NOAA Earth System Research Laboratories
Global Monitoring Laboratory
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The Cooperative Global Air Sampling Network Newsletter

Welcome to the 2021 NOAA Cooperative Global Air Sampling Network newsletter. We thank all co-operating partners and network affiliates for their continued support. As always, please email us at ccggflask@noaa.gov if you have any questions.

Despite Pandemic Slowdowns, Methane Surged

In 2020, globally-averaged CH_4 was 1879 ppb, up from 1645 ppb in 1984, the first full year of NOAA GML measurements of CH_4 from Cooperative Global Air Sampling Network flask-air samples. Since pre-industrial times when CH_4 was about 720 ppb (known from measurements of air trapped in ice cores), the increased atmospheric burden has caused 0.54 W m^{-2} additional climate heating, second only to CO_2 (2.16 W m^{-2}) for long-lived greenhouse gases. The rate of increase in atmospheric CH_4 since 1984 has not been constant; in fact, after increasing rapidly when the measurements began, the increase was near-zero from 1999-2006, after which CH_4 began increasing again in 2007. In the accompanying figure (Fig. 1, page 4), globally-averaged atmospheric CH_4 since 1998 is shown in the top panel. You will notice that the rate of increase is accelerating, reaching a peak of 14.7 ppb yr^{-1} in 2020. The reasons behind the increase since 2007 and its recent acceleration are vital for society to understand, because this will indicate CH_4 sources we need to target for mitigation. So, what is the cause? Is it increased hydraulic fracturing used for natural gas production in the US? Is it a response of natural ecosystems to climate change? Something else? How can we determine the cause?

One tool is to use the relative amount of carbon-13 in CH_4 measured from the same air samples by our colleagues at the University of Colorado, Institute of Arctic and Alpine Research (INSTAAR). Delta-C-13 ($\delta^{13}C$) helps us determine the relative contributions of broad categories of CH_4 sources. We seek the combination of sources that balances the atmospheric observations after accounting for a shift by loss processes (Fig. 2). $\delta^{13}C$ helps us distinguish among three categories of sources: microbial (MIC), fossil (FE), and biomass burning (BB). $\delta^{13}C$ in CH_4 increased for ~200 years before the recent decrease, which started around 2008, when atmospheric CH_4 began increasing. This tells us that the recent increase in atmospheric CH_4 was likely caused by increased emissions from CH_4 produced by microbes, e.g., in rice agriculture, anaerobic decay of animal waste, and natural wetlands, but from these observations alone, we cannot tell which one. And, while we are certain that much of the increase in CH_4 since pre-industrial was caused by fossil fuel exploitation, this is most certainly not driving the increase since 2007.

So, we think we know what is causing the increasing trend in CH_4 since 2007, but why the acceleration in 2020? Note how the $\delta^{13}C$ decrease accelerates downward in 2019-2020; this, again, points to microbial sources. Flooding in mid-latitude Asia and significant warmth in the Arctic likely caused the acceleration in CH_4 increase through increased emissions from natural wetlands. This will remain an active area of research for us at NOAA and INSTAAR.

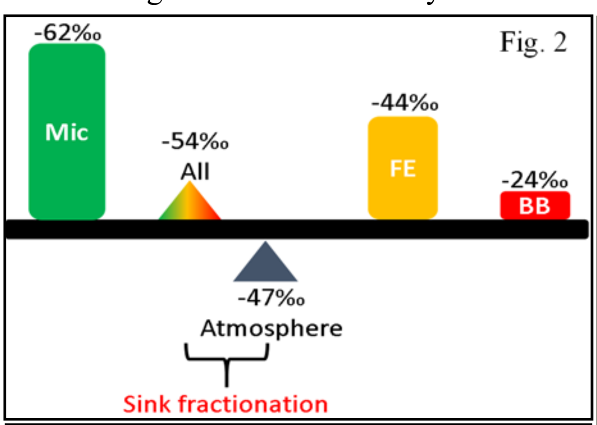

Fig. 2: $\delta^{13}C$ sources microbial (MIC), fossil (FE) and biomass burning (BB).

Contact Information:
Molly Crotwell: 303-497-4728
Eric Moglia: 303-497-3988
Don Neff: 303-497-4271
Sonja Wolter: 303-497-4801

Fax: 303-497-6290

E-mail: ccggflask@noaa.gov

Shipping Address:
Attn: Prep Lab, Rm GD305
NOAA/GML-1
325 Broadway
Boulder, CO 80305
USA

Reminders

Please…

- Return broken flasks and parts
- Use oldest flasks first
- Double check that sample collection information is complete on sample sheets
- Make sure to check appropriate time and date units on sample sheets: Coordinated Universal Time (UTC), Local Standard Time (LST) or Daylight Saving Time (DST))

COVID-19 Updates and Status of the Network

The past 18 months have been like none we've ever experienced before. Many of us here at NOAA are still working from home, and only making trips to the lab for mission critical work as needed. There are a few folks who are in the lab full time, analyzing samples and keeping the sites supplied with flasks. A big thanks to Monica Madronich for analyzing flask samples on our new measurement system and Eric Moglia for processing flasks and re-supplying field sites (Pic. 1). Their dedication to our program is remarkable!

