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1. TITLE

1.1 Data Set Identification

ISLSCP II Carbon Dioxide Emissions from Fossil Fuels, Cement, and Gas Flaring

1.2 Database Table Name(s)

Not applicable to this data set.

1.3 File Name(s)

There is one *.zip file with this data set: **co2_emis_1d_1950-1995.zip**. When extrapolated, there are 18 files, or 3 files for each of the 6 years (1950, 1960, 1970, 1980, 1990, 1995) in the following format:

- **co2_emis_1d_X.asc**: gridded ASCII maps of the global carbon dioxide emissions. "co2_emis" stands for CO₂ emissions, "1d" stands for a spatial resolution of 1.0 degree in both latitude and longitude, "X" is the 4-digit year (1950, 1960, 1970, 1980, 1990, and 1995), and ".asc" means this is ASCII, or text, data.
- **co2_emis_1d_X.dif**: ASCII tables of "differences", or points in the original files that did not match the Land/Water mask used in this International Satellite Land Surface Climatology Project (ISLSCP) Initiative II data collection, and were removed from the ASCII map files (see sections 8.4 and 9.2.3 for more details).
- **co2_emis_1d_X_changemap.asc**: gridded ASCII map showing the differences between the ISLSCP II land/water mask and the original data set: All points with negative values ("-1") are those where the ISLSCP II mask showed water but where the original data set showed land (i.e. CO₂ emissions>0) and this point was removed. All points with a value of zero are those points where the two land/water masks agreed.

Two additional files named **ndp058.pdf** and **ndp058a.pdf** contain the original documentation available from the Carbon Dioxide Information Analysis Center (CDIAC). The majority of information provided here is taken from those documents. These two documents contain many more details on data processing. These files are in Portable Document Format (PDF).

1.4 Revision Date of this Document

June 27, 2011

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2.2 Title of Investigation

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 Basis: 1950 to 1995

2.3 Contacts (For Data Production Information)

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2. Data Set Citation

Andres, R. J., G. Marland, I. Fung, E. Matthews, and A. L. Brenkert. 2011. ISLSCP II Carbon Dioxide Emissions from Fossil Fuels, Cement, and Gas Flaring. 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/ORNLDAAAC/1021](https://doi.org/10.3334/ORNLDAAAC/1021)

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.

The two databases provided here (NDP058 and NDP058a) were developed and compiled by the Carbon Dioxide Information and Archive Center (CDIAC) and are available free of charge from CDIAC (http://cdiac.esd.ornl.gov/by_new/bysubjec.html#carbon).

3. INTRODUCTION

3.1 Objective/Purpose

The database documented here presents decadal (1950, 1960, 1970, 1980, 1990 and 1995) estimates of gridded fossil-fuel emissions, expressed in 1,000 metric tons C per year per one degree latitude by one degree longitude. The CO₂ emissions are the summed emissions from fossil-fuel burning, hydraulic cement production and gas flaring. The years 1950 to 1990 were developed and compiled using somewhat different procedures and information than the 1995 data. The national annual estimates (Boden et al., 1996) from 1950 to 1990 were allocated to one degree grid cells based on gridded information on national boundaries and political units, and a 1984 gridded human population map (Andres et al., 1996). For the 1995 data, the population data base developed by Li (1996a) and documented by CDIAC (DB1016; Li, 1996b) was used as proxy to grid the 1995 emission estimates.

Marland et al. (1985) note that using population distribution as a proxy for the distribution of CO₂ emissions within a country offers a reasonable initial approximation but carries two implied assumptions that are clearly not filled: a) that per capita energy use is uniform over a political unit, and b) that the fuel mix is constant throughout a political unit. In addition, it was assumed that the 1984 population distribution provides a useful first approximation of the within-country distribution of the CO₂ emissions for each of the years between 1950 and 1990. (Note: the national CO₂ emissions are based on United Nations

statistics). The consequence of this first-order procedure is that the spatial changes observed are solely due to changes over time in national energy consumption and the nation-based fuel mix.

