The state of greenhouse gases in the atmosphere using global observations through 2018

Oksana A. Tarasova (#), Alex Vermeulen, Jocelyn Turnbull, Yousuke Sawa, Ed Dlugokencky

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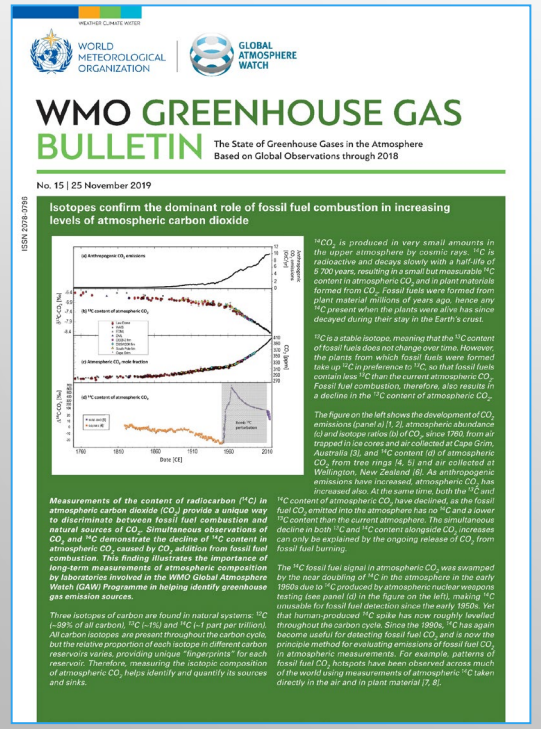
Global averaged annual mean mole fractions of key GHG in 2018


WORLD METEOROLOGICAL ORGANIZATION | GLOBAL ATMOSPHERE WATCH

WMO GREENHOUSE GAS BULLETIN

The State of Greenhouse Gases in the Atmosphere Based on Global Observations through 2018

No. 15 | 25 November 2019

Isotopes confirm the dominant role of fossil fuel combustion in increasing levels of atmospheric carbon dioxide

CO_2=407.8 ppm

details

CH_4=1869 ppb

details

N_2O=331.1 ppb

details

Other GHG

details

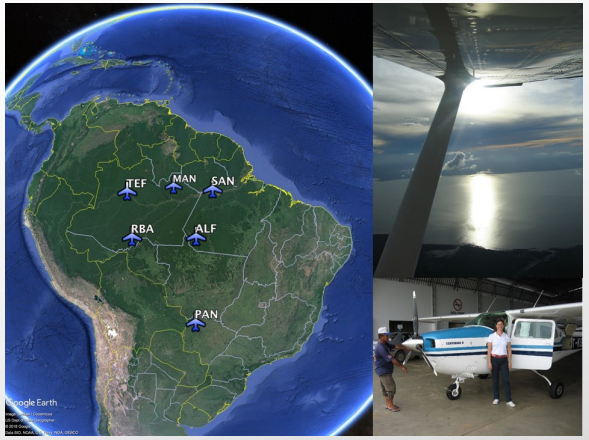
CO_2-eq=496 ppm

Underlying data

How atmospheric levels has changed?

What is the impact on climate?

How can isotopic measurements support source attribution?



Amazon aircraft programme

Park Falls, Wisconsin

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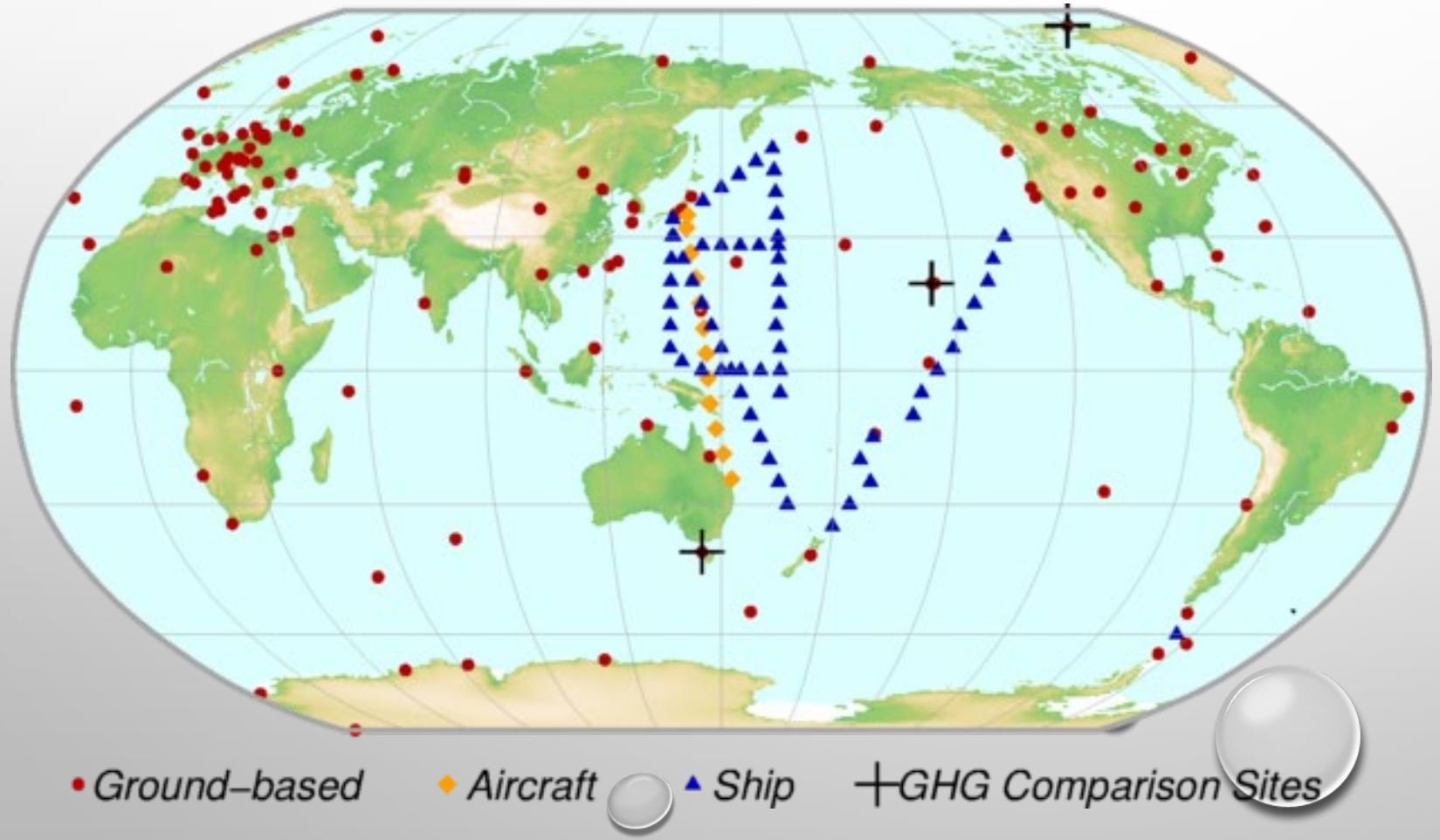

CO_2 observational network

Only the data obtained following prescribed QA/AC procedures are used for global analysis

Results of global analysis

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Global annual mean abundances (2018) and trends of key greenhouse gases from the WMO/GAW global greenhouse gas observational network

	CO_2	CH_4	N_2O
2018 global mean abundance	407.8±0.1 ppm	1869±2 ppb	331.1±0.1 ppb
2018 abundance relative to year 1750[a]	147%	259%	123%
2017-18 absolute increase	2.3 ppm	10 ppb	1.2 ppb
2017-18 relative increase	0.57%	0.54%	0.36%
Mean annual absolute increase of last 10 years	2.26 ppm yr^{-1}	7.1 ppb yr^{-1}	0.95 ppb yr^{-1}

CO_2 details

CH_4 details

N_2O details

Other gases

* Units are dry-air mole fractions, and uncertainties are 68% confidence limits

**Assuming a pre-industrial mole fraction of 278 ppm for CO_2, 722 ppb for CH_4 and 270 ppb for N_2O. Stations used for the analyses numbered 123 for CO_2, 125 for CH_4 and 33 for N_2O.