There have certainly been some challenges to operating a global air sampling network during a pandemic, but despite all of these challenges, the vast majority of sites continue to take weekly air samples, and those samples are still measured here in Boulder, Colorado for long-lived greenhouse gases. Only a handful of sites in our network had to suspend sampling due to local restrictions, depleted flask supply, or funding and staffing problems. It is from the great effort and strong collaboration with all of our partners that this global program continues to be resilient in the face of a pandemic. We can't thank each and every one of you enough for all you do to support our research.

In 2019, we measured ~ 5700 flasks on our analysis system in Boulder, Colorado. In 2020, that dropped slightly to ~ 5100 flasks. We are happy to report that all measurement systems are running, and staff are able to continue QA/QC of the data while working from home.

Pic. 1: Eric Moglia (left) and Monica Madronich (right) working in the CCGG flask-air measurement lab.

New GML Website

In 2020 NOAA's Global Monitoring Division (GMD) became the Global Monitoring Laboratory (GML), now one of the 10 NOAA research laboratories across the US. Our laboratory's core mission has remained the same: GML works with partners to provide high quality long-term measurements of the atmosphere's composition and physical properties. Over the past year the GML website got a fresh new look and some new pages (Pic 2). This includes links to our recent research news, datasets, data products, peer reviewed publications, and descriptions of our four main research programs and their observing networks . CCGG highlights include:

Link	**Comments**
https://gml.noaa.gov/ccgg/	GML/CCGG home page
https://gml.noaa.gov/ccgg/flask.html	GML/CCGG Cooperative Air Sampling Network home page
https://gml.noaa.gov/ccgg/behind_the_scenes/measurementlab.html	Description of how flask samples are analyzed for various trace gases in air (our new measurement system).
https://gml.noaa.gov/ccgg/ghgpower/	Power of Greenhouse Gases page shows the dramatic increase in atmospheric GHGs and their radiative forcing since 1800.

Spotlight - Trip to Palmer Station, Antarctica During COVID-19

Because of their small communities and remote locations with limited medical facilities, the Antarctic research stations had to exercise extra precautions in staffing their stations this past year. In a normal year, those heading to Palmer Station would fly from the US on a commercial flight to Punta Arenas, Chile, where they would spend a couple days at a hotel while finalizing preparations for their journey across the Drake Passage on the R/V Laurence M Gould. This past year, however, station staff heading south were instructed to stay home and self-isolate for two weeks prior to traveling to the US Antarctic Program's quarantine facility in a hotel at San Francisco International Airport (SFO). Once in San Francisco, staff were tested for COVID-19 and started a 10-day quarantine in their hotel rooms. Three times per day, at specified times, they were allowed to go outside for an hour, though maintaining distance from one another. Also three times per day, meals in paper bags were delivered to all the rooms. Meetings and orientation sessions were, of course, conducted via Zoom. Twice more during the stay, staff were retested for COVID. The October group did not have anyone test positive, but other cohorts heading to McMurdo or South Pole Stations had individuals test positive; these people were then sent to a quarantine facility in San Francisco before being sent home again.

Once the Palmer group's quarantine ended, which had to be extended to 12 days in October because of paperwork issues for some of the aircraft crew members, the group flew in a nearly empty, chartered Boeing 767. Aside from a refueling stop in Dallas, this was a direct flight to Punta Arenas.

Upon arrival in Punta Arenas, the group was once again tested for COVID and then shuttled via bus directly to the pier where the Gould was docked. This marked the start of two weeks of group isolation on the ship, complete with 2-3 more rounds of COVID testing. Everyone on board had at least one roommate and had to eat in the galley, so it was not as strict as in San Francisco but people were required to wear masks in public spaces and only one person at a time could be in smaller spaces, like the gym. Armed guards on the pier were there to discourage people from disembarking off any of the ships, as this would have been considered an illegal border crossing!

If a new person entered the ship environment, even if just briefly, the crew had to remain in group isolation for a minimum of another seven days. Upon departing Punta Arenas, the ship is always required to pick up a Chilean pilot for navigation through the Strait of Magellan. Normally the pilot joins the captain and bridge crew for 6-8 hours while the Gould takes a course north and east through the Strait, where the pilot disembarks and ship turns south to follow the more protected eastern coast of southern Argentina. To reduce time with a pilot on board for the October trip, the captain instead chose a route south from Punta Arenas. The pilot boarded the Gould and used all external stairways before isolating himself in the bridge's aft control room for only the hour required to get out of the bounds of the controlled area. Upon his exit from the ship, the 7-day group isolation began anew.

