NOAA Earth System Research Laboratory
Global Monitoring Division

Issue 10: October 2017

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!

Network Updates:

- Unfortunately, due to budget constraints, our sampling record at Trinidad Head, California ended in May 2017.
- We are still working on sample collection videos/ tutorials. We hope to have updates on this soon.

The accompanying figure shows globally averaged carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) in the top panels and annual growth rates in the bottom panels. These three gases are responsible for ~88% of the increase in climate forcing by long-lived greenhouse gases since the preindustrial era. CO_2 and N_2O have been increasing over the long-term, with some year to year variation. CH_4 is a special case; its growth rate decreased from the early-1980s until 2006, then began to increase again in 2007 through the present. NOAA's measurements of these gases from the samples you collect are used to understand the changes in emissions of these gases and therefore inform policy makers on the best course of action to limit their impact on climate.

Abrupt Climate Change

In 2016, globally-averaged CO_2 was nearly 403 ppm. The last time the atmospheric CO_2 level was this high was more than 3 million years ago when the temperature was 2 to 3°C greater than during the pre-industrial era and sea level was 15 to 25 meters higher than today; could this be the world we are heading for as Earth's climate slowly equilibrates to this level of forcing? And if it is, how will we get there? Will it be a gradual change or an abrupt one? Some experts who study Earth's ancient climate history believe that rapid increases in atmospheric burdens of greenhouse gases may cause abrupt shifts in climate, leaving no time for societies to adapt. Unfortunately, the paleoclimate record of the past 800,000 years determined from ice cores does not contain an example of changes in atmospheric composition as rapid as we've seen over the past two centuries. Large shifts in climate have been observed before, e.g., ~12,000 years ago temperatures in Greenland rose by ~10°C over a decade, a shift likely caused by changes in ocean circulation. Over the past 70 years, the CO_2 increase measured at Mauna Loa Observatory (RH figure) is almost 100 times greater than natural changes recorded in air trapped in Antarctic ice at the end of the last ice age (LH figure). The impacts of fast changes in atmospheric composition are unknown, but Arctic regions are already responding with rapidly disappearing summer sea ice, which will affect Earth's energy balance and result in changes to weather at mid-latitudes of the Northern Hemisphere. Enormous stores of carbon in Arctic permafrost and methane hydrates are increasingly susceptible to release. Even relatively small abrupt climate changes could have ruinous impacts for society, causing ecological and economic disruptions and an agricultural system unable to provide enough food to sustain global population. Abrupt changes to climate are not considered as part of international climate change assessments, but NOAA measurements of atmospheric greenhouse gases provide an early warning system that could identify the impacts of abrupt changes in climate on greenhouse gas emissions, giving society a better chance to act before the impacts become severe.

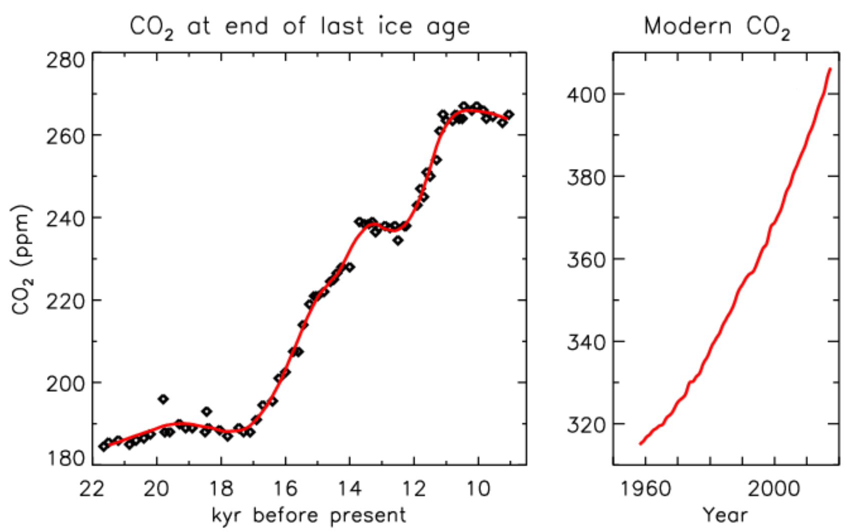

Figure above: LH: CO_2 measurements from air extracted from ice cores collected in Antarctica (Monnin et al., Science, 2001). RH: CO_2 at Mauna Loa, Hawaii provided by Scripps Institution of Oceanography (prior to May, 1974) and NOAA Global Monitoring Division (https://www.esrl.noaa.gov/gmd/ccgg/trends/full.html).

