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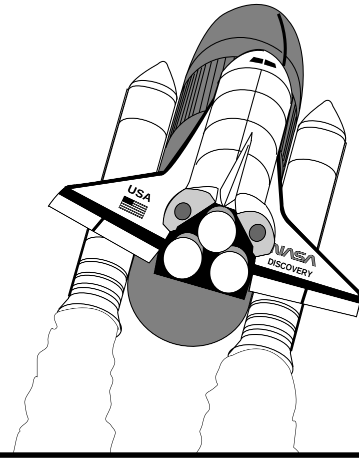

The Atmosphere Below

Video Resource Guide

VRG-006-12/92

Application: Earth Sciences
Video Length: 16:00
Description: Changes in Earth's atmosphere are investigated from outer space onboard the Space Shuttle.

Shuttle Mission Facts

Orbital scenes were taken during the STS-45 mission with a few additional scenes from the STS-48 mission.

Orbiter: *Atlantis*
Mission Dates: March 24-April 2, 1992
Commander: Charles F. Bolden, Jr. (Col., USMC)
Pilot: Brian Duffy (Lt. Col., USAF)
Payload Commander: Kathryn D. Sullivan (Ph.D.)
Mission Specialist: David C. Leestma (Capt., USN)
Mission Specialist: C. Michael Foale (Ph.D.)
Payload Specialist: Byron K. Lichtenberg (Sc.D.)
Payload Specialist: Dirk D. Frimout (Ph.D.)
Mission Duration: 8 days 22 hours 9 minutes
Distance Traveled: 5,994,555 kilometers
Orbit Inclination: 57 degrees
Number of Orbits: 143
Orbital Altitude: 296 kilometers
Payloads and Experiments:

- ATLAS 1 - Atmospheric Laboratory for Applications and Science
- SSBUV-A - Shuttle Solar Backscatter Ultraviolet Instrument
- CLOUDS - Cloud Logic to Optimize the Use of Defense Systems
- SAREX - Shuttle Amateur Radio Experiment
- IPMP - Investigations into Polymer Membrane Processing
- STL1 - Space Tissue Loss
- VFT-II - Visual Function Tester
- RME-III - Radiation Monitoring Equipment III
- Getaway Special Experiment

Background

Over the past several years, news reports have increasingly focused on potential problems occurring in Earth's atmosphere. Ozone holes, global warming, air pollution emissions, and predicted increases in skin cancers have caught the attention of scientists, environmentalists, and political leaders around the world. Many believe that important changes may be taking place in the atmosphere that could have a profound impact on all life. But much about the atmosphere is still unknown. It is a dynamic system of complex chemical and physical interactions. Because of its dynamic nature, the atmosphere is difficult to understand and model.

The atmosphere receives radiation from the Sun and is bombarded by a continuing stream of particles from the Sun and from deep space. Surrounding Earth is a magnetic field that captures electrically charged particles and brings them in contact with the atmosphere's upper reaches. The gases in the atmosphere absorb radiation at wavelengths that could be harmful to life, preventing them from reaching Earth's surface. Temperatures and chemical reactions vary widely through the atmosphere's different layers. Near Earth's surface, interactions take place with the land, ocean, and with human-made pollutants. Furthermore, the atmosphere changes from day to night, season to season, and from the equator to the poles.

Atmospheric measurements taken at Earth's surface and from balloons and sounding rockets tell only part of the story. Scientists also need data gathered from the high vantage point of Earth orbit. In March1992, NASA embarked on an important new series of atmospheric studies made from space that take advantage of the unique capabilities of the Space Shuttle. These studies may help us answer some perplexing questions about the atmosphere's future and our own.

