UNITED NATIONS

UNFCCC Framework Convention on Climate Change

Distr.
GENERAL

FCCC/SBSTA/2005/INF.2
5 April 2005

ENGLISH ONLY

SUBSIDIARY BODY FOR SCIENTIFIC AND TECHNOLOGICAL ADVICE
Twenty-second session
Bonn, 19–27 May 2005

Item 5 (a) of the provisional agenda
Methodological issues
Emissions from fuel used for international aviation and maritime transport

Information on greenhouse gas emissions from international aviation and maritime transport

Note by the secretariat

Summary

This note updates document FCCC/SBSTA/2003/INF.3. It draws on emissions data submitted in 2004 by Parties included in Annex I to the Convention (Annex I Parties) on methodological information from the technical review of Annex I Parties' greenhouse gas (GHG) inventories; on information incorporated in the national communications of Parties not included in Annex I to the Convention (non-Annex I Parties); and on traffic data for international aviation published by the United Nations Statistics Division.

For Annex I Parties total GHG emissions from international aviation in 2002 were 48 per cent higher than 1990 levels, whereas total GHG emissions from international maritime transport remained relatively constant during that period. As a result of the technical review of GHG inventories, Annex I Parties have improved their estimation and reporting procedures. A large number of non-Annex I Parties have not been able to provide GHG emissions estimates from international aviation and maritime transport because of problems in obtaining the activity data (fuel consumption) necessary for calculating these emissions.

Traffic data published by the United Nations Statistics Division, as provided by the International Civil Aviation Organization, show a strong growth in international passenger, freight and mail transport between 1990 and 2002. Despite this growth, the increase in carbon dioxide emissions has been much slower than the increase in tonne-km performed during the same period, as a result of improvements in engine fuel efficiency and operating conditions.

CONTENTS

I. Introduction

A. Mandate

1. The Subsidiary Body for Scientific and Technological Advice (SBSTA), at its nineteenth session, recognized the importance of reliable inventory data for further work on the implementation of decision 2/CP.3. It agreed to continue consideration of inventory issues relating to this decision at its twenty-second session.[1]

2. At its twenty-first session, the SBSTA recalled its conclusions from its nineteenth session and requested the secretariat to prepare, for its twenty-second session, information on methodological issues to update document FCCC/SBSTA/2003/INF.3.[2]

B. Scope of the note

3. This document has been prepared to facilitate consideration by the SBSTA, at its twenty-second session, of methodological issues relating to greenhouse gas (GHG) emissions from fuel used for international aviation and maritime transport. It contains:

(a) Summarized GHG inventory information on international aviation and maritime transport submitted by Parties included in Annex I to the Convention (Annex I Parties)

(b) Discussions on methodological issues relating to the estimation of emissions from international aviation and maritime transport identified during the review of GHG inventories of Annex I Parties, and on methodological issues identified by Parties not included in Annex I to the Convention (non-Annex I Parties) in their national communications

(c) Aviation data published by the United Nations Statistics Division.

C. Action by the Subsidiary Body for Scientific and Technological Advice

4. The SBSTA is invited to consider the information in this document and, if necessary, provide guidance to the secretariat on further work.

II. Background

5. The treatment of emissions from international aviation and maritime transport was the subject of negotiations even before the Convention entered into force. Although the Convention does not contain any specific references to these transport activities, Parties decided that, in accordance with the provisions of the Intergovernmental Panel on Climate Change (IPCC) methodologies for GHG inventories, emissions from domestic and international air and sea transport are to be handled differently; emissions from domestic activities form part of Parties' total national emissions, whereas emissions from international aviation and maritime transport are estimated as part of national GHG inventories but are excluded from national emissions totals.

6. The SBSTA, at its fourth session, noted that there are three separate issues relating to emissions from international aviation and maritime transport: adequate and consistent inventories, allocation of emissions, and control options. It considered eight options for allocation and agreed that five of these options should be the basis for further work on this issue. It also took note of work by the International

[1] FCCC/SBSTA/2003/15, paragraph 17 (f).
[2] FCCC/SBSTA/2004/13, paragraph 48.

Civil Aviation Organization (ICAO) and of the International Maritime Organization (IMO) on policies and measures to address these emissions and noted the role of ICAO and IMO in addressing the control of international bunker fuel emissions, and the opportunity for Parties to work through these bodies.

7. Through decision 2/CP.3, Parties agreed that the approach adopted under the Convention (exclusion of emissions from national totals) shall also apply to the Kyoto Protocol, and urged the SBSTA to further elaborate on the inclusion of these emissions in the overall GHG inventories of Parties. In addition, Article 2.2 of the Kyoto Protocol states that Annex I Parties shall "pursue limitation or reduction of emissions of greenhouse gases not controlled by the Montreal Protocol from aviation and marine bunker fuels, working through the International Civil Aviation Organization and the International Maritime Organization, respectively". Annex I Parties that have ratified the Kyoto Protocol are also required to report on the implementation of this article in their national communications.

8. At its tenth session, the SBSTA considered a special report on *Aviation and the Global Atmosphere*[3] prepared by the IPCC at the request of ICAO. Since that session, the SBSTA has worked on methodological issues relating to the estimation and reporting of GHG emissions from international aviation and maritime transport.