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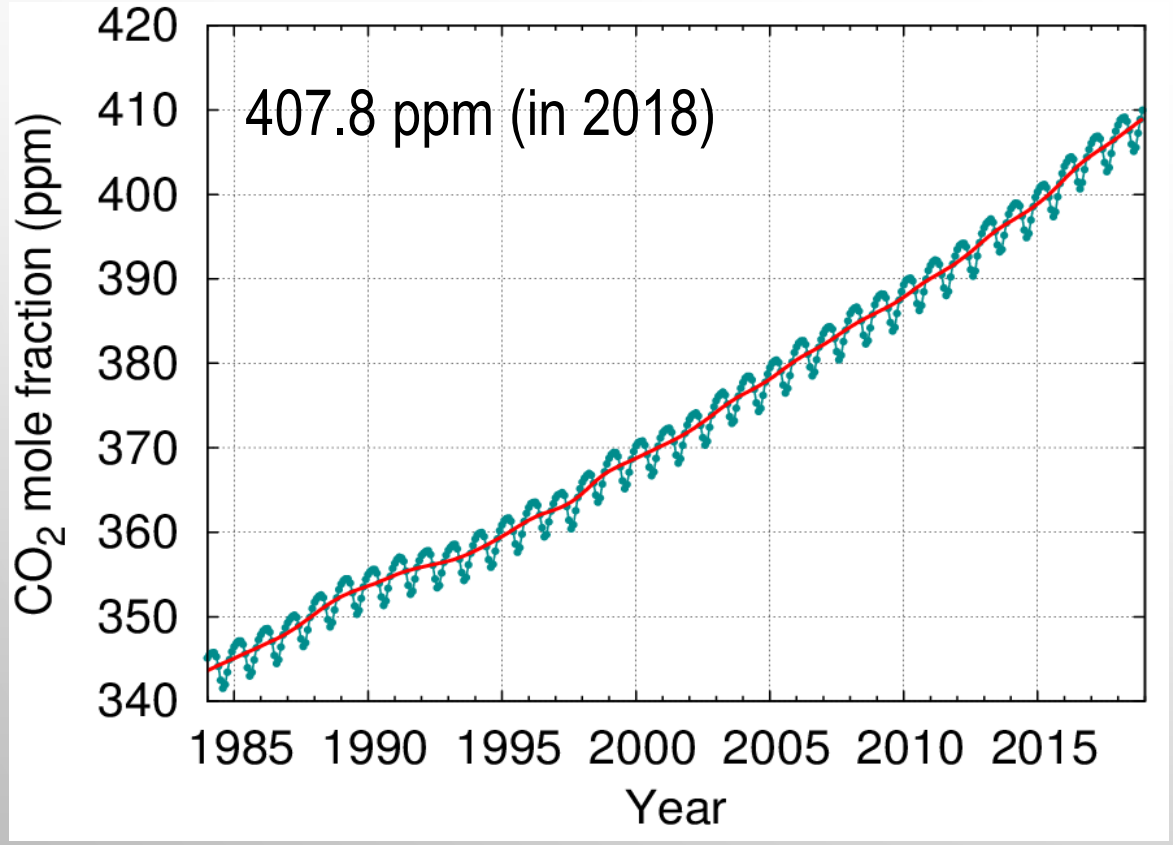

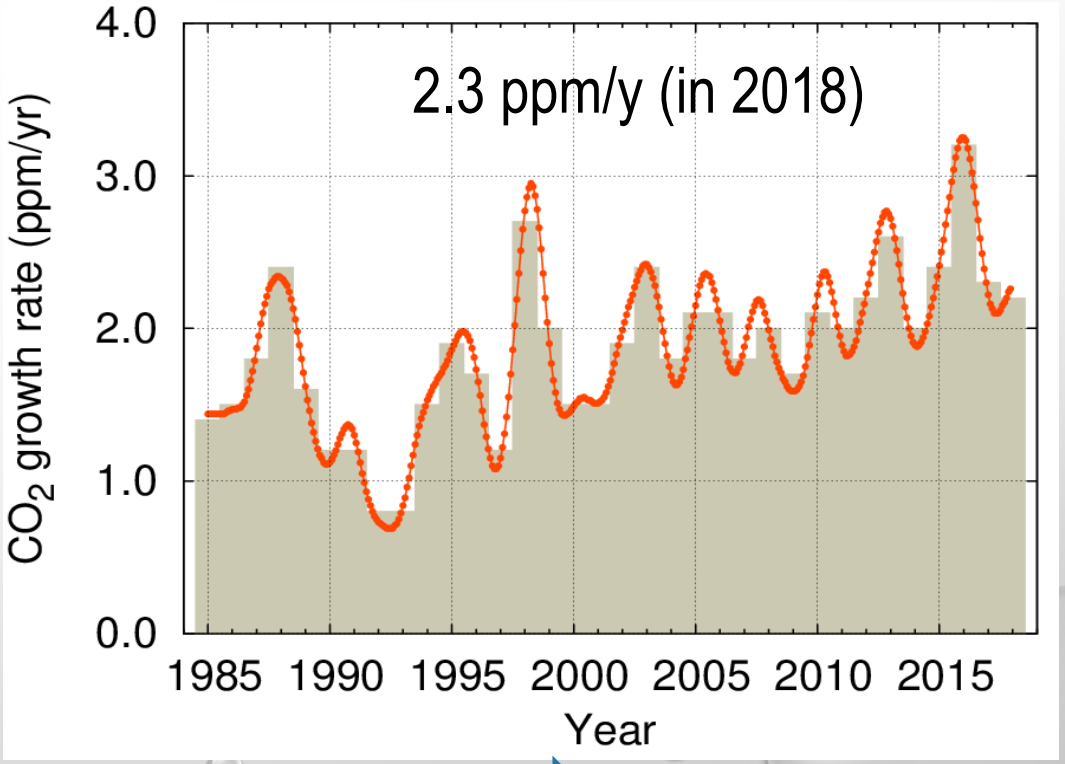

Carbon dioxide

The growth rate in 2018 is slightly higher than the 10 year averaged growth rate

Results for different latitudinal belts

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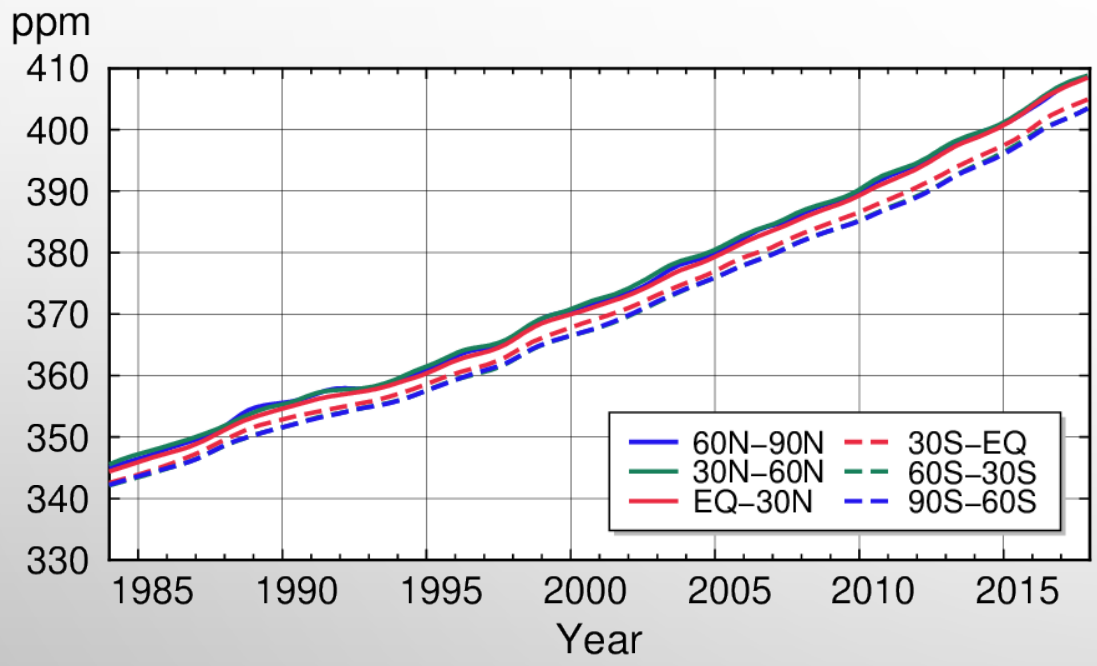