The Space Shuttle *Atlantis* carried the first of the Spacelab missions devoted to the study of the atmosphere. On board was the Atmospheric Laboratory for Applications and Science (ATLAS 1), a collection of 13 instruments designed to conduct 14 investigations in atmospheric science, solar science, space plasma physics, and astronomy for scientists from the United States, Belgium, France, Germany, Japan, Switzerland, and the Netherlands. From a 296-kilometer-high orbit inclined 57 degrees with respect to Earth's equator, the ATLAS 1 payload was in an advantageous position to observe the atmosphere, the Sun, and astronomical targets. During the 9-day mission, the instruments measured the total energy contained in sunlight and how that energy varies; measured the chemical composition of Earth's upper atmosphere; investigated how Earth's electric and magnetic fields and the atmosphere influence one another; and examined sources of ultraviolet light in the universe.

During the mission, the crew of seven maneuvered the spacecraft and continuously controlled and monitored the experiments in consultation with investigators and planners on the ground.

<u>Preliminary Mission Results</u>

During the ATLAS 1 mission, the Atmospheric Trace Spectroscopy (ATMOS) instrument surveyed atmospheric trace molecules by measuring the effects they have on infrared radiation. Similar measurements were also taken by the GRILLE Spectrometer. The data from these two instruments saw the presence of aerosol bands in the atmosphere that are remnants of the Mt. Pinatubo volcanic eruption in the Philippines last year. Future ATLAS missions will continue to survey those same remnants to determine how much they dissipated.

As a part of the 13 instruments of the ATLAS payload, *Atlantis* carried the Shuttle Solar Backscatter Ultraviolet Instrument (SSBUV-A) that has flown previously on three Shuttle missions. The SSBUV-A is similar to instruments on NIMBUS and TIROS satellites that measure ozone concentrations at various levels in the atmosphere. Over time, the performance of the instruments in space may degrade, making the accuracy of the readings suspect. Measurements taken by the SSBUV-A are being compared to those from the satellites to reestablish satellite instrument accuracy and to validate previously transmitted data. The Millimeter Wave Atmospheric Sounder (MAS) instrument on ATLAS also recorded important measurements on ozone and chlorine monoxide, a key trace molecule involved in the destruction of ozone. MAS was used for comparison with similar instruments on the Upper Atmosphere Research Satellite (UARS) which was launched in 1991 by the Space Shuttle *Discovery.*

In a similar vein, the Solar Ultraviolet Irradiance Monitor (SUSIM) and the Active Cavity Radiometer (ACR) provided data that will insure the continued accuracy of similar instruments UARS. SUSIM made very accurate measurements of the wavelength dependence of solar ultraviolet output. The ACR instrument also measured ultraviolet radiation and, along with the Measurement of Solar Constant (SOLCON) instrument, provided a very accurate measure of the solar constant, the total amount of energy the Sun constantly delivers to the atmosphere over all wavelengths regions. Scientists theorize that changes in the constant of only 0.5 percent per century could lead to global climatic changes ranging from tropical to ice age conditions.

With two exceptions, all 13 ATLAS 1 instruments had no major problems. In spite of blown fuses on 2 of the instruments (Far Ultraviolet Space Telescope or FAUST and Space Experiments with Particle Accelerators or SEPAC), all 14 investigations supported by the instruments received significant data. The FAUST instrument provided astronomers with their first opportunity to explore wide areas of the sky in the far ultraviolet radiation wavelength range. Most ultraviolet light coming to Earth from space is filtered out by Earth's atmosphere, making it essential to travel into space to study this radiation. Previous space-flown ultraviolet instruments have focused on narrow regions of the sky. Before its power failure, FAUST observed the nearby Large Magellanic Cloud galaxy to gain information that may help astronomers better understand the evolution of our own galaxy. A gas trail behind the cloud was observed that could indicate a region of star formation. FAUST also made observations of galaxy clusters in the Virgo, Telescopium, Dorado, and Ophicus constellations.