9. The SBSTA has requested the secretariat to work in collaboration with the secretariats of ICAO and IMO on such issues. This collaboration has materialized through regular participation of the secretariat in ICAO and IMO meetings, regular reports of the ICAO and IMO secretariats at UNFCCC meetings, and the organization of expert meetings to consider methodological issues that were also relevant for the work of the IPCC. This collaboration has resulted in increased awareness of the issues of common interest among experts and delegates participating in the UNFCCC, ICAO and IMO processes, as well as exchange of information and experiences on the development of an emissions trading scheme for international aviation.

III. Reporting requirements under the Convention

10. The *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (IPCC Guidelines) as elaborated by the *IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* (IPCC good practice guidance) provide methodologies for estimating and reporting emissions from fuel used for international aviation and maritime transport. The IPCC Guidelines specify that these emissions should not be included in national totals but should be reported separately. This provision has been reflected in the UNFCCC reporting guidelines adopted under the Convention (see decisions 9/CP.2, 10/CP.2, 17/CP.8 and 18/CP.8).

11. In accordance with these guidelines, Annex I Parties should make every effort to apply the IPCC good practice guidance definitions for separation between domestic and international emissions and report emissions from international aviation and marine bunker fuels as two separate entries in their inventories.[4] Numerical information such as fuel consumption, emissions estimates and implied emission factors is to be provided in table 1.C of the common reporting format, and detailed methodological information in the national inventory reports (NIRs).[5]

12. Similarly, the guidelines for the initial national communications from non-Annex I Parties state that emissions from bunker fuels should be reported separately from national emissions.[6] The revised guidelines for the preparation of national communications from non-Annex I Parties encourage non-Annex I Parties to apply the IPCC good practice guidance and stipulate that non-Annex I Parties

[3] See <http://www.grida.no/climate/ipcc/aviation/index.htm>.
[4] Paragraph 24 of the guidelines attached to decision 18/CP.8; see FCCC/CP/2002/8 and FCCC/SBSTA/2004/8.
[5] Annexes I and II to the guidelines attached to decision 18/CP.8; see FCCC/CP/2002/8 and FCCC/SBSTA/2004/8.
[6] Paragraph 9 of the guidelines attached to decision 10/CP.2; see FCCC/CP/1996/15/Add.1.

should, to the extent possible, and if disaggregated data are available, report emissions from international aviation and marine bunker fuels separately in their inventories and should not include them in their national totals.[7]

IV. Greenhouse gas information submitted by Parties

A. Annex I Parties

1. Status of reporting

13. Estimates of emissions from international aviation have been provided by 34 Annex I Parties, and estimates of emissions from international maritime transport by 25 Annex I Parties in their 2004 GHG inventory submissions.[8] Generally, Annex I Parties have been complying with the provisions of the IPCC Guidelines and the UNFCCC reporting guidelines by distinguishing between domestic and international emissions from the aviation and marine sectors and by excluding these emissions from their national totals. Emissions of the main three GHGs (carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O)) and of carbon monoxide, nitrogen oxides, non-methane volatile organic compounds and sulphur dioxide for 1990 and 2002 as reported by Annex I Parties are presented in document FCCC/WEB/2004/3.

2. Emissions from international aviation

14. Carbon dioxide is the most important GHG for this sector, accounting for about 99 per cent of the total GHG emissions in terms of CO_2 equivalent; the remaining 1 per cent is made up of N_2O emissions (about 0.8 per cent) and CH_4 emissions (about 0.2 per cent). During the period 1990–2002, CO_2 emissions increased at an average annual rate of 3.4 per cent. For the reporting Parties, this growth rate resulted in 2002 emissions being about 48 per cent higher than those in 1990.[9] The trend in these emissions is shown in figure 1.

15. In 2001 and 2002, as a consequence of the events of 11 September and the SARS (severe acute respiratory syndrome) outbreak, there was a reduction in the growth of air traffic. Although this has resulted in a relative stabilization of the overall emissions at the 2000 levels, there are marked differences among Annex I Parties. For example, reported data from EU-15,[10] Japan and the United States of America (the emissions from these Parties account for about 90 per cent of the total emissions from reporting Annex I Parties) show that CO_2 emissions from the EU-15 were about 5 per cent lower in 2002 than they were in 2000, while emissions from the United States of America have remained relatively level, and those from Japan increased (see figure 2).

16. Domestic emissions also increased overall during the period 1990–2000 (figure 1), but their growth pattern appears to have been affected more by global economic developments during this decade – a decline (slow-down) during the period 1991–1994 and a recovery after 1995. In 2001 and 2002, the

[7] Paragraph 19 of the guidelines attached to decision 17/CP.8; see FCCC/CP/2002/7/Add.2.

[8] Some Annex I Parties are land-locked countries and therefore do not supply fuel for international maritime transport activities.

[9] This growth is based on GHG emissions data from those Annex I Parties that have submitted emissions estimates for all the years since 1990. In these totals, data for the Russian Federation are not included. Taking into consideration the reductions in the GHG emissions of this Party over the period 1990–2002, it is possible that the overall growth rate for Annex I Parties is lower than 48 per cent. It is anticipated that complete data for the Russian Federation will become available in 2005.

[10] EU-15 stands for Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom.

emissions were also affected more by the two events mentioned above; an overall decrease of about 7 per cent between 2000 and 2002 means that emissions returned to about the 1998 levels.

