1. TITLE

1.1 Data Set Identification

ISLSCP II EDGAR 3 Gridded Greenhouse and Ozone Precursor Gas Emissions

1.2 Database Table Name(s)

Not applicable to this data set.

1.3 File Name(s)

There are two *.zip data files with this data set in 1.0 degree spatial resolution: **edgar_data_1deg.zip** and **edgar_maps_1deg.zip.**

When extrapolated these files each contains 28 data files and are named according to the following naming convention:

edgar_data_1deg.zip: edgar_*variable*_data_1d_YYYY.csv

edgar	identifies the data set.
variable	identifies the particular gas emissions contained in the file: ch4 = CH_4, methane co = CO, carbon monoxide co2 = CO_2, carbon dioxide n2o = N_2O, nitrous oxide nmv = NMVOC (Non-Methane Volatile Organic Compounds) nox = NO_2, nitrogen dioxide so2 = SO_2, sulphur dioxide
lto	identifies a file that includes emissions at less than 1,000 m (landing and take-off phases of aircraft operations; files without lto do not include this data)
data	identifies that this is tabular data (as opposed to the "map" files below).
1d	identifies the spatial resolution of the data set: 1d is "1.0 degree".
YYYY	is the four-digit year: 1970, 1980, 1990, or 1995.
.csv	is the extension, indicating the format of the tables as "comma-separated values".

edgar_maps_1deg.zip: These are two-dimensional ASCII map files for each gas on a 1.0 degree x 1.0 degree Earth grid. The files are named in a similar fashion as the names above except that they contain the word "map" as opposed to the word "data" and the file extension is ".asc" indicating that this is an ASCII map.

As an example, the file named **edgar_co2_map_1d_1980.asc** contains the CO_2 anthropogenic emissions for 1980 mapped onto a 1.0 degree x 1.0 degree grid and is based on data from the original data table named **edgar_co2_data_1d_1980.csv**.

The original data files submitted to the ISLSCP II staff were ASCII data tables, containing the total anthropogenic emissions of the various gases shown above. These original data files contain a 12-13 line header and 3 columns of data: Longitude, Latitude, and the emissions data for that cell. All original data can also be obtained at http://www.rivm.nl/edgar/.

1.4 Revision Date of this Document

June 30, 2011

2. INVESTIGATOR(S)

2.1 Investigator(s) Name and Title

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Netherlands Organization for Applied Scientific Research (TNO), and
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Joint Research Centre of the EC (JRC-IES),
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2.2 Title of Investigation

EDGAR Emission Database for Global Atmospheric Research

2.3 Contacts (For Data Production Information)

	Contact 1	Contact2
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*****NOTE: E-mail contacts are preferred.**

2.4 Data Set Citation

Olivier, J. G. J. 2011. ISLSCP II EDGAR 3 Gridded Greenhouse and Ozone Precursor Gas Emissions. In Hall, Forrest G., G. Collatz, B. Meeson, S. Los, E. Brown de Colstoun, and D. Landis (eds.). ISLSCP Initiative II Collection. Data set. Available on-line [http://daac.ornl.gov/] from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A. doi:10.3334/ORNLDAAC/1022

2.5 Requested Form of Acknowledgment

Users of the International Satellite Land Surface Climatology (ISLSCP) Initiative II data collection are requested to cite the collection as a whole (Hall et al. 2006) as well as the individual data sets. Please cite the following publications when these data are used:

Hall, F.G., E. Brown de Colstoun, G. J. Collatz, D. Landis, P. Dirmeyer, A. Betts, G. Huffman, L. Bounoua, and B. Meeson, The ISLSCP Initiative II Global Data sets: Surface Boundary Conditions and Atmospheric Forcings for Land-Atmosphere Studies, *J. Geophys. Res.*, 111, doi:10.1029/2006JD007366, 2006.

Olivier, J.G.J. and J.J.M. Berdowski (2001a) *Global emissions sources and sinks*. In: Berdowski, J., Guicherit, R. and B.J. Heij (eds.) "*The Climate System*", pp. 33-78. A.A. Balkema Publishers/Swets & Zeitlinger Publishers, Lisse, The Netherlands. ISBN 90 5809 255 0

The EDGAR project is a comprehensive task carried out jointly by the *National Institute for Public Health* (RIVM) and the *Netherlands Organization for Applied Scientific Research* (TNO). It combines information on all different anthropogenic emission sources and acts in practice as a reference database for many applications. The work is linked into and part of the *Global Emissions Inventory Activity* (GEIA) of the International Geosphere-Biosphere Programme's (IGBP) *International Global Atmospheric Chemistry Programme* (IGAC).

3. INTRODUCTION

3.1 Objective/Purpose

The aim of the EDGAR system, which started in 1992, is to provide global anthropogenic emissions of greenhouse gases CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 and of precursor gases CO, NO_x, NMVOC and SO_2, per source category, both at country and regional scales as well as on a 1.0 degree x 1.0 degree Earth grid. It is meant to serve as a reference database for policy applications, e.g. to provide RIVM's integrated climate change model IMAGE 2 with emissions data and for assessments of potentials for emission reductions, as well as for scientific studies by providing gridded emissions as input for atmospheric models.

3.2 Summary of Parameters

The EDGAR database contains estimates of emissions from many gases (see http://www.rivm.nl/edgar/). For this ISLSCP II collection gridded emission data files are provided for the total of all anthropogenic sources for 1970, 1980 ,1990 and 1995 for CO_2, CH_4 and N_2O and for the precursor gases CO, NO_x, NMVOC and SO_2 for 1990 and 1995. The files are provided in their original tabular format as well as two-dimensional Earth grids. EDGAR data comprise all anthropogenic sources, including international air traffic and international shipping:

(a) Fossil-fuel production, transmission, transformation (e.g. coke production, oil refineries) and combustion (F category)
(b) Biofuel production, transformation (charcoal production) and combustion (B category)
(c) Industrial production and consumption processes (including solvent use) (I category)
(d) Agricultural activities (L category)
(e) Biomass burning (L category)
(f) Waste handling (W category).

Fossil fuel fires are included (coal fires, oil fires in Kuwait in 1992).