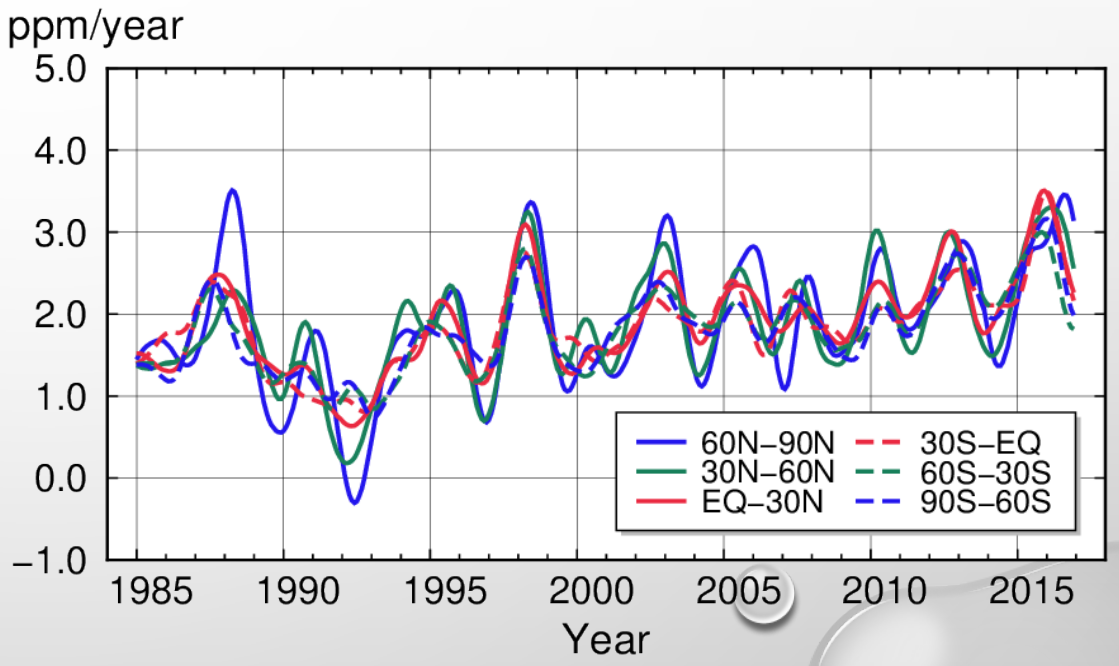

Carbon dioxide

Long-term trends in the mole fractions of CO_2 for each 30° latitudinal zone and their growth rates. The largest growth rate in 2017 is seen in the polar region of the Northern Hemisphere. ***(not updated for 2018 yet)***

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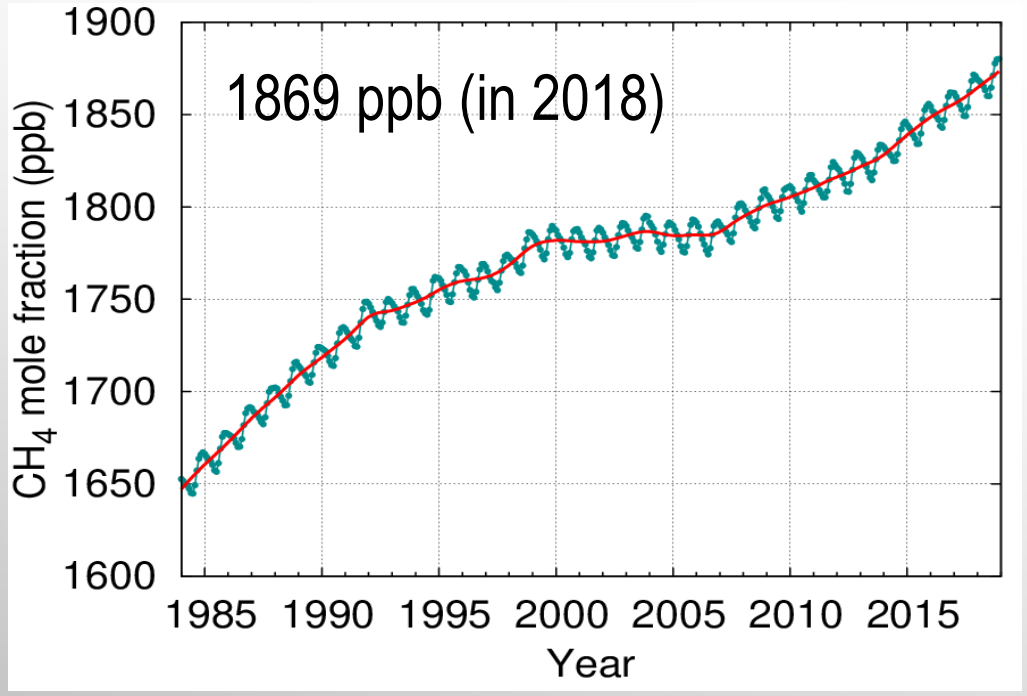

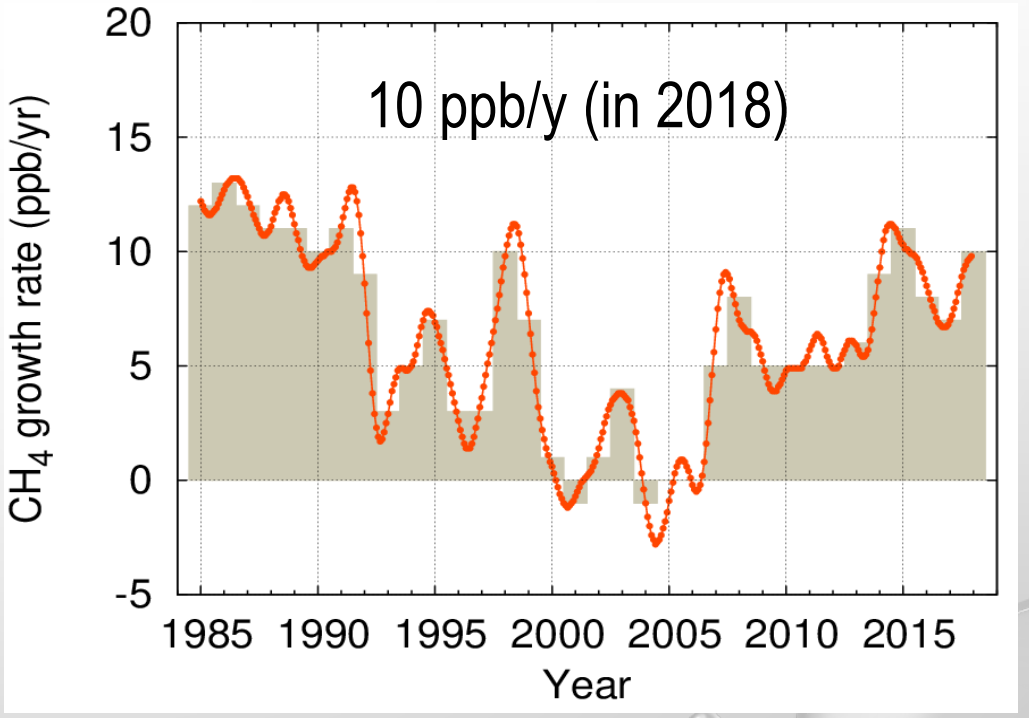

Methane

Studies using GAW CH_4 measurements indicate that increased CH_4 emissions from wetlands in the tropics and from anthropogenic sources at mid-latitudes of the northern hemisphere are likely causes of the renewed growth.

