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Upper Atmosphere Research Satellite (UARS)

The Upper Atmosphere Research Satellite (UARS) is the first major flight element of NASA's Mission to Planet Earth, a multi-year global research program that will use ground-based, airborne and space-based instruments to study the Earth as a complete environmental system. Mission to Planet Earth is NASA's contribution to the U.S. Global Change Research Program, a multi-agency effort to better understand, analyze and predict the effect of human activity on the Earth's environment.

UARS is designed to help scientists learn more about the fragile mixture of gases protecting Earth from the harsh environment of space. UARS will provide scientists with their first complete data set on the upper atmosphere's chemistry, winds and energy inputs.

One of UARS' focuses will be an area in which humanity's technological advancement is changing the Earth on a global scale -- depletion of ozone in the stratosphere, or upper atmosphere. The stratosphere ranges from approximately 9 to 30 miles above the Earth's surface. Ozone, a molecule made up of three oxygen atoms, blocks ultraviolet light that can cause skin cancer and damage food crops.

Although there are some natural causes of stratospheric ozone depletion, such as volcanic eruptions, the "ozone hole" that forms over Antarctica in the Southern Hemisphere's spring season and the 5 percent depletion observed over northern mid-latitudes in the last decade are a direct consequence of human activity. These long-term ozone trends are caused by chlorine compounds released into the atmosphere as byproducts of industry, including refrigeration and the making of plastic foam.

To study ozone depletion more completely and to better understand other aspects of Earth's fragile atmosphere, scientists need the global perspective available from an orbiting satellite, one that makes simultaneous measurements of all the factors of ozone depletion with state-of-the-art instruments. To that end, the UARS science program has been designed as a single experiment with nine component instruments that will study the upper atmosphere's chemical, dynamic and energy systems. In addition to the UARS instrument science teams, 10 other teams will use the data to improve theoretical models of the upper atmosphere and consequently, scientists' ability to predict the effects of change in the atmosphere.

An extensive program of correlative investigations using ground-based, aircraft and balloon-carried instruments is also planned. As a whole, the UARS program is designed to give scientists the data they need to address the challenge of Mission to Planet Earth -- to understand and predict the effect of human activity on the environment.

UARS's nine complementary scientific instruments each provide measurements critical to a more complete understanding of the upper atmosphere, concentrating their observations in chemistry, dynamics and energy input.

UARS carries a 10th instrument, the Active Cavity Radiometer II (ACRIM II), that is not technically part of the UARS mission. ACRIM II will take advantage of a flight opportunity aboard UARS to study the Sun's energy output, an important variable in the study of the Earth's climate.

Chemistry Studies

Four of UARS' instruments will measure the concentrations and distribution of gases important to ozone depletion, climate change and other atmospheric phenomena.

Cryogenic Limb Array Etalon Spectrometer

Like all spectrometers, the Cryogenic Limb Array Etalon Spectrometer (CLAES) will search for the tell-tale spectra that indicate the presence of certain chemicals. In particular, CLAES will determine concentrations and distributions by altitude of nitrogen and chlorine compounds, ozone, water vapor and methane, all of which take part in the chemistry of ozone depletion. Principal Investigator for CLAES is Dr. Aidan E. Roche, Lockheed Palo Alto Research Laboratory, Palo Alto, Calif. Dr. John Gille of the National Center for Atmospheric Research, Boulder, Colo., is a collaborative investigator.

Improved Stratospheric and Mesospheric Sounder

The Improved Stratospheric and Mesospheric Sounder (ISAMS) will study atmospheric water vapor, carbon dioxide, nitrous oxide, nitric acid, ozone, methane and carbon monoxide. Like CLAES, ISAMS detects infrared radiation from the atmosphere and uses it to derive information on atmospheric temperature and composition. Principal Investigator for ISAMS is Dr. Fred W. Taylor, University of Oxford, Department of Atmospheric Physics, Oxford, United Kingdom. Dr. James M. Russell III of NASA's Langley Research Center, Hampton, Va., is a collaborative investigator.

