.15E+06	5.37E+05	1.09E+06

The fuel burned, emissions, and effective emission indices as a function of altitude for each month of data are provided as tables in Appendix C. For each OAG airplane/engine type, Appendices J-O summarize the fuel burned (Appendix J), NOx (Appendix K), carbon monoxide (Appendix L), hydrocarbons (Appendix M), distance flown (Appendix N), and number of departures (Appendix O).

The global effective emission indices (summed over latitude, longitude, and altitude) are summarized in Table 3-5. Only very small seasonal variations in the global emission indices are calculated.

Table 3-5. Global effective emission indices for scheduled air traffic for selected months of 1984. (averaged over latitude, longitude, and altitude)

Month	Global EI(NOx)	Global EI(HC)	Global EI(CO)
February	12.28	3.27	6.51
May	12.33	3.21	6.39
August	12.42	3.08	6.23
November	12.34	3.08	6.26

A summary of fuel burned by generic airplane type during May 1984 is provided in Table 3-6. The table shows the daily fuel burned by each airplane and the fraction of the global total fuel burned by scheduled aircraft that this represents. Also shown are the average effective emission indices for NOx, CO, and hydrocarbons in the 0-9 kilometer altitude band (consisting of landing, takeoff, climbout, climb to cruise, and descent) and in the 9-13 kilometer altitude band (corresponding mostly to cruise but also including some initial climb and the beginning of descent). A more detailed table showing these results for each individual aircraft/engine combination is included as Appendix R.

For 1984, 11 aircraft types accounted for 88% of the global jet fuel burned by scheduled air traffic with the Boeing 747-100/200 making the largest single contribution. However, by 1984, some of the aircraft which had contributed a large fraction of the emissions were much less important. As an example, the Boeing 707 accounted for 14.3% of the fuel use in May 1976 but only 2.3% in May 1984.

Table 3-6. Summary of fuel burned and effective emission indices for different aircraft in May 1984.

Airplane Type	Fuel (1000 kg/day)	% of Global Fuel Burned	0-9 km Altitude Band EI (NOx)	EI (CO)	EI (HC)	9-13 km Altitude Band EI (NOx)	EI (CO)	EI (HC)
Boeing 747-100/200	40,319	23.10%	23.7	22.7	11.9	13.6	0.5	0.6
Boeing 727-200	30,880	17.70%	11.7	4.9	0.7	8.7	2.3	0.5
DC-10	17,070	9.80%	20.2	17.8	6.4	12.6	2	1.3
DC-9	13,261	7.60%	9.5	9.1	2.7	8.2	2.1	0.5
Boeing 737-200	13,242	7.60%	9.1	9.9	3	7.8	2.2	0.5
Lockheed 1011	10,490	6.00%	17.9	25.9	18.8	14.3	4.1	1.2
Boeing 727-100	10,040	5.80%	10.8	7.4	2.2	7.7	3.5	1
Airbus A300	6,686	3.80%	20.9	18.7	7.1	14.7	1.3	1
DC-8	4,470	2.60%	9.7	27.9	19.4	7.7	5.3	1.3
Boeing 707	4,043	2.30%	15.1	38.9	44.7	5.9	7.5	7.5
Boeing 747-SP	3,146	1.80%	23.4	28.7	17.5	14.2	0.5	0.7
McDonnell Douglas MD-80	3,030	1.70%	14.6	5.6	1.6	10.7	3.9	1.4
Boeing 767-200	2,684	1.50%	22.4	3	0.4	11.2	1.4	0.2
Large Turboprops	1,897	1.10%	12.8	4.3	0			
Small Turboprops	1,777	1.00%	8	4.2	0.2			
Tupolev 154	1,461	0.80%	11.8	4.8	0.7	8.7	2.3	0.5
Fokker 28	1,404	0.80%	8.8	28	32.4	7.5	1.1	3.7
BAC500	1,351	0.80%	11.9	32.1	18.4	10.2	7.7	4.9
Ilyushin 62	1,118	0.60%	14.9	36.7	42.3	5.9	6.7	6.7
Boeing 747-300	1,111	0.60%	25	6.9	2.1	14.5	1.7	0.4
Boeing 757-200	660	0.40%	15.1	17.7	1.1	9.7	8.2	1.3
Airbus A310	655	0.40%	17	7.4	1.6	12.8	2.6	0.6
Miscellaneous	636	0.40%	14.2	30.2	22.4	10.3	5.4	4.5
Tupolev 134	566	0.30%	9.4	9.3	2.9	8.1	2.1	0.5
Boeing 720	457	0.30%	5.7	33.2	36.9	4.6	6.9	3.2
Concorde	404	0.20%	10.4	27.9	5.4	10	26	1.8
Boeing 747-SR	369	0.20%	19.1	20.1	11.7	13.9	2.8	2.8
Medium Turboprops	345	0.20%	12.3	5	0.6			
Caravelle	165	0.10%	8.8	6.2	1.3	7.5	2.4	0.5
Mercure	165	0.10%	10.7	5.4	0.8	7.8	3.8	0.7
Ilyushin 86	162	0.10%	15.2	39.3	45.3	5.9	8.8	8.6
YAK 40	112	0.10%	10.8	7.4	2.2	7.8	5.5	1.8
BAE-146	70	0.00%	8.8	8.6	0.8	7.7	0.2	0
Ilyushin 72	26	0.00%	15.2	39.4	45.3	5.8	8.7	8.5
Convair	3	0.00%	6.1	35.2	39.6	4.6	7.1	3.3

3.3 Discussion of Results

In order to evaluate trends in aircraft emissions, the results of this study on 1976 and 1984 aircraft emissions can be combined with those generated earlier [Baughcum, *et. al.*, 1996] for 1990 and 1992.

Since aircraft spend most of their time in flight at cruise altitudes, the peak emissions occur in the 9-13 kilometer altitude band (see Figures 3-1 and 3-2). As shown in Figure 3-1, growth in air traffic also caused increased fuel usage and increased NOx emissions over the 1976 to 1992 time period.

The trends for carbon monoxide and hydrocarbon emissions are less simple since both traffic growth and improvements in combustor efficiency affect the trend. Carbon monoxide and hydrocarbon emissions are due to incomplete fuel combustion. As Lefebvre (1983) has shown, the combustor efficiency can be calculated directly from the carbon monoxide and hydrocarbon emission indices using the following equation:

$$\text{Combustion efficiency} = 1 - .001 \times [EI_{HC} + 0.232 \times EI_{CO}]$$

Improved combustor efficiency has signficantly reduced the CO and hydrocarbon emission indices in newer model aircraft engines [ICAO, 1995].

As Figure 3-2 shows, the fraction of aircraft fuel use and NOx emissions in the 0-9 kilometer altitude band has decreased over the 1976 to 1992 time period. This means that the fraction of fuel use occurring at cruise altitudes (9-13 kilometers) has increased slightly from 1976 to 1992. This may be due to a number of factors including an increase in long range flights and the introduction of aircraft which cruise at higher altitudes.

Figure 3-3 shows the effective emission indices as a function of altitude for 1976, 1984, and 1992. The emission indices at altitudes above 14 kilometers are due to the Concorde. Emissions above 14 kilometers from the Concorde account for only a very small fraction of the total fuel burned and emissions (see Figure 3-1). Approximately 0.17% of the global jet fuel use is calculated to be due to Concorde above 14 kilometers altitude (see Appendix C for tables of emissions as a function of alitude).

As Figure 3-3 shows, the fleet average effective emission indices have changed over the 1976 to 1992 time period. The effective emission indices for hydrocarbons and carbon monoxide have decreased dramatically over this time period as combustor efficiency has improved. With the increase in combustor efficiency and other changes in aircraft/engine design, the global average effective NOx emission index has increased somewhat over this time period. This can also be seen by examining the average effective emission indices for different generic aircraft in Tables 3-3 and 3-6.

A more detailed trend analysis for selected geographical regions is provided in Section 4 of this report.

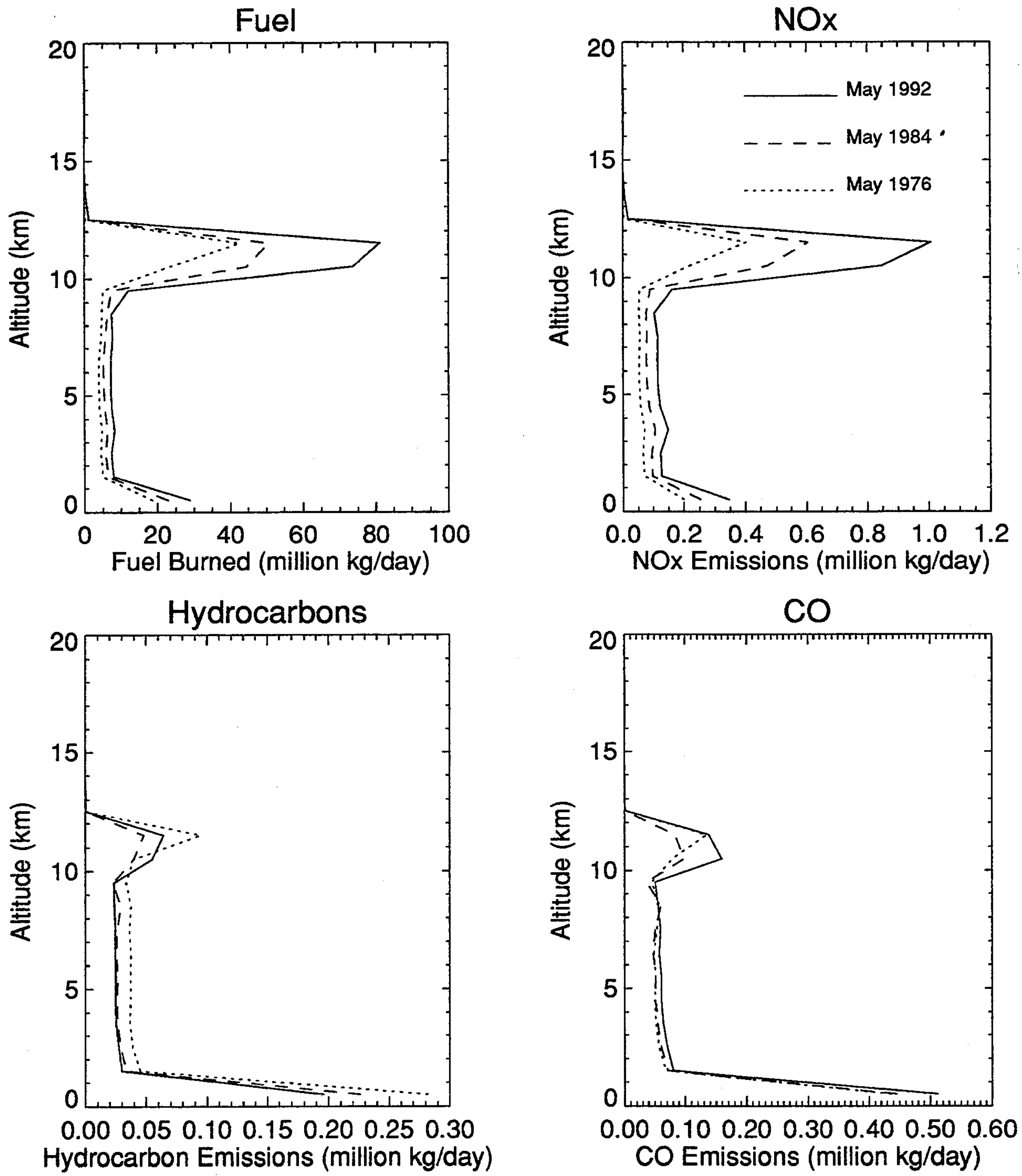

Figure 3-1. Comparison of fuel burned and emissions as a function of altitude for May 1976 (dotted line), May 1984 (dashed line), and May 1992 (solid line) for scheduled air traffic.

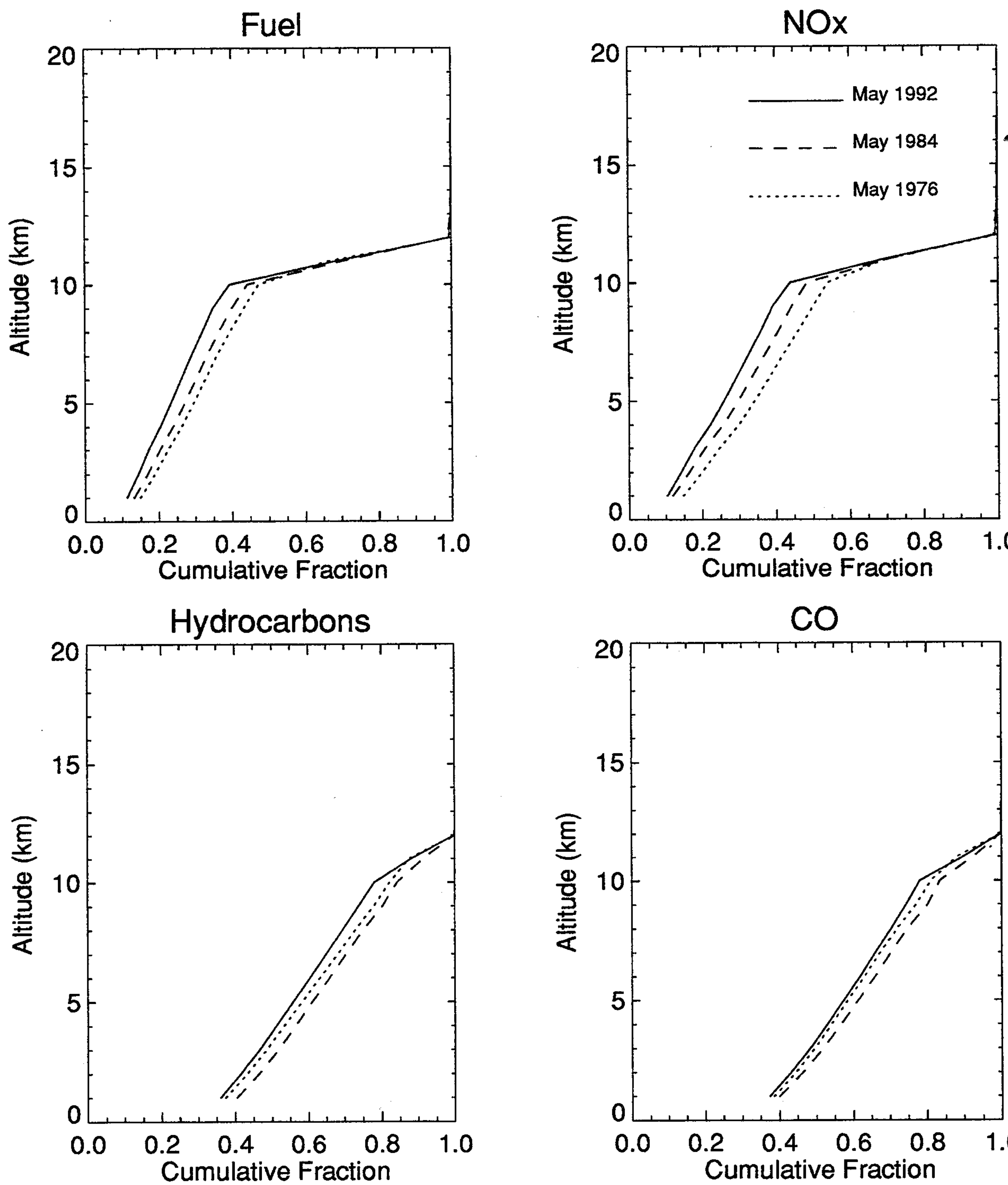

Figure 3-2. Comparison of cumulative fractions of fuel burned and emissions as a function of altitude for May 1976 (dotted line), May 1984 (dashed line), and May 1992 (solid line) for scheduled air traffic.

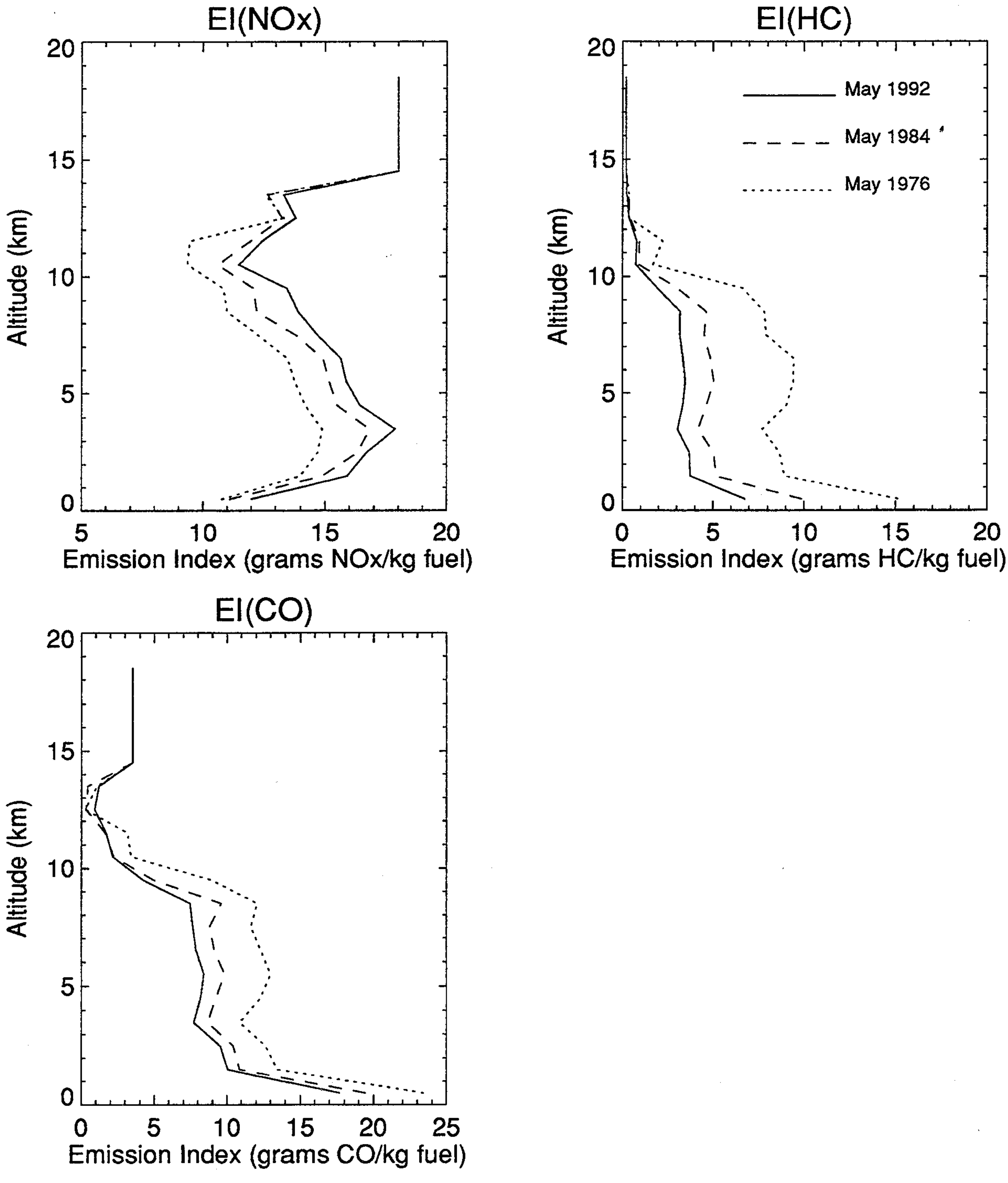

Figure 3-3. Comparison of effective emission indices as a function of altitude for May 1976 (dotted line), May 1984 (dashed line), and May 1992 (solid line) for scheduled air traffic.

4. Trend Analysis

In this section, results for 1976 and 1984 are combined with the emission inventories calculated earlier for scheduled air traffic for each month of 1992 and for May 1990. The revised May 1990 emission inventory was recalculated using the same data extraction and emission methodology (Boeing Method 2) as in this study. Both the 1992 data and the revised May 1990 have been described in detail elsewhere. [Baughcum, *et. al.*, 1996]

The overall trend in emissions deposited in a given geographical region depends on the total air traffic in that region and on the type of aircraft that are being utilized. In this section, we analyze the trends in aircraft fuel use and emissions for eight selected regions. The regions were defined as simple boxes (see Table 4-1) and are shown in Figure 4-1.

Table 4-1. Definitions of geographical regions used in the trend analysis.

Geographical Region	Latitude Range	Longitude Range
Global	90S-90N	180W-180E
Northern Hemisphere	0-90N	180W-180E
Southern Hemisphere	90S-0	180W-180E
Continental United States	25N-49N	125W-70W
Europe	37N-70N	10W-25E
North America	25N-70N	125W-70W
North Atlantic	30N-70N	70W-10W
North Pacific	30N-65N	120E-125W

The relative importance of the different regions is illustrated in Table 4-2. The Northern Hemisphere accounts for 92-93% of the global fuel use while only 7-8% occurs in the Southern Hemisphere. The fraction of fuel use occurring within North America has decreased from 45% to 36% from 1976 to 1992, while the North Pacific has increased from 6.7% of the global use to 10.1%.

Table 4-2. Fraction of global fuel use occurring within the geographical region.

Region/Date	May 1976	May 1984	May 1992
Northern Hemisphere	92.6%	92.5%	92.3%
Southern Hemisphere	7.4%	7.5%	7.7%
Continental United States	43.7%	41.5%	33.7%
Europe	13.6%	12.1%	12.9%
North America	45.1%	43.0%	35.5%
North Atlantic	7.0%	6.8%	7.5%
North Pacific	6.7%	8.2%	10.1%

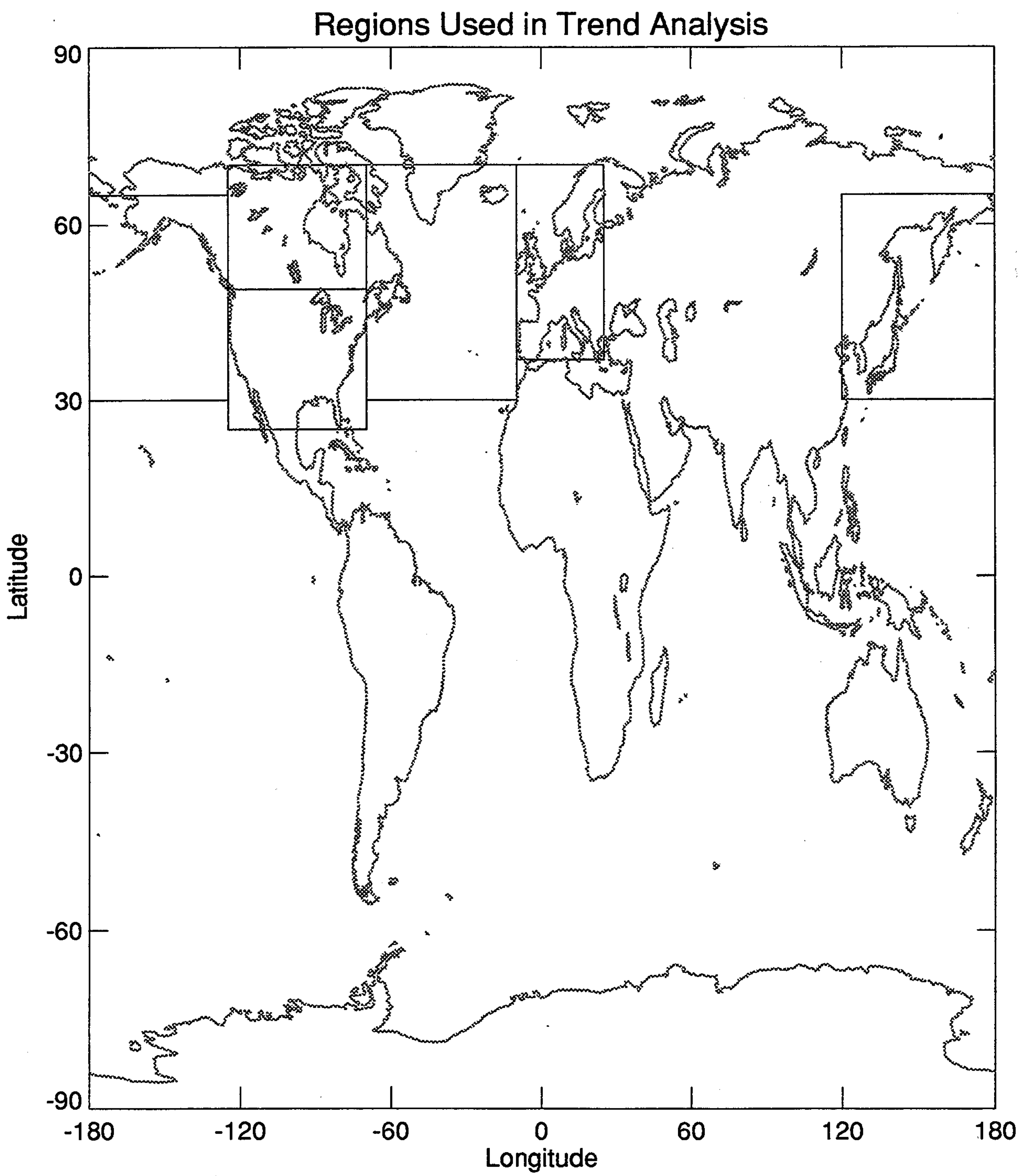

Figure 4-1. Geographical regions used in the trend analysis.

Trend analyses were done considering total emissions integrated over all altitudes and emissions integrated over the 9-13 kilometer altitude band (corresponding to the altitudes at which commercial aircraft cruise). For each region, the emissions were integrated over the altitude band using the emission inventories for scheduled air traffic for each month of 1992, May of 1990, four months of 1976, and four months of 1984. All of the emission inventories were calculated self consistently. The 1992 data and the revised May 1990 have been described in a separate report [Baughcum, *et. al.*; 1996].

For each region, the emissions for the 21 months of available data were fit to an exponential curve, primarily for visualization of the data. As will be seen, in many cases this is a good representation of the data; but for other cases, the growth was clearly not exponential. For this analysis, all available months of data are treated equally. It is assumed that the data for 1976, 1984, and 1992 includes the seasonal cycle and that its effects will be averaged out. Analyses within the Boeing marketing organization have concluded that May is generally representative of the annual average for the year. Thus, the May 1990 data has also been included. An alternative analysis would be to consider only the month of May for each year of data, but that was not done in the analysis presented here.

4.1 Fuel Trend

The calculated daily jet fuel use due to scheduled aircraft is shown in Figure 4-2 for the eight regions. The data show a seasonal cycle (lowest in winter and highest in summer) and a growth trend from 1976 to 1992. Globally,over the 1976-92 time period, the fuel use was calculated to be increasing at about 4.6%/year. Over the 1976-92 time period, fuel use increased fastest in the North Pacific region of those considered, with a rate of increase of about 7.4%/year and slowest in the continental United States and North America at about 2.8-2.9%/year. The results are summarized in Table 4-3.

Table 4-3. Calculated annual growth rate in fuel consumption over the 1976-1992 time period for scheduled air traffic.

Region	Annual Rate of Increase	Standard Deviation	Correlation Coefficient
Global	4.6%	0.2%	0.98
Northern Hemisphere	4.6%	0.2%	0.98
Southern Hemisphere	4.9%	0.1%	0.99
Continental United States	2.8%	0.1%	0.96
Europe	4.5%	0.3%	0.93
North America	3.0%	0.1%	0.96
North Atlantic	5.3%	0.5%	0.88
North Pacific	7.4%	0.2%	0.99

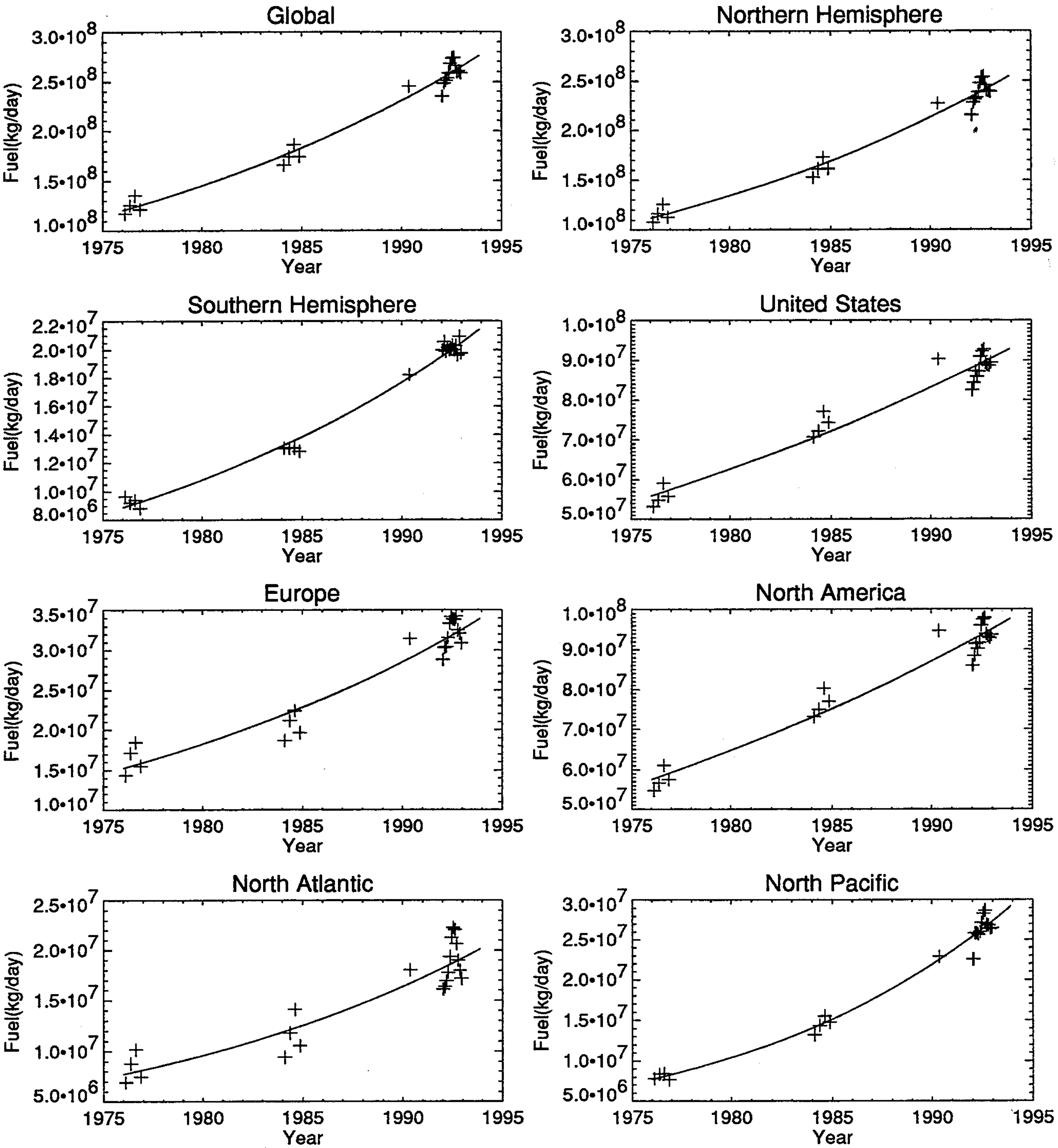

Figure 4-2. Calculated fuel burned as a function of year for the time period 1976-1992 in the 0-22 kilometer altitude band. The solid line is the fit to an exponential growth curve.

Fuel use in the 9-13 kilometer altitude band is illustrated in Figure 4-3. Fuel use in the 9-13 kilometer band increased at about 5.5% globally over the 1976-92 time period. The annual rate of increase is shown in Table 4-4 and is slightly higher than that calculated considering all flight altitudes.

Table 4-4. Calculated annual growth rate in fuel consumption in the 9-13 kilometer band over the 1976-1992 time period for scheduled air traffic.

Region	Annual Rate of Increase	Standard Deviation	Correlation Coefficient
Global	5.5%	0.2%	0.98
Northern Hemisphere	5.5%	0.2%	0.98
Southern Hemisphere	5.9%	0.2%	0.98
Continental United States	3.6%	0.1%	0.97
Europe	5.2%	0.3%	0.93
North America	3.8%	0.2%	0.97
North Atlantic	5.4%	0.5%	0.87
North Pacific	8.0%	0.2%	0.99

4.2 NOx Trend

The calculated daily NOx emissions due to scheduled aircraft are shown in Figure 4-4 for the eight regions considering the 0-22 kilometer altitude band. The NOx emissions due to the 9-13 kilometer altitude band are shown in Figure 4-5. The calculated growth rates are summarized in Table 4-5 for the 0-22 kilometer altitude band and in Table 4-5 for the 9-13 kilometer band.

An exponential growth function appears to fit the calculated NOx emissions reasonably well. The growth rate was highest in the North Pacific which showed the greatest increase in traffic growth and lowest over the continental United States.

Table 4-5. Calculated annual growth rate in NOx emissions (all altitudes) over the 1976-1992 time period for scheduled air traffic.

Region	Annual Rate of Increase	Standard Deviation	Correlation Coefficient
Global	5.7%	0.2%	0.99
Northern Hemisphere	5.6%	0.2%	0.99
Southern Hemisphere	6.3%	0.1%	1.00
Continental United States	3.5%	0.1%	0.97
Europe	5.6%	0.3%	0.96
North America	3.6%	0.1%	0.97
North Atlantic	6.6%	0.5%	0.92
North Pacific	8.2%	0.2%	0.99

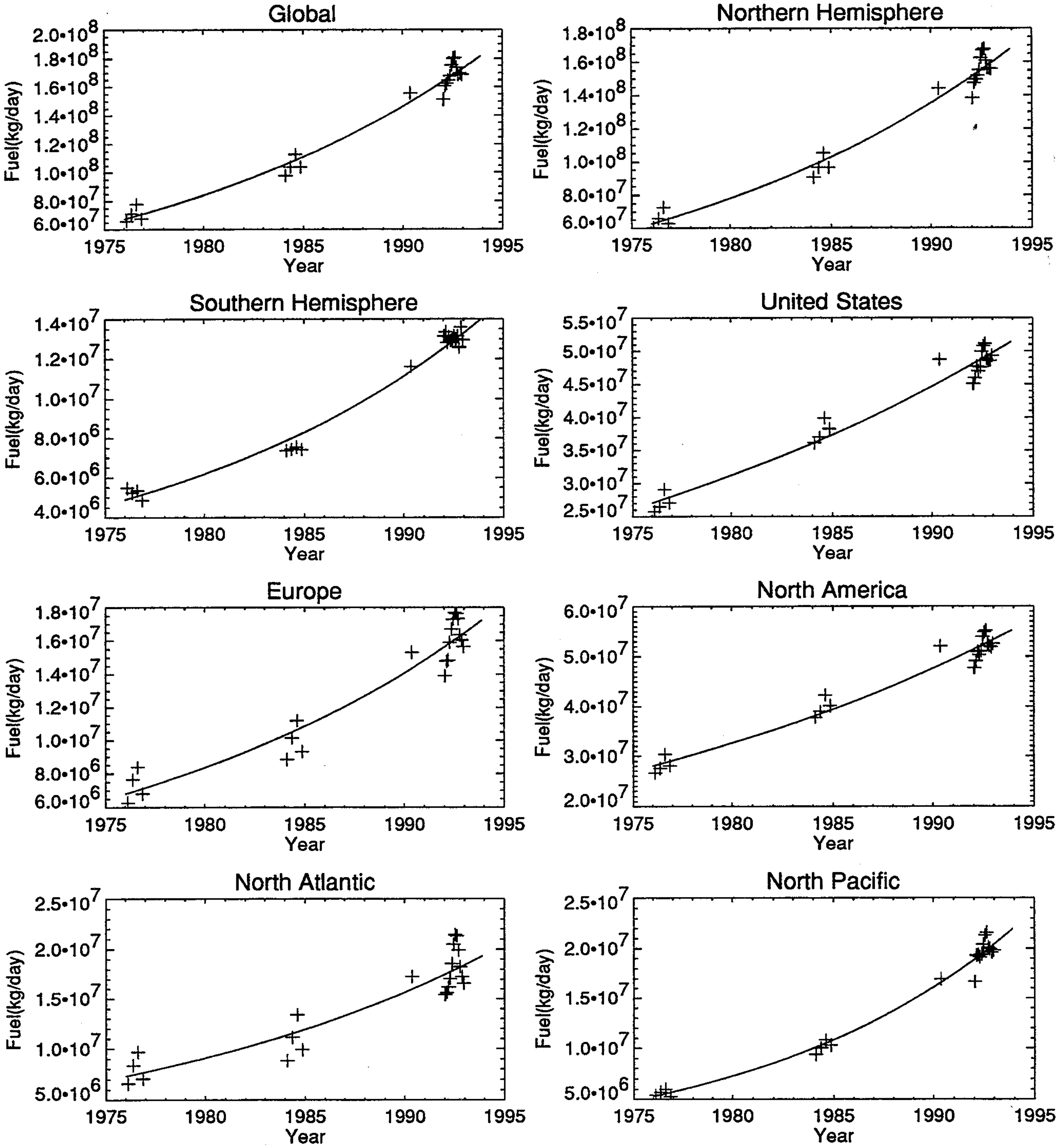

Figure 4-3. Calculated fuel burned as a function of year for the time period 1976-1992 in the 9-13 kilometer altitude band. The solid line is the fit to an exponential growth curve.

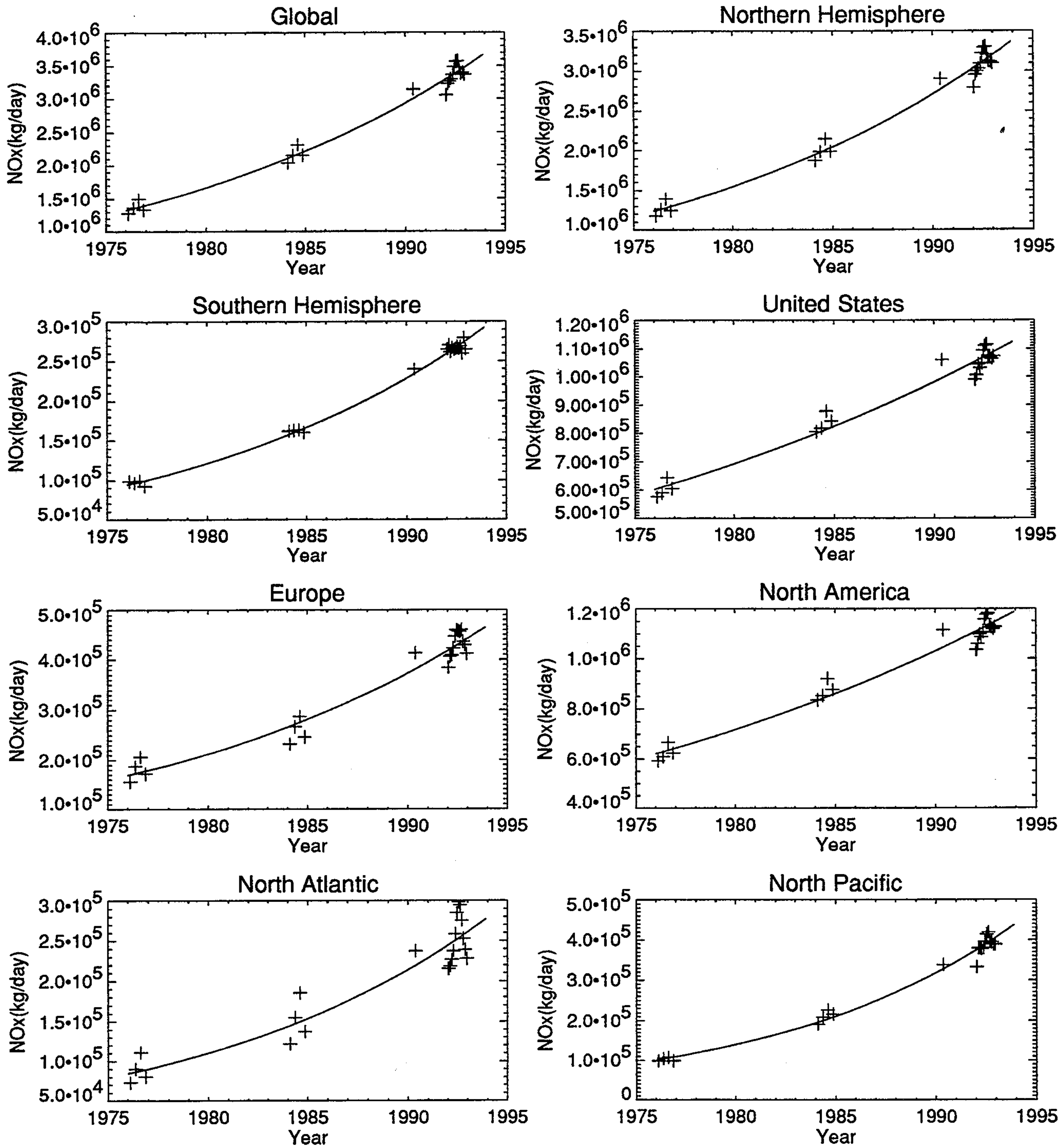

Figure 4-4. Calculated NOx emissions as a function of year for the time period 1976-1992 in the 0-22 kilometer altitude band. The solid line is the fit to an exponential growth curve.

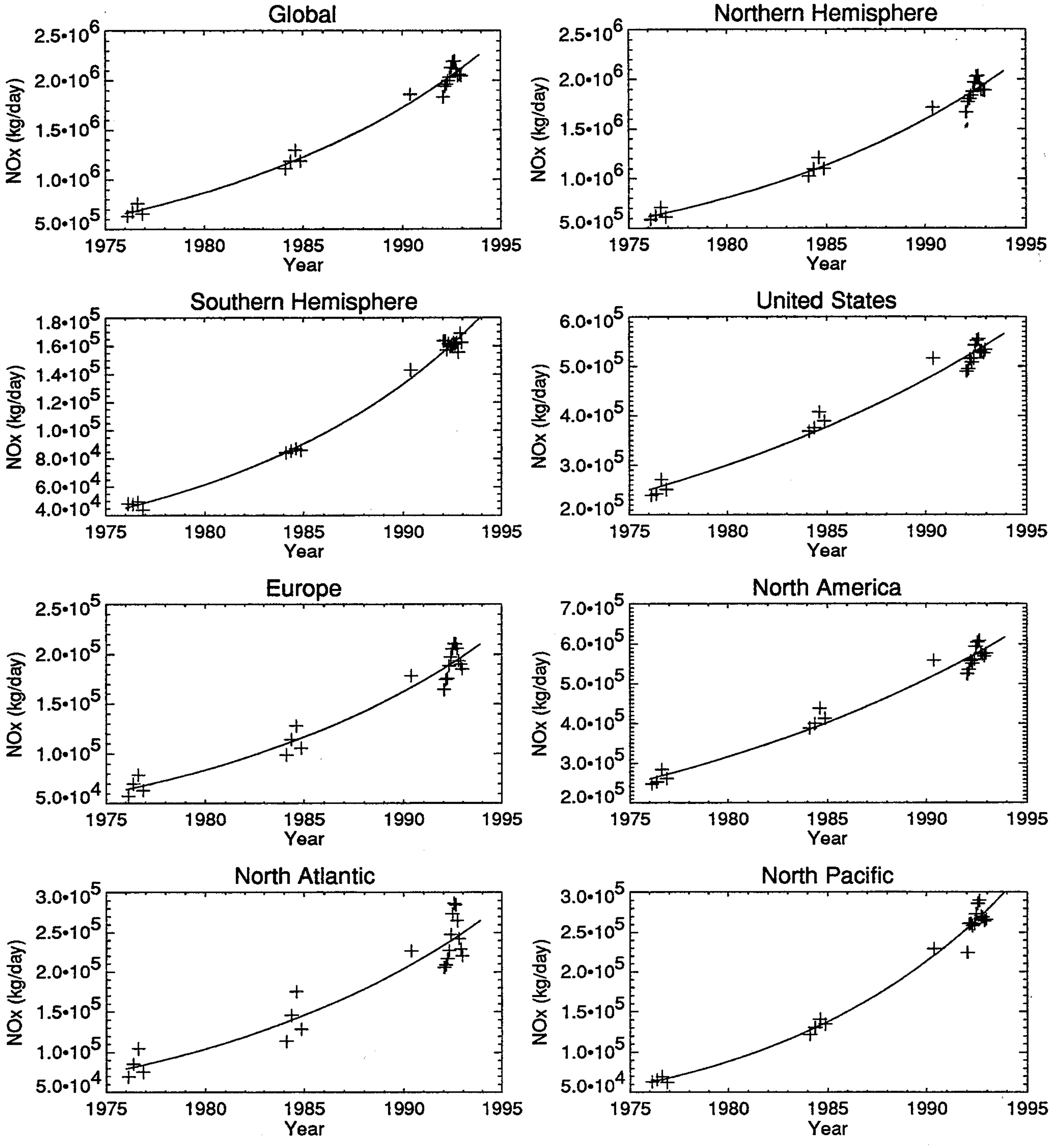

Figure 4-5. Calculated NOx emissions as a function of year for the time period 1976-1992 in the 9-13 kilometer altitude band. The solid line is the fit to an exponential growth curve.