PARAMETER DEFINITIONS

For carbon dioxide (CO_2):

- *Fuel combustion* refers to fossil fuel combustion and non-energy/feedstock use (Intergovernmental Panel on Climate Change (IPCC) category 1A) estimated using the IPCC Sectoral Approach;
- *Fugitive* refers to flaring of associated gas in oil and gas production (IPCC category 1B);
- *Industry* refers to cement production (IPCC category 2); and
- *Other* refers direct emissions from tropical forest fires plus 10% of biofuel combustion emissions, which is the fraction assumed to be produced unsustainably (IPCC category 5).

For methane (CH_4):

- *Energy* comprises production, handling, transmission and combustion of fossil fuels and biofuels (IPCC category 1A and 1B);
- *Agriculture* comprises animals, animal waste, rice production, agricultural waste burning (non-energy, on-site) and savannah burning (IPCC category 4);
- *Waste* comprises landfills, wastewater treatment, human wastewater disposal and waste incineration (non-energy) (IPCC category 6);
- *Others* include industrial process emissions and tropical and temperate forest fires (IPCC categories 2 and 5).

For nitrous oxide (NO):

- *Energy* comprises combustion of fossil fuels and biofuels (IPCC category 1A and 1B);

- *Agriculture* comprises fertilizer use (synthetic and animal manure), animal waste management, agricultural waste burning (non-energy, on-site) and savannah burning (IPCC category 4);
- Industrial Processes comprises non-combustion emissions from manufacturing of adipic acid and nitric acid (IPCC Source Category 2); and
- *Others* include N_2O usage, tropical and temperate forest fires, and human sewage discharge and waste incineration (non-energy) (IPCC Source Categories 3, 5 and 6).

3.3 Discussion

The ISLSCP II version of EDGAR is a combination of an earlier RIVM data set EDGAR 2.0 updated to EDGAR 3.2: EDGAR 2.0 provided global annual emissions for 1990 of greenhouse gases CO_2, CH_4 and N_2O and precursor gases CO, NO_x, NMVOC and SO_2, both per region and on a 1 degree x 1 degree grid for all anthropogenic sources. Similar inventories were compiled for a number of CFCs, halons and methyl bromide, methyl chloroform. In the follow-up project the database was extensively validated and an uncertainty analysis was carried out (Olivier *et al*., 2001a,b). Most of the applications of EDGAR 2.0 over the last couple of years are model studies, but EDGAR data are also extensively used for policy applications for which emissions data on country level were calculated with the EDGAR information system. Over 700 users have downloaded EDGAR 2.0 data. EDGAR data sets have also been used in IPCC Assessments, both on source strengths and on spatial distribution of emissions in emission scenarios (IPCC, 2000a, 2001).

Because there are emissions over water, the EDGAR data provided here have not been made consistent with the ISLSCP II land/water mask as most other data sets in the collection have. Therefore, we expect that users will find areas, particularly near coastlines or on small islands, where there will be emissions yet where the ISLSCP II mask will show water. Users may wish to use the ISLSCP II land/water mask to adapt the current data set to match up with the land/water boundaries of the other data sets in this collection.

4. THEORY OF ALGORITHM/MEASUREMENTS

Not available at this revision.

5. EQUIPMENT

Emissions data were mostly taken from international statistical data sources. Emission factors were selected mostly from international publications to ensure a consistent approach across countries. Sources for the emissions data depend on the type of data and are documented in the references in Section 12. No satellites or other instruments were used.

5.1 Instrument Description

5.1.1 Platform (Satellite, Aircraft, Ground, Person)

Not applicable to this data set.

5.1.2 Mission Objectives

Not applicable to this data set.

5.1.3 Key Variables

Not applicable to this data set.

5.1.4 Principles of Operation

Not applicable to this data set.

5.1.5 Instrument Measurement Geometry

Not applicable to this data set.

5.1.6 Manufacturer of Instrument

Not applicable to this data set.

5.2 Calibration

5.2.1 Specifications

5.2.1.1 Tolerance

Not applicable to this data set.

5.2.2 Frequency of Calibration

Not applicable to this data set.

5.2.3 Other Calibration Information

None.

6. PROCEDURE

6.1 Data Acquisition Methods

Energy/Fugitive/Biofuel

Data for fossil fuel production and use for 112 countries are taken from the International Energy Agency (IEA) energy statistics for OECD (Organization for Economic Co-operation and Development) and non-OECD countries 1970-1995 (extended energy balances, in ktoe units) (IEA, 1997). For the countries of the former Soviet Union (SU) a modified data set was used to achieve a complete time series for the new countries for 1970-1995 of which the sum converges to the older data set for the total former SU. For another 71 countries, the aggregated IEA data for the regions 'Other America', 'Other Africa' and 'Other Asia' have been split using the sectoral IEA data per region and total production and consumption figures per country of hard coal, brown coal, gas and oil from UN energy statistics (UN, 1998). Note that the EDGAR 3.0 data are based on IEA statistics published in 1997 and thus may differ somewhat from more recent IEA data sets; in particular for countries of the former Soviet Union the IEA data have been updated considerably. Moreover, for estimating CH_4 emissions, hard coal and brown coal production data have been split into surface and underground mining based on various national reports.

Biofuel data for developing countries in 1990 have been based on Hall *et al.* (1994), with biofuel type splits from EDGAR 2.0 (Olivier et al., 1996, 1999), which includes vegetal waste used as fuel. Data for the time series 1970-1995 were based on the trend per country in urban and

rural population. However, for Latin American countries biofuel statistics from OLADE (Organización Latinoamericana de Energía) were used (OLADE, 1999, pers. comm). Fuel wood and charcoal consumption (also production) in OECD'90 and EIT countries (Economies-In-Transition, i.e. Eastern Europe and former Soviet Union countries) were based on FAO (1998b), thereby replacing any IEA data for biofuel combustion in the 'Other sector' in these countries. For biofuel combustion in industry and power generation in OECD'90 countries, the data come from the IEA data set (IEA, 1997). However these data were often not provided for all years and all countries.

