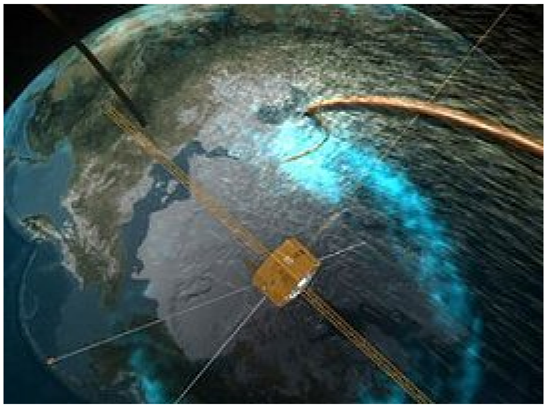
Special events in creating the Mega Electric Thunderstorm

The life cycle of ordinary thunderstorms involves three stages: cumulus, mature, and dissipating. Not unlike ordinary thunderstorms, the Mega Electric Thunderstorms tends to form in Ocean regions where the wind speed and direction do not abruptly change with increasing height above the surface. These conditions usually consist of winds of an easterly component less than ten MPH, and less than 6 degrees F between ambient air and dew point. This scenario can usually be found in between a High and Low pressure systems over Florida and Caribbean area between the Nov – Feb time frame when the earth is closest to the Sun. Additional evidence shows that Cumulus and Towering Cumulus clouds will form early in the morning in these areas coupled with increased Solar Sunspot activity and solar winds over 475 km/sec, to be a major contributing factors in setting off these special set of circumstances for Electronic Fog generation.

The Bi-Directional flow of energy from the surface of the Earth up to space, and from space down to the surface demonstrates the electrical conduits and connectivity.

"It's called a flux transfer event or 'FTE,'" says space physicist David Sibeck of the Goddard Space Flight Center**. "Ten years ago I was pretty sure they didn't exist, but now the evidence is incontrovertible."**



NASA says: The interaction between the solar wind and the plasma of the magnetosphere acts like an electric generator, creating electric fields deep inside the magnetosphere. These fields in turn give rise to a general circulation of the plasma within the magnetosphere and accelerate some electrons and ions to higher energies.

During periods of gusty solar winds, powerful magnetic storms in space near the Earth cause vivid auroras, radio and television static, power blackouts, navigation problems for ships and airplanes with magnetic compasses, and damage to satellites and spacecraft. Events on the Sun and in the magnetosphere can also trigger changes in the electrical and chemical properties of the atmosphere, the ozone layer, and high-altitude temperatures and wind patterns.

The opening was huge—four times wider than Earth itself," says Wenhui Li, a space physicist at the University of New Hampshire who has been analyzing the data. Li's colleague Jimmy

Raeder, also of New Hampshire, says "10^{27} particles per second were flowing into the magnetosphere—that's a 1 followed by 27 zeros. This kind of influx is an order of magnitude greater than what we thought was possible."

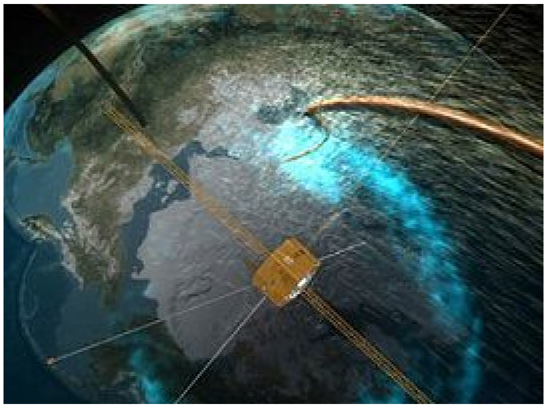
The event began with little warning when a gentle gust of solar wind delivered a bundle of magnetic fields from the Sun to Earth. Like an octopus wrapping its tentacles around a big clam, solar magnetic fields draped themselves around the magnetosphere and cracked it open. The cracking was accomplished by means of a process called "magnetic reconnection." High above Earth's poles, solar and terrestrial magnetic fields linked up (reconnected) to form conduits for solar wind. Conduits over the Arctic and Antarctic quickly expanded; within minutes they overlapped over Earth's equator to create the biggest magnetic breach ever recorded by Earth-orbiting spacecraft.

