NOAA ESRL
Global Monitoring Division
Issue 3: June 2008

The Cooperative Global Air Sampling Network Newsletter from the Carbon Cycle Greenhouse Gases (CCGG) Group

Greetings to cooperating partners and network affiliates! Thank you for your diligent work in collecting air samples over the last year. We would like to welcome the newest addition to the global network: Lac La Biche, Canada.

Included with this newsletter is a six panel plot showing carbon dioxide (CO_2), $\delta^{13}C$ isotope of CO_2, methane (CH_4), carbon monoxide (CO), nitrous oxide (N_2O), and sulfur hexafluoride (SF_6) for 2000-2007. The time series in the plot contain signals due to processes occurring on large spatial and time scales.

For example, the increase in CO_2 and decrease in $\delta^{13}C$ are due primarily to CO_2 emissions from combustion of fossil fuels. $\delta^{13}C$ represents the ratio of the isotopes $^{13}C/^{12}C$ in CO_2. CO_2 from fossil fuels is depleted in ^{13}C relative to the modern atmosphere. The near mirror image seasonality of CO_2 and $\delta^{13}C$ in the northern hemisphere is due to the seasonal imbalance between photosynthesis and respiration by plants on land. In spring and summer, when photosynthetic uptake exceeds respiration, CO_2 is removed from the atmosphere. Plants discriminate against $^{13}CO_2$, so the atmosphere becomes relatively enriched in ^{13}C. When respiration exceeds photosynthesis, CO_2 enriched in ^{12}C is returned to the atmosphere. Simultaneous measurements of atmospheric CO_2 mixing ratio and $\delta^{13}C$ of CO_2 constrain quantitative estimates of the marine and terrestrial sinks for fossil fuel CO_2 since marine discrimination is very small.

After increasing by more than a factor of 2 since pre-industrial times, the rate of increase of CH_4 has been essentially zero since 1999. This pattern was broken in 2007 with a positive CH_4 growth rate due to either increasing emissions or decreasing sinks. CO, which has the shortest lifetime of the gases measured in these air samples, shows no significant trend in recent years. N_2O and SF_6, both infrared absorbing ("greenhouse") gases, are increasing steadily at 0.7 ± 0.1 ppb yr^{-1} and 0.21 ± 0.01 ppt yr^{-1}. The main cause of N_2O increase is agricultural use of nitrogen fertilizers. SF_6 is primarily used as an insulator in electrical switches and atmospheric SF_6 measurements are often used as a tracer for anthropogenic influence on air masses and also as a constraint on atmospheric transport models.

CCGG Analysis System

The CCGG Group needs an analytical system for measurements of its network air samples that is flexible, accurate, precise, robust, and highly automated. The requirements for precision and accuracy are dictated by the scientific problems that the measurements address. For example, the international measurement community working through the World Meteorological Organization (WMO) has agreed that CO_2 measurements should be consistent to within 0.1 ppm (parts per million) out of a total of about 385 ppm. Standards are also set for the other gases we measure.

Our greenhouse gas analysis system (named MAGICC for Measurement of Atmospheric Gases that Influence Climate Change) is based on commercial analyzers that were optimized by CCGG staff to perform better than their manufacturers' stated specifications. This system (Figure 1) consists of a custom made sample inlet manifold; a module for drying samples; electronic hardware and software for controlling the system, acquiring data streams, and updating our database; modified commercial analyzers; and standard gases that are used to calibrate the analyzers. We currently measure CO_2, CH_4, CO, molecular hydrogen (H_2), N_2O, and SF_6. A typical analysis day starts with a pre-analysis check to "warm-up" the analyzers. Following that, flask samples are typically analyzed in batches of eight, the maximum the inlet manifold can handle. Each batch takes about 2 hours, and each measurement of an air sample is bracketed by measurements from our standards. At the end of the day, typically after analysis of about 36 flasks, the program that controls the system is stopped and the data are saved to the database.

With this system we can repeatably measure SF_6, an extremely powerful greenhouse gas, which, in the atmosphere, is only 1 in every 200 billion molecules, to 1%. For other more abundant gases, we repeatably measure them to 0.05% or better. In 2007, we made more than 9,000 high quality measurements for each of 6 different compounds from the samples collected in our cooperative air sampling network. Despite the effort we've put into the measurements, our project depends on our partners in the field who conscientiously go out every week and collect the samples.

Thank you again for your contribution to this project!

