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Nature's contribution [1]

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August 31, 2006

Around the world, ash and thick smoke from wildfires can choke the surrounding skies. While this visible, murky mess seems to disappear with distance from the fires, polluting gases and small particles not visible to the human eye drift upward and are carried away by global air currents. Can large wildfires contribute to smog problems in distant places? Gabriele Pfister, a researcher at the National Center for Atmospheric Research in Boulder, Colorado, is part of a team that confirmed wildfire-generated pollution can indeed be an intrepid--if unwelcome--global tourist.

Researchers investigate how much wildfires contribute to pollution, and how far this pollution can travel.

- About the data used
- About Langley Atmospheric Science Data Center (LaRC) DAAC [2]

Feedback

The 2004 Alaskan wildfire season was the worst on record, largely because of unusually warm and dry weather. Throughout central Alaska and Canada's Yukon Territory, more than eleven million acres burned, or an area equivalent to the states of New Hampshire and Massachusetts together. During this wildfire season, Pfister took part in an international study of pollutant drift, the International Consortium for Atmospheric Research on Transport and Transformation (ICARTT).

The researchers noticed that concurrent with the fires, numerous observing systems detected increases in pollutants from North America all the way to Europe. This extreme fire season posed an opportunity for researchers. "We wanted to study wildfires in boreal areas," Pfister said. "The contribution of boreal forest fires to pollution is not yet well understood. Do they produce significant amounts of tropospheric ozone?"

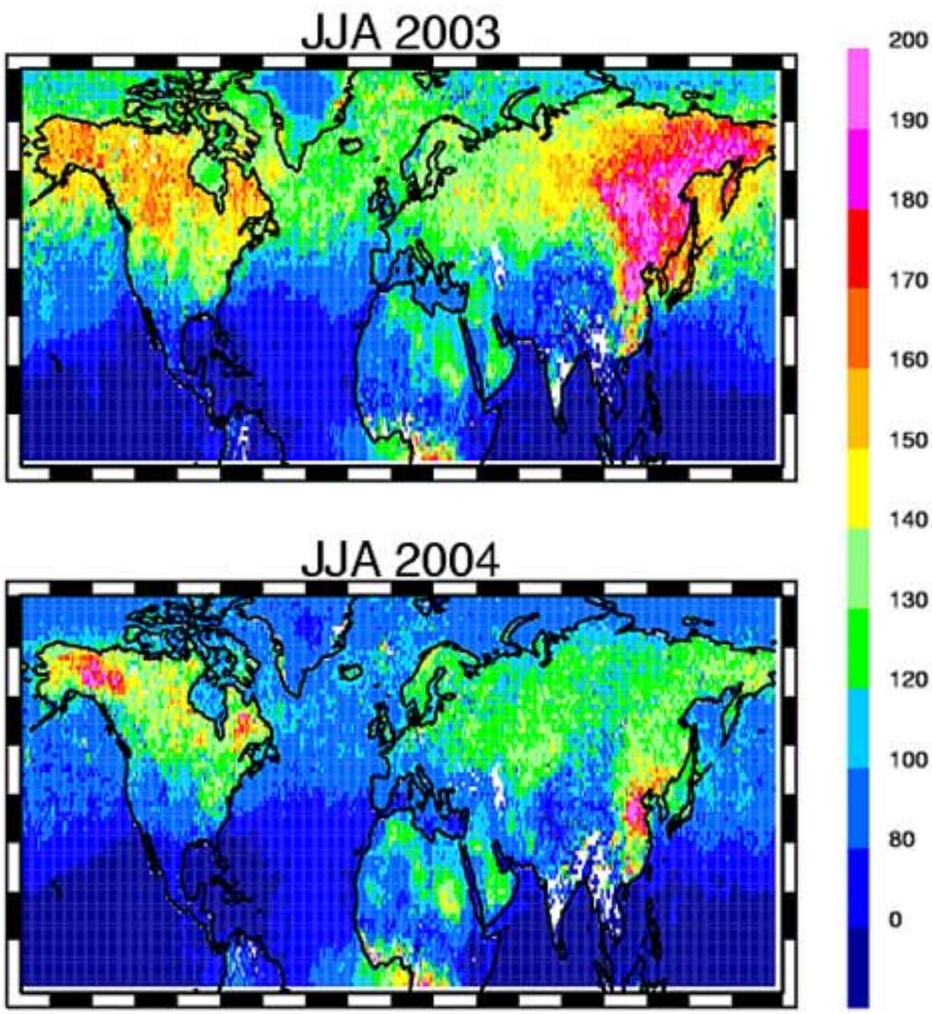
Identifying fire-generated pollutants

Wood smoke from large wildfires in central Alaska led to near-zero visibility in South Fairbanks on June 28, 2004. (Photograph by Dr. James Conner, courtesy Fairbanks North Star Borough)

As forests burn, and their underlying, thick peat layer of partially decayed plant matter also burns, they emit highly visible pollution in the form of smoke, soot, and ash. But the fires also generate other harmful pollution. "Fires can affect air quality," Pfister said. "Species emitted by the fires--pollutants such as carbon monoxide, nitrogen oxides, and volatile organic compounds--might cause a significant increase in ozone levels, even far downwind from the fires." Unlike ozone in the stratosphere, which protects us from ultraviolet radiation, high levels of ozone in the troposphere, closer to ground level, can injure or destroy living tissue.

