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TRENDS IN GLOBAL CO_2 AND TOTAL GREENHOUSE GAS EMISSIONS

Summary of the 2019 Report

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04 December 2019

PBL

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The Hague, 2019
PBL publication number: 4004

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Ultimate responsibility
PBL Netherlands Environmental Assessment Agency

Acknowledgements
We thank the International Energy Agency (IEA), U.S. Geological Survey (USGS), International Fertiliser Association (IFA) and Global Carbon Project (GCP) for providing recent statistics, and the members of the EDGAR team at EC-JRC for their support in the data compilation of the CO_2 Fast Track 2018, and Pieter Boot, Michel den Elzen (PBL), Monica Crippa and Gabriel Oreggioni (JRC), for their comments.

Graphics
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Production coordination
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Summary

Growth in global greenhouse gas emissions in 2018 highest since 2011

In 2018, the growth in total global greenhouse gas (GHG) emissions (excluding those from land-use change) resumed at a rate of 2.0%, reaching 51.8 gigatonnes of CO_2 equivalent[1] ($GtCO_2$ eq) after six years, with a somewhat lower annual growth of around 1.3% (Figure S.1). The 2018 global greenhouse gas emissions amounted to 55.6 $GtCO_2$ eq when also including those from land-use change (which are estimated at a very uncertain 3.8 $GtCO_2$ eq). This increase occurred while global economic growth in 2018 continued at about the average annual rate of 3.5% since 2012. Present greenhouse gas emissions that exclude those from land-use change are about 57% higher than in 1990 and 43% higher than in 2000.

In 2018, the 2.0% (1.0 $GtCO_2$ eq) increase in global greenhouse gas emissions was mainly due to a 2.0% increase in global fossil carbon dioxide (CO_2) emissions from fossil-fuel combustion and those from industrial non-combustion processes including cement production. Global emissions of methane (CH_4) and nitrous oxide (N_2O) increased by 1.8% and 0.8%, respectively. Global emissions of fluorinated gases (so-called F-gases) continued to grow by an estimated 6% in 2018, thereby also contributing to the 2.0% growth in total greenhouse gas emissions. The 2.0% growth in greenhouse gas emissions is higher than the annual average increase of 1.2% since 2012, but lower than the 2.5% increase over the first decade of this century (Figure S.1). Fossil CO_2 emissions are the largest source of global greenhouse gas emissions, with a share of about 72%, followed by CH_4 (19%), N_2O (6%) and F-gases (3%).
The greenhouse gas emission growth over the past years and the higher rate of 2.0% in 2018 are quite similar to the increase in CO_2 emissions, which contribute almost three quarters to total greenhouse gas emissions (excluding those from land-use change).

On a global level, the year 2018 was among the five warmest years (2014–2018) since records began in 1880. Of the 10 warmest years since 1880, 9 occurred since 2005. In 2018, temperatures across much of the world were warmer to much warmer than average. Record warm temperatures were measured across much of Europe, the Middle East, New Zealand and parts of Asia. A heatwave of unprecedented intensity and duration struck Europe, from 18 to 22 April. France, Germany and Switzerland had their warmest year since national records began. The Netherlands had its second warmest year on record (with 2014 being the record year). The departure from the average global temperature level was 0.97 °C above the 1880–1900 average, just slightly below those of the years 2015–2017 (NOAA, 2019).

