NOAA Earth System Research Laboratory
Global Monitoring Division
Carbon Cycle Greenhouse Gases (CCGG) Group
Issue 3: November 2010

Aircraft Air Sampling Network Newsletter

Welcome to the third 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 our current and past aircraft sampling sites in North America. 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.

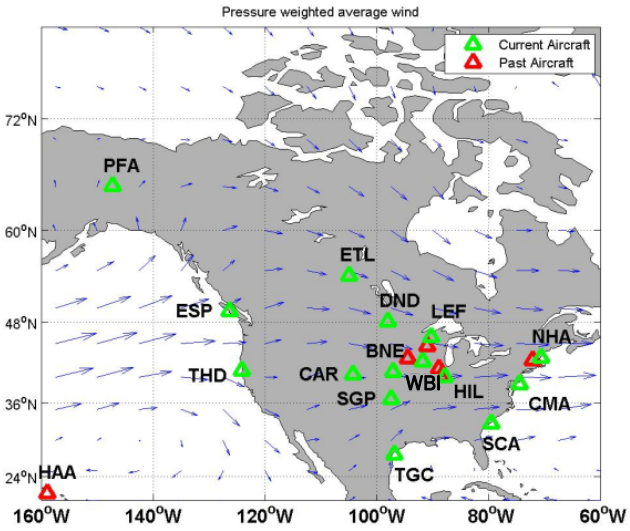


Figure 1: Aircraft network in North America

The Greenhouse Effect & Climate Change

The sun drives the Earth's climate by emitting energy in the form of solar radiation, mostly visible and ultraviolet (UV), also known as shortwave radiation. Approximately 30% of this radiation is reflected back out to space, about 20% is absorbed by the atmosphere, and the remaining half is absorbed at the Earth's surface. The energy absorbed by the surface is then emitted back into the atmosphere in a different form, known as infrared or longwave radiation. Greenhouse gases such as water vapor, carbon dioxide (CO_2), and methane (CH_4), absorb most of this infrared radiation and then reemit it in all directions—toward space, to other greenhouse gas molecules, and/or back to Earth's surface. This process, known as the greenhouse effect, prevents heat from escaping our atmosphere, thereby warming the lower stratosphere and the Earth's surface (Figure 2). This is a naturally occurring process and is vital to the survival of many species on Earth. Without the additional heat provided by the greenhouse effect, our planet's temperature would be ~33° C / 57° F cooler, similar to the moon.

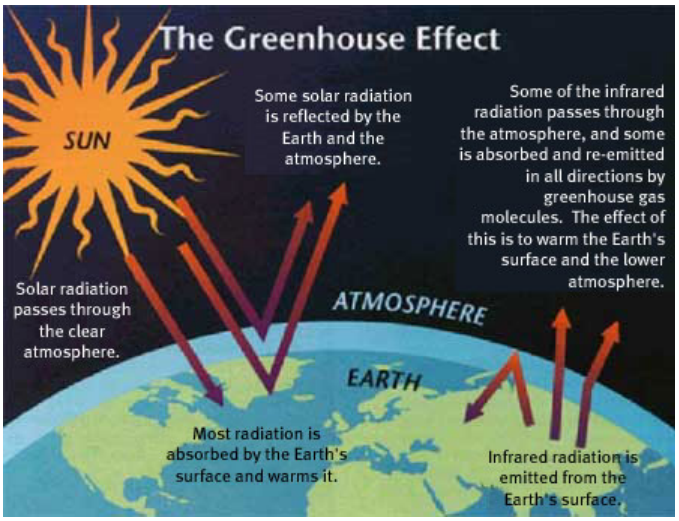


Figure 2: The basic principles of the Greenhouse Effect

Although greenhouse gases have made the earth habitable, rapidly rising concentrations since the industrial revolution have brought about enhanced warming and global climate changes. Over the past 700,000 years, global CO_2 concentrations naturally fluctuated between approximately 180-280ppm. Since the 1800s we have seen surface CO_2 concentrations rise from ~280 ppm to over 380 ppm today. This has been accompanied by increasing land and sea temperatures, shrinking sea ice and glaciers, rising sea levels, changing precipitation patterns resulting in more floods and droughts, and endangered and threatened plant and animal species.