Table 4-6. Calculated annual growth rate in NOx emissions in the 9-13 kilometer altitude band over the 1976-1992 time period for scheduled air traffic.

Region	Annual Rate of Increase	Standard Deviation	Correlation Coefficient
Global	6.9%	0.2%	0.99
Northern Hemisphere	6.8%	0.2%	0.99
Southern Hemisphere	7.7%	0.1%	0.99
Continental United States	4.6%	0.2%	0.98
Europe	6.6%	0.3%	0.96
North America	4.8%	0.2%	0.98
North Atlantic	6.7%	0.5%	0.92
North Pacific	8.8%	0.2%	0.99

4.3 CO Trend

The calculated daily carbon monoxide emissions due to scheduled aircraft are shown in Figure 4-6 for the 0-22 kilometer altitude band and in Figure 4-7 for the 9-13 kilometer band. Fits of the carbon monoxide emissions to a exponential growth curve are much poorer than those obtained for the fuel use and NOx emissions and are shown here only to help visualize the data. In the Northern Hemisphere, continental United States, North America, and North Atlantic, the CO emissions decreased between 1976 and 1984, presumably due to the introduction of more efficient combustors and aircraft. Between 1984 and 1992, the emissions increased as air traffic continued to grow.

Since exponential growth curves were found to be poor representations of the data, annual growth rates have not been tabulated for CO.

4.4 Hydrocarbon Trend

The calculated daily hydrocarbon emissions due to scheduled aircraft are shown in Figure 4-8 for the 0-22 kilometer altitude band and in Figure 4-9 for the 9-13 kilometer band. Hydrocarbon emissions from scheduled air traffic were lower in 1992 than in 1976 for all regions except the North Pacific, in marked contrast to the increases in fuel use and NOx emissions. Much of the decrease occurred between 1976 and 1984 in most regions.

The smooth lines shown Figure 4-8 and 4-9 are the result of an exponential fit and are used to help visualize the data. With the possible exception of emissions in the North Pacific, the data are not well represented by an exponential fit and the growth rates calculated by such a fit are not tabulated here.

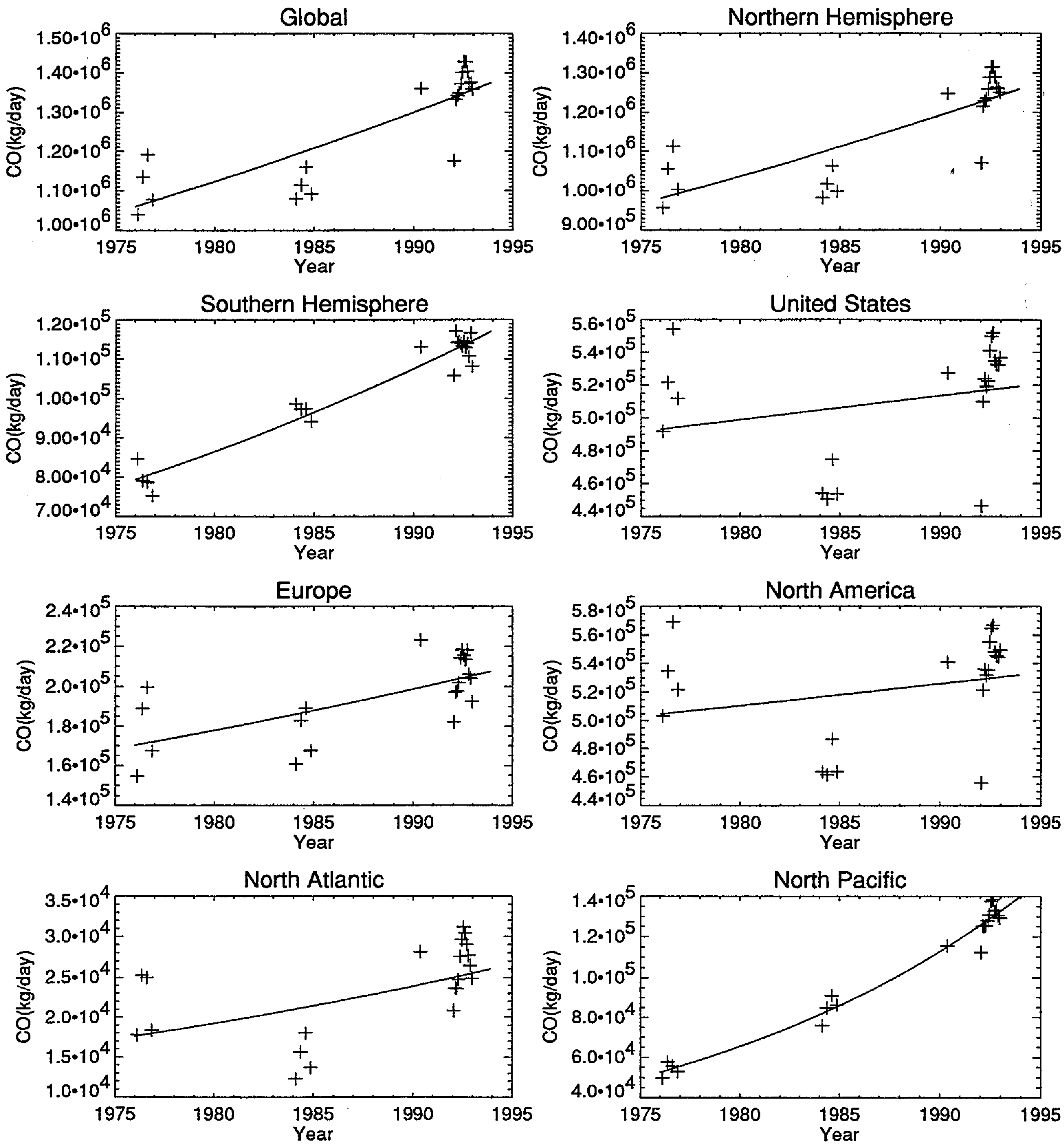

Figure 4-6. Calculated CO emissions as a function of year for the time period 1976-1992 in the 0-22 kilometer altitude band. The solid line is the fit to an exponential growth curve.

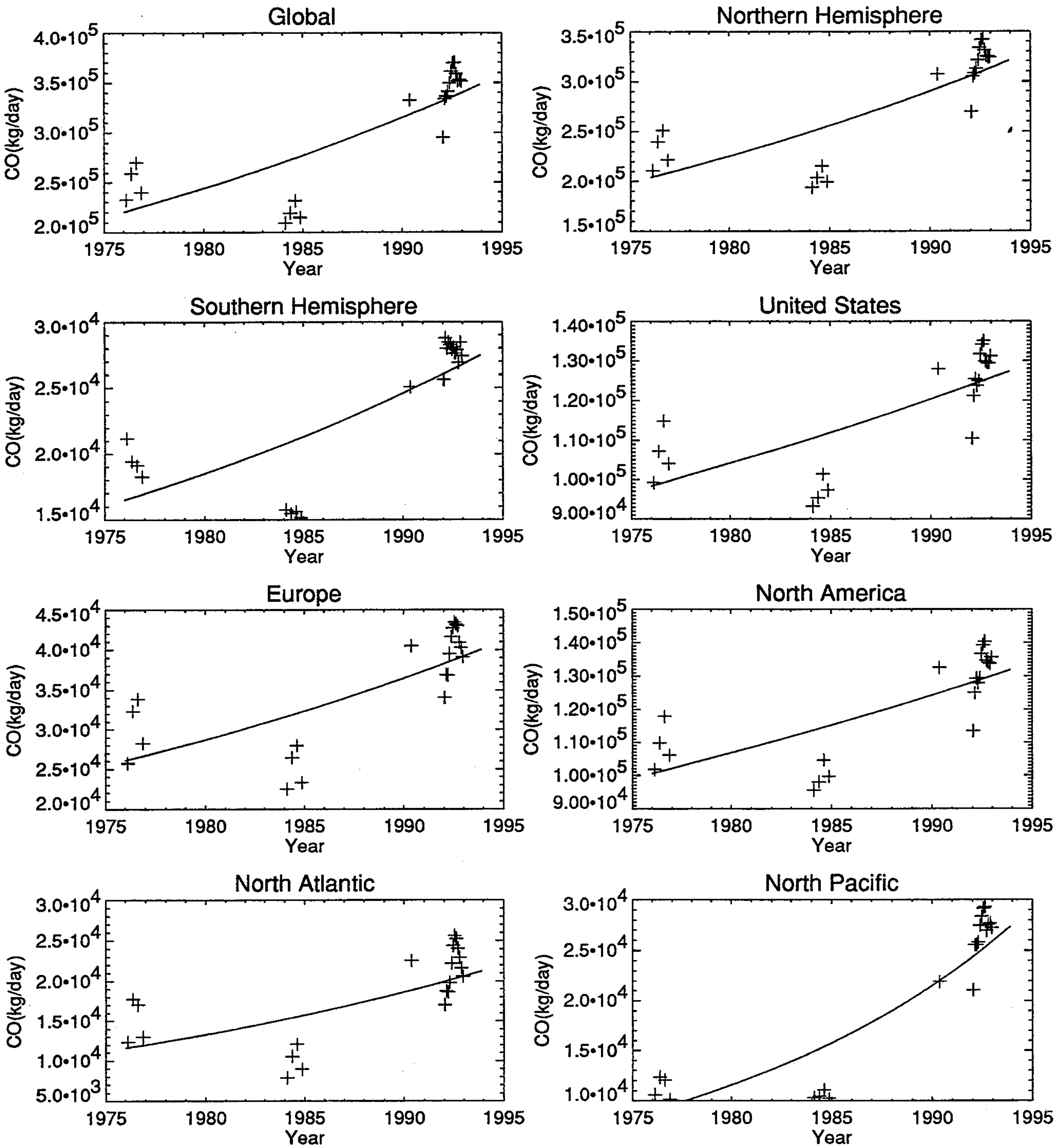

Figure 4-7. Calculated CO emissions as a function of year for the time period 1976-1992 in the 9-13 kilometer altitude band. The solid line is the fit to an exponential growth curve.

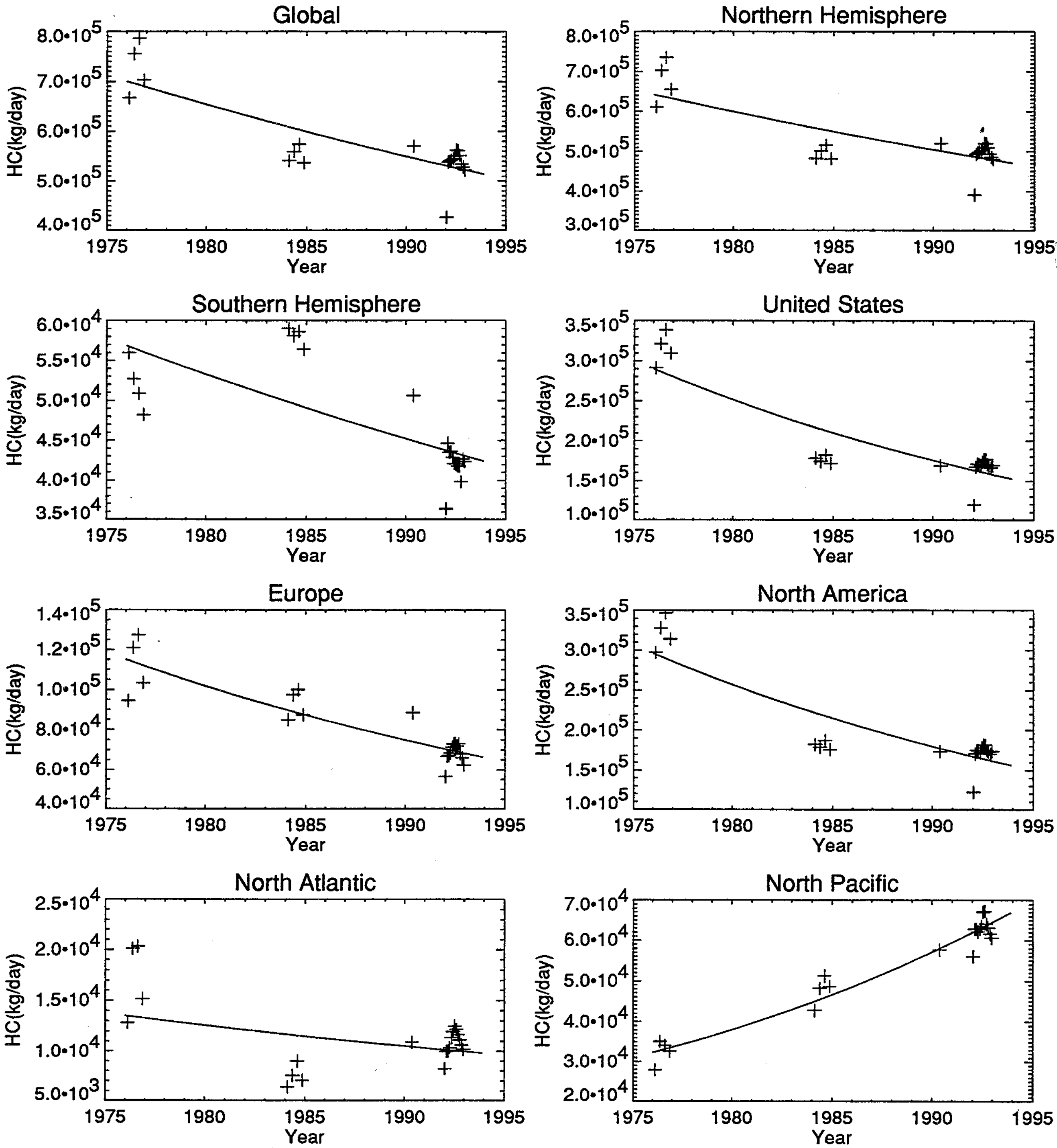

Figure 4-8. Calculated hydrocarbon emissions as a function of year for the time period 1976-1992 in the 0-22 kilometer altitude band. The solid line is the fit to an exponential growth curve.

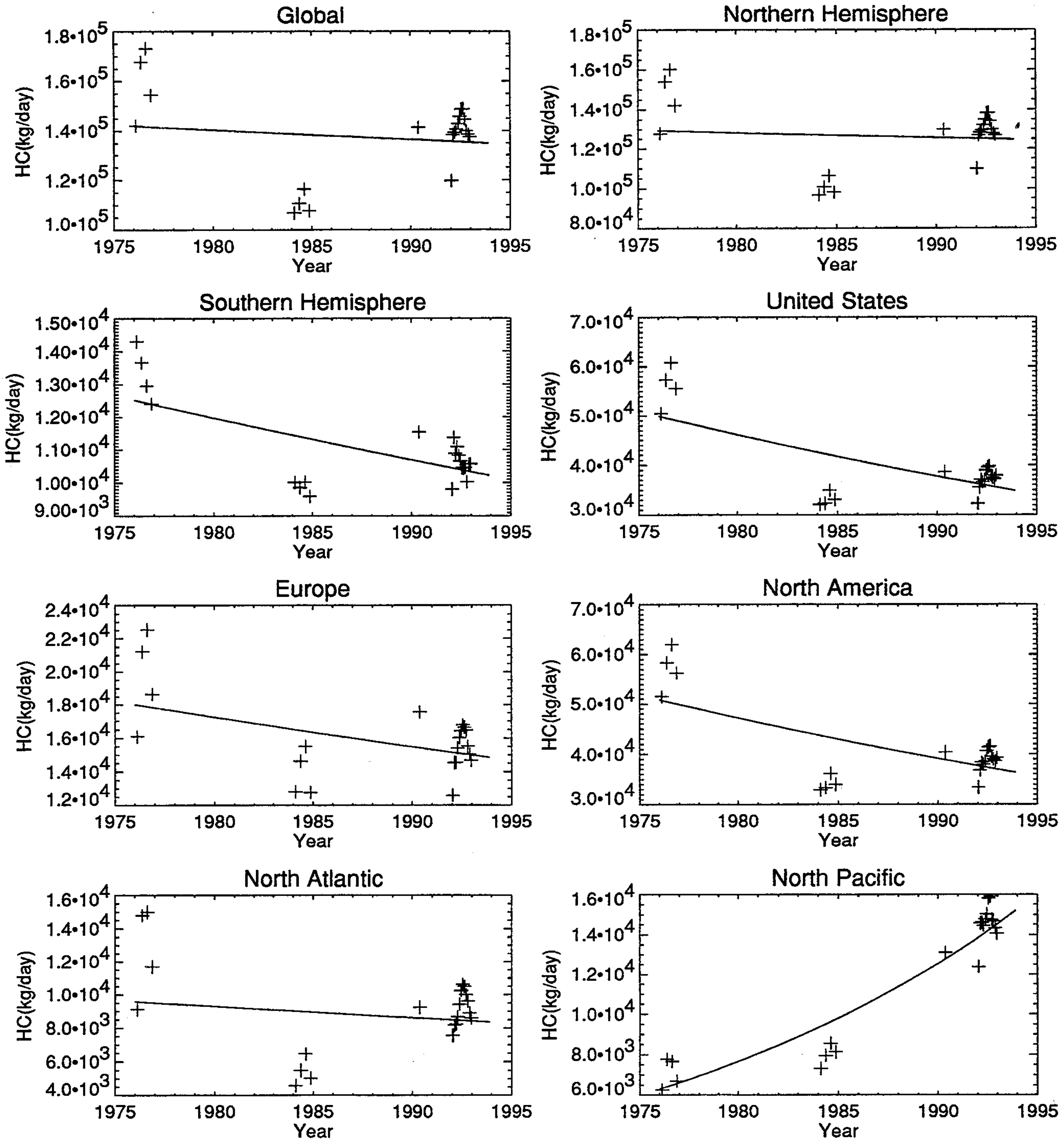

Figure 4-9. Calculated hydrocarbon emissions as a function of year for the time period 1976-1992 in the 9-13 kilometer altitude band. The solid line is the fit to an exponential growth curve.

4.5 Trend in Calculated Effective Fleet Emission Indices

Effective emission indices for NOx are plotted in Figure 4-10 for the 0-22 kilometer altitude band and in Figure 4-11 for the 9-13 kilometer band. Although not extremely well represented by exponential growth functions, the effective fleet EI(NOx) integrated over all altitudes (see Table 4-7) and at cruise altitudes (see Table 4-8) has been increasing at about 1%/year over the 1976-92 time period.

Table 4-7. Calculated annual growth rate in EI(NOx) over the 1976-1992 time period for scheduled air traffic.

Region	Annual Rate of Increase	Standard Deviation	Correlation Coefficient
Global	1.0%	0.1%	0.96
Northern Hemisphere	1.0%	0.1%	0.96
Southern Hemisphere	1.4%	0.1%	0.94
Continental United States	0.7%	0.0%	0.99
Europe	1.2%	0.1%	0.96
North America	0.7%	0.0%	0.99
North Atlantic	1.3%	0.1%	0.83
North Pacific	0.8%	0.1%	0.81

Table 4-8. Calculated annual growth rate in EI(NOx) over the 1976-1992 time period for scheduled air traffic in the 9-13 kilometer altitude band.

Region	Annual Rate of Increase	Standard Deviation	Correlation Coefficient
Global	1.4%	0.1%	0.94
Northern Hemisphere	1.3%	0.1%	0.94
Southern Hemisphere	1.8%	0.1%	0.92
Continental United States	1.0%	0.0%	0.98
Europe	1.4%	0.1%	0.91
North America	1.0%	0.0%	0.98
North Atlantic	1.3%	0.1%	0.84
North Pacific	0.8%	0.1%	0.91

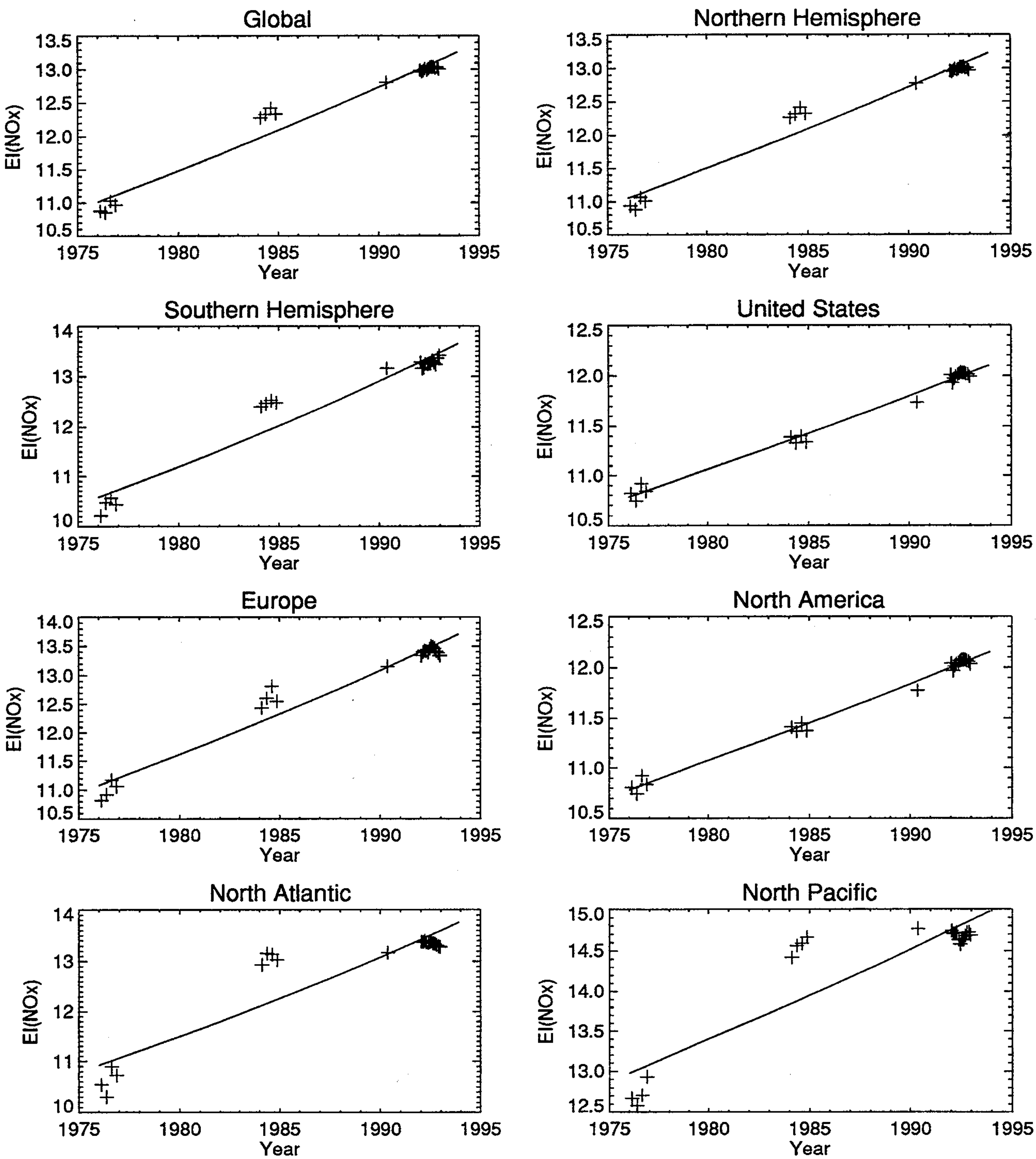

Figure 4-10. Effective EI(NOx) as a function of year for the time period 1976-92 in the 0-22 kilometer altitude band for scheduled air traffic. The solid line is the fit to an exponential growth curve.

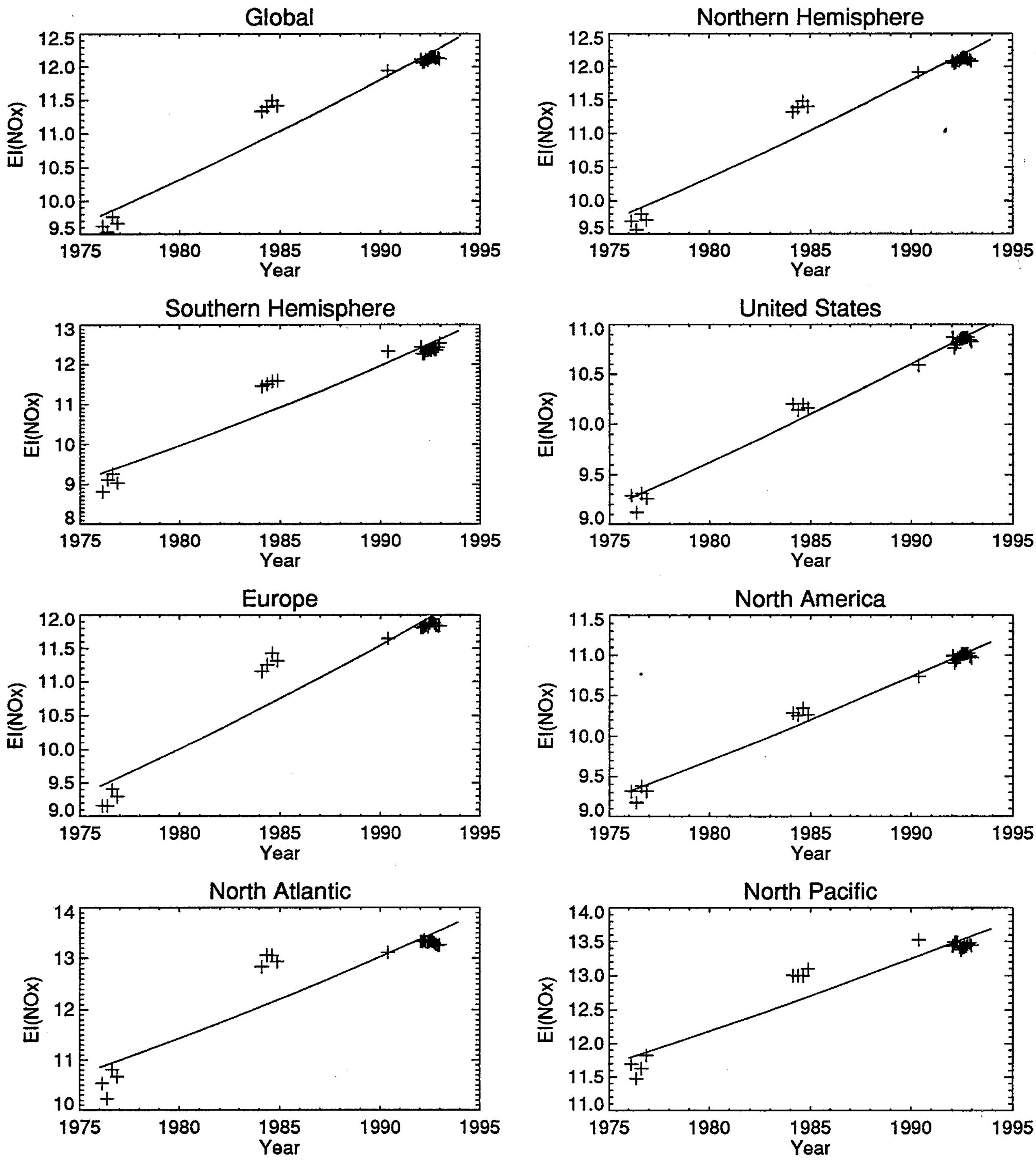

Figure 4-11. Effective EI(NOx) as a function of year for the time period 1976-92 in the 9-13 kilometer altitude band for scheduled air traffic. The solid line is the fit to an exponential growth curve.

In contrast to the trend for EI(NOx), the effective emission index for carbon monoxide has decreased over the 1976-92 time period. These results are illustrated in Figure 4-12 (integrated over all altitudes) and Figure 4-13 (for the 9-13 kilometer altitude). The solid lines in the figures are a result of an exponential fit and are intended only to aid in visualizing the data. Over this time period, the global effective EI(CO) has decreased at about 3%/year. For the 9-13 kilometer band, most of this decrease occurred between 1976 and 1984.

The effective emission index for hydrocarbons has also decreased over the 1976-92 time period. Figures 4-14 and 4-15 show the results integrated over all altitudes and for the 9-13 kilometer band, respectively. As with CO, most of this decrease occurred in the 1976 to 1984 time period during which the global effective EI(HC) dropped by half.

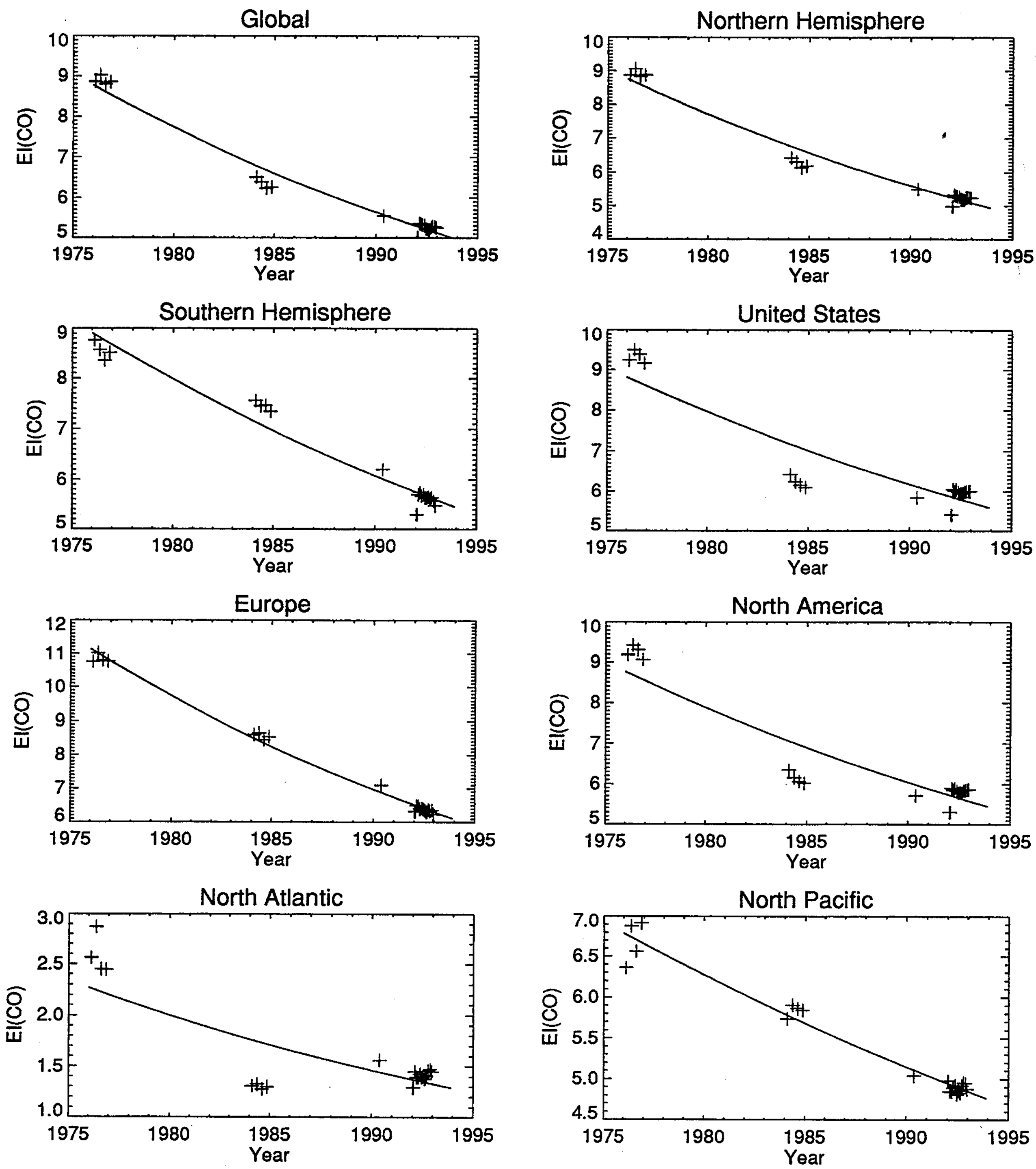

Figure 4-12. Effective EI(CO) as a function of year for the time period 1976-92 in the 0-22 kilometer altitude band for scheduled air traffic. The solid line is the fit to an exponential growth curve.

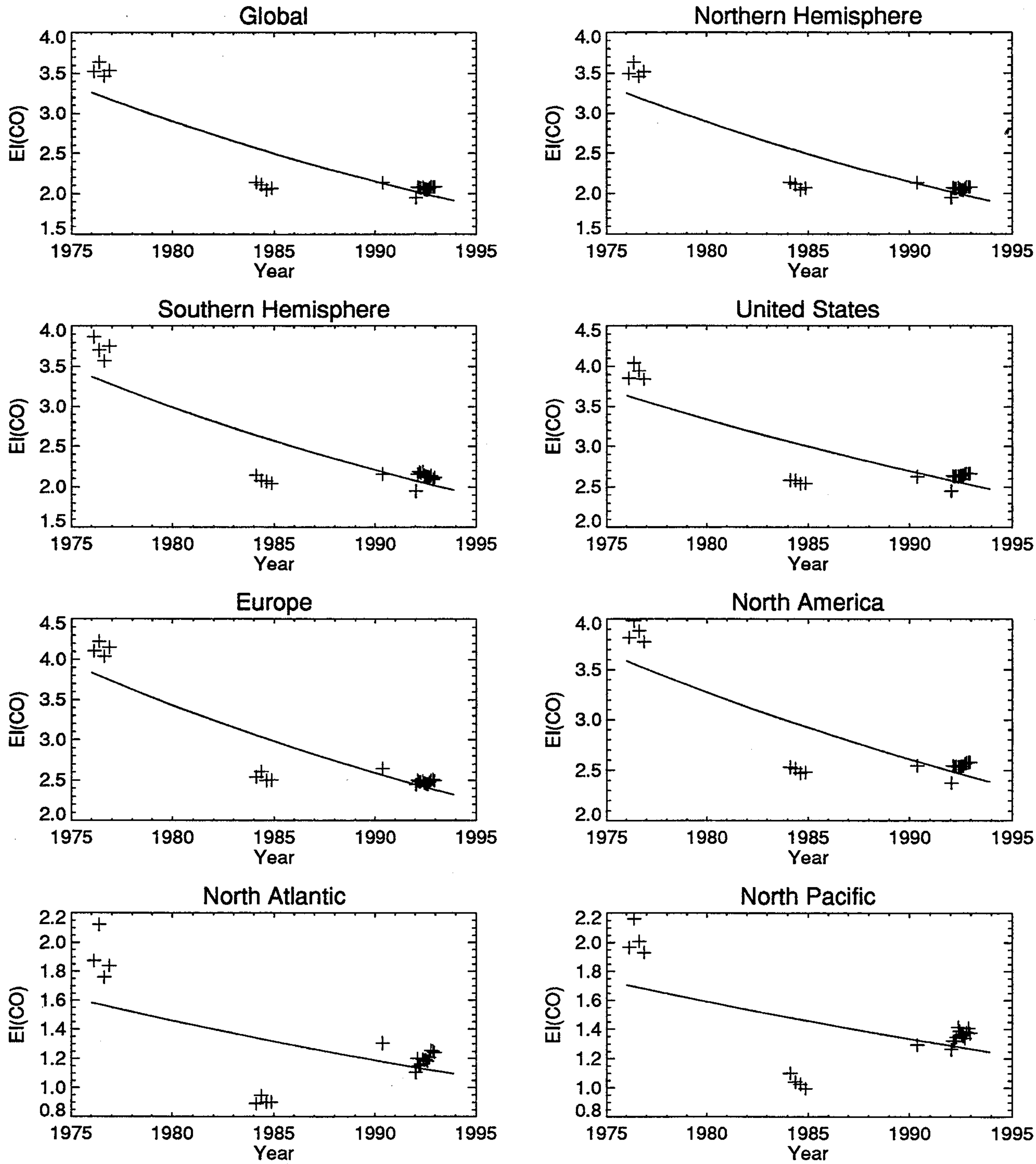

Figure 4-13. Effective EI(CO) as a function of year for the time period 1976-92 in the 9-13 kilometer altitude band for scheduled air traffic. The solid line is the fit to an exponential growth curve.

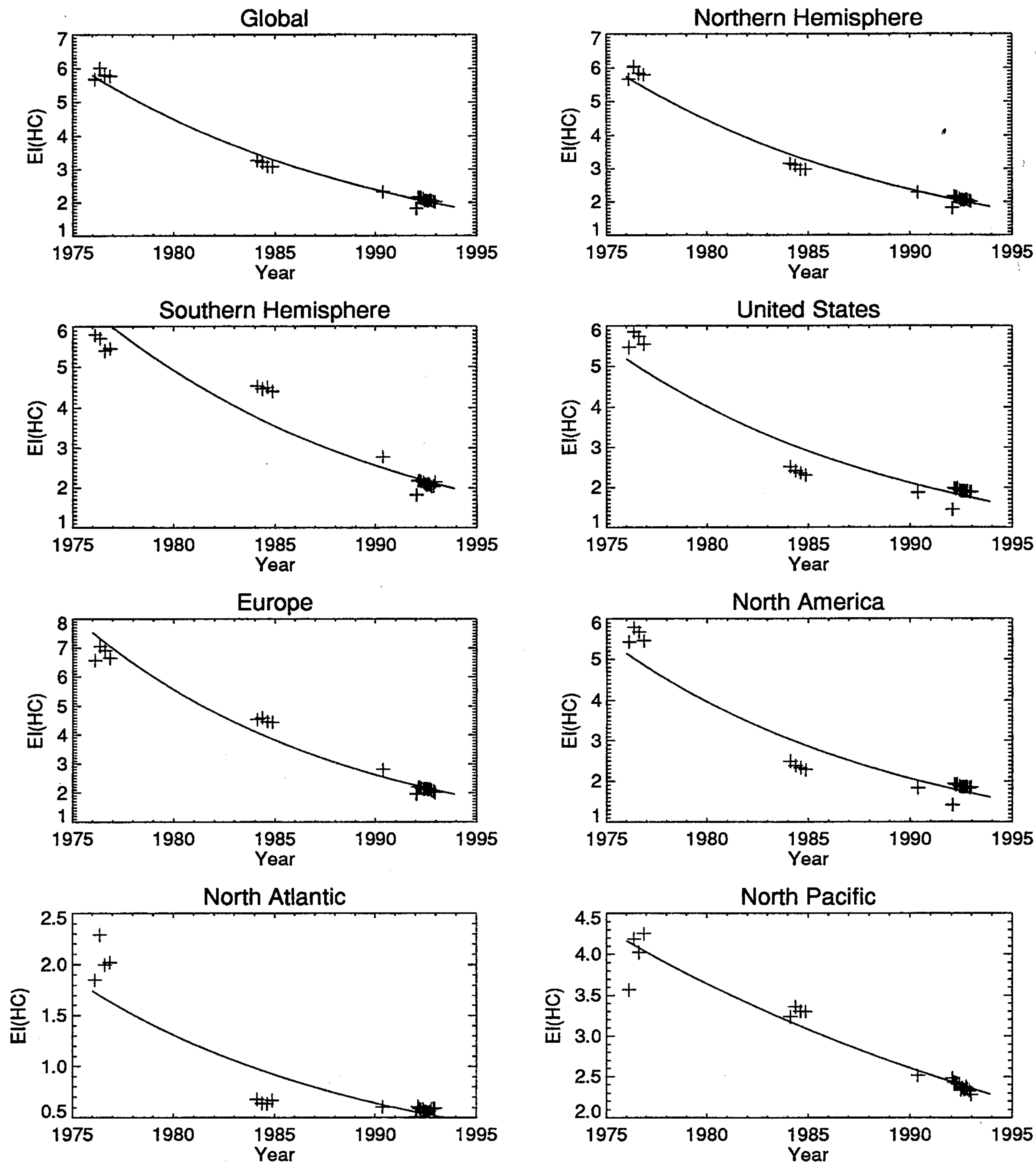

Figure 4-14. Effective EI(HC) as a function of year for the time period 1976-92 in the 0-22 kilometer altitude band for scheduled air traffic. The solid line is the fit to an exponential growth curve.

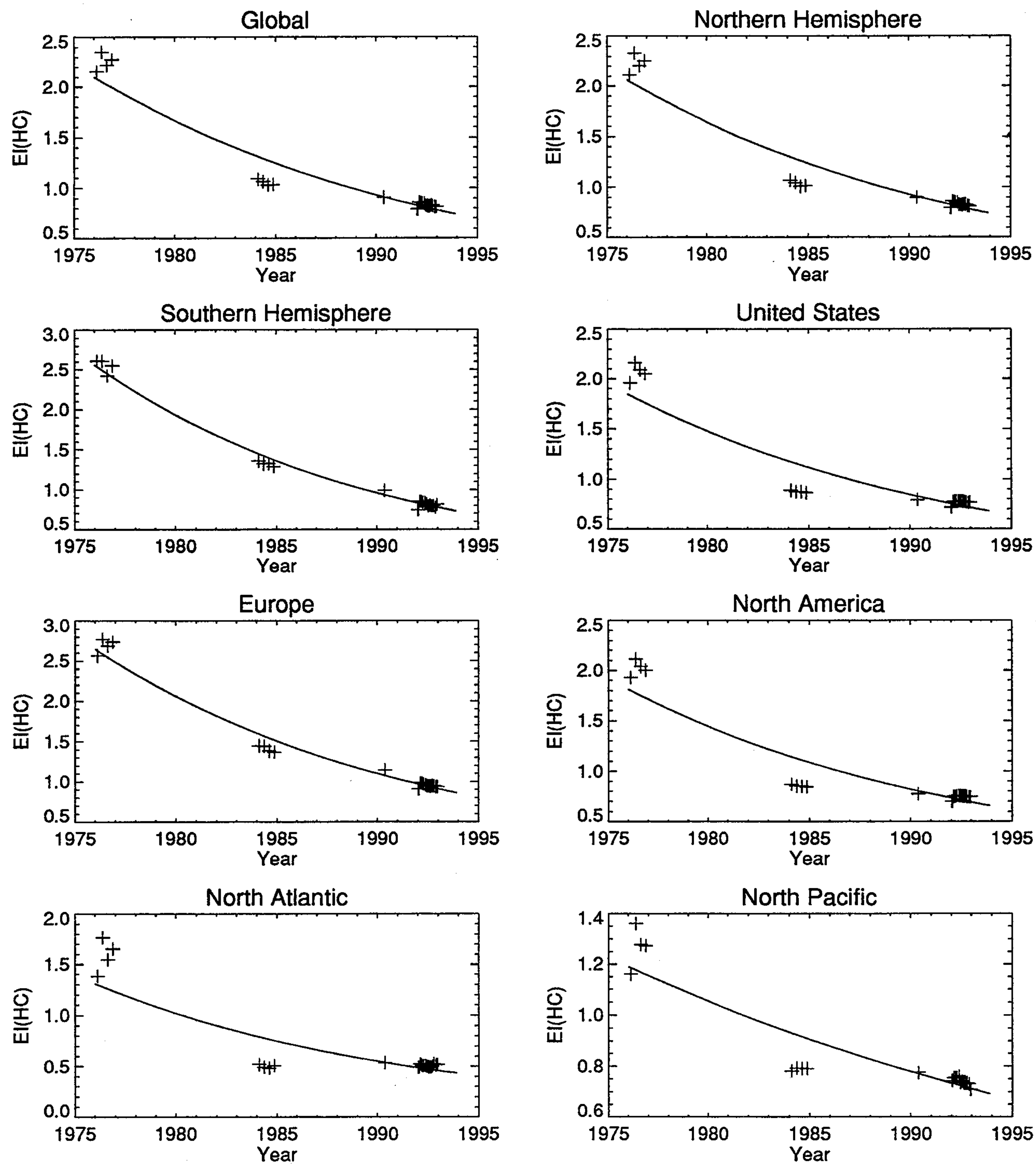

Figure 4-15. Effective EI(HC) as a function of year for the time period 1976-92 in the 9-13 kilometer altitude band for scheduled air traffic. The solid line is the fit to an exponential growth curve.

4.6 RPM Trend

The trend analysis described above for emissions used the available emission inventory data and thus was limited to using data for 1976, 1984, 1990, and 1992. More complete data on revenue passenger miles (RPMs) is compiled annually as part of industry marketing and forecasting research. The most recent Boeing Current Market Outlook document (Boeing, 1995) contains a compilation of RPMs for a number of traffic flow regions for the time period 1970 to 1994, with projections to future years.

