National Aeronautics and Space Administration

CARRUTHERS GEOCORONA OBSERVATORY

FACT SHEET

The Carruthers Geocorona Observatory is NASA's first mission dedicated to studying the outermost layer of Earth's atmosphere, the exosphere. The Carruthers mission investigates the structure of Earth's exosphere and how it evolves, especially in response to space weather.

WHAT IS THE EXOSPHERE?

The exosphere is the outermost layer of Earth's atmosphere, a region from approximately 310 to perhaps 119,000 miles above Earth's surface (500 to 192,000 kilometers). That is halfway to the Moon! Its full extent is unknown, which is a mystery that the Carruthers mission will be able to solve. In the exosphere, the density of gas particles is so low that they do not collide with each other. The gas is composed primarily of neutral hydrogen, the lightest and most abundant element in the universe. We can observe the exosphere by capturing images of ultraviolet (UV) light emitted by the Sun that is scattered in all directions by the hydrogen. This UV glow of the exosphere is called the geocorona.

THE CARRUTHERS MISSION INVESTIGATES THE ROLE EARTH'S EXOSPHERE PLAYS IN:

Space weather

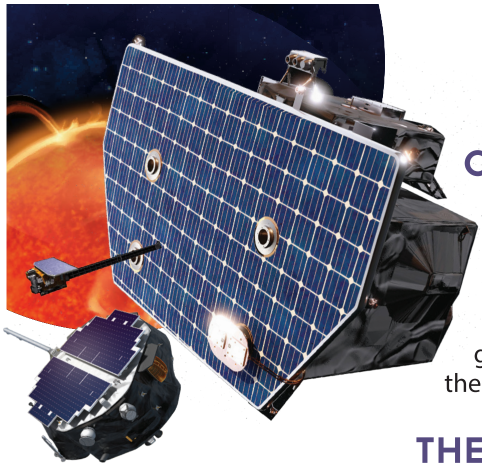
Disturbances in the solar wind can impact Earth and create geomagnetic storms. These storms can be a danger to our technology, including spacecraft, communications passing through our atmosphere, and power grids on the ground. As our reliance on technology grows, we need to better understand and predict space weather storms. The exosphere's response to these storms is one of the missing pieces of the puzzle. We have only ever taken four images of the global exosphere and have otherwise been limited to observations taken from within. With so few observations to date, we do not know how the exosphere responds to incoming solar wind, and solar storms. We also expect that the exosphere helps Earth recover from geomagnetic storms by draining the energy out of the huge electrical currents that they cause in our atmosphere.

Atmospheric escape from planets

Planets can lose their atmospheres over time. High-energy radiation (UV, X-rays, gamma rays, cosmic rays) and chemical reactions can break apart molecules in planetary atmospheres. Low mass particles, like hydrogen, diffuse up into the exosphere where they can achieve escape velocity from Earth's gravity into interplanetary space. Surface water is lost this way:

- Liquid water evaporates into the atmosphere
- H_2O breaks up into H and O
- H escapes

Carruthers studies how this process works on Earth. When we combine this knowledge with studies of the atmospheric loss process on Mars, which does not have a global magnetic field like Earth, it will give us a more complete picture of how planets lose their surface water. Since all life as we know it requires liquid water, this will be important for understanding the long-term habitability of terrestrial worlds in our solar system and beyond.



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OUR NAMESAKE

The geocorona was first observed in 1972 during the Apollo 16 mission to the Moon with a telescope invented by Dr. George Carruthers. Dr. Carruthers developed a technique to observe the invisible UV glow from the exosphere that our new mission named in his honor still uses. Scientists were surprised by how large the exosphere was. It extended beyond the field of view of the Carruthers telescope. To see the whole geocorona we need a vantage point much farther away than the Moon. This is why there have only been three other images of the geocorona since Apollo 16.

THE OBSERVATORY

The primary science instrument consists of two UV cameras: one with a wide field of view (WFI) and one with a narrow field of view, giving it a close-up perspective of Earth (NFI).

An additional instrument was designed and built by students, called COSSMo. This instrument is independent of GCI and looks in the opposite direction to measure the brightness of the Sun in UV and X-rays. Its observations complement the observations of how Earth's exosphere is responding to changes in the Sun's output.

The spacecraft bus was designed and built by BAE Systems in Boulder, Colorado, who also performed integration of the observatory and complete satellite-level testing. The observatory is about the size of a loveseat sofa with a total mass of 241 kg (which weighs 531 lbs on Earth).

Dr. George Carruthers, right, and William Conway, a project manager at the Naval Research Institute, examine the gold-plated ultraviolet camera/spectrograph, the first Moon-based observatory that Carruthers developed for the Apollo 16 mission. Apollo 16 astronauts placed the observatory on the moon in April 1972.

Credit: U.S. Naval Research Laboratory

THE MISSION

After launch, Carruthers will coast to the Sun–Earth Lagrange Point 1 (L1) approximately 932,000 miles (1.5 million kilometers) from Earth. L1 is a location in space where the gravitational forces of the Sun and Earth are balanced, allowing for a smaller object like a satellite to maintain a relatively stable position. L1 is four times farther from Earth than the Moon, giving Carruthers a perpetual view that takes in all of Earth's vast geocorona.

UC Berkeley's Space Sciences Laboratory (SSL) is responsible for the overall mission management.

Carruthers makes images of the geocorona (NFI every 30 min, WFI every 60 min), and within two hours of science observations, they will exceed the total number of pictures ever before taken of Earth's exosphere. The spacecraft only communicates with SSL through the DSN twice per week for six hours at a time.

The SDOC at UIUC processes and archives the science data for analysis and public release. The principal investigator of the Carruthers Geocorona Observatory is Dr. Lara Waldrop, who is a professor at UIUC. By a remarkable cosmic coincidence, Dr. Carruthers was a three-time alum of UIUC. The first NASA mission led by the university now bears his name.

The primary science mission is two years. This timing allows the mission to observe Earth's exosphere during the transition from solar maximum to solar minimum.

Learn more: nasa.gov/carruthers