Rainy night in Georgia, at least in Atlanta

Snow-globe souvenirs depict cities more accurately than most tourists recognize. A large city creates its own weather. Each sits under a dome of hot air, known as an urban heat island, that can produce clouds and thunderstorms.

Using high-resolution measurements taken in Atlanta during the 1996 Summer Olympics and satellite data covering the past quarter century, researchers have produced one of the most detailed portraits of a city's climatic geography. The research, presented March 24 at the Association of American Geographers conference in Honolulu, along with work on other cities, is fueling a growing area of meteorology—weather prediction for urban microenvironments.

The streets, rooftops, and parking lots that cover large cities absorb heat during the day and radiate it at night. As Atlanta has grown in the past 25 years, eating up 380,000 acres of forest, its heat island has grown with it, says Dale Quattrochi of NASA's Marshall Space Flight Center in Huntsville, Ala.

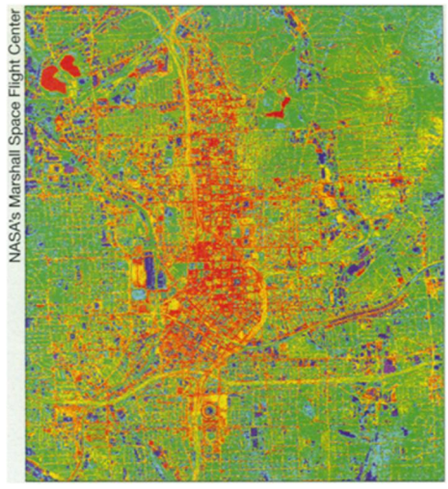
Scientists in the 1800s noticed that Berlin, London, and Paris were warmer than the countryside, says Stan Changnon of the University of Illinois at Urbana-Champaign. In the 1970s, Changnon led a detailed study showing that St. Louis creates its own thunderstorms.

Hot air bubbles up from the heart of a city, creating a low-pressure cell that sucks in cold air from its perimeter, he says. As this converging plume of heat rises, it cools, condenses, forms clouds, and produces thunderstorms.

During the Olympics, weather stations installed throughout Atlanta helped sports officials plan outdoor events (SN: 7/13/96, p. 29). During those 9 days, says Bob Bornstein of San Jose (Calif.) State University, six thunderstorms erupted. Four developed over the city, and two formed outside Atlanta and then moved in, perhaps drawn by the city's low-pressure center, he reported in Honolulu.

Bornstein says that meteorologists should be able to identify storm-prone areas: "The city doesn't change, and the mountains don't move, and the wind patterns are generally the same." In Atlanta, the south and southeast sides are most vulnerable to thunderstorms. In New York City, by contrast, Bornstein's earlier work showed that rain is most likely to fall in the west, right over Manhattan.

Cities have special needs when it comes to weather, says Walt Dabberdt, associate director of the National Center for Atmospheric Research in Boulder, Colo. Transportation systems, power grids, and sewer systems are vulnerable to storms, and floods can grow rapidly where pavement covers the ground.



Urban heat island: Night surface temperatures in downtown Atlanta are higher (redder), by 8° to 10°C, than in surrounding areas.

Urban areas need both traditional forecasting, he says, and "nowcasting"—which provides information in the 2-hour range about thunderstorms, tornadoes, blizzards, and heavy rain. Dabberdt chaired a U.S. Weather Research Center working group that concluded that the center should support new research on urban weather prediction. The topics might range from city microclimates to improved communication between forecasters and city workers who need to prepare for weather emergencies. —*L. Helmuth*

Moon's tiny core hints at earthly origin

Two new studies support the notion that the moon is essentially a chip off Earth's mantle, formed when a Mars-size body crashed into our planet.

Both studies, which rely on strikingly different measuring techniques, find that the moon has a tiny core, no bigger than about 400 kilometers in radius and containing less than 4 percent of the moon's mass. In contrast, Earth's core holds about one-third the planet's mass.

Theorists have predicted that the moon would have at most a tiny core if it formed from the debris kicked up when a giant body plowed into Earth a few billion years ago. By that time, our planet's iron-rich material had sunk toward its center (SN: 8/16/97, p. 107). The collision would have gouged material from Earth's low-density mantle, providing little matter for a dense lunar core.

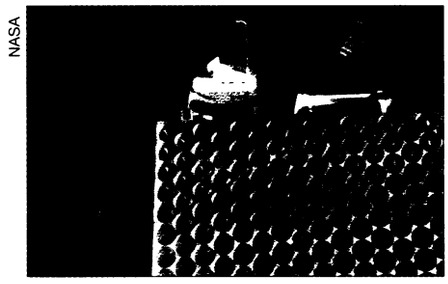
Had a fully formed moon been captured by Earth, or had the moon and Earth formed simultaneously from the same cloud of gas and dust, the moon would have a larger core more in proportion to that of our own planet, says Robin M. Canup of the Southwest Research Institute in Boulder, Colo.

The idea that the moon is an offspring of Earth has been around for decades, ever since the first samples brought back from the moon revealed that lunar rocks have a composition similar to Earth's mantle. The new findings, described last week at the annual Lunar and Planetary Science Conference in Houston, lend further credence to a terrestrial lineage.

Lon L. Hood of the University of Arizona in Tucson and his collaborators used NASA's Lunar Prospector spacecraft to measure Earth's magnetic field in the vicinity of the moon. The craft's magnetometer detected variations in the field such as would be expected if the moon has a small, electrically conducting core, perhaps made of iron. Hood and his colleagues estimate that the radius of the core is 300 to 425 km.

These numbers agree with an earlier estimate of core size based on a gravity map of the moon, also generated by Lunar Prospector. Alex Konopliv of NASA's Jet Propulsion Laboratory (JPL) in Pasadena, Calif., and his collaborators reported that analysis in the Sept. 4, 1998 SCIENCE.

Recent experiments have measured minute variations in the moon's rotation and wobble by bouncing laser beams off



Lunar reflecting array left by Apollo 15.

reflectors that were left on the lunar surface some 3 decades ago. These variations result from a loss of energy. Earth's gravitational influence, which robs the moon of energy by flexing it, can't account for all of the fluctuations.

James G. Williams, J. Todd Ratcliff, and their JPL colleagues conclude that the variations can best be explained if the moon has a small, at least partially molten core that is no bigger than 374 km. Friction between a small, fluid core and an overlying layer of rock could account for the extra energy loss.

"The existence of a small lunar core favors the impact hypothesis," says Canup. She adds that further modeling will be required to determine the size and velocity of the body that struck Earth some 4 billion years ago. —*R. Cowen*