Astronomy

Ron Cowen reports from Baltimore at a meeting of the American Geophysical Union

Venus: Dragging out new findings

In analyzing the effects of atmospheric drag on the Magellan spacecraft, researchers have discovered that the density of Venus' upper atmosphere fluctuates with a period of about four Earth days. The fluctuation may relate to the way cloud layers revolve around the planet. Astronomers previously determined that the clouds, which lie some 100 kilometers below the craft, cycle around the planet every 4.2 days.

Gerald M. Keating of NASA's Langley Research Center in Hampton, Va., and his colleagues suggest that the moving cloud tops transmit waves of energy to higher altitudes. Like ocean waves that dump water onto the shore, these waves would deliver heat into the Venusian atmosphere, causing particles such as oxygen atoms and carbon dioxide molecules to rise temporarily to greater heights. During such times, the upper reaches of the atmosphere would increase in density.

The researchers suspect that the entire upper atmosphere may revolve around the planet, since the same waves would carry with them angular momentum from the clouds below. Verification of these results would indicate that the middle atmosphere of Venus strongly influences the upper atmosphere, Keating says.

He notes that atmospheric studies with Magellan, which previously used radar to image Venus, have been possible only since last September, the start of Magellan's fourth 243-day cycle around the planet. During this cycle, the craft descended to about 180 km above the Venusian surface – low enough to encounter significant drag from the planet's atmosphere.

To study the Venusian atmosphere, scientists send a radio signal from Earth to the craft, which beams the signal back to Earth. A change in atmospheric drag would speed or slow Magellan, causing a frequency shift in the radio signal beamed back to Earth. Because denser regions generate more drag, this experiment effectively measures the density of the atmosphere.

Researchers are using the same technique to measure Venus' gravitational field, since the craft also speeds up or slows down when it passes over a region of the planet that has a higher or lower mass density. Magellan should begin taking high-resolution gravity measurements in late August after NASA engineers complete an unprecedented set of maneuvers, using atmospheric drag rather than expending fuel, to further lower and circularize the craft's elliptical orbit. These maneuvers have already brought the craft to within 140 km of the surface, the nearest any orbiting craft has come to Venus while still transmitting data to Earth.

In another study, Keating and his co-workers found that the solar cycle, roughly 11 Earth years in length, has little effect on the density of Venus' upper atmosphere. The finding may have consequences for Earth's atmosphere, Keating notes. The team examined data gathered by the Pioneer Venus spacecraft in 1979, when the sun was near its peak of activity, and compared them with data collected by Magellan and the Pioneer Venus in 1992, when the sun had significantly less activity.

Keating suggests that in Venus' atmosphere, which is rich in carbon dioxide, the increase in heating at the peak of the solar cycle is counterbalanced by a cooling mechanism. When oxygen atoms collide with carbon dioxide molecules high above the surface of Venus, the molecules dramatically cool the upper atmosphere by emitting infrared light. Ironically, such an effect, known as radiative cooling, is enhanced during the peak of the solar cycle, when the high intensity of sunlight creates a high abundance of oxygen atoms.

If, as scientists expect, the carbon dioxide concentration in Earth's atmosphere doubles in the next century, the same radiative process will cool our planet's upper atmosphere, Keating says. This same gas, however, has the opposite effect lower in the atmosphere, acting to warm Earth's surface.

Earth Science

Richard Monastersky reports from Baltimore at a meeting of the American Geophysical Union

First evidence of a mantle plume

According to the theory of plate tectonics, the Hawaiian islands and many other volcanic chains represent rows of geologic blisters, formed as the Earth's ever-shifting surface plates pass over stationary hot patches in the mantle. Geoscientists believe such hot spots are fed by cylindrical plumes of sweltering rock rising from deep in the mantle, but attempts to locate such plumes have failed to deliver convincing evidence. Two seismologists now say they have found the first clear signs of a plume rising from the deep mantle toward a seamount off the west coast of Canada.

Henri-Claude Nataf of the École Normale Supérieur in Paris and John C. VanDecar of Utrecht University in the Netherlands focused their search beneath the Bowie seamount, the youngest in a line of submerged volcanoes running toward the northwest. To probe the deep mantle, they analyzed records of Alaskan earthquakes, looking specifically at how long it took seismic waves to travel under the seamount and reach recording stations in Washington state. Because seismic vibrations slow down when passing through hot rock, this technique can reveal temperature variations in the mantle.

The travel-time data suggest the existence of a plume about 150 kilometers in diameter at a depth of 700 km below the ocean floor, the researchers say. They were surprised to find that the suspected plume lies 150 km east of the seamount, rather than directly beneath. To explain the offset, they suggest that the plume could take a tilted path upward or that the hot spot's position may not coincide exactly with the seamount.

Nataf and VanDecar may find themselves in a hot spot of their own as their controversial claim arouses debate among geophysicists. Thorne Lay, a seismologist at the University of California, Santa Cruz, credits the two for making one of the best attempts so far at detecting the subtle signature of a plume. But he says the data are far from conclusive, and he remains unconvinced that they have indeed located a plume.

Fastest fault in the world?

Volcanologists often call Hawaii's Kilauea the world's most active volcano – a title bestowed because it erupts so frequently. New evidence collected by Global Positioning System satellites suggests that Kilauea may also have the world's fastest-moving fault, reports Susan Owen of the U.S. Geological Survey in Menlo Park, Calif.

Measurements made in 1990 and 1992 show that the volcano's southern flank has edged seaward at a pace of 10 centimeters per year. Owen and her co-workers think the flank is sliding atop a nearly horizontal fault that lies 9 kilometers below the surface. Their calculations suggest that the rock along the fault is slipping at 25 cm per year, making this the fastest known fault, says Owen. Kilauea has generated large quakes in the past, and it remains unclear whether the fast but peaceful motion now going on represents a harbinger of a strong jolt.

Ancient greenhouse born in collision

Creeping steadily northward for 50 million years, India plowed into Asia in a continent-buckling collision that raised the world's highest mountains. But the slow impact warped more than just the land surface, say Derrill M. Kerrick and Ken Caldeira of Pennsylvania State University in University Park. They propose that the continental crack-up forced several hundred trillion tons of carbon dioxide into the air. If so, that release could explain why Earth grew so warm during the Eocene period (from 52 million to 38 million years ago).

Kerrick and Caldeira note that the Himalayas contain the mashed remnants of rocks once rich in carbon dioxide. They suggest the collision cooked such rocks, forcing the widespread release of carbon dioxide, thus warming the Earth.