NASA GOLD Mission to image Earth's interface to space

January 24 2018, by Lina Tran

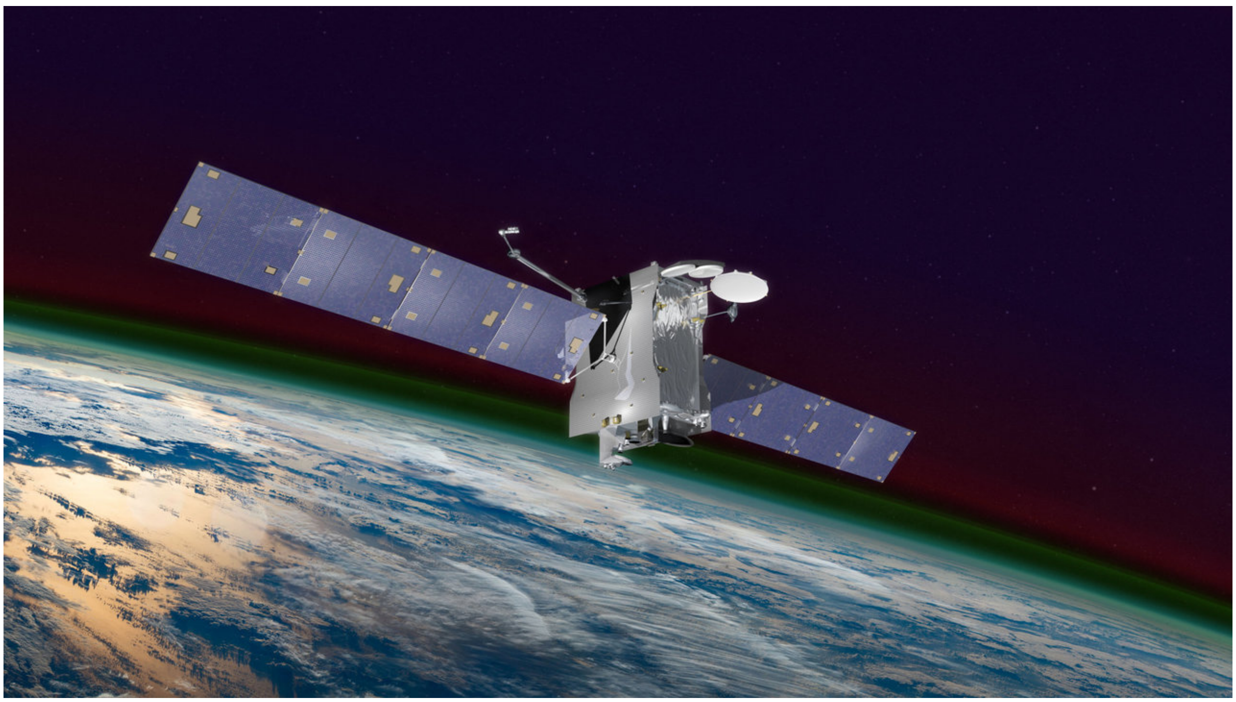


Illustration of SES-14, a commercial communications satellite that will carry NASA's GOLD instrument. Credit: NASA Goddard's Conceptual Image Lab/Chris Meaney

On Jan. 25, 2018, NASA launches Global-scale Observations of the Limb and Disk, or GOLD, a hosted payload aboard SES-14, a commercial communications satellite. GOLD will investigate the dynamic intermingling of space and Earth's uppermost atmosphere—and is the first NASA science mission to fly an instrument as a commercially hosted payload.

Space is not completely empty: It's teeming with fast-moving charged particles and electric and magnetic fields that guide their motion. At the boundary between Earth's atmosphere and space, the charged particles—called the ionosphere—co-exist with the upper reaches of the neutral atmosphere, called the thermosphere. The two commingle and influence one another constantly. This interplay—and the role terrestrial weather, space weather and Earth's own magnetic field each have in it—is the focus of GOLD's mission.