Imagine the challenge of tracking a carbon monoxide molecule as it travels thousands of miles around the Earth, several miles above the surface, drifting and mixing with carbon monoxide from other sources. To track the Alaska and Yukon fire pollutants, Pfister's team designed a unique combination of established methods, including remote-sensing data from satellite instruments, and data modeling. The team needed a way to distinguish fire-generated carbon monoxide from other sources of the gas.

Combining several remote-sensing and modeling approaches produced a sharper picture of the pollution from the fires. "The first step is to know how much carbon monoxide is emitted from the fires," explained Pfister. The team determined a first estimate of fire location and emissions using fire area and vegetation data from the Moderate Resolution Imaging Spectroradiometer (MODIS), a remote sensing instrument on NASA's Earth Observing System Aqua and Terra satellites. Actual measurements of carbon monoxide were obtained from Terra's Measurements of Pollution in the Troposphere (MOPITT), data distributed by the NASA Langley Atmospheric Science Data Center Distributed Active Archive Center (LaRC DAAC). The MOPITT data have been key to helping researchers better understand pollution in the Earth's atmosphere system, including pollutant transport. Using an atmospheric chemical transport model named the Model for Ozone and Related Chemical Tracers (MOZART), the researchers calculated the transport of the emissions to tie in with the MOPITT observations.



The images above show examples of the Northern Hemispheric Measurements of Pollution in the Troposphere (MOPITT) carbon retrievals, indicating carbon monoxide levels in the atmosphere. "JJA" stands for June, July, August. The summer 2003 image includes the large fires in Siberia; warm colors show how the fires increased carbon levels over North America.

The summer 2004 image shows the strong signal from the Alaska/Canada fires. (Courtesy Gabriele Pfister/NCAR)

Measuring the impacts of the fires

The photograph above and in the title graphic shows smoke rising from the Chain Lakes fire on June 27, 2004, in Yukon Territory, Canada. (Image in title graphic and in photograph above courtesy Government of Yukon 2006)

Feedback

Using the emissions and transport estimates, together with actual pollution data, the team was able to calculate the amount of Alaskan wildfire pollution and how it affected large parts of the Northern Hemisphere. "We were surprised to learn the magnitude of the fires and their impact," Pfister said. From June through August, the fires produced approximately thirty teragrams of carbon monoxide, roughly equal to all the human-generated carbon monoxide for the entire continental United States during the same period. Their study estimated ground-level ozone increased by up to twenty-five percent in the northern continental United States, and by up to ten percent in Europe.

Pfister believes that continuing studies of boreal forest fires are needed to answer many remaining questions. One task, for example, is to refine estimates of peat burning. "At northern latitudes, fire emissions might include a large contribution from peat fires," Pfister said. "Many fire models do not yet include peat burning, but burning peat and burning forest emit different pollutants and, as a result, produce ozone differently."

Pfister hopes that her work will contribute to a better understanding of air pollution sources. "It's important to know what wildfires contribute to pollution, so that we can accurately measure the impacts of nature and of human activity on air quality," Pfister said. "Plus, human-induced climate change might cause an increase in intensity and frequency of wildfires, as other studies have indicated." The fire season of 2004 made a significant contribution to pollution levels during certain time periods. But humans far outweigh nature as a polluter, because our contributions do not come from isolated events. "It's important that people don't dismiss the significance of human activity," Pfister said, "because our contribution to pollution is year round."

References

2004 wildland fire season summary [3].
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Global chemical transport modeling: Model for ozone and related chemical tracers (MOZART) [4].
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Tropospheric ozone, the polluter [5].
Boulder, CO: University Corporation for Atmospheric Research. Accessed May 2, 2006.

Related Links

- NASA Langley Atmospheric Science Data Center DAAC [6]
- Measurements of Pollution in the Troposphere (MOPITT) [7]
- Tracking Nature's Contribution to Pollution [8] NASA Earth Observatory

About the remote sensing data used	
Satellite	Terra
Sensor	Measurements of Pollution in the Troposphere (MOPITT)
Data sets	MOPITT Level 2 V3 [9]
Resolution	22 square kilometers
Tile size	North America
Parameter	Carbon monoxide
Data center	NASA Langley Atmospheric Science Data Center (LaRC DAAC [2])
Science funding	NASA

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