3.2 Summary of Parameters

The database documented here presents decadal (1950, 1960, 1970, 1980, 1990 and 1995) estimates of gridded fossil-fuel emissions, expressed in 1,000 metric tons C per year per one degree latitude by one degree longitude. The CO₂ emissions are the summed emissions from fossil-fuel burning, hydraulic cement production and gas flaring. The original documentation for these two data sets is also provided in PDF format.

3.3 Discussion

The data provided here consist of two separate but related data sets provided by CDIAC. The data from 1950 to 1990 (NDP058) and the 1995 data (NDP058a) are prepared with some methodological differences which create some small inconsistencies in historical emissions for certain data points. In order to make this data set consistent with the land/water boundaries used in the ISLSCP II data collection, the original data set has been modified by removing those points that did not match the ISLSCP II land/water mask. Because of this, regional or global totals in emissions may be different from those provided in the literature using the original data sets. We provide to the user a map and listing of any points that have been removed during this process so that the original data sets can be recreated. The user can also access the original data sets from the CDIAC web site at: http://cdiac.esd.ornl.gov/by_new/bysubjec.html#carbon

4. THEORY OF ALGORITHM/MEASUREMENTS

For the 1950 to 1990 emissions data sets, a gridded population data set, with population estimates for the year 1984 was used to allocate the national annual emissions over the grid cells. The population and political unit data sets were obtained from the Goddard Institute of Space Studies (GISS). The initial NASA-GISS gridded population data set and the initial NASA-GISS gridded political unit data set were adjusted by Andres et al. (1996) to ensure that for each of the dates (1950, 1960, 1970, 1980, 1990) existing countries were represented, the populations were associated with the proper political units, and the available national emission estimates were properly distributed over that country's area using population. The 1995 emissions estimates were gridded using the population database developed by Li (1996a) and documented by CDIAC (DB1016: Li, 1996b) was used as a proxy.

The initial one degree gridded NASA-GISS population density data set describes the 1984 worldwide distribution of human population densities. It was constructed, following a method identical to Lerner et al. (1988), placing all urban centers with more than 100,000 inhabitants into the appropriate grid cells. Then, the sum of the urban populations for a political unit was subtracted from the total population for that political unit. The remaining rural and smaller urban populations were evenly distributed among cells showing human land use as defined by Matthews (1983). The aim of the NASA-GISS population density data set was to yield a geographically correct, rather than a politically correct population distribution. This population density data set was first converted by Andres et al. (1996) to total population per grid cell by multiplying the population density with the cell surface area. The data set was then modified by relocating 43 border urban area populations into the nearest cell identified with the correct political unit. In addition 95 coastal urban areas were reassigned from ocean to the correct

political unit (but not moved to the nearest cell). Thus, no geographical changes of populations over time within a country or political unit were taken into account.

The initial one degree gridded NASA-GISS political unit data set contains 186 countries, with 9 of these further subdivided into 168 provinces, states, or regions. Each grid cell was assigned to the spatially dominant political unit, with the exception that small countries and island nations were assigned a grid cell, even when not dominant. Andres et al. (1996) added 15 political units and 10 subdivisions (e.g., Bangladesh and Pakistan were the combined E&W Pakistan before 1972) that occur in the U.N. energy statistics but not in the original GISS data set. There is a change in the methodology used to calculate the national CO₂ emission estimates for 1995 which was the implementation of separate carbon coefficients for soft and hard coal; the emissions estimates in other years were calculated using a single carbon coefficient to characterize the carbon content of all coals. All original data sets and ancillary files are available from CDIAC at <http://cdiac.ornl.gov/ftp/ndp058/> and <http://cdiac.ornl.gov/ftp/ndp058a/>.

