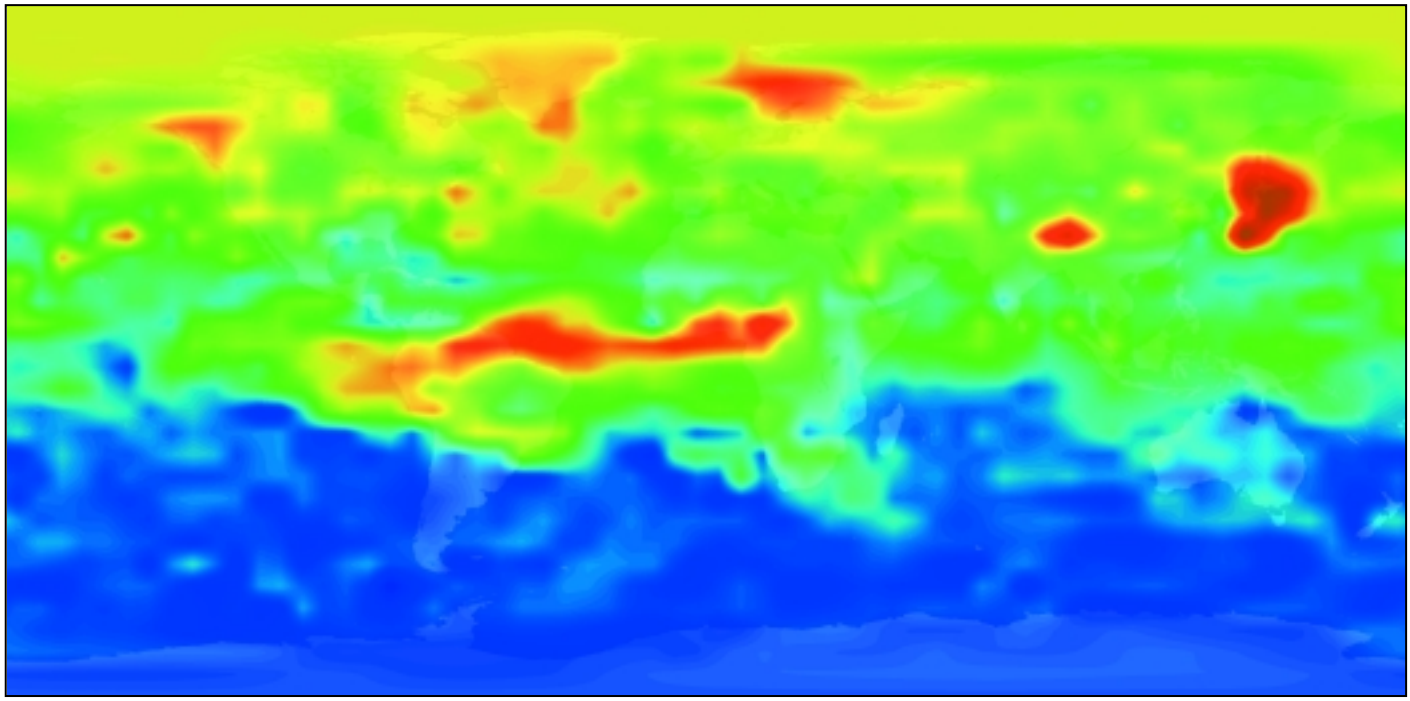
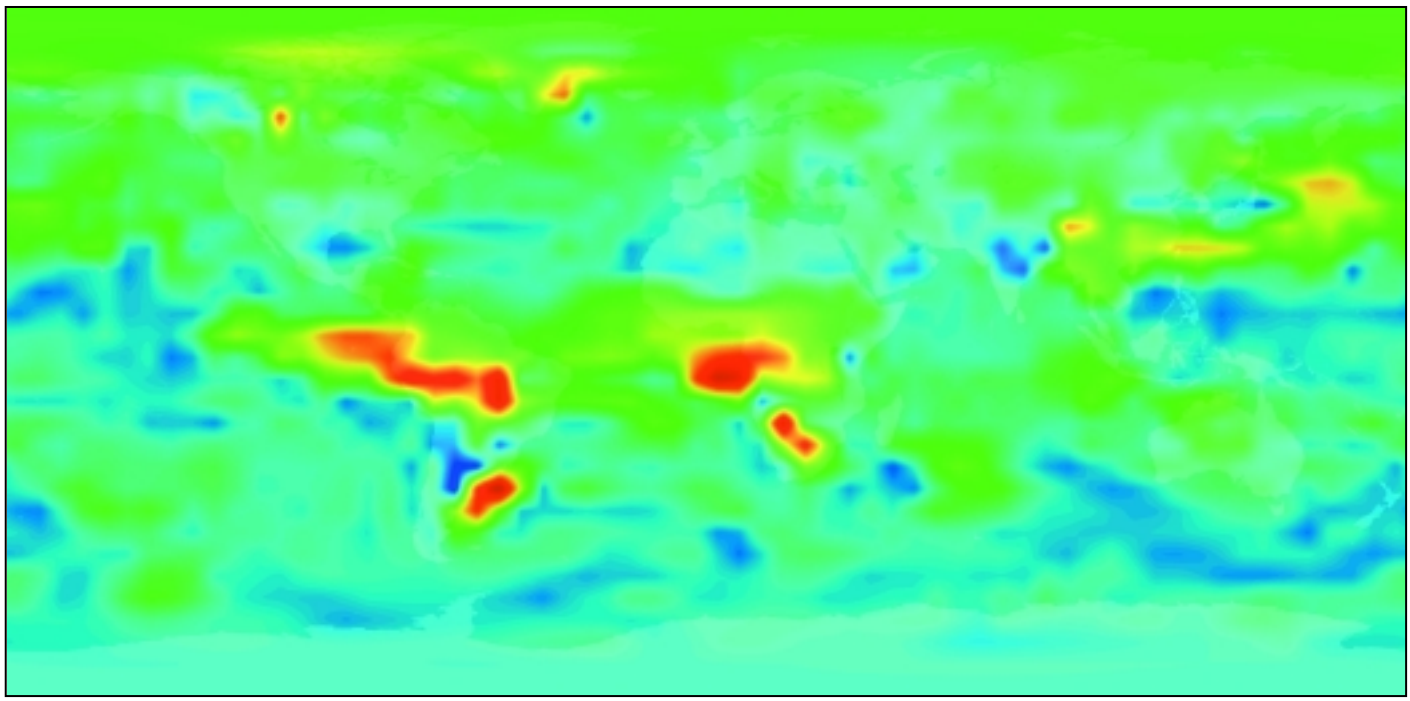
National Aeronautics and
Space Administration