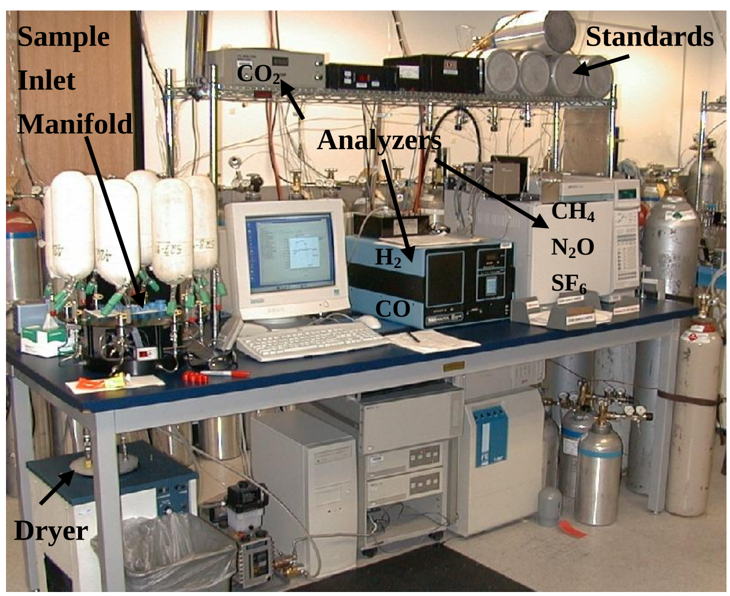


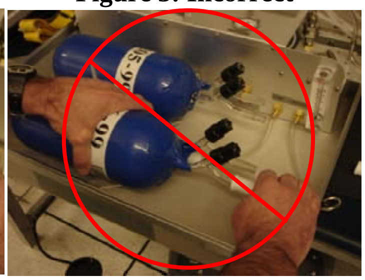
Figure 1: The CCGG analysis system in Boulder, Colorado, consisting of a sample inlet manifold; a module for drying samples; electronic hardware and software; modified commercial analyzers; and standard gases that are used to calibrate the analyzers.

Sampling Tip

The two photos below show the correct (Fig. 2) and incorrect (Fig. 3) places to hold flasks when attaching Teflon connectors and closing valves. When making the connections, hold the stopcock with your left hand, and use your right hand to gently push and twist on the connector. Hold the stopcock in the same way when closing valves. This reduces the chance of breaking flasks and cutting your hand on glass. The incorrect way puts excessive strain on the flasks, which can cause breakages and injuries.

Figure 2: Correct

Figure 3: Incorrect



International Polar Year

Though actually two years in length, the period from March 2007 to March 2009 has been designated as an International Polar Year (IPY), an extensive program of scientific research focused on the Arctic and Antarctic. This IPY is the fourth such international collaboration on conducting research in the Polar Regions. The first IPY was the inspiration of an Austrian naval officer, explorer, and scientist who was a co-commander of the Austro-Hungarian Polar Expedition in 1872-74. Lt. Karl Weyprecht realized that answers for the fundamental questions of meteorology and geophysics would most likely be found near the Earth's poles. He also understood that a task of such magnitude could not be undertaken by one nation alone; rather, this would require a coordinated international effort. Twelve countries participated in the first IPY; 40 countries participated in the second IPY (1932-33); and 67 countries were involved in the third such collaboration, although this one was named the International Geophysical Year (1957-58). The current IPY involves over 200 projects being conducted by thousands of scientists from over 60 nations, maintaining the legacy of international scientific collaboration from the first IPY.

In a time of very abrupt climate change in the Arctic, areas of IPY study include a wide range of physical, biological, chemical and social research topics. The CCGG group has air samples being collected at four Antarctic sites and six to nine Arctic sites, depending on whether defining the Arctic based solely on being north of the Arctic Circle, or based on climate and ecology. These sites are located in Canada, Finland, Greenland, Iceland, Norway, the Norwegian Sea, and the United States. Although these sites are part of a long-term, ongoing monitoring program and are not funded by special IPY monies, the data from these samples will be studied as part of the larger IPY effort. As part of an official IPY project, NOAA is working with Russia's Roshydromet and the Finnish Meteorological Institute to set up a new observatory in Tiksi, Siberia. For further information about IPY, see www.ipy.org.

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Spotlight

A typical week may have Beth Anderson feeding cows, irrigating fields, and artificially inseminating heifers at her family's fifth generation cow-calf ranch in Callao, Utah. A typical week for Beth also has her collecting an air sample for the CCGG group's sampling network. Beth's father, David Bagley, began collecting weekly air samples in 1993, a job that Beth took over in 1995 when she moved back to the family ranch with her husband and five children. In the 13 years since, she has gone out weekly and collected well over 600 samples. For this dedication, Beth is being recognized as one of NOAA's Environmental Heroes, an award bestowed upon a select few volunteers each year.

The Anderson family ranch is located at an oasis between the Great Salt Lake Desert and the Deep Creek Mountains. The natural springs and meadows there made it a prime location for growing hay, so an obvious choice for the family's first-generation ranchers, as well as for Overland Stage and Pony Express stations in the mid-1800s. On sample collection days, Beth often adds notes about the weather on her sample sheet, for example "very, very hot", "dusty", "rain (yeah!)", "icy cold", and then in May "beautiful spring day". One of her more memorable sample collecting experiences was when a "horrible west wind" snatched up her sample sheet and blew it across their fields. She chased the sheet across the property, eventually recapturing it after about five minutes. She noted with a laugh that the flasks got an especially long flush that day before being filled.

Congratulations and thank you to Beth for her many dedicated years of volunteer service!

If you have Internet access and are interested in learning more about GMD's projects, you may check these Web links:

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

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

Cooperative Air Sampling Network home page: www.esrl.noaa.gov/gmd/ccgg/flask.html

Interactive Data Visualization home page: www.esrl.noaa.gov/gmd/ccgg/iadv

Thank you sample collectors and network affiliates!