Results for different latitudinal belts

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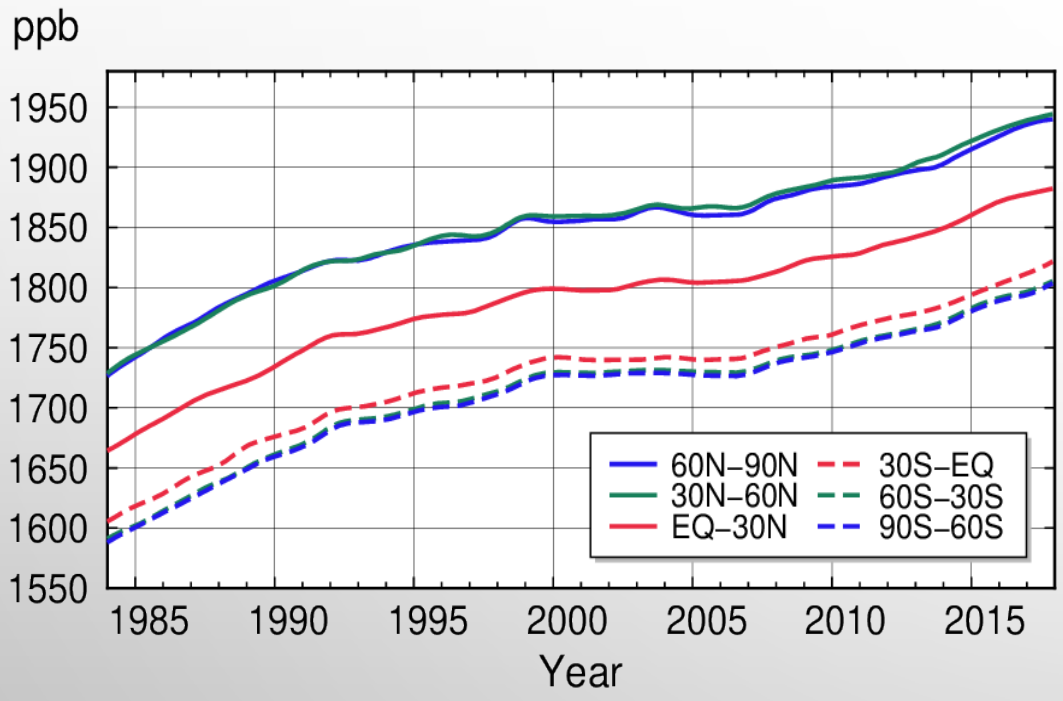

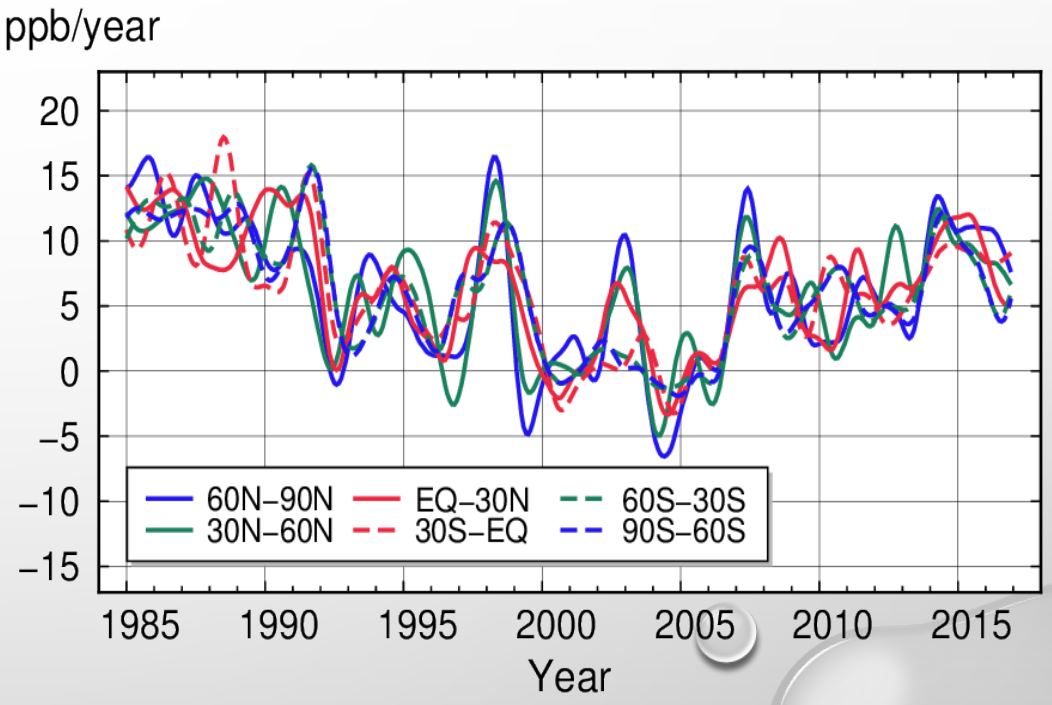

Methane

Long-term trends in the mole fractions of CH_4 for each 30° latitudinal zone and their growth rates. Studies using GAW CH_4 measurements indicate that increased CH_4 emissions from wetlands in the tropics and from anthropogenic sources at mid-latitudes of the northern hemisphere are likely causes or renewed methane growth. **(not updated for 2018 yet)**

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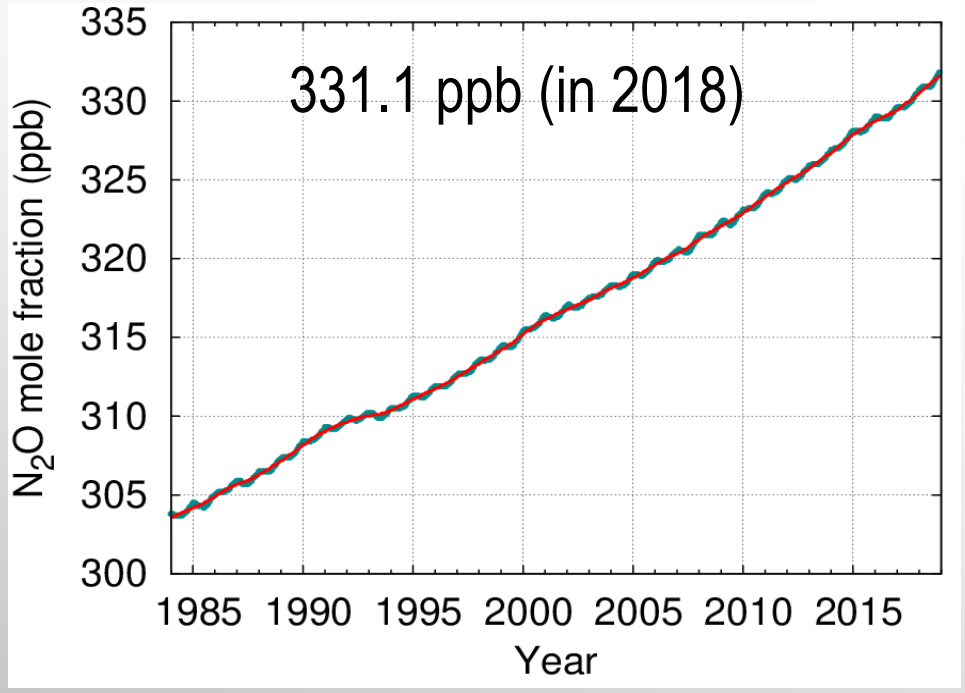