5. EQUIPMENT

These to data sets of national, annual CO₂ emission *estimates* are based on statistics on fossil fuel burning, cement manufacturing and gas flaring in oil fields as well as energy production, consumption and trade data, using the methods of Marland and Rotty (1984). 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

The national annual emission estimates for the decades 1950 to 1990 were combined with gridded one-degree data on political units and 1984 human populations (Andres et al., 1996) to create the new gridded CO₂ emission data sets. The same population distribution was used for each of the years as proxy for the emission distribution within each country. For 1995, the population data base developed by Li (1996a) and documented by CDIAC (DB1016: Li, 1996b) was used as proxy.

The implied assumption for that procedure was that per capita energy use and fuel mix is uniform over a political unit. The consequence of this first-order procedure is that the spatial changes observed over time are solely due to changes in national energy consumption and nation-based fuel mix.

6.2 Spatial Characteristics

6.2.1 Spatial Coverage

The data provide global coverage.

6.2.2 Spatial Resolution

The data are given in an equal-angle lat/long Earth grid that has a spatial resolution of 1.0 degree by 1.0 degree in both latitude and longitude.

6.3 Temporal Characteristics

6.3.1 Temporal Coverage

The data are decadal (1950, 1960, 1970, 1980, 1990, and 1995).

6.3.2 Temporal Resolution

Emission data are in thousand metric tons of carbon (C) 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) Yearly CO₂ Emission Maps (*.asc)				
CO ₂ emissions	Gridded CO ₂ emission from fossil fuel burning, cement manufacturing and gas flaring in oil fields.	Min=0 Max=69253.59 Water=-99	Thousand metric tons of carbon (C) per year	Various economic and energy utilization reports
2) Differences Tables (*.dif)				
Lat	Latitude for the center of a cell. South latitudes are negative.	Min=-90 Max=90	Decimal Degrees	Earth Grid
Lon	Longitude for the center of a cell. West longitudes are negative.	Min=-180 Max=180	Decimal Degrees	Earth Grid
Data_removed	CO ₂ emission value in each cell of the original file that did not match the ISLSCP II land/water mask, and was removed.	N/A	Thousand metric tons of carbon (C) per year	Original data
3) Change Map (*.changemap.asc)				
Point Changed	Differences between the ISLSCP II land/water mask and the original data: -1 = ISLSCP II mask is water and original data is land (data removed) 0 = Data sets agree over land or water (data unchanged) 1 = ISLSCP II mask is land or water and original data is missing (fill value used).	Min=-1 Max=1	See 8.2.2	Original data and ISLSCP II land/water mask

8.3 Sample Data Record

The "differences" file is an ASCII table with some header lines, then the Latitude and Longitude coordinates of each removed point, plus the value of that point. See the sample below.

```
ISLSCP II Differences for file 'co2_emis_1d_1995.asc'.
Contains Lat-Lon coordinates and data for each point in the original file
that differed from the ISLSCP-2 Land/Sea mask, and thus was removed.
```

```
Lat,Lon,Data_removed
77.5,-72.5,2.52
```



```

77.5,-71.5,3.36
76.5,-82.5,0.48
76.5,-69.5,1.68
74.5,-57.5,1.68
73.5,-85.5,2.26
73.5,-84.5,1.19
73.5,80.5,9.93

```

8.4 Data Format

All of the files in the ISLSCP Initiative II data collection are in ESRI ArcGIS ASCII grid, or text format. 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 file format for these data files consists of ASCII numerical fields in real number format. The files contain 360 columns by 180 rows. Water cells are assigned the value of "-99".

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.

The ASCII map files (with the extension of ".asc") have all had the ISLSCP II land/water mask applied to them. All points removed from the ASCII map files were replaced with the value of zero. The removed points are stored in "differences" files (with the extension ".dif"). These ASCII files contain the Latitude and Longitude location of the cell-center of each removed point, and the data value at that point. There is one ".dif" file for each ASCII map file.

The "change map" files show the results of applying the land/water mask, as a viewable ASCII map: all points added ("1"), all points unchanged ("0"), and all points removed ("-1").