The SEPAC instrument was used for controlled experiments that were successful in generating the first artificial auroras ever produced in Earth's upper atmosphere. By firing a 7.4 kilowatt electron beam into Earth's upper atmosphere, electrons circling atmospheric nitrogen and oxygen atoms and molecules were excited to higher energy levels. As they returned to lower levels, they released light, forming high intensity auroras several kilometers in diameter. Forty of the sixty beams produced artificial auroras and were imaged by the Atmospheric Emission Photometric Imaging experiment mounted in *Atlantis*'s payload bay. The energy output of these auroras was greater than the energy input from the beam, indicating that the beam may have triggered larger reactions in the atmosphere. SEPAC was also used to investigate the interaction of ionized and neutral gases in space by injecting over 1,000 xenon gas clouds into the atmosphere. Furthermore, SEPAC generated radio waves with about 100,000 electron beam pulses. The pulses were observed by ATLAS 1 instruments and by over 100 receivers on the ground in the United States and Japan.

Classroom Activities

NASA has published a major curriculum guide on the objectives of the ATLAS missions. The guide, Earth's Mysterious Atmosphere - ATLAS 1 Teacher's Guide with Activities, EP-274/2-92 is available from NASA. Please refer to the reference list for details on how to obtain this curriculum guide.

References

- To request copies of the NASA publications below, write:

  NASA Education Division
  Code FET
  NASA Headquarters
  Washington, DC 20546

- Publication text is also available from NASA SPACELINK. See references and resources section below.
- To request copies of videotapes and slide sets, write to:

  NASA CORE
  Lorain County Joint Vocational School
  15181 Route 58 South
  Oberlin, OH 44074

DOE (1991), The Greenhouse Effect, United States Department of Energy, Washington, DC.

NASA (1992), ATLAS Educator Slide Set, NASA Education Division, Washington, D.C.

NASA (1992), Earth's Mysterious Atmosphere - ATLAS 1 Teacher's Guide with Activities, EP-274/2-92, NASA Education Division, Washington, D.C.

NASA (1991), "Shuttle Amateur Radio Experiment (SAREX) for STS-45," SAREX2-Dec91, NASA Education Division, Washington, D.C.

NASA (1991), Beyond The Clouds, NASA educational videotape.

Terms

Atmospheric Laboratory for Applications in Science (ATLAS) - Series of Spacelab-based missions to study the nature of Earth's atmosphere, environmental problems, and the atmosphere's relationship to the outer space environment.

Carbon Dioxide - Molecule consisting of one atom of carbon and two of oxygen.

Chlorofluorocarbons - A series of human-made chemical compounds used in cooling and other applications.

Global Warming - A suspected increase in worldwide temperatures.

Greenhouse Effect - Trapping of solar energy by gases in Earth's atmosphere.

Methane - Molecule consisting of one atom of carbon and four of hydrogen.

Oxides of Nitrogen - A group of molecules consisting of nitrogen and oxygen.

Ozone - Molecule of oxygen consisting of three atoms of oxygen.

Ozone Depletion - The destruction of upper atmosphere ozone molecules through the action of human-made chemicals and sunlight.

Ultraviolet Radiation - Short wave electromagnetic radiation just beyond the visible violet light.

Upper Atmosphere Research Satellite (UARS) - Scientific satellite launched by the STS-48 mission in 1991.

NASA (1989), The Upper Atmosphere, A Program to Study Global Ozone Change, 3/89:20K.

Rosenthal, D. & Golden, R. (1991), Global Warming High School Science Activities, Climate Protection Institute, San Francisco.

Snow, R. & Golden, R. (1991), Global Warming Social Studies Activities, Climate Protection Institute, San Francisco.

USA Today (1990), Earth Today - Your Place in the Environment, Teacher's Guide, Gannett Co., Inc.

WP Press (1992), Earthwise Environmental Learning Series, Sunlight, V1n2, WP Press, Tucson.