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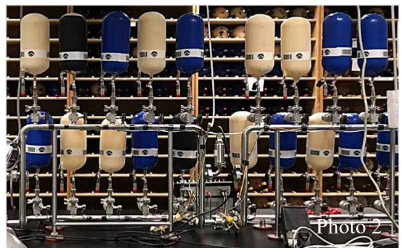
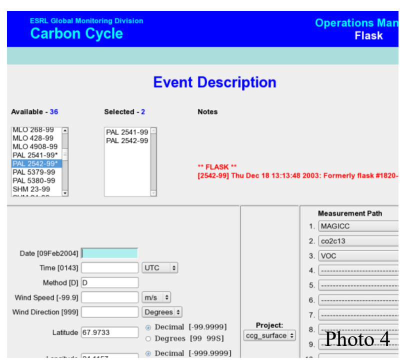
Life of an Air Flask

Network flasks are in constant motion, traveling the world to collect air samples from specific locations. The flask journeys can be to wide-ranging and sometimes very remote places. Flask #1991-99, for example, took its first trip in 2003 to the Trinidad Head Observatory in California. Since then it has been used for samples as far north as Alert, Nunavut, (82°N) and as far south as the South Pole (90°S). Locations in between have included Israel, New Zealand, the US, Finland, "northern" Antarctica, Algeria, Chile, Korea and an ocean cruise. Most of us can only dream of having such a dynamic list of destinations in our passports!

These journeys all start at a local glass company in Boulder, Colorado, where each flask is manufactured by hand. In the NOAA Flask Prep Lab, we then coat the flask with a shrink wrap to protect the sample from sunlight and to protect people handling the flask should it break. The new flask is assigned a unique flask ID number and goes through a thorough check to ensure there are no leaks or defects in the glass. If it passes the tests, it can be prepared with a synthetic fill gas mixture that is low for CO_2, but sufficient to condition the flask walls, and no CH_4, and then shipped to one of our 55 sites around the world (photos 1-2). Volunteers and people associated with other scientific institutions receive the flasks and collect local air samples in flask pairs and return them to Boulder for measurement (photo 3). We use our Operations Manager (OM) database to record the information from the sample sheet, assign the sample a unique ID number, and assign a measurement path and routing plan to the different measurement labs (photo 4). Some of the sample quality control measures include comparing measurements of two flasks collected as a pair; large differences between them could indicate that the flasks were not flushed long enough or that the pump is not functioning properly. After analysis a flask returns to the prep lab where it is prepped with fill gas again and sent back into the field. In 2016 we measured ~7,000 air samples from network flasks, including samples from your site.

There are approximately 5,000 flasks in our network. It is a big challenge to manage the logistics of a network of this scale. OM has a variety of tools we can use to track, search, and monitor the overall operations of our network. Unfortunately, flasks can break during shipping and sampling. In 2016, ~2% of flasks broke during transit or handling. Luckily we can usually get broken flasks repaired at a local glass shop and send the flasks out into circulation again to continue collecting air samples.



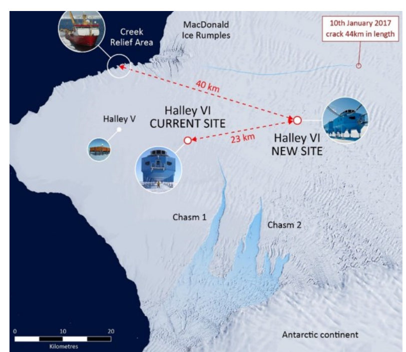


Photos from top to bottom: 1) Prepared flasks ready to go into the field; 2) Flasks loaded on the prep manifold; 3) Carbon Cycle measurement lab; 4) screenshot of Operations Manager event details page.

Spotlight

On October 31st, 2016, a large crack, nicknamed the "Halloween Crack", was discovered in the Brunt Ice Shelf near the British Antarctic Survey's (BAS) Halley Bay Station (HBA) on Antarctica. BAS made the decision to close the station down in March 2017 before winter made access impossible (map below).

BAS has been on the Brunt Ice Shelf since 1956, and NOAA/GMD began measurements of air samples collected in flasks at HBA in 1983. This year, with the uncertainty over a crack near station and the difficulty of reaching the station in winter, the station closed and all staff have left. BAS has been monitoring the crack with satellites and ground instruments and plans to reopen the station in November, but the long-term fate of the station is still undecided.



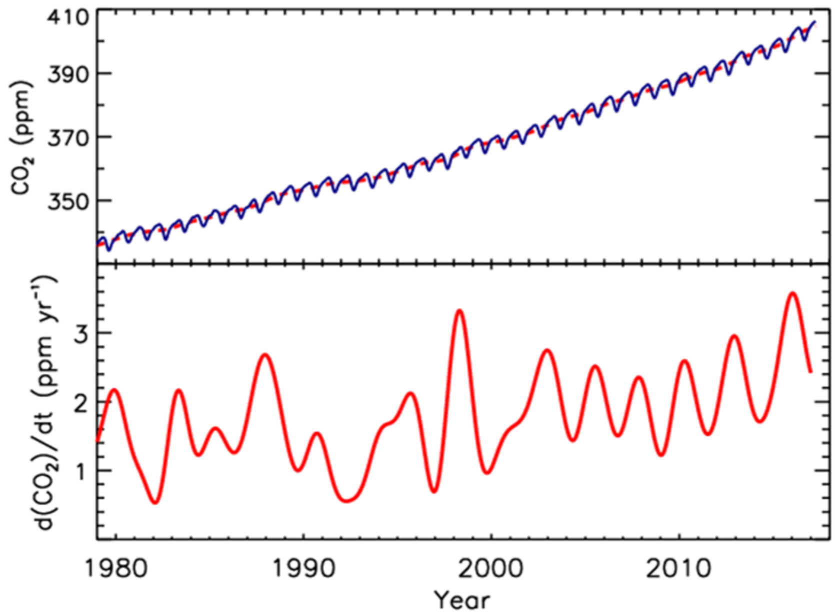
Map: Courtesy of Steve Colwell, British Antarctic Survey.