Figure 1. Carbon dioxide emissions from domestic and international aviation for Annex I Parties that have submitted emissions estimates for all the years since 1990

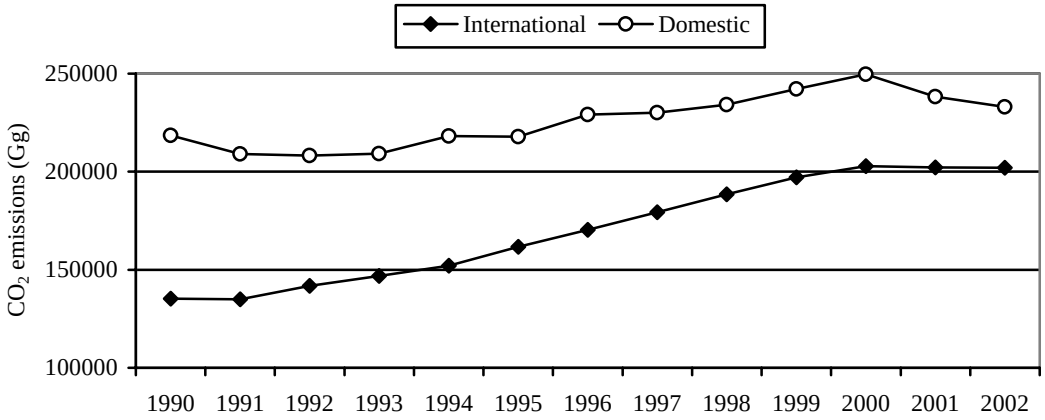
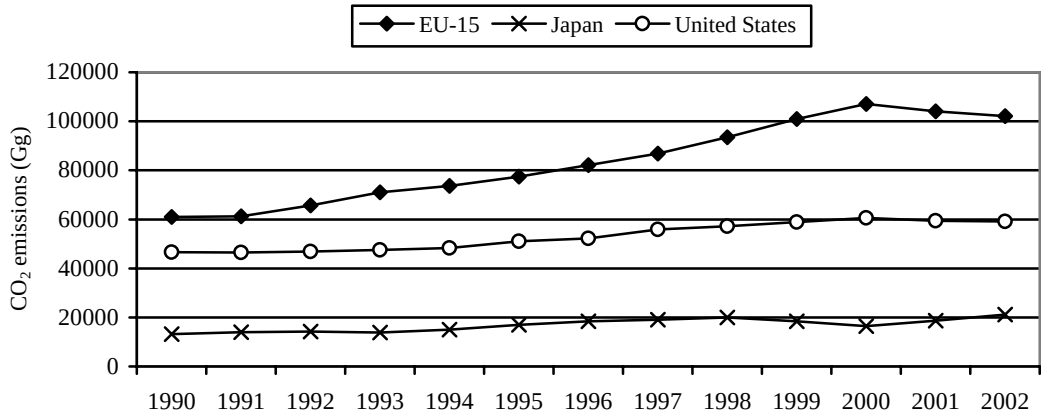


Figure 2. Carbon dioxide emissions from international aviation for EU-15, Japan and the United States (accounting for about 90 per cent of total emissions from reporting Annex I Parties)



17. In 2002, total GHG emissions from international aviation were about 205,000 Gg CO_2 equivalent, which is equivalent to about 1.2 per cent of the total national GHG emissions (excluding emissions from international aviation and maritime transport and CO_2 emissions from land-use change and forestry) of reporting Annex I Parties. As shown in figure 3, the relative importance of international aviation emissions varies among Annex I Parties; from 0.1 per cent for Slovakia to almost 10 per cent for Switzerland.

3. Emissions from international maritime transport

18. The most important GHG for the maritime transport sector is also CO_2, accounting for about 98 per cent of the total GHG emissions; the remaining 2 per cent is made up of N_2O (about 1.5 per cent) and CH_4 (about 0.5 per cent). Although emissions from international maritime transport have remained relatively constant during the period 1990–2002 (figure 4), there are marked differences among Annex I Parties. For example, reported data from EU-15, Japan and the United States (the emissions from these Parties account for about 95 per cent of the total emissions from reporting Annex I Parties) show that

CO_2 emissions from the EU-15 increased by about 35 per cent between 1990 and 2002, while emissions from the United States declined by about 59 per cent, and those from Japan remained relative stable (see figure 5).

Figure 3. Greenhouse gas emissions from international aviation as a percentage of national totals for Annex I Parties