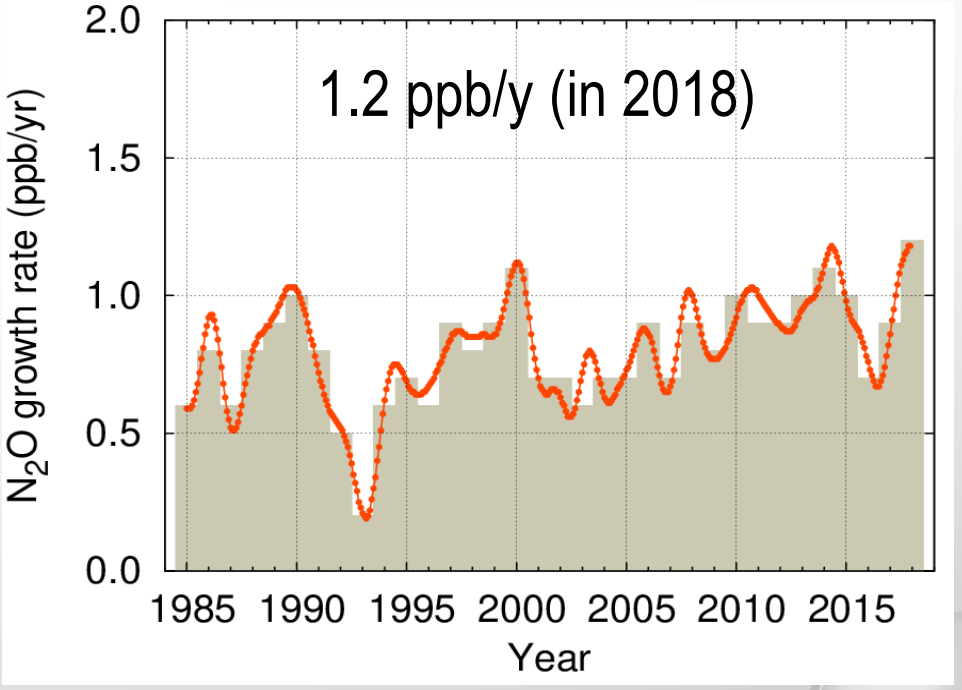

Nitrous oxide

The annual increase in 2018 is the highest since the global analysis is performed.

Results for two Hemispheres

The state of greenhouse gases in the atmosphere using global observations through 2018

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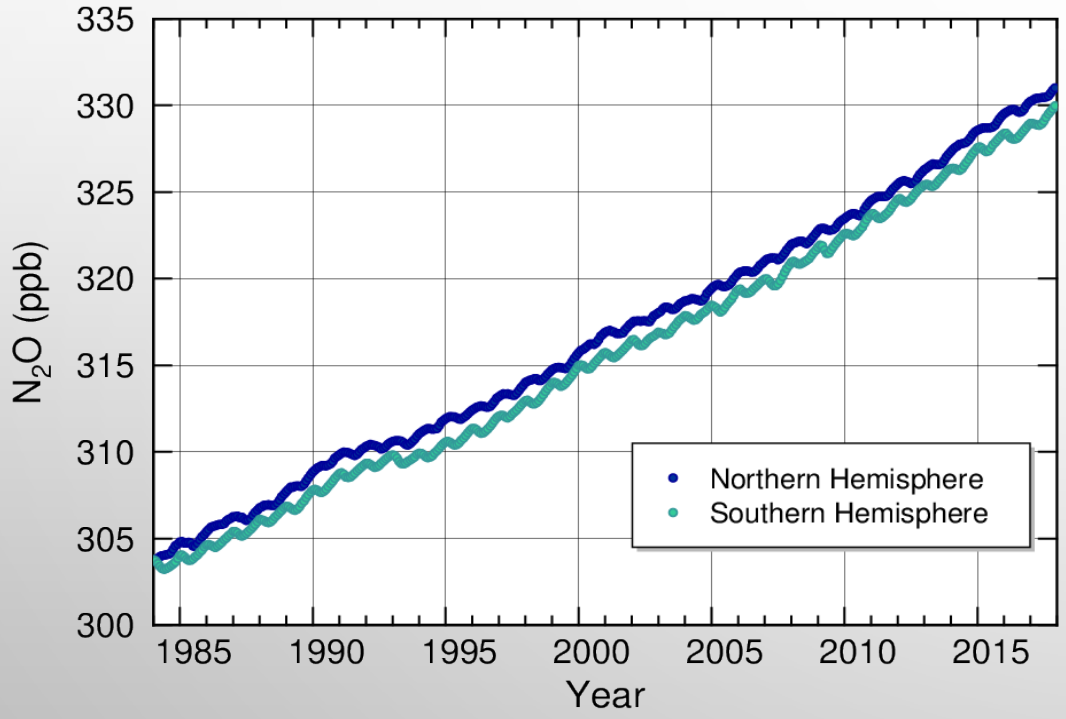

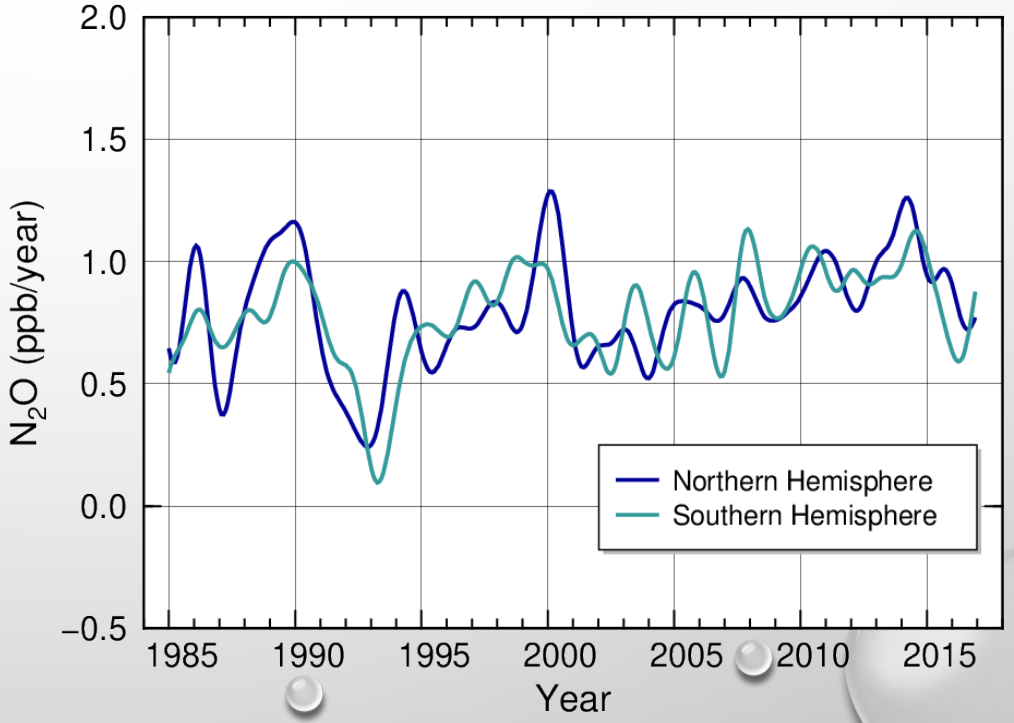

Nitrous oxide

Monthly mean mole fractions of N_2O from 1980 to 2017 and annual growth rates, averaged over the Northern and Southern Hemispheres. Extensive use of fertilizer in the Northern Hemisphere leads to the increase of the inter-hemispheric gradient. **(not updated for 2018 yet)**