8.5 Related Data Sets

See http://cdiac.esd.ornl.gov/pns/pns_main.html for other available CDIAC global data sets and products. In this ISLSCP II data collection, users may also wish to examine the EDGAR global anthropogenic emissions data set for several gases including CO₂. An updated gridded population data set is also included in this collection. 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

9.1 Formulas

9.1.1 Derivation Techniques/Algorithms

See [NDP058.pdf](#) and [NDP058a.pdf](#) for more information. To distribute the national emission estimates from 1995 within each country, the population data base developed by Li (1996a) and documented by CDIAC (DB1016: Li, 1996b) was used as proxy. Previously, Andres et al. (1996a) had used a 1984 human population data set (Goddard Institute of Space Studies, Lerner et al., 1988) as proxy for gridding the 1950 through 1990 emission estimates within countries. The structure of the gridded 1995

emission data file differs, consequently, from the 1950-1990 gridded emission files (CDIAC: NDP-058) in that individual grid cells may have been partitioned into more than one country analogous to Li's population data base. A country's representation in a grid cell is quantified by the percentage of that country's land area in a particular grid cell and identified by its United Nations identification code. The percentages and United Nations identification codes were used to allocate the national CO₂ emissions estimates to the grid cells. Only those grid cells with a United Nations identification code, population estimate and carbon emission estimate are listed in the data file. Grid cells representing more than one country are repeated for each country represented. Note that to calculate national estimates from the data file, one has to sum by United Nations identification code. To calculate emissions for each grid cell or by latitude one has to sum by grid cell (latitude and longitude), or by latitude, respectively.

A number of manipulations of Li's population database were necessary to properly distribute the national 1995 CO₂ emission estimates. When CO₂ emission estimates were available for locations not represented in Li's population database (DB1016) we added those locations and calculated the representation (percentage) of the added country as grid cell information. The following seven sections summarize the changes (see

[NDP058a.pdf](#)):

- 1) Li's alphanumeric identification codes were converted to numeric codes, and to United Nations codes where possible:
- 2) A number of Li's identification codes were changed to match the energy statistics UN codes:
- 3) A number of locations and UN identification codes were added:
- 4) Czechoslovakia (formerly with UN-id 200) was split and percentages adjusted:
- 5) The Socialist Federal Republic of Yugoslavia (formerly with UN-id 890) was split and percentages adjusted:
- 6) A number of population percentages were adjusted slightly in order to complete the distribution of all national CO₂ estimates (i.e., so that the sum of all grid cells equals more closely the sum of the national totals) (note that only the first four adjustment caused significant improvement in the national fossil-fuel estimates):
- 7) Antarctic and ocean cells were deleted.

9.2 Data Processing Sequence

9.2.1 Processing Steps and Data Sets

See Section 4.0 and [NPD058.pdf](#) and [NDP058a.pdf](#) documents.

9.2.2 Processing Changes

The two original data sets (1950 to 1990, 1995) were processed using somewhat different methodologies. See Section 4.0 and [NDP058a.pdf](#) document for more details.

9.2.3 Additional Processing by the ISLSCP II Staff

The ISLSCP II staff processed the data files by comparing them for consistency against the ISLSCP II land/water mask. Any point where the ISLSCP II land/water mask showed water but where the data were greater than zero was removed and replaced with the value -99. This removed a number of points in the Southern hemisphere oceans in 1990 that were attributed to emissions from Antarctic fishing vessels. New ASCII table files containing the removed points, also called "differences" files with the extension

".dif", were created. These files contain the Latitude and Longitude of the cell-center of each removed point, and the original data value for that point.

Finally, a "change map" was created for each decadal file, showing the results of applying the land/water mask, as a viewable ASCII map: all points added ("1"), all points unchanged ("0"), and all points removed ("-1").

9.3 Calculations

9.3.1 Special Corrections/Adjustments

None given.