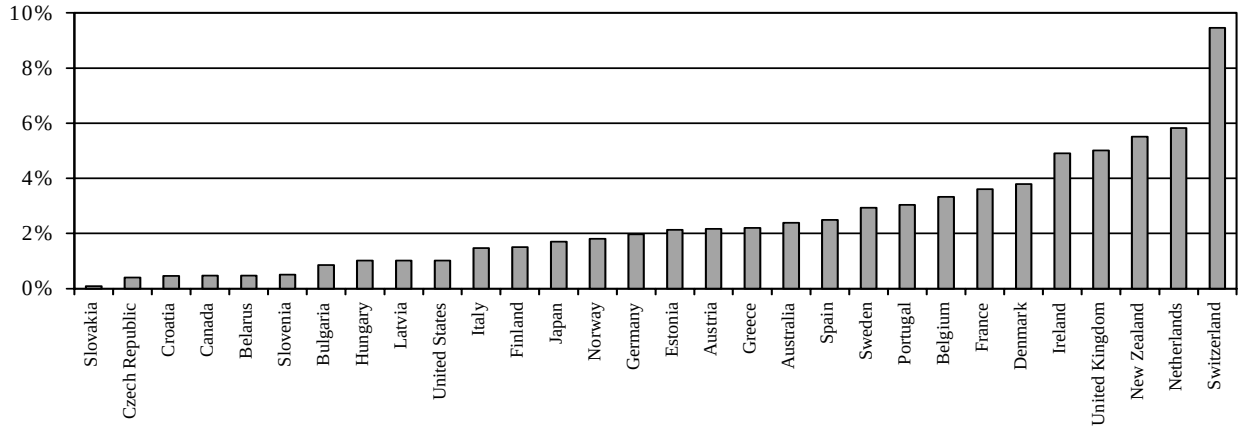
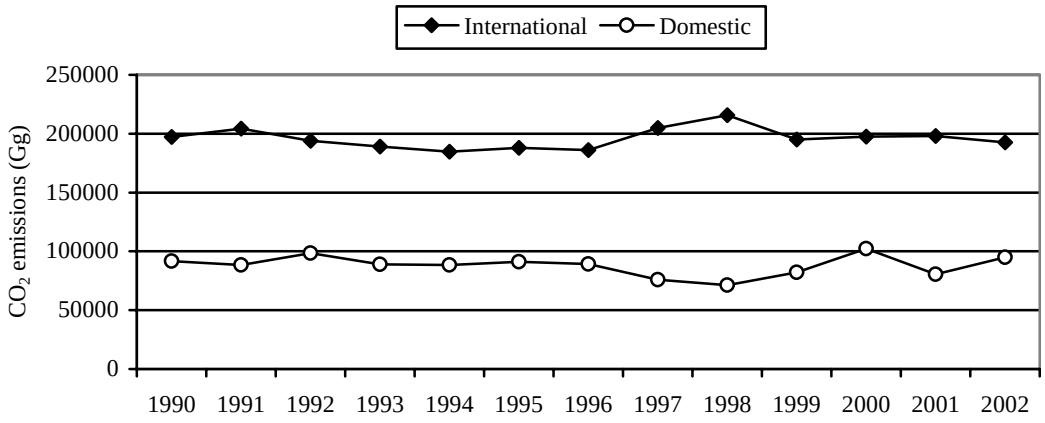


Figure 4. Carbon dioxide emissions from domestic and international maritime transport for Annex I Parties that have submitted emissions estimates for all the years since 1990



19. The main characteristic of the domestic and international maritime emissions is the opposite trends for the years 1990–1992 and 1996–1999 (figure 4). The reason for this is reductions of emissions during the periods 1990–1992 and 1996–1999 reported by the United States, which dominate the overall trends for domestic maritime transport (on average, the United States accounted for more than 60 per cent of the total emissions during the period 1990–2002).

20. In 2002, total GHG emissions from international maritime transport were about 204,000 Gg CO_2 equivalent, which is equivalent to about 1.2 per cent of the total national GHG emissions (excluding emissions from international aviation and maritime transport and CO_2 emissions from land-use change and forestry) of reporting Annex I Parties. As shown in figure 6, the relative importance of international maritime transport emissions varies among Annex I Parties; from less than 0.1 per cent for Slovakia to almost 27 per cent for Netherlands.

Figure 5. Carbon dioxide emissions from international maritime transport for EU-15, Japan and the United States (accounting for about 95 per cent of the total emissions from reporting Annex I Parties)

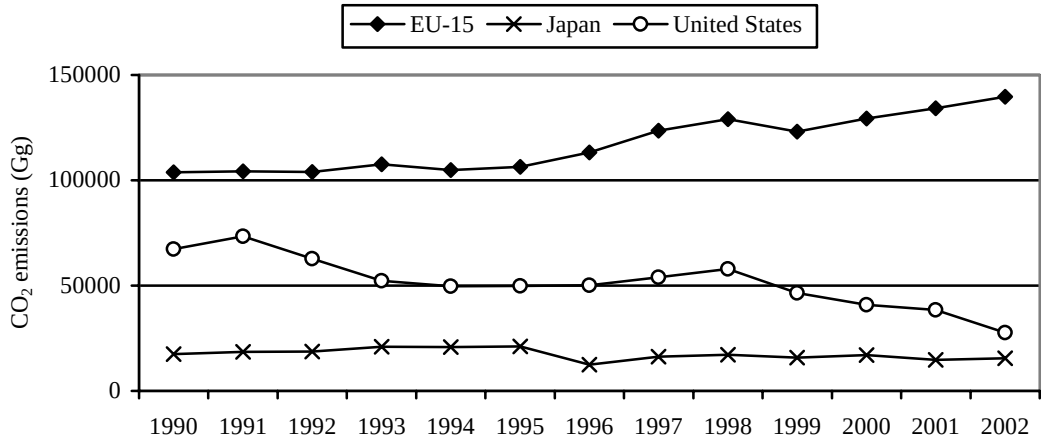
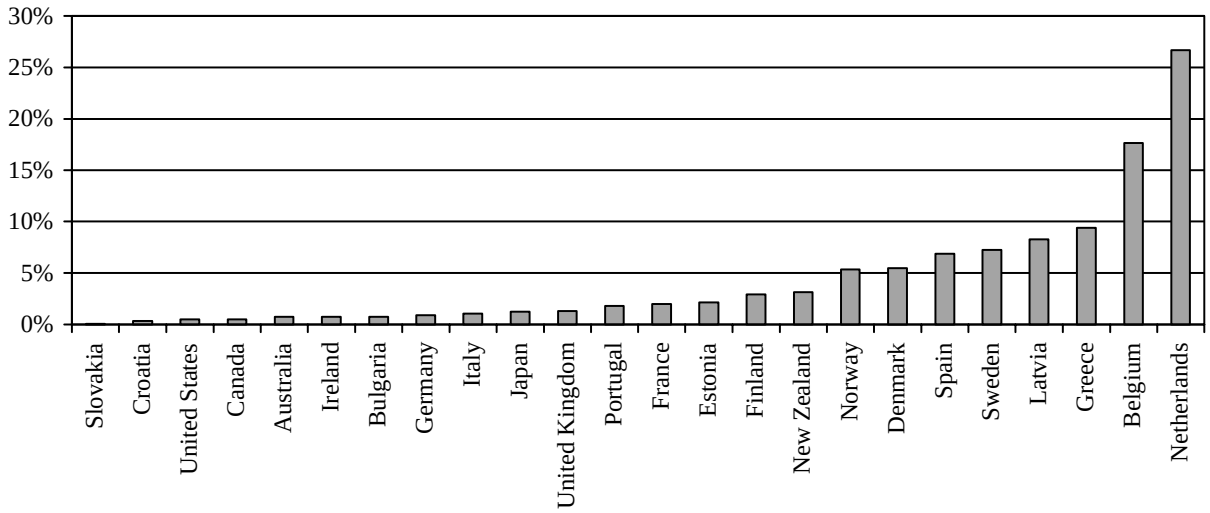