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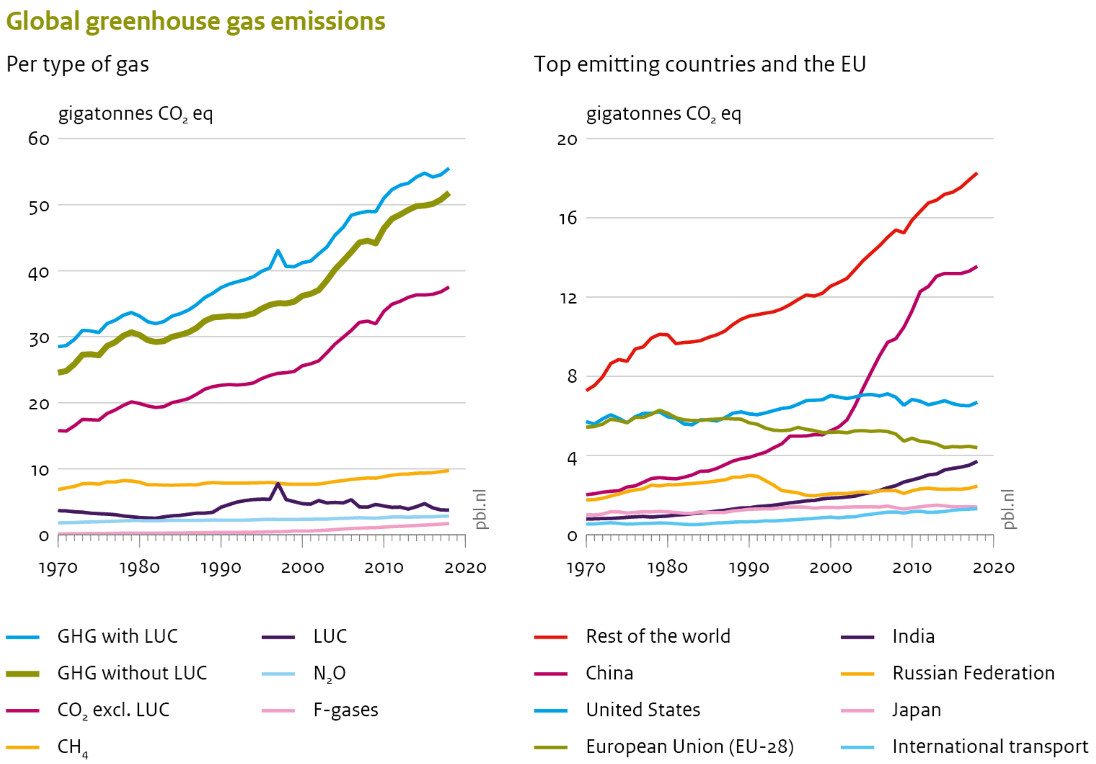
[1] Greenhouse gas emissions, without including land-use change, are based on EDGARv5 (this report) and those that include CO_2 emissions from land-use change are from Houghton and Nassikas (2017). The 3.8 $GtCO_2$ eq includes 0.2 $GtCO_2$ eq in CH_4 and data on N_2O from forest fires was taken from the GFED 4.1s data set. For CH_4, N_2O and F-gases, we used the Global Warming Potential (GWP) metric for 100 years from the Fourth Assessment Report (AR4) of the IPCC. The historical greenhouse gas emission trends (excluding those from land-use change) from the EDGAR database are also presented in UNEP's Emissions Gap Report 2019 (UNEP, 2019).

In 2018, greenhouse gas emissions increased in four of the largest emitting countries, and decreased in EU and Japan

The five largest emitters of greenhouse gas, together accounting for 62%, globally, are China (26%), the United States (13%), the European Union (more than 8%), India (7%), the Russian Federation (5%) and Japan (almost 3%). These countries also have the highest CO_2 emission levels (Figure S.1). In 2018, a real increase in greenhouse gas emissions was shown in four of these countries: China (+1.9%), India (+5.5%), the United States (+2.7%) and the Russian Federation (+5.1%), whereas emissions decreased in the European Union (-1.5%) and Japan (-1.2%). However, the increase in the rest of the world was even more substantial than in the individual, largest emitting countries. This is different from the recent past when China's emission growth eclipsed the increases elsewhere.

Figure S.1
Global greenhouse gas emissions from all sources (left) and for the top emitters (right)



LUC = Land-use change, GHG = greenhouse gas

Source: GHG excl. LUC EDGAR v5.0
LUC: Houghton and Nassikas 2017.

Source: EDGAR v5.0 FT2018 (without land-use change).
both: F-gas: EDGAR v4.2 FT2018; incl. savanna fires.

Global CO_2 emissions show largest increase since 2011

The relatively large 2.0% increase in global greenhouse gas emissions in 2018 was mainly due to a 2.0% increase in global carbon dioxide (CO_2) emissions, after six years with a somewhat lower annual growth of around 1.2%. In the decade before 2011, annual CO_2 emission growth was much larger, with an average of about 2.8%, annually (Figure S.1). However, the 2018 CO_2 emission growth rate was well below the average annual growth rate of 2.8%, which occurred in the first decade of the 21st century, when China showed very high annual growth in CO_2 emissions due to its rapid industrialisation.