Emission factors for CO_2, CH_4 and N_2O from fossil fuel production and use are described in Olivier *et al.* (1999), except for CO_2 from gas flaring/venting, which were based on data compiled by the Carbon Dioxide Information Analysis Center (CDIAC) (Marland, 1998, pers. comm.) from data collected by the U.S. Geological Survey. For N_2O from gasoline cars in road transport, the fraction of cars equipped with a catalytic converter was taken into account (based on data from Eurostat and others). The factors for biofuel combustion and charcoal production are based on a review made for the *Revised 1996 IPCC Guidelines* (IPCC, 1997). For CO_2 from biofuels, it was tentatively assumed that 10% was produced unsustainably. For methane emissions from coal mining the methane recovery for ten countries amounted to about 1 Tg in 1990 (of which about half was allocated to the USA and Germany). Recovery in 1995 was estimated at 2 Tg (Thakur *et al.*, 1996; Bibler *et al.*, 1998; and national reports to Climate Convention).

Industrial Processes

Production data of cement, nitric acid, iron and steel, and various chemicals were based on UN Industrial Commodity Statistics (UN, 1998). However, for many countries interpolations and extrapolations were necessary to arrive at complete time series per country for 1970-1995. Special attention had to be given to new EIT countries, in particular to former USSR countries, to match the older totals for the former countries. Cement production data were supplemented with data from the USGS. For adipic acid production data were taken from SRI (1998) (smoothed and averaged); steel production was split into different technologies using data from IISI (1997), supplemented with UN data. For nitric acid (NA) production data are primary based on UN statistics. However, since industry estimates of global total production are substantially higher, the data set has been expanded, first by adding countries not included in the UN NA statistics, for which the amount of N in the production of nitrogen fertilizers according to FAO statistics was used as an estimate for NA production, secondly by increasing the official UN production statistics of nitric acid by 40% to arrive at the estimated global industry total of about 55 Mton HNO_3.

Global annual total production of HCFC-22 and consumption of HFC-134a are based on AFEAS (1997). Primary aluminium production statistics per country from UN (1998) were combined with smelters types characterized by one of five process types according to Aluminium Verlag (1998). Global consumption data of PFCs for semiconductors are taken from Mocella (1993) and for SF_6 per application from S&PS (1997) and Smythe (2000). These global totals were distribution over individual countries using related variables and statistics such as CFC consumption per country, per country semiconductor production and electricity use.

Emission factors for CO_2, CH_4 and N_2O are described in Olivier *et al.* (1999). Note that emissions of CO_2 from cement production are only a proxy for cement clinker production. The emission factors for NA production are based on IPCC (2000), assuming that in 1990 20% of global total production is equipped with Non-Selective Catalytic Reduction (NSCR) technology,

all in OECD'90 countries, and that for other plants the emission factor in 1990 is the average of the IPC default for non-NSCR plants, whereas the emission factors for 1975 and before have been assumed to be equal to the IPCC defaults for 'old plants'. The emission factors for the F-gases were taken from various sources (Olivier and Bakker, 2000). We note that both the variables for distributing global total consumption and the emission factor may vary widely between different plants. This means the emissions at country level of the F-gases should more or less be considered as an order of magnitude estimate.

Solvent and other product use

For N_2O from the use of anesthesia in hospitals, a fixed amount of N_2O per capita in OECD'90 countries was used, tentatively set at 25 g/cap/year, based on Kroeze (1994).

Agriculture

Activity data for livestock number were taken from FAO (2000), which were combined with information on animal waste generated per head in IPCC (1997) to estimate the total amount of animal waste. Net crop production was also taken from FAO (2000), with harvested areas of rice production split over different ecology types (rainfed, irrigated, deep water and upland) using the draft version of March 1977 the RICE-ECO database of FAO (Van Gnuu, 1997, pers. comm.). In addition, the total harvested area of rice production in China was increased by 40%, due to recognition that official harvested rice area statistics of China are largely underestimating the actual area (Denier van der Gon, pers. comm., 2000).

The fraction of agricultural waste associated with net crop production was based on a recent study by Smill (1999), whereas the fraction of agricultural residues burned on-site have been based on an analysis made by Bouwman (1997) and data reported in the Second National Communications. For OECD'90 countries 5% was assumed, for EIT countries 20% and for developing regions 30% - including amounts used as biofuel in developing countries, except for OECD'90 Europe, where a decreasing trend from 40% in 1970 to 5% in 1995 was assumed.

Emission factors for CH_4 and N_2O for enteric fermentation, animal waste (confined and outside), N-fixing crops were taken from the *Revised 1996 IPCC Guidelines* (IPCC, 1997), where a 1x1 degree grid map for non-dairy cattle from Lerner *et al.* (1988) and the annual average temperature per grid cell from New *et al.* (1999) was used to calculate the fraction of the countries in the three climate zones (cold, temperate, warm). Other additional information, such as factors for indirect emissions of N_2O from agriculture, were taken from IPCC (1997) but were replacing values updated in IPCC (2000). However, the emission factors for CH_4 from rice production in 1990 were taken from a review by Neue (1997); for the period 1970-1990 an emission factor improvement based on data of Van der Gon (1999, 2000) was assumed. For agricultural biomass burning the emission factors for CH_4 and N_2O were based on IPCC (1997).

Large-scale Biomass Burning

Biomass burning data (large-scale vegetation fires) were based on FAO reports providing ten year or five year averaged estimates per country of the change in forested areas for the 1970s, 1980s and the first half of the 1990s (FAO, 1993, 1995, 1998). Following the methodology described in the *Revised 1996 IPCC Guidelines*, these data were used as a proxy for estimating the amount of biomass being burned in tropical countries. Since there is no time-series data per country on this subject readily available, a smoothing function to construct a continuous time series per country for the 1970-1995 period was used. Tentatively, it was assumed that 50% of

the biomass removed is burned. Given the uncertainty in this figure, the fraction oxidized is assumed to be 1. For OECD'90 and EIT countries, forest fire statistics for 1986-1997 have been included based on UN/ECE statistics of annual area burned (UN-ECE/FAO, 1996) combined with forest biomass densities per hectare from FAO (1995). There is a large uncertainty in the assumption for the carbon density of 0.5 and the fraction of carbon that is actually being burned of 0.5, and thus in the amount of burned carbon. The data selected, although often criticized for their limited accuracy are, however, well known and relatively well-documented.

