Pioneer Venus: Six Out of Two

Until last week, two U.S. spacecraft were on their way to Venus. Now there are six — and without any additional help from NASA's launch pads. The first craft to leave the earth, launched last May 20, will go into orbit around Venus on Dec. 4 to look down on the planet from distances as small as 150 kilometers and as great as 66,000 km. It is the other vehicle, which began its journey on Aug. 8, that has now become a fleet.

On Nov. 15, as the orbiter cruised on toward its rendezvous, ground controllers with the Pioneer Venus project at NASA's Ames Research Center in Palo Alto, Calif., sent a radio message to their other charge, a complex craft known as the multiprobe. Weighing nearly a ton, the multiprobe resembled a tall hatbox, about 2.5 meters across and 2.9 meters high, with four large, conical mushrooms growing on its lid. "Resembled" — past tense — because the mushrooms are no longer there.

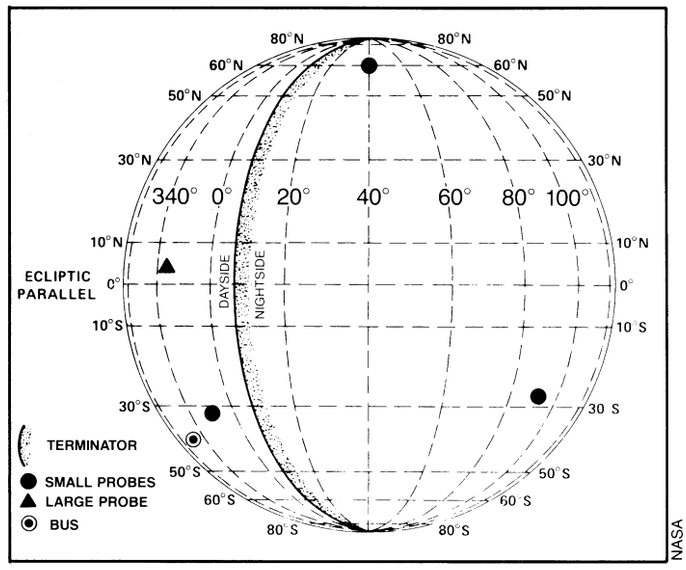
The radio signal was the first step in setting them free, to become individual, instrument-laden probes that will descend through the atmosphere of Venus on Dec. 9 all the way to the ground, taking measurements as they go. (They have not been designed to survive the impact, but project scientist Lawrence Colin believes it possible that one or more may provide a few moments of valuable data from the surface.) The signal instructed the multiprobe to nose down a bit from the orientation in which it had made the flight from earth, so that the top of the largest mushroom — actually the heat-shield of the largest probe — would be properly aimed to protect the probe when it strikes the atmosphere. Then, after carefully calculating the probe's distance from the planet (a task that caused a nearly six-hour delay due to ambiguous interpretations of tracking data), the controllers sent a command to fire an explosive spring device that literally snapped the probe on its way. Among its seven instruments, the 316-kilogram craft carries a gas chromatograph and mass spectrometer that will provide the mission's key measurements of the atmosphere's composition, gathered during a descent just north of the equator on the day side of Venus.

On Nov. 19, four days after the large probe's departure from the mothership or "bus," the Ames controllers prepared to release the three remaining smaller mushrooms, 90-kg probes instrumented primarily to measure only the atmosphere's temperature, pressure and density. Despite their limited data, the small probes are a key part of the Pioneer Venus mission since they will be sampling the atmosphere at widely separated points in regions of both day and night. One of the little probes, in fact, bound for 60°N latitude, will go closer to the planet's polar regions than have any of the other spacecraft — all of them Soviet Venera landers (see chart) — yet sent to the surface. Jettisoning the small probes involved turning the hatbox into a merry-go-round, by commanding the bus to spin at a rate calculated to toss each probe onto its proper entry trajectory. Here again there was a delay, this time of almost half a day, when doppler-shift measurements before the release showed the bus to be approaching the planet too rapidly, though the holdup is not expected to significantly affect the arrival times or entry points. (The probes' post-release travel times to Venus are critical because a timer will turn them on at what is supposed to be 22 minutes before entry. Their battery life, says Colin, is only about 90 minutes, so a premature activation could leave them dead before they ever reach the ground.)

The bus, in fact, despite its humble nickname, will play a major, even unique role in the mission. The now-separated probes will be taking their measurements only below an altitude of about 65 to 70 km (after they emerge from the radio "blackout" of entry), and the orbiter will get no lower than about 150 km. In between is the portion of the planet's upper atmosphere that includes the "turbopause," a region below which the atmosphere is mixed but above which its components are separated by molecular weight. Only the bus (relatively unprotected and thus expected to burn up before reaching the ground) will be able to directly locate and study the turbopause.

Meanwhile, Colin and officials at NASA headquarters are continuing to seek detailed information from Soviet officials about the trajectories and timelines of Venera 11 and 12, launched earlier this year and due to reach Venus later in December. Each will fly past the planet rather than go into orbit around it, thus giving longer radio contact with the landing craft that each Venera will send down on the way by. Soviet officials have provided landing dates — Dec. 21 and 25 — and given Colin predicted landing coordinates (chart), but he wants data on the flybys so that the U.S. and Soviet craft can work together. Once past Venus, the flybys would be able to see the solar wind coming in from the sun, while the U.S. orbiter — with forewarning — could set its instruments to measure the same wind nearer the planet. □

Planned atmospheric entry points for the U.S. Pioneer Venus probes (right) spread over Venus, though all are well away from the subsolar point where the sun's energy hits the planet directly. Soviet Venera landing sites (below), including two to come, get somewhat closer.



Venera	landing date	latitude	longitude	longitude of subsolar point	distance from subsolar point
7	Dec. 15, 1970	4°S	34° (nightside)	288°	106°
8	July 22, 1972	12°S	13° (dayside)	286°	87°
9	Oct. 22, 1975	32°N	291° (dayside)	309°	18°
10	Oct. 25, 1975	16°N	291° (dayside)	317°	26°
11*	Dec. 21, 1978	10°S	300° (dayside)	274°	26°
12*	Dec. 25, 1978	30°S	330° (dayside)	286°	44°

*Soviet predictions