NOAA Earth System Research Laboratory
Global Monitoring Division
Issue 11: December 2018

The Cooperative Global Air Sampling Network Newsletter

Greetings to our cooperating partners and network affiliates. Thank you for your continued support of our greenhouse gas monitoring program!

The accompanying figure shows temporal and spatial variations in the atmospheric increases in methane (CH_4, top) and carbon dioxide (CO_2, bottom). These contour plots are derived from measurements of samples collected as part of our Cooperative Global Air Sampling Network. Variations in the growth rates are due to interannual changes in the imbalance between emissions and sinks, as well as variations in atmospheric transport. For CH_4, increases in growth rate started in 2007 and have continued steadily through 2017. CO_2 has larger increases and decreases in the Northern Hemisphere, with a large global increase in 2015-2016 due in part to changing net terrestrial biosphere fluxes during a strong El Niño. This is just one example of how data from our network can be used to show changes in atmospheric CH_4 and CO_2 over time.

50th Anniversary of The Cooperative Global Air Sampling Network

On January 16, 1968, in a bracing chill at 11,568 ft above sea level, a researcher collected an air sample atop Niwot Ridge in Colorado, USA. The sample was carried down the mountain and then measured for CO_2 at our lab in Boulder, Colorado.

NOAA was not officially established until 1970, but this air sample turned out to be the first of many to be collected and measured as part of what is now NOAA's Cooperative Global Air Sampling Network (Network). In the 50 years since, more than 274,000 air samples have been collected at over 60 sites around the globe (Fig. 1), and all have been transported to Boulder for measurements of carbon cycle gases. Samples have been collected on all continents, on seas and on many small islands by scientists and technicians, as well as soldiers, ranchers, mariners, school teachers, lighthouse keepers, a monk, and a host of other volunteers. Locations extend from the South Pole at 90°S to Alert, Canada at 82°N, range from desert sites to ocean stations, and vary from tropical paradises to barren icecaps. And, they still come from Niwot Ridge. That first sample from 1968 was only measured for CO_2 with 322.4 parts per million (ppm). CO_2 measurements have continued since then, and the Niwot Ridge 50th anniversary sample had 409.1 ppm. Over the years measurements were refined and added, and now samples are analyzed for as many as 60 different trace gases, some at part per trillion levels. Collection and measurement methods have changed over the decades, but the historical data are valid and continue to be used by researchers around the world to understand the carbon cycle.

We are often asked how we can be sure this increase of almost 90 ppm is real and not the result of changing measurement technologies. In short, it is because the analyzers we use to measure CO_2 (currently a non-dispersive infrared (NDIR) analyzer) do not give an absolute measure of the amount of CO_2 in the atmosphere. NDIRs give us readings from 0 to 5 volts; so the more CO_2 molecules in the sample, the greater the voltage response. We must relate the response of the NDIR (volts) to CO_2 abundance with a set of *calibration standards* that span the range of air samples measured, currently from ~380 to 430 ppm (where ppm stands for parts per million, after removing water). The CO_2 values in the standards are calculated from fundamental physical quantities whose definitions have not changed appreciably for centuries. In this case, these quantities are *temperature* (kelvin) and *pressure* (pascal). The amount of CO_2 in the standard is determined by measuring temperature and pressure of the air in a vessel of known volume, then transferring only the CO_2 to a smaller known volume, and measuring its temperature and pressure. For other greenhouse gases we measure, standards are based only on *mass*. While measurement methods have improved over time, the quantities of temperature, pressure and mass themselves have not. So, while the uncertainties of CO_2 measurements today (0.07 ppm) are less than 1968 (0.53 ppm), they are still directly comparable. For more detail, please see: www.esrl.noaa.gov/gmd/ccgg/about/co2_measurements.html.

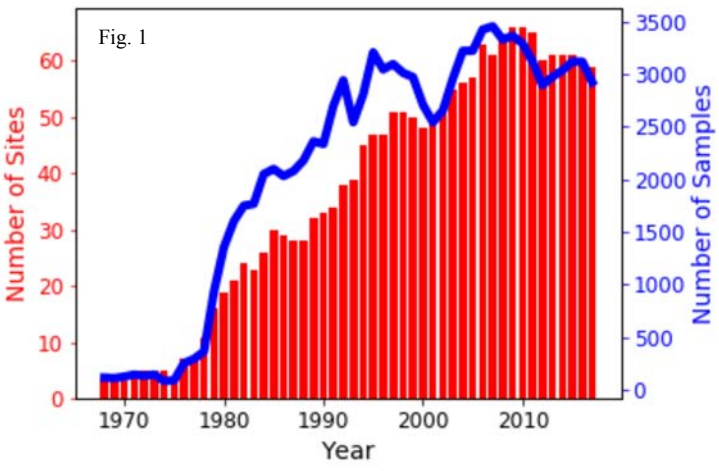

Fig. 1: Number of sites and number of samples measured from the Cooperative Global Air Sampling Network by year.