9.4 Graphs and Plots

Several summary tables and figures are available in the original documentation ([NDP058.pdf](#)) and along with the data sets at CDIAC (See <http://cdiac.ornl.gov/ftp/ndp058/> and <http://cdiac.ornl.gov/ftp/ndp058a/>). Figure 1 on the next page shows an example of the latitudinal distribution of carbon emissions estimates for both data sets provided here.

10. ERRORS

10.1 Sources of Error

These data sets are compiled from national statistics databases. Errors in these databases can introduce errors in the emissions estimates given here. However, to guarantee that the data are of the highest possible quality, CDIAC performs extensive quality assurance (QA) checks, examining the data for completeness, reasonableness, and accuracy (See Section 10.2 below).

10.2 Quality Assessment

The following data checks were specifically performed for the NDP058 data set:

1) National totals were compared to reported global totals:

- a) Grid cell values of fossil-fuel emissions were summed by country name in the SAS program and the resulting national emissions were compared to a previously published database of national emissions (NDP030/R6, available from CDIAC). Summed gridded national totals check out exactly with NDP030/R6's national totals, but:
- b) Andres et al. (1996) allocated to Puerto Rico a population-based fraction of the total US emissions (UN code 840) (i.e., C emissions of 18786 thousand metric tons for 1990), while the national emissions in NDP030/R6 had for Puerto Rico (UN code 630) a separately calculated emission of ~6-fold less than the population based fraction (i.e., 3193 thousand metric tons for 1990). This population based fraction, allocated to Puerto Rico, was in the NDP030/R6 appropriately allocated to the 50 states of the U.S.A. (total of 1322212 thousand metric tons for 1990). This has now been corrected, based on the NDP030/R6 data, for each of gridded database files.
- c) The national total emissions reported in NDP030/R6 had failed to replace UN code 887 by UN code 886 for 1990's cement production (113 thousand metric tons C per year (Yemen). Democratic Yemen (UN code 720) and Yemen (UN code 886) merged on 22 May, 1990 to form a single state (UN code 887). For 1990, the separation between Democratic Yemen and former Yemen should have been maintained for all emissions and UN code 887 should not have been in the database. Therefore, the 1990 cement emission allocation of Yemen was not incorporated in the gridded database of Andres et al. (1996). This has now been corrected.

2) Converting negative emission values to zero:

Fossil fuel emissions for Iran for 1950 and for the Netherlands Antilles for 1990 were set to zero. Negative emissions were calculated and reported for these two instances in NDP030/R6 because exports of fossil fuels were larger than the sum of gross production and imports.