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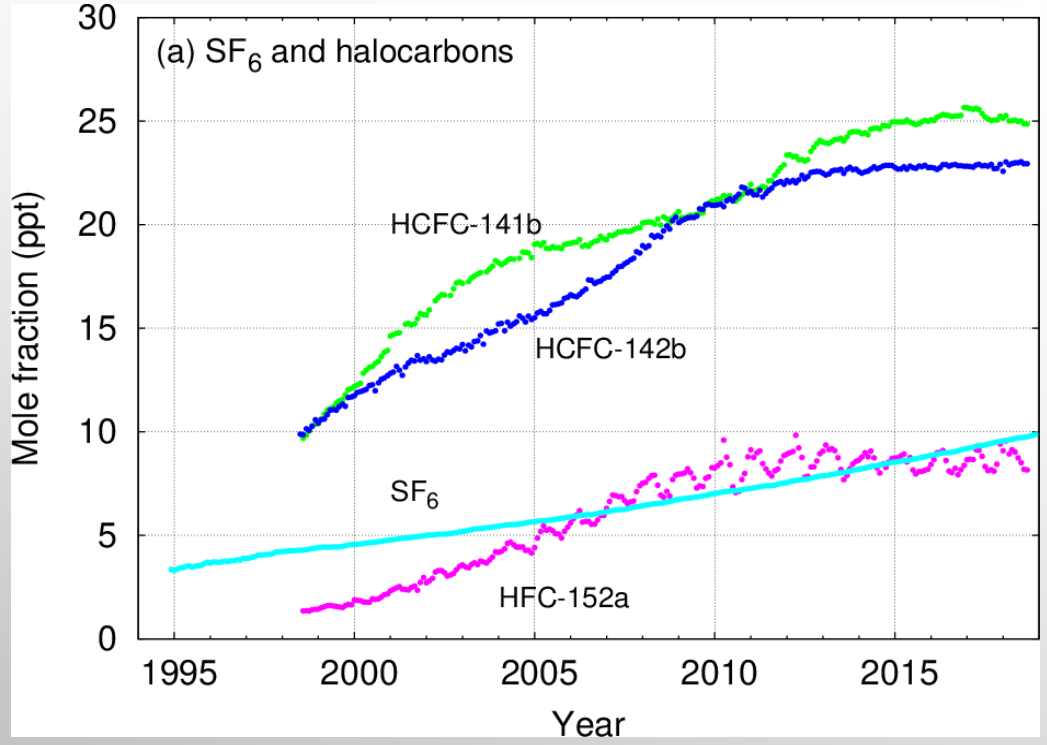

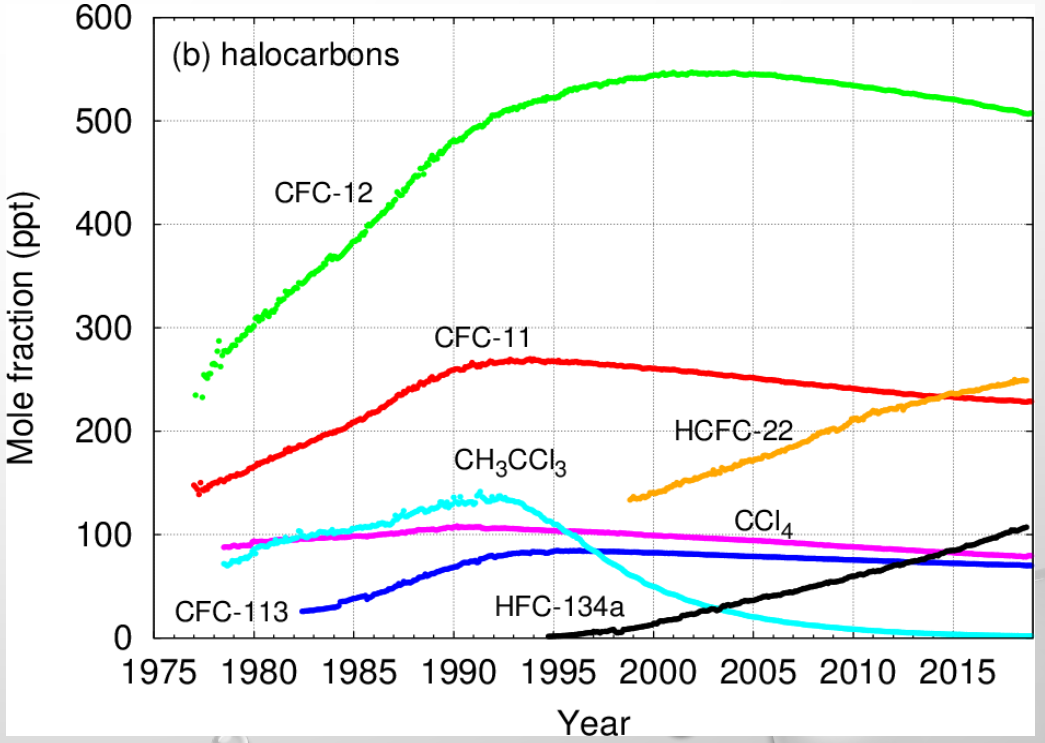

Other greenhouse gases

Monthly mean mole fractions of sulphur hexafluoride (SF_6) and the most important halocarbons: (a) SF_6 and lower mole fractions of halocarbons and (b) higher halocarbon mole fractions. The numbers of stations used for the analyses are as follows: SF_6 (85), CFC-11 (23), CFC-12 (25), CFC-113 (21), CCl_4 (22), CH_3CCl_3 (24), HCFC-141b (9), HCFC-142b (14), HCFC-22 (13), HFC-134a (10), HFC-152a (9).

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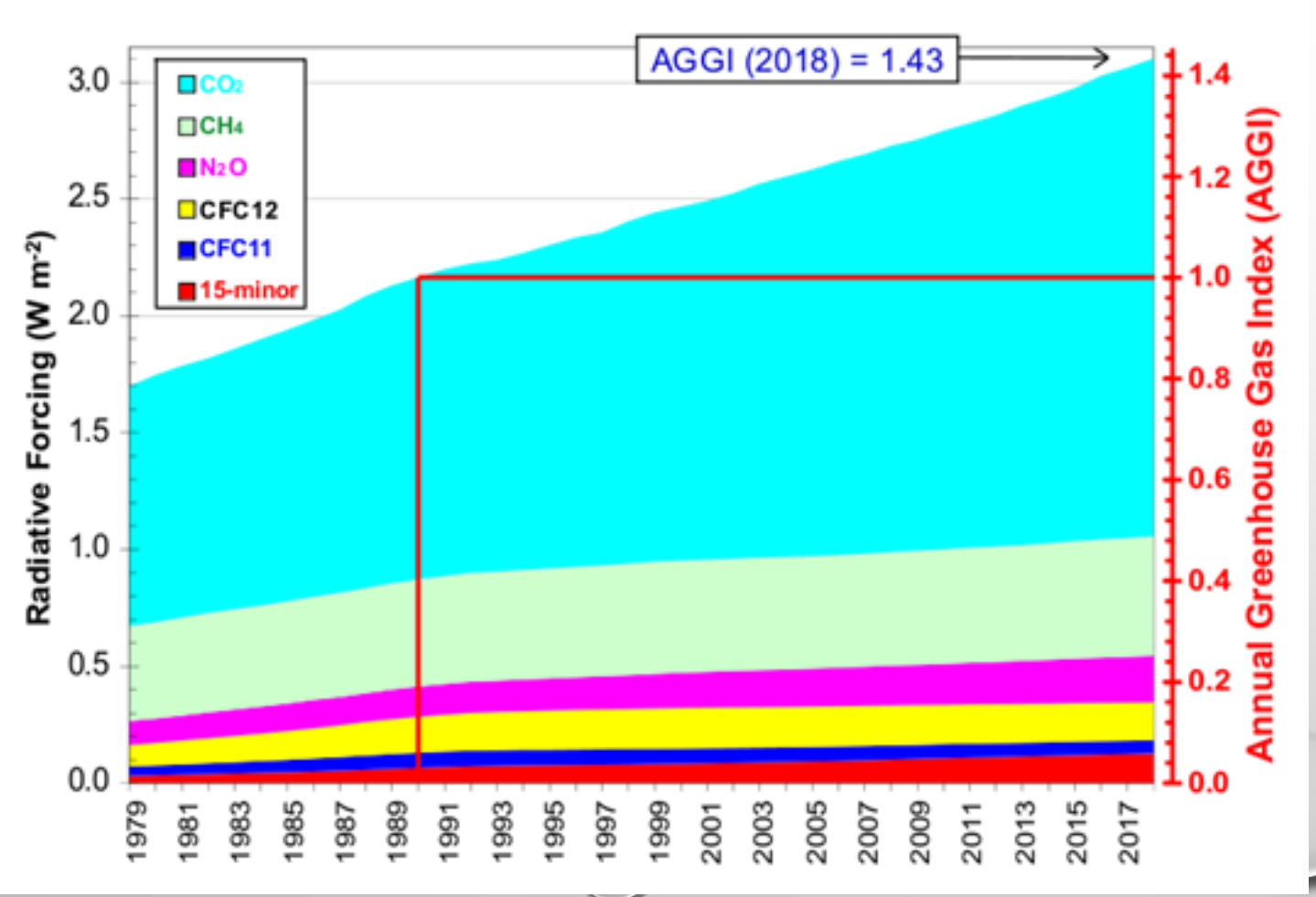

