A smoke screen for greenhouse warming?

In the drama of global warming, the plot grows more convoluted with each scene. Three atmospheric scientists reported last week that smoke from burning tropical forests and grasslands may exert a strong – but as yet undetermined – cooling force on the climate.

Such findings do not invalidate the theory that human actions are pushing Earth's climate in a warmer direction. But recognition of this effect does complicate the job of predicting the various ways the climate will change, says Joyce E. Penner of the Lawrence Livermore (Calif.) National Laboratory, who studied the smoke question with Robert Dickinson and Christine O'Neill at the University of Arizona in Tucson.

Tiny smoke particles, or smoke aerosols, from burning vegetation in the tropics and equatorial regions can influence the climate in two ways. In what scientists term a direct effect, the particles reflect sunlight back toward space, blocking some of the radiation originally headed toward Earth's surface. In a more indirect fashion, the particles serve as nuclei around which water vapor can condense to form cloud droplets. By increasing the number of droplets, smoke aerosols brighten a cloud, making it reflect more sunlight back toward space.

Scientists have known about these effects in the past, but only recently have they started quantifying the impact of smoke on climate. Penner and her colleagues used an extremely simple mathematical model to estimate smoke's direct and indirect roles. At a meeting of the American Geophysical Union in Montreal, they reported that smoke aerosols could have a globally averaged cooling power of 1 watt per square meter (W/m^2) for the direct effect and 1 W/m^2 for the indirect effect.

Together, these cooling effects would nearly equal the warming power of the greenhouse gases that are building up in the atmosphere. Scientists estimate that carbon dioxide and other heat-trapping gases emitted since the beginning of the Industrial Revolution exert a warming power of roughly 2.5 W/m^2.

Penner and her colleagues realize that their calculations may well contain flaws. The group could have underestimated the influence of black soot, which is produced in the same fires as the smoke particles. Since soot absorbs sunlight, it reduces the net cooling effect of smoke. The researchers may also have overemphasized the indirect cooling from smoke particles.

Robert J. Charlson of the University of Washington in Seattle adds that significant uncertainties also plague estimates of the amount of material being burned each year, a critical number in the calculations.

The report by Penner and her colleagues on smoke aerosols comes at a time when climate researchers have focused attention on a different class of aerosols, those produced by sulfur emissions from fossil fuel combustion. Like the smoke particles, these sulfate aerosols also have direct and indirect cooling power. Charlson and his co-workers recently estimated that the combined effect of sulfate aerosols could cool the climate by 2 W/m^2, averaged over the globe. Their analysis, among others, led the Intergovernmental Panel on Climate Change (IPCC) to emphasize in its recent update that sulfate aerosols may have slowed the rate of global warming (SN: 4/11/92, p.232).

The IPCC update included only a brief mention of aerosols from biomass burning. "We have very few measurements. It's something that needs a lot more investigation to firm up," says Michael C. MacCracken, Penner's boss at Livermore and a participant in the IPCC assessment.

Charlson and Penner agree that sulfate and smoke aerosols probably do not exert a cooling effect of 2 W/m^2 each, otherwise they would have overpowered greenhouse gas emissions, leading to a global cooling. Because temperature records indicate the Earth has warmed over the last century, scientists must consider whether they have overestimated the influence of sulfates or smoke aerosols or both.

While both kinds of aerosols apparently slow the global temperature rise, Charlson argues that they do not protect against climate change. Because greenhouse gases warm the entire globe and aerosols cool only certain regions, the combination will lead to variations in warming – a situation that will eventually alter the climate all over, he says. Even if some places do not warm, they may experience changes in precipitation, the frequency of drought and other climatic phenomena. – *R. Monastersky*

Young scientists honored for prize work

Laura E. Becvar began the studies underlying her new patent-pending technique for spotting potentially toxic pollutants four years ago, when she was 12. Adam R. Healey, 17, has created an inexpensive biosensor for diagnosing Lyme disease. For their accomplishments, the pair carried home a bevy of awards last week from the 43rd International Science and Engineering Fair (ISEF), held in Nashville, Tenn. Chief among each young researcher's winnings: the top, Glenn T. Seaborg prize, a trip to Stockholm, Sweden, next December that includes attending the Nobel Prize ceremonies.

More than 750 high school scientists exhibited research projects – some of them six years in the making – at ISEF, a program administered by Science Service, Inc., in Washington, D.C. These finalists, the winners of nearly 400 affiliated science fairs in 47 U.S. states, American Samoa, Guam, Puerto Rico, Canada, Germany, Ireland, Japan, the Republic of China (Taiwan), Sweden and the United Kingdom, competed for more than 600 additional prizes last week. Though top awards in most categories totaled only $300 to $500, federal, academic and corporate sponsors of some special awards provided their top winners computers, scholarships of up to $20,000 – even shares of company stock.

Becvar's new process places blue-light-emitting bacteria against a chromatogram – a paper-like sheet onto which a mix of chemicals has been physically separated into discrete substances. When the bacteria encounter a toxic chemical, "their luminescence is extinguished," Becvar reports. Affected zones on the chromatogram show up as black spots in photographs of the glowing bacteria. Becvar, now a junior at Coronado High School in El Paso, Texas, has used the technique to identify and quantify a range of toxic substances – including pesticides and heavy metals.

A senior at Paul D. Schreiber High School in Port Washington, N.Y., Healey married a gold-plated quartz crystal to a homemade electronic device. By coating the crystal with protein from the Lyme bacterium, *Borrelia burgdorferi*, Healey created a biosensor that can detect antibodies to this tick-borne microbe.

Antibodies in a drop of blood placed on the sensor bind to the protein. When the blood is rinsed off, the antibodies that remain increase the crystal's mass enough to change its oscillating frequency. Healey found that 88 percent of the time this device proved as reliable at diagnosing Lyme disease as the two most accurate clinical assays.

The European Community (EC) awarded a pair of trips to the Fourth EC Contest for Young Scientists in Seville, Spain. Design of a four-dimensional computer-graphics language brought Jonobie D. Baker, 15, of Theodore Roosevelt High School in Kent, Ohio, one of those trips. Baker was also an alternate for a Seaborg prize. Barnas G. Monteith, 16, of Randolph (Mass.) High School, won the second EC trip for his comparison of the microstructures of bird and dinosaur eggshells. – *J. Raloff*