Goddard Space Flight Center

Measurements of Pollution in the Troposphere (MOPITT)



March 23, 2000



October 23, 2000

Carbon Monoxide Concentrations (parts per billion)

50 220 390

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About These Images

The most complete view ever assembled of the world's air pollution has been produced by the Measurements of Pollution in the Troposphere (MOPITT) instrument onboard NASA's Terra spacecraft. For the first time, scientists have a powerful new tool to track massive clouds of air pollution, shown in red, as they travel across the Earth. The observations represent a powerful new tool for identifying and quantifying pollution sources and for observing the transport of pollution on international and global scales.

These images show global concentrations of carbon monoxide (CO) at altitudes of 15,000 feet. Red colors in these images indicate high levels of CO—220 parts per billion (ppb) or more. Blue colors indicate low levels of CO—50 ppb.

Much of the air pollution that humans generate comes from sources such as smoke from large fires that travels great distances and affects areas far from the source. The most dramatic features in the global observations on March 23, 2000 and October 23, 2000 are the immense clouds of carbon monoxide from grassland and forest fires in Africa and South America.

In March 2000, CO from fires burning in equatorial Africa is carried across the Atlantic Ocean to South America and beyond out over the Pacific Ocean by equatorial easterly winds (blowing from east to west). In October 2000, large plumes of CO are present over South America and the west coast of Africa as a result of the fires burning in Amazonia and western Africa. In the following months, mid-latitude westerly winds transported portions of the CO plumes rapidly across the Southern Hemisphere for thousands of miles, reaching as far as Australia and New Zealand. The movements of CO around the globe are particularly striking when viewed as an animation at http://earthobservatory.nasa.gov/Newsroom/NewImages/Images/mopitt_first_yeara.mpg.