Emissions CO_2 from deforestation and temperate vegetation fires are calculated according to IPCC (1997) and include only direct burning effects (thus no emissions due to decay of biomass). For large-scale biomass burning the emission factors for CH_4 and N_2O were also based on IPCC (1997), except for CH_4 from deforestation fires, where the GEIA value proposed by Veldt and Berdowski (1995) was used, and N_2O where post-burn emissions (Bouwman *et al.*, 1997) were used. The emission factors of CH_4 and N_2O used for temperate vegetation fires are the same that are used for other large-scale biomass burning activities. For accounting purposes, net CO_2 emissions from temperate vegetation fires and savannah fires have been assumed to be zero (organic carbon in a short cycle).

Waste Handling

For solid waste generation, the 1970-1995 trend in activity data per country has been based on a fit with international waste generation figures per capita for 1990 - as recently published by IPCC and EPA and references mentioned therein - with per capita income per country. This fit was also used to estimate the activity data for 1990, for countries not mentioned in IPCC (1997) and in an EPA report by Adler (1994). Country-specific fractions of total MSW generated that is disposed of in landfills were based on IPCC (1997). For most countries it was assumed that this fraction has remained constant over time. Many other parameters, such as the fraction of Degradable Organic Carbon (DOC) were also based on the *Revised 1996 IPCC Guidelines*; in addition, many others were estimated through consultation of experts (Olivier *et al*., 2001). The methodology used for the calculation of CH_4 emissions from landfills in EDGAR 3.0 is a *first order decay model* resembling the description in the *Revised 1996 IPCC Guidelines* of the more complex Tier 2 method, taking into account that the generation of methane from landfills is not an instantaneous process. Thus, the methodology calculates emissions in a specific year as the sum of delayed emissions from all MSW deposited in past years. A 40-year integration period was used, assuming emissions from MSW deposited more than 40 years ago are negligible. Based on national reports submitted to the Climate Convention methane recovery amounts for eight OECD countries were included, amounting to about 2 Tg in 1990 and 4 Tg in 1995, about half of which was allocated to the United States.

For domestic and industrial wastewater discharged in city sewers and subsequently treated by municipal Waste Water Treatment Plants (WWTP), the approach based on per capita organics loading and industrial waste water generation selected by Doorn *et al.* (1997) was used as information on domestic wastewater generation rates is very sparse and because it is essentially the same as the default IPCC methodology (IPCC, 1997). Estimates are based on population data from the UN (1999), whereas wastewater generation was based on industrial production statistics of the UN (1998) combined with wastewater generation rates of Doorn *et al.* (1997). It is well known that in OECD countries, which cover about 60% of this source, a large fraction of the methane generated in municipal WWTPs is generally recovered. Therefore methane recovery for municipal WWTPs in OECD'90 countries was tentatively assumed to be 75%, effectively reducing the total emissions of OECD countries in 1990 by 0.6 Tg.

For untreated domestic wastewater handling, treatment and disposal emission factors and other factors were based on Doorn *et al.* (1999), who distinguished disposal in septic tanks, latrines and sewers. The later was divided into sewage with municipal wastewater treatment and open sewers. Emission factors for CH_4 from domestic wastewater in latrines or open pits and septic tanks and from stagnant open sewers (untreated wastewater) were based on Doorn *et al.* (1999). Here the same approach as for domestic WWTPs was followed, but distinguishing national population into three population groups: rural and urban, with urban population further split into high and low income groups. For the each of four municipal wastewater disposal types, region-specific and country-specific utilization fractions were estimated for each of these three population categories. Emissions from open sewers were increased by 25% to account for the global amount of industrial wastewater annually discharged in municipal sewers. Globally, according to the assumptions of Doorn *et al.* (1999), this source of CH_4 appears to be as large as emissions from landfills.

For N_2O from human sewage the default IPCC methodology was used, with protein intake per country for various years from FAO (2000); for the small emissions of N_2O from DOC in wastewater from the meat processing industry the emission factor provided by Doorn *et al.* (1997) was applied.

In addition, for domestic waste burning (i.e. by households for non-energetic purposes) a fixed amount per urban capita burned per year *by urban households* in less developed countries was used. In rural areas of LDC it was assumed that there is no uncontrolled burning in addition to the agricultural residue burning and biofuel use that has already been accounted for in other source categories. In contrast, for industrialized countries, it was assumed that domestic waste burning only occurs in rural areas, where waste incineration regulation is less well controlled.

6.2 Spatial Characteristics

6.2.1 Spatial Coverage

The data provide global land coverage with selected ocean grid points corresponding to aviation and shipping routes.

6.2.2 Spatial Resolution

The data are given in an equal-angle lat/long Earth grid that has a spatial resolution of 1degree by 1degree in both latitude and longitude.

6.3 Temporal Characteristics

6.3.1 Temporal Coverage

The data are decadal (1970, 1980, 1990, and 1995). The precursor gas data only cover the years 1990 and 1995.

6.3.2 Temporal Resolution

Emissions per year.

7. OBSERVATIONS

7.1 Field Notes

Not applicable to this data set/

8. DATA DESCRIPTION

8.1 Table Definition with Comments

Not applicable to this data set.