To evaluate whether the trends calculated from the emissions data are representative of air traffic over a wider time frame, the RPM data for the 1970-1994 time frame was analyzed. Figure 4-16 shows the annual RPMs as a function of year for selected traffic flow regions. In addition to the data points for each year, the results of a fit to an exponential growth function has been superimposed as a solid line. This fit was obtained by a linear least squares fit of the RPM data considering only the 1976-92 time period to be consistent with the fitting process used for the calculated emissions data. The comparison between the RPM and emission inventory data is difficult because the RPM data is for traffic flow within or between regions while the emissions data is the sum of emissions deposited within a specific geographical region.

Figure 4-16 shows that in general, air traffic has increased exponentially over this time period although there are fluctuations due to economic and political factors. For example, world domestic air traffic peaked in 1989 and has remained fairly constant through 1994. Similarly, growth of domestic air traffic in the United States has been slower in the 90's than in earlier decades. Air traffic between North America and Asia has not grown as rapidly in recent years as the analysis of 1976-92 data would have projected.

The results of the fit for selected traffic regions are shown in Table 4-9. During the 1976-92 time period, domestic RPMs grew at an annual rate of 5.1%/year while international traffic grew at 6.1%/year. The total world air traffic grew at 5.6%/year.

The most dramatic growth is in Asia where the growth rate exceeded 11%/year over this time period. In the United States and Europe, growth was about 5.4%/year.

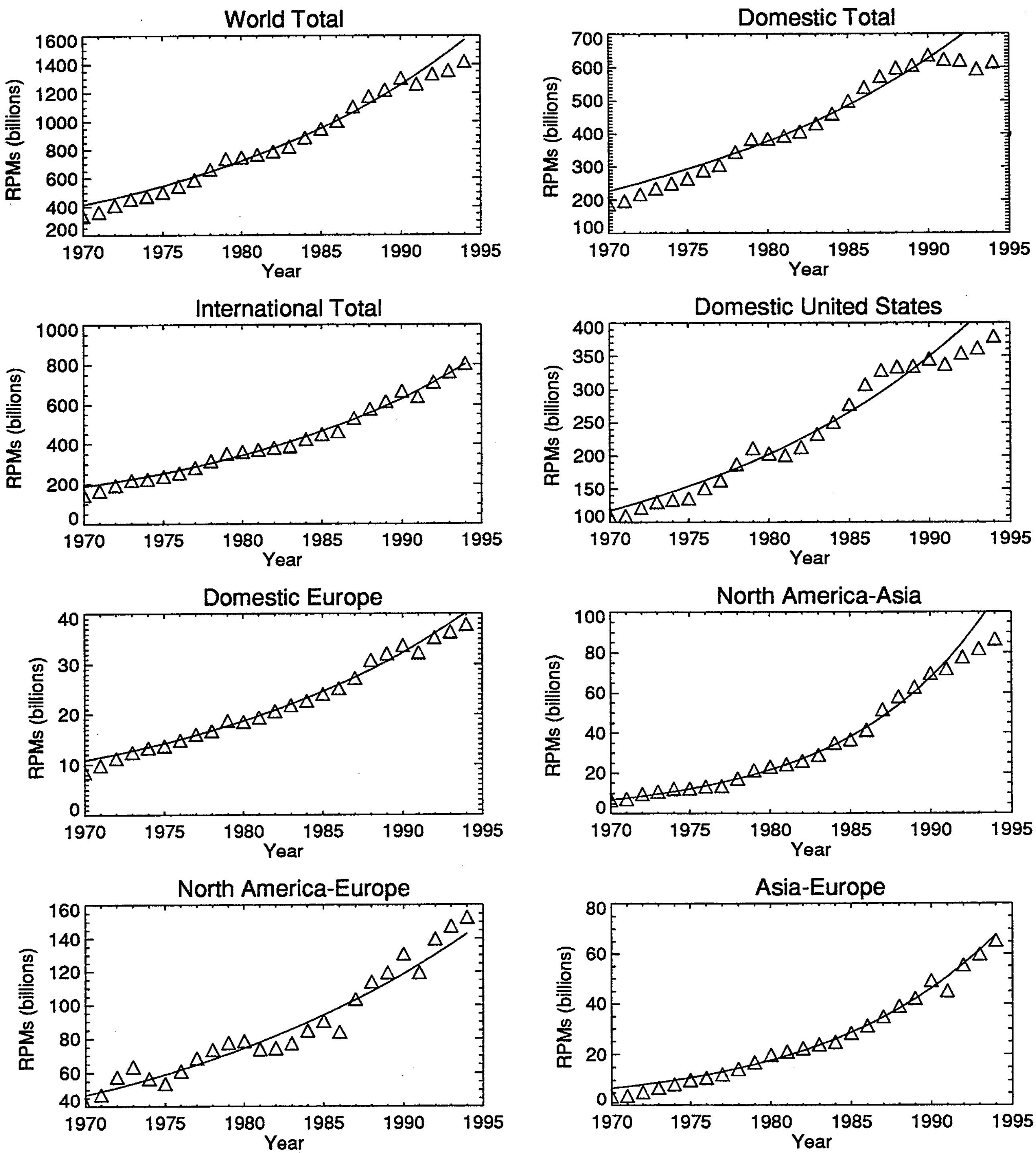

Figure 4-16. Revenue passenger miles (RPMs) plotted as a function of year for some of the major traffic flow regions. The smooth line is the result of a fit to an exponential growth function using the data for 1976-1992 and is intended to help visualize the data.

Table 4-9. Average annual growth rates (1976-92) for RPMs for selected traffic regions.

Region	Average Annual Rate of Growth (1976-1992)	Standard Deviation	Correlation Coefficient
Domestic CIS	3.2%	0.4%	0.77
Domestic United States	5.4%	0.3%	0.95
Domestic Europe	5.5%	0.2%	0.99
Domestic Asia	8.3%	0.3%	0.98
Domestic Japan	5.6%	0.4%	0.93
Domestic China	21.0%	0.9%	0.97
Domestic Total	5.1%	0.3%	0.96
International:			
CIS International	5.3%	0.4%	0.92
Intra North America	4.0%	0.2%	0.95
North America-Asia	11.4%	0.3%	0.99
North America-Europe	4.7%	0.4%	0.90
Intra Asia	11.2%	0.7%	0.95
Intra Europe	5.3%	0.3%	0.94
International Total	6.1%	0.2%	0.98
World Total	5.6%	0.2%	0.98

As Figure 4-17 illustrates, some regions have not shown the monotonic increase in RPMs exhibited by the major markets.* For example, although international traffic in the CIS (former Soviet Union) has increased with time, domestic traffic in the CIS has dropped precipitously after 1990. In other markets (e.g., domestic middle east and Latin America), there has been relatively little growth since the mid-80s.

Appendix P contains a table of world traffic for each year of the 1970-94 time period and plots of the RPMs for each of the traffic flow regions.

* Note that the lines plotted in Figure 4-17 are the result of the exponential growth fit and are shown here for visualization only. Clearly in many cases, this fit is a poor representation of the data.

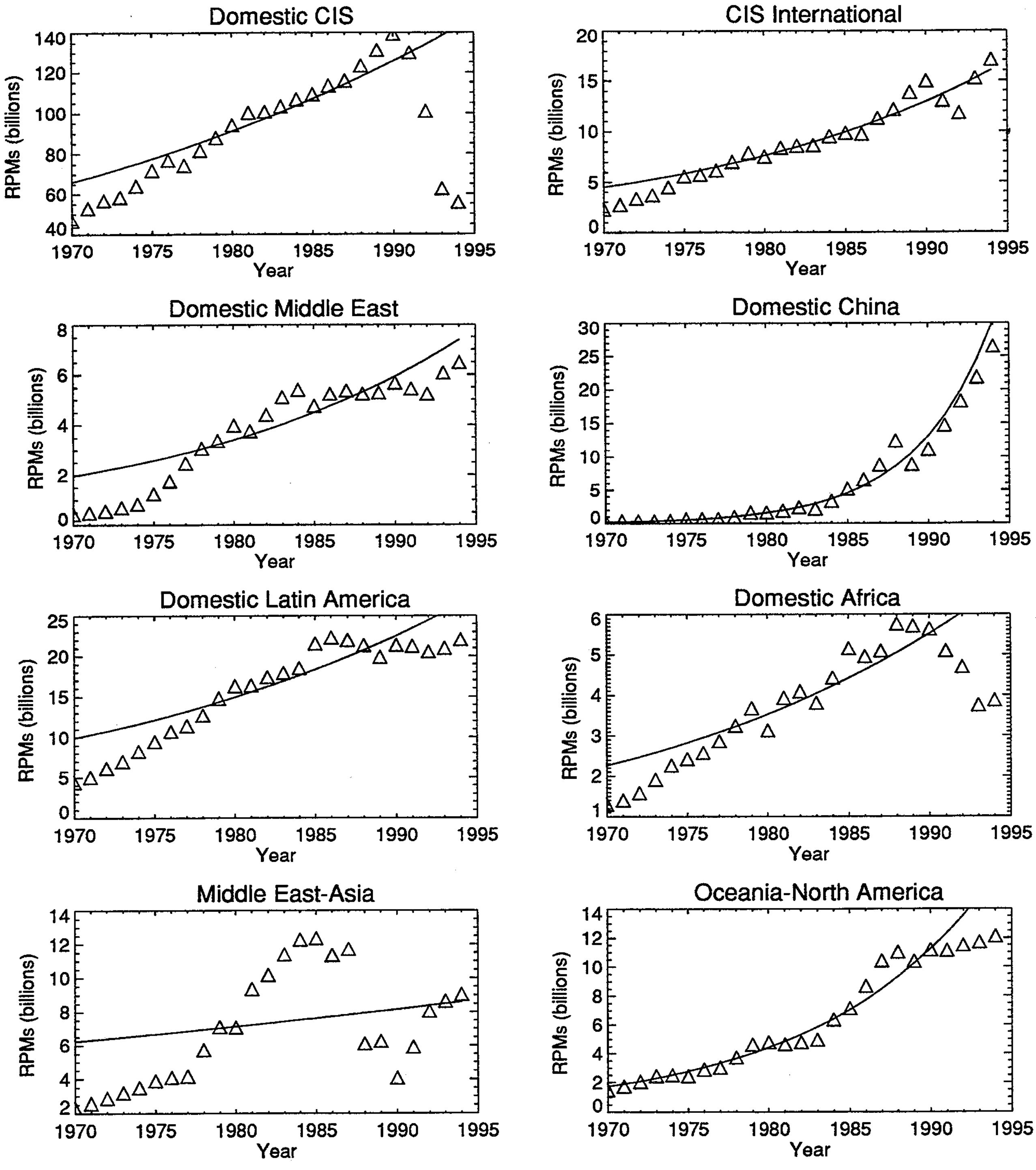

Figure 4-17. Revenue passenger miles (RPMs) plotted as a function of year for selected traffic flow regions. The smooth line is the result of a fit to an exponential growth function using the data for 1976-1992 and is intended to help visualize the data. For some regions, the traffic clearly does not exhibit exponential growth.

4.7 Discussion

In general, it is difficult to compare the geographical regions of the 3-dimensional emission inventories with the traffic flow data since a significant fraction of the mission fuel consumption occurs near the originating airports during the landing/takeoff cycle. Table 4-10 summarizes the global results and compares flights in the North Atlantic and North Pacific. As it shows, the increase in calculated fuel and NOx is roughly comparable to the rate of RPM increase. Since newer technology aircraft are more efficient than older aircraft this is somewhat surprising at first glance. To examine this, the fleet inventories have been examined to see how they have evolved with time.

Table 4-10. Average annual rate of increase over the 1976-92 time period.

Region	RPM	Calculated fuel use	Calculated NOx emissions
Global	5.6 % ± 0.2 %	4.6 % ± 0.2%	5.7 % ± 0.2 %
North America - Europe	4.7 % ± 0.4 %	5.3 % ± 0.5 %	6.6 % ± 0.5 %
North America - Asia	11.4 % ± 0.3 %	7.4 % ± 0.2 %	8.2 % ± 0.2 %

* Error bars = 1 standard deviation

Figures 4-18 thru 4-22 show the fleet size as a function of year for the different aircraft manufactured by Boeing (Figure 4-18), McDonnell Douglas (Figure 4-19), Airbus (Figure 4-20), others (Figure 4-21) and old aircraft (Figure 4-22).* As the figures show, with the exception of the very old aircraft (see Figure 4-22) the fleet sizes have been growing steadily over the the 1970 to 1992 time period. In most cases, the introduction of new, more-efficient aircraft has been in addition to the existing fleet rather than displacing older, less-efficient aircraft.

The OAG database, from which all flight information was extracted, does not always designate which particular model within a given airplane type is used on a flight. For instance, the OAG will list 747 flight equipment as 747, 747PAX, 7473, and 7474. In general, the 747 and 747PAX designations refer to either 747-100 or 747-200's. If the airline has both 747-100's and 747-200's, we assumed that all flights designated by 747 or 747PAX were flown by the airplane model which formed the majority of the airline's characteristics. This assumption has introduced difficult-to-quantify uncertainties in the trend analysis. (The 1984 inventory used only 747-100 and 747-300 models, since the -100 formed the majority of airplanes in the fleets of each of the 747 operators, and the -300 model was designated separately in the OAG. The 1992 inventory used the 747-100, -200, -300, and -400 since the -200 model now formed the majority in the fleets of some 747 operators, and both the -300 and -400 models were designated separately.)

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* Fleet inventory data were obtained from C. R. Francoeur, Jet Information Services, Inc., 18711 198th Avenue NE, Woodinville, WA 98072-8840.

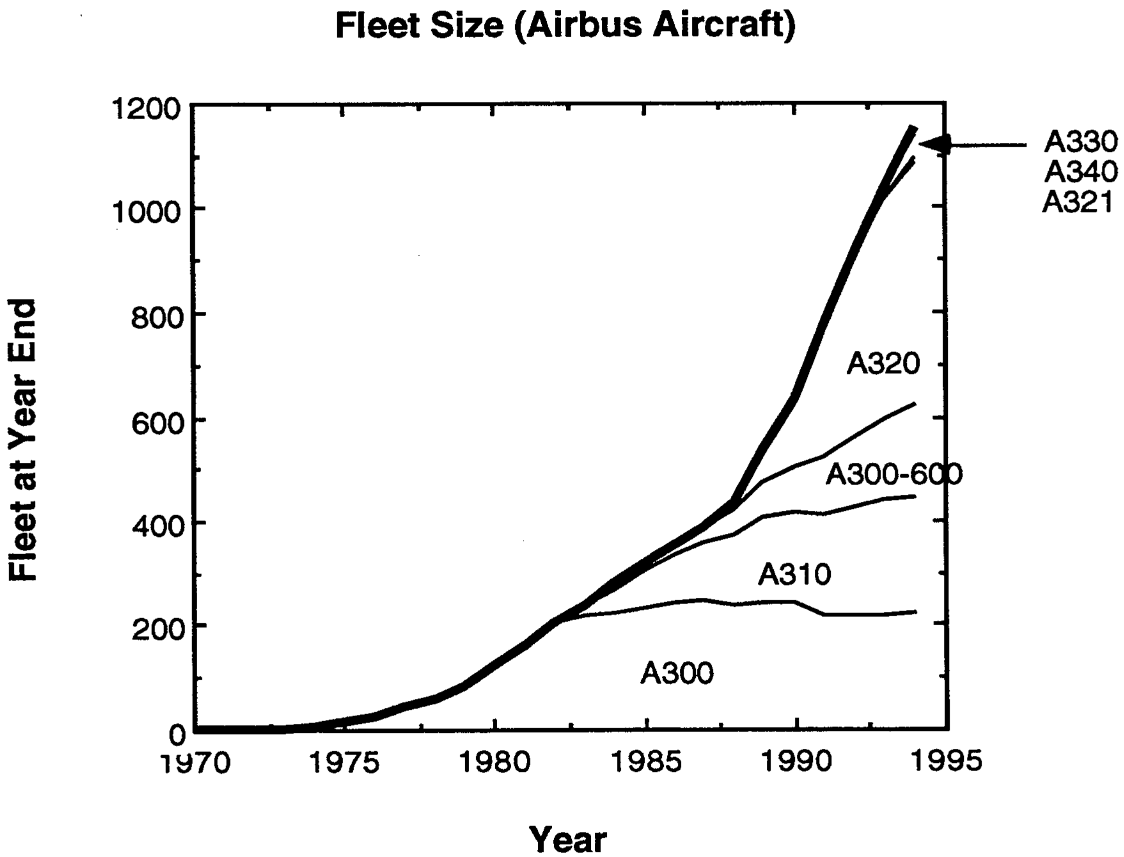

Figure 4-20. Number of aircraft manufactured by Airbus in the commercial fleet as a function of year.

Fleet Size (Other Aircraft)

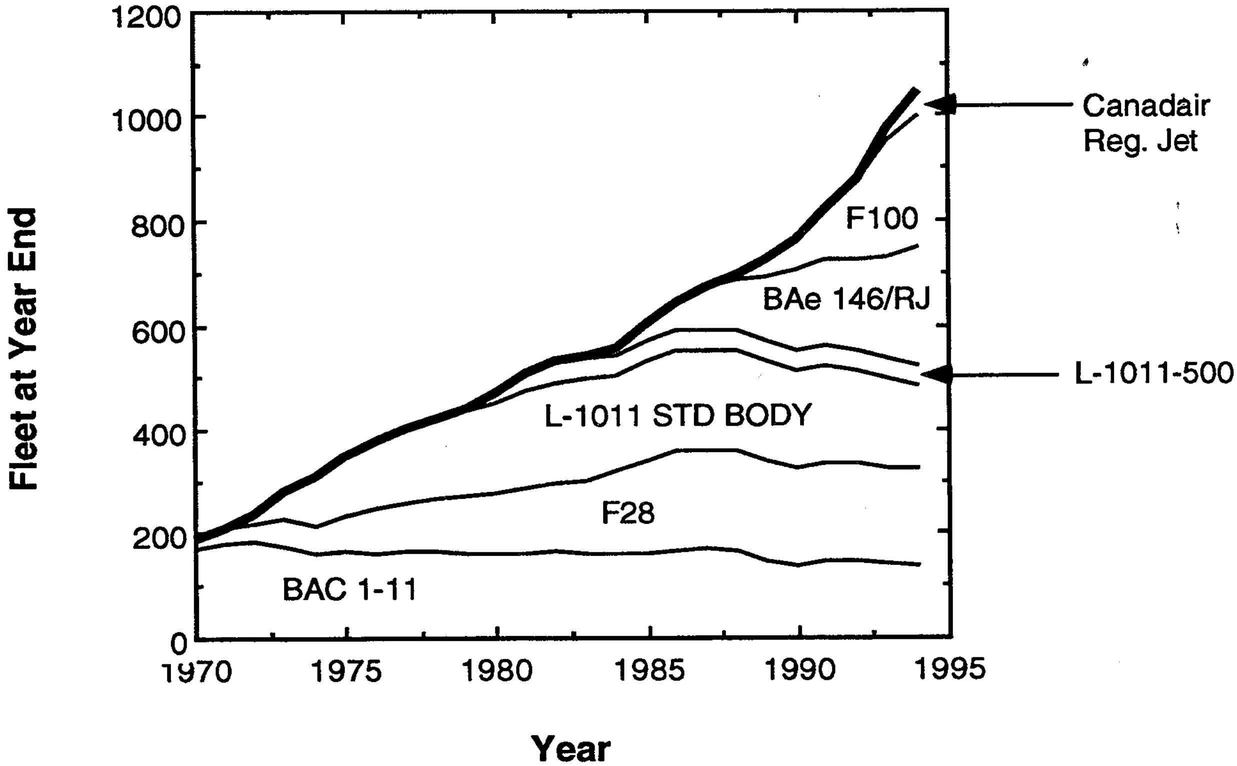

Figure 4-21. Number of aircraft manufactured by other aircraft manufacturers (not Boeing, Airbus, or McDonnell Douglas) in the commercial fleet as a function of year.

More work is planned to try to evaluate the uncertainties of the emission inventory. One concern is that our assumption that aircraft fly great circle routes according to design performance may lead to larger errors in 1976 and 1984 than in 1992 and thus skew the trend analysis. Air traffic control is more efficient now than in the 1970s. Aircraft in the U.S. now hold on the ground rather than circling over major airports as was common in the 70s. Better meteorological data, better air traffic control, and the need to minimize fuel use by the airlines suggest that the overall system efficiency may have improved over the 1976 to 1992 time period.

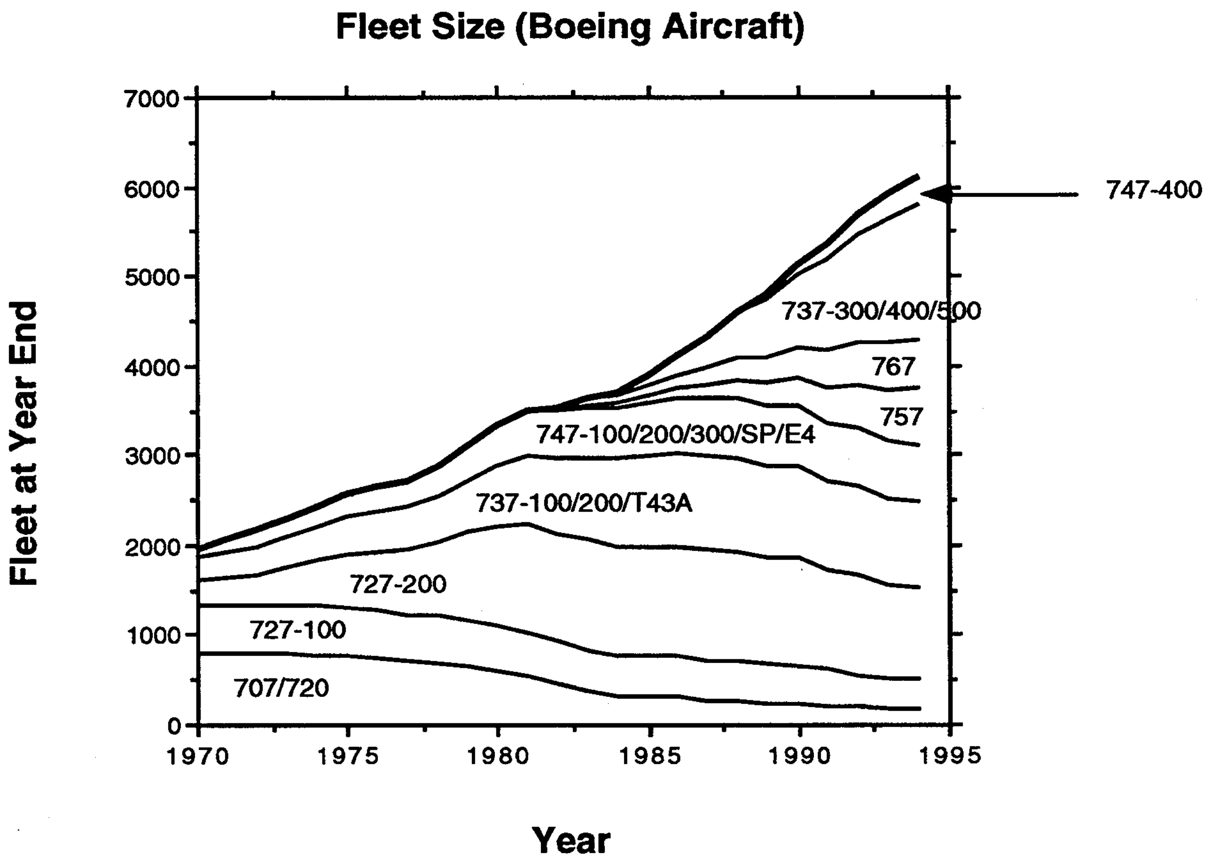

Figure 4-18. Number of aircraft manufactured by Boeing in the commercial fleet as a function of year.

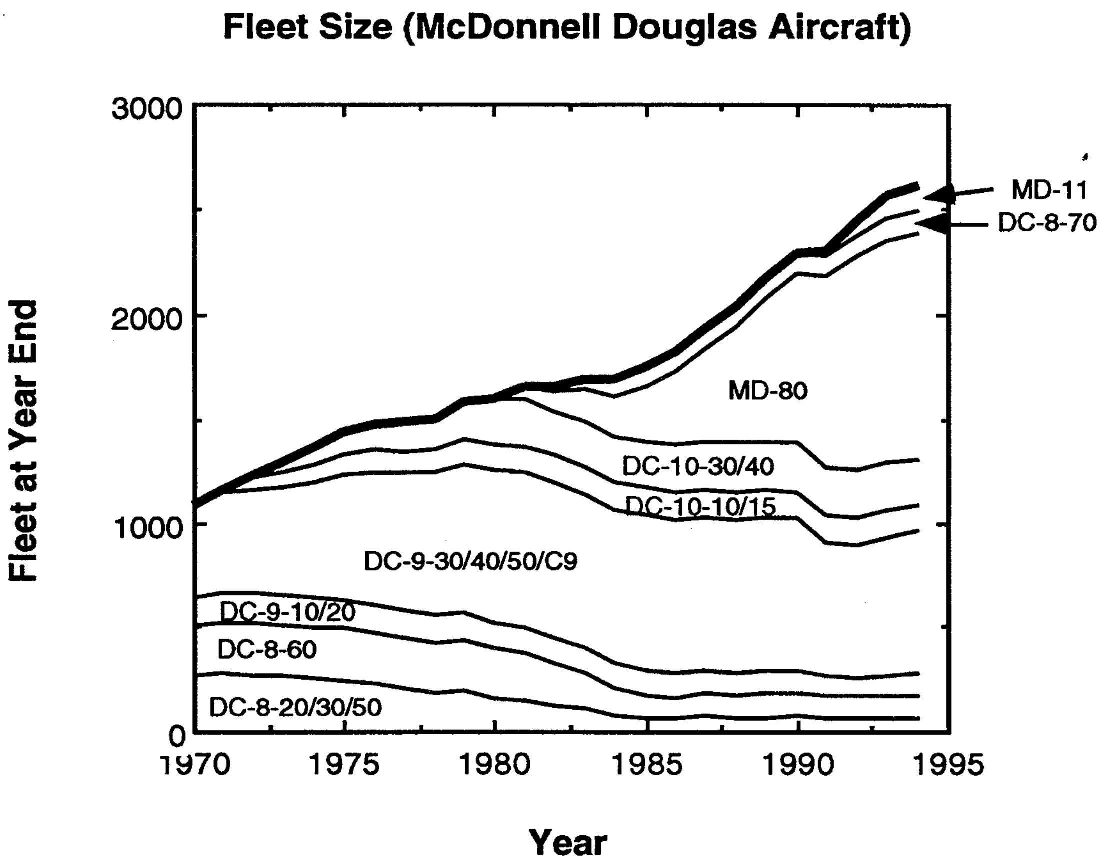

Figure 4-19. Number of aircraft manufactured by McDonnell Douglas in the commercial fleet as a function of year.

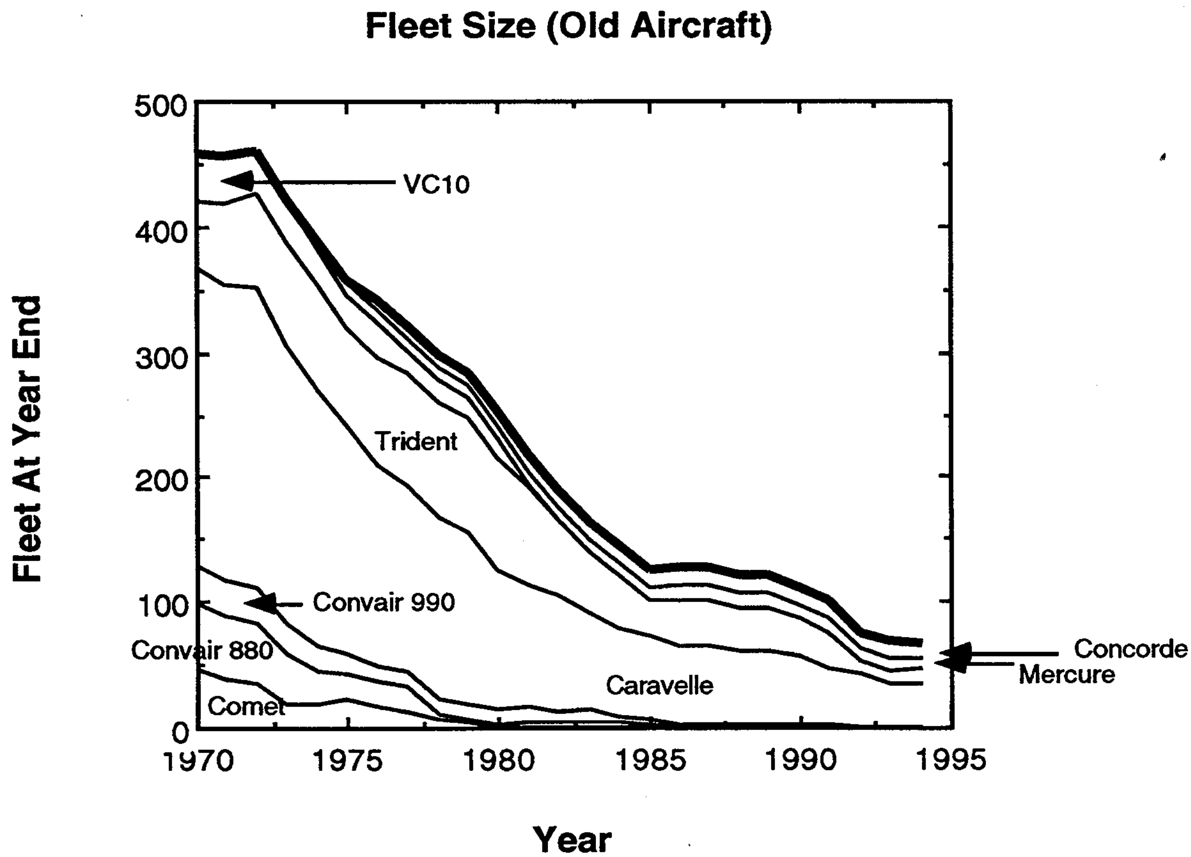

Figure 4-22. Older aircraft in the commercial fleet as a function of year.

5. Sulfur Emissions

Jet fuel includes sulfur-containing compounds which are oxidized in the combustor to produce sulfur oxides (SOx). In the past, it was assumed that these oxides were emitted as sulfur dioxide (SO_2) which were further oxidized in the atmosphere to form sulfuric acid. Recent measurements behind the Concorde [Fahey, *et. al.*; 1995] suggest that this conversion may occur to some extent within the engine or in the near-field plume producing many small condensation nuclei. This has raised interest in the the three-dimensional distribution of sulfur emissions from aircraft.

Since sulfur emissions are a property of the jet fuel, to first order the 3-dimensional distributions of SOx can be estimated from the average sulfur content of jet fuel. Hadaller and Momenthy [1989] have measured sulfur in a number of jet fuel samples taken worldwide. They obtained a mean value of 0.042% by weight with 90% of the samples below 0.1%. This is equivalent to an $EI(SO_x)$=0.8 grams SO_x (as SO_2)/kilogram fuel burned. Projections by Hadaller and Momenthy [1993] are that the sulfur content of jet fuel will continue to decrease in the future to a value of about 0.02% by the year 2015. This is equivalent to $EI(SO_x)$=0.4 grams SO_x (as SO_2)/kilogram fuel burned.

Sulfur content of jet fuel varies regionally depending both on the sulfur content of the crude oil and on the technology being used at the refinery. The use of hydrotreating at the refinery also lowers the sulfur content of the jet fuel produced. Both the crude oil characteristics and the refinery technology change with time. We are aware of no data which can be used to estimate the historical trend in global aircraft SO_x emissions.

To conduct a true 3-dimensional inventory of aircraft-emitted SO_x would require measurements of sulfur content at the major airports around the world. This would be an expensive process.

If significant oxidation of SO_2 occurs in the engine or in the near field, it will likely be sensitive to the temperature and pressure in the combustor and engine. Thus, the extent to which SO_2 is converted to SO_3 and H_2SO_4 may be sensitive to the aircraft/engine combination being evaluated. Little can be done in this arena until further measurement data on sulfur speciation in aircraft plumes are obtained by other components of the NASA AEAP project.

6. Conclusions

Three-dimensional inventories of fuel burned and emissions (NOx, CO, and hydrocarbons) from scheduled air traffic have been calculated for four months (February, May, August, and November) of 1976 and of 1984. Global fuel use by scheduled air traffic was calculated to be 1.26 x 10^8 kg/day during May 1976 and 1.66 x 10^8 kg/day during May 1984. Global NOx emissions increased from 1.36 x 10^6 kg/day in May 1976 to 2.15 x 10^6 kg/day in May 1984.

Using this data combined with earlier results [Baughcum, *et. al.*; 1996] for May 1990 and for each month of 1992, trends in emissions from scheduled air traffic have been calculated globally and for selected geographical regions. The results show that calculated fuel use by scheduled air traffic increased at a rate of 4.6 %/year over the 1976 to 1992 time period. NOx emissions in the 9-13 kilometer band were calculated to have increased globally at 6.9%/year over that time period. The rate of increase in specific areas depended both on increases in passenger demand and the introduction of new, more efficient aircraft into the fleet.

Global emissions of carbon monoxide decreased in many regions between 1976 and 1984 and then increased between 1984 and 1992. Similarly, hydrocarbon emissions from scheduled air traffic decreased in globally and in most regions analyzed between 1976 and 1992, with the largest drop occurring between 1976 and 1984.

The fleet average effective EI(NOx) was calculated to have increased at about 1%/year over the 1976 to 1992 time period. Over the same time period, the fleet average effective EI(CO) and EI(HC) was calculated to have decreased significantly as more efficient combustors came into service.

An analysis of the trend in revenue passenger miles indicated a growth rate of 5.6%/year which was faster than the average annual rate of increase of calculated fuel consumption.

The inventories of jet fuel burned and emissions (NOx, CO, total hydrocarbons) are on a 1° latitude x 1° longitude x 1 km altitude grid. They will be available by contacting Karen H. Sage (sage@uadp2.larc.nasa.gov) at NASA Langley Research Center or by sending a request to the Atmospheric Sciences Division, NASA Langley Research Center, Hampton, VA 23681-0001.

Technical questions about the emission inventories should be directed to Steven L. Baughcum (baughcum@atc.boeing.com), The Boeing Company, P. O. Box 3707, MS 6H-FC, Seattle, WA 98124.

7. References

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Appendix A. Airplane/Engine Substitution Tables for 1976 Emission Inventory Calculations

OAG	OAG Engine	Performance Airplane	Performance Engine	Emissions Engine
720-000	JT3D	707-320B-C	JT3D-3B	JT3D-3B
727-100	JT8D-7B	727-100	JT8D-7	JT8D-7seriesRedemiss
72C	*	727-100	JT8D-7	JT8D-7seriesRedemiss
72S-200	JT8D-15	727-200	JT8D-15-15A	JT8D-15Redemiss
737-200	JT8D-7B	737-200	JT8D-7	JT8D-7seriesRedemiss
73C-200C	JT8D-9A	737-200ADV	JT8D-9-9A	JT8D-9seriesRedemiss
747-100	JT9D-7A	747-100-200	JT9D-7A	JT9D-7A
748	MDTURB	MDTURB	PW120	PW120
74C-100F	JT9D-7A	747-100-200	JT9D-7A	JT9D-7A
74P-SP	JT9D-7A	747SP	JT9D-7A	JT9D-7A
880-22	GE_CJ805-3	707-320B-C	JT3D-3B	JT3D-3B
A12	MDTURB	MDTURB	PW120	PW120
A24	SMTURB	SMTURB	PT6A	PT6A
A30B2-100	CF6-50C2R	A300-B2-B4	CF6-50C2	CF6-50C2R
A3B	*	A300-B2-B4	CF6-50C2	CF6-50C1,-C2
AC6	*	SMTURB	PT6A	PT6A
AN1	*	LGTURB	PW125B	PW125B
AN4	LGTURB	LGTURB	PW125B	PW125B
ARG	LGTURB	LGTURB	PW125B	PW125B
B2F-000B	JT3D-3B	707-320B-C	JT3D-3B	JT3D-3B
B3C-320C	JT3D-3B	707-320B-C	JT3D-3B	JT3D-3B
B3F-320B	JT3D	707-320B-C	JT3D-3B	JT3D-3B
B3J	*	707-320B-C	JT3D-3B	JT3D-3B
B99	SMTURB	SMTURB	PT6A	PT6A
BAC-200	RR_SPEY-506	BAC111-500	MK512-14	SPEYMk511
BE9	SMTURB	SMTURB	PT6A	PT6A
BET	*	SMTURB	PT6A	PT6A
BRT	*	LGTURB	PW125B	PW125B
BTP	SMTURB	SMTURB	PT6A	PT6A
C44	*	LGTURB	PW125B	PW125B
CL4	LGTURB	LGTURB	PW125B	PW125B
CM4	*	707-320B-C	JT3D-3B	JT3D-3B
CMT-4C	*	720	JT3C-7	JT3C
CON-101	*	Concorde	OLYMPUS-593-610	OLYMPUS-593-610
CV5	LGTURB	LGTURB	PW125B	PW125B
CV6	LGTURB	LGTURB	PW125B	PW125B
CVL-3	*	CARAVELLE-10B	JT8D-1	JT8D-11
CVS	*	CARAVELLE-10B	JT8D-1	JT8D-7seriesRedemiss
D10-10	CF6-6D	DC-10-30	CF6-50C2	CF6-50C1,-C2
D8C-32F	JT4A	DC-8-21-31-33	JT4A-9	JT4A
D8F-51	JT3D	DC8-55-55CF	JT3D-3B	JT3D-3B
D8S-61	CFM56-2C	DC-8-71-71CF	CFM56-1B	CFM56-2-C5
D9C-10C	JT8D-7B	DC9-30	JT8D-7	JT8D-7seriesRedemiss
D9S-30	JT8D-7B	DC9-30	JT8D-7	JT8D-7seriesRedemiss

Appendix A. Airplane/Engine Substitution Tables for 1976 Emission Inventory Calculations

OAG	OAG Engine	Performance Airplane	Performance Engine	Emissions Engine
D9X-50	JT8D-17	DC9-50	JT8D-15	JT8D-17Redemiss
DAF	*	F-28-4000	MK555-15H	SPEYMk555Transply
DBV	*	SMTURB	PT6A	PT6A
DC8-21	JT4A	DC-8-21-31-33	JT4A-9	JT4A
DC9-10	JT8D-7B	DC9-30	JT8D-7	JT8D-7seriesRedemiss
DFC-54F	JT3D-3B	DC-8-63-63CF	JT3D-7	JT3D-3B
DH7	LGTURB	LGTURB	PW125B	PW125B
DHT	SMTURB	SMTURB	PT6A	PT6A
DLR-40	JT9D-20	DC10-40	JT9D-20	JT9D-20
DME	*	737-200	JT8D-7	JT8D-7seriesRedemiss
DSC	*	F-28-4000	MK555-15H	SPEYMk555Transply
DTO	SMTURB	SMTURB	PT6A	PT6A
EMB	SMTURB	SMTURB	PT6A	PT6A
F27	LGTURB	LGTURB	PW125B	PW125B
F28-1000	RR_SPEY-MK555	F-28-4000	MK555-15H	SPEYMk555Transply
FH7	MDTURB	MDTURB	PW120	PW120
FK5	*	LGTURB	PW125B	PW125B
FK7	LGTURB	LGTURB	PW125B	PW125B
FKF	*	LGTURB	PW125B	PW125B
HFH	*	MDTURB	PW120	PW120
HPJ	*	SMTURB	PT6A	PT6A
HS7	LGTURB	LGTURB	PW125B	PW125B
HSF	LGTURB	LGTURB	PW125B	PW125B
I62	SOL	707-320B-C	JT3D-3B	JT3D-3B
IL8	LGTURB	LGTURB	PW125B	PW125B
L10-1	RB211-22B	L-1011-1-100	RB211-22B	RB211-22B(B)
L41	SMTURB	SMTURB	PT6A	PT6A
LEC	LGTURB	LGTURB	PW125B	PW125B
LHR	MDTURB	MDTURB	PW120	PW120
LJT	MDTURB	MDTURB	PW120	PW120
LOE	LGTURB	LGTURB	PW125B	PW125B
LOH	LGTURB	LGTURB	PW125B	PW125B
LT4	*	SMTURB	PT6A	PT6A
M20	SMTURB	SMTURB	PT6A	PT6A
MRC-100	JT8D-15	737-200	JT8D-15	JT8D-15Redemiss
MU2	SMTURB	SMTURB	PT6A	PT6A
N26	MDTURB	MDTURB	PW120	PW120
ND2	MDTURB	MDTURB	PW120	PW120
NDC	*	F-28-4000	MK555-15H	SPEYMk555Transply
PHP	SMTURB	SMTURB	PT6A	PT6A
PP6	*	SMTURB	PT6A	PT6A
S11	*	LGTURB	PW125B	PW125B
SA2	*	SMTURB	PT6A	PT6A
SH3	MDTURB	MDTURB	PW120	PW120

Appendix A. Airplane/Engine Substitution Tables for 1976 Emission Inventory Calculations

OAG	OAG Engine	Performance Airplane	Performance Engine	Emissions Engine
SHP	*	SMTURB	PT6A	PT6A
SHS	*	SMTURB	PT6A	PT6A
ST2	SMTURB	SMTURB	PT6A	PT6A
STV	*	727-200	JT8D-9	JT8D-9seriesRedemiss
SUV	*	DC8-55-55CF	JT3D-3B	JT3D-3B
SWM	SMTURB	SMTURB	PT6A	PT6A
T04	*	DC9-30	JT8D-7	JT8D-7seriesRedemiss
T1E	*	727-100	JT8D-7	JT8D-7seriesRedemiss
T24	*	LGTURB	PW125B	PW125B
T34	SOL	DC9-30	JT8D-7	JT8D-7seriesRedemiss
T54	SOL	727-200	JT8D-15-15A	JT8D-15Redemiss
TRD-2E	RR_SPEY-512	727-100	JT8D-7	SPEYMk511
TS4	SMTURB	SMTURB	PT6A	PT6A
TS6	*	SMTURB	PT6A	PT6A
TU0	*	LGTURB	PW125B	PW125B
TU2	*	LGTURB	PW125B	PW125B
V10-1150	*	707-320B-C	JT3D-3B	JT3D-3B
V70	MDTURB	MDTURB	PW120	PW120
V80	LGTURB	LGTURB	PW125B	PW125B
VAN	LGTURB	LGTURB	PW125B	PW125B
VC7	*	MDTURB	PW120	PW120
VC8	LGTURB	LGTURB	PW125B	PW125B
VCP	*	LGTURB	PW125B	PW125B
VCV	LGTURB	LGTURB	PW125B	PW125B
VF6	*	MDTURB	PW120	PW120
VIS	MDTURB	MDTURB	PW120	PW120
VOF	*	MDTURB	PW120	PW120
Y11	LGTURB	LGTURB	PW125B	PW125B
Y18	*	737-200	JT8D-7	JT8D-7seriesRedemiss
Y40	IVC	727-100	JT8D-7	JT8D-7seriesRedemiss
Y62	*	707-320B-C	JT3D-3B	JT3D-3B
YS1	LGTURB	LGTURB	PW125B	PW125B

Notes:

SMTURB	Small Turboprop
MDTURB	Medium Turboprop
LGTURB	Large Turboprop

Appendix B. Airplane/Engine Substitution Tables for 1984 Emission Inventory Calculations