Since the late 1960s, NOAA has been measuring air samples from all over the world to monitor concentrations of greenhouse gases. Every sample collected helps us better understand how the greenhouse gas concentrations are changing over time, where these gases come from, and how they are removed from the atmosphere. In addition to our aircraft network, we have surface and tall tower networks, which together monitor atmospheric changes from the surface to the lower stratosphere. Samples coming from all over the world from people like you make our monitoring program possible. We thank you for your efforts in helping to understand Earth's changing atmosphere and climate.

Arctic Collaboration with the United States Coast Guard

The Arctic is of intense interest these days when it comes to discussions of climate change. This part of the world is subject to extremes of incoming solar radiation throughout the year, areas north of the Arctic Circle seeing little to no sun during the winter and 24 hours of daylight during summer. Across the globe, varying amounts of incoming solar energy are reflected or absorbed by the earth's surface depending on its albedo (a measure of reflectivity). Snow and ice have a higher albedo than bare ground or open ocean, so more solar energy is reflected back out to space from the Arctic and Antarctic as compared with most other regions. Unlike the Antarctic, however, the Arctic is undergoing rapid changes in albedo as the sea ice extent of the Arctic Ocean shrinks, which allows more solar radiation to be absorbed by the open ocean. Diminished sea ice cover also allows more heat to later be emitted back into the atmosphere during the cold season; this serves to warm the Arctic atmosphere during autumn and winter, which both warms land areas and inhibits new sea ice formation. For these reasons, the Arctic is seeing much more pronounced increases in temperature than any other part of the world.

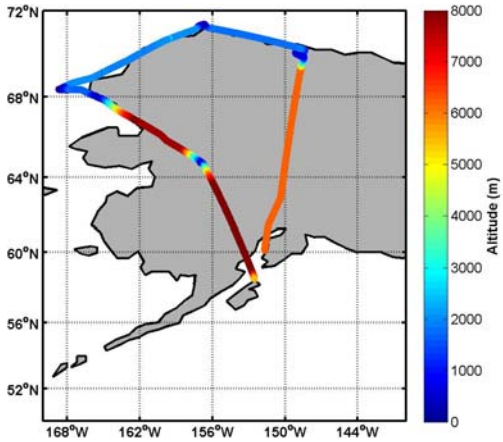
Several years ago the US Coast Guard based at Air Station Kodiak began regular C130 flights to monitor the changing coastline of northern Alaska. Their mission goals include reconnaissance for marine safety, search and rescue, pollution response, fisheries law enforcement, waterways management and maritime security. In addition, they offered up "science of opportunity" space on these flights. The Carbon Cycle Group's Aircraft Program jumped at the opportunity to instrument these flights with atmospheric monitoring equipment. Because this is a much larger platform than the group's standard small aircraft operations, the project allowed for a wider array of onboard instruments including those that continuously measure carbon dioxide, methane, ozone, temperature and humidity, as well as the standard flask packages used for air sample collection on our network's smaller aircraft.


Coast Guard C130 used for Arctic monitoring flights

Specially designed window replacement for inlets

Flights vary depending on the USCG's mission on a given day, but the March-to-November biweekly sampling flights often depart from Kodiak in the south, perform an altitude profile over Galena south of the Brooks Range, descend again over Kivalina, continue at low altitude to Barrow and sometimes Prudhoe Bay before a high-altitude return to Kodiak.

Though the collaboration has only been going on for two seasons, the data collected during these flights are quite fascinating. Results have given a very good, large-scale picture of greenhouse gases over Alaska, with carbon dioxide showing a strong seasonal gradient and methane showing a strong spatial gradient. Overall this has proven to be a very valuable contribution to NOAA's monitoring of the changing Arctic atmosphere. The Carbon Cycle Group has been extremely appreciative of the Kodiak Coast Guard crewmembers' efforts to facilitate this collaboration. For more on this project, please visit: http://esrl.noaa.gov/gmd/ccgg/aircraft/alaska.html



Typical Coast Guard sampling flight path and altitude pattern

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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.

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

New Aircraft Program website!
Please visit our recently updated website to learn more about the network, the equipment we use, sample measurements, data, special projects & more.