Interested in learning more? Check out these links:
GMD home page: www.esrl.noaa.gov/gmd/
CCGG home page: www.esrl.noaa.gov/gmd/ccgg/
Cooperative Network: www.esrl.noaa.gov/gmd/ccgg/flask.php

Trends in Atmospheric CO_2 and CH_4

NOAA GMD maintains web pages that report globally-averaged monthly mean atmospheric CO_2 and CH_4 abundances at Earth's surface determined from air samples collected by the Network. A trend is the general movement over time of a statistically detectable change, sometimes referred to as the rate of change. NOAA determines trends by smoothing and averaging weekly measurements from a subset of marine boundary layer sites that represent large, well-mixed volumes of the atmosphere. A mathematical curve is fitted to the data from each sampling site to reduce noise; the curves are then smoothed spatially to get global averages. The trends are reported as globally-averaged monthly means (Fig. 2). A full explanation is available here: www.esrl.noaa.gov/gmd/ccgg/about/global_means.html

Trends tell us about the net imbalance between emissions (sources) and loss processes (sinks) of these trace gases. For example, if we know how long CH_4 remains in the atmosphere (lifetime), we can estimate emissions and changes in the emissions. For CO_2, it is difficult to extract emissions from the trend signal because of large two-way fluxes between the atmosphere and the ocean and terrestrial biosphere, but we can see the rate of increase in the troposphere caused predominately by fossil fuel combustion and, thus, the impact on climate.

The NOAA GMD trends pages, which are updated around the 6th of each month, are used extensively by scientists, researchers, teachers, and other interested people. These web pages are popular, with the trends home page getting 25,000 – 30,000 visits per month.

In the future, trends of N_2O and SF_6 will be added to our web pages.

For more detail, please visit:
www.esrl.noaa.gov/gmd/ccgg/trends/global.html
www.esrl.noaa.gov/gmd/ccgg/trends_ch4

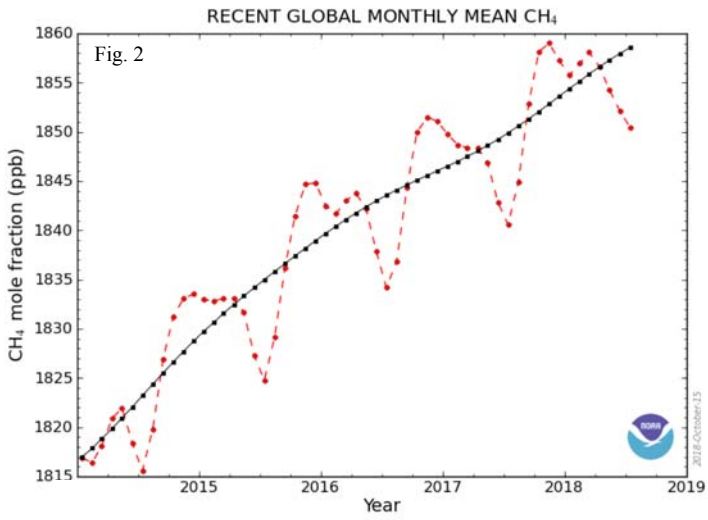

Fig. 2: Global monthly mean CH_4 calculated from our Cooperative Global Air Sampling Network with a black trend line.

Sample Collection Reminders

- Before starting sample, open all flask valves a few turns, making certain there is no resistance to the air flow through the valves. The flask valves must be open to allow normal flow, but this typically requires only a few turns to sufficiently open the valves.
- Read and record the flow rate indicated on the flow meter and the battery voltage from the volt meter after starting the sample process. Then close the lid of the sampler while it is running.
- Wait ~10 meters downwind of the sampler while it is running so that you don't 'contaminate' the sample with your breathing, etc.
- When the sample is completed, read and record the sample pressure indicated on the pressure gauge.
- Close the flask valves to isolate the air sample inside the flask bottles.
- Please record all information requested on the sample sheet, and mark whether you are using local or UTC time and date. Please use the same designation for both the time and the date – i.e. if you are using UTC time be sure the date is also correct for UTC.