OAG	OAG Engine	Performance Airplane	Performance Engine	Emissions Engine
146-200	ALF502R-5	BAE146-300	ALF502R-5	ALF502R-5
720-000	JT3C-12	720	JT3C-7	JT3C
727-100	JT8D-7B	727-100	JT8D-7	JT8D-7seriesRedemiss
72C-100F	JT8D-7B	727-100	JT8D-7	JT8D-7seriesRedemiss
72S-200	JT8D-15	727-200	JT8D-15-15A	JT8D-15Redemiss
737-200	JT8D-7B	737-200	JT8D-7	JT8D-7seriesRedemiss
73C-200C	JT8D-17	737-200	JT8D-15	JT8D-17Redemiss
747-100	JT9D-7A	747-100-200	JT9D-7A	JT9D-7A
74C-100F	JT9D-7A	747-100-200	JT9D-7A	JT9D-7A
74P-SP	JT9D-7A	747SP	JT9D-7A	JT9D-7A
74Q-200M	CF6-50E2	747-100-200	CF6-50E2	CF6-50E2
74U-300	JT9D-7R4G2	747-300	JT9D-7R4G2	JT9D-7R4G2
74X-100SR	CF6-45A2	747-100-100SR	CF6-45A2	CF6-45A2
757-200	RB211-535C	757-200	RB211-535C	RB211-535C
767-200	JT9D-7R4D	767-200	JT9D-7R4D	JT9D-7R4D,-7R4D1
7UQ-300M	CF6-50E2	747-300	CF6-50E2	CF6-50E2
880-22	GE_CJ805-3	720	JT3C-7	JT3C
A30B4-100	CF6-50C2	A300-B2-B4	CF6-50C2	CF6-50C1,-C2
A31-200	CF6-80A3	A310-300	CF6-80A3	CF6-80A3
AC6	*	SMTURB	PT6A	PT6A
AN2	*	MDTURB	PW120	PW120
AN4	LGTURB	LGTURB	PW125B	PW125B
AN6	LGTURB	LGTURB	PW125B	PW125B
ANF	MDTURB	MDTURB	PW120	PW120
B3C-320C	JT3D-3B	707-320B-C	JT3D-3B	JT3D-3B
B3F-320B	JT3D	707-320B-C	JT3D-3B	JT3D-3B
B7F-120B	JT3D	707-320B-C	JT3D-3B	JT3D-3B
BAC-500	RR_SPEY-512	BAC111-500	MK512-14	SPEYMk511
BE1	SMTURB	SMTURB	PT6A	PT6A
BE2	*	SMTURB	PT6A	PT6A
BE3	SMTURB	SMTURB	PT6A	PT6A
BE9	SMTURB	SMTURB	PT6A	PT6A
BEK	SMTURB	SMTURB	PT6A	PT6A
CD2	SMTURB	SMTURB	PT6A	PT6A
CL4	LGTURB	LGTURB	PW125B	PW125B
CNC	SMTURB	SMTURB	PT6A	PT6A
CON-101	*	Concorde	OLYMPUS-593-610	OLYMPUS-593-610
CV5	LGTURB	LGTURB	PW125B	PW125B
CV6	LGTURB	LGTURB	PW125B	PW125B
CVL-12	JT8D-9	CARAVELLE-10B	JT8D-1	JT8D-9seriesRedemiss
D10-10	CF6-6D	DC-10-30	CF6-50C2	CF6-50C1,-C2
D1C-10F	CF6-6D	DC10-10	CF6-6D	CF6-6D
D8C-21F	JT4A	DC-8-21-31-33	JT4A-9	JT4A
D8F-51	JT3D-3B	DC8-55-55CF	JT3D-3B	JT3D-3B

Appendix B. Airplane/Engine Substitution Tables for 1984 Emission Inventory Calculations

OAG	OAG Engine	Performance Airplane	Performance Engine	Emissions Engine
D8S-71	CFM56-2C	DC-8-71-71CF	CFM56-1B	CFM56-2-C5
D9C-30F	JT8D-7B	DC9-30	JT8D-7	JT8D-9seriesRedemiss
D9S-30	JT8D-7B	DC9-30	JT8D-7	JT8D-7seriesRedemiss
D9X-50	JT8D-17	DC9-50	JT8D-15	JT8D-17Redemiss
D9Z-82	JT8D-217	MD-82	JT8D-217A	JT8D-217series
DC8	*	DC-8-63-63CF	JT3D-7	JT3D-7series
DC9-10	JT8D-7B	DC9-30	JT8D-7	JT8D-7seriesRedemiss
DFC-54F	JT3D-3B	DC-8-63-63CF	JT3D-7	JT3D-3B
DFL	*	F-28-4000	MK555-15H	SPEYMk555
DH7	LGTURB	LGTURB	PW125B	PW125B
DHB	SMTURB	SMTURB	PT6A	PT6A
DHT	SMTURB	SMTURB	PT6A	PT6A
DLR-40	JT9D-59A	DC10-40	JT9D-20	JT9D-59A
DO8	SMTURB	SMTURB	PT6A	PT6A
EMB	SMTURB	SMTURB	PT6A	PT6A
F27	LGTURB	LGTURB	PW125B	PW125B
F28-4000	RR_SPEY-MK555	F-28-4000	MK555-15H	SPEYMk555
F2A	LGTURB	LGTURB	PW125B	PW125B
F2B	LGTURB	LGTURB	PW125B	PW125B
F2E	LGTURB	LGTURB	PW125B	PW125B
F2S	*	LGTURB	PW125B	PW125B
FK7	LGTURB	LGTURB	PW125B	PW125B
GR1	*	F-28-4000	MK555-15H	SPEYMk555
HPJ	*	SMTURB	PT6A	PT6A
HS7	LGTURB	LGTURB	PW125B	PW125B
HSF	LGTURB	LGTURB	PW125B	PW125B
I62	SOL	707-320B-C	JT3D-3B	JT3D-3B
I72	*	707-320B-C	JT3D-3B	JT3D-3B
I86	KUZ	707-320B-C	JT3D-3B	JT3D-3B
IL8	LGTURB	LGTURB	PW125B	PW125B
J31	SMTURB	SMTURB	PT6A	PT6A
L10-1	RB211-22B	L-1011-1-100	RB211-22B	RB211-22B(B)
LLR-500	RB211-524B4	L1011-500AC	RB211-524B4	RB211-524BseriesPackage1
LOE	LGTURB	LGTURB	PW125B	PW125B
LOF	LGTURB	LGTURB	PW125B	PW125B
LOH	LGTURB	LGTURB	PW125B	PW125B
LOM	LGTURB	LGTURB	PW125B	PW125B
LRJ	*	F-28-4000	MK555-15H	SPEYMk555
LV2	*	SMTURB	PT6A	PT6A
MRC-100	JT8D-15	737-200	JT8D-15	JT8D-15Redemiss
MU2	SMTURB	SMTURB	PT6A	PT6A
ND2	MDTURB	MDTURB	PW120	PW120
PA1	*	SMTURB	PT6A	PT6A
PA6	SMTURB	SMTURB	PT6A	PT6A

Appendix B. Airplane/Engine Substitution Tables for 1984 Emission Inventory Calculations

OAG	OAG Engine	Performance Airplane	Performance Engine	Emissions Engine
PL6	SMTURB	SMTURB	PT6A	PT6A
RV1	*	SMTURB	PT6A	PT6A
SA2	*	SMTURB	PT6A	PT6A
SF3	MDTURB	MDTURB	PW120	PW120
SH3	MDTURB	MDTURB	PW120	PW120
SH6	MDTURB	MDTURB	PW120	PW120
SHP	*	SMTURB	PT6A	PT6A
SHS	*	SMTURB	PT6A	PT6A
SWM	SMTURB	SMTURB	PT6A	PT6A
T34	SOL	DC9-30	JT8D-7	JT8D-7seriesRedemiss
T54	SOL	727-200	JT8D-15-15A	JT8D-15Redemiss
TRD-2E	RR_SPEY-512	727-100	JT8D-7	SPEYMk511
VC8	LGTURB	LGTURB	PW125B	PW125B
VCV	LGTURB	LGTURB	PW125B	PW125B
VGP	*	LGTURB	PW125B	PW125B
Y40	IVC	727-100	JT8D-7	JT8D-7seriesRedemiss
YN5	*	SMTURB	PT6A	PT6A
YS1	LGTURB	LGTURB	PW125B	PW125B

Notes:

SMTURB Small Turboprop
MDTURB Medium Turboprop
LGTURB Large Turboprop

Appendix C. Fuel Burned and Emissions as a Function of Altitude for each Month

Table C-1. Fuel burned, emissions, cumulative fractions of emissions, and emission indices as a function of altitude (Summed over Latitude and Longitude) for scheduled air traffic in February 1976.

Altitude Band (km)	Fuel (kg/day)	cum fuel (%)	NOx (kg/day)	cum NOx (%)	HC (kg/day)	cum HC (%)	CO (kg/day)	cum CO (%)	EI(NOx)	EI(HC)	EI(CO)
0 - 1	1.76E+07	14.99%	1.86E+05	14.58%	2.53E+05	38.01%	4.04E+05	38.79%	10.58	14.39	22.93
1 - 2	4.83E+06	19.10%	6.70E+04	19.83%	4.05E+04	44.09%	6.32E+04	44.87%	13.89	8.39	13.09
2 - 3	4.28E+06	22.75%	6.26E+04	24.73%	3.47E+04	49.29%	5.28E+04	49.94%	14.61	8.10	12.32
3 - 4	4.52E+06	26.59%	6.72E+04	29.99%	3.26E+04	54.18%	4.81E+04	54.55%	14.87	7.21	10.64
4 - 5	3.87E+06	29.89%	5.48E+04	34.28%	3.27E+04	59.08%	4.63E+04	59.00%	14.16	8.45	11.96
5 - 6	3.76E+06	33.09%	5.15E+04	38.31%	3.29E+04	64.02%	4.75E+04	63.56%	13.70	8.75	12.63
6 - 7	3.76E+06	36.29%	5.05E+04	42.26%	3.28E+04	68.93%	4.48E+04	67.87%	13.43	8.72	11.93
7 - 8	4.35E+06	39.99%	5.31E+04	46.42%	3.18E+04	73.71%	4.87E+04	72.55%	12.22	7.32	11.21
8 - 9	4.51E+06	43.83%	4.95E+04	50.30%	3.31E+04	78.67%	5.30E+04	77.65%	10.97	7.32	11.74
9 - 10	4.85E+06	47.96%	5.24E+04	54.40%	2.95E+04	83.09%	4.10E+04	81.59%	10.81	6.08	8.47
10 - 11	2.22E+07	66.83%	2.07E+05	70.59%	3.49E+04	88.33%	7.40E+04	88.70%	9.33	1.58	3.34
11 - 12	3.89E+07	99.97%	3.75E+05	99.95%	7.78E+04	100.00%	1.17E+05	99.99%	9.64	2.00	3.02
12 - 13	5.55E+02	99.97%	5.80E+00	99.95%	9.00E-01	100.00%	1.41E+01	99.99%	10.40	1.64	25.43
13 - 14	1.06E+03	99.97%	1.56E+01	99.96%	9.00E-01	100.00%	1.41E+01	99.99%	14.77	0.85	13.35
14 - 15	3.16E+03	99.98%	5.68E+01	99.96%	6.00E-01	100.00%	1.10E+01	99.99%	18.00	0.20	3.50
15 - 16	3.16E+03	99.98%	5.68E+01	99.96%	6.00E-01	100.00%	1.10E+01	99.99%	18.00	0.20	3.50
16 - 17	4.02E+03	99.98%	7.23E+01	99.97%	8.00E-01	100.00%	1.41E+01	99.99%	18.00	0.20	3.50
17 - 18	1.59E+04	100.00%	2.87E+02	99.99%	3.20E+00	100.00%	5.58E+01	100.00%	18.00	0.20	3.50
18 - 19	4.96E+03	100.00%	8.93E+01	100.00%	1.00E+00	100.00%	1.74E+01	100.00%	18.00	0.20	3.50
Global Total	1.17E+08		1.28E+06		6.67E+05		1.04E+06		10.88	5.68	8.86

Appendix C. Fuel Burned and Emissions as a Function of Altitude for each Month

Table C-2. Fuel burned, emissions, cumulative fractions of emissions, and emission indices as a function of altitude (Summed over Latitude and Longitude) for scheduled air traffic in May 1976.

Altitude Band (km)	Fuel (kg/day)	cum fuel (%)	NOx (kg/day)	cum NOx (%)	HC (kg/day)	cum HC (%)	CO (kg/day)	cum CO (%)	EI(NOx)	EI(HC)	EI(CO)
0 - 1	1.87E+07	14.84%	2.01E+05	14.72%	2.82E+05	37.31%	4.37E+05	38.51%	10.76	15.12	23.43
1 - 2	5.05E+06	18.86%	7.06E+04	19.90%	4.51E+04	43.28%	6.82E+04	44.51%	13.98	8.92	13.49
2 - 3	4.49E+06	22.44%	6.61E+04	24.74%	3.89E+04	48.43%	5.69E+04	49.52%	14.70	8.66	12.66
3 - 4	4.78E+06	26.24%	7.12E+04	29.96%	3.69E+04	53.31%	5.20E+04	54.11%	14.89	7.71	10.88
4 - 5	4.09E+06	29.50%	5.80E+04	34.22%	3.70E+04	58.20%	5.02E+04	58.53%	14.19	9.04	12.28
5 - 6	3.95E+06	32.64%	5.43E+04	38.20%	3.72E+04	63.12%	5.13E+04	63.05%	13.76	9.42	13.00
6 - 7	3.96E+06	35.79%	5.34E+04	42.11%	3.74E+04	68.06%	4.87E+04	67.34%	13.48	9.44	12.30
7 - 8	4.59E+06	39.44%	5.63E+04	46.25%	3.63E+04	72.86%	5.35E+04	72.05%	12.27	7.91	11.65
8 - 9	4.78E+06	43.25%	5.26E+04	50.11%	3.74E+04	77.82%	5.77E+04	77.14%	11.00	7.82	12.07
9 - 10	5.05E+06	47.27%	5.48E+04	54.13%	3.36E+04	82.25%	4.51E+04	81.12%	10.85	6.64	8.93
10 - 11	2.33E+07	65.82%	2.19E+05	70.15%	3.95E+04	87.48%	7.92E+04	88.10%	9.37	1.69	3.40
11 - 12	4.27E+07	99.79%	4.03E+05	99.73%	9.46E+04	99.99%	1.35E+05	99.98%	9.45	2.22	3.16
12 - 13	1.94E+05	99.94%	2.59E+03	99.92%	6.87E+01	100.00%	4.86E+01	99.98%	13.32	0.35	0.25
13 - 14	2.33E+04	99.96%	2.93E+02	99.94%	8.20E+00	100.00%	2.49E+01	99.99%	12.57	0.35	1.07
14 - 15	4.92E+03	99.97%	8.85E+01	99.94%	1.00E+00	100.00%	1.72E+01	99.99%	18.00	0.20	3.50
15 - 16	4.92E+03	99.97%	8.85E+01	99.95%	1.00E+00	100.00%	1.72E+01	99.99%	18.00	0.20	3.50
16 - 17	6.23E+03	99.97%	1.12E+02	99.96%	1.20E+00	100.00%	2.18E+01	99.99%	18.00	0.20	3.50
17 - 18	2.30E+04	99.99%	4.13E+02	99.99%	4.60E+00	100.00%	8.03E+01	100.00%	18.00	0.20	3.50
18 - 19	8.67E+03	100.00%	1.56E+02	100.00%	1.70E+00	100.00%	3.04E+01	100.00%	18.00	0.20	3.50
Global Total	1.26E+08		1.36E+06		7.56E+05		1.13E+06		10.85	6.01	9.03

Appendix C. Fuel Burned and Emissions as a Function of Altitude for each Month

Table C-3. Fuel burned, emissions, cumulative fractions of emissions, and emission indices as a function of altitude (Summed over Latitude and Longitude) for scheduled air traffic in August 1976.

Altitude Band (km)	Fuel (kg/day)	cum fuel (%)	NOx (kg/day)	cum NOx (%)	HC (kg/day)	cum HC (%)	CO (kg/day)	cum CO (%)	EI(NOx)	EI(HC)	EI(CO)
0 - 1	1.96E+07	14.45%	2.12E+05	14.23%	2.94E+05	37.34%	4.59E+05	38.56%	10.86	15.01	23.48
1 - 2	5.35E+06	18.40%	7.57E+04	19.29%	4.69E+04	43.30%	7.21E+04	44.61%	14.14	8.76	13.48
2 - 3	4.73E+06	21.89%	7.06E+04	24.02%	4.08E+04	48.50%	6.03E+04	49.67%	14.93	8.64	12.75
3 - 4	5.05E+06	25.62%	7.65E+04	29.13%	3.85E+04	53.40%	5.51E+04	54.29%	15.14	7.63	10.90
4 - 5	4.31E+06	28.80%	6.21E+04	33.29%	3.86E+04	58.31%	5.29E+04	58.73%	14.39	8.96	12.26
5 - 6	4.16E+06	31.88%	5.80E+04	37.17%	3.88E+04	63.25%	5.42E+04	63.28%	13.94	9.33	13.03
6 - 7	4.19E+06	34.97%	5.72E+04	41.01%	3.89E+04	68.19%	5.12E+04	67.58%	13.66	9.29	12.22
7 - 8	4.86E+06	38.56%	6.07E+04	45.07%	3.78E+04	73.00%	5.57E+04	72.25%	12.49	7.79	11.47
8 - 9	5.03E+06	42.27%	5.64E+04	48.84%	3.91E+04	77.98%	5.99E+04	77.28%	11.22	7.78	11.91
9 - 10	5.36E+06	46.23%	5.90E+04	52.79%	3.51E+04	82.44%	4.72E+04	81.24%	11.00	6.54	8.81
10 - 11	2.56E+07	65.11%	2.43E+05	69.07%	4.14E+04	87.70%	8.40E+04	88.29%	9.52	1.62	3.29
11 - 12	4.68E+07	99.63%	4.55E+05	99.53%	9.66E+04	99.98%	1.39E+05	99.95%	9.73	2.07	2.97
12 - 13	3.11E+05	99.86%	4.12E+03	99.80%	1.21E+02	99.99%	1.05E+02	99.96%	13.25	0.39	0.34
13 - 14	7.62E+04	99.92%	9.80E+02	99.87%	2.43E+01	100.00%	5.68E+01	99.97%	12.86	0.32	0.74
14 - 15	9.74E+03	99.93%	1.75E+02	99.88%	1.90E+00	100.00%	3.41E+01	99.97%	18.00	0.20	3.50
15 - 16	9.74E+03	99.93%	1.75E+02	99.89%	1.90E+00	100.00%	3.41E+01	99.97%	18.00	0.20	3.50
16 - 17	2.61E+04	99.95%	4.70E+02	99.92%	5.20E+00	100.00%	9.14E+01	99.98%	18.00	0.20	3.50
17 - 18	5.08E+04	99.99%	9.14E+02	99.98%	1.02E+01	100.00%	1.78E+02	100.00%	18.00	0.20	3.50
18 - 19	1.46E+04	100.00%	2.63E+02	100.00%	2.90E+00	100.00%	5.12E+01	100.00%	18.00	0.20	3.50
Global Total	1.35E+08		1.49E+06		7.87E+05		1.19E+06		11.03	5.81	8.80

Appendix C. Fuel Burned and Emissions as a Function of Altitude for each Month

Table C-4. Fuel burned, emissions, cumulative fractions of emissions, and emission indices as a function of altitude (Summed over Latitude and Longitude) for scheduled air traffic in November 1976.

Altitude Band (km)	Fuel (kg/day)	cum fuel (%)	NOx (kg/day)	cum NOx (%)	HC (kg/day)	cum HC (%)	CO (kg/day)	cum CO (%)	EI(NOx)	EI(HC)	EI(CO)
0 - 1	1.83E+07	15.01%	1.95E+05	14.63%	2.62E+05	37.31%	4.18E+05	38.75%	10.69	14.36	22.85
1 - 2	5.02E+06	19.14%	7.00E+04	19.88%	4.20E+04	43.28%	6.54E+04	44.83%	13.92	8.37	13.03
2 - 3	4.42E+06	22.78%	6.52E+04	24.76%	3.68E+04	48.52%	5.49E+04	49.92%	14.73	8.31	12.40
3 - 4	4.70E+06	26.64%	7.03E+04	30.02%	3.46E+04	53.44%	5.00E+04	54.56%	14.96	7.36	10.63
4 - 5	4.03E+06	29.95%	5.76E+04	34.34%	3.46E+04	58.36%	4.81E+04	59.02%	14.29	8.59	11.93
5 - 6	3.90E+06	33.16%	5.40E+04	38.38%	3.48E+04	63.30%	4.94E+04	63.60%	13.83	8.91	12.65
6 - 7	3.90E+06	36.36%	5.29E+04	42.35%	3.48E+04	68.26%	4.64E+04	67.91%	13.56	8.93	11.89
7 - 8	4.67E+06	40.20%	5.84E+04	46.72%	3.38E+04	73.06%	5.11E+04	72.65%	12.51	7.23	10.94
8 - 9	4.72E+06	44.08%	5.22E+04	50.64%	3.49E+04	78.03%	5.44E+04	77.70%	11.07	7.40	11.52
9 - 10	5.06E+06	48.23%	5.50E+04	54.76%	3.15E+04	82.50%	4.29E+04	81.68%	10.88	6.23	8.48
10 - 11	2.31E+07	67.22%	2.18E+05	71.09%	3.75E+04	87.83%	7.65E+04	88.78%	9.43	1.62	3.31
11 - 12	3.93E+07	99.51%	3.78E+05	99.38%	8.53E+04	99.97%	1.20E+05	99.95%	9.61	2.17	3.07
12 - 13	3.74E+05	99.82%	5.01E+03	99.75%	1.54E+02	99.99%	1.17E+02	99.96%	13.39	0.41	0.31
13 - 14	1.28E+05	99.92%	1.65E+03	99.87%	3.81E+01	100.00%	5.18E+01	99.97%	12.83	0.30	0.40
14 - 15	8.38E+03	99.93%	1.51E+02	99.89%	1.70E+00	100.00%	2.93E+01	99.97%	18.00	0.20	3.50
15 - 16	8.38E+03	99.94%	1.51E+02	99.90%	1.70E+00	100.00%	2.93E+01	99.98%	18.00	0.20	3.50
16 - 17	2.22E+04	99.96%	4.00E+02	99.93%	4.40E+00	100.00%	7.78E+01	99.98%	18.00	0.20	3.50
17 - 18	4.22E+04	99.99%	7.60E+02	99.98%	8.40E+00	100.00%	1.48E+02	100.00%	18.00	0.20	3.50
18 - 19	1.22E+04	100.00%	2.19E+02	100.00%	2.40E+00	100.00%	4.26E+01	100.00%	18.00	0.20	3.50
Global Total	1.22E+08		1.33E+06		7.03E+05		1.08E+06		10.97	5.78	8.85

Appendix C. Fuel Burned and Emissions as a Function of Altitude for each Month

Table C-5. Fuel burned, emissions, cumulative fractions of emissions, and emission indices as a function of altitude (Summed over Latitude and Longitude) for scheduled air traffic in February 1984.

Altitude Band (km)	Fuel (kg/day)	cum fuel (%)	NOx (kg/day)	cum NOx (%)	HC (kg/day)	cum HC (%)	CO (kg/day)	cum CO (%)	EI(NOx)	EI(HC)	EI(CO)
0 - 1	2.22E+07	13.35%	2.45E+05	12.01%	2.18E+05	40.30%	4.33E+05	40.11%	11.04	9.85	19.56
1 - 2	6.36E+06	17.19%	9.39E+04	16.62%	3.32E+04	46.44%	6.98E+04	46.58%	14.77	5.23	10.98
2 - 3	5.64E+06	20.59%	9.14E+04	21.11%	2.84E+04	51.69%	5.91E+04	52.05%	16.20	5.04	10.47
3 - 4	6.14E+06	24.29%	1.03E+05	26.16%	2.57E+04	56.44%	5.33E+04	56.98%	16.72	4.19	8.68
4 - 5	5.41E+06	27.56%	8.34E+04	30.25%	2.51E+04	61.07%	4.98E+04	61.60%	15.41	4.64	9.21
5 - 6	5.09E+06	30.62%	7.69E+04	34.03%	2.56E+04	65.81%	5.00E+04	66.23%	15.10	5.04	9.82
6 - 7	5.00E+06	33.64%	7.46E+04	37.69%	2.45E+04	70.33%	4.59E+04	70.48%	14.91	4.90	9.18
7 - 8	5.46E+06	36.93%	7.55E+04	41.40%	2.52E+04	74.99%	4.92E+04	75.03%	13.82	4.62	9.01
8 - 9	6.09E+06	40.60%	7.41E+04	45.04%	2.84E+04	80.24%	5.91E+04	80.50%	12.17	4.67	9.70
9 - 10	7.04E+06	44.85%	8.48E+04	49.20%	2.20E+04	84.31%	3.59E+04	83.83%	12.05	3.13	5.10
10 - 11	4.19E+07	70.12%	4.41E+05	70.86%	3.81E+04	91.34%	9.47E+04	92.60%	10.52	0.91	2.26
11 - 12	4.77E+07	98.90%	5.68E+05	98.75%	4.62E+04	99.88%	7.85E+04	99.86%	11.90	0.97	1.64
12 - 13	1.21E+06	99.63%	1.62E+04	99.55%	4.94E+02	99.97%	3.60E+02	99.90%	13.36	0.41	0.30
13 - 14	3.37E+05	99.83%	4.26E+03	99.76%	1.04E+02	99.99%	1.44E+02	99.91%	12.66	0.31	0.43
14 - 15	9.91E+03	99.84%	1.78E+02	99.77%	2.00E+00	99.99%	3.47E+01	99.91%	18.00	0.20	3.50
15 - 16	9.91E+03	99.85%	1.78E+02	99.77%	2.00E+00	99.99%	3.47E+01	99.92%	18.00	0.20	3.50
16 - 17	9.41E+04	99.90%	1.69E+03	99.86%	1.88E+01	99.99%	3.30E+02	99.95%	18.00	0.20	3.50
17 - 18	1.25E+05	99.98%	2.25E+03	99.97%	2.50E+01	100.00%	4.37E+02	99.99%	18.00	0.20	3.50
18 - 19	3.60E+04	100.00%	6.48E+02	100.00%	7.20E+00	100.00%	1.26E+02	100.00%	18.00	0.20	3.50
Global Total	1.66E+08		2.04E+06		5.42E+05		1.08E+06		12.28	3.27	6.51

Appendix C. Fuel Burned and Emissions as a Function of Altitude for each Month

Table C-6. Fuel burned, emissions, cumulative fractions of emissions, and emission indices as a function of altitude (Summed over Latitude and Longitude) for scheduled air traffic in May 1984.

Altitude Band (km)	Fuel (kg/day)	cum fuel (%)	NOx (kg/day)	cum NOx (%)	HC (kg/day)	cum HC (%)	CO (kg/day)	cum CO (%)	EI(NOx)	EI(HC)	EI(CO)
0 - 1	2.29E+07	13.15%	2.54E+05	11.84%	2.26E+05	40.43%	4.46E+05	39.99%	11.10	9.87	19.44
1 - 2	6.53E+06	16.89%	9.71E+04	16.36%	3.37E+04	46.46%	7.11E+04	46.37%	14.88	5.17	10.89
2 - 3	5.80E+06	20.22%	9.48E+04	20.78%	2.93E+04	51.69%	6.06E+04	51.81%	16.34	5.04	10.45
3 - 4	6.35E+06	23.87%	1.07E+05	25.74%	2.65E+04	56.43%	5.49E+04	56.74%	16.82	4.18	8.66
4 - 5	5.58E+06	27.07%	8.64E+04	29.76%	2.59E+04	61.06%	5.14E+04	61.35%	15.49	4.64	9.21
5 - 6	5.26E+06	30.08%	7.98E+04	33.48%	2.66E+04	65.81%	5.17E+04	65.99%	15.17	5.05	9.83
6 - 7	5.22E+06	33.08%	7.79E+04	37.11%	2.54E+04	70.34%	4.76E+04	70.26%	14.92	4.86	9.11
7 - 8	5.76E+06	36.39%	7.96E+04	40.81%	2.60E+04	74.99%	5.07E+04	74.81%	13.80	4.51	8.80
8 - 9	6.29E+06	40.00%	7.69E+04	44.39%	2.90E+04	80.18%	6.03E+04	80.22%	12.22	4.62	9.58
9 - 10	7.42E+06	44.25%	8.98E+04	48.57%	2.26E+04	84.23%	3.68E+04	83.52%	12.10	3.05	4.96
10 - 11	4.45E+07	69.80%	4.72E+05	70.55%	3.96E+04	91.31%	9.88E+04	92.39%	10.61	0.89	2.22
11 - 12	5.07E+07	98.89%	6.06E+05	98.75%	4.79E+04	99.88%	8.32E+04	99.86%	11.95	0.94	1.64
12 - 13	1.27E+06	99.62%	1.69E+04	99.54%	5.27E+02	99.97%	3.91E+02	99.89%	13.26	0.41	0.31
13 - 14	3.61E+05	99.83%	4.58E+03	99.75%	1.11E+02	99.99%	1.56E+02	99.91%	12.67	0.31	0.43
14 - 15	1.08E+04	99.83%	1.95E+02	99.76%	2.20E+00	99.99%	3.79E+01	99.91%	18.00	0.20	3.50
15 - 16	1.08E+04	99.84%	1.95E+02	99.77%	2.20E+00	99.99%	3.79E+01	99.91%	18.00	0.20	3.50
16 - 17	1.03E+05	99.90%	1.85E+03	99.85%	2.06E+01	99.99%	3.60E+02	99.94%	18.00	0.20	3.50
17 - 18	1.36E+05	99.98%	2.45E+03	99.97%	2.73E+01	100.00%	4.77E+02	99.99%	18.00	0.20	3.50
18 - 19	3.93E+04	100.00%	7.07E+02	100.00%	7.90E+00	100.00%	1.37E+02	100.00%	18.00	0.20	3.50
Global Total	1.74E+08		2.15E+06		5.59E+05		1.11E+06		12.33	3.21	6.39

Appendix C. Fuel Burned and Emissions as a Function of Altitude for each Month

Table C-7. Fuel burned, emissions, cumulative fractions of emissions, and emission indices as a function of altitude (Summed over Latitude and Longitude) for scheduled air traffic in August 1984.

Altitude Band (km)	Fuel (kg/day)	cum fuel (%)	NOx (kg/day)	cum NOx (%)	HC (kg/day)	cum HC (%)	CO (kg/day)	cum CO (%)	EI(NOx)	EI(HC)	EI(CO)
0 - 1	2.39E+07	12.81%	2.68E+05	11.59%	2.29E+05	39.89%	4.63E+05	39.86%	11.23	9.60	19.39
1 - 2	6.82E+06	16.47%	1.02E+05	16.01%	3.50E+04	45.98%	7.43E+04	46.26%	15.00	5.13	10.90
2 - 3	6.06E+06	19.73%	1.00E+05	20.34%	3.02E+04	51.24%	6.33E+04	51.72%	16.52	4.98	10.44
3 - 4	6.65E+06	23.30%	1.13E+05	25.24%	2.72E+04	55.98%	5.72E+04	56.64%	17.03	4.09	8.59
4 - 5	5.83E+06	26.43%	9.12E+04	29.18%	2.65E+04	60.59%	5.33E+04	61.24%	15.62	4.54	9.14
5 - 6	5.51E+06	29.39%	8.43E+04	32.83%	2.72E+04	65.32%	5.36E+04	65.85%	15.31	4.93	9.72
6 - 7	5.43E+06	32.31%	8.20E+04	36.38%	2.59E+04	69.83%	4.93E+04	70.10%	15.10	4.76	9.07
7 - 8	5.96E+06	35.51%	8.34E+04	39.98%	2.67E+04	74.48%	5.21E+04	74.59%	13.99	4.48	8.75
8 - 9	6.56E+06	39.03%	8.11E+04	43.49%	2.99E+04	79.70%	6.23E+04	79.96%	12.36	4.57	9.50
9 - 10	7.96E+06	43.31%	9.73E+04	47.69%	2.35E+04	83.79%	3.83E+04	83.26%	12.22	2.95	4.81
10 - 11	4.84E+07	69.29%	5.17E+05	70.06%	4.25E+04	91.20%	1.06E+05	92.37%	10.69	0.88	2.18
11 - 12	5.53E+07	98.97%	6.66E+05	98.85%	4.99E+04	99.88%	8.70E+04	99.86%	12.05	0.90	1.57
12 - 13	1.24E+06	99.63%	1.64E+04	99.56%	5.23E+02	99.97%	3.95E+02	99.90%	13.27	0.42	0.32
13 - 14	3.80E+05	99.84%	4.82E+03	99.77%	1.16E+02	99.99%	1.57E+02	99.91%	12.69	0.30	0.41
14 - 15	1.08E+04	99.84%	1.95E+02	99.77%	2.20E+00	99.99%	3.79E+01	99.91%	18.00	0.20	3.50
15 - 16	1.08E+04	99.85%	1.95E+02	99.78%	2.20E+00	99.99%	3.79E+01	99.92%	18.00	0.20	3.50
16 - 17	1.03E+05	99.91%	1.85E+03	99.86%	2.06E+01	99.99%	3.60E+02	99.95%	18.00	0.20	3.50
17 - 18	1.36E+05	99.98%	2.45E+03	99.97%	2.73E+01	100.00%	4.77E+02	99.99%	18.00	0.20	3.50
18 - 19	3.93E+04	100.00%	7.07E+02	100.00%	7.90E+00	100.00%	1.37E+02	100.00%	18.00	0.20	3.50
Global Total	1.86E+08		2.31E+06		5.74E+05		1.16E+06		12.42	3.08	6.23

Appendix C. Fuel Burned and Emissions as a Function of Altitude for each Month

Table C-8. Fuel burned, emissions, cumulative fractions of emissions, and emission indices as a function of altitude (Summed over Latitude and Longitude) for scheduled air traffic in November 1984.

Altitude Band (km)	Fuel (kg/day)	cum fuel (%)	NOx (kg/day)	cum NOx (%)	HC (kg/day)	cum HC (%)	CO (kg/day)	cum CO (%)	EI(NOx)	EI(HC)	EI(CO)
0 - 1	2.28E+07	13.11%	2.53E+05	11.79%	2.17E+05	40.29%	4.36E+05	39.91%	11.09	9.48	19.07
1 - 2	6.56E+06	16.87%	9.72E+04	16.31%	3.24E+04	46.32%	7.01E+04	46.33%	14.81	4.94	10.69
2 - 3	5.82E+06	20.21%	9.47E+04	20.71%	2.81E+04	51.55%	5.96E+04	51.79%	16.27	4.82	10.24
3 - 4	6.41E+06	23.88%	1.08E+05	25.71%	2.53E+04	56.25%	5.39E+04	56.72%	16.79	3.95	8.41
4 - 5	5.62E+06	27.11%	8.69E+04	29.76%	2.46E+04	60.82%	5.02E+04	61.32%	15.47	4.37	8.93
5 - 6	5.27E+06	30.13%	8.00E+04	33.48%	2.52E+04	65.51%	5.03E+04	65.93%	15.18	4.78	9.55
6 - 7	5.20E+06	33.12%	7.79E+04	37.10%	2.41E+04	70.00%	4.63E+04	70.18%	14.96	4.64	8.90
7 - 8	5.68E+06	36.38%	7.87E+04	40.76%	2.49E+04	74.64%	4.93E+04	74.69%	13.87	4.39	8.68
8 - 9	6.32E+06	40.00%	7.71E+04	44.35%	2.84E+04	79.92%	6.03E+04	80.21%	12.21	4.49	9.54
9 - 10	7.56E+06	44.33%	9.12E+04	48.59%	2.18E+04	83.99%	3.62E+04	83.53%	12.07	2.89	4.79
10 - 11	4.51E+07	70.19%	4.78E+05	70.82%	3.95E+04	91.34%	9.93E+04	92.62%	10.60	0.88	2.20
11 - 12	5.02E+07	98.97%	6.02E+05	98.83%	4.59E+04	99.88%	7.90E+04	99.86%	12.01	0.91	1.57
12 - 13	1.16E+06	99.64%	1.54E+04	99.55%	4.86E+02	99.97%	3.74E+02	99.89%	13.26	0.42	0.32
13 - 14	3.36E+05	99.83%	4.26E+03	99.75%	1.03E+02	99.99%	1.54E+02	99.90%	12.68	0.31	0.46
14 - 15	1.08E+04	99.83%	1.95E+02	99.76%	2.20E+00	99.99%	3.79E+01	99.91%	18.00	0.20	3.50
15 - 16	1.08E+04	99.84%	1.95E+02	99.77%	2.20E+00	99.99%	3.79E+01	99.91%	18.00	0.20	3.50
16 - 17	1.03E+05	99.90%	1.85E+03	99.85%	2.06E+01	99.99%	3.60E+02	99.94%	18.00	0.20	3.50
17 - 18	1.36E+05	99.98%	2.45E+03	99.97%	2.73E+01	100.00%	4.77E+02	99.99%	18.00	0.20	3.50
18 - 19	3.93E+04	100.00%	7.07E+02	100.00%	7.90E+00	100.00%	1.37E+02	100.00%	18.00	0.20	3.50
Global Total	1.74E+08		2.15E+06		5.37E+05		1.09E+06		12.34	3.08	6.26

Appendix D. Fuel Burned in 1976 by Airplane Type

Airplane/engine	1976 Fuel burned in thousand kilograms/day Feb.	May	Aug.	Nov.
720-000/JT3D	1,310.0	1,440.0	1,730.0	709.0
727-100/JT8D-7B	14,300.0	14,600.0	16,000.0	13,300.0
72C/*	209.0	259.0	240.0	211.0
72S-200/JT8D-15	14,500.0	14,500.0	14,700.0	16,400.0
737-200/JT8D-7B	5,360.0	5,570.0	6,000.0	5,900.0
73C-200C/JT8D-9A	68.5	85.9	91.0	181.0
747-100/JT9D-7A	16,700.0	17,800.0	21,200.0	15,700.0
748/MDTURB	224.0	228.0	218.0	0.0
74C-100F/JT9D-7A	1,200.0	1,170.0	1,360.0	1,480.0
74P-SP/JT9D-7A	0.0	392.0	701.0	864.0
880-22/GE_CJ805-3	46.1	50.7	49.0	48.1
A12/MDTURB	10.9	3.4	3.4	0.0
A24/SMTURB	72.8	78.1	112.0	0.0
A30B2-100/CF6-50C2R	0.0	0.0	0.0	349.0
A3B/*	229.0	314.0	358.0	0.0
AC6/*	0.0	0.0	0.0	2.7
AN1/*	0.0	0.0	0.0	11.3
AN4/LGTURB	0.0	0.0	0.0	106.0
ARG/LGTURB	1.7	1.7	1.7	0.0
B2F-000B/JT3D-3B	0.0	0.0	0.0	745.0
B3C-320C/JT3D-3B	0.0	2,250.0	2,170.0	2,170.0
B3F-320B/JT3D	13,700.0	13,400.0	13,100.0	14,000.0
B3J/*	0.0	2,380.0	2,440.0	0.0
B99/SMTURB	186.0	190.0	196.0	0.0
BAC-200/RR_SPEY-506	1,250.0	1,210.0	1,260.0	1,670.0
BE9/SMTURB	0.0	0.0	0.0	191.0
BET/*	0.0	0.0	0.0	48.2
BRT/*	0.0	0.0	0.0	1.8
BTP/SMTURB	23.3	25.6	26.3	0.0
C44/*	0.0	0.0	3.1	0.0
CL4/LGTURB	0.0	0.0	0.0	3.1
CM4/*	28.7	16.6	0.0	0.0
CMT-4C/*	0.0	0.0	0.0	18.9
CONCORDE	43.2	66.8	151.0	127.0
CV5/LGTURB	248.0	237.0	259.0	144.0
CV6/LGTURB	0.0	0.0	0.0	31.0
CVL-3/*	928.0	947.0	857.0	1,010.0
CVS/*	249.0	229.0	221.0	0.0
D10-10/CF6-6D	10,500.0	10,800.0	12,400.0	10,800.0
D8C-32F/JT4A	2,650.0	2,710.0	2,450.0	2,220.0
D8F-51/JT3D	0.0	0.0	0.0	110.0
D8S-61/CFM56-2C	4,180.0	4,140.0	4,090.0	3,810.0
D9C-10C/JT8D-7B	193.0	200.0	182.0	196.0
D9S-30/JT8D-7B	6,520.0	6,650.0	6,760.0	7,490.0

Appendix D. Fuel Burned in 1976 by Airplane Type

Airplane/engine	1976 Fuel burned in thousand kilograms/day Feb.	May	Aug.	Nov.
D9X-50/JT8D-17	0.0	245.0	213.0	351.0
DAF/*	0.0	0.0	0.0	396.0
DBV/*	0.0	0.9	0.9	0.0
DC8-21/JT4A	5,550.0	5,340.0	5,570.0	4,210.0
DC9-10/JT8D-7B	4,410.0	4,630.0	4,720.0	3,560.0
DFC-54F/JT3D-3B	0.0	0.0	0.0	68.3
DH7/LGTURB	0.0	1.4	3.1	0.0
DHT/SMTURB	0.0	0.0	0.0	246.0
DLR-40/JT9D-20	0.0	0.0	0.0	449.0
DME/*	120.0	126.0	127.0	0.0
DSC/*	0.0	0.0	0.0	55.6
DTO/SMTURB	254.0	247.0	259.0	0.0
EMB/SMTURB	54.6	31.1	27.3	12.7
F27/LGTURB	597.0	586.0	648.0	0.0
F28-1000/RR_SPEY-MK555	685.0	666.0	696.0	742.0
FH7/MDTURB	63.1	55.0	69.1	0.0
FK5/*	0.0	0.0	0.0	32.8
FK7/LGTURB	0.0	0.0	0.0	57.5
FKF/*	0.0	0.0	0.0	571.0
HFH/*	0.0	0.0	0.0	1.5
HPJ/*	0.0	0.0	0.0	10.0
HS7/LGTURB	0.0	0.0	0.0	208.0
HSF/LGTURB	0.0	0.0	0.0	1.7
I62/SOL	0.0	0.0	0.0	1,050.0
IL8/LGTURB	0.0	0.0	0.0	263.0
L10-1/RB211-22B	4,820.0	5,260.0	6,140.0	5,320.0
L41/SMTURB	9.4	9.0	10.8	0.0
LEC/LGTURB	113.0	99.1	120.0	0.0
LHR/MDTURB	1.8	2.6	3.8	0.0
LJT/MDTURB	9.9	12.3	12.3	0.0
LOE/LGTURB	0.0	0.0	0.0	119.0
LOH/LGTURB	0.0	0.0	0.0	3.9
LT4/*	0.0	0.0	0.0	6.4
M20/SMTURB	126.0	133.0	132.0	0.0
MRC-100/JT8D-15	0.0	0.0	0.0	130.0
MU2/SMTURB	0.0	1.5	0.0	0.0
N26/MDTURB	44.8	43.6	47.9	0.0
ND2/MDTURB	0.0	0.0	0.0	42.3
NDC/*	0.0	0.0	0.0	69.8
PHP/SMTURB	10.2	7.6	9.8	0.0
PP6/*	0.2	0.2	0.2	0.0
S11/*	111.0	156.0	159.0	0.0
SA2/*	0.0	0.0	0.0	5.9
SH3/MDTURB	0.0	0.0	0.0	14.1

Appendix D. Fuel Burned in 1976 by Airplane Type

Airplane/engine	1976 Fuel burned in thousand kilograms/day Feb.	May	Aug.	Nov.
SHP/*	0.0	0.0	0.0	5.2
SHS/*	0.0	0.0	0.0	3.1
ST2/SMTURB	8.1	4.8	4.8	0.0
STV/*	34.7	27.6	31.5	0.0
SUV/*	175.0	188.0	159.0	0.0
SWM/SMTURB	32.7	34.4	45.1	42.1
T04/*	227.0	202.0	344.0	0.0
T1E/*	21.1	30.4	34.1	0.0
T24/*	43.0	44.7	48.6	0.0
T34/SOL	703.0	723.0	1,000.0	783.0
T54/SOL	445.0	680.0	992.0	780.0
TRD-2E/RR_SPEY-512	777.0	839.0	838.0	772.0
TS4/SMTURB	4.9	4.9	0.0	0.0
TS6/*	0.0	0.0	0.0	2.5
TU0/*	0.0	0.0	0.0	89.8
TU2/*	0.0	0.0	0.0	35.2
V10-1150/*	818.0	835.0	759.0	639.0
V70/MDTURB	3.6	4.6	7.2	0.0
V80/LGTURB	87.0	87.5	99.4	0.0
VAN/LGTURB	7.3	10.6	10.4	0.0
VC7/*	0.0	0.0	0.0	5.7
VC8/LGTURB	0.0	0.0	0.0	58.4
VCP/*	0.0	0.0	0.0	10.2
VCV/LGTURB	0.0	0.0	0.0	48.7
VF6/*	0.0	0.0	0.0	11.1
VIS/MDTURB	46.7	43.9	33.8	0.0
VOF/*	0.0	0.0	0.0	4.3
Y11/LGTURB	292.0	316.0	289.0	0.0
Y18/*	680.0	723.0	951.0	0.0
Y40/IVC	100.0	112.0	126.0	126.0
Y62/*	942.0	1,130.0	1,220.0	0.0
YS1/LGTURB	0.0	0.0	0.0	314.0
Total	117,359.1	125,639.4	135,291.5	121,775.9