Although MOPITT cannot distinguish between individual industrial sources in the same city, it can map different sources that cover a few hundred square miles. This is accurate enough to differentiate air pollution from a major metropolitan area, for example, from a major fire in a national forest. About half of the global emissions of carbon monoxide are a result of human activities.

MOPITT sees carbon monoxide in the atmosphere from 2 to 3 miles above the surface, where it interacts with other gases and forms ozone, a greenhouse gas that is a human health hazard at ground levels. This pollutant can move upward to altitudes where it can be blown rapidly for great distances or it can move downward to the surface.

Carbon Monoxide In The Atmosphere

Carbon monoxide is a colorless, odorless gas that is present in the lower atmosphere at a concentration of about 100 ppb depending on the geographic location. "Clean" areas may show concentrations as low as 50 ppb, whereas polluted areas may have much higher concentrations. At very high levels, CO is poisonous.

CO is produced by a number of processes, almost all of which happen at or near the ground. Some of these sources are natural while others, such as fossil fuel consumption and biomass burning, are connected with human activity. Total planetary production of CO is estimated at between two and five gigatons (giga=1 billion) per year. The major loss, or "sink" of carbon monoxide occurs through its reaction with the hydroxyl (OH) radical. In addition to converting CO to carbon dioxide (CO_2), a prominent greenhouse gas, the OH radical is also a key participant in the destruction and removal of the greenhouse gas methane (CH_4). CH_4 itself is important in the chemical cycle of stratospheric ozone.

As the amount of carbon monoxide in the atmosphere increases, its reactions with the OH radical may increase accordingly. This may leave less OH available to break down and remove greenhouse gases from the atmosphere. Therefore, increases in carbon monoxide levels may cause subsequent decreases in OH levels, which can have long-term consequences on stratospheric ozone and the levels of various greenhouse gases, potentially influencing the Earth's climate.

The average lifetime of a CO molecule is quite variable, but on average is on the order of a few weeks. Since it takes much longer than that for a chemical to completely mix throughout the lower atmosphere, the distribution of CO concentrations show the locations of the sources. The major sink is weak and very widespread, and has no distinctive pattern. Thus, using advanced mathematical models it is possible not only to locate the sources of CO, but also to estimate their distribution. In addition, by monitoring how the patterns of CO concentration change with time, scientists can build up an understanding of how the atmosphere transports this and other chemicals from one area of the planet to another.

About MOPITT

The new global air pollution monitor onboard Terra is the innovative Measurements of Pollution in the Troposphere, or MOPITT experiment, which was contributed to the Terra mission by the Canadian Space Agency. The instrument was developed by Canadian scientists at the University of Toronto and built by COM DEV International of Cambridge, Ontario. A team at the U.S. National Center for Atmospheric Research (NCAR) processed the data. MOPITT is an infrared gas correlation radiometer that is making the first long-term global observations of carbon monoxide and methane as Terra circles the Earth from pole to pole, 14.4 times every day. From these measurements the sources, motions and sinks of CO can be determined.

For the Classroom

Human Impact

Carbon monoxide is a gaseous byproduct from the burning of fossil fuels, in industry and automobiles, as well as burning of forests and grasslands. Notice in the March 23, 2000 image that levels of carbon monoxide are much higher in the Northern Hemisphere as compared to the Southern Hemisphere. Speculate on why such a large difference exists. *Answer: Human population and industry is much greater than in the Southern Hemisphere.* However, in the October 3, 2000 image notice the immense plumes of the gas in the areas around South America and Southern Africa. Speculate on why these high-concentration plumes exist. *Answer: CO is being emitted from forest and grassland fires burning in the rain forests.*

Resources

Terra Website: http://terra.nasa.gov
NASA's Earth Observatory: http://earthobservatory.nasa.gov
NASA Goddard Space Flight Center on-line News Releases: http://www.gsfc.nasa.gov/GSFC/EARTH/Terra/co.htm

Image Credit: MOPITT Science Team, National Center for Atmospheric Research, Boulder, Colorado.

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