Supporting Documents below:

Oct. 30, 2008: During the time it takes you to read this article, something will happen high overhead that until recently many scientists didn't believe in. A magnetic portal will open, linking Earth to the sun 93 million miles away. Tons of high-energy particles may flow through the opening before it closes again, around the time you reach the end of the page.

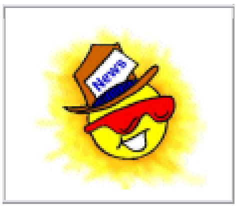
"It's called a flux transfer event or 'FTE,'" says space physicist David Sibeck of the Goddard Space Flight Center. "Ten years ago I was pretty sure they didn't exist, but now the evidence is incontrovertible."

Indeed, today Sibeck is telling an international assembly of space physicists at the 2008 Plasma Workshop in Huntsville, Alabama, that FTEs are not just common, but possibly twice as common as anyone had ever imagined.



Right: An artist's concept of Earth's magnetic field connecting to the sun's--a.k.a. a "flux transfer event"--with a spacecraft on hand to measure particles and fields. [Larger image]

Researchers have long known that the Earth and sun must be connected. Earth's magnetosphere (the magnetic bubble that surrounds our planet) is filled with particles from the sun that arrive via the solar wind and penetrate the planet's magnetic defenses. They enter by following magnetic field lines that can be traced from *terra firma* all the way back to the sun's atmosphere.



"We used to think the connection was permanent and that solar wind could trickle into the near-Earth environment anytime the wind was active," says Sibeck. "We were wrong. The connections are not steady at all. They are often brief, bursty and very dynamic."

Several speakers at the Workshop have outlined how FTEs form: On the dayside of Earth (the side closest to the sun), Earth's magnetic field presses against the sun's magnetic field. Approximately every eight minutes, the two fields briefly merge or "reconnect," forming a portal through which particles can flow. The portal takes the form of a magnetic cylinder about as wide as Earth. The European Space Agency's fleet of four Cluster spacecraft and NASA's five THEMIS probes have flown through and surrounded these cylinders, measuring their dimensions and sensing the particles that shoot through. "They're real," says Sibeck.

Dec. 16, 2008: NASA's five THEMIS spacecraft have discovered a breach in Earth's magnetic field ten times larger than anything previously thought to exist. Solar wind can flow in through the opening to "load up" the magnetosphere for powerful geomagnetic storms. But the breach itself is not the biggest surprise. Researchers are even more amazed at the strange and unexpected way it forms, overturning long-held ideas of space physics.

"The opening was huge—four times wider than Earth itself," says Wenhui Li, a space physicist at the University of New Hampshire who has been analyzing the data. Li's colleague Jimmy Raeder, also of New Hampshire, says "10^{27} particles per second were flowing into the magnetosphere—that's a 1 followed by 27 zeros. This kind of influx is an order of magnitude greater than what we thought was possible."

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A geomagnetic storm, from the perspective of the upper atmosphere, is a period of intense energy input from the magnetosphere for a period of several hours to days. The manifestations of a storm are well defined and include the following effects. Auroral electron precipitation increase in magnitude and expands to lower latitudes than normal, and these particles heat and ionize the gas and increase the conductivity of the atmosphere. The magnetospheric electric field mapped to the atmosphere intensifies and expands in concert with the aurora, and combines with the increased conductivity to produce large enhancements of Joule heating, which is the dominant atmospheric energy source during a storm. Joule heating can increase from tens of gigawatts during quiet times, to hundreds of gigawatts during severe geomagnetic disturbances. The combined input can dump thousands of Terajoules of energy into the upper atmosphere during the course of a storm, and can raise the temperature of the gas by hundreds of degrees Kelvin. Thermal expansion of the atmosphere raises neutral density and can have significant effects on satellite drag. Ionosphere ions drift in response to the electric field and, by colliding with the atmosphere, can drive winds in excess of 1 km/s at high latitudes.

