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COVER: Jupiter, photographed Dec. 10 by Voyager 1 from about 84 million kilometers out, shows substantial changes since last photographed from space several years ago. Purple border on right limb is a result of the imaging technique; it will be removed by later processing. See p. 437. (Photo: NASA/JPL)

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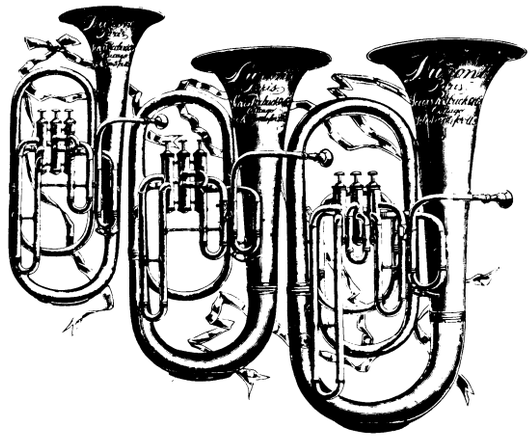


Happy New Year from Science News

It's been a very good year — for science and for SCIENCE NEWS. What better way to celebrate 75 years of flight, for instance, than with the near-flawless Pioneer Venus mission, the equally impressive probing of Venus by the U.S.S.R. and the ongoing Voyager mission that is only beginning to send back data (including our cover photo) about the solar system.

Advances in the space sciences, of course, represent only one part of the scientific endeavor. See p. 450 for our review of the year in science.

As for SCIENCE NEWS, we have a special reason for holiday cheer. With this issue we hit an all time high in circulation — 175,164 — representing an increase of more than 80 percent over the past five years. We are proud of our success, but as communicators of science we recognize that any success we may achieve is due to the loyalty of our audience as well as to the scientists and researchers without whom we would have little to communicate. We thank you all and look forward to 1979.

— Robert J. Trotter
and the staff of Science News

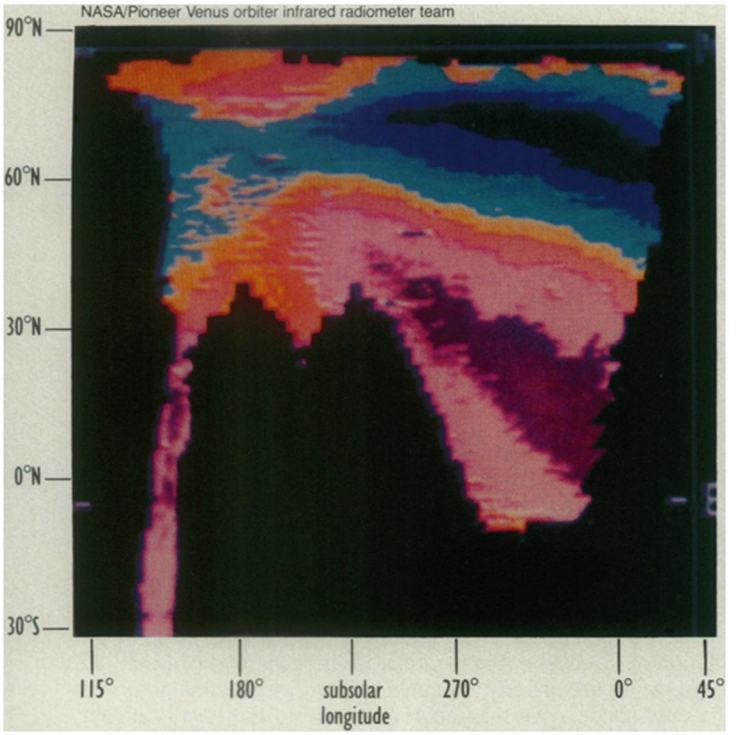
SCIENCE NEWS OF THE WEEK

Pioneer Venus: The Forest *and* the Trees

So many scientists are working on the voluminous data from the various spacecraft of the Pioneer Venus project that it's not surprising that one of them actually said it: "The more we learn, the less we know." Five probes penetrated the atmosphere and an orbiter circles the planet (SN: 12/16/78, p. 420), perhaps providing a greater surfeit of riches in a short time than any other interplanetary mission to date, including Viking. At this early stage of the game, preliminary and conflicting results offer ammunition for almost any side of one's favorite hypothesis, salted with surprises and mysteries — yet through it all, an enriched portrait of Venus is beginning to emerge.

