NOAA ESRL
Global Monitoring Division
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The Aircraft Air Sampling Network Newsletter from the Carbon Cycle Greenhouse Gases (CCGG) Group

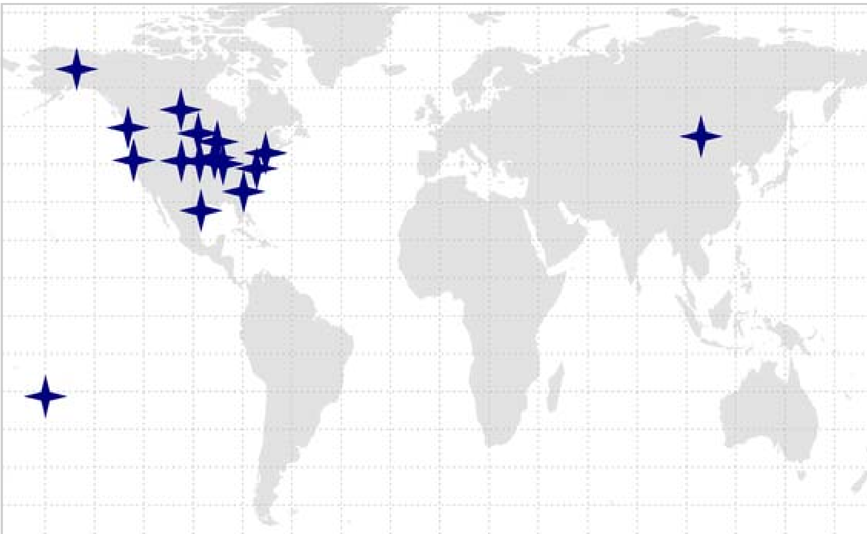

Figure 1: Map showing locations of current CCGG aircraft sampling sites

Welcome to the second issue of the NOAA Carbon Cycle Greenhouse Gases Group's newsletter for the pilots and collaborators in our aircraft sampling network. Thank you for your ongoing work on behalf of this important project!

Figure 1 shows a map of all our current aircraft sampling sites. While budget cuts have forced us to discontinue some sites and decrease the frequency of sampling at other sites, you continue to collect quality data for use in valuable climate-related research.

With this newsletter, we are including an updated plot with data from the air samples collected at your site, including data from the start of sampling flights through the present. The black diamonds represent the date and altitude of samples. The colors represent the concentrations of carbon dioxide (CO_2) in parts per million (ppm), with CO_2 values being interpolated between sampling altitudes.

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 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 carbon dioxide (CO_2) measurements should be consistent to within 0.1 parts per million (ppm) in air that has an average concentration of 385 ppm CO_2. 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 2) 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. Aside from CO_2, we also measure methane (CH_4), carbon monoxide (CO), molecular hydrogen (H_2), nitrous oxide (N_2O), and sulfur hexafluoride (SF_6). During the day, samples from the surface network are analyzed on the MAGICC system because these samples require more handling by analysis staff. At the end of the work day, programmable flask packages (PFPs) from aircraft and tower sites are connected to the analysis system for measurement. Up to six PFPs can be connected to MAGICC and analyzed in an automated fashion throughout the night, with the run time for each PFP being 3.5 hours.

MAGICC brackets measurements of each air sample with measurements of known reference gases. 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 2008, we made nearly 17,000 high quality measurements for each of six different compounds from the samples collected at surface, aircraft and tower sites. Despite the effort we've put into the measurements, our project could not exist without our partners in the field who conscientiously go out regularly and collect the samples. Again, thank you for your efforts!

Figure 2: The CCGG analysis system in Boulder, Colorado, consists of a sample inlet manifold; a module for drying samples (behind the PFPs); electronic hardware and software; modified commercial analyzers; & gases for calibration of the analyzers.

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 the ground surface 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. Additionally, samples have been collected via aircraft for 10 years above Poker Flat Research Range, a rocket launching facility north of Fairbanks, Alaska. 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. For further information about IPY, see www.ipy.org.

As part of an official IPY project, the CCGG aircraft group has modified 25 of their programmable flask packages (PFPs) for use on the HIPPO mission, a pole-to-pole air monitoring mission being conducted aboard a specially outfitted Gulfstream V owned by the National Science Foundation and the National Center for Atmospheric Research. For more about HIPPO, see www.eol.ucar.edu/deployment/field-deployments/field-projects/hippo_global

British Antarctic Survey Twin Otter over Gerlache Strait, Antarctica

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Please include the following information on all your invoices: **1)** Date of flight **2)** Flight hours **3)** Tail number **4)** Name(s) of pilot(s) **5)** If samples were not collected because of equipment failure or similar.

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To learn 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

Look for an update soon!

Aircraft Air Sampling Network: http://www.esrl.noaa.gov/gmd/ccgg/aircraft.html

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

Thank you!

Fossil Fuel CO_2

We know that increasing CO_2 in the atmosphere is caused by emissions of CO_2 from fossil fuel combustion, but it is difficult to measure exactly how much fossil fuel CO_2 is being emitted. Until recently, the only method for determining how much carbon dioxide is produced from fossil fuel burning was "economic inventories", whereby governments and industry report how much oil, coal and natural gas they buy and sell each year. The amount of CO_2 released is calculated from these reports. We are using our aircraft and surface networks to obtain independent estimates of these emissions.

To do this, we use a novel application of radiocarbon dating, turning this well-known technique for determining the age of organic materials on its head. CO_2 is a mixture of two components: (a) natural CO_2 (from respiration by plants, animals and soils, and from oceans), with a radiocarbon age of about zero; and (b) CO_2 from fossil fuel burning, & this CO_2 is the same age as the fossil fuels it came from - millions of years old. By measuring the radiocarbon age of the CO_2 mixture, we can calculate how much comes from each component, & hence how much CO_2 is produced by fossil fuel burning.

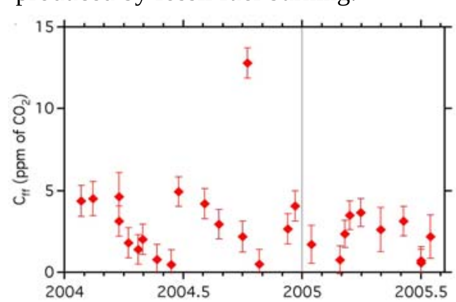

Figure 3: Radiocarbon data

Figure 3 shows some of our measurements of fossil fuel CO_2 from aircraft samples collected at the lowest sampling level over Harvard Forest, New England. Because of the difficult nature of the radiocarbon measurement, we combine two flasks from the same altitude to provide enough air for this measurement. The values are the amount (in ppm) of recently added fossil fuel CO_2 in each sample. The value varies depending on atmospheric conditions and where the air has come from. High values indicate air from polluted regions, such as nearby urban areas, whereas low values indicate "clean" air.