In 2018, the relatively large increase in global CO_2 emissions of 2.0% to 37.5 $GtCO_2$ (about 66% higher than that of 1990) was mainly due to a larger increase in global coal consumption (1.4%) than in previous years, mainly caused by a strong increase in coal consumption in India (+8.7%, more than twice the rate of 2017), China (+0.9%) and the Russian Federation (+4.9%) (ranked according to the largest absolute changes). Other countries contributing to the global increase in coal consumption in 2018 were Vietnam (+22.9%), Pakistan (+63%), Indonesia (+7.7%), Kazakhstan (+12.2%) and Turkey (+7.2%) (in largest absolute changes). In contrast, coal consumption continued to decrease in the United States (-4.3%) and the European Union (-5.1%) (notably in Germany, Spain, the United Kingdom and the Netherlands), and Japan (-2.1%).

The lower growth rate in global CO_2 emissions in 2015 and 2016 (0.0% and +0.3%, respectively) was mainly due to declining global coal consumption, caused by three years of decreasing coal consumption in China (in 2014 to 2016 only), in the United States and the European Union, mainly because of increased renewable power generation, in particular, wind and solar power, and power plant fuel switches from coal to natural gas. The decrease in coal consumption continued in the United States and European Union in 2017 and 2018. Changes in coal consumption in China are important, as China accounts for half of the global coal consumption, and because global coal combustion accounts for about 40% of global CO_2 emissions.

In 2018, global consumption of oil products and natural gas continued to increase, by a respective 1.2% and 5.3%. The absolute increase in global oil consumption was led by China (+5.0%), the United States (+2.1%) and India (+5.1%), followed by Indonesia (+5.3%), Australia (+4.4%) and Iraq (+7.7%). In contrast, oil consumption decreased in Saudi Arabia (-3.6%), Japan (-2.9%) and Pakistan (-16.6%) and the European Union, in particular in Germany (-5.1%). The increase in global natural gas consumption concerned mainly the United States (+10.5%), China (+17.7%), the Russian Federation (+5.4%) and Iran (+7.4%) (ranked according to the largest absolute changes).

In 2018, global energy demand increased by about 2.1%. More than half of this increase was met by fossil fuels and the rest by renewables plus nuclear power. Since 2010, renewable and nuclear power increased their share in total power generation by 3 percentage points, to almost 36%.

Global CH_4 emissions again increase after five years of slow growth

In 2018, global methane emissions continued to increase by 1.8%, to a total of 389 Mt CH_4 (9.7 $GtCO_2$ eq). This is 24% more than in 1990. In 2017, methane emissions also saw a 1.8% increase, which was markedly greater than in the four preceding years, when the average annual growth was 0.6%. For methane, too, in the decade before 2011, the growth in anthropogenic emissions was larger, of on average about 1.3%, annually (Figure S.1).

Sources that contributed the most to the net increase in global CH_4 emissions in 2018 were (in decreasing order of absolute changes): coal production (+5.0%), natural gas production (+4.5%), livestock farming (+1.5%) — particularly sheep (+9.3%) and cattle (+0.7%) — and waste water (1.2%). With a 2.3% increase in CH_4 emissions, China (+2.3%) accounts for one fifth of the net increase in global methane emissions, followed by Indonesia (+5.0%), the United States (+2.6%), India (+1.7%), the Russian Federation (+2.5%) and Brazil (+1.1%).

Global N_2O emissions and F-gas emissions continue to grow

For 2018, the growth rate of global N_2O emissions was estimated at 0.8%, reaching a total of 9.5 Mt N_2O (2.8 $GtCO_2$ eq). Since 2011, global nitrous oxide emissions show an emission pattern that is similar to that of methane, except that the 2018 emission increase was one percentage point lower than that of CH_4 (Figure S.1). This means that, after an increase of 2.2% in 2017, the annual growth rate was back at the level of the years 2014–2016. Current global emission levels are 28% higher than in 1990. Increases in N_2O emissions from the largest sources, notably the use of synthetic nitrogen fertilisers (+2.9%), manure in pastures, rangeland and paddocks (+1.3%) and N-fixing crops (+6.9%) contributed most to global N_2O emission changes in 2018. With a 4.2% increase, Brazil accounts for the largest contribution to the global N_2O increase, followed by India (+1.6%), the United States (+0.9%), China (+0.6%) and Turkey (+5.2%). In contrast, Australia saw an 8.9% decrease, mainly due to fewer emissions from savannah burning in 2018, after a peak in 2017.