NASA SPACELINK provides information about current and historic NASA programs, lesson plans, and the text from previous Mission Watch and Mission Highlights fact sheets. Anyone with a personal computer, modem, communications software, and a long distance telephone line can communicate directly with NASA SPACELINK. Use your computer to dial 205-895-0028 (8 data bits, no parity, and 1 stop bit). NASA SPACELINK may also be accessed through Internet through the following address:

spacelink.msfc.nasa.gov
xsl.msfc.nasa.gov
128.158.13.250

STS-45 Crew Biographies

Charles F. Bolden, Jr. (Col., USMC). Charles Bolden was born in Columbia, South Carolina. He earned a bachelor of science degree in electrical science from the United States Naval Academy and a master of science in systems management from the University of Southern California. After graduation, Bolden became a naval aviator and later a test pilot. He has logged more than 5,000 hours flying time. Bolden became an astronaut in 1981 and has flown in space twice previously, as pilot of the STS-61C and STS-31 missions.

Brian Duffy (Lt. Col., USAF). Brian Duffy was born in Boston, Massachusetts. He received a bachelor of science degree in mathematics from the U.S. Air Force Academy and a master of science degree in systems management from the University of Southern California. Upon graduation Duffy completed pilot and test pilot training. Duffy became an astronaut in 1986. This was his first space flight.

Kathryn D. Sullivan (Ph.D.). Kathryn Sullivan was born in Paterson, New Jersey, but considers Woodland Hills, California her home. She earned a bachelor of science degree in Earth sciences from the University of California, Santa Cruz, and a doctorate in geology from Dalhousie University (Halifax, Nova Scotia). Dr. Sullivan is an oceanography officer in the U.S. Naval Reserve and an Adjunct Professor of Geology at Rice University, Houston, Texas. Dr. Sullivan became an astronaut in 1979 and has flown previously as a mission specialist on STS-41G and on STS-31.

David C. Leestma (Capt., USN). David Leestma was born in Muskegon, Michigan. He graduated from the U.S. Naval Academy and earned a master of science degree in aeronautical engineering from the U.S. Naval Postgraduate School. He then became a naval aviator. Prior to this mission, Leestma served as a mission specialist on the crews of STS-41G and STS-28.

C. Michael Foale (Ph.D.). Michael Foale was born in Louth, England, but considers Cambridge, England, to be his hometown. He attended the University of Cambridge, Queens' College, receiving a bachelor of arts degree in physics and a doctorate in laboratory astrophysics. Foale joined NASA Johnson Space Center in 1983 in the payload operations area of the Mission Operations Directorate. He was selected as an astronaut in 1987. This was his first space flight.

Byron K. Lichtenberg (Sc.D.). Byron Lichtenberg was born in Stroudsburg, Pennsylvania. He received a bachelor of science degree in aerospace engineering from Brown University, a master of science degree in mechanical engineering from MIT, and a doctor of science degree in biomedical engineering from MIT. Upon receiving his undergraduate degree, Lichtenberg entered the Air Force and became a pilot. He served as a payload specialist on the STS-9 (Spacelab-1) mission. This was his second flight.

Dirk D. Frimout (Ph.D.). Dirk Frimout was born in Poperinge, Belgium. He received the degree of electrotechnical engineer at the State University of Ghent (Belgium) and a doctorate in applied physics from the University of Ghent. He performed postdoctoral work at the University of Colorado, Laboratory of Atmospheric and Space Physics. Dr. Frimout is senior engineer in the Payload Utilization Department of the Columbus Directorate of the European Space Agency (ESA) and has been responsible for ESA support to the European experiments on ATLAS-1 since 1985. He was selected as a flight payload specialist in 1991. This was Dr. Frimout's first space flight.

Flight Crew Operations Directorate
NASA Johnson Space Center 12/92

The Atmosphere Below

Videotape and Video Resource Guide Evaluation

The National Aeronautics and Space Administration would appreciate your taking a few minutes to evaluate *The Atmosphere Below* video tape and accompanying guide. Your feedback will be of great assistance in helping to develop new educational materials. When completed, please fold on the dotted line, and staple or tape, and return it to us by mail. Thank you.

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