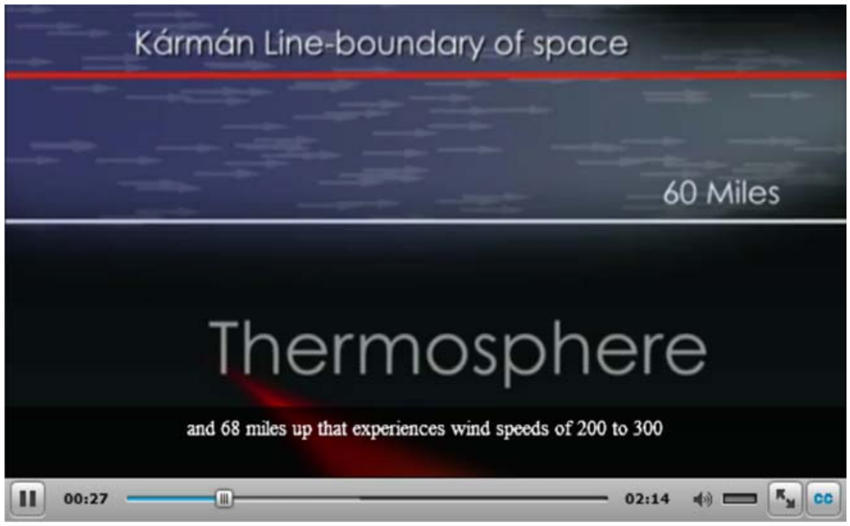
News

NASA Jet Stream Study Will Light up The Night Sky 03.07.12



› Download video

In March 2012, NASA will launch five sounding rockets in approximately five minutes to measure 200-300 mile-per-hour winds at the edge of space. This mission will trace these winds and study their intimate connection to the complicated electrical current patterns that surround Earth. NASA/Goddard Space Flight Center

High in the sky, 60 to 65 miles above Earth's surface, winds rush through a little understood region of Earth's atmosphere at speeds of 200 to 300 miles per hour. Lower than a typical satellite's orbit, higher than where most planes fly, this upper atmosphere jet stream makes a perfect target for a particular kind of scientific experiment: the sounding rocket. Some 35 to 40 feet long, sounding rockets shoot up into the sky for short journeys of eight to ten minutes, allowing scientists to probe difficult-to-reach layers of the atmosphere.

In March, NASA will launch five such rockets in approximately five minutes to study these high-altitude winds and their intimate connection to the complicated electrical current patterns that surround Earth. First noticed in the 1960s, the winds in this jet stream shouldn't be confused with the lower jet stream located around 30,000 feet, through which passenger jets fly and which is reported in weather forecasts. This rocket experiment is designed to gain a better understanding of the high-altitude winds and help scientists better model the electromagnetic regions of space that can damage man-made satellites and disrupt communications systems. The experiment will also help explain how the effects of atmospheric disturbances in one part of the globe can be transported to other parts of the globe in a mere day or two.

"This area shows winds much larger than expected," says Miguel Larsen, a space scientist at Clemson University who is the principal investigator for these five rockets, known as the Anomalous Transport Rocket Experiment (ATREX). "We don't yet know what we're going to see, but there is definitely something unusual going on. ATREX will help us understand the big question about what is driving these fast winds."

Determining what drives these winds requires precise understanding of the way the winds move and what kind of turbulence they show. To get an idea of the task at hand, imagine mapping not just the ups and downs of ocean waves but the attendant surf, undertow, and tides, all from 60 miles away and in only 20 minutes. To accomplish this, the five sounding rockets will launch from NASA's

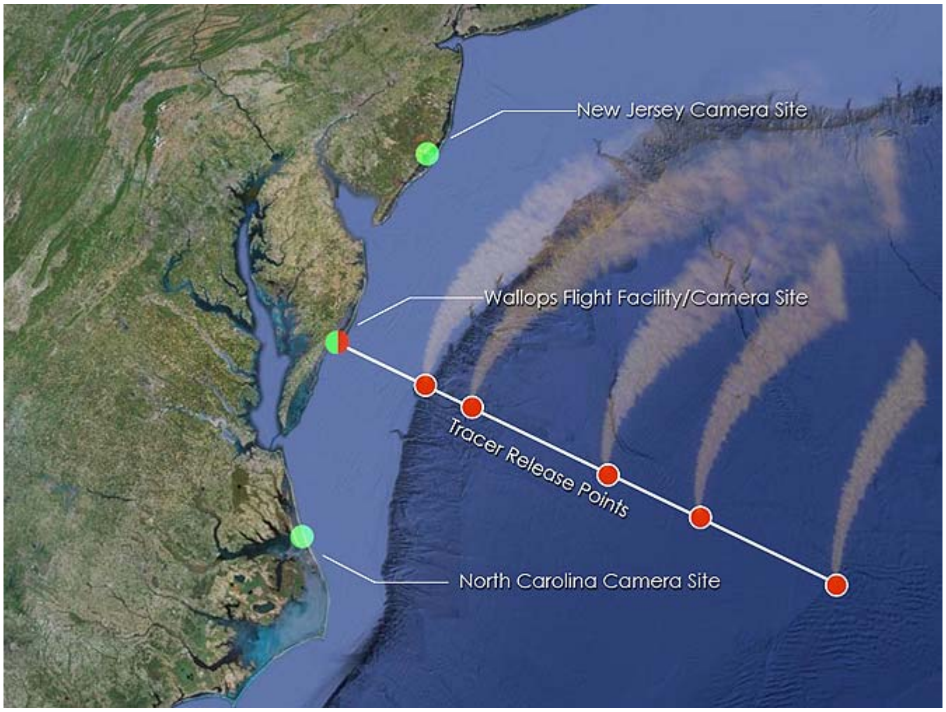
Location of the two known jet streams in