The NOAA Annual Greenhouse Gas Index (AGGI) in 2018 was 1.43 representing a 43% increase in total radiative forcing RF (relative to 1750) by all LLGHGs since 1990 and a 1.8% increase from 2017 to 2018. The total radiative forcing by all LLGHGs in 2018 corresponds to a CO2-equivalent mole fraction of **496 ppm** (http://www.esrl.noaa.gov/gmd/aggi).

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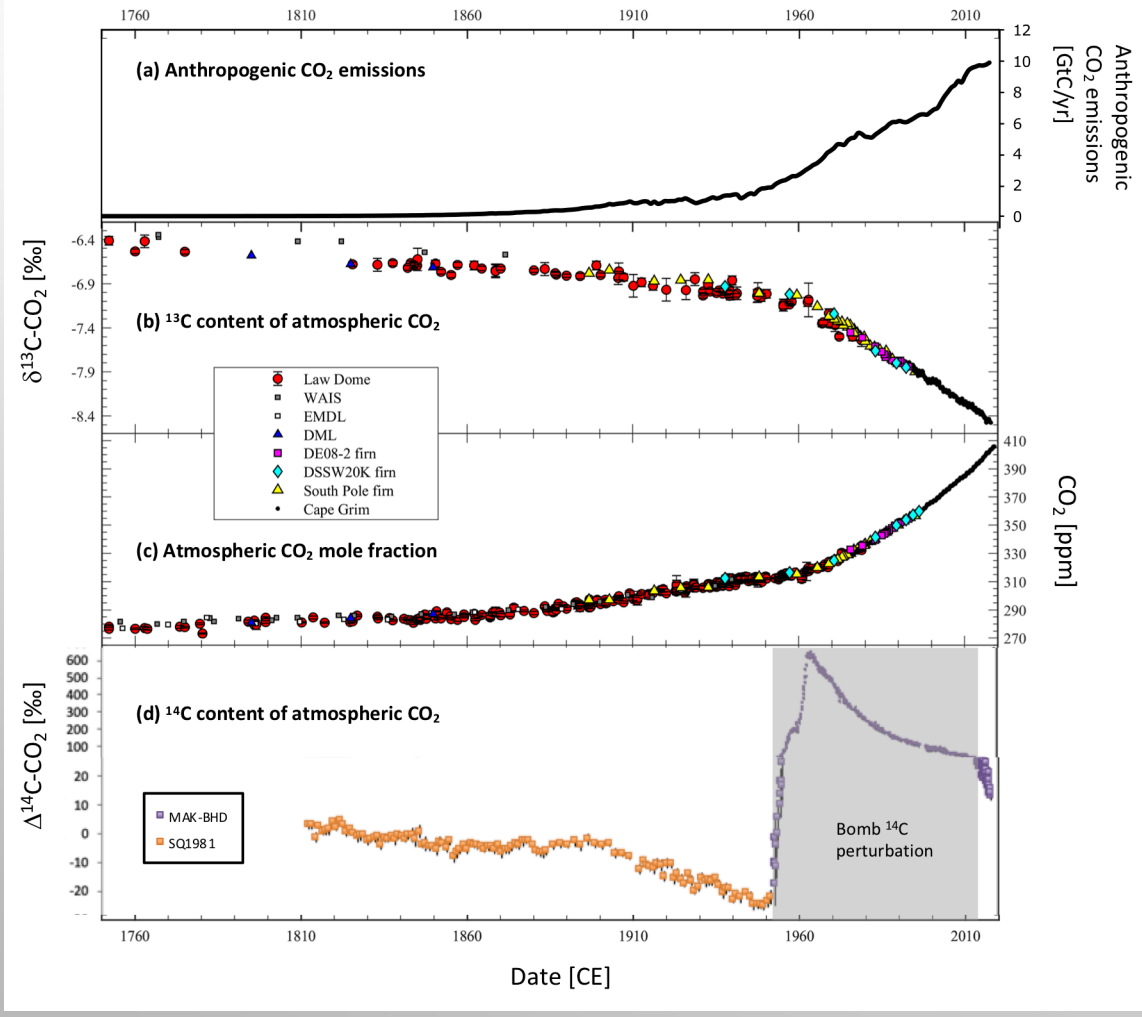

^{14}C for fossil fuel discrimination

Measurements of the content of radiocarbon (^{14}C) in atmospheric carbon dioxide (CO_2) provide a unique way to discriminate between fossil fuel combustion and natural sources of CO_2. Fossil fuels were formed from plant material millions of years ago and do not contain ^{14}C. Simultaneous observations of CO_2 and ^{14}C in it demonstrate the decline of ^{14}C content in atmospheric CO_2 caused by CO_2 addition from the fossil fuel combustion.

What is on the plot?

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The figure shows the development of emissions, atmospheric abundance and isotope ratios of CO_2 since 1760. with panel (a) reflecting estimated global total anthropogenic CO_2 emissions; panel (b) presenting ^{13}C content of atmospheric CO_2 from air trapped in ice cores and air collected at Cape Grim, Australia; panel (c) shows measured atmospheric CO_2 mole fractions from air trapped in ice cores and from air collected at Cape Grim, Australia and panel (d) showing ^{14}C content of atmospheric CO_2 from tree rings and air collected at Wellington, New Zealand. As anthropogenic emissions have increased, atmospheric CO_2 increases. At the same time, both the ^{13}C and ^{14}C content of atmospheric CO_2 have declined, as the fossil fuel CO_2 emitted to the atmosphere has no ^{14}C, and lower ^{13}C content than the current atmosphere. While there are several possible explanations for the declines in each of ^{14}C (fossil fuel combustion, geological CO_2 emissions) and ^{13}C (plant and animal respiration, fossil fuel combustion**), the simultaneous declines in both ^{13}C and ^{14}C content that track with CO_2 increases can only be explained by the ongoing release of CO_2 from fossil fuel burning.**