Figure 6. Greenhouse gas emissions from international maritime transport as a percentage of national totals for Annex I Parties



B. Non-Annex I Parties

21. As at 31 January 2005, 123 non-Annex I Parties had submitted their first national communication and three Parties had submitted their second national communication. To the date of publication of this document, about 100 national communications have been processed. Of this 100 national communications, 55 contain GHG data from international aviation and maritime transport (these data are available on the UNFCCC web site[11]). Because non-Annex I Parties are not required to provide emissions estimates for all the years since 1990, it is not possible to aggregate and present emissions trends for these Parties.

[11] <http://ghg.unfccc.int/default.htf>.

V. Methodological issues

A. Aviation

22. One tier 1 and two tier 2 methods (designated tier 2a and 2b) are outlined in the IPCC Guidelines and the IPCC good practice guidance. All methods are based on distinguishing fuel use between domestic and international travel. The tier 1 method is based purely on fuel use, whereas the tier 2 methods are based on the number of landing and take-off (LTO) cycles and fuel use. Estimates of CO_2 emissions depend on carbon content of fuel and the fraction oxidized and therefore should not vary significantly between the methods. The IPCC good practice guidance indicates that national approaches can also be used if they are well documented and have been peer reviewed. The choice of method depends on national circumstances, particularly the availability of data.

23. Twenty-nine Annex I Parties provided information on the methodologies used for estimating emissions from international aviation; 16 Parties reported that they used the tier 1 method, 11 reported that they used a tier 2 method and two reported that they used a hybrid method (tier 1 for CO_2 and tier 2 for other gases).[12]

B. Marine

24. The IPCC Guidelines and the IPCC good practice guidance elaborate two tiers of methods for estimating emissions of CO_2, CH_4 and N_2O from water-borne navigation. Both tiers rely on essentially the same analytical approach, which is to apply emission factors to fuel used for domestic and international transport. The IPCC good practice guidance suggests that Parties should use tier 1 for CO_2 and tier 2 for CH_4 and N_2O. National approaches may also be used if they are well documented and have been peer reviewed.

25. Twenty-five Annex I Parties provided information on the methodologies used for estimating emissions from international maritime transport; 23 reported that they used the tier 1 method and two reported that they used a hybrid method (tier 1 for CO_2 and tier 2 for other gases).[12]

C. Summary of findings in greenhouse gas review reports

26. In general, the quality and quantity of GHG inventory information reported by Annex I Parties have improved over the past four years as a result of the technical review of GHG inventories, during which shortcomings in their estimation methodologies were identified leading to action taken by Annex I Parties to fix problems in their GHG inventory preparation process.

27. The improvements relate to both the completeness of the estimates provided and the provision of more detailed methodological and supporting information regarding the estimation of emissions from international aviation and maritime transport. Some of the most common findings by the expert review teams relate to the need for more explanatory information on how Parties distinguish between domestic and international fuel use, and the need for more information on the emission factors used.

1. Disaggregation between domestic and international use of fuels

28. One of the biggest challenges for Parties trying to estimate emissions from international aviation and maritime transport is obtaining disaggregated fuel data for these activities. Although the IPCC good practice guidance provides a set of criteria for distinguishing between domestic and international flight segments, it indicates that obtaining data for fuel used for these flights depends on national circumstances.

[12] These numbers include Annex I Parties that have reported using the CORINAIR methodologies (simple methodology corresponding to the IPCC tier 1 and detailed methodology corresponding to the IPCC tier 2).

29. There is no uniform approach among Annex I Parties for disaggregating fuel-use data into domestic and international components. Fuel use for domestic and international purposes is estimated in various ways by national statistical agencies using, for example, information on fuel taxation, information on the flag or country of registration of carriers, information received from oil companies, or information from airlines. In other cases, the national statistical agencies provide data on total amounts of fuel used and the domestic and international amounts are estimated by using surrogate data. For example, for aviation fuels, some Parties use LTO cycles and "default" fuel consumption factors, whereas others use jet fuel expenditures and information on the flag of the carriers.