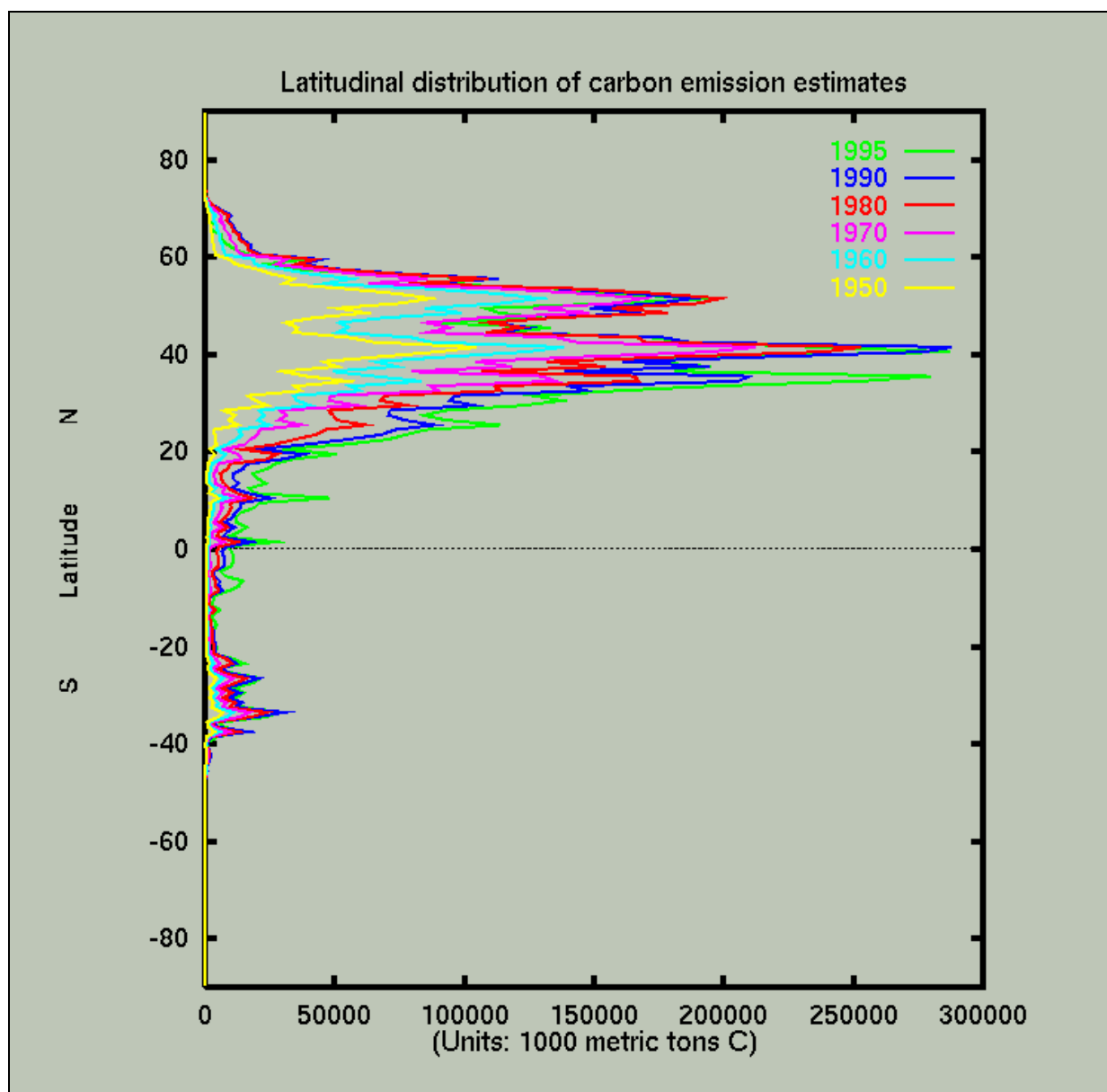


Figure 1. Latitudinal distribution of carbon emission estimates for all data sets provided here (1950 to 1995). Data and figures are available directly from CDIAC.

3) Bunker Summations:

An additional QA was performed on the NDP30/R6 while collecting information for Table 3.1 in [NDP058.pdf](#) document. Due to SAS not performing any calculations when missing values occur as any of the elements in an equation, the summation of bunkers could not be performed correctly using the SAS program in the NDP30/R6. Replacement of missing values by zeros has corrected this potential error in using the NDP30/R6 database.

CDIAC's quality assurance checks for the NDP058a data set were:

- a) The population divisions of Czechoslovakia and the former Socialist Federal Republic of Yugoslavia were checked against the 1995 U.N. population statistics provided by the U.N. Statistical Office.
- b) The national populations were checked against values published in DB1016 (Li, 1996b)
- c) The gridded national fossil-fuel emission summations were checked against the values available in NDP-030 (Boden, 1998; Marland et al, 1997)) (the largest difference is 8 units for the United Kingdom).
- d) The summed national emissions published in NDP030R8 amounted to 6172918 units of 1,000 metric tons C. The summed gridded national estimates presented here amount to 6172869 units of 1,000 metric tons C. The total difference of 49 units (due to roundoff) is less than 0.001%.
- e) Latitudinal summations of the gridded emissions were compared with previously published gridded data (NDP-058) and a graph produced (See Figure 1).