8.2 Type of Data

8.2.1 Parameter/ Variable Name	8.2.2 Parameter/ Variable Description	8.2.3 Data Range	8.2.4 Units of Measurement	8.2.5 Data Source
1) EDGAR Data Files ("edgar_*variable*_data_1d_YYYY.csv")				
Longitude	Longitude for the lower left corner of each cell. West longitudes are negative.	-180 degrees to 179^{o}	Degrees	EDGAR 3
Latitude	Latitude for the lower left corner of each cell. South latitudes are negative.	79 degrees to – 73 degrees	Degrees	
CH4	CH_4, methane emissions estimates per cell	0 to 1.62E+09	kg CH_4 (FMM*)/yr	
CO	CO, carbon monoxide emissions estimates per cell	0 to 5.46E+09	kg CO (FMM*)/yr	
CO2	CO_2, carbon dioxide emissions estimates per cell	*0 to 2.75E+11*	kg CO_2 (FMM*)/yr	
N2O	N_2O, nitrous oxide emissions estimates per cell	0 to 1.03E+08	kg N_2O (FMM*)/yr	
NMV	NMVOC emissions estimates per cell	0 to 1.32E+09	kg NMVOC (FMM*)/yr	
NOX	NO_2, nitrogen dioxide emissions estimates per cell	0 to 8.45E+08	kg NO_2 (FMM*)/yr	
SO2	SO_2, sulphur dioxide emissions estimates per cell	0 to 1.71E+09	kg SO_2 (FMM*)/yr	
2) EDGAR Map Files ("edgar_*variable*_map_1d_YYYY.asc")				
CH4	CH_4, methane emissions estimates per cell	0 to 1.62E+09	kg CH_4 (FMM)/yr	EDGAR 3 Data files
CO	CO, carbon monoxide emissions estimates per cell	0 to 5.46E+09	kg CO (FMM)/yr	
CO2	CO_2, carbon dioxide emissions estimates per cell	*0 to 2.75E+11*	kg CO_2 (FMM)/yr	
N2O	N_2O, nitrous oxide	0 to	kg N_2O	

	emissions estimates per cell	1.03E+08	(FMM)/yr	
NMV	NMVOC emissions estimates per cell	0 to 1.32E+09	kg NMVOC (FMM)/yr	
NOX	NO_2, nitrogen dioxide emissions estimates per cell	0 to 8.45E+08	kg NO_2 (FMM)/yr	
SO2	SO_2, sulphur dioxide emissions estimates per cell	0 to 1.71E+09	kg SO_2 (FMM)/yr	

*****FMM = Full Molecular Mass**

8.3 Sample Data Record

The original data tables with the filename extension **.csv** have 12-13 lines with general file information, and then the individual data points. Sample data records for the original data file named **edgar_ch4_data_1d_1970.csv** are given below:

```
-----------------------------------------------------
EMISSIONS ON GRID FOR METHANE IN 1970

Calculated by EDGAR on 24/07/02 by laeedg
calculation name : G: EDGV32 CH4: 70 ALL (EXCL AIR)
                   G: EDGV32 CH4: 71 ALL (EXCL AIR)
(this file created on 24/07/02 14:28:01)
-----------------------------------------------------
EDGAR Inventory 1x1 ALL PROCESSGROUPS
METHANE 1970 annual   # cells: 12729 (<>0)
Values: min: 5.04E+01 max: 1.59E+09 sum: 2.41E+11
Units : kg CH4 (FMM)/yr       For cells <> 0: avg: 1.89E+07
-----------------------------------------------------
-180,47,7.73E+03
-180,66,1.87E+05
-180,68,1.87E+05
-179,47,7.73E+03
-179,67,2.18E+05
-178,47,7.73E+03
-177,-14,6.99E+04
-177,47,7.73E+03
-176,-19,1.77E+06
-176,47,7.73E+03
-176,65,3.11E+04
-176,67,6.22E+04
-175,47,7.73E+03
-174,47,7.73E+03
```

8.4 Data Format

All of the files in the ISLSCP Initiative II data collection are in ESRI ArcGIS ASCII Grid format. The original data files submitted to the ISLSCP II staff contain the emissions of the various gases in tabular form. The data files contain a 12-13 line header (see above) and 3 columns of data (Longitude, Latitude, and the emissions for that cell), delimited by a single comma: The data are all in scientific E-notation (i.e. 0.0111E-04).

The file format for the "mapped" files consists of numerical fields of varying length, which are delimited by a single space and arranged in columns and rows. The files each contain 360 columns by 180 rows. All values in these files are written as real numbers. No distinction is made for cells with no emissions over water or land (i.e. value=0).

All files are gridded to a common equal-angle lat/long grid, where the coordinates of the upper left corner of the files are located at 180 degrees W, 90 degrees N and the lower right corner coordinates are located at 180 degrees E, 90 degrees S. Data in the map files are ordered from North to South and from West to East beginning at 180 degrees West and 90 degrees North.

8.5 Related Data Sets

See http://www.rivm.nl/edgar for other available RIVM/EDGAR global data sets and products. In this ISLSCP II data collection, users may also wish to examine the Geographic Patterns of Carbon Dioxide Emissions from Fossil-Fuel Burning, Hydraulic Cement Production, and Gas Flaring on a One Degree by One Degree Grid Cell (1950-1995) data set from CDIAC. In addition, ISLSCP II project information and data sets can be obtained from the Oak Ridge National Laboratory Distributed Active Archive Center (ORNL DAAC) http://daac.ornl.gov/ISLSCP_II/islscpii.html .

9. DATA MANIPULATIONS

Emissions data were mostly taken from international statistical data sources. Emission factors were selected mostly from international publications to ensure a consistent approach across countries. Sources for the emissions data depend on the type of data and are documented to varying degrees in the references of Section 6.1.

9.1 Formulas

9.1.1 Derivation Techniques/Algorithms

See Olivier et al. (2001a).

9.2 Data Processing Sequence

9.2.1 Processing Steps and Data Sets

See Olivier et al. (2001a).

9.2.2 Processing Changes

EDGAR 2.0 has been updated to EDGAR 3.2: an update and extension from 1990 to 1995 for all gases and extended time series for direct greenhouse gases CO_2, CH_4 and N_2O to 1970-1995; and inclusion of 1970-1995 emissions of the new 'Kyoto' greenhouse gases HFCs, PFCs, SF_6 (Olivier *et al*., 2001a,b). Also see http://www.rivm.nl/edgar

9.2.3 Additional Processing by the ISLSCP II Staff

The ISLSCP II staff used the coordinates given in the original tabular data (**.csv**) to create two-dimensional ASCII map files for each gas on a 1.0 degree x 1.0 degree Earth grid. Areas with no emissions over either land or water were assigned the value of 0

(zero).These files are named in a similar fashion to the tabular data, but with a ".asc" extension.

9.3 Calculations

9.3.1 Special Corrections/Adjustments

See Olivier et al. (2001a).

