EARTH SCIENCES

Tunguska-caused ozone depletion?

On June 30, 1908, a monstrous explosion devastated 800 square miles of forest in the remote Stony Tunguska River basin of Central Siberia. The blast was heard 600 miles away, and was later associated with the mysteriously glowing night skies seen across Europe and Asia for several evenings after the event.

Another significant effect of that awesome blast, according to Robert P. Turco and co-workers, may have been atmospheric and climatic. The Tunguska event, they told the spring meeting of the American Geophysical Union, may be the "largest global ozone perturbation, natural or man-made, ever recorded."

Long the subject of scientific and pseudo-scientific musings, the Tunguska explosion has been variously attributed to a matter-antimatter annihilation, a black hole and other extraterrestrial imaginings. Most scientists now believe, however, that the catastrophic explosion was due to the impact of a cometary fragment or a loosely coagulated meteor weighing several million tons that disintegrated explosively on entering the earth's atmosphere.

Using the hypothetical cometary fragment, Turco, of R & D Associates of Marina del Ray, Calif., and Owen B. Toon, C. Park and R. C. Whitten, of NASA Ames Research Center at Moffett Field, Calif., developed a computer model to study the photochemical effects of such a body on stratospheric trace gases. Based on the size of the meteor and the required speed—about 30 miles per second—the researchers estimate that the air in the wake of the meteor was heated several thousand degrees centigrade, which would have generated as much as 30 million tons of nitric oxide in the upper atmosphere. The nitric oxide, which is highly reactive with ozone, in turn would have depleted the stratospheric ozone by about 45 percent, according to the researchers' model, and the large ozone reduction, though declining, could have persisted, until 1911.

Other evidence supports the calculated Tunguska ozone depletion, according to Turco. During that time, the Smithsonian Astrophysical Observatory was measuring the spectral distribution of sunlight at Mount Wilson, Calif., in order to study the solar constant. Included in those spectral data is the wavelength that corresponds to ozone absorption. When Turco and co-workers extracted that band from the spectral data from 1908 to 1911, they found a curve of ozone depletion and recovery quite similar to the calculated curve.

Climatic effects, however, are not as clear. The researchers found a significant cooling (about 0.3°C) in the northern hemisphere in the decade after the explosion, but Turco notes that the eruption of two volcanoes in 1907 and 1912 may have contributed to the cooling.

Sick of the weather

It's about time North American scientists started finding out if there's anything literal about being "under the weather," says Simon Kevan of John Abbott College in Ste Anne de Bellevue, Quebec. Now out of fashion in North American science, the study of the effects of weather on health has been actively growing in Central Europe, he told the American Geophysical Union. The German weather service, for example, produced daily medical meteorological forecasts including the general weather conditions, the degree of weather influence and the types of medical conditions that may be affected. Kevan suggests that American scientists could choose one easily diagnosed and frequently weather-associated medical event—such as stroke, heart attack or epileptic seizure—to correlate to certain weather conditions. While earlier studies have been inconclusive, Kevan feels that the recent development of better and more accurate regional weather forecasting models promises more definitive results.

SPACE SCIENCES

Teflon-fueled engine for satellites

When the discussion turns to technological "spinoffs" from the space program, the inevitable example always seems to be Teflon, the versatile polymer whose uses range from lining frying pans to insulating wires. As it happens, says duPont, which makes the stuff, Teflon was not a space-research by-product at all, but the accidental 1938 discovery of a duPont scientist puzzling over the strange, waxy residue in some supposedly empty cylinders that had contained fluorocarbons. Now, however, Teflon is being developed for a use that is not only highly different from most of its other applications, but as space-related as it could possibly be: as an unusual type of rocket propellant.

It is not being used in liquid form and combined with an oxidizer like liquid propellants, nor even ignited into burning like conventional solid fuels. Instead, in a project being pursued for the U.S. Air Force by Fairchild Republic Co. of Long Island, N.Y., the end of a Teflon rod is zapped by a powerful spark from an electrical capacitor, which turns a bit of the Teflon into a plasma and creates a magnetic field that accelerates it through a nozzle into space.

This is not a way of launching payloads from earth or pushing them toward other planets. The device is a "microthruster," designed to provide the tiny nudges needed to keep earth-orbiting satellites facing the right direction. Beginning in the late 1960s with a test version that provided millionths of a pound of thrust, says Dominic Palumbo of Fairchild Republic, the company is now at work on the "big model"—whose push is measured in thousandths of a pound. The Teflon is used so sparingly that in a typical application, says Palumbo, two 35-pound Teflon rods could handle the daily needs of a one-ton satellite in near-polar orbit for a decade. In such a role, the two microthrusters would operate on alternate days, each working for a four-hour period during which it would provide a one-millipound pulse every five seconds. In ten years, then, each microthruster would fire more than 5,000,000 times.

Firing automatically in brief pulses (each lasts 30 millionths of a second) offers better control and thus more precise pointing than timing the "ons" and "offs" of a continuous-thrust system, Palumbo says. Furthermore, he maintains, the electrically activated solid propellant allows simpler, more reliable design than do pulsed microthrusters with gaseous or liquid propellants, which depend on valves for their operation.

But why Teflon? Other materials can be zapped into plasma. Teflon, says Palumbo, remains stable in extremely low pressures, so it needs no container to keep it from "outgassing" away in space. Its high electrical resistivity lets it withstand a high charge without premature breakdown. Its "burning" surface (the end of the rod, advanced after each pulse by a simple spring) is consistently uniform. And finally, it turns to a plasma without leaving a charred layer behind, which could conduct electricity and prevent the capacitor from recharging.

The longevity of COS-B

The European Space Agency's first satellite, a gamma-ray observatory called COS-B, passed its fifth year of successful operation on Aug. 9. It was designed for a mere one-year lifetime, but other satellites have similarly exceeded specifications. COS-B's accomplishment is notable in that it carried only an estimated two-year supply of "consumables"—materials such as steering gas whose depletion spells the end when they run out. COS-B's main consumable is the supply of neon gas that is periodically used to refill its gamma-ray detector's spark chamber. Planning on two-month refill intervals, ESA has found that intervals as long as 14 weeks seem to work well. The satellite is expected to expire sometime this year.