10.2.1 Data Validation by Source

See Andres et al. (1996) and [NDP058.pdf](#) and [NDP058a.pdf](#) documents.

10.2.2 Confidence Level/Accuracy Judgment

See Andres et al. (1996) and [NDP058.pdf](#) and [NDP058a.pdf](#) documents.

10.2.3 Measurement Error for Parameters and Variables

See Andres et al. (1996) and [NDP058.pdf](#) and [NDP058a.pdf](#) documents.

10.2.4 Additional Quality Assessment Applied

See Andres et al. (1996) and [NDP058.pdf](#) and [NDP058a.pdf](#) documents.

11. NOTES

11.1 Known Problems with the Data

Reported estimates of global totals of CO₂ emissions and globally summed national CO₂ emissions differ. Boden et al. (1996) present four reasons why:

- a) Global totals include emissions from bunker fuel whereas these are not included in any national totals. Bunker fuels are fuels consumed by ships and aircraft engaged in international transportation.
- b) Global totals include estimates for the oxidation of non-fuel hydrocarbon products whereas national totals do not.

- c) Global totals do not include annual changes in fuel stocks whereas annual changes in fuel stocks are included in national totals.
- d) There are statistical anomalies in the international statistics: for example, the sum of exports from all exporters is not identical to the sum of imports for all importers.

The ISLSCP II staff has found a number of points where there are emissions for the period from 1950 to 1990 and no emissions in 1995. There are also several cells where there are no emissions from 1950 to 1990 and then emissions in 1995. While both scenarios are clearly possible, the cells tend to occur near coastlines and may be indicative of an inconsistency in land/water masks used for the two data sets.

11.2 Usage Guidance

These data sets were produced from country emissions totals. They are expected to accurately represent continental to global patterns of emissions, as well as latitudinal variations. However, analyses on a per cell basis may not be as accurate. Users may wish to compare these data sets with those provided by the EDGAR data base.

The ISLSCP II staff has removed a number of cells from the original data set in order to provide consistency with land/water boundaries in other data sets. This may change global or continental totals from the original data. Users are urged to use and consult the original data set as much as possible.

11.3 Other Relevant Information

None given.

12. REFERENCES

12.1 Satellite/Instrument/Data Processing Documentation

- Andres, R.J., G. Marland, I. Fung, E. Matthews, and A.L. Brenkert. 1996b. *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 basis: 1950 to 1990*. ORNL/CDIAC-97, NDP-058. Carbon Dioxide Analysis Center, Oak Ridge, Tennessee. Available from <http://cdiac.esd.ornl.gov/epubs/ndp/ndp058/ndp058.html>
- Boden, T.A., G. Marland, and R.J. Andres, 1996. *Estimates of global, regional, and national annual CO₂ emissions from fossil-fuel burning, hydraulic cement production, and gas flaring: 1950-1992*, Rep. ORNL/CDIAC-90, NDP-030/R6, 600 pp., Oak Ridge Nat. Lab., Oak Ridge, Tenn.
- Brenkert A. L. (1998) *Carbon Dioxide Emission Estimates from Fossil-Fuel Burning, Hydraulic Cement Production, and Gas Flaring for 1995 on a One Degree Grid Cell Basis*. ORNL/CDIAC-97, NDP-058a. Carbon Dioxide Analysis Center, Oak Ridge, Tennessee. <http://cdiac.esd.ornl.gov/epubs/ndp/ndp058a/ndp058a.html>

12.2 Journal Articles and Study Reports

- Andres, R.J., G. Marland, I. Fung, and E. Matthews. 1996. A one degree by one degree distribution of carbon dioxide emissions from fossil-fuel consumption and cement manufacture, 1950-1990. *Global Biogeochemical Cycles* 10:3:419-429.

