

A constellation of thermometers

With an eye toward improving weather predictions, scientists have developed an efficient way of gauging atmospheric temperatures around the globe with a fleet of orbiting satellites.

The constellation of 24 Global Positioning System (GPS) satellites is best known as a locating tool. The satellites send out signals that can be picked up with a handheld receiver by a person on the ground. By triangulating from three or more satellites, a receiver can pinpoint its position with extreme accuracy.

Last year, researchers at NASA's Jet Propulsion Laboratory (JPL) in Pasadena, Calif., conducted an experiment to test other uses of the positioning satellites. They flew a GPS receiver onboard a new satellite launched into a low orbit around Earth. From this vantage, the receiver can pick up signals from distant GPS satellites as they disappear behind the planet and emerge from the other side.

Such occultation measurements provide a way of sensing the atmosphere's temperature. As the GPS radio signals graze the planet, they pass briefly through the atmosphere. The air acts as a giant lens, bending the radio waves. The amount of bending, or refraction, depends on the temperature of the air and how much water vapor it holds. In cold parts of the atmosphere, which are extremely dry, the refraction provides an accurate measurement of the temperature.

In the Feb. 23 *SCIENCE*, E. Robert Kursinski of JPL and his colleagues compare the GPS occultation measurements to temperatures taken with routine balloon launches. At high latitudes, the satellite technique matched balloon measurements to within 1°C. In warmer climes, moisture in the air hindered temperature measurements near the ground, but the satellite technique worked well above 10 kilometers in altitude. This accuracy surpasses that of routine satellite sensors, which measure atmospheric temperature by reading infrared or microwave radiation emitted by air molecules.

A group of similar orbiting receivers would significantly expand the geographic distribution of temperature measurements and improve weather prediction, the scientists claim. But the GPS system faces some competition. In the next several years, NASA plans to test other space techniques for measuring atmospheric temperature.

The premiere of the marsupial pouch

Marsupials face a tough road from the start. Instead of growing within the comfy confines of a womb, they are born extremely early in their development and then spend weeks in an external pouch, hanging for dear life onto a nipple. Now, scientists have used evidence from fossil teeth to decipher when this peculiar reproductive strategy arose.

Paleontologist Richard L. Cifelli of the University of Oklahoma in Norman and his colleagues studied the jaw of a baby *Alphadon*, a 70-million-year-old mouse-size mammal. Using very high resolution X-ray computer tomography, they discovered a pattern of tooth replacement exactly like that of modern marsupials. They report their findings in the Feb. 22 *NATURE*.

Kangaroos, opossums, and other marsupials have extremely delayed tooth development because they spend so much of their early life latched onto a nipple, where teeth would provide a distinct disadvantage. As a result, modern marsupials largely bypass baby teeth in favor of adult teeth, which come in after the period of intense suckling. They replace only one pair of baby premolars on the upper and lower jaws.

Discovery of this same tooth pattern in an ancient mammal from the time of the dinosaurs suggests that the marsupial reproductive system had evolved as far back as the Cretaceous period, says Cifelli.

Kidney stones: Rating what you drink

At some point in life, approximately one in eight U.S. residents develops kidney stones, often heralded by nausea and intermittent, stabbing pains in the back or groin. To limit recurrence of these mineral deposits, doctors frequently tell patients to drink more fluids. Now, a study indicates that what people drink can also make a big difference.

As part of an ongoing project, Meir J. Stampfer and his coworkers at the Harvard School of Public Health in Boston surveyed diet and other health factors among 45,289 male health professionals (none of them physicians). Over a 6-year period, 753 of these volunteers developed kidney stones. After accounting for known risk factors, including age, the researchers identified certain drinks that appeared to affect stone development.

On average, they report in the Feb. 1 *AMERICAN JOURNAL OF EPIDEMIOLOGY*, a man's risk of developing kidney stones fell by 4 percent for each 8 ounces of water consumed daily. That same amount of liquid lowered the risk by 10 percent for coffee, 14 percent for tea, 21 percent for beer, and 39 percent for wine. For each 8-ounce glass of apple or grapefruit juice consumed daily, the risk of stone formation skyrocketed some 36 percent.

Stampfer acknowledges that the juice findings came as a surprise. And while the coffee and tea benefit may reflect caffeine's role in boosting urine output, he notes that caffeinated soft drinks offered no clear benefit over water.

Evaluating dietary carcinogens

A much-cited 1981 study concluded that some 35 percent of human cancer deaths probably trace to carcinogens in foods—both synthetic chemicals, such as pesticides and food additives, and naturally occurring ones, like fungal toxins.

To get a better fix on the risks posed by such compounds, the National Research Council in Washington, D.C., set up a committee to study the amounts and toxicity of these chemicals in food and to compare them to data on the occurrence and potency of natural cancer-fighting agents.

The committee's findings appear in "Carcinogens and Anticarcinogens in the Human Diet," a 417-page report issued on Feb. 15. Overall, its tone is reassuring, arguing that "the great majority of individual naturally occurring and synthetic chemicals in the diet appears to be present at levels below which any significant adverse biologic effect is likely, and . . . [thus] are unlikely to pose an appreciable cancer risk."

These compounds don't occur individually, however (SN: 7/3/93, p. 4). The report concedes that important questions remain regarding how to assess risk from the interaction of the tens or even hundreds consumed daily—each in what might represent a nontoxic quantity.

While much attention has been focused on the potential risks posed by pesticides and other agricultural chemicals in food, the new analysis argues that when it comes to cancer, "natural components of the diet may prove to be of greater concern." It points out that naturally occurring carcinogens function much as synthetic ones do, tend to occur in higher numbers, have been less well studied, and have largely escaped regulation.

For perspective, the study concludes, health risks posed by carcinogens in food tend to pale in comparison to those posed by gluttony—especially the overeating of foods rich in fat.

While food analyst Richard Wiles of the Environmental Working Group in Washington, D.C., agrees, he remains worried about those unknown risks associated with the mix of low-level carcinogens in our diet. Indeed, he argues, given that some carcinogens naturally taint foods, "why shouldn't we be concerned about adding synthetic ones?"