New Year in Space

NASA zeros in on planet Earth

By RON COWEN

From ultraviolet imaging of the heavens to a long-awaited exploration of the sun's polar regions, an assortment of projects forms the lineup of NASA's 1994 mission schedule. But the majority of flights this year — running the gamut from ozone measurements to radar imaging of ocean and land features — zero in on planet Earth. And with a little bit of luck, a spacecraft will take the first close-up portrait of a near-Earth asteroid.

As usual, mechanical and operational delays will likely alter the flight schedule over the year. But the following calendar gives the space agency's best estimate for research flights throughout 1994.

January: On Jan. 25, an unusual mission kicks off the year in space science. The satellite Clementine, sponsored by the Pentagon's former "Star Wars" office, will test an armada of high-tech detectors by orbiting and observing the moon. Many of the detectors on board, though not ideal for high-resolution science studies, will provide new observations of the moon in visible, ultraviolet, and infrared light.

If all goes well, Clementine will fly by the near-Earth asteroid Geographos on Aug. 31, just before the end of the mission. This would be the first time a spacecraft has encountered an asteroid that lies so close to our planet. But astronomers caution that because Clementine — in contrast to the typical research mission — doesn't have redundant hardware in case of equipment failure, the craft may not last long enough to meet the asteroid. Indeed, says Richard P. Binzel of the Massachusetts Institute of Technology, given all the maneuvers the craft must perform before meeting the asteroid, the craft may only have about a 50 percent chance of surviving until the encounter.

March: A space shuttle will host the second flight of the U.S. Microgravity Payload. These missions, which NASA hopes to continue about once a year, investigate the effects of the space environment on a variety of materials. Mounted on carriers open to space instead of housed in a pressurized space laboratory, experiments are limited to those that shuttle crew members can conduct using remote commands.

Also this month, one of NASA's frequent fliers — the Shuttle Solar Backscatter Ultraviolet (SSBUV) experiment — will hitch a ride on a shuttle orbiter for the sixth time. During its eight-day sojourn, SSBUV will once again measure concentrations of ozone, the fragile blanket of gas that protects life on Earth by absorbing much of the sun's harmful ultraviolet radiation. The satellite accomplishes this task by comparing the amount of solar ultraviolet radiation striking Earth with the amount scattered back into space by our planet's atmosphere. The greater the amount of light scattered, the lower the concentration of ozone.

The instrument will allow scientists to compare ozone measurements and calibrate ozone detectors on such long-duration craft as the NOAA-9 and NOAA-11 weather satellites and NASA's Upper Atmosphere Research Satellite (UARS). Simultaneous measurements made by the various SSBUV missions and the UARS will allow researchers to assess long-term changes in the ozone concentration in the stratosphere.

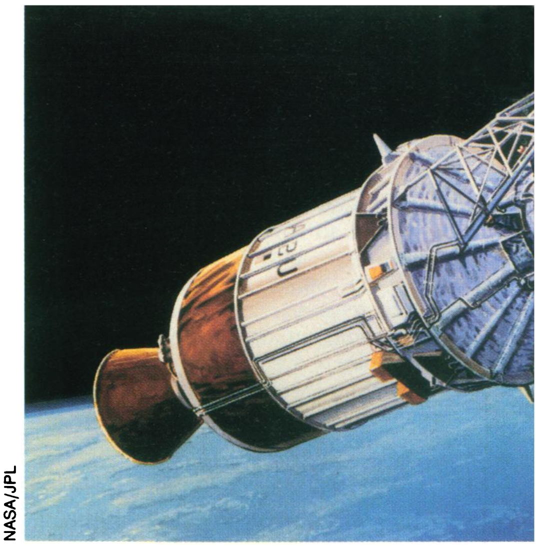
April: NASA plans three launches in the fourth month of 1994.

Mounted in the shuttle's cargo bay, the Space Radar Laboratory, making the first of two 1994 flights, will study Earth's surface and atmosphere using two instruments. Shuttle Imaging Radar, built in collaboration with the German and Italian space programs, will use a 12-meter radio antenna to take radar images of land, ocean, snow, and ice cover at three radio wavelengths.