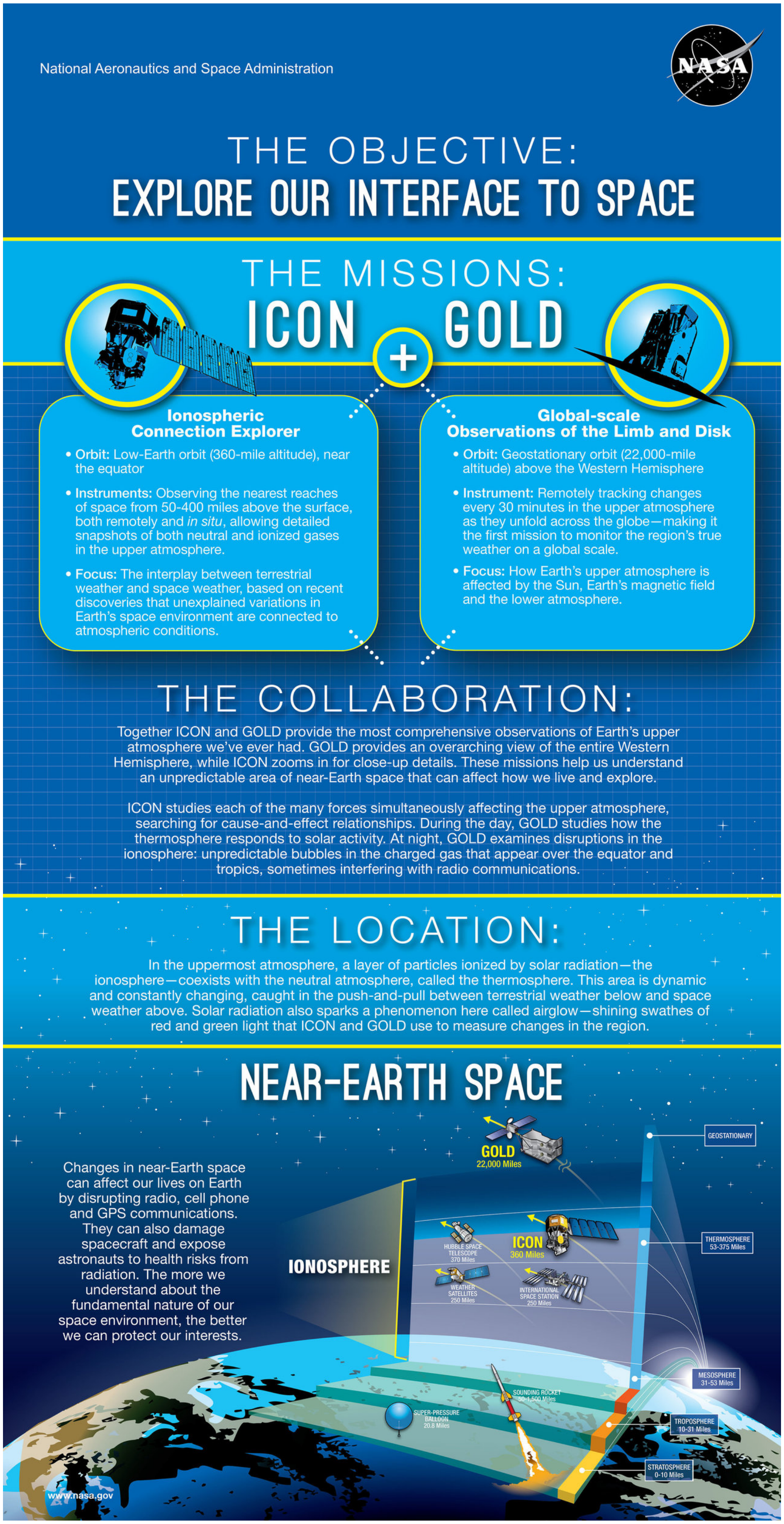
"The upper atmosphere is far more variable than previously imagined, but we don't understand the interactions between all the factors involved," said Richard Eastes, GOLD principal investigator at the Laboratory for Atmospheric and Space Physics at the University of Colorado Boulder. "That's where GOLD comes in: For the first time, the mission gives us the big picture of how different drivers meet and influence each other."

Historically difficult to observe, this little understood region responds both to terrestrial weather in the lower atmosphere below and the tumult of space weather from above. And it responds rapidly too, undergoing dramatic change in as little as an hour, Eastes said.

Big events in the lower atmosphere, like hurricanes or tsunamis, create waves that can travel all the way up to this interface to space, changing wind patterns and causing disruptions. On the opposite side, from above this region, flurries of energized particles and solar storms carry electric and magnetic fields and have the potential to disrupt Earth's space environment. This combination of factors makes it difficult to predict changes in the ionosphere—and these changes can have a big impact.