- Andres, R.J., G. Marland, I. Fung, E. Matthews, and A.L. Brenkert. 1996b. *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 basis: 1950 to 1990*. ORNL/CDIAC-97, NDP-058. Carbon Dioxide Analysis Center, Oak Ridge, Tennessee.
<http://cdiac.esd.ornl.gov/epubs/ndp/ndp058/ndp058.html>
- Boden, T.A., G. Marland, and R.J. Andres, 1996. *Estimates of global, regional, and national annual CO₂ emissions from fossil-fuel burning, hydraulic cement production, and gas flaring: 1950-1992*, Rep. ORNL/CDIAC-90, NDP-030/R6, 600 pp., Oak Ridge Nat. Lab., Oak Ridge, Tenn.
- Boden, T.A., D.P. Kaiser, R.J. Sepanski and F.W. Stoss, 1994. Trends '93, *A Compendium of Data on Global Change*. Carbon Dioxide Information Analysis Center, World Data Center-A for Atmospheric Trace Gases. Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tenn. 37831-6335.
- Broecker, W.S. et al., 1986. Isotopic versus micrometeorological ocean CO₂ fluxes: A serious conflict. *J. Geophys. Res.* 91:10517-10527.
- Fung, I., C.J. Tucker and K.C. Prentice, 1987. Application of AVHRR vegetation index to study atmosphere-biosphere exchange of CO₂. *J. Geophys. Res.* 92:2999-3015.
- Houghton, R.A. et al., 1987. The flux of carbon from terrestrial ecosystems to the atmosphere in 1980 due to changes in land use: geographic distribution of global flux. *Tellus* 39B:122-139.
- Keeling, C.D., 1973. Industrial production of carbon dioxide from fossil-fuels and limestone. *Tellus* 25:174-198.
- Lerner, J., E. Matthews and I. Fung, 1988. Methane emissions from animals: A global high-resolution database. *Global Biochemical Cycles*, 2:139-156.
- Li., Y.-F., A. McMillan, and M.T. Scholtz. 1996a. Global HCH usage with 1 degrees x 1 degrees longitude/latitude resolution. *Environmental Science & Technology* 30:3525-33.
- Li., Y.-F. 1996b. Global Population Distribution (1990), *Terrestrial Area and Country Name Information on a One by One Degree Grid Cell Basis*. ORNL/CDIAC-96, DB1016, Carbon Dioxide Analysis Center, Oak Ridge, Tenn. <http://cdiac.esd.ornl.gov/ndps/db1016.html>
- Marland, G., and R.M. Rotty, 1984. Carbon dioxide emissions from fossil-fuels: A procedure for estimation and results for 1950-1982. *Tellus* 36(B):232-261.
- Marland, G, R.M. Rotty and N.L. Treat, 1985. CO₂ from fossil fuel burning: Global distribution of emissions. *Tellus* 37(B):243-258.
- Matthews, E. 1983. Global vegetation and land use: New high-resolution data bases for climate studies. *J. Clim. Appl. Meteorol.*, 22:474-487.
- Solomon, C., 1993. *Cement*. In Cement Minerals Yearbook-1992. U.S. Department of Interior, Bureau of Mines, Washington, D.C.
- U.S. Department of Interior, 1995. *Annual Review*, U.S. Geological Survey, Gordon P. Eaton, Director. Reston, VA 20192. February, 1997.
- United Nations, 1994. *1992 Energy Statistics Yearbook*. United Nations Statistical Division (UNSTAT), 2 United Nations Plaza, New York. N.Y. 10017
- United Nations, 1997. *Statistical Yearbook*. United Nations Statistics Division, United Nations, New York. N.Y. 10017.

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

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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

CDIAC	Carbon Dioxide Information Analysis Center
DAAC	Distributed Active Archive Center
GISS	Goddard Institute of Space Studies
GSFC	Goddard Space Flight Center
ISLSCP	International Satellite Land Surface Climatology Project
NASA	National Aeronautics and Space Administration
ORNL	Oak Ridge National Laboratory
PDF	Portable Document Format
QA	Quality Assurance