A second instrument, Measurement of Air Pollution from Space (MAPS), will map the distribution of carbon monoxide in the atmosphere, a chemical implicated in the buildup of greenhouse gases.

Using an Atlas rocket, NASA also plans to send aloft another weather satellite in the Geostationary Operational Environmental Satellite series. Known as GOES-I, the craft will snap pictures of the atmosphere, measure variations in atmospheric temperature and humidity, and monitor wind velocity and the development of storms over Earth's western hemisphere.

Also in April, a craft called Wind will join the ranks of an international group of instruments designed to study the sun's influence on Earth. In particular, this satellite will study the impact of the solar wind — the stream of charged particles that continuously blows out from the sun. The stream exits the sun through regions of exceptionally low atmospheric density and temperature known as coronal holes. Wind will act, in part, as an early warning system, detecting global magnetic storms, auroras, and other disturbances triggered by the solar wind.


NASA/JPL

During the first part of its mission, the craft will take readings in the turbulent region where the solar wind bounces back from a shock wave that forms when the wind rams into Earth's magnetic field.

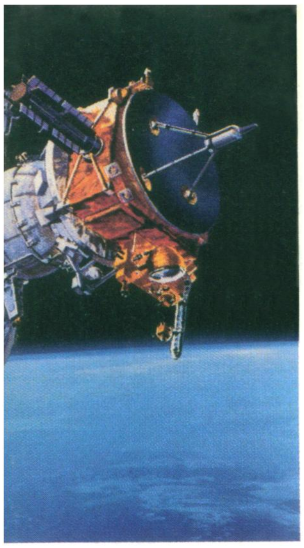
To reach its final flight path, Wind will swing by the moon for a gravitational kick that will hurl it into its new orbit, some 1.4 million kilometers from Earth.

At that distance, the gravitational tug of Earth balances exactly that of the sun, and the craft will experience no net gravitational force. Careful navigation and an onboard propulsion system will then keep the craft in its prescribed orbit about the sun, in front of our planet.

This will enable Wind to record the impact of the solar wind one to two hours before the ion stream strikes our planet's magnetosphere, the region in which Earth's magnetic field exerts a strong influence. In combination with other instruments that directly measure Earth's magnetosphere, the craft's detectors should show how Earth responds to different intensities of solar wind.

May: NASA plans to launch another weather satellite for the National Oceanic and Atmospheric Administration (NOAA). Known as the Polar Orbiting Environmental Satellite, now called NOAA-J, the craft will track hurricanes and other weather phenomena from an orbit that circles the poles of Earth. Because it flies at lower altitudes than weather satellites in geostationary orbits (such as GOES-I), which monitor weather at a single spot on Earth, this craft can record more accurate temperatures at a variety of depths and locations in the atmosphere.

Also in May, NASA will launch another in its continuing series of probes to measure global ozone concentrations. Known as the Total Ozone Mapping Spectrometer (TOMS), this instrument is the third generation to fly in space. The last TOMS flew on a Russian satellite in 1991.



Launched in 1990, Ulysses this May will begin a four-month exploration of the sun's south pole. The craft is the first to embark on such a study.

The instrument monitors ozone at six wavelengths ranging from 3,100 to 3,800 angstroms. In addition to monitoring ozone, the new TOMS will also measure the amount of sulfur dioxide released by volcanic eruptions.

Two years ago, the Ulysses spacecraft — a joint venture of NASA and the European Space Agency — swung close to Jupiter, using the planet's gravity as a slingshot to hurl the craft out of the plane in which the planets orbit the sun (SN: 2/22/92, p.118).

In May, Ulysses embarks on an exploration of the sun's polar regions by passing over the solar south pole — a feat accomplished by no other spacecraft. Ulysses will reach 70 degrees south solar latitude in May and spend about four months even farther south at a distance of about 330 million kilometers from the sun — about twice the Earth-sun span.

Nine onboard instruments will collect information about the sun's outer atmosphere, or corona; the solar wind; the sun's magnetic field; and cosmic radiation from outside the solar system. (In February 1995, Ulysses will cross the sun's equator and in May of that year begin a similar four-month exploration of the sun's northern polar region.)