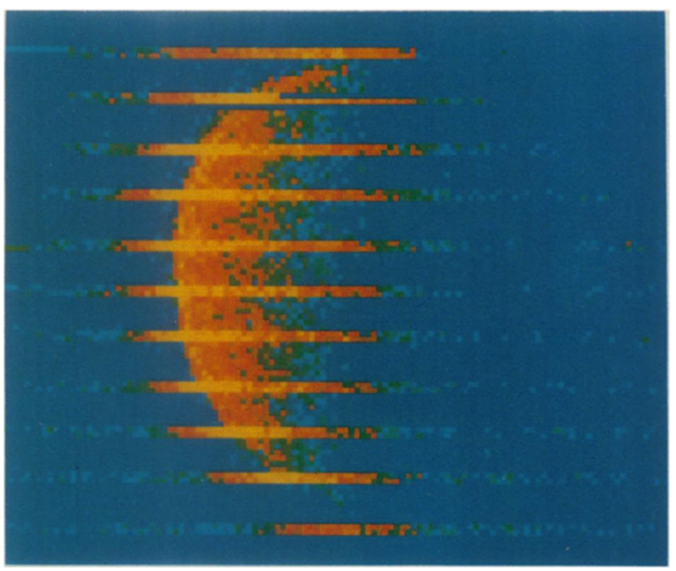
Does the so-called "greenhouse effect," for example, really account for the planet's Hadean temperatures, blocking the reradiation from the surface of energy initially absorbed at shorter wavelengths from the sun? "The greenhouse looks good," says James Pollack of the NASA Ames Research Center, control site for the mission. If so, a key factor is water vapor in the atmosphere, narrowing the range of wavelengths at which energy can escape. But one set of Pioneer Venus instruments recorded only a few tenths of a percent of H_2O, perhaps too little (by some reckonings) to do the job, while other sensors showed several *percent,* more than enough for the task — and perhaps too much to be real. Complicating the picture is the planet's variety of hazes, particles and clouds, which the data suggest to be not a dominant factor, but at least relevant in trapping heat generated in the atmosphere's mid-levels.

Important to an understanding of the atmosphere is the turbopause, apparently about 144 km above the surface, atop which gases separate by molecular weight, some of them escaping into space. Instruments aboard the orbiter have begun mapping their behavior, noting the huge hydrogen cloud that surrounds the planet and fueling studies of whether Venus once had vast quantities of water that have since escaped. The hydrogen has been found to escape rather slowly, but it is still a question whether hydrogen was always rare (not much water to provide it) or is simply depleted. Below the turbopause, in the well-mixed portion of the atmosphere, instruments detected about 60 parts per million of oxygen, surprisingly high compared to the amount observed at loftier altitudes but not enough to account for a vanished "ocean" of water. If abundant water was once present, suggests Thomas Donahue of the University of Michigan, perhaps some oxygen may exist in an



	Measured Temp (°K)	Inferred Relative Altitude (km)*
Deep blue	215	8
Blue	218	7
Blue-gray	221	6
Cyan	224	5
White	227	4
Yellow	230	3
Orange	233	2
Pink	236	1
Magenta	239	0

*"0" relative altitude corresponds to about 70-75 km above the surface of Venus.



NASA (data: A.I. Stewart et al.)