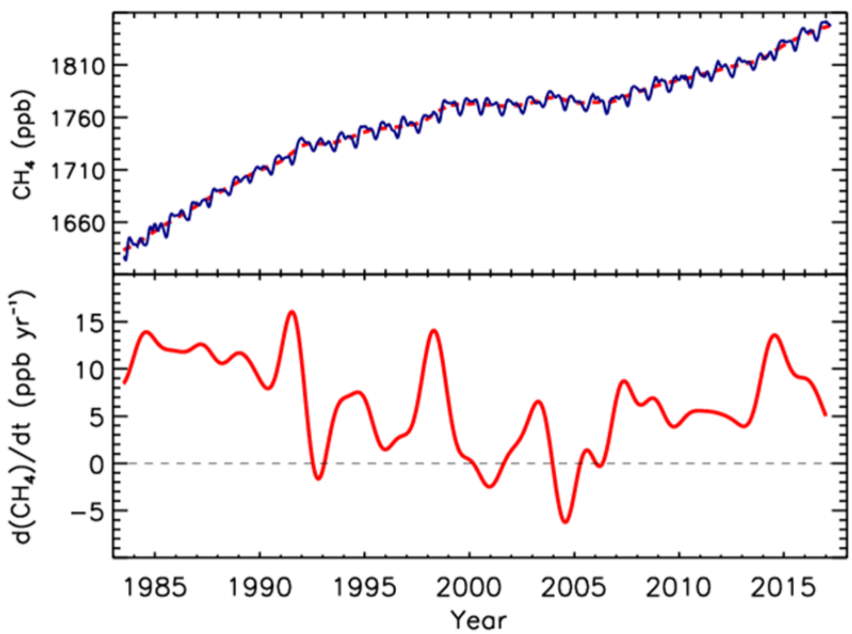
Interested in learning more? Check out these Web links:

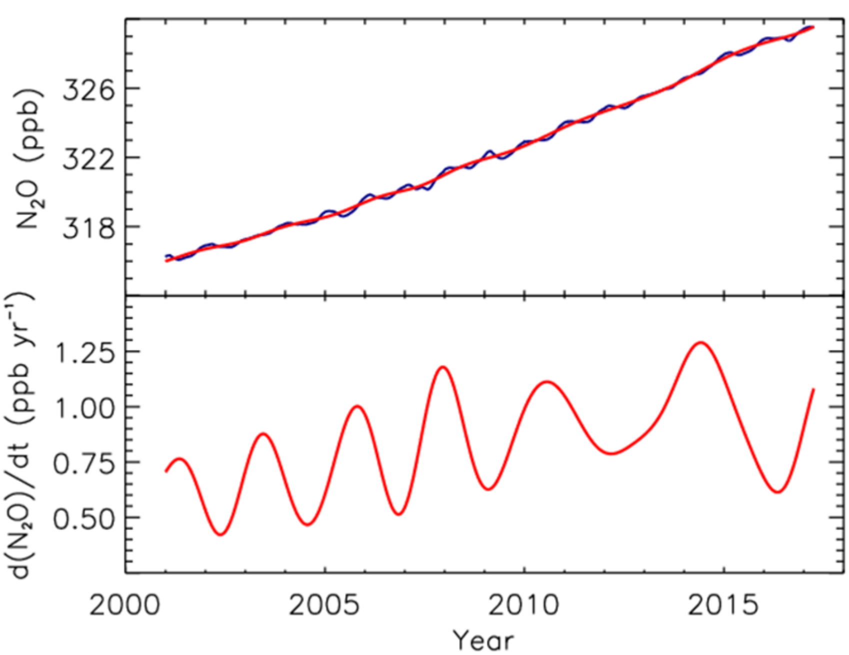
GMD home page: www.esrl.noaa.gov/gmd/

CCGG home page: www.esrl.noaa.gov/gmd/ccgg/

Cooperative Network: www.esrl.noaa.gov/gmd/ccgg/flask.php


CO_2 (ppm)
410
390
370
350
$d(CO_2)/dt$ (ppm yr^{-1})
3
2
1
1980
1990
2000
2010
Year


CH_4 (ppb)
1810
1760
1710
1660
$d(CH_4)/dt$ (ppb yr^{-1})
15
10
5
0
−5
1985
1990
1995
2000
2005
2010
2015
Year


N_2O (ppb)
326
322
318
$d(N_2O)/dt$ (ppb yr^{-1})
1.25
1.00
0.75
0.50
2000
2005
2010
2015
Year