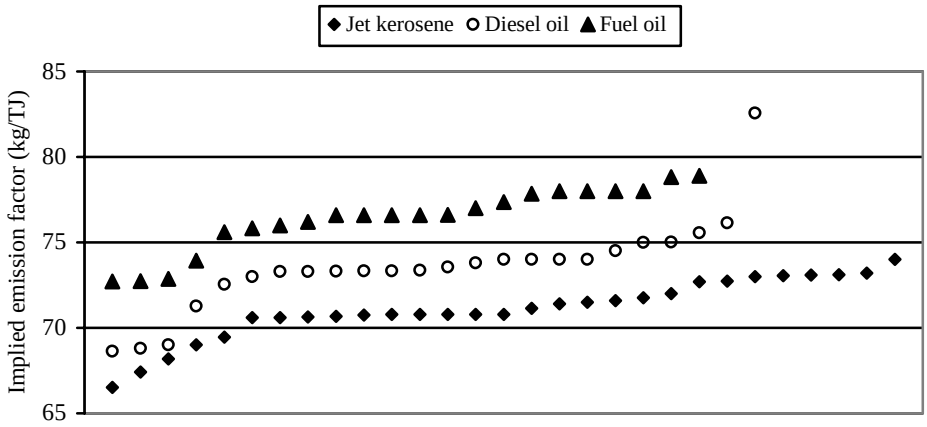
30. Some Parties reported problems with distinguishing between domestic and international fuel use, particularly because their statistical systems do not allow for an appropriate differentiation. These problems have led to the allocation of all fuel used to either international transport or domestic purposes. Furthermore, in some Parties different national agencies use different definitions of international transport.

2. Emission factors

31. Expert review teams were able to identify reporting discrepancies or issues relating to the use of unexpectedly high or low emission factors used to relate activity data to emissions. They did this by comparing implied emission factors across different Annex I Parties (see figures 7–9) and with the default emission factors provided in the IPCC Guidelines and the IPCC good practice guidance.[13]

32. As illustrated in figure 7, there is small variation in the CO_2 implied emission factors reported by Annex I Parties, with the exception of one Party reporting an uncharacteristically high implied emission factor for diesel oil. The lower implied emission factors are reported by Parties that estimate fuel consumption using conversion factors based on the gross calorific value of fuels.

Figure 7. Carbon dioxide implied emission factors from individual Annex I Parties for jet kerosene, diesel oil and fuel oil



33. As shown in figure 8 (note that the vertical axis has been plotted on a logarithmic scale), some Annex I Parties have reported implied emission factors that are higher by two to three orders of magnitude than the median value of the reporting Annex I Parties (1.8 kg CH_4/TJ and 2.3 kg N_2O/TJ). Some Annex I Parties have also reported implied emission factors for N_2O emissions from fuel oil used

[13] Implied emission factors are top-down ratios between a Party's emissions estimates and activity data for specific sectoral activities. The implied emission factors are intended solely for purposes of data comparison. They are not necessarily the emission factors actually used in the original emission estimate, unless this was a simple multiplication based on the same aggregate activity data used to calculate the implied emission factor.

in international maritime transport (figure 9) that are much higher than the median value for the reporting Annex I Parties (2 kg N_2O/TJ).

Figure 8. Methane and nitrous oxide implied emission factors from individual Annex I Parties for jet kerosene used in international aviation

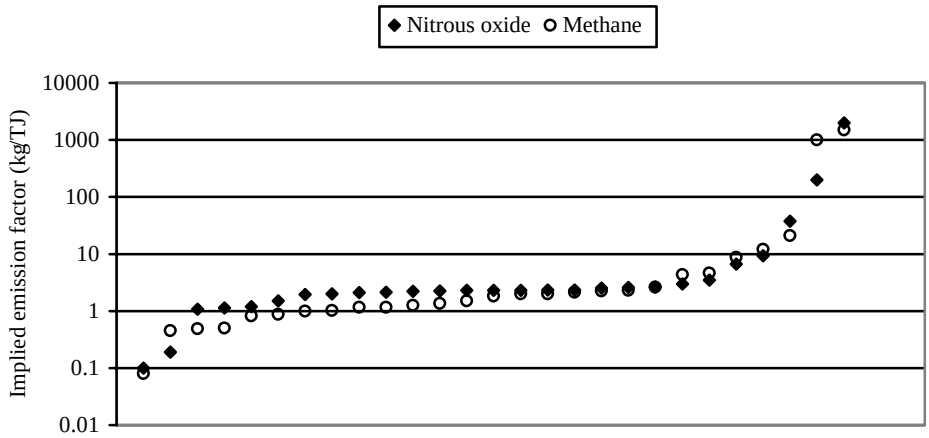
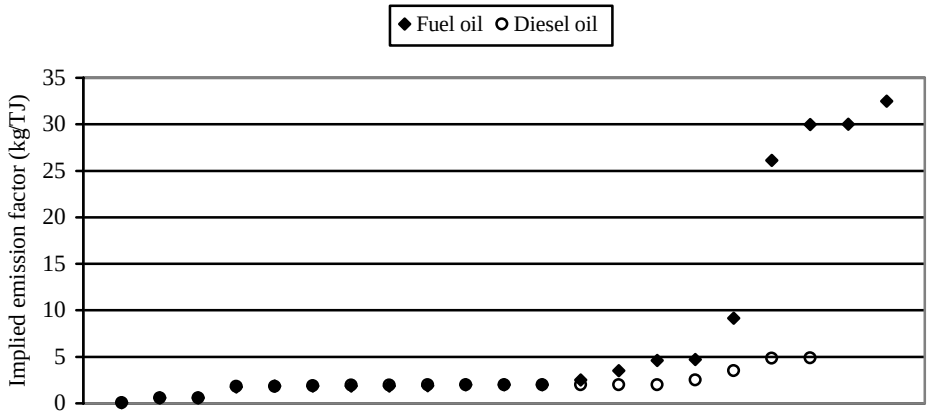