Cloud tops of Venus (false-color 12μ:14μ infrared brightness-ratio map) suggest wide altitude variations. Dark blue feature indicates high, partially circumpolar feature; magenta region may be part of chevron-shaped feature that is angled due to rapid rotation of upper atmosphere. UV spectrometer scan (left) shows atomic oxygen (crescent-shaped feature) and atomic hydrogen (intervening bars), with yellow and orange representing high intensity and blue showing low intensity. Results indicate slow escape rate of atomic hydrogen from the planet.

oxidized crust, although it would take an improbable amount of geologic thrashing to expose enough crustal material to hold the requisite amount.

Appropriately for the hellishly hot world, a significant factor in its atmosphere is sulfur in a variety of forms. A high haze of sulfuric acid droplets, measured by Pioneer Venus, had already been detected from earth (which has a lesser amount in its own atmosphere). In addition, there is about 240 parts per million of sulfur dioxide, and the project's scientists are now unraveling data that seem to indicate hydrogen sulfide, carbonyl sulfide (COS) and a variety of other versions including elemental sulfur itself. Early analyses suggest that the sulfur in the low levels of the hazes and clouds may be in liquid form, while higher up it is solid. Complex models of the atmospheric chemistry of Venus were around long before this mission, but the details of what compounds exist at what altitudes and in what concentrations are critical to the understanding of a system that is so different from earth's.

Except for the surprisingly "clean" bottom few tens of kilometers of atmosphere, the hazes/mists/clouds are everywhere. Yet according to Robert Knollenberg of Particle Measuring Systems, Inc., many are so diffuse that in places they would permit visibilities of tens to hundreds of kilometers, were it not for the dense gases making up most of the atmosphere. A region about 49 to 52 km above the surface, he says, contains "the only layer that really looks like a cloud."

The invisibility of the surface of Venus to an outsider, in fact, may be misunderstood if it is attributed solely to notions of "the cloudy planet." Even with no such features, says James Hansen of the Goddard Institute for Space Studies, the density of the atmosphere (measured near the surface by two of the probes as 90.5 and 91.5 bars) would bend light so sharply from a straight path that an observer gazing down from orbit might see no planet at all. Looking down on even a haze-free Venus, one infers, might be like looking at empty sky.

Well down in the atmosphere, of course, the planet would be conspicuously visible — along with, perhaps, one of the Pioneer Venus mission's major surprises. On the two probes that descended over the nightside, says Boris Ragent of NASA Ames, instruments detected "a very faint glow," beginning about 12 to 15 km up and getting slightly stronger near the surface. Problems with the instruments, Ragent believes, are unlikely. Two fascinating alternatives suggest themselves: In the intense heat and other exotic conditions near the surface of Venus, either the surface or the very "air" itself could be aglow. Atmospheric chemoluminescence is certainly a possibility, says Michigan's Donahue, though the molecules and processes that would cause it have yet to be positively identified. If the surface is to blame, still more work remains. The Pioneer Venus probes, after all, were neither instrumented nor even intended as landing craft.

The latest pair of Soviet Venera space vehicles, however, are. On Dec. 21, less than two weeks after the U.S. probes did their work, the first of the Soviet vehicles descended to the surface of Venus, lasting, according to initial reports, for what would be a record-setting time of nearly two hours. Hot on its heels was the second lander, due to touch down on Christmas Day. According to several U.S. Pioneer Venus scientists who have been in touch with their Soviet counterparts, the landers were said to be equipped with instruments considerably improved in sophistication over their predecessors.

Relaying communications for each lander, furthermore, was the "fly-by" craft that had brought it from earth (also reportedly making X-ray, gamma-ray and other astronomical observations on the way). The U.S. and Soviet data on Venus are likely to be shared to a degree, but U.S. scientists were also hoping that coordinated measurements of the solar wind could be made with the Pioneer Venus orbiter and the Venera fly-bys. Their interest was heightened when the sun, relatively quiescent for six days following the orbiter's arrival, abruptly kicked up no fewer than three large flares on successive days. The solar wind could be particularly significant to Venus, which is only poorly protected by its weak magnetic field, and the increased solar wind accompanying the first flare, says Christopher Russell of the University of California at Los Angeles, drove the planet's intervening magnetic "bow shock" to within 250 km of the top of the ionosphere. □