9.4 Graphs and Plots

See Figure 1 on the following page. Other graphics are available at http://www.rivm.nl/edgar

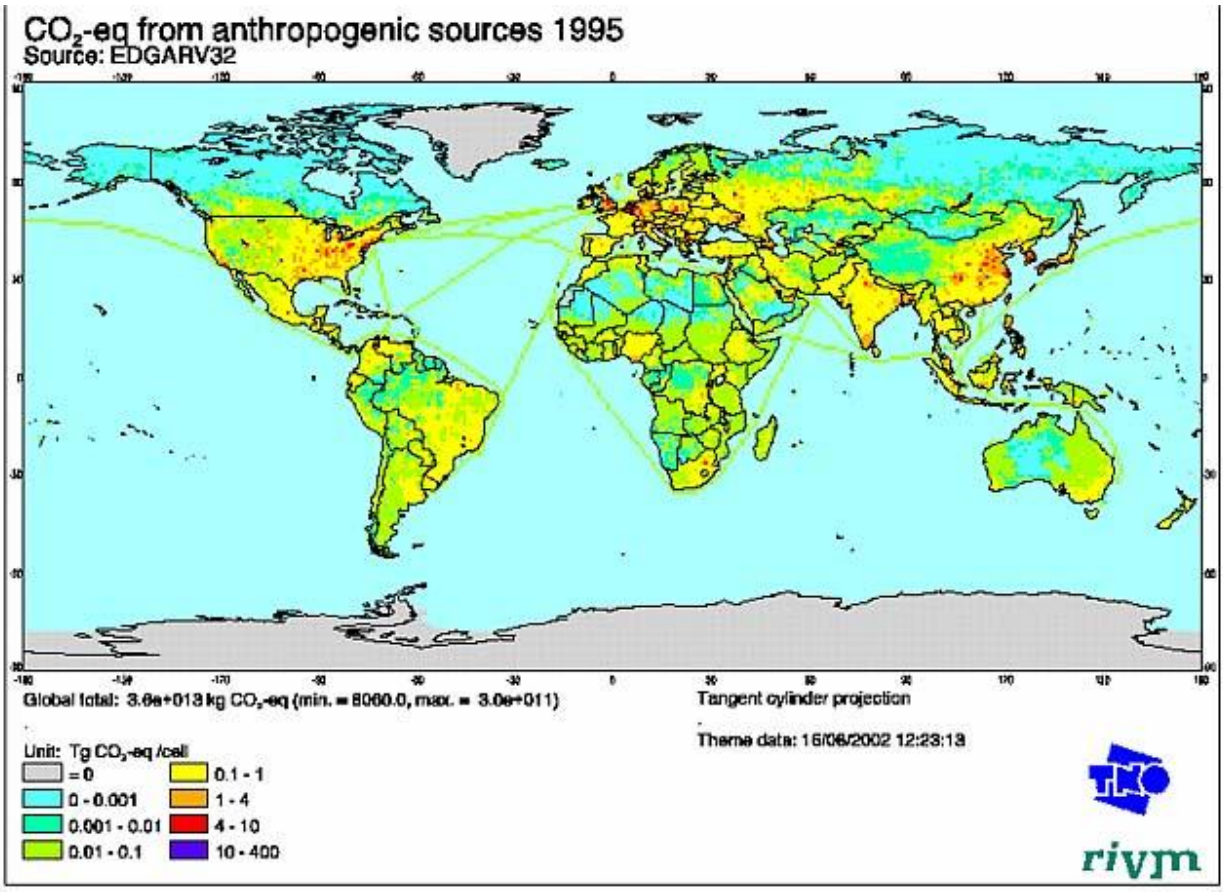


Figure 1. Gridded Carbon Dioxide Emissions for 1995.

10. ERRORS

10.1 Sources of Error

It has been acknowledged that providing improved uncertainty estimates is an urgent need for models and policy applications, but also that it is difficult to achieve on the short term other than through collective expert judgment. Within the IPCC Inventory Programme a special activity has recently been started aiming at providing default values and a better framework for estimating and reporting of uncertainties. A similar activity has started within GEIA, aiming at the same results at country level as well as on grid level, but for a more extended group of compounds and in a more scientific setting. Comparisons of different data sets, e.g. as done with the EDGAR data, may be an important input to this process.

Therefore, it was decided by the EDGAR team that it was at present not feasible to go beyond the uncertainty tables compiled for Version 2.0 (see Table 1 and 2). However, in addition some apparent conclusions on uncertainty can be drawn from the comparison of V2.0 with other data sets as part of the validation and check for urgent adaptations. For more detailed info on uncertainty in specific inventories we refer to the papers on N_2O, NH_3 and CO (Bouwman *et al.* 1995, 1997; Olivier *et al*, 1999) and conclusions on validation in Olivier *et al*. (2001b).

Table 1. Indication of uncertainty estimate for greenhouse gases (Olivier et al., 1999a).

Main source	Sub-category	Activity data	Emission factors			Total emissions		
			CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
Fossil fuel use	Fossil fuel combustion	S	S	M	M	S	M	M
	Fossil fuel production	S	M	M	-	M	M	-
Biofuel	Biofuel combustion	L	S	M	L	L	L	L
Industry/ solvent use	Iron & steel production	S	-	S		-	S	-
	Non-ferro production	S	-	S	-	-	S	-
	Chemicals production	S	-	S	L	-	S	M
	Cement production	S	S	-	-	S	-	-
	Solvent use	M	-	-	-	-	-	-
	Miscellaneous	V	-	-	-	-	-	-
Landuse/ waste treatment	Agriculture	S	-	L	L	-	L	L
	Animals (excreta; ruminants)	S	-	M	L	-	M	L
	Biomass burning	L	S	M	L	L	L	L
	Landfills	L	-	M	-	-	L	-
	Agricultural waste burning	L	-	L	L	-	L	L
	Uncontrolled waste burning	L	-	-	-	-	-	-
Natural sources	Natural soils	M	-	L	L	-	L	L
	Grasslands	M	-	M	L	-	M	L
	Natural vegetation	M	-	M	-	-	M	-
	Oceans/wetlands	M	-	L	L	-	L	L
	Lightning	S	-	-	-	-	-	-
			CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
All sources		-	-	-	-	S	M	L

Notes: Expert judgment of uncertainty ranges, which were assigned with the following classification in terms of order of magnitude of the uncertainty in mind: S = small (10%); M = medium (50%); L = large (100%); V = very large (>100%).