Appendix E. NOx Emitted in 1976 by Airplane Type

Airplane/engine	1976 NOx (as NO2) emitted in kilograms/day Feb.	May	Aug.	Nov.
720-000/JT3D	13,200.0	14,600.0	17,800.0	7,260.0
727-100/JT8D-7B	134,000.0	137,000.0	150,000.0	124,000.0
72C/*	1,940.0	2,380.0	2,210.0	1,950.0
72S-200/JT8D-15	150,000.0	150,000.0	152,000.0	169,000.0
737-200/JT8D-7B	46,400.0	48,200.0	51,900.0	51,000.0
73C-200C/JT8D-9A	624.0	773.0	811.0	1,630.0
747-100/JT9D-7A	258,000.0	273,000.0	326,000.0	242,000.0
748/MDTURB	2,640.0	2,680.0	2,560.0	0.0
74C-100F/JT9D-7A	18,400.0	17,900.0	21,000.0	22,900.0
74P-SP/JT9D-7A	0.0	5,890.0	10,600.0	13,000.0
880-22/GE_CJ805-3	526.0	589.0	564.0	553.0
A12/MDTURB	120.0	37.2	37.2	0.0
A24/SMTURB	593.0	636.0	908.0	0.0
A30B2-100/CF6-50C2R	0.0	0.0	0.0	6,280.0
A3B/*	3,990.0	5,550.0	6,350.0	0.0
AC6/*	0.0	0.0	0.0	22.8
AN1/*	0.0	0.0	0.0	147.0
AN4/LGTURB	0.0	0.0	0.0	1,390.0
ARG/LGTURB	22.6	22.6	22.6	0.0
B2F-000B/JT3D-3B	0.0	0.0	0.0	7,600.0
B3C-320C/JT3D-3B	0.0	18,000.0	17,500.0	17,500.0
B3F-320B/JT3D	121,000.0	119,000.0	118,000.0	124,000.0
B3J/*	0.0	19,500.0	19,900.0	0.0
B99/SMTURB	1,480.0	1,510.0	1,560.0	0.0
BAC-200/RR_SPEY-506	14,200.0	13,700.0	14,400.0	18,900.0
BE9/SMTURB	0.0	0.0	0.0	1,520.0
BET/*	0.0	0.0	0.0	384.0
BRT/*	0.0	0.0	0.0	23.7
BTP/SMTURB	187.0	204.0	209.0	0.0
C44/*	0.0	0.0	40.0	0.0
CL4/LGTURB	0.0	0.0	0.0	40.0
CM4/*	432.0	234.0	0.0	0.0
CMT-4C/*	0.0	0.0	0.0	74.2
CONCORDE	693.0	1,070.0	2,430.0	2,040.0
CV5/LGTURB	3,130.0	2,990.0	3,290.0	1,760.0
CV6/LGTURB	0.0	0.0	0.0	397.0
CVL-3/*	7,000.0	7,130.0	6,440.0	7,650.0
CVS/*	2,130.0	1,960.0	1,900.0	0.0
D10-10/CF6-6D	153,000.0	157,000.0	181,000.0	157,000.0
D8C-32F/JT4A	15,900.0	16,300.0	14,800.0	13,400.0
D8F-51/JT3D	0.0	0.0	0.0	879.0
D8S-61/CFM56-2C	44,300.0	43,800.0	43,400.0	40,300.0
D9C-10C/JT8D-7B	1,720.0	1,780.0	1,620.0	1,740.0
D9S-30/JT8D-7B	58,400.0	59,600.0	60,600.0	67,200.0

Appendix E. NOx Emitted in 1976 by Airplane Type

Airplane/engine	1976 NOx (as NO2) emitted in kilograms/day Feb.	May	Aug.	Nov.
D9X-50/JT8D-17	0.0	2,530.0	2,210.0	3,600.0
DAF/*	0.0	0.0	0.0	3,820.0
DBV/*	0.0	6.8	6.8	0.0
DC8-21/JT4A	33,300.0	32,000.0	33,400.0	25,200.0
DC9-10/JT8D-7B	39,700.0	41,600.0	42,400.0	32,000.0
DFC-54F/JT3D-3B	0.0	0.0	0.0	532.0
DH7/LGTURB	0.0	19.6	41.6	0.0
DHT/SMTURB	0.0	0.0	0.0	1,900.0
DLR-40/JT9D-20	0.0	0.0	0.0	7,090.0
DME/*	1,040.0	1,090.0	1,100.0	0.0
DSC/*	0.0	0.0	0.0	482.0
DTO/SMTURB	1,970.0	1,890.0	1,990.0	0.0
EMB/SMTURB	462.0	254.0	223.0	104.0
F27/LGTURB	7,690.0	7,560.0	8,390.0	0.0
F28-1000/RR_SPEY-MK555	6,710.0	6,520.0	6,810.0	7,200.0
FH7/MDTURB	778.0	679.0	847.0	0.0
FK5/*	0.0	0.0	0.0	408.0
FK7/LGTURB	0.0	0.0	0.0	713.0
FKF/*	0.0	0.0	0.0	7,400.0
HFH/*	0.0	0.0	0.0	15.7
HPJ/*	0.0	0.0	0.0	79.0
HS7/LGTURB	0.0	0.0	0.0	2,660.0
HSF/LGTURB	0.0	0.0	0.0	22.6
I62/SOL	0.0	0.0	0.0	8,240.0
IL8/LGTURB	0.0	0.0	0.0	3,420.0
L10-1/RB211-22B	76,000.0	82,800.0	96,600.0	83,600.0
L41/SMTURB	76.8	72.5	87.0	0.0
LEC/LGTURB	1,490.0	1,310.0	1,580.0	0.0
LHR/MDTURB	18.6	28.4	41.3	0.0
LJT/MDTURB	110.0	137.0	137.0	0.0
LOE/LGTURB	0.0	0.0	0.0	1,570.0
LOH/LGTURB	0.0	0.0	0.0	49.4
LT4/*	0.0	0.0	0.0	52.0
M20/SMTURB	1,060.0	1,110.0	1,110.0	0.0
MRC-100/JT8D-15	0.0	0.0	0.0	1,290.0
MU2/SMTURB	0.0	11.9	0.0	0.0
N26/MDTURB	545.0	532.0	583.0	0.0
ND2/MDTURB	0.0	0.0	0.0	514.0
NDC/*	0.0	0.0	0.0	704.0
PHP/SMTURB	81.1	60.4	77.6	0.0
PP6/*	1.4	1.4	1.4	0.0
S11/*	1,440.0	2,020.0	2,060.0	0.0
SA2/*	0.0	0.0	0.0	49.2
SH3/MDTURB	0.0	0.0	0.0	178.0

Appendix E. NOx Emitted in 1976 by Airplane Type

Airplane/engine	1976 NOx (as NO2) emitted in kilograms/day Feb.	May	Aug.	Nov.
SHP/*	0.0	0.0	0.0	41.1
SHS/*	0.0	0.0	0.0	25.1
ST2/SMTURB	67.8	40.1	40.1	0.0
STV/*	339.0	272.0	307.0	0.0
SUV/*	1,320.0	1,430.0	1,190.0	0.0
SWM/SMTURB	263.0	277.0	366.0	342.0
T04/*	1,960.0	1,750.0	2,980.0	0.0
T1E/*	215.0	306.0	343.0	0.0
T24/*	545.0	565.0	615.0	0.0
T34/SOL	6,150.0	6,330.0	8,750.0	6,870.0
T54/SOL	4,350.0	6,670.0	9,730.0	7,620.0
TRD-2E/RR_SPEY-512	10,300.0	11,100.0	11,000.0	10,200.0
TS4/SMTURB	40.8	40.8	0.0	0.0
TS6/*	0.0	0.0	0.0	20.4
TU0/*	0.0	0.0	0.0	1,150.0
TU2/*	0.0	0.0	0.0	443.0
V10-1150/*	6,570.0	6,760.0	6,110.0	5,290.0
V70/MDTURB	44.3	56.5	88.6	0.0
V80/LGTURB	1,120.0	1,130.0	1,280.0	0.0
VAN/LGTURB	93.2	136.0	134.0	0.0
VC7/*	0.0	0.0	0.0	69.5
VC8/LGTURB	0.0	0.0	0.0	740.0
VCP/*	0.0	0.0	0.0	131.0
VCV/LGTURB	0.0	0.0	0.0	641.0
VF6/*	0.0	0.0	0.0	134.0
VIS/MDTURB	556.0	523.0	401.0	0.0
VOF/*	0.0	0.0	0.0	47.9
Y11/LGTURB	3,700.0	4,010.0	3,650.0	0.0
Y18/*	5,730.0	6,080.0	7,990.0	0.0
Y40/IVC	1,040.0	1,160.0	1,300.0	1,310.0
Y62/*	7,430.0	8,880.0	9,610.0	0.0
YS1/LGTURB	0.0	0.0	0.0	3,990.0
Total	1,278,334.6	1,362,785.2	1,495,432.2	1,335,498.6

Appendix F. Hydrocarbons Emitted in 1976 by Airplane Type

Airplane/engine	1976 Hydrocarbons emitted in kilograms/day Feb.	May	Aug.	Nov.
720-000/JT3D	33,800.0	37,400.0	46,200.0	18,900.0
727-100/JT8D-7B	23,200.0	23,800.0	25,800.0	21,500.0
72C/*	322.0	385.0	357.0	321.0
72S-200/JT8D-15	9,510.0	9,560.0	9,650.0	10,700.0
737-200/JT8D-7B	12,400.0	12,900.0	13,700.0	13,500.0
73C-200C/JT8D-9A	77.6	94.6	97.4	202.0
747-100/JT9D-7A	49,100.0	50,700.0	58,500.0	44,700.0
748/MDTURB	126.0	128.0	119.0	0.0
74C-100F/JT9D-7A	3,700.0	3,580.0	4,230.0	4,710.0
74P-SP/JT9D-7A	0.0	840.0	1,790.0	2,470.0
880-22/GE_CJ805-3	1,480.0	1,680.0	1,600.0	1,570.0
A12/MDTURB	2.4	0.8	0.8	0.0
A24/SMTURB	15.2	16.5	23.5	0.0
A30B2-100/CF6-50C2R	0.0	0.0	0.0	1,650.0
A3B/*	867.0	1,350.0	1,570.0	0.0
AC6/*	0.0	0.0	0.0	0.5
AN1/*	0.0	0.0	0.0	0.0
AN4/LGTURB	0.0	0.0	0.0	0.0
ARG/LGTURB	0.0	0.0	0.0	0.0
B2F-000B/JT3D-3B	0.0	0.0	0.0	19,600.0
B3C-320C/JT3D-3B	0.0	34,300.0	33,500.0	33,700.0
B3F-320B/JT3D	263,000.0	263,000.0	264,000.0	273,000.0
B3J/*	0.0	38,800.0	39,000.0	0.0
B99/SMTURB	46.6	47.6	49.5	0.0
BAC-200/RR_SPEY-506	18,800.0	18,300.0	19,300.0	24,600.0
BE9/SMTURB	0.0	0.0	0.0	48.0
BET/*	0.0	0.0	0.0	11.7
BRT/*	0.0	0.0	0.0	0.0
BTP/SMTURB	5.6	6.2	6.4	0.0
C44/*	0.0	0.0	0.0	0.0
CL4/LGTURB	0.0	0.0	0.0	0.0
CM4/*	1,350.0	722.0	0.0	0.0
CMT-4C/*	0.0	0.0	0.0	1,090.0
CONCORDE	60.0	98.6	194.0	163.0
CV5/LGTURB	0.0	0.0	0.0	0.0
CV6/LGTURB	0.0	0.0	0.0	0.0
CVL-3/*	3,580.0	3,650.0	3,300.0	3,890.0
CVS/*	299.0	273.0	266.0	0.0
D10-10/CF6-6D	29,100.0	29,900.0	34,600.0	30,000.0
D8C-32F/JT4A	28,800.0	29,500.0	27,600.0	26,100.0
D8F-51/JT3D	0.0	0.0	0.0	1,900.0
D8S-61/CFM56-2C	1,520.0	1,550.0	1,510.0	1,460.0
D9C-10C/JT8D-7B	390.0	399.0	373.0	394.0
D9S-30/JT8D-7B	15,000.0	15,300.0	15,600.0	17,200.0

Appendix F. Hydrocarbons Emitted in 1976 by Airplane Type

Airplane/engine	1976 Hydrocarbons emitted in kilograms/day Feb.	May	Aug.	Nov.
D9X-50/JT8D-17	0.0	179.0	156.0	250.0
DAF/*	0.0	0.0	0.0	176.0
DBV/*	0.0	0.3	0.3	0.0
DC8-21/JT4A	78,200.0	76,500.0	77,100.0	58,700.0
DC9-10/JT8D-7B	10,300.0	10,600.0	10,900.0	8,370.0
DFC-54F/JT3D-3B	0.0	0.0	0.0	657.0
DH7/LGTURB	0.0	0.0	0.0	0.0
DHT/SMTURB	0.0	0.0	0.0	66.2
DLR-40/JT9D-20	0.0	0.0	0.0	549.0
DME/*	317.0	332.0	327.0	0.0
DSC/*	0.0	0.0	0.0	20.9
DTO/SMTURB	68.7	68.8	72.6	0.0
EMB/SMTURB	6.2	6.4	5.6	2.7
F27/LGTURB	0.0	0.0	0.0	0.0
F28-1000/RR_SPEY-MK555	324.0	315.0	330.0	353.0
FH7/MDTURB	37.3	32.3	42.2	0.0
FK5/*	0.0	0.0	0.0	0.0
FK7/LGTURB	0.0	0.0	0.0	0.0
FKF/*	0.0	0.0	0.0	0.0
HFH/*	0.0	0.0	0.0	0.8
HPJ/*	0.0	0.0	0.0	2.4
HS7/LGTURB	0.0	0.0	0.0	0.0
HSF/LGTURB	0.0	0.0	0.0	0.0
I62/SOL	0.0	0.0	0.0	15,200.0
IL8/LGTURB	0.0	0.0	0.0	0.0
L10-1/RB211-22B	38,300.0	42,300.0	47,600.0	42,100.0
L41/SMTURB	2.1	2.1	2.5	0.0
LEC/LGTURB	0.0	0.0	0.0	0.0
LHR/MDTURB	0.9	1.3	1.7	0.0
LJT/MDTURB	5.4	6.5	6.5	0.0
LOE/LGTURB	0.0	0.0	0.0	0.0
LOH/LGTURB	0.0	0.0	0.0	0.0
LT4/*	0.0	0.0	0.0	1.4
M20/SMTURB	16.9	16.3	16.1	0.0
MRC-100/JT8D-15	0.0	0.0	0.0	101.0
MU2/SMTURB	0.0	0.3	0.0	0.0
N26/MDTURB	28.9	28.3	30.7	0.0
ND2/MDTURB	0.0	0.0	0.0	27.5
NDC/*	0.0	0.0	0.0	33.4
PHP/SMTURB	2.4	1.8	2.4	0.0
PP6/*	0.0	0.0	0.0	0.0
S11/*	0.0	0.0	0.0	0.0
SA2/*	0.0	0.0	0.0	1.2
SH3/MDTURB	0.0	0.0	0.0	7.9

Appendix F. Hydrocarbons Emitted in 1976 by Airplane Type

Airplane/engine	1976 Hydrocarbons emitted in kilograms/day Feb.	May	Aug.	Nov.
SHP/*	0.0	0.0	0.0	1.4
SHS/*	0.0	0.0	0.0	0.7
ST2/SMTURB	1.6	0.9	0.9	0.0
STV/*	19.4	16.8	16.5	0.0
SUV/*	2,710.0	2,930.0	2,400.0	0.0
SWM/SMTURB	7.7	8.2	10.1	9.3
T04/*	344.0	304.0	520.0	0.0
T1E/*	48.5	67.4	75.6	0.0
T24/*	0.0	0.0	0.0	0.0
T34/SOL	1,220.0	1,280.0	1,750.0	1,420.0
T54/SOL	262.0	405.0	592.0	459.0
TRD-2E/RR_SPEY-512	10,000.0	10,700.0	10,600.0	10,200.0
TS4/SMTURB	0.8	0.8	0.0	0.0
TS6/*	0.0	0.0	0.0	0.6
TU0/*	0.0	0.0	0.0	0.0
TU2/*	0.0	0.0	0.0	0.0
V10-1150/*	12,600.0	13,100.0	11,800.0	10,600.0
V70/MDTURB	2.0	2.5	4.4	0.0
V80/LGTURB	0.0	0.0	0.0	0.0
VAN/LGTURB	0.0	0.0	0.0	0.0
VC7/*	0.0	0.0	0.0	3.5
VC8/LGTURB	0.0	0.0	0.0	0.0
VCP/*	0.0	0.0	0.0	0.0
VCV/LGTURB	0.0	0.0	0.0	0.0
VF6/*	0.0	0.0	0.0	7.3
VIS/MDTURB	26.5	26.1	19.3	0.0
VOF/*	0.0	0.0	0.0	2.5
Y11/LGTURB	0.0	0.0	0.0	0.0
Y18/*	1,110.0	1,180.0	1,500.0	0.0
Y40/IVC	220.0	244.0	273.0	272.0
Y62/*	14,000.0	16,600.0	17,900.0	0.0
YS1/LGTURB	0.0	0.0	0.0	0.0
Total	666,733.7	755,537.6	786,992.0	702,976.7

Appendix G. Carbon Monoxide Emitted in 1976 by Airplane Type

	1976 CO emitted in kilograms/day			
Airplane/engine	Feb.	May	Aug.	Nov.
720-000/JT3D	30,600.0	33,900.0	41,800.0	17,100.0
727-100/JT8D-7B	79,300.0	81,600.0	88,300.0	73,500.0
72C/*	1,110.0	1,330.0	1,240.0	1,110.0
72S-200/JT8D-15	56,200.0	56,600.0	56,900.0	63,000.0
737-200/JT8D-7B	41,500.0	43,200.0	45,900.0	45,200.0
73C-200C/JT8D-9A	369.0	450.0	464.0	959.0
747-100/JT9D-7A	82,900.0	85,400.0	98,300.0	75,300.0
748/MDTURB	1,110.0	1,130.0	1,070.0	0.0
74C-100F/JT9D-7A	6,260.0	6,060.0	7,200.0	8,040.0
74P-SP/JT9D-7A	0.0	1,180.0	2,560.0	3,560.0
880-22/GE_CJ805-3	1,330.0	1,510.0	1,430.0	1,410.0
A12/MDTURB	46.2	14.7	14.7	0.0
A24/SMTURB	288.0	311.0	443.0	0.0
A30B2-100/CF6-50C2R	0.0	0.0	0.0	3,980.0
A3B/*	2,120.0	3,360.0	3,930.0	0.0
AC6/*	0.0	0.0	0.0	10.5
AN1/*	0.0	0.0	0.0	43.9
AN4/LGTURB	0.0	0.0	0.0	457.0
ARG/LGTURB	7.4	7.4	7.4	0.0
B2F-000B/JT3D-3B	0.0	0.0	0.0	17,700.0
B3C-320C/JT3D-3B	0.0	31,100.0	30,500.0	30,600.0
B3F-320B/JT3D	238,000.0	239,000.0	239,000.0	248,000.0
B3J/*	0.0	35,300.0	35,500.0	0.0
B99/SMTURB	795.0	811.0	840.0	0.0
BAC-200/RR_SPEY-506	32,600.0	31,800.0	33,500.0	42,800.0
BE9/SMTURB	0.0	0.0	0.0	818.0
BET/*	0.0	0.0	0.0	203.0
BRT/*	0.0	0.0	0.0	6.6
BTP/SMTURB	98.0	108.0	112.0	0.0
C44/*	0.0	0.0	11.7	0.0
CL4/LGTURB	0.0	0.0	0.0	11.7
CM4/*	1,190.0	642.0	0.0	0.0
CMT-4C/*	0.0	0.0	0.0	937.0
CONCORDE	415.0	666.0	1,430.0	1,210.0
CV5/LGTURB	1,070.0	1,020.0	1,110.0	636.0
CV6/LGTURB	0.0	0.0	0.0	134.0
CVL-3/*	12,400.0	12,700.0	11,500.0	13,500.0
CVS/*	1,150.0	1,050.0	1,020.0	0.0
D10-10/CF6-6D	66,900.0	68,500.0	79,700.0	69,000.0
D8C-32F/JT4A	42,100.0	43,000.0	40,200.0	37,700.0
D8F-51/JT3D	0.0	0.0	0.0	2,140.0
D8S-61/CFM56-2C	23,600.0	24,100.0	23,400.0	22,500.0
D9C-10C/JT8D-7B	1,280.0	1,320.0	1,230.0	1,300.0
D9S-30/JT8D-7B	48,900.0	50,000.0	50,800.0	56,100.0

Appendix G. Carbon Monoxide Emitted in 1976 by Airplane Type

Airplane/engine	1976 CO emitted in kilograms/day Feb.	May	Aug.	Nov.
D9X-50/JT8D-17	0.0	1,320.0	1,150.0	1,790.0
DAF/*	0.0	0.0	0.0	1,560.0
DBV/*	0.0	4.4	4.4	0.0
DC8-21/JT4A	110,000.0	108,000.0	109,000.0	82,800.0
DC9-10/JT8D-7B	33,500.0	34,600.0	35,400.0	27,200.0
DFC-54F/JT3D-3B	0.0	0.0	0.0	591.0
DH7/LGTURB	0.0	5.9	13.0	0.0
DHT/SMTURB	0.0	0.0	0.0	1,100.0
DLR-40/JT9D-20	0.0	0.0	0.0	1,220.0
DME/*	1,040.0	1,090.0	1,080.0	0.0
DSC/*	0.0	0.0	0.0	129.0
DTO/SMTURB	1,140.0	1,130.0	1,180.0	0.0
EMB/SMTURB	170.0	122.0	107.0	50.5
F27/LGTURB	2,590.0	2,540.0	2,770.0	0.0
F28-1000/RR_SPEY-MK555	3,280.0	3,190.0	3,360.0	3,620.0
FH7/MDTURB	319.0	278.0	351.0	0.0
FK5/*	0.0	0.0	0.0	147.0
FK7/LGTURB	0.0	0.0	0.0	255.0
FKF/*	0.0	0.0	0.0	2,450.0
HFH/*	0.0	0.0	0.0	7.7
HPJ/*	0.0	0.0	0.0	42.5
HS7/LGTURB	0.0	0.0	0.0	888.0
HSF/LGTURB	0.0	0.0	0.0	7.4
I62/SOL	0.0	0.0	0.0	13,900.0
IL8/LGTURB	0.0	0.0	0.0	1,050.0
L10-1/RB211-22B	57,000.0	62,800.0	71,100.0	62,700.0
L41/SMTURB	37.9	36.5	44.3	0.0
LEC/LGTURB	475.0	417.0	500.0	0.0
LHR/MDTURB	9.0	13.4	18.8	0.0
LJT/MDTURB	49.7	61.8	61.8	0.0
LOE/LGTURB	0.0	0.0	0.0	498.0
LOH/LGTURB	0.0	0.0	0.0	16.2
LT4/*	0.0	0.0	0.0	25.2
M20/SMTURB	419.0	429.0	426.0	0.0
MRC-100/JT8D-15	0.0	0.0	0.0	646.0
MU2/SMTURB	0.0	6.2	0.0	0.0
N26/MDTURB	227.0	220.0	242.0	0.0
ND2/MDTURB	0.0	0.0	0.0	213.0
NDC/*	0.0	0.0	0.0	348.0
PHP/SMTURB	42.5	32.0	41.5	0.0
PP6/*	0.7	0.7	0.7	0.0
S11/*	479.0	670.0	683.0	0.0
SA2/*	0.0	0.0	0.0	22.8
SH3/MDTURB	0.0	0.0	0.0	67.4

Appendix G. Carbon Monoxide Emitted in 1976 by Airplane Type

Airplane/engine	1976 CO emitted in kilograms/day Feb.	May	Aug.	Nov.
SHP/*	0.0	0.0	0.0	22.9
SHS/*	0.0	0.0	0.0	12.7
ST2/SMTURB	30.6	18.0	18.0	0.0
STV/*	100.0	85.5	85.9	0.0
SUV/*	3,170.0	3,420.0	2,820.0	0.0
SWM/SMTURB	135.0	143.0	182.0	169.0
T04/*	1,170.0	1,040.0	1,770.0	0.0
T1E/*	159.0	222.0	248.0	0.0
T24/*	182.0	189.0	205.0	0.0
T34/SOL	4,100.0	4,280.0	5,870.0	4,730.0
T54/SOL	1,400.0	2,180.0	3,200.0	2,460.0
TRD-2E/RR_SPEY-512	14,700.0	15,800.0	15,600.0	15,000.0
TS4/SMTURB	17.5	17.5	0.0	0.0
TS6/*	0.0	0.0	0.0	10.3
TU0/*	0.0	0.0	0.0	363.0
TU2/*	0.0	0.0	0.0	150.0
V10-1150/*	11,500.0	11,900.0	10,700.0	9,620.0
V70/MDTURB	17.1	21.9	35.4	0.0
V80/LGTURB	378.0	379.0	433.0	0.0
VAN/LGTURB	29.4	43.0	42.2	0.0
VC7/*	0.0	0.0	0.0	28.2
VC8/LGTURB	0.0	0.0	0.0	255.0
VCP/*	0.0	0.0	0.0	41.3
VCV/LGTURB	0.0	0.0	0.0	207.0
VF6/*	0.0	0.0	0.0	55.5
VIS/MDTURB	230.0	220.0	167.0	0.0
VOF/*	0.0	0.0	0.0	22.2
Y11/LGTURB	1,270.0	1,370.0	1,270.0	0.0
Y18/*	3,840.0	4,080.0	5,200.0	0.0
Y40/IVC	739.0	821.0	917.0	915.0
Y62/*	12,800.0	15,100.0	16,300.0	0.0
YS1/LGTURB	0.0	0.0	0.0	1,360.0
Total	1,040,385.0	1,135,466.9	1,192,009.8	1,077,733.5

Appendix H. Distance Flown in 1976 by Airplane Type

Airplane/engine	1976 Distance flown in 1000 nautical miles/day Feb.	May	Aug.	Nov.
720-000/JT3D	107.7	117.7	139.8	57.4
727-100/JT8D-7B	1,494.9	1,517.2	1,680.4	1,383.1
72C/*	22.2	28.3	26.2	22.6
72S-200/JT8D-15	1,262.7	1,256.9	1,285.0	1,439.3
737-200/JT8D-7B	702.9	732.0	791.9	779.8
73C-200C/JT8D-9A	8.8	11.4	12.4	23.9
747-100/JT9D-7A	802.7	854.6	1,022.1	756.9
748/MDTURB	87.7	89.4	86.7	0.0
74C-100F/JT9D-7A	57.5	55.9	65.1	70.6
74P-SP/JT9D-7A	0.0	21.1	37.6	46.4
880-22/GE_CJ805-3	3.5	3.8	3.7	3.7
A12/MDTURB	5.4	1.7	1.7	0.0
A24/SMTURB	34.6	37.1	52.8	0.0
A30B2-100/CF6-50C2R	0.0	0.0	0.0	22.0
A3B/*	16.0	20.7	23.5	0.0
AC6/*	0.0	0.0	0.0	1.3
AN1/*	0.0	0.0	0.0	5.0
AN4/LGTURB	0.0	0.0	0.0	38.3
ARG/LGTURB	0.6	0.6	0.6	0.0
B2F-000B/JT3D-3B	0.0	0.0	0.0	60.7
B3C-320C/JT3D-3B	0.0	199.5	192.9	192.9
B3F-320B/JT3D	1,183.1	1,152.5	1,123.5	1,201.3
B3J/*	0.0	210.4	216.3	0.0
B99/SMTURB	80.0	81.6	83.9	0.0
BAC-200/RR_SPEY-506	161.2	154.2	160.9	220.2
BE9/SMTURB	0.0	0.0	0.0	82.0
BET/*	0.0	0.0	0.0	20.9
BRT/*	0.0	0.0	0.0	0.8
BTP/SMTURB	10.4	11.3	11.5	0.0
C44/*	0.0	0.0	1.4	0.0
CL4/LGTURB	0.0	0.0	0.0	1.4
CM4/*	1.5	1.0	0.0	0.0
CMT-4C/*	0.0	0.0	0.0	0.5
CONCORDE	2.2	3.4	7.8	6.6
CV5/LGTURB	82.1	78.3	86.3	47.3
CV6/LGTURB	0.0	0.0	0.0	10.8
CVL-3/*	116.3	119.1	108.2	128.0
CVS/*	31.2	28.8	27.6	0.0
D10-10/CF6-6D	706.6	727.4	833.6	724.0
D8C-32F/JT4A	174.7	179.2	162.3	146.7
D8F-51/JT3D	0.0	0.0	0.0	9.3
D8S-61/CFM56-2C	366.0	362.1	357.6	331.1
D9C-10C/JT8D-7B	27.7	28.9	26.0	28.3
D9S-30/JT8D-7B	861.2	876.4	891.6	989.8

Appendix H. Distance Flown in 1976 by Airplane Type

Airplane/engine	1976 Distance flown in 1000 nautical miles/day Feb.	May	Aug.	Nov.
D9X-50/JT8D-17	0.0	26.6	22.8	40.0
DAF/*	0.0	0.0	0.0	68.1
DBV/*	0.0	0.3	0.3	0.0
DC8-21/JT4A	366.5	353.4	369.5	279.5
DC9-10/JT8D-7B	577.4	612.4	625.2	465.6
DFC-54F/JT3D-3B	0.0	0.0	0.0	5.1
DH7/LGTURB	0.0	0.5	1.1	0.0
DHT/SMTURB	0.0	0.0	0.0	98.5
DLR-40/JT9D-20	0.0	0.0	0.0	26.1
DME/*	15.6	16.5	16.8	0.0
DSC/*	0.0	0.0	0.0	12.0
DTO/SMTURB	101.2	97.1	102.2	0.0
EMB/SMTURB	27.7	14.5	12.7	6.1
F27/LGTURB	214.2	210.6	237.5	0.0
F28-1000/RR_SPEY-MK555	107.2	104.0	108.1	117.1
FH7/MDTURB	21.0	18.3	23.1	0.0
FK5/*	0.0	0.0	0.0	11.0
FK7/LGTURB	0.0	0.0	0.0	19.0
FKF/*	0.0	0.0	0.0	208.9
HFH/*	0.0	0.0	0.0	0.7
HPJ/*	0.0	0.0	0.0	4.4
HS7/LGTURB	0.0	0.0	0.0	76.8
HSF/LGTURB	0.0	0.0	0.0	0.6
I62/SOL	0.0	0.0	0.0	94.4
IL8/LGTURB	0.0	0.0	0.0	111.8
L10-1/RB211-22B	299.1	323.9	380.2	327.2
L41/SMTURB	4.3	4.0	4.8	0.0
LEC/LGTURB	42.9	37.6	46.5	0.0
LHR/MDTURB	0.8	1.2	1.8	0.0
LJT/MDTURB	4.2	5.4	5.4	0.0
LOE/LGTURB	0.0	0.0	0.0	46.1
LOH/LGTURB	0.0	0.0	0.0	1.6
LT4/*	0.0	0.0	0.0	3.0
M20/SMTURB	64.0	68.0	67.7	0.0
MRC-100/JT8D-15	0.0	0.0	0.0	15.7
MU2/SMTURB	0.0	0.7	0.0	0.0
N26/MDTURB	15.6	15.2	16.8	0.0
ND2/MDTURB	0.0	0.0	0.0	14.9
NDC/*	0.0	0.0	0.0	10.5
PHP/SMTURB	4.5	3.3	4.3	0.0
PP6/*	0.1	0.1	0.1	0.0
S11/*	43.5	61.6	62.6	0.0
SA2/*	0.0	0.0	0.0	2.5
SH3/MDTURB	0.0	0.0	0.0	5.0

Appendix H. Distance Flown in 1976 by Airplane Type

Airplane/engine	1976 Distance flown in 1000 nautical miles/day Feb.	May	Aug.	Nov.
SHP/*	0.0	0.0	0.0	2.2
SHS/*	0.0	0.0	0.0	1.4
ST2/SMTURB	3.5	2.0	2.0	0.0
STV/*	3.6	2.8	3.3	0.0
SUV/*	15.3	16.4	13.9	0.0
SWM/SMTURB	14.6	15.3	20.3	19.0
T04/*	36.8	33.0	55.9	0.0
T1E/*	1.7	2.6	2.9	0.0
T24/*	17.9	18.6	20.4	0.0
T34/SOL	108.8	111.2	154.5	119.5
T54/SOL	45.8	69.3	101.0	80.1
TRD-2E/RR_SPEY-512	81.3	88.2	88.4	79.7
TS4/SMTURB	2.3	2.3	0.0	0.0
TS6/*	0.0	0.0	0.0	1.1
TU0/*	0.0	0.0	0.0	38.6
TU2/*	0.0	0.0	0.0	14.6
V10-1150/*	72.9	74.2	67.7	56.2
V70/MDTURB	1.4	1.8	2.6	0.0
V80/LGTURB	31.3	31.8	36.1	0.0
VAN/LGTURB	3.1	4.6	4.5	0.0
VC7/*	0.0	0.0	0.0	2.1
VC8/LGTURB	0.0	0.0	0.0	21.0
VCP/*	0.0	0.0	0.0	4.4
VCV/LGTURB	0.0	0.0	0.0	17.8
VF6/*	0.0	0.0	0.0	4.0
VIS/MDTURB	18.2	16.7	13.3	0.0
VOF/*	0.0	0.0	0.0	1.8
Y11/LGTURB	105.5	114.8	102.4	0.0
Y18/*	106.6	113.3	151.2	0.0
Y40/IVC	6.9	7.7	8.9	9.1
Y62/*	84.9	101.7	110.0	0.0
YS1/LGTURB	0.0	0.0	0.0	114.1
Total	11,083.8	11,765.7	12,589.8	11,511.5

Appendix I. Daily Departures in 1976 by Airplane Type

Airplane/engine	1976 Daily Departures Feb.	May	Aug.	Nov.
720-000/JT3D	158	176	218	90
727-100/JT8D-7B	3,191	3,304	3,532	2,977
72C/*	44	50	47	43
72S-200/JT8D-15	3,009	3,060	3,051	3,343
737-200/JT8D-7B	2,587	2,677	2,867	2,819
73C-200C/JT8D-9A	28	34	34	72
747-100/JT9D-7A	420	433	499	382
748/MDTURB	531	539	494	0
74C-100F/JT9D-7A	32	31	37	41
74P-SP/JT9D-7A	0	5	12	16
880-22/GE_CJ805-3	7	8	8	7
A12/MDTURB	6	2	2	0
A24/SMTURB	191	205	299	0
A30B2-100/CF6-50C2R	0	0	0	59
A3B/*	28	47	54	0
AC6/*	0	0	0	6
AN1/*	0	0	0	5
AN4/LGTURB	0	0	0	226
ARG/LGTURB	3	3	3	0
B2F-000B/JT3D-3B	0	0	0	91
B3C-320C/JT3D-3B	0	126	124	125
B3F-320B/JT3D	1,077	1,089	1,101	1,128
B3J/*	0	148	146	0
B99/SMTURB	818	836	876	0
BAC-200/RR_SPEY-506	655	643	678	845
BE9/SMTURB	0	0	0	847
BET/*	0	0	0	204
BRT/*	0	0	0	1
BTP/SMTURB	90	102	110	0
C44/*	0	0	1	0
CL4/LGTURB	0	0	0	1
CM4/*	8	4	0	0
CMT-4C/*	0	0	0	13
Concorde	1	1	3	2
CV5/LGTURB	842	805	862	517
CV6/LGTURB	0	0	0	83
CVL-3/*	380	386	347	410
CVS/*	101	91	89	0
D10-10/CF6-6D	559	573	666	573
D8C-32F/JT4A	139	142	133	128
D8F-51/JT3D	0	0	0	9

Appendix I. Daily Departures in 1976 by Airplane Type

Airplane/engine	1976 Feb.	Daily Departures May	Aug.	Nov.
D8S-61/CFM56-2C	376	389	378	369
D9C-10C/JT8D-7B	77	78	72	76
D9S-30/JT8D-7B	3,206	3,282	3,333	3,671
D9X-50/JT8D-17	0	115	102	149
DAF/*	0	0	0	168
DBV/*	0	7	7	0
DC8-21/JT4A	388	379	380	291
DC9-10/JT8D-7B	2,209	2,256	2,290	1,786
DFC-54F/JT3D-3B	0	0	0	3
DH7/LGTURB	0	3	6	0
DHT/SMTURB	0	0	0	1,453
DLR-40/JT9D-20	0	0	0	13
DME/*	56	58	57	0
DSC/*	0	0	0	5
DTO/SMTURB	1,524	1,523	1,589	0
EMB/SMTURB	85	89	80	32
F27/LGTURB	1,402	1,362	1,400	0
F28-1000/RR_SPEY-MK555	374	365	387	406
FH7/MDTURB	220	192	241	0
FK5/*	0	0	0	104
FK7/LGTURB	0	0	0	195
FKF/*	0	0	0	1,221
HFH/*	0	0	0	2
HPJ/*	0	0	0	42
HS7/LGTURB	0	0	0	446
HSF/LGTURB	0	0	0	3
I62/SOL	0	0	0	54
IL8/LGTURB	0	0	0	196
L10-1/RB211-22B	371	411	461	410
L41/SMTURB	31	31	39	0
LEC/LGTURB	183	161	182	0
LHR/MDTURB	2	3	4	0
LJT/MDTURB	17	20	20	0
LOE/LGTURB	0	0	0	179
LOH/LGTURB	0	0	0	4
LT4/*	0	0	0	21
M20/SMTURB	175	162	160	0
MRC-100/JT8D-15	0	0	0	55
MU2/SMTURB	0	4	0	0
N26/MDTURB	142	134	149	0
ND2/MDTURB	0	0	0	127

Appendix I. Daily Departures in 1976 by Airplane Type

Airplane/engine	1976 Feb.	Daily Departures May	Aug.	Nov.
NDC/*	0	0	0	40
PHP/SMTURB	44	33	40	0
PP6/*	1	1	1	0
S11/*	159	210	218	0
SA2/*	0	0	0	27
SH3/MDTURB	0	0	0	39
SHP/*	0	0	0	26
SHS/*	0	0	0	10
ST2/SMTURB	32	22	22	0
STV/*	3	3	2	0
SUV/*	12	14	11	0
SWM/SMTURB	124	131	161	148
T04/*	57	50	86	0
T1E/*	7	9	11	0
T24/*	41	42	44	0
T34/SOL	217	229	311	255
T54/SOL	51	83	122	90
TRD-2E/RR_SPEY-512	169	180	178	173
TS4/SMTURB	14	14	0	0
TS6/*	0	0	0	9
TU0/*	0	0	0	60
TU2/*	0	0	0	34
V10-1150/*	47	50	44	41
V70/MDTURB	9	11	22	0
V80/LGTURB	201	191	218	0
VAN/LGTURB	5	7	7	0
VC7/*	0	0	0	17
VC8/LGTURB	0	0	0	143
VCP/*	0	0	0	7
VCV/LGTURB	0	0	0	102
VF6/*	0	0	0	29
VIS/MDTURB	111	113	78	0
VOF/*	0	0	0	9
Y11/LGTURB	708	755	746	0
Y18/*	194	211	256	0
Y40/IVC	40	45	49	49
Y62/*	50	59	63	0
YS1/LGTURB	0	0	0	742
Total	28,039	29,007	30,320	28,594

Appendix J. Fuel Burned in 1984 by Airplane Type

Airplane/engine	1984 Fuel burned in thousand kilograms/day Feb.	May	Aug.	Nov.
146-200/ALF502R-5	57.6	70.4	163.0	173.0
720-000/JT3C-12	293.0	457.0	284.0	343.0
727-100/JT8D-7B	9,070.0	9,470.0	8,860.0	8,350.0
72C-100F/JT8D-7B	540.0	566.0	582.0	626.0
72S-200/JT8D-15	29,500.0	30,900.0	33,400.0	32,300.0
737-200/JT8D-7B	12,700.0	12,800.0	13,300.0	13,200.0
73C-200C/JT8D-17	396.0	448.0	507.0	442.0
747-100/JT9D-7A	33,300.0	35,100.0	39,700.0	34,000.0
74C-100F/JT9D-7A	4,680.0	5,250.0	5,380.0	5,760.0
74P-SP/JT9D-7A	2,850.0	3,150.0	3,140.0	2,970.0
74Q-200M/CF6-50E2	0.0	0.0	0.0	138.0
74U-300/JT9D-7R4G2	689.0	978.0	1,030.0	1,180.0
74X-100SR/CF6-45A2	212.0	369.0	439.0	506.0
757-200/RB211-535C	588.0	660.0	669.0	731.0
767-200/JT9D-7R4D	2,520.0	2,680.0	3,210.0	3,090.0
7UQ-300M/CF6-50E2	0.0	133.0	128.0	144.0
880-22/GE_CJ805-3	3.3	3.3	3.3	3.3
A30B4-100/CF6-50C2	6,370.0	6,690.0	7,290.0	6,800.0
A31-200/CF6-80A3	328.0	655.0	781.0	729.0
AC6/*	7.6	4.1	1.6	1.6
AN2/*	1.2	1.2	1.2	1.2
AN4/LGTURB	110.0	107.0	130.0	108.0
AN6/LGTURB	2.6	2.6	2.6	2.6
ANF/MDTURB	1.7	1.7	0.9	0.9
B3C-320C/JT3D-3B	1,140.0	1,250.0	1,170.0	1,140.0
B3F-320B/JT3D	2,840.0	2,740.0	2,510.0	2,420.0
B7F-120B/JT3D	48.0	57.7	79.4	13.6
BAC-500/RR_SPEY-512	1,500.0	1,350.0	1,370.0	1,220.0
BE1/SMTURB	0.0	0.0	0.0	48.8
BE2/*	0.0	14.3	27.9	0.0
BE3/SMTURB	1.6	1.6	1.9	1.6
BE9/SMTURB	239.0	254.0	280.0	268.0
BEK/SMTURB	0.5	0.7	0.4	4.5
CD2/SMTURB	4.9	4.7	4.9	5.3
CL4/LGTURB	4.6	4.6	4.6	4.6
CNC/SMTURB	3.7	3.8	1.6	4.1
CONCORDE	370.0	404.0	404.0	404.0
CV5/LGTURB	51.9	53.7	32.3	44.4
CV6/LGTURB	14.5	19.7	19.2	19.2
CVL-12/JT8D-9	177.0	165.0	136.0	171.0
D10-10/CF6-6D	14,500.0	14,900.0	16,500.0	15,100.0

Appendix J. Fuel Burned in 1984 by Airplane Type

Airplane/engine	1984 Fuel burned in thousand kilograms/day Feb.	May	Aug.	Nov.
D1C-10F/CF6-6D	159.0	82.1	82.1	82.1
D8C-21F/JT4A	1,750.0	1,640.0	1,540.0	1,400.0
D8F-51/JT3D-3B	201.0	222.0	231.0	214.0
D8S-71/CFM56-2C	2,170.0	2,170.0	2,420.0	2,010.0
D9C-30F/JT8D-7B	157.0	133.0	128.0	125.0
D9S-30/JT8D-7B	9,360.0	9,450.0	9,440.0	9,250.0
D9X-50/JT8D-17	1,530.0	1,590.0	1,530.0	1,470.0
D9Z-82/JT8D-217	2,840.0	3,030.0	3,430.0	3,630.0
DC8/*	448.0	436.0	475.0	349.0
DC9-10/JT8D-7B	1,900.0	2,090.0	2,220.0	1,960.0
DFC-54F/JT3D-3B	0.0	0.0	22.1	14.2
DFL/*	79.4	79.4	79.4	79.4
DH7/LGTURB	226.0	231.0	250.0	237.0
DHB/SMTURB	1.4	2.2	1.9	0.5
DHT/SMTURB	441.0	436.0	442.0	416.0
DLR-40/JT9D-59A	2,130.0	2,070.0	2,570.0	2,920.0
DO8/SMTURB	2.3	10.9	17.0	25.5
EMB/SMTURB	436.0	420.0	406.0	424.0
F27/LGTURB	511.0	580.0	584.0	595.0
F28-4000/RR_SPEY-MK555	1,260.0	1,400.0	1,400.0	1,480.0
F2A/LGTURB	1.6	0.6	0.0	0.0
F2B/LGTURB	8.9	9.3	5.8	9.6
F2E/LGTURB	55.7	7.6	5.1	6.6
F2S/*	10.7	13.0	14.9	22.9
FK7/LGTURB	71.8	74.6	65.5	60.0
GR1/*	0.0	4.1	4.1	4.1
HPJ/*	53.3	38.7	23.0	23.0
HS7/LGTURB	227.0	222.0	228.0	220.0
HSF/LGTURB	3.3	2.4	2.4	2.4
I62/SOL	1,100.0	1,120.0	1,240.0	1,090.0
I72/*	25.6	25.6	25.6	25.6
I86/KUZ	125.0	162.0	152.0	148.0
IL8/LGTURB	59.6	67.4	77.7	56.8
J31/SMTURB	0.0	27.7	58.5	63.9
L10-1/RB211-22B	8,010.0	8,740.0	8,850.0	7,680.0
LLR-500/RB211-524B4	1,580.0	1,750.0	2,070.0	1,640.0
LOE/LGTURB	80.0	82.6	86.8	54.3
LOF/LGTURB	15.2	15.8	16.0	45.9
LOH/LGTURB	17.4	14.9	16.8	11.4
LOM/LGTURB	11.1	6.6	7.8	8.2
LRJ/*	22.0	25.8	32.7	42.8

