Cool times ahead for the upper atmosphere

Not all parts of the atmosphere will warm as carbon dioxide and other greenhouse gases accumulate above Earth. A new computer modeling of the upper atmosphere shows that the thin air high above the planet's surface should cool substantially – an effect that may help some satellites stay in orbit longer.

Most climate projections for the next century have focused on how accumulating greenhouse gases will affect the troposphere and the stratosphere, the two layers closest to Earth. This is the first time researchers have used complex computer models to predict the effect on the two highest regions, the mesosphere and thermosphere, says Raymond G. Roble of the National Center for Atmospheric Research in Boulder, Colo. Roble and colleague Robert E. Dickinson discuss their findings in the December GEOPHYSICAL RESEARCH LETTERS.

Their computer simulations suggest that when carbon dioxide and methane reach double their 1970s levels throughout the entire atmosphere, the mesosphere (about 50 to 90 kilometers in altitude) will cool by about 10°C and the thermosphere (90 to 500 km) by 50°C. Simulations by others have indicated that temperatures in the stratosphere (about 12 to 50 km) will also drop as greenhouse gases accumulate, but temperatures in the troposphere (reaching from Earth's surface to 12 km) will rise.

The predicted cooling in the stratosphere, mesosphere and thermosphere stems from carbon dioxide's ability to absorb atmospheric heat-energy and emit it as infrared radiation, Roble explains. As the number of carbon dioxide molecules in the upper atmosphere increases, this region will send more of its heat-energy toward space and therefore will cool.

Closer to home, a doubling of carbon dioxide should warm the troposphere because this layer holds far more carbon dioxide and other greenhouse gases than does the upper atmosphere. In the troposphere, radiation emitted by these gases cannot travel far before it hits another molecule and is absorbed, becoming trapped at that level. In the upper atmosphere, where greenhouse gases are more diffuse, emitted radiation stands a much greater chance of escaping into space.

A cooling in the stratosphere will likely worsen the ozone depletion around Earth's poles. But researchers say they cannot tell what will happen to the planet as a result of a cooling in the mesosphere and thermosphere. "We really are fairly ignorant about a lot of the major processes occurring in that region," says Darrell Strobel, an atmospheric physicist at Johns Hopkins University in Baltimore.

Strobel says some researchers have jokingly used the term "ignorosphere" to describe the mesosphere and the lower portion of the thermosphere, which are too high for research balloons and too low for satellites to study.

Several scientists say an upper-atmosphere cooling could influence certain space missions. As the thermosphere cools, it will contract, pulling the edges of the atmosphere closer to the planet. This should extend the lifetime of low-orbiting satellites, says Roble. As their orbits weaken with time, such satellites slowly descend toward Earth until atmospheric friction eventually knocks them out of orbit. – *R. Monastersky*

Cocaine danger on the road

Nearly one out of four New York City drivers aged 16 to 45 who died in motor vehicle accidents during three years in the mid-1980s had used cocaine within 48 hours of their death, a research team reports. Despite that "fairly remarkable" finding, the scientists say their study may underestimate the true scope of cocaine-related traffic fatalities in New York City and perhaps in other urban areas, such as Miami and Los Angeles, where cocaine use seems endemic.

Peter M. Marzuk and J. John Mann of the Cornell University Medical College in New York City and four colleagues studied New York City medical examiner records for 643 drivers and passengers of all ages involved in fatal accidents from 1984 to 1987. They found the highest rates of cocaine use among younger age groups, but determined overall that 18.2 percent of the accident victims studied showed cocaine or its principal metabolite in blood or urine samples tested during autopsies. In 10 percent of the cases studied, medical examiners had found both cocaine and alcohol in blood and urine samples, the researchers report in the Jan. 12 JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION.

Mann, now at the University of Pittsburgh, suspects cocaine by itself compromises driving ability but says future studies must prove that link. He notes, for example, that cocaine users are more aggressive and take greater risks soon after getting high. However, one previous study found no adverse effects on vigilance and other driving skills soon after cocaine use.

Mann thinks the days following cocaine administration may also pose a risk for users and their passengers. During that period, cocaine users often drink alcohol or take other sedatives to blunt cocaine-induced anxiety – a pattern suggesting alcohol may play some role in traffic fatalities involving cocaine users, Mann says. □

Smog wars: Changing rules, weighing fuels

EPA proposed new rules last week to limit the leading source of hydrocarbon pollution from motor vehicles – emissions of evaporated gasoline trapped in the tank and fuel lines. Agency officials say the rules, which they hope to implement within three years, should reduce U.S. air emissions of volatile organic compounds by about 5 percent. Volatile organics represent a major cause of smog ozone.

U.S. vehicles already contain charcoal canisters to trap gas vapors from parked cars. However, recent fuel-volatility increases allow cars parked for a day or longer to develop such a massive buildup of vapor – especially on the hottest summer days, when smog tends to be worst – that it can overwhelm today's collection systems. The new rules would require larger canisters, as well as vapor-purging improvements in fuel-distribution systems to ensure that even under most summertime conditions, gas flows only to the engine or charcoal canisters once the car is restarted.

Researchers are weighing methanol, an alternative to gasoline, as another major recruit into the war on urban ozone. A new analysis of the alcohol fuel's potential to combat smog throughout the Los Angeles basin – the nation's most ozone-troubled region – indicates that running all new vehicles there on methanol starting this year could reduce peak ozone levels by about 13 percent by the year 2000 and lower by 22 percent human exposures to ozone levels exceeding the federal standard, according to a report in the Jan. 12 SCIENCE. And if cities begin controlling ozone-precursor chemicals emitted by industrial boilers, "our studies show going to methanol vehicles can have an even bigger impact" – easily a 20 percent ozone reduction by 2000, says study leader Ted Russell at Carnegie Mellon University in Pittsburgh.

Unlike earlier computer studies of methanol's smog-limiting potential, which confined their analyses to small air parcels, Russell's model covers an entire metropolitan area, "from downtown to downwind." It also includes previously omitted variables accounting for most of the chemistry and physics influencing reactions between air pollutants, he says. The new analysis shows that even though methanol-run vehicles can emit five times as much formaldehyde as gasoline-fueled cars, a shift to methanol should not worsen urban formaldehyde concentrations and might even improve them. Other emissions from gasoline-fueled vehicles react with pollutants in the air to create more formaldehyde than methanol vehicles spew directly, Russell explains. – *J. Raloff*