"-" Indicates that the compound is not applicable for this source or that emissions are negligible.

10.2 Quality Assessment

10.2.1 Data Validation by Source

See Olivier et al. (2001b).

10.2.2 Confidence Level/Accuracy Judgment

To illustrate the usefulness of the uncertainty indications presented here, we translated for methane the qualifications into the percentage ranges mentioned in the notes of these tables. Next, we compared the results with the uncertainty estimates used by IPCC Working Group I for the preparation of the Third Assessment Report (Fig. 2). The overall picture is rather similar, which shows that this simple approach and interpretation of uncertainty ranges is still quite useful for application at global levels.

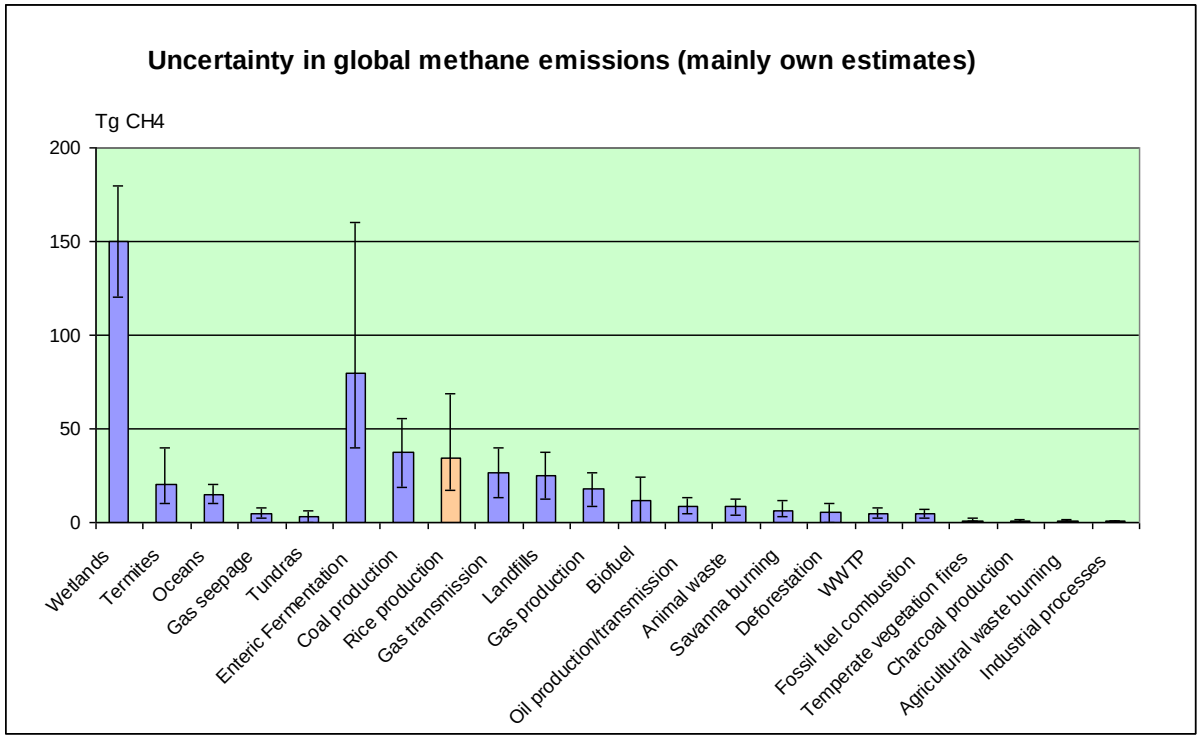
Table 2. Indication of uncertainty estimate for ozone and aerosol precursors (Olivier et al., 1999b).

Main source	Sub-category	Activity data	Emission factors				Total emissions			
			CO	NO_x	SO_2	NMVOC	CO	NO_x	SO_2	NMVOC
Fossil fuel use	Fossil fuel combustion	S	M	M	S	M	M	M	S	M
	Fossil fuel production	S	-	-	-	M	-	-	-	M
Biofuel	Biofuel combustion	L	M	M	M	M	L	L	L	L
Industry/ solvent use	Iron & steel production	S	M	M	M	L	M	M	M	L
	Non-ferro production	S	M	M	L	L	M	M	L	L
	Chemicals production	S	M	M	L	L	M	M	L	L
	Cement production	S	-	-	-	-	-	M	-	-
	Solvent use	M	-	-	-	M	-	-	-	M
	Miscellaneous	V				V				V
Landuse/ waste treatment	Agriculture	S	-	-	-	-	-	-	-	-
	Animals (excreta; ruminants)	S	-	-	-	-	-	-	-	-
	Biomass burning	L	M	L	M	L	L	L	L	L
	Landfills	L	-	-	-	-	-	-	-	-
	Agricultural waste burning	L	L	L	L	L	L	L	L	L
	Uncontrolled waste burning	L	-	-	-	L	-	-	-	V
Natural Sources	Natural soils	M	-	L	-	-	-	L	-	-
	Grasslands	M	-	-	-	-	-	-	-	-
	Natural vegetation	M	M	-	-	L	M	-	-	L
	Oceans/wetlands	M	L	-	-	-	L	-	-	-
	Lightning	S	-	L	-	-	-	L	-	-
			CO	NO_x	SO_2	NMVOC	CO	NO_x	SO_2	NMVOC
All sources		-	-	-	-	-	M	M	M	L

Notes: Expert judgment of uncertainty ranges, which were assigned with the following classification in terms of order of magnitude of the uncertainty in mind: S = small (10%); M = medium (50%); L = large (100%); V = very large (>100%).
"-" Indicates that the compound is not applicable for this source or that emissions are negligible.

10.2.3 Measurement Error for Parameters and Variables

See Figure 2 and Olivier et al. (2001a,b).