A normal trip to Palmer on the Gould is a 4-day cruise, so the crew had to slow down the transit. While the ship docked at the station after six days and the crew were able to offload cargo containers that day, no one from the ship could disembark until the seventh day (Pic. 3).

So from start to finish, travel from home to Palmer Station took personnel about 5 weeks, a trip that normally lasts about one week. Although vaccinations are rolling out and some parts of the world are able to ease restrictions, the US Antarctic Program is currently continuing its extra-vigilant approach to staffing its stations because the risks of a remote outbreak are simply too great.

Pic. 3: R/V Laurence M. Gould docked at Palmer Station, Antarctica

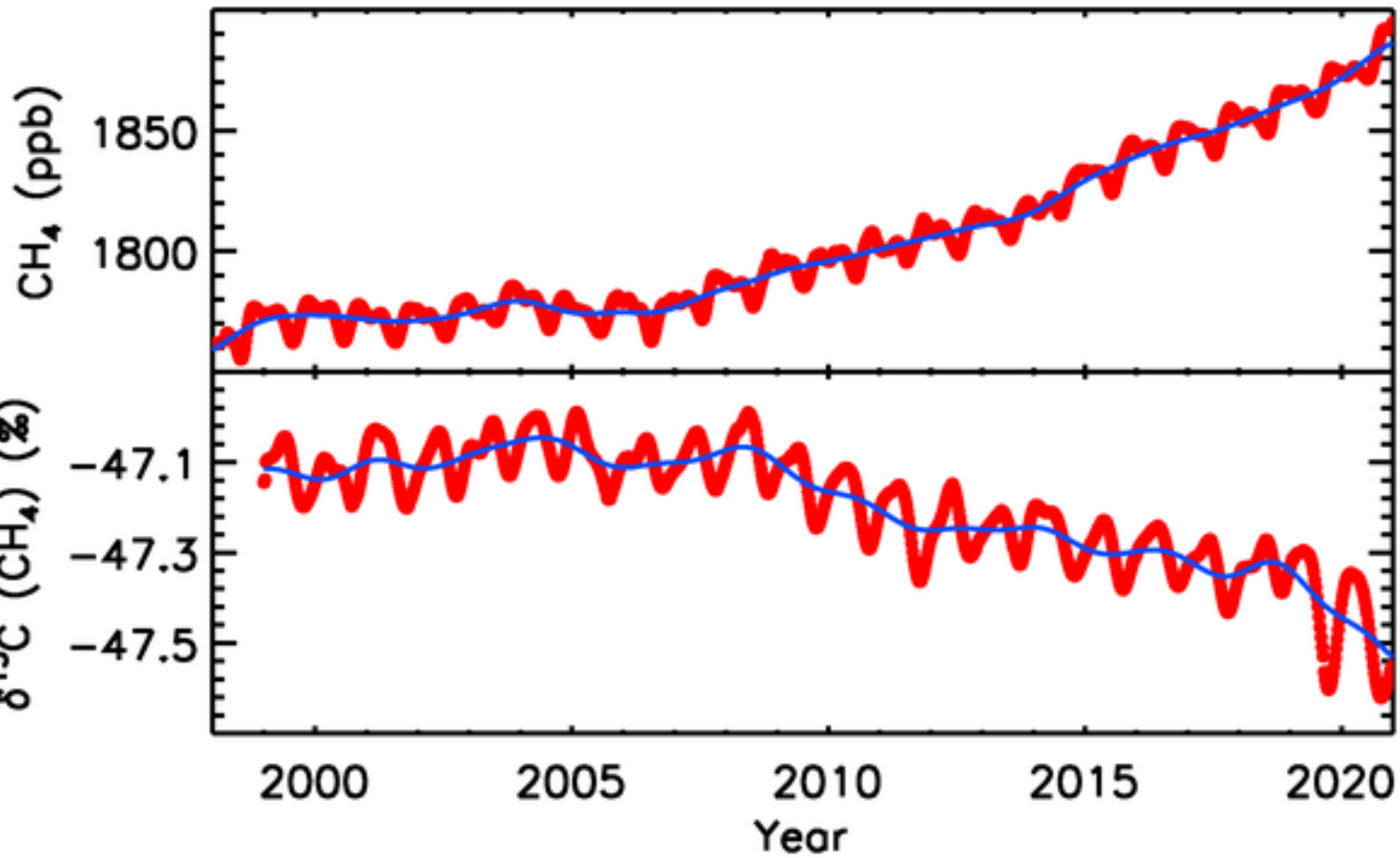

Figure 1: Globally-averaged atmospheric methane (CH_4) since 1998 is shown in the top panel. The blue line represents the trend after the seasonal cycle is removed. The bottom panel is a time series of globally-averaged delta-C-13 (data provided by our colleagues at the University of Colorado, Institute of Arctic and Alpine Research (INSTAAR). Recent data are preliminary).