Figure 9. Nitrous oxide implied emission factors from individual Annex I Parties for diesel and fuel oil used in international maritime transport



34. For the majority of Annex I Parties, the CO_2, CH_4 and N_2O implied emission factors agree well with the corresponding IPCC default emission factors for these gases. However, the use of emission factors that are higher or lower than the IPCC default emission factors does not necessarily constitute an error in the GHG inventory preparation process, provided that Parties give, in their NIRs, appropriate explanations for the use of such emission factors. Given the small contribution of CH_4 and N_2O emissions in the total GHG emissions from international aviation and maritime transport, changes in the emission factors used should not lead to significant changes in the overall level of emissions and their trends (see figures 1 and 4). Correcting such problems, however, results in both greater confidence in the GHG inventory data submitted by Annex I Parties, and greater reliability of the GHG emissions and trends presented to the COP.

D. Issues identified by non-Annex I Parties

35. As mentioned above (paragraph 21), about half of the non-Annex I Parties that have submitted their initial national communication provided estimates of emissions from international aviation and maritime transport. Problems encountered by non-Annex I Parties have been presented in the compilation and synthesis reports of the initial national communications that have been published by the secretariat (see for example FCCC/SBI/2001/14/Add.1, FCCC/SBI/2002/16, FCCC/SBI/2003/13). The most commonly mentioned difficulty that non-Annex I Parties face in estimating these emissions is lack of statistical information on fuel consumption for these transport activities. Other related problems include:

(a) Shortcomings in national statistical systems that do not allow the disaggregation of fuel used for domestic and international purposes

(b) Unavailability of data on fuel usage and number, type and size of vessels in marine transport and in commercial and recreational fishing.

VI. Traffic data for international aviation

36. During the twenty-first session of the SBSTA there was a request for detailed information on the effective increase of international aviation since 1990, including information on the movement of passengers and cargo and on the number of flights. This part of the note contains publicly available traffic data for the international aviation sector published by the United Nations Statistic Division, as provided by ICAO.[14] Trends in international air passenger travel and freight transport on scheduled services[15] between 1990 and 2002 are illustrated in figure 10.

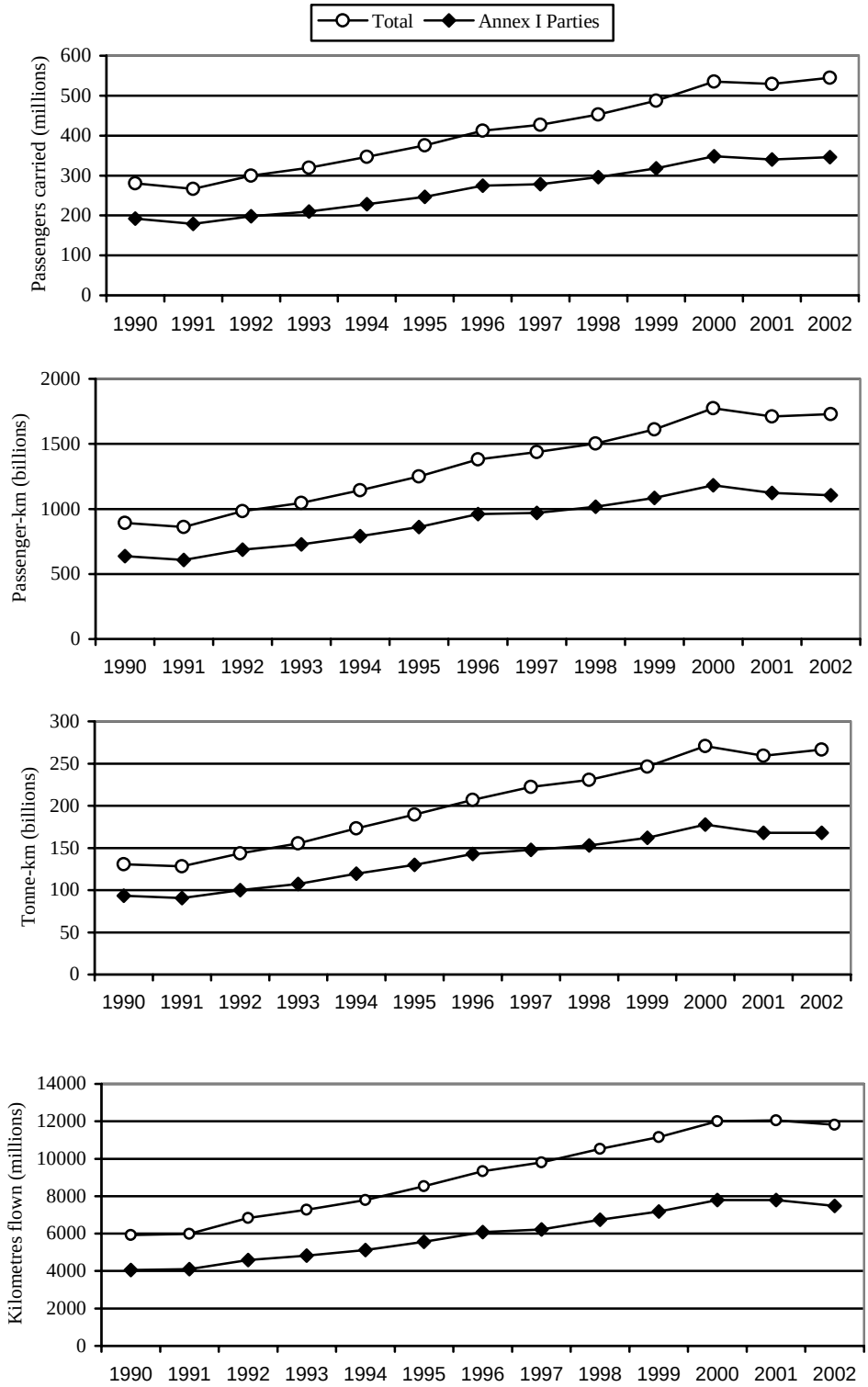
37. For passengers carried and passenger-km performed, the growth observed over the period 1990–2002 is equivalent to an average annual rate of 5.7 per cent, resulting in an overall increase by a factor of almost 2. The demand for passengers, coupled with more demand for air freight and mail, has generated increases in both tonne-km performed and in kilometres flown. The average rates of growth were 6.1 per cent for tonne-km performed and 5.9 per cent for kilometres flown.