Appendix J. Fuel Burned in 1984 by Airplane Type

Airplane/engine	1984 Fuel burned in thousand kilograms/day Feb.	May	Aug.	Nov.
LV2/*	0.7	0.7	0.7	0.7
MRC-100/JT8D-15	160.0	165.0	154.0	164.0
MU2/SMTURB	3.7	0.0	0.0	1.6
ND2/MDTURB	41.5	41.3	47.7	44.4
PA1/*	5.8	8.3	12.2	17.2
PA6/SMTURB	2.1	2.1	0.8	0.0
PL6/SMTURB	0.7	0.7	1.8	1.8
RV1/*	3.2	6.0	0.3	0.1
SA2/*	5.1	5.0	4.8	4.9
SF3/MDTURB	0.0	0.4	12.4	34.5
SH3/MDTURB	195.0	190.0	185.0	174.0
SH6/MDTURB	73.7	111.0	133.0	138.0
SHP/*	2.5	2.5	0.7	0.8
SHS/*	0.9	2.9	4.7	2.5
SWM/SMTURB	553.0	583.0	600.0	637.0
T34/SOL	542.0	566.0	667.0	557.0
T54/SOL	1,240.0	1,460.0	1,660.0	1,400.0
TRD-2E/RR_SPEY-512	514.0	531.0	530.0	450.0
VC8/LGTURB	0.0	2.0	2.5	1.7
VCV/LGTURB	48.0	52.8	42.8	39.9
VGP/*	5.0	0.9	0.9	0.8
Y40/IVC	93.1	112.0	113.0	104.0
YN5/*	1.9	1.9	1.9	1.9
YS1/LGTURB	253.0	263.0	261.0	272.0
Total	165,940.7	174,000.0	186,000.0	174,000.0

Appendix K. NOx Emitted in 1984 by Airplane Type

Airplane/engine	1984 NOx (as NO2) emitted in kilograms/day Feb.	May	Aug.	Nov.
146-200/ALF502R-5	499.0	605.0	1,400.0	1,480.0
720-000/JT3C-12	1,490.0	2,320.0	1,450.0	1,750.0
727-100/JT8D-7B	85,300.0	88,800.0	83,000.0	78,500.0
72C-100F/JT8D-7B	5,070.0	5,300.0	5,470.0	5,850.0
72S-200/JT8D-15	298,000.0	312,000.0	337,000.0	326,000.0
737-200/JT8D-7B	109,000.0	110,000.0	114,000.0	113,000.0
73C-200C/JT8D-17	3,840.0	4,360.0	4,970.0	4,320.0
747-100/JT9D-7A	514,000.0	542,000.0	613,000.0	525,000.0
74C-100F/JT9D-7A	72,100.0	80,700.0	82,700.0	88,200.0
74P-SP/JT9D-7A	43,200.0	47,700.0	47,800.0	45,200.0
74Q-200M/CF6-50E2	0.0	0.0	0.0	2,090.0
74U-300/JT9D-7R4G2	11,000.0	15,500.0	16,300.0	18,900.0
74X-100SR/CF6-45A2	3,470.0	6,090.0	7,250.0	8,350.0
757-200/RB211-535C	7,340.0	8,070.0	8,190.0	9,000.0
767-200/JT9D-7R4D	38,500.0	40,900.0	48,600.0	46,500.0
7UQ-300M/CF6-50E2	0.0	2,110.0	2,020.0	2,280.0
880-22/GE_CJ805-3	16.7	16.7	16.7	16.7
A30B4-100/CF6-50C2	111,000.0	117,000.0	127,000.0	118,000.0
A31-200/CF6-80A3	4,840.0	9,530.0	11,400.0	10,600.0
AC6/*	61.5	33.4	12.2	12.2
AN2/*	13.4	13.4	13.4	13.4
AN4/LGTURB	1,450.0	1,420.0	1,730.0	1,430.0
AN6/LGTURB	33.6	33.6	33.6	33.6
ANF/MDTURB	18.7	18.7	10.1	10.1
B3C-320C/JT3D-3B	9,280.0	10,000.0	9,500.0	9,190.0
B3F-320B/JT3D	24,900.0	24,600.0	22,200.0	21,400.0
B7F-120B/JT3D	377.0	476.0	657.0	123.0
BAC-500/RR_SPEY-512	17,000.0	15,400.0	15,600.0	13,900.0
BE1/SMTURB	0.0	0.0	0.0	390.0
BE2/*	0.0	116.0	223.0	0.0
BE3/SMTURB	12.1	12.1	14.5	12.1
BE9/SMTURB	1,910.0	2,040.0	2,250.0	2,150.0
BEK/SMTURB	4.2	5.8	3.2	37.3
CD2/SMTURB	37.9	36.3	38.0	40.9
CL4/LGTURB	60.9	60.9	60.9	60.9
CNC/SMTURB	30.0	31.1	13.5	33.6
CONCORDE	5,940.0	6,480.0	6,480.0	6,480.0
CV5/LGTURB	672.0	696.0	412.0	569.0
CV6/LGTURB	185.0	252.0	249.0	245.0
CVL-12/JT8D-9	1,490.0	1,400.0	1,140.0	1,440.0
D10-10/CF6-6D	209,000.0	215,000.0	237,000.0	218,000.0
D1C-10F/CF6-6D	3,460.0	1,800.0	1,800.0	1,800.0
D8C-21F/JT4A	10,500.0	9,840.0	9,210.0	8,420.0
D8F-51/JT3D-3B	1,490.0	1,790.0	1,810.0	1,720.0

Appendix K. NOx Emitted in 1984 by Airplane Type

Airplane/engine	1984 NOx (as NO2) emitted in kilograms/day Feb.	May	Aug.	Nov.
D8S-71/CFM56-2C	22,800.0	22,900.0	25,400.0	21,100.0
D9C-30F/JT8D-7B	1,340.0	1,130.0	1,100.0	1,070.0
D9S-30/JT8D-7B	83,200.0	84,000.0	84,000.0	82,400.0
D9X-50/JT8D-17	15,600.0	16,200.0	15,600.0	15,000.0
D9Z-82/JT8D-217	36,200.0	38,600.0	43,500.0	45,800.0
DC8/*	2,910.0	2,820.0	3,070.0	2,270.0
DC9-10/JT8D-7B	16,900.0	18,700.0	19,800.0	17,400.0
DFC-54F/JT3D-3B	0.0	0.0	172.0	114.0
DFL/*	660.0	660.0	660.0	660.0
DH7/LGTURB	2,900.0	2,960.0	3,200.0	3,020.0
DHB/SMTURB	9.6	15.4	12.6	3.2
DHT/SMTURB	3,420.0	3,390.0	3,440.0	3,240.0
DLR-40/JT9D-59A	27,800.0	27,100.0	33,400.0	38,100.0
DO8/SMTURB	17.5	86.3	135.0	204.0
EMB/SMTURB	3,500.0	3,370.0	3,260.0	3,400.0
F27/LGTURB	6,640.0	7,540.0	7,590.0	7,720.0
F28-4000/RR_SPEY-MK555	10,800.0	12,000.0	11,900.0	12,600.0
F2A/LGTURB	21.7	7.6	0.0	0.0
F2B/LGTURB	110.0	115.0	71.5	118.0
F2E/LGTURB	722.0	99.3	65.6	86.2
F2S/*	142.0	171.0	194.0	303.0
FK7/LGTURB	931.0	967.0	843.0	765.0
GR1/*	0.0	34.1	34.1	34.1
HPJ/*	434.0	317.0	186.0	185.0
HS7/LGTURB	2,910.0	2,850.0	2,940.0	2,820.0
HSF/LGTURB	42.7	29.8	29.8	29.8
I62/SOL	8,590.0	8,760.0	9,730.0	8,460.0
I72/*	228.0	228.0	228.0	228.0
I86/KUZ	1,120.0	1,460.0	1,330.0	1,290.0
IL8/LGTURB	770.0	865.0	997.0	730.0
J31/SMTURB	0.0	226.0	480.0	524.0
L10-1/RB211-22B	126,000.0	138,000.0	139,000.0	121,000.0
LLR-500/RB211-524B4	22,400.0	24,800.0	29,300.0	23,200.0
LOE/LGTURB	1,050.0	1,080.0	1,140.0	721.0
LOF/LGTURB	193.0	201.0	202.0	584.0
LOH/LGTURB	223.0	192.0	216.0	147.0
LOM/LGTURB	143.0	85.5	101.0	105.0
LRJ/*	181.0	213.0	267.0	350.0
LV2/*	6.1	6.1	6.1	6.1
MRC-100/JT8D-15	1,600.0	1,640.0	1,530.0	1,630.0
MU2/SMTURB	29.1	0.0	0.0	13.3
ND2/MDTURB	505.0	505.0	582.0	543.0
PA1/*	46.5	67.1	99.1	137.0
PA6/SMTURB	15.8	15.8	5.6	0.0

Appendix K. NOx Emitted in 1984 by Airplane Type

Airplane/engine	1984 NOx (as NO2) emitted in kilograms/day Feb.	May	Aug.	Nov.
PL6/SMTURB	4.7	4.7	12.9	12.9
RV1/*	24.7	46.7	2.2	0.4
SA2/*	41.3	40.6	38.5	39.6
SF3/MDTURB	0.0	5.0	148.0	403.0
SH3/MDTURB	2,390.0	2,340.0	2,270.0	2,140.0
SH6/MDTURB	908.0	1,360.0	1,630.0	1,700.0
SHP/*	19.4	19.4	5.5	5.9
SHS/*	7.0	22.5	36.3	18.8
SWM/SMTURB	4,510.0	4,750.0	4,890.0	5,190.0
T34/SOL	4,750.0	4,940.0	5,840.0	4,880.0
T54/SOL	12,200.0	14,400.0	16,400.0	13,800.0
TRD-2E/RR_SPEY-512	6,920.0	7,130.0	7,110.0	5,990.0
VC8/LGTURB	0.0	25.8	32.6	22.5
VCV/LGTURB	634.0	699.0	564.0	525.0
VGP/*	64.5	11.0	11.0	10.6
Y40/IVC	940.0	1,140.0	1,160.0	1,060.0
YN5/*	14.9	14.9	14.9	14.9
YS1/LGTURB	3,210.0	3,350.0	3,310.0	3,460.0
Total	2,036,341.4	2,149,263.6	2,311,320.3	2,149,932.1

Appendix L. Carbon Monoxide Emitted in 1984 by Airplane Type

	1984 CO emitted in kilograms/day			
Airplane/engine	Feb.	May	Aug.	Nov.
146-200/ALF502R-5	440.0	504.0	1,060.0	1,130.0
720-000/JT3C-12	5,540.0	8,310.0	5,610.0	6,520.0
727-100/JT8D-7B	51,200.0	52,700.0	49,400.0	47,000.0
72C-100F/JT8D-7B	3,090.0	3,210.0	3,340.0	3,520.0
72S-200/JT8D-15	105,000.0	110,000.0	118,000.0	115,000.0
737-200/JT8D-7B	93,500.0	94,300.0	97,300.0	96,700.0
73C-200C/JT8D-17	1,700.0	1,950.0	2,240.0	1,930.0
747-100/JT9D-7A	147,000.0	153,000.0	172,000.0	147,000.0
74C-100F/JT9D-7A	24,400.0	26,600.0	27,300.0	28,400.0
74P-SP/JT9D-7A	11,500.0	12,500.0	12,700.0	11,700.0
74Q-200M/CF6-50E2	0.0	0.0	0.0	682.0
74U-300/JT9D-7R4G2	1,410.0	2,020.0	2,120.0	2,440.0
74X-100SR/CF6-45A2	2,270.0	4,230.0	4,980.0	5,800.0
757-200/RB211-535C	7,790.0	8,360.0	8,490.0	9,510.0
767-200/JT9D-7R4D	4,890.0	5,200.0	6,160.0	5,850.0
7UQ-300M/CF6-50E2	0.0	566.0	485.0	569.0
880-22/GE_CJ805-3	52.3	52.3	52.3	52.3
A30B4-100/CF6-50C2	56,300.0	60,100.0	64,500.0	59,800.0
A31-200/CF6-80A3	1,640.0	3,020.0	3,590.0	3,330.0
AC6/*	30.0	16.9	7.0	7.0
AN2/*	6.3	6.3	6.3	6.3
AN4/LGTURB	469.0	460.0	557.0	463.0
AN6/LGTURB	11.2	11.2	11.2	11.2
ANF/MDTURB	7.7	7.7	4.1	4.1
B3C-320C/JT3D-3B	16,800.0	17,800.0	17,000.0	16,500.0
B3F-320B/JT3D	49,600.0	49,900.0	44,500.0	42,900.0
B7F-120B/JT3D	665.0	905.0	1,250.0	257.0
BAC-500/RR_SPEY-512	38,400.0	33,700.0	34,100.0	30,500.0
BE1/SMTURB	0.0	0.0	0.0	205.0
BE2/*	0.0	57.9	116.0	0.0
BE3/SMTURB	7.0	7.0	8.4	7.0
BE9/SMTURB	1,000.0	1,070.0	1,170.0	1,120.0
BEK/SMTURB	2.1	2.6	1.3	16.2
CD2/SMTURB	22.0	21.0	21.8	23.3
CL4/LGTURB	17.1	17.1	17.1	17.1
CNC/SMTURB	14.1	14.7	6.4	15.8
CONCORDE	3,540.0	3,860.0	3,860.0	3,860.0
CV5/LGTURB	225.0	232.0	140.0	193.0
CV6/LGTURB	61.7	84.0	82.6	82.2
CVL-12/JT8D-9	911.0	851.0	690.0	874.0
D10-10/CF6-6D	88,900.0	89,200.0	97,700.0	92,800.0
D1C-10F/CF6-6D	597.0	420.0	420.0	420.0
D8C-21F/JT4A	33,300.0	31,600.0	29,200.0	26,900.0
D8F-51/JT3D-3B	3,770.0	4,990.0	4,950.0	4,820.0

Appendix L. Carbon Monoxide Emitted in 1984 by Airplane Type

Airplane/engine	1984 CO emitted in kilograms/day Feb.	May	Aug.	Nov.
D8S-71/CFM56-2C	13,100.0	13,200.0	14,000.0	12,700.0
D9C-30F/JT8D-7B	979.0	802.0	778.0	753.0
D9S-30/JT8D-7B	64,600.0	65,300.0	65,100.0	64,700.0
D9X-50/JT8D-17	7,350.0	7,650.0	7,380.0	7,040.0
D9Z-82/JT8D-217	13,600.0	14,400.0	16,200.0	17,000.0
DC8/*	6,210.0	5,780.0	7,730.0	6,260.0
DC9-10/JT8D-7B	13,800.0	15,300.0	15,900.0	14,000.0
DFC-54F/JT3D-3B	0.0	0.0	235.0	167.0
DFL/*	1,330.0	1,330.0	1,330.0	1,330.0
DH7/LGTURB	977.0	1,000.0	1,080.0	1,030.0
DHB/SMTURB	8.0	11.9	10.5	3.5
DHT/SMTURB	1,970.0	1,940.0	1,960.0	1,830.0
DLR-40/JT9D-59A	6,250.0	5,150.0	6,570.0	7,470.0
DO8/SMTURB	10.1	44.4	69.7	105.0
EMB/SMTURB	1,810.0	1,750.0	1,690.0	1,770.0
F27/LGTURB	2,210.0	2,520.0	2,530.0	2,580.0
F28-4000/RR_SPEY-MK555	29,400.0	32,200.0	31,700.0	33,700.0
F2A/LGTURB	6.8	2.4	0.0	0.0
F2B/LGTURB	39.8	41.5	26.3	42.6
F2E/LGTURB	244.0	33.2	22.5	28.6
F2S/*	45.9	55.8	64.3	98.5
FK7/LGTURB	314.0	325.0	288.0	264.0
GR1/*	0.0	53.9	53.9	53.9
HPJ/*	209.0	147.0	93.1	93.2
HS7/LGTURB	990.0	969.0	998.0	958.0
HSF/LGTURB	14.6	10.3	10.3	10.3
I62/SOL	14,300.0	14,800.0	16,400.0	14,100.0
I72/*	483.0	483.0	483.0	483.0
I86/KUZ	2,380.0	3,090.0	2,750.0	2,680.0
IL8/LGTURB	248.0	279.0	322.0	235.0
J31/SMTURB	0.0	110.0	223.0	247.0
L10-1/RB211-22B	92,100.0	91,300.0	91,000.0	82,600.0
LLR-500/RB211-524B4	23,400.0	25,600.0	29,500.0	23,500.0
LOE/LGTURB	337.0	348.0	366.0	230.0
LOF/LGTURB	64.1	66.8	67.5	192.0
LOH/LGTURB	74.8	63.6	71.6	48.5
LOM/LGTURB	44.6	26.4	31.4	32.9
LRJ/*	298.0	350.0	405.0	513.0
LV2/*	3.1	3.1	3.1	3.1
MRC-100/JT8D-15	802.0	823.0	763.0	816.0
MU2/SMTURB	16.2	0.0	0.0	6.1
ND2/MDTURB	211.0	209.0	241.0	225.0
PA1/*	23.6	34.7	49.9	72.3
PA6/SMTURB	9.7	9.7	4.6	0.0

Appendix L. Carbon Monoxide Emitted in 1984 by Airplane Type

Airplane/engine	1984 CO emitted in kilograms/day Feb.	May	Aug.	Nov.
PL6/SMTURB	4.5	4.5	9.5	9.5
RV1/*	14.3	27.3	1.3	0.3
SA2/*	21.1	20.5	19.6	20.6
SF3/MDTURB	0.0	2.2	63.8	177.0
SH3/MDTURB	982.0	960.0	930.0	879.0
SH6/MDTURB	374.0	561.0	672.0	696.0
SHP/*	10.7	10.7	3.2	3.4
SHS/*	4.2	13.3	21.7	11.4
SWM/SMTURB	2,210.0	2,340.0	2,410.0	2,550.0
T34/SOL	3,230.0	3,260.0	3,960.0	3,300.0
T54/SOL	3,970.0	4,730.0	5,400.0	4,530.0
TRD-2E/RR_SPEY-512	10,800.0	11,000.0	10,900.0	8,990.0
VC8/LGTURB	0.0	8.4	10.5	7.2
VCV/LGTURB	201.0	220.0	180.0	167.0
VGP/*	20.9	3.9	3.9	3.7
Y40/IVC	643.0	793.0	801.0	729.0
YN5/*	8.2	8.2	8.2	8.2
YS1/LGTURB	1,120.0	1,160.0	1,150.0	1,200.0
Total	1,079,955.7	1,114,592.2	1,160,191.7	1,092,189.2

Appendix M. Hydrocarbons Emitted in 1984 by Airplane Type

	1984 Hydrocarbons emitted in kilograms/day			
Airplane/engine	Feb.	May	Aug.	Nov.
146-200/ALF502R-5	41.5	47.6	101.0	108.0
720-000/JT3C-12	5,460.0	8,080.0	5,580.0	6,420.0
727-100/JT8D-7B	15,000.0	15,400.0	14,400.0	13,800.0
72C-100F/JT8D-7B	909.0	943.0	983.0	1,030.0
72S-200/JT8D-15	18,500.0	19,400.0	20,900.0	20,200.0
737-200/JT8D-7B	27,800.0	28,100.0	28,900.0	28,800.0
73C-200C/JT8D-17	269.0	305.0	346.0	301.0
747-100/JT9D-7A	87,700.0	91,100.0	103,000.0	88,000.0
74C-100F/JT9D-7A	14,400.0	15,700.0	16,100.0	16,800.0
74P-SP/JT9D-7A	8,000.0	8,690.0	8,830.0	8,130.0
74Q-200M/CF6-50E2	0.0	0.0	0.0	411.0
74U-300/JT9D-7R4G2	239.0	342.0	360.0	413.0
74X-100SR/CF6-45A2	1,450.0	2,680.0	3,160.0	3,660.0
757-200/RB211-535C	726.0	812.0	824.0	892.0
767-200/JT9D-7R4D	790.0	839.0	993.0	945.0
7UQ-300M/CF6-50E2	0.0	366.0	324.0	378.0
880-22/GE_CJ805-3	48.1	48.1	48.1	48.1
A30B4-100/CF6-50C2	23,200.0	24,700.0	26,600.0	24,700.0
A31-200/CF6-80A3	372.0	690.0	823.0	765.0
AC6/*	1.6	0.9	0.4	0.4
AN2/*	0.8	0.8	0.8	0.8
AN4/LGTURB	0.0	0.0	0.0	0.0
AN6/LGTURB	0.0	0.0	0.0	0.0
ANF/MDTURB	0.5	0.5	0.2	0.2
B3C-320C/JT3D-3B	18,400.0	19,500.0	18,700.0	18,100.0
B3F-320B/JT3D	54,600.0	55,100.0	49,000.0	47,300.0
B7F-120B/JT3D	733.0	996.0	1,380.0	284.0
BAC-500/RR_SPEY-512	22,200.0	19,500.0	19,700.0	17,600.0
BE1/SMTURB	0.0	0.0	0.0	11.7
BE2/*	0.0	3.2	6.6	0.0
BE3/SMTURB	0.4	0.4	0.5	0.4
BE9/SMTURB	58.1	61.4	66.6	64.0
BEK/SMTURB	0.1	0.1	0.0	0.7
CD2/SMTURB	1.3	1.3	1.3	1.4
CL4/LGTURB	0.0	0.0	0.0	0.0
CNC/SMTURB	0.7	0.7	0.3	0.8
CONCORDE	480.0	524.0	524.0	524.0
CV5/LGTURB	0.0	0.0	0.0	0.0
CV6/LGTURB	0.0	0.0	0.0	0.0
CVL-12/JT8D-9	192.0	180.0	146.0	185.0
D10-10/CF6-6D	39,000.0	39,400.0	43,200.0	40,700.0
D1C-10F/CF6-6D	223.0	154.0	154.0	154.0
D8C-21F/JT4A	23,600.0	22,400.0	20,800.0	19,100.0
D8F-51/JT3D-3B	3,070.0	4,130.0	4,050.0	4,020.0

Appendix M. Hydrocarbons Emitted in 1984 by Airplane Type

	1984 Hydrocarbons emitted in kilograms/day			
Airplane/engine	Feb.	May	Aug.	Nov.
D8S-71/CFM56-2C	850.0	850.0	901.0	829.0
D9C-30F/JT8D-7B	197.0	161.0	156.0	151.0
D9S-30/JT8D-7B	19,700.0	19,900.0	19,800.0	19,700.0
D9X-50/JT8D-17	1,050.0	1,100.0	1,050.0	1,010.0
D9Z-82/JT8D-217	4,220.0	4,490.0	5,050.0	5,310.0
DC8/*	4,270.0	3,950.0	5,420.0	4,470.0
DC9-10/JT8D-7B	4,220.0	4,670.0	4,860.0	4,270.0
DFC-54F/JT3D-3B	0.0	0.0	257.0	183.0
DFL/*	1,630.0	1,630.0	1,630.0	1,630.0
DH7/LGTURB	0.0	0.0	0.0	0.0
DHB/SMTURB	0.5	0.8	0.7	0.2
DHT/SMTURB	120.0	117.0	118.0	109.0
DLR-40/JT9D-59A	1,820.0	1,560.0	1,980.0	2,250.0
DO8/SMTURB	0.6	2.5	3.9	5.9
EMB/SMTURB	103.0	99.4	96.4	101.0
F27/LGTURB	0.0	0.0	0.0	0.0
F28-4000/RR_SPEY-MK555	34,500.0	37,900.0	37,400.0	39,700.0
F2A/LGTURB	0.0	0.0	0.0	0.0
F2B/LGTURB	0.0	0.0	0.0	0.0
F2E/LGTURB	0.0	0.0	0.0	0.0
F2S/*	0.0	0.0	0.0	0.0
FK7/LGTURB	0.0	0.0	0.0	0.0
GR1/*	0.0	67.7	67.7	67.7
HPJ/*	10.8	7.4	5.1	5.1
HS7/LGTURB	0.0	0.0	0.0	0.0
HSF/LGTURB	0.0	0.0	0.0	0.0
I62/SOL	15,700.0	16,200.0	18,000.0	15,400.0
I72/*	530.0	530.0	530.0	530.0
I86/KUZ	2,610.0	3,390.0	3,020.0	2,940.0
IL8/LGTURB	0.0	0.0	0.0	0.0
J31/SMTURB	0.0	5.8	11.2	12.7
L10-1/RB211-22B	61,400.0	59,900.0	59,400.0	54,500.0
LLR-500/RB211-524B4	11,200.0	12,200.0	13,900.0	11,200.0
LOE/LGTURB	0.0	0.0	0.0	0.0
LOF/LGTURB	0.0	0.0	0.0	0.0
LOH/LGTURB	0.0	0.0	0.0	0.0
LOM/LGTURB	0.0	0.0	0.0	0.0
LRJ/*	373.0	438.0	517.0	658.0
LV2/*	0.2	0.2	0.2	0.2
MRC-100/JT8D-15	125.0	128.0	119.0	127.0
MU2/SMTURB	1.0	0.0	0.0	0.3
ND2/MDTURB	27.1	26.9	31.2	28.5
PA1/*	1.3	2.0	2.8	4.1
PA6/SMTURB	0.6	0.6	0.3	0.0

Appendix M. Hydrocarbons Emitted in 1984 by Airplane Type

Airplane/engine	1984 Hydrocarbons emitted in kilograms/day Feb.	May	Aug.	Nov.
PL6/SMTURB	0.3	0.3	0.6	0.6
RV1/*	0.9	1.7	0.1	0.0
SA2/*	1.2	1.2	1.1	1.2
SF3/MDTURB	0.0	0.3	7.9	22.1
SH3/MDTURB	121.0	116.0	113.0	108.0
SH6/MDTURB	43.6	68.2	81.8	83.3
SHP/*	0.7	0.7	0.2	0.2
SHS/*	0.3	0.8	1.4	0.7
SWM/SMTURB	120.0	127.0	131.0	139.0
T34/SOL	967.0	970.0	1,180.0	985.0
T54/SOL	737.0	872.0	993.0	836.0
TRD-2E/RR_SPEY-512	7,290.0	7,480.0	7,440.0	6,100.0
VC8/LGTURB	0.0	0.0	0.0	0.0
VCV/LGTURB	0.0	0.0	0.0	0.0
VGP/*	0.0	0.0	0.0	0.0
Y40/IVC	190.0	235.0	237.0	215.0
YN5/*	0.5	0.5	0.5	0.5
YS1/LGTURB	0.0	0.0	0.0	0.0
Total	541,598.7	559,397.0	574,518.0	537,533.1

Appendix N. Distance Flown in 1984 by Airplane Type

Airplane/engine	1984 Distance flown in 1000 nautical miles/day Feb.	May	Aug.	Nov.
146-200/ALF502R-5	6.4	8.2	20.1	21.4
720-000/JT3C-12	22.8	36.7	21.9	27.0
727-100/JT8D-7B	929.6	984.5	922.1	862.0
72C-100F/JT8D-7B	56.0	59.1	60.3	65.8
72S-200/JT8D-15	2,757.3	2,894.0	3,142.7	3,028.9
737-200/JT8D-7B	1,733.0	1,751.2	1,832.4	1,816.8
73C-200C/JT8D-17	54.4	60.6	67.5	59.2
747-100/JT9D-7A	1,594.0	1,676.2	1,896.2	1,624.2
74C-100F/JT9D-7A	225.5	253.4	259.5	278.5
74P-SP/JT9D-7A	152.2	167.1	166.7	157.3
74Q-200M/CF6-50E2	0.0	0.0	0.0	6.6
74U-300/JT9D-7R4G2	33.0	46.9	49.3	56.4
74X-100SR/CF6-45A2	9.0	15.2	18.3	20.9
757-200/RB211-535C	62.6	71.0	72.0	76.0
767-200/JT9D-7R4D	249.5	265.6	317.7	309.3
7UQ-300M/CF6-50E2	0.0	6.3	6.1	6.9
880-22/GE_CJ805-3	0.3	0.3	0.3	0.3
A30B4-100/CF6-50C2	448.3	468.1	512.5	478.4
A31-200/CF6-80A3	30.0	61.7	74.3	69.5
AC6/*	3.5	1.9	0.7	0.7
AN2/*	0.5	0.5	0.5	0.5
AN4/LGTURB	40.2	39.3	47.7	39.6
AN6/LGTURB	1.0	1.0	1.0	1.0
ANF/MDTURB	0.8	0.8	0.5	0.5
B3C-320C/JT3D-3B	102.2	111.8	104.6	101.2
B3F-320B/JT3D	246.3	234.0	216.1	208.5
B7F-120B/JT3D	4.5	5.3	7.2	1.2
BAC-500/RR_SPEY-512	197.8	182.1	186.3	164.2
BE1/SMTURB	0.0	0.0	0.0	21.5
BE2/*	0.0	6.6	12.4	0.0
BE3/SMTURB	0.6	0.6	0.8	0.6
BE9/SMTURB	103.6	110.9	122.6	116.8
BEK/SMTURB	0.2	0.3	0.2	2.2
CD2/SMTURB	2.0	1.9	2.0	2.2
CL4/LGTURB	2.1	2.1	2.1	2.1
CNC/SMTURB	1.8	1.9	0.8	2.0
CONCORDE	19.3	21.0	21.0	21.0
CV5/LGTURB	18.9	19.7	11.7	16.1
CV6/LGTURB	5.9	7.6	7.3	7.3
CVL-12/JT8D-9	20.7	19.2	16.2	20.2
D10-10/CF6-6D	977.6	1,011.7	1,119.5	1,020.7

Appendix N. Distance Flown in 1984 by Airplane Type

Airplane/engine	1984 Distance flown in 1000 nautical miles/day Feb.	May	Aug.	Nov.
D1C-10F/CF6-6D	10.3	5.2	5.2	5.2
D8C-21F/JT4A	116.3	108.8	102.7	93.9
D8F-51/JT3D-3B	18.1	18.6	19.9	18.4
D8S-71/CFM56-2C	190.2	190.6	213.5	175.8
D9C-30F/JT8D-7B	24.0	20.5	19.9	19.4
D9S-30/JT8D-7B	1,317.3	1,328.9	1,329.9	1,293.0
D9X-50/JT8D-17	180.5	188.1	179.3	175.2
D9Z-82/JT8D-217	359.3	384.0	439.8	467.5
DC8/*	33.5	32.8	35.8	25.8
DC9-10/JT8D-7B	258.3	283.8	305.2	270.7
DFC-54F/JT3D-3B	0.0	0.0	1.8	1.1
DFL/*	13.3	13.3	13.3	13.3
DH7/LGTURB	75.5	77.4	83.8	79.5
DHB/SMTURB	0.4	0.7	0.6	0.1
DHT/SMTURB	178.3	177.2	179.7	170.3
DLR-40/JT9D-59A	125.1	122.2	151.5	172.2
DO8/SMTURB	0.9	4.7	7.4	11.3
EMB/SMTURB	194.0	186.1	179.7	187.6
F27/LGTURB	182.9	207.6	208.2	212.2
F28-4000/RR_SPEY-MK555	180.6	202.0	201.9	213.5
F2A/LGTURB	0.6	0.2	0.0	0.0
F2B/LGTURB	2.9	3.1	1.9	3.2
F2E/LGTURB	19.6	2.8	2.0	2.5
F2S/*	3.7	4.5	5.1	7.9
FK7/LGTURB	25.1	26.0	22.9	20.5
GR1/*	0.0	0.8	0.8	0.8
HPJ/*	25.1	18.4	10.6	10.6
HS7/LGTURB	79.9	78.4	80.6	77.9
HSF/LGTURB	1.3	0.9	0.9	0.9
I62/SOL	99.0	100.3	111.1	97.7
I72/*	2.3	2.3	2.3	2.3
I86/KUZ	11.1	14.4	13.6	13.2
IL8/LGTURB	24.4	27.9	32.4	23.7
J31/SMTURB	0.0	13.1	28.1	30.4
L10-1/RB211-22B	494.8	546.8	555.0	479.1
LLR-500/RB211-524B4	112.8	124.8	147.2	116.5
LOE/LGTURB	31.3	32.5	34.2	20.7
LOF/LGTURB	6.2	6.4	6.4	18.9
LOH/LGTURB	6.9	5.9	6.7	4.5
LOM/LGTURB	4.8	2.9	3.4	3.5
LRJ/*	3.9	4.6	5.9	7.8

Appendix N. Distance Flown in 1984 by Airplane Type

Airplane/engine	1984 Distance flown in 1000 nautical miles/day Feb.	May	Aug.	Nov.
LV2/*	0.4	0.4	0.4	0.4
MRC-100/JT8D-15	19.2	19.9	18.5	19.8
MU2/SMTURB	1.6	0.0	0.0	0.8
ND2/MDTURB	14.6	14.6	16.9	15.4
PA1/*	2.6	3.7	5.6	7.6
PA6/SMTURB	0.9	0.9	0.3	0.0
PL6/SMTURB	0.2	0.2	0.6	0.6
RV1/*	1.3	2.5	0.1	0.0
SA2/*	2.3	2.3	2.1	2.2
SF3/MDTURB	0.0	0.2	4.7	13.7
SH3/MDTURB	66.5	64.0	62.3	59.3
SH6/MDTURB	24.6	38.2	45.6	46.4
SHP/*	1.1	1.1	0.3	0.3
SHS/*	0.4	1.2	1.9	1.0
SWM/SMTURB	250.2	263.9	271.0	288.0
T34/SOL	83.2	88.0	102.5	85.6
T54/SOL	126.4	147.2	166.4	141.3
TRD-2E/RR_SPEY-512	50.9	53.0	53.0	45.9
VC8/LGTURB	0.0	0.7	0.9	0.6
VCV/LGTURB	18.1	19.9	16.4	15.3
VGP/*	2.1	0.3	0.3	0.3
Y40/IVC	7.1	8.4	8.4	7.7
YN5/*	0.8	0.8	0.8	0.8
YS1/LGTURB	90.2	93.6	92.3	96.3
Total	15,292.6	174,000.0	186,000.0	174,000.0

Appendix O. Daily Departures in 1984 by Airplane Type

Airplane/engine	1984 Feb.	Daily Departures May	Aug.	Nov.
146-200/ALF502R-5	43	50	102	109
720-000/JT3C-12	40	56	40	46
727-100/JT8D-7B	2,111	2,140	1,997	1,915
72C-100F/JT8D-7B	122	125	131	137
72S-200/JT8D-15	5,019	5,215	5,572	5,405
737-200/JT8D-7B	5,570	5,599	5,742	5,666
73C-200C/JT8D-17	131	153	179	154
747-100/JT9D-7A	743	774	871	746
74C-100F/JT9D-7A	124	135	139	144
74P-SP/JT9D-7A	52	56	57	53
74Q-200M/CF6-50E2	0	0	0	4
74U-300/JT9D-7R4G2	10	15	16	18
74X-100SR/CF6-45A2	15	29	34	40
757-200/RB211-535C	117	126	127	157
767-200/JT9D-7R4D	315	333	391	360
7UQ-300M/CF6-50E2	0	3	2	3
880-22/GE_CJ805-3	1	1	1	1
A30B4-100/CF6-50C2	727	779	833	772
A31-200/CF6-80A3	56	97	112	103
AC6/*	22	13	8	8
AN2/*	2	2	2	2
AN4/LGTURB	212	207	249	211
AN6/LGTURB	4	4	4	4
ANF/MDTURB	1	1	1	1
B3C-320C/JT3D-3B	69	72	70	67
B3F-320B/JT3D	225	234	205	196
B7F-120B/JT3D	3	4	5	1
BAC-500/RR_SPEY-512	750	648	654	588
BE1/SMTURB	0	0	0	197
BE2/*	0	48	110	0
BE3/SMTURB	8	8	10	8
BE9/SMTURB	1,000	1,046	1,119	1,104
BEK/SMTURB	1	1	1	8
CD2/SMTURB	25	24	25	26
CL4/LGTURB	1	1	1	1
CNC/SMTURB	7	8	3	8
CONCORDE	6	7	7	7
CV5/LGTURB	114	113	76	102

Appendix O. Daily Departures in 1984 by Airplane Type

Airplane/engine	1984 Feb.	Daily Departures May	Aug.	Nov.
CV6/LGTURB	16	35	33	36
CVL-12/JT8D-9	79	74	59	76
D10-10/CF6-6D	723	716	782	756
D1C-10F/CF6-6D	7	6	6	6
D8C-21F/JT4A	114	109	99	91
D8F-51/JT3D-3B	14	24	22	21
D8S-71/CFM56-2C	218	220	229	211
D9C-30F/JT8D-7B	50	40	39	37
D9S-30/JT8D-7B	3,896	3,938	3,913	3,919
D9X-50/JT8D-17	598	618	600	549
D9Z-82/JT8D-217	832	878	955	992
DC8/*	31	28	40	34
DC9-10/JT8D-7B	867	959	990	867
DFC-54F/JT3D-3B	0	0	1	1
DFL/*	37	37	37	37
DH7/LGTURB	709	721	767	741
DHB/SMTURB	15	20	19	8
DHT/SMTURB	2,453	2,418	2,435	2,263
DLR-40/JT9D-59A	67	53	68	77
DO8/SMTURB	13	48	71	101
EMB/SMTURB	1,668	1,632	1,565	1,635
F27/LGTURB	1,169	1,331	1,354	1,385
F28-4000/RR_SPEY-MK555	813	891	880	933
F2A/LGTURB	3	1	0	0
F2B/LGTURB	30	31	21	32
F2E/LGTURB	133	12	7	10
F2S/*	27	35	41	59
FK7/LGTURB	179	188	169	171
GR1/*	0	1	1	1
HPJ/*	148	102	74	74
HS7/LGTURB	574	554	569	542
HSF/LGTURB	4	3	3	3
I62/SOL	55	57	63	53
I72/*	2	2	2	2
I86/KUZ	11	14	12	12
IL8/LGTURB	62	66	70	51
J31/SMTURB	0	75	143	167
L10-1/RB211-22B	601	578	573	528

Appendix O. Daily Departures in 1984 by Airplane Type

Airplane/engine	1984 Daily Departures Feb.	May	Aug.	Nov.
LLR-500/RB211-524B4	69	76	85	69
LOE/LGTURB	103	105	110	78
LOF/LGTURB	17	20	21	50
LOH/LGTURB	23	19	21	15
LOM/LGTURB	7	4	5	5
LRJ/*	8	10	11	14
LV2/*	2	2	2	2
MRC-100/JT8D-15	69	70	65	69
MU2/SMTURB	17	0	0	3
ND2/MDTURB	124	119	140	134
PA1/*	20	31	40	70
PA6/SMTURB	12	12	8	0
PL6/SMTURB	9	9	16	16
RV1/*	17	32	1	1
SA2/*	19	18	17	18
SF3/MDTURB	0	1	29	73
SH3/MDTURB	636	643	618	576
SH6/MDTURB	253	356	430	460
SHP/*	11	11	4	4
SHS/*	5	15	25	13
SWM/SMTURB	1,923	2,020	2,098	2,206
T34/SOL	172	170	212	177
T54/SOL	151	184	213	177
TRD-2E/RR_SPEY-512	127	129	128	105
VC8/LGTURB	0	4	5	4
VCV/LGTURB	83	89	69	63
VGP/*	5	2	2	1
Y40/IVC	35	42	43	40
YN5/*	8	8	8	8
YS1/LGTURB	623	653	657	688
Total	38,412	39,496	40,691	39,992

Appendix P. RPM Trend Data

Annual air traffic in revenue passenger miles is compiled by Boeing for selected regional traffic flows. (Boeing, 1995) In Table P-1, tables of the RPMs for each year and each region are shown for the time period 1970-94. In the plots which follow the tables, the RPMs for each region are plotted as function of year. Superimposed on each plot is the result of a fit of the data in the 1976-92 time period to a simple exponential function [y=A exp (kt)]. Although for many regions, the fits are good representations of the data, for other regions the traffic change with time is more complicated. In those cases, the line is only used to help visualize the data.

Table P-2 shows the annual growth rates derived from the fits of the 1976-92 RPM data. Regions which were poorly represented by the fit have not been included in this table.