Recent experimental investigations relating to the electrical coupling between the troposphere, ionosphere and magnetosphere suggest the possible solar modulation of atmospheric electrification. Analysis of the 1200 hours of stratospheric balloon data has indicated correlation between the vertical electric field and the magnetic activity parameters (D'Angelo et al., 1982). Markson (1978) has observed correlation between the earth-ionospheric potential variations deduced from airplane soundings and the solar wind parameters. Evidence suggests that higher solar wind speeds yield higher potential differences. Holzworth and Mozer (1979) from the study of the stratospheric balloon data obtained during the August 1972 solar flare have concluded that the solar proton shower occurred during the event 'compressed' the atmosphere down to a level below 30 km. The solar proton fluxes have been found to be correlated with a decrease in the local vertical field component near 30 km. The above observations provide the evidence for the downward coupling of high altitude processes into the middle atmosphere and the troposphere.

Plasma Bullets Spark Northern Lights

07.24.2008

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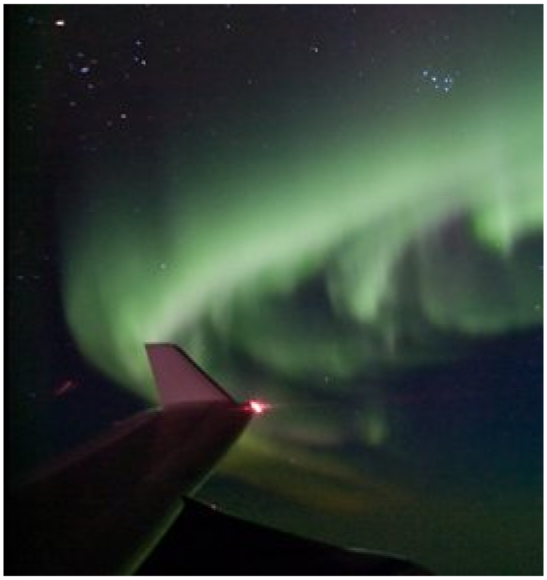
July 24, 2008: Duck! Plasma bullets are zinging past Earth.

That's the conclusion of researchers studying data from NASA's five THEMIS spacecraft. The gigantic bullets, they say, are launched by explosions 1/3rd of the way to the Moon and when they hit Earth—wow. The impacts spark colorful outbursts of Northern Lights called "substorms."



Right: A substorm of Northern Lights photographed from the window of an airplane over Hudson Bay, Canada, on Feb 27, 2008. Credit: Jeff Hapeman. [more]

"We have discovered what makes the Northern Lights dance," declares UCLA physicist Vassilis Angelopoulos, principal investigator of the THEMIS mission. The findings appear online in the July 24 issue of *Science Express* and in print August 14 in the journal *Science*.

The THEMIS fleet was launched in February 2007 to unravel the mystery of substorms, which have long puzzled observers with their unpredictable eruptions of light and color. The spacecraft wouldn't merely observe substorms from afar; they would actually plunge into the tempest using onboard sensors to measure particles and fields. Mission scientists hoped this *in situ* approach would allow them to figure out what caused substorms--and they were right.