F-gases, as a group, show an annual global growth rate of 5.9% in 2018, which is somewhat higher than the average 4.4% annual increase over the 2011–2016 period. For 2018, global total F-gas emissions are estimated at 1.7 $GtCO_2$ eq worldwide, which is almost five times the emissions in 1990, when HFC emissions from the use of these substances were non-existent. At present, emissions from HFCs used as a substitute for CFCs — as CFCs are phased out to protect the ozone layer — together with HFC-23 by-product emissions from the production of HCFC-22, make up more than 80% of present total F-gas emissions, while the remainder of F-gas emissions are those of SF_6 (13%) and PFCs 6%). The largest absolute increase in 2018 was seen in the estimated increase in emissions of by-product HFC-23 (+16%) and those from the use of HFCs (+3.5%). The country that contributed most to the estimated 2018 increase was the Russian Federation, followed by China, Turkey and the United States. It should be noted that the F-gas emissions, while reasonably accurate at a global level, are very uncertain at a national level, due to the methodology used for EDGAR v4.2 FT2018, which mainly relies on top-down estimates distributed to individual countries using various proxies.

Methodology

The calculation of these emissions was based on the EDGAR database version 5.0 for CO_2 from the use of fossil fuel and carbonate (e.g. in cement clinker production and lime production) (Crippa et al., 2019), mainly based on IEA energy statistics (IEA, 2017a) and the new version 5.0 for methane and nitrous oxide that was released this year (see Annex I in Crippa et al., 2019)[2].

The EDGAR v5 database covers the years 1970-2015 and includes comprehensive activity statistics and emission factor data up to 2015. In this report, we used the EDGAR v4.2 FT2010 dataset for F-gases, since a comprehensive and consistent new data set for all F-gases is not yet available.

[2] The EDGAR v5.0 dataset does not include CH_4 and N_2O emissions from savannah burning. For our report, these emissions were added on the basis of the FAO data set for this source category.

For 2016, 2017 and 2018, a fast-track (FT) method was used for CO_2 emissions (as described in Olivier et al., 2017 and reported in Crippa et al., 2019)[3]. For 2016, the CO_2 emissions from fossil fuel combustion, national trends in coal, oil product and natural gas consumption were based on the latest detailed IEA statistics on 2015 and 2016 (IEA, 2018). For 2017 and 2018, the FT estimates were based on the latest BP coal, oil and natural gas statistics on 2016 to 2018 (BP, 2019).

For methane and nitrous oxide emissions over the 2016–2018 period, we mainly used an FT method for about 80% to 90% of global emissions, with detailed agricultural statistics from FAO (CH_4 and N_2O), fuel production and transmission statistics from IEA and BP (CH_4), for so-called Annex-I countries (industrialised countries under the UN Climate Convention) supplemented with data on coal production (CH_4 recovery) and the production of chemicals (N_2O abatement) (UNFCCC, 2019). For agricultural statistics, extrapolation was used for many sources where international statistics are not yet available for 2018.

For F-gases, we used an FT method for Annex-I countries, for the most important gases and sources, using the reported emission trends in 2010–2017 (UNFCCC, 2019). For the remaining countries and years, for F-gases, we generally used extrapolation, since international statistics are not available[4].

We stress that the F-gas emissions, while reasonably accurate at a global level, are very uncertain on national levels, due to the methodology used for EDGAR v4.2 FT2010, which mainly relies on top-down estimates distributed to individual countries using various proxies.

Most comprehensive data set

This is the most comprehensive report on global greenhouse gas emissions up to 2018, with detailed data on all greenhouse gas emissions. Other studies focus on CO_2 emissions only, which make up around three quarters of total greenhouse gas emissions, and/or present shorter historical time series.

[3] A small difference with the Crippa et al. (2019) data can be found in the CO_2 emissions from cement production in 2016–2018, where PBL uses updated emission factors resulting in 1.0% higher global total CO_2 emission level in 2018 (0.36 $GtCO_2$ higher).

[4] This analysis is based primarily on greenhouse gas emission data (CO_2 from fossil-fuel use and industrial processes, CH_4, N_2O and fluorinated gases), but excluding CO_2 from land-use change using data from EDGAR v5.0 FT2018. The largest changes, compared to v4.3.2 greenhouse gas FT2017 (Olivier et al., 2018), concern the CH_4 and N_2O emissions, since these data sets have been updated in v5.0 from 2012 to 2015). This includes new statistics and several revisions on previous years. In general, for non-CO_2 sources, updated international statistics from IEA, BP (2019), USGS, FAO, IFA, IRRI, UNFCCC (CRF) and other sources were used to estimate the trends for 2015–2018 emissions of CH_4 and N_2O. For more details on the methodologies and data sources used, please see Annex I in Crippa et al. (2019).

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