Email Quarantine Problem

As some of you are aware, our new NOAA IT e-mail filtering system is preventing some legitimate e-mail messages from appearing in our inboxes. This e-mail quarantine problem is affecting our group email account (ccggflask@noaa.gov) and our individual accounts. We've requested help with this issue, but it has yet to be resolved. If you suspect your e-mail has been quarantined please:

- **Try us again** - please re-send your e-mail if you have not heard back from us in a few days.
- **Call us -** our phone numbers are listed to the right →
- **E-mail us from a different account**
- **Send the e-mail to a different person in our group**
- **Fax your e-mail message to us -** with Attn:_____ (one of us)

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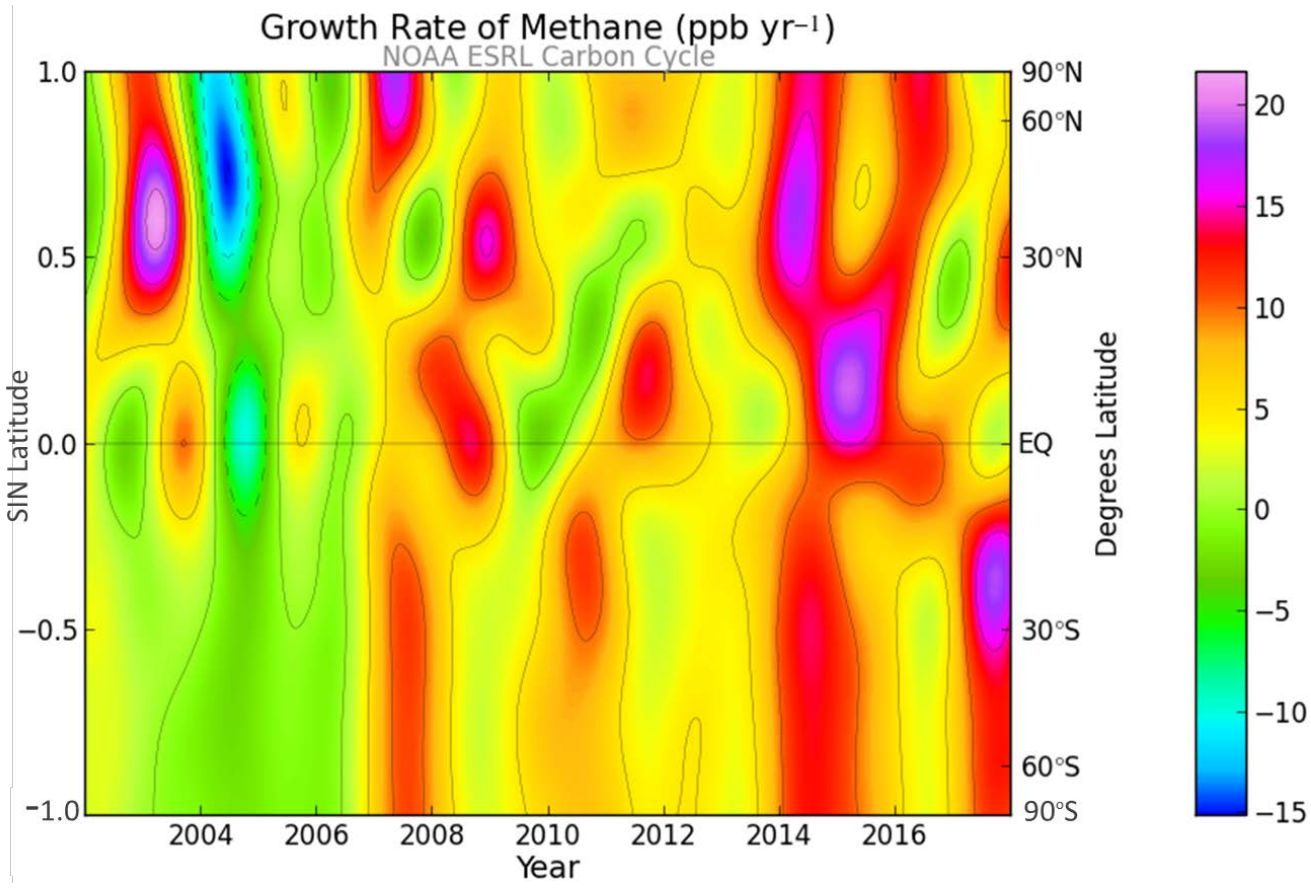
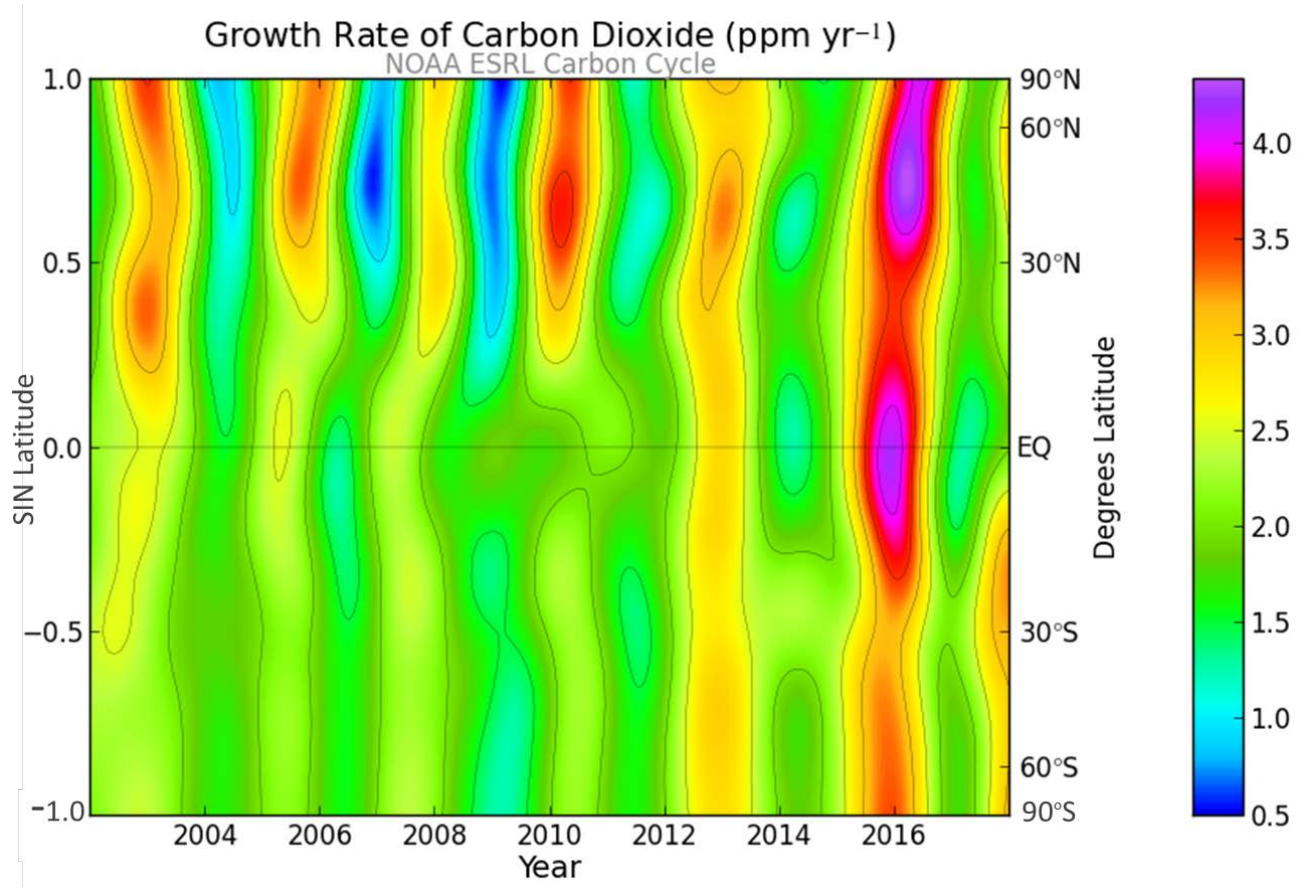

Growth Rate of Methane (ppb yr⁻¹)
NOAA ESRL Carbon Cycle
SIN Latitude
1.0
0.5
0.0
−0.5
−1.0
2004
2006
2008
2010
2012
2014
2016
Year
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Degrees Latitude
20
15
10
5
0
−5
−10
−15


Growth Rate of Carbon Dioxide (ppm yr⁻¹)
NOAA ESRL Carbon Cycle
SIN Latitude
1.0
0.5
0.0
−0.5
−1.0
2004
2006
2008
2010
2012
2014
2016
Year
90°N
60°N
30°N
EQ
30°S
60°S
90°S
Degrees Latitude
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5