Continue to CH_4 results

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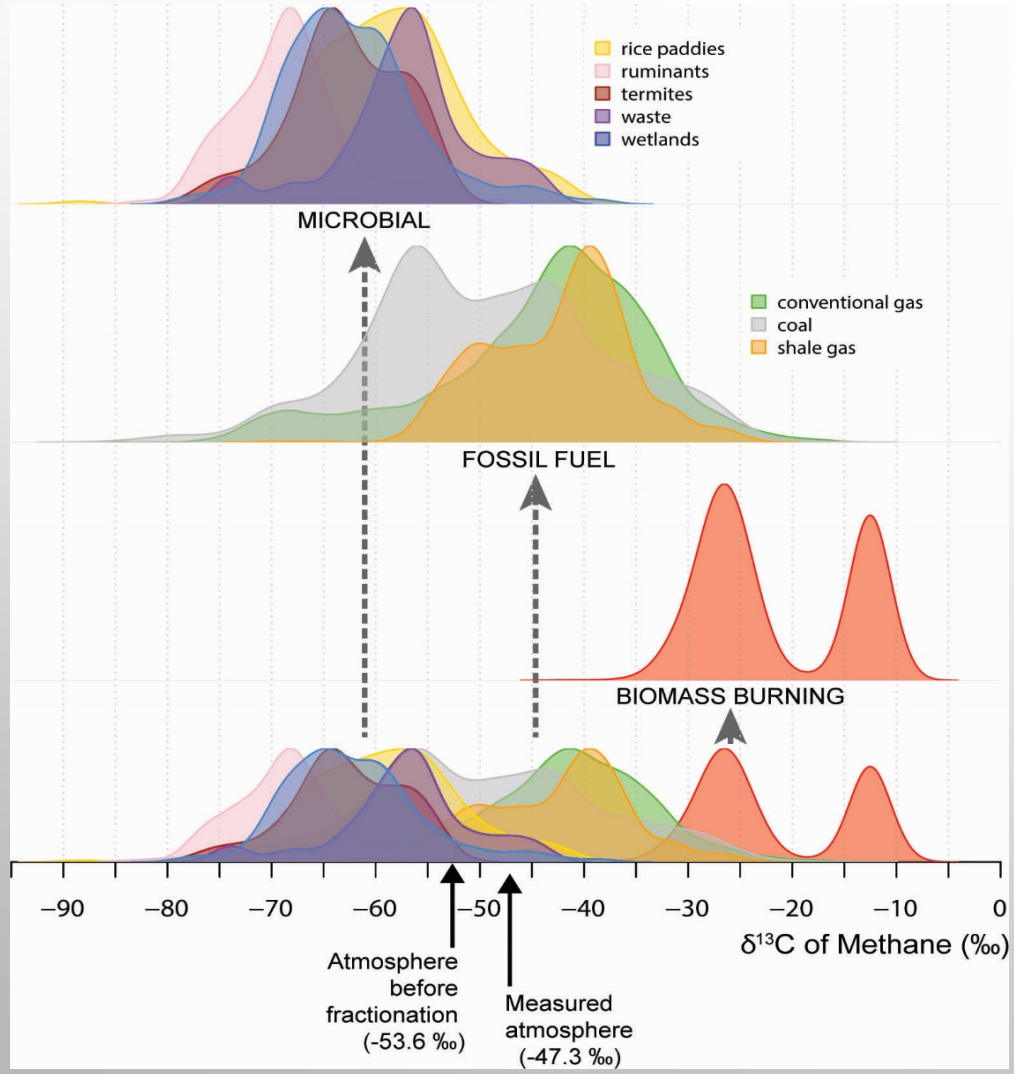

Normalized probability density distributions for the $\delta^{13}C_{CH4}$ of microbial, fossil, and biomass burning sources of methane. The flux-weighted average of all sources produces a mean atmospheric $\delta\ ^{13}C_{CH4}$ of ~ −53.6 ‰, as inferred from measured atmospheric $\delta^{13}C_{CH4}$ and isotopic fractionation associated with photochemical methane destruction.

What can we see in the global atmosphere?

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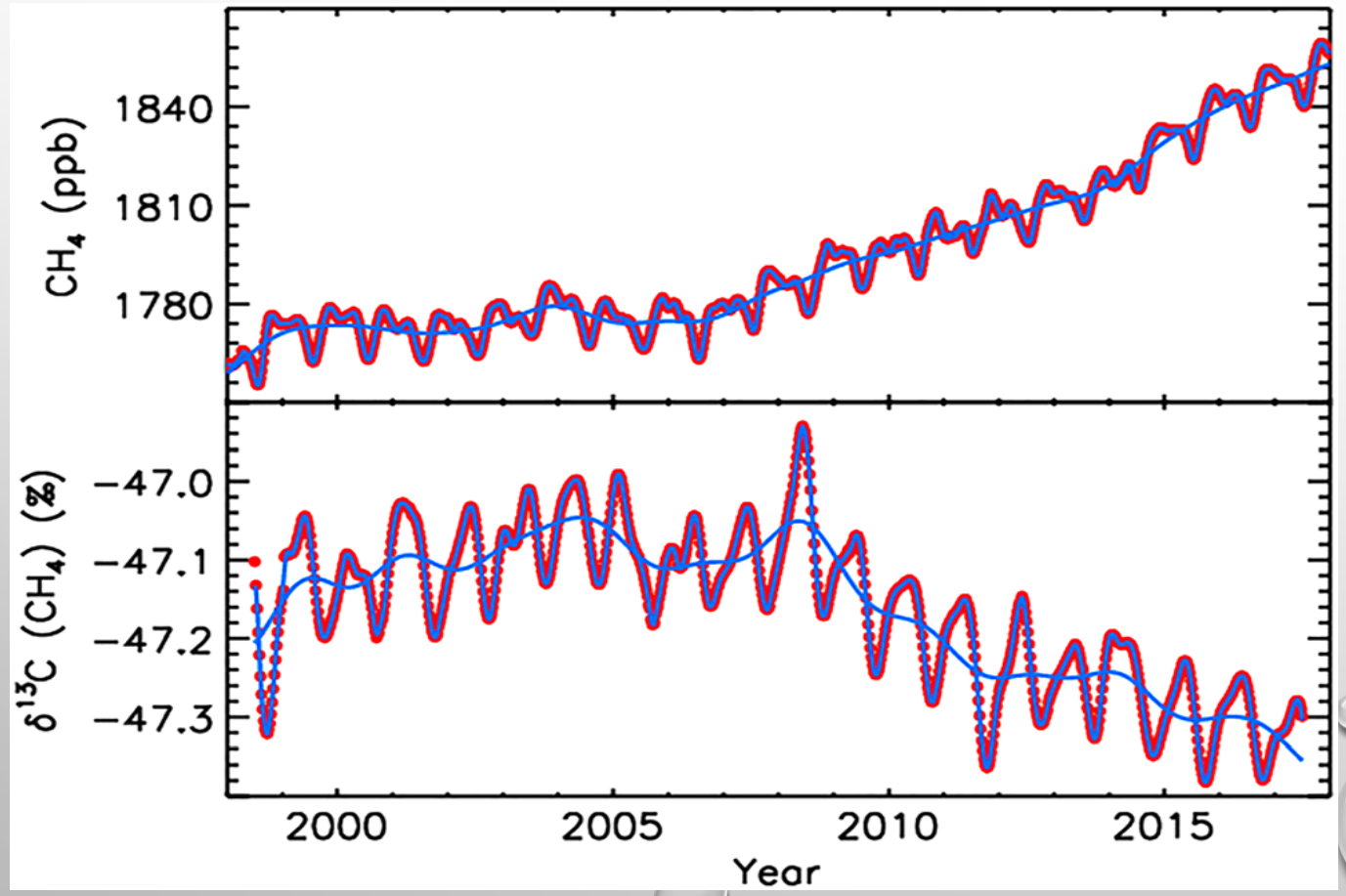

Though there are several hypotheses exist, the most plausible one is that an increase has occurred in some or all sources of biogenic (wetlands, ruminants or waste) emissions, which contain relatively little ^{13}C. An increase in the proportion of global emissions from microbial sources may have driven both the increase in the methane burden and the shift in $\delta^{13}C$-CH_4.

More information

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The full version of the Greenhouse Gas Bulletin is available at
https://library.wmo.int/doc_num.php?explnum_id=10100

The full Data Summary by the World Data Center is available at
https://gaw.kishou.go.jp/static/publications/summary/sum43/sum43.pdf

Fifty-four WMO Members have contributed CO_2 and other greenhouse gases data to the GAW WDCGG. Approximately 41% of the measurement records submitted to WDCGG were obtained at sites of the NOAA Earth System Research Laboratory cooperative air-sampling network. For other networks and stations, see GAW Report No. 242. The Advanced Global Atmospheric Gases Experiment also contributed observations to this bulletin. Furthermore, the GAW observational stations that contributed data to this bulletin, shown in Slide 2, are included in the list of contributors on the WDCGG web page (https://gaw.kishou.go.jp/). They are also described in the GAW Station Information System, GAWSIS (http://gawsis.meteoswiss.ch) supported by MeteoSwiss, Switzerland.