"Space isn't just the home of astronauts and satellites; it affects our day-to-day lives," said Sarah Jones, GOLD mission scientist at NASA's Goddard Space Flight Center in Greenbelt, Maryland. Low-Earth orbiting satellites—including the International Space Station—fly through the ionosphere. But communication signals, like radio waves and signals that make our GPS systems work, also travel through this region, and sudden changes can distort them or even cut them off completely.

GOLD seeks to understand what drives change in this critical region. Resulting data will improve forecasting models of the space weather events that can impact life on Earth, as well as satellites and astronauts in space. GOLD is the first mission that can provide us with observations fast enough to monitor the details of regular, hour-by-hour changes in space weather—not just its overarching climate.

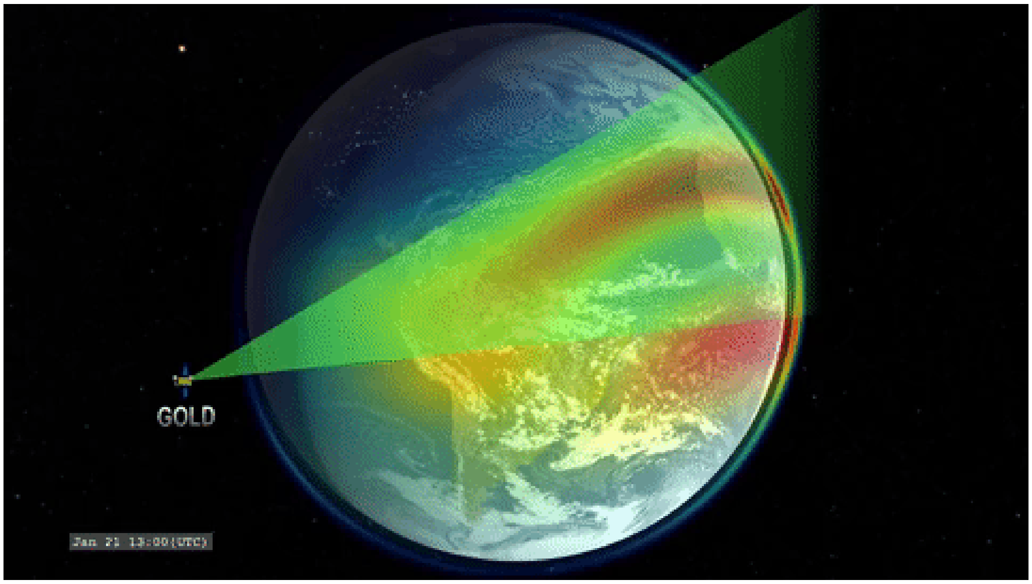

National Aeronautics and Space Administration
NASA
THE OBJECTIVE:
EXPLORE OUR INTERFACE TO SPACE
THE MISSIONS:
ICON + GOLD
Ionospheric Connection Explorer
• Orbit: Low-Earth orbit (360-mile altitude), near the equator
• Instruments: Observing the nearest reaches of space from 50-400 miles above the surface, both remotely and *in situ*, allowing detailed snapshots of both neutral and ionized gases in the upper atmosphere.
• Focus: The interplay between terrestrial weather and space weather, based on recent discoveries that unexplained variations in Earth's space environment are connected to atmospheric conditions.
Global-scale Observations of the Limb and Disk
• Orbit: Geostationary orbit (22,000-mile altitude) above the Western Hemisphere
• Instrument: Remotely tracking changes every 30 minutes in the upper atmosphere as they unfold across the globe—making it the first mission to monitor the region's true weather on a global scale.
• Focus: How Earth's upper atmosphere is affected by the Sun, Earth's magnetic field and the lower atmosphere.
THE COLLABORATION:
Together ICON and GOLD provide the most comprehensive observations of Earth's upper atmosphere we've ever had. GOLD provides an overarching view of the entire Western Hemisphere, while ICON zooms in for close-up details. These missions help us understand an unpredictable area of near-Earth space that can affect how we live and explore.
ICON studies each of the many forces simultaneously affecting the upper atmosphere, searching for cause-and-effect relationships. During the day, GOLD studies how the thermosphere responds to solar activity. At night, GOLD examines disruptions in the ionosphere: unpredictable bubbles in the charged gas that appear over the equator and tropics, sometimes interfering with radio communications.
THE LOCATION:
In the uppermost atmosphere, a layer of particles ionized by solar radiation—the ionosphere—coexists with the neutral atmosphere, called the thermosphere. This area is dynamic and constantly changing, caught in the push-and-pull between terrestrial weather below and space weather above. Solar radiation also sparks a phenomenon here called airglow—shining swathes of red and green light that ICON and GOLD use to measure changes in the region.
NEAR-EARTH SPACE
Changes in near-Earth space can affect our lives on Earth by disrupting radio, cell phone and GPS communications. They can also damage spacecraft and expose astronauts to health risks from radiation. The more we understand about the fundamental nature of our space environment, the better we can protect our interests.
GOLD
22,000 Miles
GEOSTATIONARY
IONOSPHERE
HUBBLE SPACE TELESCOPE 370 Miles
ICON
360 Miles
THERMOSPHERE 53-375 Miles
WEATHER SATELLITES 250 Miles
INTERNATIONAL SPACE STATION 250 Miles
MESOSPHERE 31-53 Miles
SOUNDING ROCKET 50-1,500 Miles
SUPER-PRESSURE BALLOON 20.8 Miles
TROPOSPHERE 10-31 Miles
STRATOSPHERE 0-10 Miles
www.nasa.gov