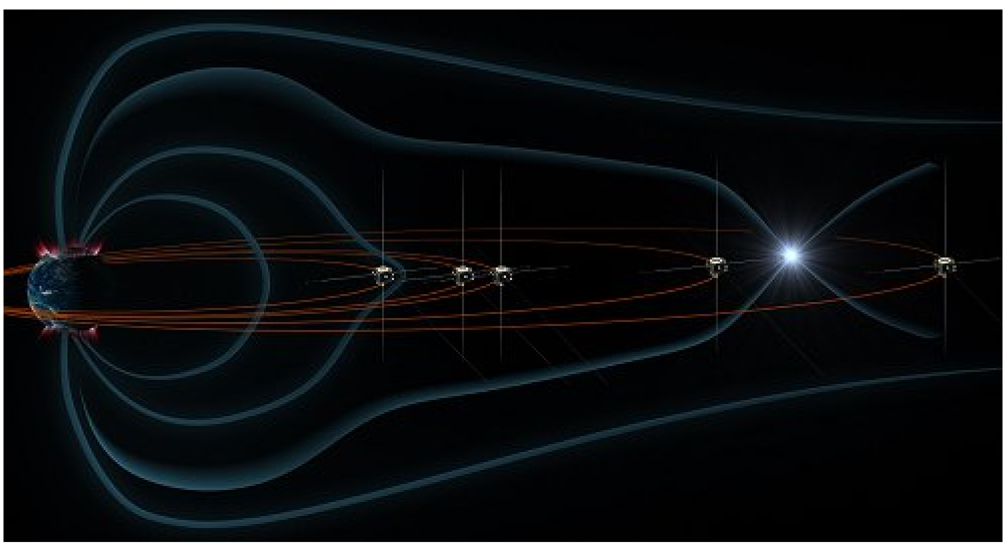
The discovery came on what began as a quiet day, Feb 26, 2008. Arctic skies were dark and Earth's magnetic field was still. High above the planet, the five THEMIS satellites had just arranged themselves in a line down the middle of Earth’s magnetotail—a million kilometer long tail of magnetism pulled into space by the action of the solar wind.

That's when the explosion occurred.

A little more than midway up the THEMIS line, magnetic fields erupted, "releasing about 10^{15} Joules of energy," says Angelopoulos. "For comparison, that's about as much energy as a magnitude 5 earthquake."

Although the explosion happened inside Earth's magnetic field, it was actually a release of energy from the sun. When the solar wind stretches Earth's magnetic field, it stores energy there, in much the same way energy is stored in a rubber band when you stretch it between thumb and forefinger. Bend your forefinger and—crack!—the rubber band snaps back on your thumb. Something similar happened inside the magnetotail on Feb. 26, 2008. Over-stretched magnetic fields snapped back, producing a powerful explosion. This process is called "magnetic reconnection" and it is thought to be common in stellar and planetary magnetic fields.

The blast launched two "plasma bullets," gigantic clouds of protons and electrons, one toward Earth and one away from Earth. The Earth-directed cloud crashed into the planet below, sparking vivid auroras observed by some 20 THEMIS ground stations in Canada and Alaska. The opposite cloud shot harmlessly into space, and may still be going for all researchers know.



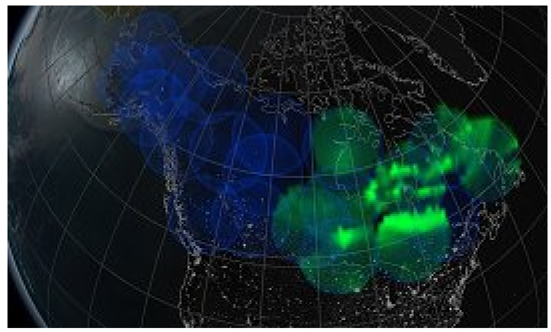
Above: An artist's concept of the THEMIS satellites lined up inside Earth's magnetotail with an explosion between the 4th and 5th satellites. [Larger image]

The THEMIS satellites were perfectly positioned to catch the shot.