June: Complementing the April launch of Wind, NASA this month sends aloft the Polar satellite, which will carry 11 instruments to monitor the flow of the solar wind within Earth's magnetosphere. The craft will track the movement of charged particles from the sun over Earth's magnetic poles. By photographing the northern aurora, the satellite will also observe the energy exchange between the ionosphere, the region just above Earth's upper atmosphere, and the magnetosphere.

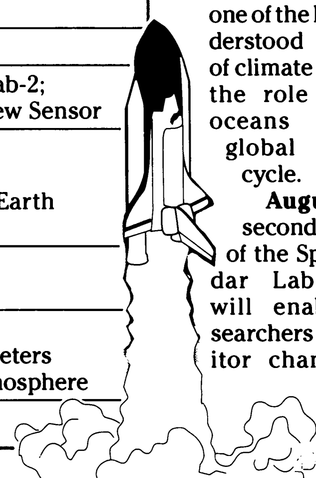
July: The second in a series of hands-on microgravity investigations flies aboard the space shuttle. Like its 1992 predecessor, the International Microgravity Laboratory-2 will explore the effects of weightlessness on several biological systems and on certain materials.

An international flight crew will tend the experiments, which are housed during the seven-day mission in a reusable workshop known as Spacelab. The crew will themselves undergo biomedical tests to assess changes in the eye, inner ear, and nervous system associated with the low-gravity environment in orbit.

By analyzing the color of the seas, a second mission scheduled for July will measure the distribution of phytoplankton, tiny organisms that remove carbon from the atmosphere and serve as an underwater storehouse for the element. In mapping the distribution of phytoplankton, the Sea-Viewing Wide Field-of-View Sensor will illuminate one of the least understood aspects of climate change: the role of the oceans in the global carbon cycle.

August: A second launch of the Space Radar Laboratory will enable researchers to monitor changes in Earth's atmosphere and surface at a different season (see April).

Month	Event
January	Clementine
March	U.S. Microgravity Payload-2; Shuttle Solar Backscatter Ultraviolet experiment
April	Space Radar Laboratory-1; GOES-I (weather satellite); Wind
May	NOAA-J (weather satellite); Total Ozone Mapping Spectrometer; Ulysses begins pass over sun's south pole
June	Polar
July	International Microgravity Lab-2; Sea-Viewing Wide Field-of-View Sensor
August	Space Radar Lab-2; FAST; Clementine encounters near-Earth asteroid
September	Spartan 201; LITE
October	ATLAS-3; Cryogenic Infrared Spectrometers and Telescopes for the Atmosphere
November	Astro-2



NASA will also launch one of its "small-class explorers" this month to study Earth's auroras, the brilliant colored lights above the planet's polar regions. These displays occur when charged particles trapped in Earth's magnetic field crash into uncharged particles in the atmosphere, prompting them to emit radiation. The Fast Auroral Snapshot (FAST) satellite will monitor the electric and magnetic fields and charged particles just above the auroras, probing the mechanisms that generate these fireworks. The satellite's observations will complement those of higher-flying spacecraft, such as Polar (see June), which will photograph the aurora from above. At the same time, observatories on the ground will collect information about how rapidly the energetic processes recorded by FAST affect Earth. FAST is designed to operate for at least a year.

September: Two telescopes aboard Spartan 201, a small, Earth-orbiting satellite to be launched by a space shuttle, will continue this year's exploration of the sun and its wind of charged particles. During its 40-hour mission, Spartan 201 will attempt to shed new light on the force driving the solar wind, which appears to originate in the sun's corona. It will also try to elucidate the mechanism that makes the solar corona so much hotter than the sun's visible surface — even though the surface lies nearer the extremely hot solar core.

The satellite will carry its own pointing system, batteries, and tape recorder for storing data. Once the doors to the shuttle's payload bay open, a crew member will use a robotic arm to release the independent satellite. After it flies on its own for 27 orbits, an astronaut will grab the satellite with the robotic arm and place it back in the payload bay for the return to Earth.

Spartan 201's two telescopes will study the corona and its connection with the solar wind in different but complementary ways.