GOLD and ICON are teaming up to explore Earth's interface to space -- a little-understood area that's close to home but historically hard to observe. Download as PDF: https://www.nasa.gov/sites/default/files/atoms/files/new_icon_vs_gold_infographic_v7.pdf Credit: NASA's Goddard Space Flight Center/Mary Pat Hrybyk

"The first meteorological satellites revolutionized our understanding of—and ability to predict—terrestrial weather," said Elsayed Talaat, heliophysics chief scientist at NASA Headquarters in Washington. "We anticipate GOLD will give us new, similar insight into the dynamics of the upper atmosphere and our planet's space environment."

Roughly the size of a mini fridge, the 80-pound GOLD instrument is an imaging spectrograph, an instrument that breaks light down into its component wavelengths and measures their intensities. Specifically, it measures far ultraviolet light, creating full-disk ultraviolet images of Earth from its geostationary vantage point above the Western Hemisphere.

"Just like an infrared camera allows you to see how temperatures change with different colors, GOLD images ultraviolet light to provide a map of the Earth that reveals how temperature and atmospheric composition change by location," Eastes said.



GOLD scans the entirety of the Earth's disk every half hour. Credit: NASA's Goddard Space Flight Center/Scientific Visualization Studio

From these images, scientists can determine the temperature and relative amounts of different particles—such as atomic oxygen and molecular nitrogen—present in the neutral atmosphere, which is useful for determining how these neutral gases shape ionospheric conditions. These data will provide the first maps of the upper atmosphere's changing temperature and composition all over the Americas.

GOLD is a NASA mission of opportunity led by the University of Central Florida. The Laboratory for Atmospheric and Space Physics at the University of Colorado Boulder built the instrument. A payload hosted on an otherwise unrelated satellite, the GOLD instrument flies in geostationary orbit on a commercial communications satellite, SES-14, built by Airbus for Luxembourg-based satellite operator, SES.

"For years, we've studied Earth's upper atmosphere in detail from the ground and low-Earth orbit," Eastes said. "By backing out to geostationary, we can put things in a global context. You can see half the Earth from out there."

The ionosphere stretches from roughly 50 – 360 miles above Earth's surface. Red and green swaths of light, known as airglow, are seen in this video of Earth's limb shot from the International Space Station. Credit: NASA

Also launching this year is the Ionospheric Connection Explorer, or ICON, which will study the ionosphere and neutral upper atmosphere. But while GOLD flies in geostationary orbit 22,000 miles above the Western Hemisphere, ICON flies just 350 miles above Earth, where it can gather close-up images of this region. Together, these missions provide the most comprehensive ionosphere observations we've ever had, enabling a deeper understanding of how our planet interacts with space.

GOLD is the newest addition to NASA's fleet of Heliophysics missions.

NASA Heliophysics missions study a vast interconnected system from the Sun to the space surrounding Earth and other planets, and to the farthest limits of the Sun's constantly flowing stream of solar wind. GOLD's observations will provide key information about how Earth's upper atmosphere is connected to this dynamic and complex system.

Provided by NASA's Goddard Space Flight Center