Table P-1. World Traffic by Market (RPMS in billions)

Region	1970	1971	1972	1973	1974	1975	1976
CIS	46.912	52.869	56.720	58.396	64.130	71.907	76.857
CANADA	5.014	5.141	5.956	7.493	8.515	8.747	8.968
USA	109.491	109.965	121.936	130.486	133.669	135.999	151.378
LATIN AMERICA	4.385	5.056	6.168	7.011	8.247	9.473	10.744
EUROPE	8.456	9.818	11.235	12.470	13.317	13.743	14.852
AFRICA	1.302	1.402	1.587	1.916	2.268	2.428	2.577
INDIAN SUB.	1.694	2.052	1.518	1.688	1.663	2.042	2.389
M.E.	0.435	0.493	0.578	0.703	0.840	1.249	1.761
OCEANIA	3.562	3.854	4.065	4.474	4.675	4.770	5.089
ASIA	1.225	1.401	1.473	1.869	2.351	2.631	2.940
JAPAN	5.083	5.885	7.077	9.088	10.458	11.166	11.876
CHINA	0.311	0.373	0.385	0.391	0.435	0.652	0.690
DOMSTIC TOTL	**187.870**	**198.308**	**218.698**	**235.985**	**250.568**	**264.807**	**290.121**
International Flights							
CIS INT'L	2.285	2.719	3.353	3.719	4.500	5.598	5.733
US MAC(INT'L)	5.041	7.525	4.176	3.337	2.444	2.395	1.646
LATIN AMER - AFRICA	0.429	0.498	0.656	0.793	0.986	1.067	0.863
LATIN AMER- OCEANIA	0.007	0.010	0.011	0.011	0.015	0.022	0.033
INTRA AFRICA	2.006	2.114	2.470	2.713	3.153	3.224	3.374
AFR- INDIAN SUB.	0.265	0.300	0.341	0.363	0.369	0.421	0.474
AFR- M.E.	1.097	1.309	1.457	1.634	2.071	1.592	1.980
AFR-OCEANIA	0.180	0.191	0.236	0.268	0.275	0.261	0.268
INTRA INDIA SUB.	0.303	0.242	0.295	0.364	0.288	0.351	0.379
INDIAN SUB.-M.E.	1.043	0.974	1.352	1.703	1.772	2.131	2.517
INDIAN SUB.-OCE.	0.000	0.000	0.008	0.011	0.293	0.457	0.533
INDIAN SUB.-ASIA	0.924	0.960	1.046	1.169	1.252	1.335	1.510
INSIAN SUB.-EUROPE	1.387	1.347	1.960	2.500	3.115	3.973	4.320
INTRA M.E.	1.666	2.331	2.785	3.722	4.274	5.531	5.911
M.E.-OCEANIA	0.000	0.000	0.000	0.000	0.000	0.000	0.000
M.E.-ASIA	2.288	2.582	2.876	3.203	3.505	3.896	4.104
M.E.-EUROPE	4.819	6.001	6.885	7.648	7.972	9.599	11.995
INTRA OCEANIA	0.871	1.020	1.236	1.491	1.765	1.872	1.834
OCEANIA-N.AMER	1.487	1.736	2.069	2.473	2.511	2.451	2.901
OCEANIA-ASIA	2.179	2.590	3.568	4.361	5.128	5.611	6.028
N.AMER-M.E.	0.613	0.795	0.885	0.844	0.865	0.679	0.878
INTRA N. AMER	4.116	4.317	4.144	5.058	5.971	6.270	6.979
N.AMER-L.AMER	10.253	11.028	12.641	13.820	14.988	14.805	15.637
N.AMER-ASIA	6.708	7.440	9.888	11.058	12.336	12.399	13.354
N.AMER-AFRICA	0.101	0.090	0.143	0.148	0.196	0.289	0.305
N.AMER-EUROPE	41.432	47.130	57.699	63.702	56.649	53.789	61.105
INTRA L.AMER	3.687	3.445	4.255	4.830	5.560	6.042	5.667
L. AMER-EUROPE	3.784	4.391	5.197	6.585	7.697	9.151	8.551
INTRA ASIA	3.652	3.733	4.699	6.227	6.687	7.440	7.680
ASIA-AFRICA	0.009	0.013	0.014	0.018	0.023	0.047	0.056
ASIA-EUROPE	3.587	3.781	5.327	6.984	8.389	10.084	11.019
AFRICA-EUROPE	9.847	10.224	10.171	11.331	11.940	14.502	16.018
INTRA EUROPE	28.535	35.871	42.050	46.813	46.871	50.401	52.151
International Total	**144.599**	**166.709**	**193.895**	**218.901**	**223.860**	**237.683**	**255.804**
WORLD TOTAL	**332.470**	**365.017**	**412.593**	**454.886**	**474.428**	**502.491**	**545.926**

Table P-1. World Traffic by Market (RPMS in billions)

Region	1977	1978	1979	1980	1981	1982	1983
CIS	74.368	81.656	87.778	94.015	100.229	100.624	103.239
CANADA	9.041	9.771	11.217	12.391	12.633	11.133	10.717
USA	163.219	187.809	211.680	203.658	201.337	213.198	232.426
LATIN AMERICA	11.431	12.737	14.806	16.284	16.374	17.396	17.915
EUROPE	16.024	16.743	18.757	18.557	19.438	20.654	21.802
AFRICA	2.866	3.251	3.685	3.135	3.935	4.090	3.811
INDIAN SUB.	2.696	3.199	3.416	3.450	3.803	4.181	4.552
M.E.	2.474	3.073	3.371	3.983	3.759	4.400	5.101
OCEANIA	5.151	5.384	5.698	5.905	6.283	6.298	6.377
ASIA	3.530	4.070	4.323	4.353	4.616	4.821	5.181
JAPAN	14.407	16.068	18.444	18.650	19.374	18.646	18.880
CHINA	0.715	0.976	1.650	1.656	1.934	2.405	2.206
DOMSTIC TOTL	**305.922**	**344.738**	**384.824**	**386.037**	**393.715**	**407.845**	**432.205**
International Flights							
CIS INT'L	6.179	7.020	7.917	7.541	8.421	8.608	8.662
US MAC(INT'L)	1.516	1.467	1.231	1.224	1.269	1.471	2.173
LATIN AMER - AFRICA	0.955	1.145	1.257	1.004	0.709	0.486	0.321
LATIN AMER- OCEANIA	0.072	0.076	0.085	0.086	0.052	0.126	0.061
INTRA AFRICA	3.612	3.958	3.987	4.018	4.181	4.118	4.372
AFR- INDIAN SUB.	0.505	0.505	0.511	0.449	0.529	0.652	0.565
AFR- M.E.	2.430	2.869	3.169	3.545	4.300	4.887	4.669
AFR-OCEANIA	0.210	0.137	0.245	0.245	0.305	0.339	0.436
INTRA INDIA SUB.	0.403	0.416	0.476	0.615	0.678	0.693	0.705
INDIAN SUB.-M.E.	3.348	3.750	4.321	4.876	6.193	6.662	6.720
INDIAN SUB.-OCE.	0.539	0.689	0.864	0.960	0.789	0.845	0.395
INDIAN SUB.-ASIA	1.772	2.122	2.414	2.387	2.659	2.711	2.679
INSIAN SUB.-EUROPE	4.872	6.082	6.815	6.055	6.459	6.402	6.082
INTRA M.E.	5.220	6.220	6.810	6.986	7.482	7.410	8.705
M.E.-OCEANIA	0.000	0.000	0.000	0.094	0.096	0.099	0.122
M.E.-ASIA	4.173	5.740	7.109	7.073	9.360	10.193	11.393
M.E.-EUROPE	15.360	18.196	19.111	18.626	18.850	19.551	19.603
INTRA OCEANIA	1.878	2.065	2.343	2.557	2.468	2.537	2.533
OCEANIA-N.AMER	3.031	3.734	4.638	4.788	4.647	4.789	4.950
OCEANIA-ASIA	6.049	6.425	7.381	8.212	9.151	9.564	9.991
N.AMER-M.E.	1.409	1.725	2.548	2.747	2.140	1.690	1.602
INTRA N. AMER	7.808	8.629	9.153	9.128	8.929	9.497	9.017
N.AMER-L.AMER	16.413	19.405	23.098	25.573	25.364	22.457	21.336
N.AMER-ASIA	13.636	17.382	21.470	23.169	24.386	26.071	29.001
N.AMER-AFRICA	0.361	0.584	0.694	0.668	0.713	0.652	0.825
N.AMER-EUROPE	68.546	73.536	77.716	78.681	73.943	74.592	77.216
INTRA L.AMER	6.113	7.401	8.074	8.299	7.559	7.061	6.236
L. AMER-EUROPE	9.378	11.164	12.412	13.078	14.344	15.287	14.562
INTRA ASIA	8.649	10.498	12.253	14.087	16.525	18.210	18.544
ASIA-AFRICA	0.070	0.095	0.094	0.084	0.079	0.097	0.225
ASIA-EUROPE	12.333	14.395	16.984	19.848	21.145	22.425	23.902
AFRICA-EUROPE	17.277	19.024	22.466	22.860	24.375	25.495	25.599
INTRA EUROPE	56.817	60.423	64.661	62.860	64.029	64.959	66.536
International Total	**280.933**	**316.874**	**352.305**	**362.422**	**372.130**	**380.635**	**389.740**
WORLD TOTAL	**586.855**	**661.612**	**737.130**	**748.459**	**765.846**	**788.480**	**821.946**

Table P-1. World Traffic by Market (RPMS in billions)

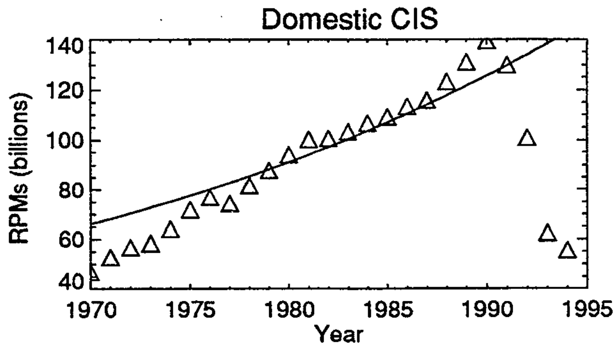
Region	1984	1985	1986	1987	1988	1989	1990
CIS	106.815	109.269	113.545	115.956	123.447	131.182	139.366
CANADA	11.369	11.567	12.656	13.375	15.285	15.377	15.363
USA	250.631	277.902	307.951	329.187	334.221	335.181	345.819
LATIN AMERICA	18.516	21.579	22.318	22.029	21.366	19.873	21.376
EUROPE	22.726	24.036	25.235	27.260	30.890	32.142	33.763
AFRICA	4.426	5.158	4.965	5.100	5.765	5.718	5.643
INDIAN SUB.	5.152	5.703	6.025	6.550	6.880	7.083	6.273
M.E.	5.398	4.759	5.237	5.365	5.237	5.272	5.675
OCEANIA	7.168	7.733	8.280	9.056	9.808	8.012	9.403
ASIA	5.665	6.095	6.630	7.445	8.593	9.256	10.798
JAPAN	20.457	20.831	21.277	23.428	25.082	28.376	31.632
CHINA	3.386	5.190	6.559	8.768	12.390	8.863	11.108
DOMSTIC TOTL	**461.709**	**499.821**	**540.677**	**573.520**	**598.963**	**606.335**	**636.219**
International Flights							
CIS INT'L	9.533	9.859	9.738	11.328	12.158	13.889	14.977
US MAC(INT'L)	2.047	2.610	2.554	2.818	2.856	2.403	3.745
LATIN AMER - AFRICA	0.248	0.403	0.468	0.676	0.605	0.648	0.664
LATIN AMER- OCEANIA	0.049	0.059	0.126	0.188	0.204	0.249	0.253
INTRA AFRICA	4.424	4.237	4.088	4.427	4.610	4.982	5.331
AFR- INDIAN SUB.	0.658	0.608	0.703	0.662	0.498	0.505	0.523
AFR- M.E.	4.377	3.900	4.000	4.345	4.670	5.284	5.489
AFR-OCEANIA	0.395	0.378	0.345	0.236	0.226	0.275	0.429
INTRA INDIA SUB.	0.728	0.805	0.852	0.884	0.930	0.912	0.938
INDIAN SUB.-M.E.	7.531	7.558	7.619	7.584	7.889	8.300	8.675
INDIAN SUB.-OCE.	0.395	0.266	0.866	0.701	0.059	0.172	0.273
INDIAN SUB.-ASIA	2.815	3.055	3.223	3.503	3.881	4.308	4.843
INSIAN SUB.-EUROPE	6.361	7.036	8.683	8.444	9.064	10.061	10.216
INTRA M.E.	8.237	8.138	8.243	8.961	9.663	10.061	10.289
M.E.-OCEANIA	0.143	0.158	0.040	0.597	0.549	0.555	0.780
M.E.-ASIA	12.281	12.355	11.355	11.712	6.110	6.248	4.065
M.E.-EUROPE	20.999	22.620	21.823	23.117	23.658	23.829	23.042
INTRA OCEANIA	2.828	2.884	3.416	4.272	4.578	4.665	4.990
OCEANIA-N.AMER	6.369	7.160	8.685	10.438	11.030	10.398	11.183
OCEANIA-ASIA	10.125	11.045	13.814	15.754	19.312	23.172	27.560
N.AMER-M.E.	2.158	2.480	2.858	3.149	3.149	3.235	3.133
INTRA N. AMER	10.876	10.672	11.800	12.042	12.317	12.315	13.248
N.AMER-L.AMER	22.690	24.487	27.605	33.319	36.544	35.783	35.503
N.AMER-ASIA	35.046	36.600	41.414	51.658	58.111	62.765	69.644
N.AMER-AFRICA	1.135	1.172	0.742	0.639	0.627	0.818	1.015
N.AMER-EUROPE	84.888	90.420	84.111	103.528	113.964	119.419	130.785
INTRA L.AMER	6.758	6.761	7.288	8.284	8.484	8.756	8.490
L. AMER-EUROPE	15.543	16.090	18.565	19.559	21.550	23.072	25.460
INTRA ASIA	20.027	20.713	17.606	22.007	29.930	39.208	42.802
ASIA-AFRICA	0.332	0.407	0.578	0.694	0.634	0.559	0.547
ASIA-EUROPE	24.894	28.355	31.201	34.894	39.081	42.207	49.289
AFRICA-EUROPE	27.333	27.512	27.900	27.595	29.054	29.785	28.678
INTRA EUROPE	71.757	78.388	81.185	93.111	102.235	107.960	121.863
International Total	**423.981**	**449.191**	**463.491**	**531.125**	**578.233**	**616.798**	**668.723**
WORLD TOTAL	**885.690**	**949.013**	**1004.167**	**1104.645**	**1177.197**	**1223.133**	**1304.943**

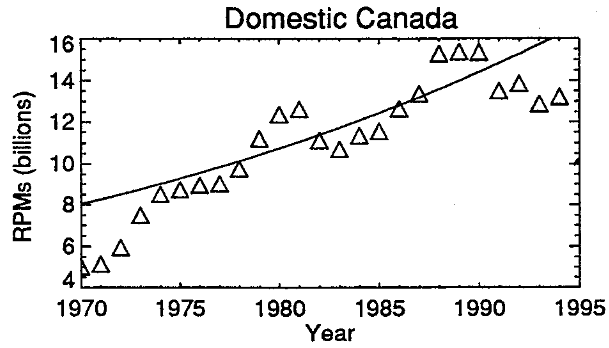
Table P-1. World Traffic by Market (RPMS in billions)

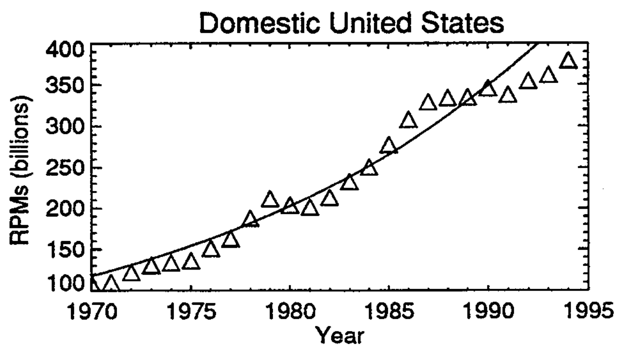
Region	1991	1992	1993	1994
CIS	129.903	100.862	62.535	55.656
CANADA	13.520	13.863	12.893	13.241
USA	338.039	354.369	361.860	379.591
LATIN AMERICA	21.249	20.548	21.000	22.040
EUROPE	32.354	35.264	36.408	37.865
AFRICA	5.103	4.697	3.758	3.873
INDIAN SUB.	6.314	6.856	7.301	7.926
M.E.	5.434	5.230	6.066	6.473
OCEANIA	12.162	13.436	14.058	14.735
ASIA	11.421	11.787	11.449	12.239
JAPAN	33.773	35.176	35.177	35.582
CHINA	14.716	18.293	21.870	26.463
DOMSTIC TOTL	**623.988**	**620.381**	**594.375**	**615.683**
International Flights				
CIS INT'L	13.072	11.820	15.254	17.085
US MAC(INT'L)	5.657	2.312	2.339	2.328
LATIN AMER - AFRICA	0.440	0.445	0.271	0.491
LATIN AMER- OCEANIA	0.221	0.282	0.298	0.319
INTRA AFRICA	4.770	5.261	5.555	5.790
AFR- INDIAN SUB.	0.517	0.590	0.623	0.645
AFR- M.E.	4.014	4.831	5.247	5.525
AFR-OCEANIA	0.549	0.727	0.701	0.731
INTRA INDIA SUB.	0.947	1.045	1.082	1.168
INDIAN SUB.-M.E.	7.804	9.550	10.393	11.058
INDIAN SUB.-OCE.	0.142	0.221	0.062	0.239
INDIAN SUB.-ASIA	4.235	4.472	4.830	5.030
INSIAN SUB.-EUROPE	8.888	9.084	10.319	10.733
INTRA M.E.	8.916	10.311	10.736	11.176
M.E.-OCEANIA	0.398	0.352	0.387	0.416
M.E.-ASIA	5.901	8.054	8.649	9.048
M.E.-EUROPE	19.447	21.007	23.654	24.425
INTRA OCEANIA	5.875	6.319	6.511	6.952
OCEANIA-N.AMER	11.138	11.495	11.713	12.123
OCEANIA-ASIA	28.756	30.350	32.414	34.585
N.AMER-M.E.	2.697	3.502	3.964	4.158
INTRA N. AMER	13.619	14.408	15.898	16.646
N.AMER-L.AMER	35.561	39.662	42.974	45.595
N.AMER-ASIA	72.016	77.813	82.015	86.690
N.AMER-AFRICA	0.868	1.057	1.200	1.252
N.AMER-EUROPE	119.534	139.883	147.435	152.743
INTRA L.AMER	8.135	8.425	8.594	8.865
L. AMER-EUROPE	26.309	30.568	32.066	33.701
INTRA ASIA	48.692	53.290	57.210	61.615
ASIA-AFRICA	0.808	0.863	0.911	0.969
ASIA-EUROPE	45.187	55.445	59.991	65.330
AFRICA-EUROPE	25.811	28.481	29.335	30.567
INTRA EUROPE	108.458	120.896	130.728	137.134
International Total	**639.380**	**712.819**	**763.360**	**805.133**
WORLD TOTAL	**1263.368**	**1333.200**	**1357.735**	**1420.815**

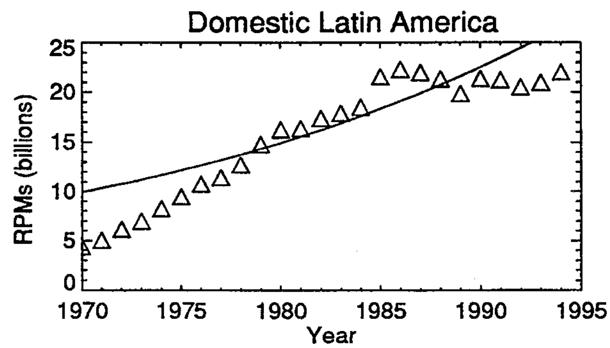
Table P-2. Annual growth rates for the 1976-92 time period derived from the RPM data.

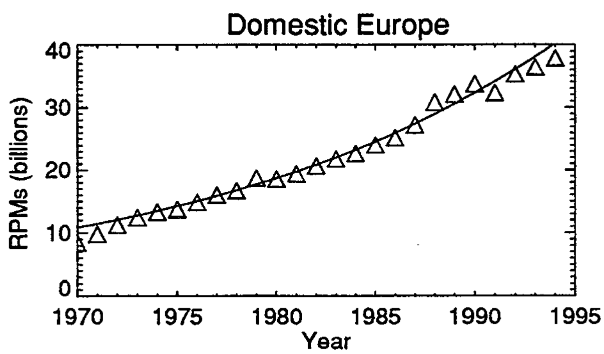
Region	Annual Rate of Growth (1976-1992)	Standard Deviation	Correlation Coefficient
Domestic CIS	3.2%	0.4%	0.77
Domestic Canada	2.9%	0.4%	0.75
Domestic United States	5.4%	0.3%	0.95
Domestic Latin America	4.1%	0.6%	0.79
Domestic Europe	5.5%	0.2%	0.99
Domestic Africa	4.5%	0.6%	0.81
Domestic Indian Subcontinent	6.7%	0.5%	0.91
Domestic Middle East	5.5%	0.9%	0.72
Domestic Oceania	5.6%	0.4%	0.92
Domestic Asia	8.3%	0.3%	0.98
Domestic Japan	5.6%	0.4%	0.93
Domestic China	21.0%	0.9%	0.97
Domestic Total	5.1%	0.3%	0.96
International:			
CIS International	5.3%	0.4%	0.92
Latin America- Oceania	11.0%	2.0%	0.68
Intra Africa	2.2%	0.2%	0.85
Africa- Middle East	4.3%	0.9%	0.62
Africa-Oceania	5.1%	1.5%	0.42
Intra Indian Subcontinent	6.2%	0.5%	0.91
Indian Subcontinent-Middle East	6.8%	0.8%	0.82
Indian Subcontinent-Asia	6.3%	0.4%	0.94
Indian Subcontinent-Europe	4.5%	0.5%	0.84
Intra Middle East	3.7%	0.4%	0.88
Intra Oceania	7.7%	0.4%	0.95
Oceania-North America	9.3%	0.6%	0.95
Oceania-Asia	10.8%	0.5%	0.96
North America-Middle East	5.8%	1.2%	0.62
Intra North America	4.0%	0.2%	0.95
North America-Latin America	5.3%	0.5%	0.86
North America-Asia	11.4%	0.3%	0.99
North America-Africa	5.0%	1.3%	0.48
North America-Europe	4.7%	0.4%	0.90
Latin America-Europe	7.1%	0.3%	0.98
Intra Asia	11.2%	0.7%	0.95
Asia-Africa	18.9%	1.6%	0.90
Asia-Europe	9.6%	0.3%	0.98
Africa-Europe	3.2%	0.5%	0.73
Intra Europe	5.3%	0.3%	0.94
International Total	6.1%	0.2%	0.98
World Total	5.6%	0.2%	0.98

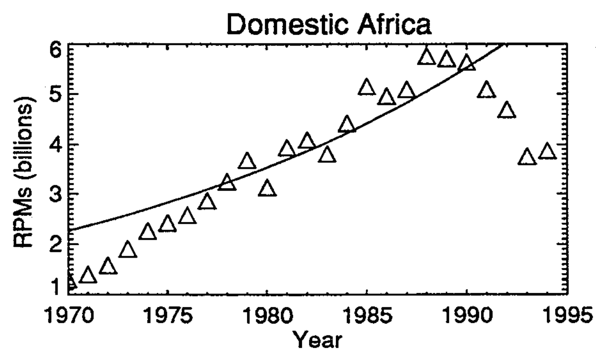

Domestic CIS
RPMs (billions)
140
120
100
80
60
40
1970
1975
1980
1985
1990
1995
Year

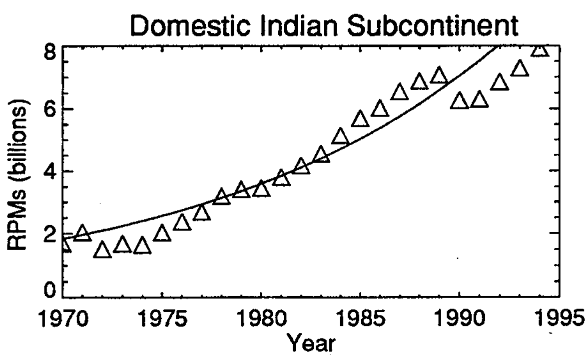

Domestic Canada
RPMs (billions)
16
14
12
10
8
6
4
1970
1975
1980
1985
1990
1995
Year

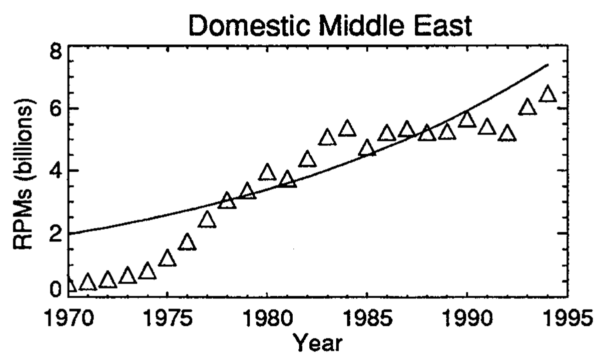

Domestic United States
RPMs (billions)
400
350
300
250
200
150
100
1970
1975
1980
1985
1990
1995
Year

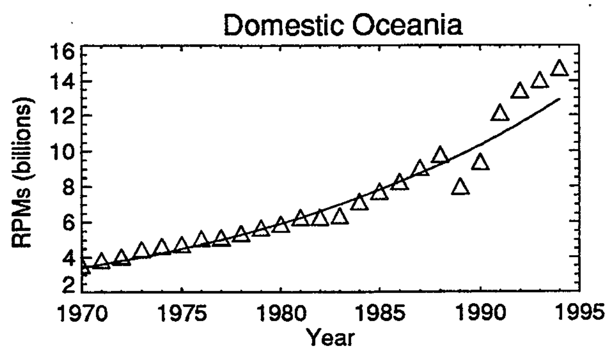

Domestic Latin America
RPMs (billions)
25
20
15
10
5
0
1970
1975
1980
1985
1990
1995
Year

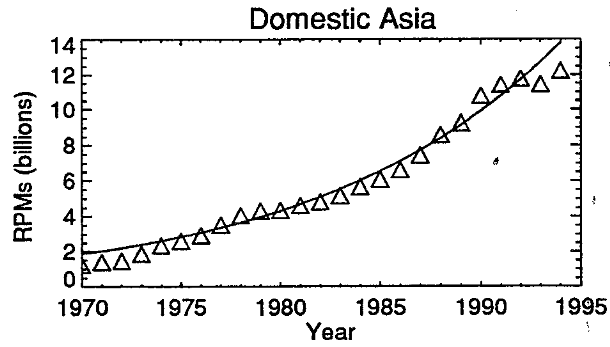

Domestic Europe
RPMs (billions)
40
30
20
10
0
1970
1975
1980
1985
1990
1995
Year

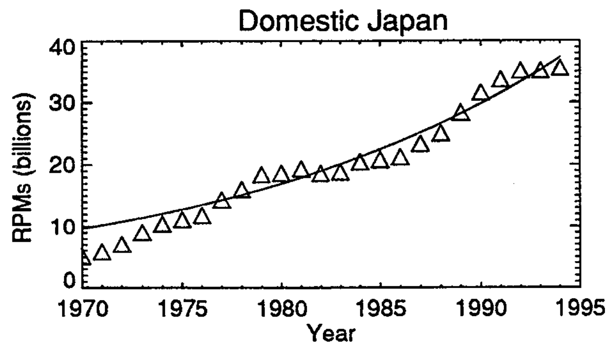

Domestic Africa
RPMs (billions)
6
5
4
3
2
1
1970
1975
1980
1985
1990
1995
Year

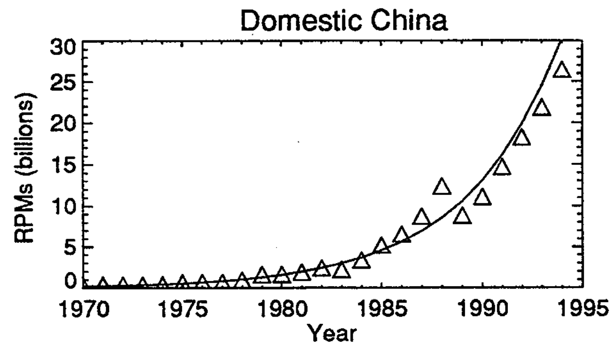

Domestic Indian Subcontinent
RPMs (billions)
8
6
4
2
0
1970
1975
1980
1985
1990
1995
Year

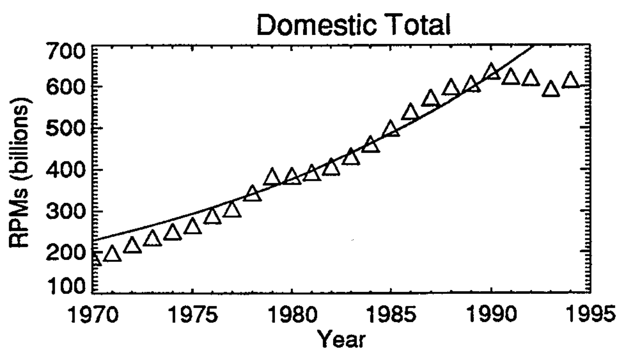

Domestic Middle East
RPMs (billions)
8
6
4
2
0
1970
1975
1980
1985
1990
1995
Year

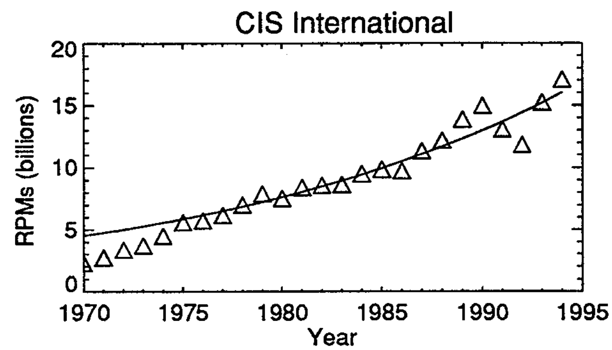

Domestic Oceania
RPMs (billions)
Year
16
14
12
10
8
6
4
2
1970
1975
1980
1985
1990
1995

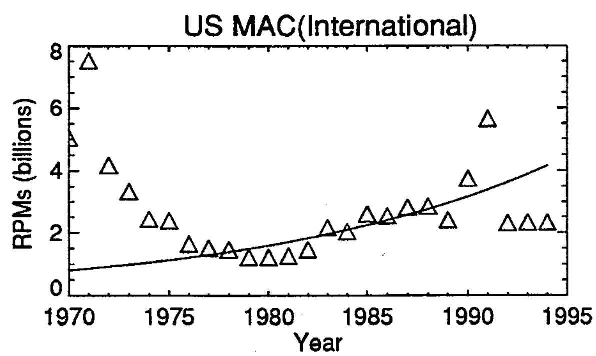

Domestic Asia
RPMs (billions)
Year
14
12
10
8
6
4
2
0
1970
1975
1980
1985
1990
1995

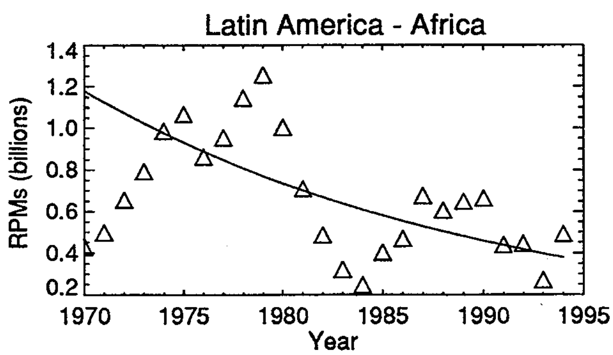

Domestic Japan
RPMs (billions)
Year
40
30
20
10
0
1970
1975
1980
1985
1990
1995

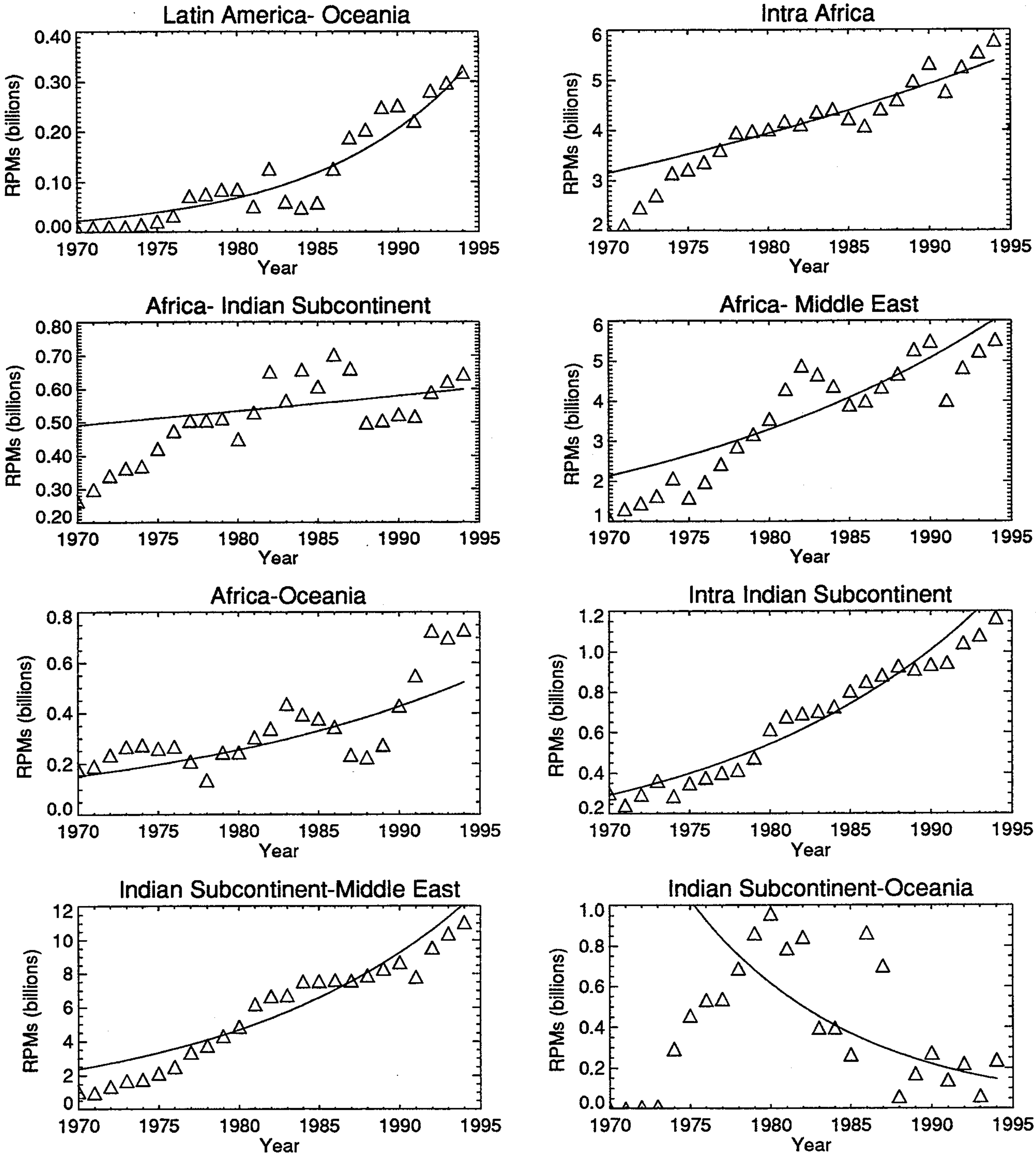

Domestic China
RPMs (billions)
Year
30
25
20
15
10
5
0
1970
1975
1980
1985
1990
1995

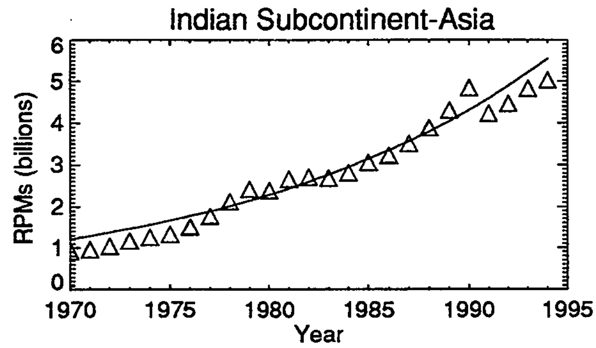

Domestic Total
RPMs (billions)
Year
700
600
500
400
300
200
100
1970
1975
1980
1985
1990
1995

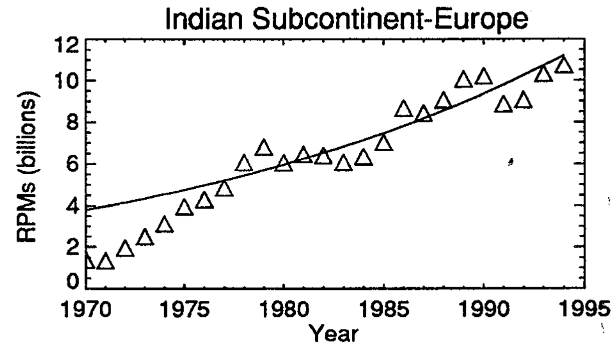

CIS International
RPMs (billions)
Year
20
15
10
5
0
1970
1975
1980
1985
1990
1995

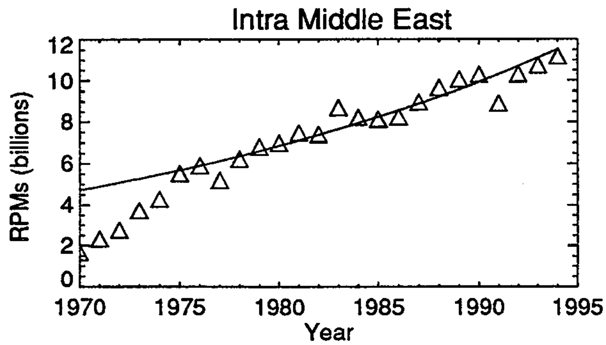

US MAC(International)
RPMs (billions)
Year
8
6
4
2
0
1970
1975
1980
1985
1990
1995

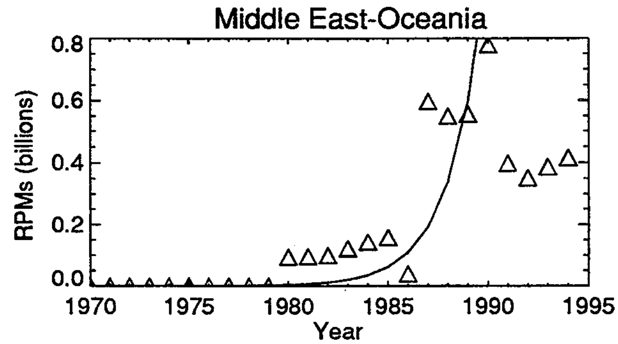

Latin America - Africa
RPMs (billions)
Year
1.4
1.2
1.0
0.8
0.6
0.4
0.2
1970
1975
1980
1985
1990
1995

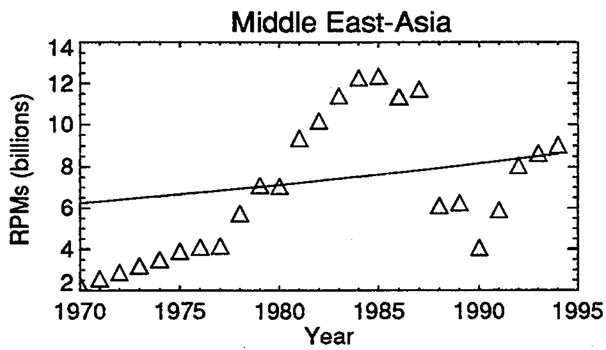

Latin America- Oceania
Intra Africa
Africa- Indian Subcontinent
Africa- Middle East
Africa-Oceania
Intra Indian Subcontinent
Indian Subcontinent-Middle East
Indian Subcontinent-Oceania
RPMs (billions)
Year
1970 1975 1980 1985 1990 1995

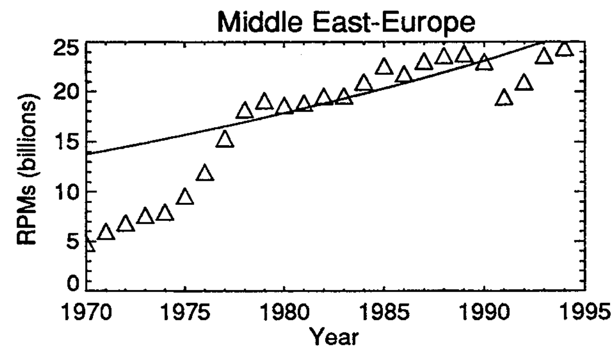

Indian Subcontinent-Asia
RPMs (billions)
0 1 2 3 4 5 6
1970 1975 1980 1985 1990 1995
Year

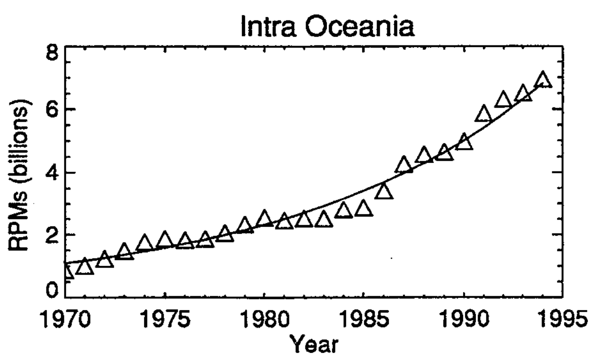

Indian Subcontinent-Europe
RPMs (billions)
0 2 4 6 8 10 12
1970 1975 1980 1985 1990 1995
Year

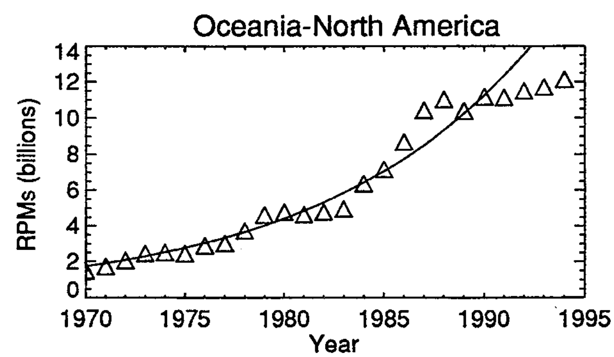

Intra Middle East
RPMs (billions)
0 2 4 6 8 10 12
1970 1975 1980 1985 1990 1995
Year

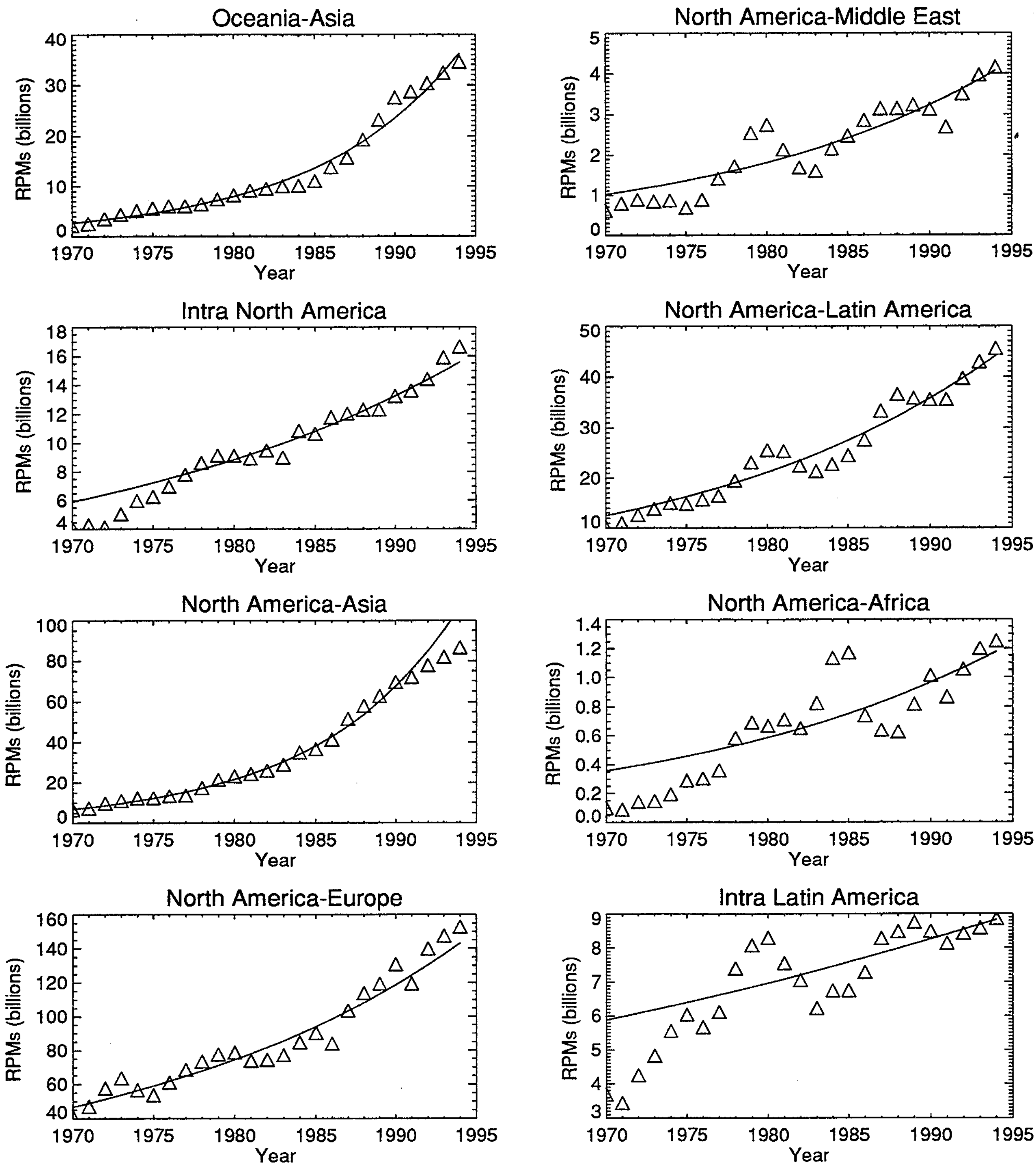

Middle East-Oceania
RPMs (billions)
0.0 0.2 0.4 0.6 0.8
1970 1975 1980 1985 1990 1995
Year

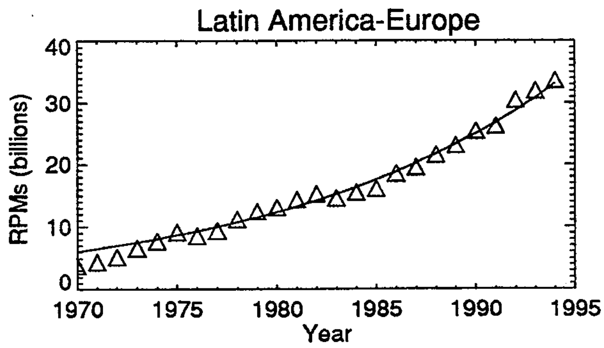

Middle East-Asia
RPMs (billions)
2 4 6 8 10 12 14
1970 1975 1980 1985 1990 1995
Year

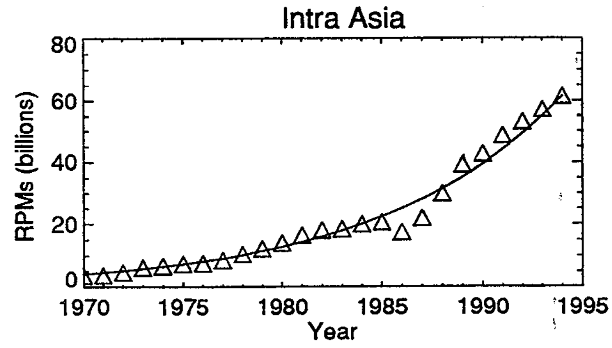

Middle East-Europe
RPMs (billions)
0 5 10 15 20 25
1970 1975 1980 1985 1990 1995
Year

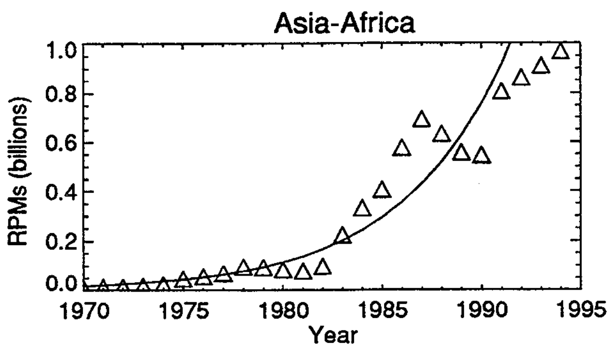

Intra Oceania
RPMs (billions)
0 2 4 6 8
1970 1975 1980 1985 1990 1995
Year

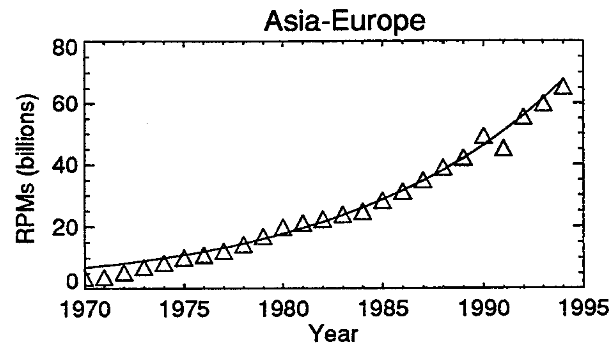

Oceania-North America
RPMs (billions)
0 2 4 6 8 10 12 14
1970 1975 1980 1985 1990 1995
Year

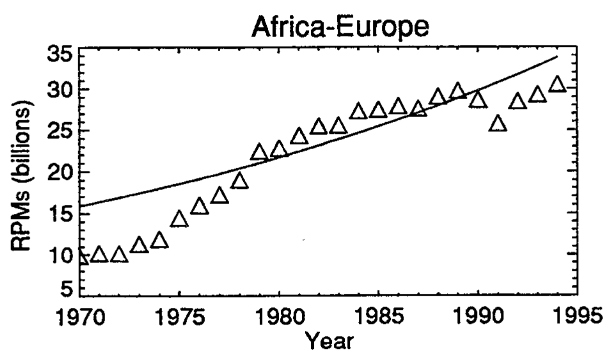

Oceania-Asia
North America-Middle East
Intra North America
North America-Latin America
North America-Asia
North America-Africa
North America-Europe
Intra Latin America
RPMs (billions)
Year
1970
1975
1980
1985
1990
1995

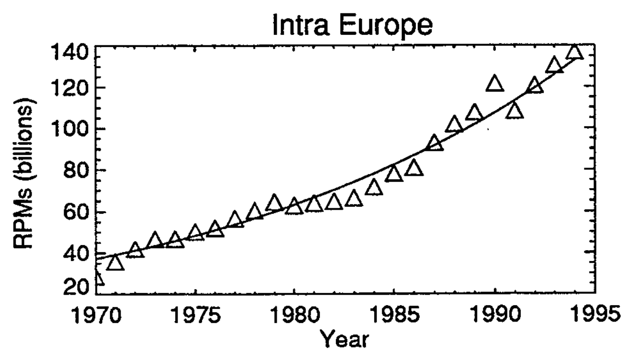

Latin America-Europe
RPMs (billions)
Year

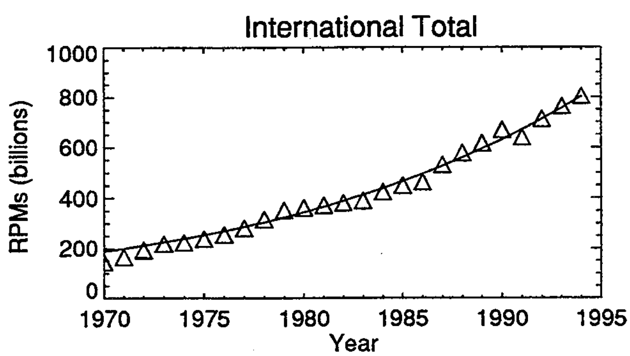

Intra Asia
RPMs (billions)
Year

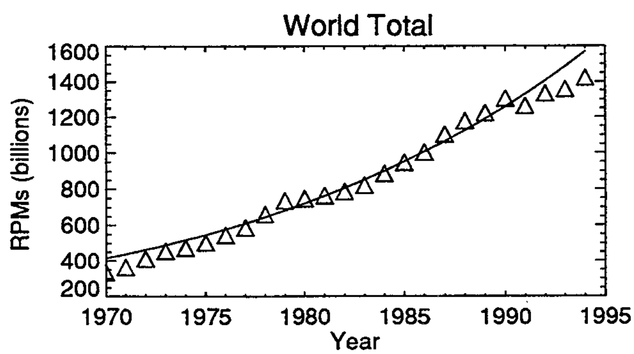

Asia-Africa
RPMs (billions)
Year


Asia-Europe
RPMs (billions)
Year


Africa-Europe
RPMs (billions)
Year


Intra Europe
RPMs (billions)
Year


International Total
RPMs (billions)
Year


World Total
RPMs (billions)
Year

Appendix Q. Effective Global Emission Indices for 1976 Aircraft

In this appendix, the effective global emission indices for May 1976 aircraft/engine combinations have been tabulated. The airplane/engine combinations have been grouped by generic types to simplify discussion. For each generic type, the total amount of fuel burned by that type is listed. The percent of global fuel use by that generic type is also shown. Effective emission indices in the 0-9 and 9-13 kilometer altitude bands have been calculated by integrating the fuel burned and emissions over all latitudes and longitudes within the altitude band for all the OAG airplane types included in the generic type.