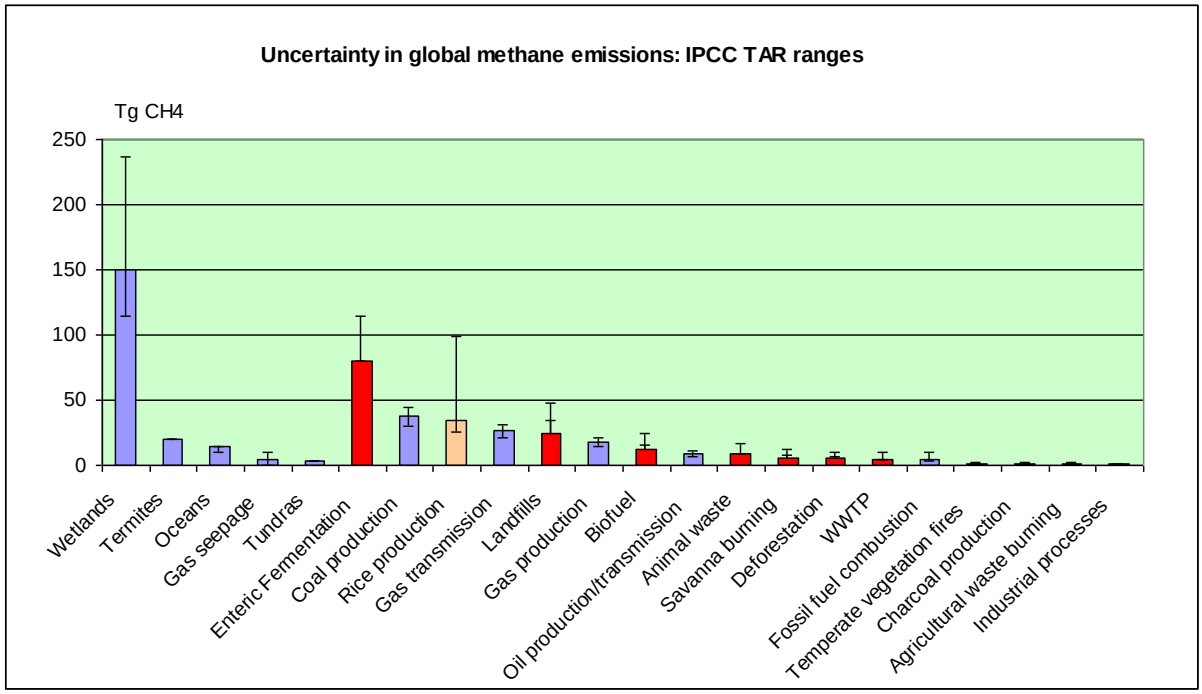


Figure 2. Comparison of uncertainty estimates for major global methane sources (a) using the uncertainty estimates by the EDGAR team and (b) the compilation made for the Third Assessment Report of IPCC Working Group I.

10.2.4 Additional Quality Assessment Applied

None.

11. NOTES

11.1 Known Problems with the Data

It is stressed that the uncertainty in the resulting data set at national level may be substantial, especially for methane and nitrous oxide, and even more so for the F-gases. The uncertainty is caused by the limited accuracy of international activity data used and in particular of emission factors selected for calculating emissions on a country level (Olivier *et al.,* 1999, 2001).

11.2 Usage Guidance

Methods used are comparable with IPCC methodologies and global totals comply with budgets used in atmospheric studies and the data were based on international information sources; hence, this data set should provide a sound basis for comparability.

11.3 Other Relevant Information

RIVM and TNO have made all reasonable efforts to ensure that the publicly available information at this homepage is accurate. However, there may be inadvertent and occasional errors for which we apologies. **Although this database has been constructed with great care, RIVM and TNO do not accept any liability from using the data.** Any decisions based on information contained in the EDGAR data sets are the sole responsibility of the user. RIVM accepts no liability for any direct or indirect damages resulting from whatever cause through the use of any information obtained directly or indirectly from EDGAR data.

Mention of any company, association or product is for information purposes only and does not constitute any recommendation of any such company, association or product, either express or implied by RIVM. In particular, countries and country names mentioned are only used to specify geographical entities and do not constitute any recommendation whatsoever with respect to political boundaries etc.

12. REFERENCES

12.1 Satellite/Instrument/Data Processing Documentation

See http://www.rivm.nl/edgar and http://www.rivm.nl/edgar/documentation/

12.2 Journal Articles and Study Reports

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13. DATA ACCESS

13.1 Contacts for Archive/Data Access Information

The ISLSCP Initiative II data are available are archived and distributed through the Oak Ridge National Laboratory (ORNL) DAAC for Biogeochemical Dynamics at http://daac.ornl.gov.

13.2 Contacts for Archive

E-mail: uso@daac.ornl.gov
Telephone: +1 (865) 241-3952

13.3 Archive/Status/Plans

The ISLSCP Initiative II data are archived at the ORNL DAAC. There are no plans to update these data.

14. GLOSSARY OF ACRONYMS

AFEAS	Alternative Fluorocarbons Environmental Acceptability Study
CDIAC	Carbon Dioxide Information Analysis Center
DAAC	Distributed Active Archive Center
DISC	Data and Information Service Center
DOC	Degradable Organic Carbon
DVD	Digital Video Disk
EDGAR	Emission Database for Global Atmospheric Research
EIT	Economies-In-Transition
EPA	Environmental Protection Agency
FAO	Food and Agricultural Organization of the United Nations
GEIA	Global Emissions Inventory Activity
GES	Goddard Earth Sciences
GSFC	Goddard Space Flight Center
IEA	International Energy Agency
IGAC	International Global Atmospheric Chemistry Programme
IGBP	International Geosphere-Biosphere Programme
IPCC	Intergovernmental Panel on Climate Change
ISLSCP	International Satellite Land Surface Climatology Project
LDC	Less Developed Countries
NASA	National Aeronautics and Space Administration
NMVOC	Non-Methane Volatile Organic Compounds
NSCR	Non-Selective Catalytic Reduction
OECD	Organization for Economic Co-operation and Development

OLADE	Organización Latinoamericana de Energía
ORNL	Oak Ridge National Laboratory
RIVM	National Institute for Public Health (The Netherlands)
TNO	Netherlands Organization for Applied Scientific Research
UN	United Nations
WWTP	Waste Water Treatment Plants