Microwave Limb Sounder

The Microwave Limb Sounder (MLS) will provide, for the first time, a global data set on chlorine monoxide, the key intermediate compound in the ozone destruction cycle. MLS data also will be used to generate three-dimensional maps of ozone distribution and to detect water vapor in the microwave spectral range. Principal Investigator for MLS is Dr. Joseph W. Waters, NASA's Jet Propulsion Laboratory, Pasadena, Calif.

Halogen Occultation Experiment

The Halogen Occultation Experiment (HALOE) will observe the vertical distribution of hydrofluoric acid, hydrochloric acid, methane, carbon dioxide, ozone, water vapor and members of the nitrogen family. Each day, HALOE will observe 28 solar occultations, that is, it will look through Earth's atmosphere toward the sun to measure the energy absorption of the Sun's rays by these gases. Principal Investigator for HALOE is Dr. James M. Russell III, NASA's Langley Research Center, Hampton, Va.

Dynamics

Two instruments, the High Resolution Doppler Imager and the Wind Imaging Interferometer, will provide scientists with the first directly measured, global picture of the horizontal winds that disperse chemicals and aerosols through the upper atmosphere.

High Resolution Doppler Imager

By measuring the Doppler shifts of atmospheric chemicals, the High Resolution Doppler Imager (HRDI) will measure atmospheric winds between 6.2 and 28 miles and above 34 miles. These data are important to understanding the essential role of atmospheric motion on the distribution of chemicals in the upper atmosphere. Principal Investigator for HRDI is Dr. Paul B. Hays, University of Michigan, Space Physics Research Laboratory, Ann Arbor.

Wind Imaging Interferometer

The Wind Imaging Interferometer (WINDII) also will use the Doppler shift measurement technique to develop altitude profiles of horizontal winds in the upper atmosphere. WINDII's measurements will tell scientists about the winds at and above 49 miles. Principal Investigator for WINDII is Dr. Gordon G. Shepherd, York University, Ontario, Canada. The investigation is provided by a partnership between Canada and France, with the latter making important contributions to the data analysis software.

Energy Inputs

Three instruments, the Solar Ultraviolet Spectral Irradiance Monitor, the Solar Stellar Irradiance Comparison Experiment, and the Partial Environment Monitor, will measure solar energy that reaches the Earth and study its effect on the atmosphere.

Solar Ultraviolet Spectral Irradiance Monitor

Ultraviolet light from the Sun is the driver of the ozone cycle, dissociating chlorine compounds into reactive chlorine atoms that in turn break up ozone molecules . The Solar Ultraviolet Spectral Irradiance Monitor (SUSIM) will measure solar ultraviolet energy, the most important spectral range in ozone chemistry. Principal Investigator for SUSIM is Dr. Guenter E. Brueckner, Naval Research Laboratory, Washington, D.C.

Solar Stellar Irradiance Comparison Experiment

Like SUSIM, the Solar Stellar Irradiance Comparison Experiment (SOLSTICE) will conduct in-depth ultraviolet studies of the Sun. SUSIM will compare the Sun's ultraviolet energy to the UV radiation of bright blue stars, providing a standard against which the solar energy level can be measured in future long-term monitoring of the Sun. Principal Investigator for SOLSTICE is Dr.

Gary J. Rottman, University of Colorado, Boulder.

Particle Environment Monitor

The Particle Environment Monitor (PEM) will help to answer questions about the effect of energetic particles from the Sun on the upper atmosphere, detecting and measuring the particles as they enter the atmosphere. PEM uses four primary instrument subunits to take detailed particle measurements in different energy ranges. Principal Investigator for PEM is Dr. J. David Winningham, Southwest Research Institute, San Antonio, Texas.