One of the telescopes, the Ultraviolet Coronal Spectrometer, will detect ultraviolet light emitted by atomic hydrogen and ions in the corona. The emissions may help determine which of two theories about coronal heating may be correct.

Some astronomers propose that the corona's heat stems from intermittent but powerful microflares, created when magnetic loops in the corona suddenly snap like a rubber band and release vast amounts of stored energy. Others suggest that sound waves produced in the turbulent region beneath the sun's visible surface create shock waves that heat the corona.

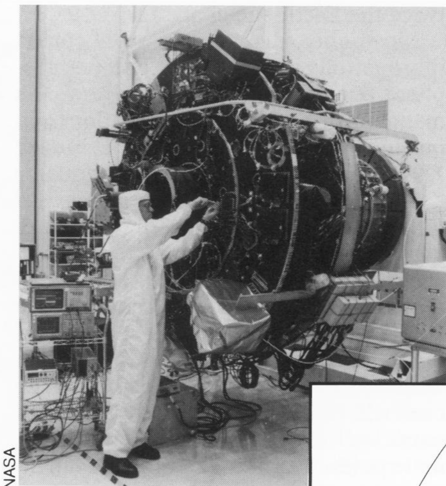
While the spectrometer aboard Spartan 201 lacks the resolution to observe either the microflares or the shocks directly, the satellite should discern their differing effects on the corona and solar wind flow.

The craft's other telescope, the White-Light Coronagraph, detects visible light to determine the density of electrons in different parts of the corona, both in closed magnetic-field loops and in open magnetic-field structures. These observations may help track the bulk flow of the corona and pinpoint regions where material in the corona expands and becomes part of the solar wind.

On the same September shuttle flight, scientists will test a laser system designed to investigate atmospheric chemistry. Known as LITE, for LIDAR In-Space Technology Experiment, this pilot study will examine the composition of aerosols in the stratosphere and troposphere, gauge the altitudes of clouds, and measure the temperature and density of the upper atmosphere in the range of 10 to 40 kilometers.

A transmitter on the LITE payload generates 10 laser pulses per second at three wavelengths, directing the pulses into Earth's atmosphere. Aerosols and clouds in the atmosphere scatter some of the laser light back toward LITE, and a telescope collects the backscattered signals and directs them to an optical receiver.

October: For the third time, a suite of instruments dedicated to studying the chemistry of ozone creation and destruction will ride aboard a shuttle orbiter. The third flight of the Atmospheric Laboratory for Applications and Science (ATLAS-3) will examine Earth's atmosphere and the energy output of the sun to better understand ozone processes.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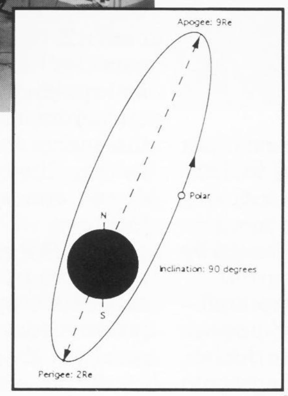

The Polar satellite, which NASA plans to send aloft in June, will orbit Earth's polar regions to monitor the flow of the solar wind within our planet's magnetosphere and to photograph the northern aurora.

Because scientists will precisely calibrate the ATLAS instruments just before launch and after its return, engineers can use these detectors to verify the accuracy of data from several similar or identical devices aboard NASA and NOAA satellites.

The same shuttle flight will also carry a new set of cooled infrared spectrometers and telescopes to observe the atmosphere. The assembly, known as the Cryogenic Infrared Spectrometers and Telescopes for the Atmosphere (CRISTA), will be released from the shuttle and float freely in space to make its observations. The shuttle crew will then retrieve CRISTA for its return to Earth.

November: Astro-2, NASA's final mission of the year, features a trio of telescopes that will image the heavens and take the spectra of faint astronomical objects in the far ultraviolet. One of the telescopes will study the polarization of ultraviolet light emitted by hot stars and galaxies to investigate such phenomena as their magnetic fields. All of the instruments, which will make observations during a 10-day flight aboard the space shuttle, are holdovers from the first Astro mission (SN: 1/5/91, p.10), which also included an X-ray detector. □