38. The growth of the international aviation sector has been affected by the events of 11 September and the SARS outbreak during 2001 and 2002. These events resulted in a slower growth rate in 2001 and 2002, although, according to ICAO data for 2003 and 2004, the sector has started showing signs of a strong recovery.[16]

39. Figure 10 shows that, between 1990–2002, air carriers having headquarters in Annex I Parties have provided the largest share of the scheduled services for air passenger and freight transport. Although, the increase in the services provided by these air carriers was about 80 per cent during this period, their relative share of the total passenger-km and tonne-km performed has gradually decreased from 71 per cent in 1990 to 64 per cent in 2002, as a result of larger increases (more than 200 per cent) in the services provided by air carriers having headquarters in non-Annex I Parties.

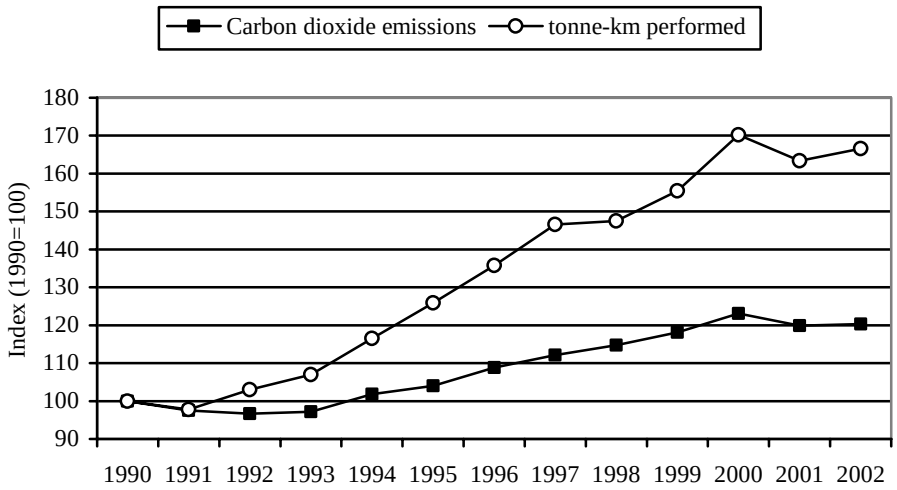
[14] <http://unstats.un.org/unsd/cdb/cdb_help/cdb_quick_start.asp>.
[15] Scheduled services account for about 88 per cent of the total international air passenger traffic.
[16] For 2003, see ICAO Doc 9826, Annual Report of the Council, 2003, Appendix 12. For 2004 see <http://www.icao.int/icao/en/nr/2004/pio200416_e.pdf>.

Figure 10. Traffic data for scheduled international aviation services during the period 1990–2002



40. As illustrated in figure 11, despite the considerable increases in the tonne-km performed (including passenger, freight and mail carried by domestic and international scheduled and non-scheduled services) during 1990–2002, the increase in CO_2 emissions from aviation (domestic and international) has been much slower than the increase in tonne-km performed. This difference appears to be due to such improvements as the introduction of new aircraft into the fleet and changes to operating conditions and passenger management (for example increase in load factor and aircraft capacity or size). In the absence of any such improvements, CO_2 emissions between 1990 and 2002 would possibly have increased by more than 48 per cent as indicated by the data reported by Annex I Parties (figure 1).

Figure 11. Growth in carbon dioxide emissions and tonne-km performed for the period 1990–2002[a]



[a] For this figure, data for both domestic and international aviation of all Parties were used. Carbon dioxide emissions come from the International Energy Agency (IEA) and tonne-km performed data come from ICAO. Because of differences in the definitions of domestic and international aviation used by IEA and ICAO (see FCCC/SBSTA/2003/INF.3), no attempt has been made to combine these two data sets and provide, for example, trends for CO_2 emissions per tonne-km performed.

- - - - -