Solar Constant

Active Cavity Radiometer Irradiance Monitor

The Active Cavity Radiometer Irradiance Monitor (ACRIM II) will provide accurate monitoring of total solar activity for long-term climate studies. ACRIM II is an instrument of opportunity, added to the UARS spacecraft after the engineering team determined that the spacecraft could fly a 10th instrument. Though not a part of the UARS program, ACRIM II data is important to other studies within Mission to Planet Earth. Principal Investigator for ACRIM II is Dr. Richard D. Willson, NASA's Jet Propulsion Laboratory, Pasadena, Calif.

Propulsion

The UARS observatory consists of a standard design Multi-mission Modular Spacecraft (MMS), coupled to a module that includes the 10 instruments. The MMS Hydrazine Propulsion Module will power orbit adjustment maneuvers for the initial boost to orbit and maintain the required altitude. The system consists of four 5-pound thrusters and 12 small 0.2-pound attitude control thrusters. The MMS was built by Fairchild, Inc., Germantown, Md.

Modular Attitude Control System

For UARS to make the minute changes in its orientation toward the Earth needed for the long-duration measurements of the atmosphere, the spacecraft must know at all times where it is pointed. To do this, UARS uses a system known as the Modular Attitude Control System (MACS). The MACS subsystem is a three-axis system made up of many flight- proven NASA components contained within the MMS. The system contains sensors that tell UARS where it's pointed and actuators that can point the spacecraft as required. The MACS module originally flew aboard the Solar Maximum Mission (SMM). It was returned to Earth as part of the 1984 SMM repair mission and refurbished for flight aboard UARS.

Communications and Data Handling

The Communications and Data Handling (CADH) system uses software based on proven modular technology that flew on the Solar Maximum Mission and Landsat 4 and 5. The modular programming allows sections of the software to be rewritten or repaired without requiring end-to-end verification of an entire new program. The CADH system consists of the CADH module, a high-gain antenna and two omni-directional low-gain antennas.

The CADH also has a Tracking and Data Relay Satellite System (TDRSS) transponder for communications between UARS and TDRSS. UARS uses a NASA standard spacecraft computer which provides for some autonomous operation of the spacecraft. It will perform such tasks as command processing, attitude determination computations and power management.

Payload Operation and Control Center

Instructions to UARS during its space voyage begin with the controllers at computer terminals located in the UARS Payload Operations Control Center (POCC) at the Goddard Space Flight Center, Greenbelt, Md. The POCC is the focal point for all UARS pre-mission preparations and on- orbit operations. For the UARS mission, the POCC is part of the Multi-satellite Operations Control Center (MSOCC) at Goddard that provides mission scheduling, tracking, telemetry data acquisition, command and processing required for down linked data.

UARS Ground Data System

A dedicated Central Data Handling Facility (CDHF), located at the Goddard Space Flight Center, will process the UARS scientific data. The CDHF is linked to 20 Remote Analysis Computers at the instrument and theoretical principal investigator's home institutions via an electronic communications system. This will make all UARS data available to all investigators. The CDHF also is designed to encourage frequent interactions between the different investigation groups and facilitate quick response to unusual events, such as solar flares and volcanic eruptions.

UARS scientific data will be continuously recorded on two alternating onboard tape recorders at the rate of 32 kilobits per second. Upon acquiring contact with the Tracking and Data Relay Satellite, the UARS data will be transmitted via the NASA Communications Network to the Data Capture Facility (DCF), located at Goddard. The DCF will perform telemetry preprocessing, which includes time- ordering, merging, editing and sorting of the data stream. The output will be transferred to the UARS CDHF.

Thermal Subsystems

Thermal control of UARS during launch and orbital operation will be largely through passive means -- paint, blankets, coatings and temperature sensors augmented by electrical heaters. The CLAES and ISAMS instruments have special cooling requirements met by subsystems within the instruments.

UARS was built and integrated by General Electric Astro-Space Division, Valley Forge, Penn., and East Windsor, N.J. The UARS project is managed by the Goddard Space Flight Center, Greenbelt, Md., for NASA's Office of Space Science and Applications.

Comments and questions: Jennifer Green
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