Wallops Flight Facility in Virginia releasing a chemical tracer into the air. The chemical – a substance called trimethyl aluminum (TMA) -- forms milky, white clouds that allow those on the ground to "see" the winds in space and track them with cameras. In addition, two of the rockets will have instrumented payloads to measure pressure and temperature in the atmosphere.

the atmosphere. Credit: NASA/Goddard Space Flight Center
› View larger
› View full atmosphere map

The rockets will be launched on a clear night within a period of minutes, so the trails can all be seen at the same time. The trimethyl aluminum will then be released in space out over the Atlantic Ocean at altitudes from 50 to 90 miles. The cloud tracers will last for up to 20 minutes and will be visible in the mid-Atlantic region, and along the east coast of the United States from parts of South Carolina to New Jersey.

"People have launched single rockets before," says Larsen. "But the key here is that we're extending the range of measurements to many hundreds of miles. The furthest rocket will make it half way to Bermuda."



The red dots over the water show where ATREX will deploy chemical tracers to watch how super fast winds move some 60 miles up in the atmosphere. While there are only five rockets, two will deploy two sets of tracers, resulting in seven clouds. Only six dots appear in this image, since two will be deployed at the left-most red/green dot, which represents Wallops. Three cameras will track the cloud tracers – one at Wallops and two located at the green dots. Credit: NASA/Goddard Space Flight Center
› View larger
› View unlabeled version

Sounding rockets are usually launched one or two at a time, so launching five at once will call for specific timing and direction to gather the required data. The rockets must be launched on a clear night between March 14 and April 3. Scientists will then use special camera equipment to track the five clouds and measure how quickly they move away from each other. They can then plug this information into equations that will describe what kind of turbulence exists in the winds.

One possible kind of turbulence is called three-dimensional turbulence, turbulence much like what one sees flowing down a river and swirling around rocks or in gusting winds on Earth. If this is seen, it would suggest the winds move with laws of motion similar to those governing small-scale waves in water. Such waves might be driven by heat in the atmosphere that varies in the course of a day. This would jibe with one of the original theories for how the winds are created, and indeed there are those who think of this region as a kind of atmospheric "surf zone" in the sky. Another view is that the winds at that height are too fast to jibe with this model. Moreover, man-made tracers, such as Space Shuttle exhaust, do not break up and dissipate as one might expect from such turbulence, but remain remarkably coherent.

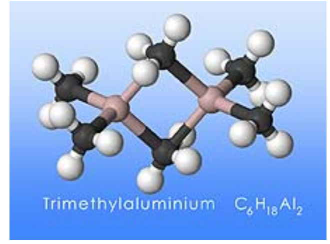
› View larger
The ATREX rockets will launch chemical tracers such as these that can be tracked by special cameras to help study winds in Earth's atmosphere. Credit: Miguel Larsen/Clemson Univ.

On the other hand, if ATREX sees winds that exhibit what's called two-dimensional turbulence, this would support a model based on a more directed, jet stream flow.

"In 3-D turbulence, one sees complicated movement," says Larsen. "But there's a tendency for 2-D turbulence to behave almost in the opposite manner – the airflow coalesces into single streams, like a jet stream."

This kind of airflow would also be strongly enhanced by the combination of electrical currents in the region and the rate of the Earth's rotation. Together, this connection might result in the fast, coherent streams of air so far observed.

The rockets being used for the mission are two Terrier-Improved Malemutes, two Terrier-Improved Orions and one Terrier-Oriole. In order for the launches to occur, clear skies are required at three special camera sites located along the coast in Virginia, North Carolina and New Jersey.



› View larger
Simple TMA molecule. Credit: NASA/Goddard Space Flight Center

NASA has used TMA for decades as part of rocket studies from sites worldwide to study the near-space environment. TMA burns slowly and produces visible light that can be tracked visually and with special camera equipment.

The products of the reaction when TMA is exposed to air or water are aluminum oxide, carbon dioxide and water vapor. Aluminum oxides are used to combat heartburn and to purify drinking water. Also, all three products occur naturally in the atmosphere. The TMA poses no threat to the public during preparation on the ground or during the release in space.

To try to spot the sounding rocket trails, follow the launch status updates at:

http://www.nasa.gov/mission_pages/sunearth/missions/atrex.html

Karen C. Fox
NASA Goddard Space Flight Center*, *Greenbelt, MD

› Back To Top