For each generic type, the OAG airplane/engine combinations contributing to it are also shown. For each, the calculated fuel use and relative contribution within the generic class is tabulated . Effective emission indices are calculated for both altitude bands. The fuel use in the two altitude bands is also included in the table for each aircraft type.

It should be emphasized that generic types were not used in the calculation of the actual emission inventories. Three-dimensional inventories were calculated for each OAG airplane/engine combination and then combined to produce the scheduled air traffic emission inventories. The table in this appendix was constructed by post-processing the individual (OAG airplane/engine combinaitons) 3-D emission inventories.

Table Q-1. Effective Global Emission Indices for 1976 Aircraft

Generic Type	OAG Airplane/engine	Fuel (1000 kg/day)	% of Global Fuel Burned	% of Total within Type	0-9 km Altitude Band EI (NOx)	EI (CO)	EI (HC)	9-13 km Altitude Band EI (NOx)	EI (CO)	EI (HC)	Fuel (1000 kg/day) (0-9 km)	Fuel (1000 kg/day) (9-13 km)
Boeing 707		**18,017.1**	**14.3%**		**15.1**	**38.8**	**44.7**	**5.9**	**7.6**	**7.5**		
	B3F-320B/JT3D	13,392.5		74.3%	15.2	39.1	45.0	5.9	7.8	7.8	4,270.5	9,122.0
	B3J/*	2,377.2		13.2%	15.1	37.9	43.7	5.9	7.0	7.0	605.2	1,772.0
	B3C-320C/JT3D-3B	2,247.3		12.5%	15.0	37.3	43.0	5.9	6.7	6.7	526.7	1,720.6
Boeing 720		**1,443.2**	**1.1%**		**15.3**	**40.9**	**46.6**	**6.0**	**9.5**	**9.4**		
	720-000/JT3D	1,443.2		100.0%	15.3	40.9	46.6	6.0	9.5	9.4	640.4	802.8
Boeing 727-100		**14,894.1**	**11.9%**		**10.8**	**7.4**	**2.2**	**7.7**	**3.5**	**1.0**		
	727-100/JT8D-7B	14,635.4		98.3%	10.8	7.4	2.2	7.7	3.5	1.0	7,750.5	6,884.9
	72C/*	258.7		1.7%	10.9	7.3	2.2	7.8	3.2	0.9	119.9	138.8
Boeing 727-200		**14,485.0**	**11.5%**		**11.6**	**5.0**	**0.8**	**8.6**	**2.4**	**0.5**		
	72S-200/JT8D-15	14,485.0		100.0%	11.6	5.0	0.8	8.6	2.4	0.5	8,423.2	6,061.8
Boeing 737-200		**5,658.9**	**4.5%**		**9.0**	**10.0**	**3.0**	**7.8**	**2.1**	**0.5**		
	737-200/JT8D-7B	5,573.0		0.984823	9.0	10.0	3.1	7.8	2.1	0.5	3,954.1	1,618.9
	73C-200C/JT8D-9A	85.9		0.015177	9.9	6.8	1.4	7.4	2.4	0.5	55.8	30.1

Table Q-1. Effective Global Emission Indices for 1976 Aircraft

Generic Type	OAG Airplane/engine	Fuel (1000 kg/day)	% of Global Fuel Burned	% of Total within Type	0-9 km Altitude Band EI (NOx)	EI (CO)	EI (HC)	9-13 km Altitude Band EI (NOx)	EI (CO)	EI (HC)	Fuel (1000 kg/day) (0-9 km)	Fuel (1000 kg/day) (9-13 km)
Boeing 747-100		**18,941.2**	**15.1%**		**23.5**	**23.3**	**12.2**	**13.5**	**0.5**	**0.7**		
	747-100/JT9D-7A	17,775.4		93.8%	23.5	23.3	12.2	13.5	0.5	0.7	3,361.6	14,413.9
	74C-100F/JT9D-7A	1,165.7		6.2%	23.3	23.7	12.4	13.4	0.5	0.7	234.8	931.0
Boeing 747-SP		**391.7**	**0.3%**		**24.3**	**26.4**	**16.1**	**14.1**	**0.4**	**0.6**		
	74P-SP/JT9D-7A	391.7		100.0%	24.3	26.4	16.1	14.1	0.4	0.6	39.8	330.3
BAC111		**1,205.1**	**1.0%**		**11.7**	**32.5**	**18.6**	**10.2**	**7.6**	**4.8**		
	BAC-200/RR_SPEY-50	1,205.1		100.0%	11.7	32.5	18.6	10.2	7.6	4.8	908.9	296.2
Concorde		**66.8**	**0.1%**		**10.5**	**28.3**	**5.9**	**10.6**	**23.2**	**1.5**		
	Concorde	66.8		100.0%	10.5	28.3	5.9	10.6	23.2	1.5	13.8	3.6
Convair		**50.7**	**0.0%**		**15.4**	**41.7**	**47.8**	**6.3**	**13.2**	**12.8**		
	880-22/GE_CJ805-3	50.7		100.0%	15.4	41.7	47.8	6.3	13.2	12.8	29.5	21.2
Caravelle		**1,175.6**	**0.9%**		**8.3**	**14.7**	**4.5**	**6.8**	**6.2**	**1.2**		
	CVL-3/*	946.7		80.5%	8.1	16.8	5.2	6.5	7.2	1.4	614.0	332.7
	CVS/*	228.9		19.5%	9.1	5.9	1.6	7.7	2.2	0.5	147.1	81.7

Table Q-1. Effective Global Emission Indices for 1976 Aircraft

Generic Type	OAG Airplane/engine	Fuel (1000 kg/day)	% of Global Fuel Burned	% of Total within Type	0-9 km Altitude Band EI (NOx)	EI (CO)	EI (HC)	9-13 km Altitude Band EI (NOx)	EI (CO)	EI (HC)	Fuel (1000 kg/day) (0-9 km)	Fuel (1000 kg/day) (9-13 km)
DC-8		**12,193.1**	**9.7%**		**8.7**	**33.9**	**25.7**	**7.1**	**5.6**	**1.3**		
	DC8-21/JT4A	5,339.1		43.8%	7.3	45.1	38.6	5.4	7.5	2.0	1,797.1	3,542.1
	D8S-61/CFM56-2C	4,144.0		34.0%	11.4	12.8	0.8	10.2	2.8	0.2	1,256.1	2,887.8
	D8C-32F/JT4A	2,710.0		22.2%	7.5	42.8	36.7	5.5	6.3	1.7	712.4	1,997.6
DC-9		**11,723.9**	**9.3%**		**9.4**	**9.5**	**2.9**	**8.1**	**2.1**	**0.5**		
	D9S-30/JT8D-7B	6,651.1		56.7%	9.3	9.6	3.0	8.1	2.1	0.5	4,824.4	1,826.8
	DC9-10/JT8D-7B	4,627.5		39.5%	9.3	9.5	3.0	8.1	2.1	0.5	3,364.6	1,263.0
	D9X-50/JT8D-17	245.4		2.1%	10.6	6.2	0.8	9.4	2.5	0.5	192.5	52.9
	D9C-10C/JT8D-7B	199.8		1.7%	9.4	9.5	3.0	8.1	2.1	0.5	122.1	77.8
DC-10		**10,849.3**	**8.6%**		**20.2**	**18.5**	**6.8**	**12.6**	**2.3**	**1.4**		
	D10-10/CF6-6D	10,849.3		100.0%	20.2	18.5	6.8	12.6	2.3	1.4	2,705.9	8,143.4
Fokker 28		**665.5**	**0.5%**		**10.2**	**5.7**	**0.5**	**8.4**	**1.7**	**0.4**		
	F28-1000/RR_SPEY-M	665.5		100.0%	10.2	5.7	0.5	8.4	1.7	0.4	514.5	151.0
Lockheed 1011		**5,255.9**	**4.2%**		**17.8**	**25.5**	**18.8**	**14.5**	**3.2**	**1.1**		
	L10-1/RB211-22B	5,255.9		100.0%	17.8	25.5	18.8	14.5	3.2	1.1	2,058.6	3,197.3

Table Q-1. Effective Global Emission Indices for 1976 Aircraft

Generic Type	OAG Airplane/engine	Fuel (1000 kg/day)	% of Global Fuel Burned	% of Total within Type	0-9 km Altitude Band EI (NOx)	0-9 km Altitude Band EI (CO)	0-9 km Altitude Band EI (HC)	9-13 km Altitude Band EI (NOx)	9-13 km Altitude Band EI (CO)	9-13 km Altitude Band EI (HC)	Fuel (1000 kg/day) (0-9 km)	Fuel (1000 kg/day) (9-13 km)
Tupolev 134		**722.9**	**0.6%**		**9.4**	**9.3**	**2.9**	**8.0**	**2.1**	**0.5**		
	T34/SOL	722.9		100.0%	9.4	9.3	2.9	8.0	2.1	0.5	383.6	339.3
Tupolev 154		**680.0**	**0.5%**		**11.8**	**4.8**	**0.7**	**8.6**	**2.3**	**0.5**		
	T54/SOL	680.0		100.0%	11.8	4.8	0.7	8.6	2.3	0.5	251.0	429.0
YAK 40		**111.6**	**0.1%**		**10.8**	**7.4**	**2.2**	**8.0**	**6.8**	**2.3**		
	Y40/IVC	111.6		100.0%	10.8	7.4	2.2	8.0	6.8	2.3	97.9	13.6
Miscellaneous		**4,635.1**	**3.7%**		**13.6**	**22.6**	**18.2**	**7.4**	**5.6**	**4.8**		
	Y62/*	1,130.0		24.4%	14.9	36.9	42.5	5.9	6.7	6.8	249.9	880.2
	TRD-2E/RR_SPEY-512	839.2		18.1%	15.3	30.6	20.6	10.9	5.8	4.2	438.9	400.3
	V10-1150/*	835.4		18.0%	15.0	37.7	43.5	5.8	6.6	6.7	205.0	630.5
	Y18/*	723.3		15.6%	9.1	9.9	3.0	7.8	2.1	0.5	329.7	393.6
	A3B/*	314.1		6.8%	20.3	19.0	7.2	14.6	1.3	1.0	167.0	147.1
	T04/*	202.4		4.4%	9.4	9.2	2.9	8.1	2.1	0.5	86.7	115.8
	SUV/*	187.8		4.1%	12.8	35.3	37.7	5.4	10.9	6.1	56.5	131.3
	S11/*	156.1		3.4%	12.9	4.3	0.0	0.0	0.0	0.0	156.1	0.0
	DME/*	126.3		2.7%	9.0	11.1	3.4	7.9	2.2	0.5	92.0	34.4
	T24/*	44.7		1.0%	12.7	4.2	0.0	0.0	0.0	0.0	44.7	0.0
	T1E/*	30.4		0.7%	10.8	7.6	2.2	8.0	6.5	2.1	22.5	7.9
	STV/*	27.6		0.6%	11.3	5.1	1.1	9.2	2.1	0.4	9.2	18.4
	CM4/*	16.6		0.4%	15.9	43.2	49.4	7.4	21.9	21.4	13.1	3.4
	DBV/*	0.9		0.0%	7.4	4.8	0.3	0.0	0.0	0.0	0.9	0.0
	PP6/*	0.2		0.0%	8.0	4.1	0.2	0.0	0.0	0.0	0.2	0.0

Table Q-1. Effective Global Emission Indices for 1976 Aircraft

Generic Type	OAG Airplane/engine	Fuel (1000 kg/day)	% of Global Fuel Burned	% of Total within Type	0-9 km Altitude Band EI (NOx)	EI (CO)	EI (HC)	9-13 km Altitude Band EI (NOx)	EI (CO)	EI (HC)	Fuel (1000 kg/day) (0-9 km)	Fuel (1000 kg/day) (9-13 km)
Small Turboprops		**766.2**	**0.6%**		**8.0**	**4.1**	**0.2**					
	DTO/SMTURB	246.5		32.2%	7.7	4.6	0.3	0.0	0.0	0.0	246.5	0.0
	B99/SMTURB	190.1		24.8%	8.0	4.3	0.3	0.0	0.0	0.0	190.1	0.0
	M20/SMTURB	132.7		17.3%	8.4	3.2	0.1	0.0	0.0	0.0	132.7	0.0
	A24/SMTURB	78.1		10.2%	8.1	4.0	0.2	0.0	0.0	0.0	78.1	0.0
	SWM/SMTURB	34.4		4.5%	8.1	4.2	0.2	0.0	0.0	0.0	34.4	0.0
	EMB/SMTURB	31.1		4.1%	8.2	3.9	0.2	0.0	0.0	0.0	31.1	0.0
	BTP/SMTURB	25.6		3.3%	8.0	4.2	0.2	0.0	0.0	0.0	25.6	0.0
	L41/SMTURB	8.9		1.2%	8.1	4.1	0.2	0.0	0.0	0.0	8.9	0.0
	PHP/SMTURB	7.6		1.0%	8.0	4.2	0.2	0.0	0.0	0.0	7.6	0.0
	TS4/SMTURB	4.9		0.6%	8.4	3.6	0.2	0.0	0.0	0.0	4.9	0.0
	ST2/SMTURB	4.8		0.6%	8.4	3.8	0.2	0.0	0.0	0.0	4.8	0.0
	MU2/SMTURB	1.5		0.2%	8.1	4.2	0.2	0.0	0.0	0.0	1.5	0.0
Medium Turboprops		**393.7**	**0.3%**		**11.9**	**5.0**	**0.6**					
	748/MDTURB	228.2		58.0%	11.7	5.0	0.6	0.0	0.0	0.0	228.2	0.0
	FH7/MDTURB	55.0		14.0%	12.3	5.1	0.6	0.0	0.0	0.0	55.0	0.0
	VIS/MDTURB	43.9		11.1%	11.9	5.0	0.6	0.0	0.0	0.0	43.9	0.0
	N26/MDTURB	43.6		11.1%	12.2	5.1	0.7	0.0	0.0	0.0	43.6	0.0
	LJT/MDTURB	12.3		3.1%	11.1	5.0	0.5	0.0	0.0	0.0	12.3	0.0
	V70/MDTURB	4.6		1.2%	12.3	4.8	0.6	0.0	0.0	0.0	4.6	0.0
	A12/MDTURB	3.4		0.9%	10.9	4.3	0.2	0.0	0.0	0.0	3.4	0.0
	LHR/MDTURB	2.6		0.7%	10.8	5.1	0.5	0.0	0.0	0.0	2.6	0.0

Table Q-1. Effective Global Emission Indices for 1976 Aircraft

Generic Type	OAG Airplane/engine	Fuel (1000 kg/day)	% of Global Fuel Burned	% of Total within Type	0-9 km Altitude Band EI (NOx)	EI (CO)	EI (HC)	9-13 km Altitude Band EI (NOx)	EI (CO)	EI (HC)	Fuel (1000 kg/day) (0-9 km)	Fuel (1000 kg/day) (9-13 km)
Large Turboprops		**1,339.3**	**1.1%**		**12.8**	**4.3**	**0.0**					
	F27/LGTURB	585.7		43.7%	12.9	4.3	0.0	0.0	0.0	0.0	585.7	0.0
	Y11/LGTURB	316.4		23.6%	12.7	4.3	0.0	0.0	0.0	0.0	316.4	0.0
	CV5/LGTURB	236.9		17.7%	12.6	4.3	0.0	0.0	0.0	0.0	236.9	0.0
	LEC/LGTURB	99.1		7.4%	13.2	4.2	0.0	0.0	0.0	0.0	99.1	0.0
	V80/LGTURB	87.5		6.5%	12.9	4.3	0.0	0.0	0.0	0.0	87.5	0.0
	VAN/LGTURB	10.6		0.8%	12.8	4.1	0.0	0.0	0.0	0.0	10.6	0.0
	ARG/LGTURB	1.7		0.1%	13.4	4.4	0.0	0.0	0.0	0.0	1.7	0.0
	DH7/LGTURB	1.4		0.1%	13.6	4.1	0.0	0.0	0.0	0.0	1.4	0.0

Appendix R. Effective Global Emission Indices for 1984 Aircraft

In this appendix, the effective global emission indices for May 1984 aircraft/engine combinations have been tabulated. The airplane/engine combinations have been grouped by generic types to simplify discussion. For each generic type, the total amount of fuel burned by that type is listed. The percent of global fuel use by that generic type is also shown. Effective emission indices in the 0-9 and 9-13 kilometer altitude bands have been calculated by integrating the fuel burned and emissions over all latitudes and longitudes within the altitude band for all the OAG airplane types included in the generic type.

For each generic type, the OAG airplane/engine combinations contributing to it are also shown. For each, the calculated fuel use and relative contribution within the generic class is tabulated . Effective emission indices are calculated for both altitude bands. The fuel use in the two altitude bands is also included in the table for each aircraft type.

It should be emphasized that generic types were not used in the calculation of the actual emission inventories. Three-dimensional inventories were calculated for each OAG airplane/engine combination and then combined to produce the scheduled air traffic emission inventories. The table in this appendix was constructed by post-processing the individual (OAG airplane/engine combinaitons) 3-D emission inventories.

Table R-1. Effective Global Emission Indices for 1984 Aircraft

Generic Type	OAG Airplane/engine	Fuel (1000 kg/day)	% of Global Fuel Burned	% of Total within Type	0-9 km Altitude Band EI (NOx)	EI (CO)	EI (HC)	9-13 km Altitude Band EI (NOx)	EI (CO)	EI (HC)	Fuel (1000 kg/day) (0-9 km)	Fuel (1000 kg/day) (9-13 km)
BAE-146		**70.4**	**0.0%**		**8.8**	**8.6**	**0.8**	**7.7**	**0.2**	**0.0**		
	146-200/ALF502R-5	70.4		100.0%	8.8	8.6	0.8	7.7	0.2	0.0	58.4	12.0
Boeing 707		**4,042.8**	**2.3%**		**15.1**	**38.9**	**44.7**	**5.9**	**7.5**	**7.5**		
	B3F-320B/JT3D	2,735.3		67.7%	15.2	39.4	45.2	5.9	7.8	7.8	905.8	1,829.5
	B3C-320C/JT3D-3B	1,249.7		30.9%	15.0	37.5	43.2	5.9	6.9	6.9	300.2	949.5
	B7F-120B/JT3D	57.7		1.4%	15.1	38.1	44.0	5.8	7.6	7.6	15.4	42.3
Boeing 720		**457.3**	**0.3%**		**5.7**	**33.2**	**36.9**	**4.6**	**6.9**	**3.2**		
	720-000/JT3C-12	457.3		100.0%	5.7	33.2	36.9	4.6	6.9	3.2	196.0	261.3
Boeing 727-100		**10,040.3**	**5.8%**		**10.8**	**7.4**	**2.2**	**7.7**	**3.5**	**1.0**		
	727-100/JT8D-7B	9,474.0		94.4%	10.8	7.4	2.2	7.7	3.5	1.0	5,013.3	4,460.6
	72C-100F/JT8D-7B	566.4		5.6%	10.8	7.4	2.2	7.7	3.7	1.1	299.6	266.8
Boeing 727-200		**30,879.9**	**17.7%**		**11.7**	**4.9**	**0.7**	**8.7**	**2.3**	**0.5**		
	72S-200/JT8D-15	30,879.9		100.0%	11.7	4.9	0.7	8.7	2.3	0.5	14,819.5	16,060.6
Boeing 737-200		**13,241.5**	**7.6%**		**9.1**	**9.9**	**3.0**	**7.8**	**2.2**	**0.5**		
	737-200/JT8D-7B	12,794.0		96.6%	9.0	10.1	3.1	7.8	2.1	0.5	8,424.1	4,369.9
	73C-200C/JT8D-17	447.5		3.4%	10.8	5.0	0.7	8.3	3.4	0.7	263.8	183.7

Table R-1. Effective Global Emission Indices for 1984 Aircraft

Generic Type	OAG Airplane/engine	Fuel (1000 kg/day)	% of Global Fuel Burned	% of Total within Type	0-9 km Altitude Band EI (NOx)	0-9 km Altitude Band EI (CO)	0-9 km Altitude Band EI (HC)	9-13 km Altitude Band EI (NOx)	9-13 km Altitude Band EI (CO)	9-13 km Altitude Band EI (HC)	Fuel (1000 kg/day) (0-9 km)	Fuel (1000 kg/day) (9-13 km)
Boeing 747-100		**40,318.8**	**23.1%**		**23.7**	**22.7**	**11.9**	**13.6**	**0.5**	**0.6**		
	747-100/JT9D-7A	35,066.2		87.0%	23.7	22.6	11.8	13.7	0.4	0.6	6,193.3	28,872.7
	74C-100F/JT9D-7A	5,252.5		13.0%	23.3	23.4	12.2	13.4	0.5	0.7	1,043.3	4,209.3
Boeing 747-300		**1,110.9**	**0.6%**		**25.0**	**6.9**	**2.1**	**14.5**	**1.7**	**0.4**		
	74U-300/JT9D-7R4G2	978.4		88.1%	25.4	4.6	0.6	14.5	1.7	0.3	116.2	862.1
	7UQ-300M/CF6-50E2	132.5		11.9%	22.5	19.1	10.1	14.6	1.4	1.3	21.7	110.8
Boeing 747-SP		**3,145.7**	**1.8%**		**23.4**	**28.7**	**17.5**	**14.2**	**0.5**	**0.7**		
	74P-SP/JT9D-7A	3,145.7		100.0%	23.4	28.7	17.5	14.2	0.5	0.7	390.8	2,400.1
Boeing 747-SR		**368.5**	**0.2%**		**19.1**	**20.1**	**11.7**	**13.9**	**2.8**	**2.8**		
	74X-100SR/CF6-45A2	368.5		100.0%	19.1	20.1	11.7	13.9	2.8	2.8	185.9	182.6
Boeing 757-200		**659.7**	**0.4%**		**15.1**	**17.7**	**1.1**	**9.7**	**8.2**	**1.3**		
	757-200/RB211-535C	659.7		100.0%	15.1	17.7	1.1	9.7	8.2	1.3	308.8	350.9
Boeing 767-200		**2,683.6**	**1.5%**		**22.4**	**3.0**	**0.4**	**11.2**	**1.4**	**0.2**		
	767-200/JT9D-7R4D	2,683.6		100.0%	22.4	3.0	0.4	11.2	1.4	0.2	969.7	1,714.0

Table R-1. Effective Global Emission Indices for 1984 Aircraft

Generic Type	OAG Airplane/engine	Fuel (1000 kg/day)	% of Global Fuel Burned	% of Total within Type	0-9 km Altitude Band EI (NOx)	EI (CO)	EI (HC)	9-13 km Altitude Band EI (NOx)	EI (CO)	EI (HC)	Fuel (1000 kg/day) (0-9 km)	Fuel (1000 kg/day) (9-13 km)
Airbus A300		**6,686.2**	**3.8%**		**20.9**	**18.7**	**7.1**	**14.7**	**1.3**	**1.0**		
	A30B4-100/CF6-50C2	6,686.2		100.0%	20.9	18.7	7.1	14.7	1.3	1.0	2,960.3	3,725.9
Airbus A310		**654.6**	**0.4%**		**17.0**	**7.4**	**1.6**	**12.8**	**2.6**	**0.6**		
	A31-200/CF6-80A3	654.6		100.0%	17.0	7.4	1.6	12.8	2.6	0.6	270.2	384.4
BAC111		**1,350.6**	**0.8%**		**11.9**	**32.1**	**18.4**	**10.2**	**7.7**	**4.9**		
	BAC-500/RR_SPEY-51	1,350.6		100.0%	11.9	32.1	18.4	10.2	7.7	4.9	956.0	394.6
Concorde		**403.6**	**0.2%**		**10.4**	**27.9**	**5.4**	**10.0**	**26.0**	**1.8**		
	Concorde	403.6		100.0%	10.4	27.9	5.4	10.0	26.0	1.8	76.6	20.8
Convair		**3.3**	**0.0%**		**6.1**	**35.2**	**39.6**	**4.6**	**7.1**	**3.3**		
	880-22/GE_CJ805-3	3.3		100.0%	6.1	35.2	39.6	4.6	7.1	3.3	1.0	2.3
Caravelle		**164.6**	**0.1%**		**8.8**	**6.2**	**1.3**	**7.5**	**2.4**	**0.5**		
	CVL-12/JT8D-9	164.6		100.0%	8.8	6.2	1.3	7.5	2.4	0.5	119.7	44.9

Table R-1. Effective Global Emission Indices for 1984 Aircraft

Generic Type	OAG Airplane/engine	Fuel (1000 kg/day)	% of Global Fuel Burned	% of Total within Type	0-9 km Altitude Band EI (NOx)	EI (CO)	EI (HC)	9-13 km Altitude Band EI (NOx)	EI (CO)	EI (HC)	Fuel (1000 kg/day) (0-9 km)	Fuel (1000 kg/day) (9-13 km)
DC-8		**4,469.9**	**2.6%**		**9.7**	**27.9**	**19.4**	**7.7**	**5.3**	**1.3**		
	D8S-71/CFM56-2C	2,174.7		48.7%	11.3	13.0	0.9	10.2	2.8	0.2	692.5	1,482.3
	D8C-21F/JT4A	1,637.4		36.6%	7.4	45.0	39.3	5.4	7.6	2.0	513.2	1,124.2
	DC8/*	435.7		9.7%	8.0	35.2	28.8	5.9	5.2	1.8	117.1	318.5
	D8F-51/JT3D-3B	222.1		5.0%	12.4	36.5	36.6	5.2	13.1	6.6	88.8	133.3
DC-9		**13,261.0**	**7.6%**		**9.5**	**9.1**	**2.7**	**8.2**	**2.1**	**0.5**		
	D9S-30/JT8D-7B	9,445.8		71.2%	9.4	9.5	3.0	8.1	2.1	0.5	6,181.9	3,264.0
	DC9-10/JT8D-7B	2,090.4		15.8%	9.3	9.5	3.0	8.0	2.1	0.5	1,468.8	621.5
	D9X-50/JT8D-17	1,592.3		12.0%	10.6	6.2	0.8	9.4	2.3	0.5	1,032.2	560.1
	D9C-30F/JT8D-7B	132.5		1.0%	9.3	9.8	2.0	7.8	2.3	0.5	66.4	66.1
DC-10		**17,069.9**	**9.8%**		**20.2**	**17.8**	**6.4**	**12.6**	**2.0**	**1.3**		
	D10-10/CF6-6D	14,916.7		87.4%	20.6	18.5	6.8	12.6	2.3	1.4	3,413.5	11,503.2
	DLR-40/JT9D-59A	2,071.0		12.1%	16.2	12.1	2.9	12.5	0.6	0.3	344.7	1,726.3
	D1C-10F/CF6-6D	82.1		0.5%	25.9	11.6	3.8	19.9	1.8	0.8	28.2	54.0
Fokker 28		**1,404.2**	**0.8%**		**8.8**	**28.0**	**32.4**	**7.5**	**1.1**	**3.7**		
	F28-4000/RR_SPEY-M	1,404.2		100.0%	8.8	28.0	32.4	7.5	1.1	3.7	1,140.7	263.5
Ilyushin 62		**1,117.9**	**0.6%**		**14.9**	**36.7**	**42.3**	**5.9**	**6.7**	**6.7**		
	I62/SOL	1,117.9		100.0%	14.9	36.7	42.3	5.9	6.7	6.7	243.9	874.0

Table R-1. Effective Global Emission Indices for 1984 Aircraft

Generic Type	OAG Airplane/engine	Fuel (1000 kg/day)	% of Global Fuel Burned	% of Total within Type	0-9 km Altitude Band EI (NOx)	EI (CO)	EI (HC)	9-13 km Altitude Band EI (NOx)	EI (CO)	EI (HC)	Fuel (1000 kg/day) (0-9 km)	Fuel (1000 kg/day) (9-13 km)
Ilyushin 72		**25.6**	**0.0%**		**15.2**	**39.4**	**45.3**	**5.8**	**8.7**	**8.5**		
	I72/*	25.6		100.0%	15.2	39.4	45.3	5.8	8.7	8.5	8.5	17.2
Ilyushin 86		**162.4**	**0.1%**		**15.2**	**39.3**	**45.3**	**5.9**	**8.8**	**8.6**		
	I86/KUZ	162.4		100.0%	15.2	39.3	45.3	5.9	8.8	8.6	54.4	108.0
Lockheed 1011		**10,490.5**	**6.0%**		**17.9**	**25.9**	**18.8**	**14.3**	**4.1**	**1.2**		
	L10-1/RB211-22B	8,740.7		83.3%	17.7	24.4	17.9	14.7	3.0	1.0	3,043.7	5,697.0
	LLR-500/RB211-524B4	1,749.7		16.7%	19.7	39.3	26.7	12.8	8.6	2.1	346.8	1,403.0
McDonnell Douglas MD-80		**3,029.6**	**1.7%**		**14.6**	**5.6**	**1.6**	**10.7**	**3.9**	**1.4**		
	D9Z-82/JT8D-217	3,029.6		100.0%	14.6	5.6	1.6	10.7	3.9	1.4	1,567.6	1,462.0
Mercure		**165.5**	**0.1%**		**10.7**	**5.4**	**0.8**	**7.8**	**3.8**	**0.7**		
	MRC-100/JT8D-15	165.5		100.0%	10.7	5.4	0.8	7.8	3.8	0.7	120.6	44.8
Tupolev 134		**565.5**	**0.3%**		**9.4**	**9.3**	**2.9**	**8.1**	**2.1**	**0.5**		
	T34/SOL	565.5		100.0%	9.4	9.3	2.9	8.1	2.1	0.5	287.4	278.1
Tupolev 154		**1,460.6**	**0.8%**		**11.8**	**4.8**	**0.7**	**8.7**	**2.3**	**0.5**		
	T54/SOL	1,460.6		100.0%	11.8	4.8	0.7	8.7	2.3	0.5	555.9	904.7

Table R-1. Effective Global Emission Indices for 1984 Aircraft

Generic Type	OAG Airplane/engine	Fuel (1000 kg/day)	% of Global Fuel Burned	% of Total within Type	0-9 km Altitude Band EI (NOx)	0-9 km Altitude Band EI (CO)	0-9 km Altitude Band EI (HC)	9-13 km Altitude Band EI (NOx)	9-13 km Altitude Band EI (CO)	9-13 km Altitude Band EI (HC)	Fuel (1000 kg/day) (0-9 km)	Fuel (1000 kg/day) (9-13 km)
YAK 40		**112.1**	**0.1%**		**10.8**	**7.4**	**2.2**	**7.8**	**5.5**	**1.8**		
	Y40/IVC	112.1		100.0%	10.8	7.4	2.2	7.8	5.5	1.8	91.1	21.0
Miscellaneous		**636.1**	**0.4%**		**14.2**	**30.2**	**22.4**	**10.3**	**5.4**	**4.5**		
	TRD-2E/RR_SPEY-512	531.0		83.5%	15.3	30.9	20.7	10.8	6.4	4.7	310.9	220.1
	DFL/*	79.4		12.5%	8.9	27.1	31.3	7.4	0.6	3.5	48.5	30.9
	LRJ/*	25.8		4.1%	9.0	26.2	30.0	7.5	0.4	3.4	13.2	12.6
Small Turboprops		**1,776.7**	**1.0%**		**8.0**	**4.2**	**0.2**					
	SWM/SMTURB	583.4		32.8%	8.1	4.0	0.2	0.0	0.0	0.0	583.4	0.0
	DHT/SMTURB	436.3		24.6%	7.8	4.4	0.3	0.0	0.0	0.0	436.3	0.0
	EMB/SMTURB	420.3		23.7%	8.0	4.2	0.2	0.0	0.0	0.0	420.3	0.0
	BE9/SMTURB	254.4		14.3%	8.0	4.2	0.2	0.0	0.0	0.0	254.4	0.0
	J31/SMTURB	27.7		1.6%	8.2	4.0	0.2	0.0	0.0	0.0	27.7	0.0
	BE2/*	14.3		0.8%	8.1	4.0	0.2	0.0	0.0	0.0	14.3	0.0
	DO8/SMTURB	10.9		0.6%	7.9	4.1	0.2	0.0	0.0	0.0	10.9	0.0
	PA1/*	8.3		0.5%	8.1	4.2	0.2	0.0	0.0	0.0	8.3	0.0
	CD2/SMTURB	4.7		0.3%	7.8	4.5	0.3	0.0	0.0	0.0	4.7	0.0
	AC6/*	4.1		0.2%	8.1	4.1	0.2	0.0	0.0	0.0	4.1	0.0
	CNC/SMTURB	3.8		0.2%	8.2	3.9	0.2	0.0	0.0	0.0	3.8	0.0
	DHB/SMTURB	2.2		0.1%	7.0	5.4	0.4	0.0	0.0	0.0	2.2	0.0
	PA6/SMTURB	2.1		0.1%	7.6	4.7	0.3	0.0	0.0	0.0	2.1	0.0
	BE3/SMTURB	1.6		0.1%	7.8	4.5	0.3	0.0	0.0	0.0	1.6	0.0
	AN2/*	1.2		0.1%	11.4	5.3	0.7	0.0	0.0	0.0	1.2	0.0
	PL6/SMTURB	0.7		0.0%	6.6	6.2	0.4	0.0	0.0	0.0	0.7	0.0
	BEK/SMTURB	0.7		0.0%	8.3	3.8	0.2	0.0	0.0	0.0	0.7	0.0

Table R-1. Effective Global Emission Indices for 1984 Aircraft

Generic Type	OAG Airplane/engine	Fuel (1000 kg/day)	% of Global Fuel Burned	% of Total within Type	0-9 km Altitude Band			9-13 km Altitude Band			Fuel (1000 kg/day) (0-9 km)	Fuel (1000 kg/day) (9-13 km)
					EI (NOx)	EI (CO)	EI (HC)	EI (NOx)	EI (CO)	EI (HC)		
Medium Turboprops		**344.8**	**0.2%**		**12.3**	**5.0**	**0.6**					
	SH3/MDTURB	190.3		55.2%	12.3	5.0	0.6	0.0	0.0	0.0	190.3	0.0
	SH6/MDTURB	111.0		32.2%	12.3	5.1	0.6	0.0	0.0	0.0	111.0	0.0
	ND2/MDTURB	41.3		12.0%	12.2	5.0	0.7	0.0	0.0	0.0	41.3	0.0
	ANF/MDTURB	1.7		0.5%	10.8	4.4	0.3	0.0	0.0	0.0	1.7	0.0
	SF3/MDTURB	0.4		0.1%	11.8	5.2	0.8	0.0	0.0	0.0	0.4	0.0
Large Turboprops		**1,896.5**	**1.1%**		**12.8**	**4.3**	**0.0**					
	F27/LGTURB	580.4		30.6%	13.0	4.3	0.0	0.0	0.0	0.0	580.4	0.0
	YS1/LGTURB	263.3		13.9%	12.7	4.4	0.0	0.0	0.0	0.0	263.3	0.0
	DH7/LGTURB	231.2		12.2%	12.8	4.3	0.0	0.0	0.0	0.0	231.2	0.0
	HS7/LGTURB	221.6		11.7%	12.9	4.4	0.0	0.0	0.0	0.0	221.6	0.0
	AN4/LGTURB	107.3		5.7%	13.2	4.3	0.0	0.0	0.0	0.0	107.3	0.0
	LOE/LGTURB	82.6		4.4%	13.1	4.2	0.0	0.0	0.0	0.0	82.6	0.0
	FK7/LGTURB	74.6		3.9%	13.0	4.4	0.0	0.0	0.0	0.0	74.6	0.0
	IL8/LGTURB	67.4		3.6%	12.9	4.1	0.0	0.0	0.0	0.0	67.4	0.0
	CV5/LGTURB	53.7		2.8%	13.0	4.3	0.0	0.0	0.0	0.0	53.7	0.0
	VCV/LGTURB	52.8		2.8%	13.3	4.2	0.0	0.0	0.0	0.0	52.8	0.0
	HPJ/*	38.7		2.0%	8.2	3.8	0.2	0.0	0.0	0.0	38.7	0.0
	CV6/LGTURB	19.7		1.0%	12.8	4.3	0.0	0.0	0.0	0.0	19.7	0.0
	LOF/LGTURB	15.8		0.8%	12.7	4.2	0.0	0.0	0.0	0.0	15.8	0.0
	LOH/LGTURB	14.9		0.8%	12.9	4.3	0.0	0.0	0.0	0.0	14.9	0.0
	F2S/*	13.0		0.7%	13.1	4.3	0.0	0.0	0.0	0.0	13.0	0.0
	F2B/LGTURB	9.3		0.5%	12.3	4.5	0.0	0.0	0.0	0.0	9.3	0.0
	F2E/LGTURB	7.6		0.4%	13.1	4.4	0.0	0.0	0.0	0.0	7.6	0.0
	LOM/LGTURB	6.6		0.3%	12.9	4.0	0.0	0.0	0.0	0.0	6.6	0.0

Table R-1. Effective Global Emission Indices for 1984 Aircraft

Generic Type	OAG Airplane/engine	Fuel (1000 kg/day)	% of Global Fuel Burned	% of Total within Type	0-9 km Altitude Band EI (NOx)	EI (CO)	EI (HC)	9-13 km Altitude Band EI (NOx)	EI (CO)	EI (HC)	Fuel (1000 kg/day) (0-9 km)	Fuel (1000 kg/day) (9-13 km)
	RV1/*	6.0		0.3%	7.7	4.5	0.3	0.0	0.0	0.0	6.0	0.0
	SA2/*	5.0		0.3%	8.1	4.1	0.2	0.0	0.0	0.0	5.0	0.0
	CL4/LGTURB	4.6		0.2%	13.3	3.7	0.0	0.0	0.0	0.0	4.6	0.0
	GR1/*	4.1		0.2%	9.1	25.5	29.0	7.4	0.4	3.6	2.1	2.1
	SHS/*	2.9		0.2%	7.8	4.6	0.3	0.0	0.0	0.0	2.9	0.0
	AN6/LGTURB	2.6		0.1%	13.1	4.4	0.0	0.0	0.0	0.0	2.6	0.0
	SHP/*	2.5		0.1%	7.9	4.4	0.3	0.0	0.0	0.0	2.5	0.0
	HSF/LGTURB	2.4		0.1%	12.7	4.4	0.0	0.0	0.0	0.0	2.4	0.0
	VC8/LGTURB	2.0		0.1%	13.2	4.3	0.0	0.0	0.0	0.0	2.0	0.0
	YN5/*	1.9		0.1%	7.9	4.4	0.3	0.0	0.0	0.0	1.9	0.0
	VGP/*	0.9		0.0%	12.9	4.5	0.0	0.0	0.0	0.0	0.9	0.0
	LV2/*	0.7		0.0%	8.1	4.1	0.2	0.0	0.0	0.0	0.7	0.0
	F2A/LGTURB	0.6		0.0%	13.3	4.2	0.0	0.0	0.0	0.0	0.6	0.0

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13. ABSTRACT *(Maximum 200 words)*

This report describes the development of a three-dimensional database of aircraft fuel burn and emissions (fuel burned,NOx, CO, and hydrocarbons) from scheduled commercial aircraft for four months (February, May, August, and November) of 1976 and 1984 Combining this data with earlier published data for 1990 and 1992, trend analyses for fuel burned, NOx, carbon monoxide, and hydrocarbons were calculated for selected regions (global, North America, Europe, North Atlantic, and North Pacific).

These emissions inventories are available for use by atmospheric scientists conducting the Atmospheric Effects of Aviation Project (AEAP) modeling studies. Fuel burned and emissions of nitrogen oxides (NOx as NO2), carbon monoxide, and hydrocarbons have been calculated on a 1 degree latitude x 1 degree longitude x 1 kilometer altitude grid and delivered to NASA as electronic files.

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