"We had bulls-eyes on our solar panels," says THEMIS project scientist David Sibeck of NASA's Goddard Space Flight Center. "Four of the satellites were hit by the Earth-directed cloud, while the opposite cloud hit the fifth satellite." Simple geometry pinpointed the site of the blast between the 4th and 5th satellite or "about 1/3rd of the way to the Moon."

No damage was done to the satellites. Plasma bullets are vast, gossamer structures less dense than the gentlest wisp of Earth's upper atmosphere. They whoosh past, allowing THEMIS instruments to sample the cloud’s internal particles and fields without truly buffeting the satellite.

This peaceful encounter on the small scale of a spacecraft, however, belies the energy deposited on the large scale of a planet. The bullet-shaped clouds are half as wide as Earth and 10 times as long, traveling hundreds of km/s. When such a bullet strikes the planet, brilliant auroras and geomagnetic storms ensue.



Right: A collection of ground-based All-Sky Imagers (ASI) captures the aurora brightening caused by a substorm. Credit: NASA/Goddard Space Flight Center Scientific Visualization Studio. [animation]

"For the first time, THEMIS has shown us the whole process in action—from magnetic reconnection to aurora borealis," says Sibeck. "We are finally solving the puzzle of substorms."

The THEMIS mission is scheduled to continue for more than another year, and during that time Angelopoulos expects to catch lots more substorms--"dozens of them," he says. "This will give us a chance to study plasma bullets in greater detail and learn how they can help us predict space weather."

"THEMIS is not finished making discoveries," believes Sibeck. "The best may be yet to come."

NASA Spacecraft Make New Discoveries about Northern Lights **12.11.2007**

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Dec. 11, 2007: NASA's fleet of THEMIS spacecraft, launched less than 8 months ago, has made three important discoveries about spectacular eruptions of Northern Lights called "substorms" and the source of their power. The discoveries include giant magnetic ropes that connect Earth's upper atmosphere to the Sun and explosions in the outskirts of Earth's magnetic field.

"The mission is only beginning but THEMIS is already surprising us," says Vassilis Angelopoulos the mission's principal investigator at the University of California, Los Angeles.

The discoveries began in March less than a month after the five THEMIS satellites had been activated. "On March 23, 2007, a substorm erupted over Alaska and Canada producing vivid auroras for more than two hours." A network of ground cameras organized to support THEMIS photographed the display from below while the satellites measured particles and fields from above.

Right: Auroras over Alaska on March 23-24, 2007. Photo credit: Daryl Pederson. [More]

Right away the substorm surprised investigators: "The auroras surged westward twice as fast as anyone thought possible, crossing 15 degrees of longitude in less than one minute," says Angelopoulos. The storm had traversed an entire polar time zone in 60 seconds flat!

Also, "the display was surprisingly bursty." Photographs taken by ground cameras and NASA's Polar satellite (also supporting the THEMIS mission) revealed a series of staccato outbursts each lasting 10 minutes or so. "Some of the bursts died out while others reinforced each other and went on to become major events."

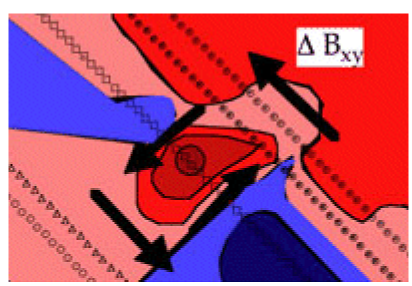
Scientists have been tracking and studying substorms for more than a century, yet these phenomena remained mostly unknown until THEMIS went into action.

Even more impressive was the substorm's power. Angelopoulos estimates the total energy of the two-hour event at five hundred thousand billion (5×10^{14}) Joules. That's approximately equivalent to the energy of a magnitude 5.5 earthquake.

Where does all that energy come from? THEMIS may have found an answer:

"The satellites have found evidence for magnetic ropes connecting Earth's upper atmosphere directly to the Sun," says Dave Sibeck, project scientist for the mission at the Goddard Space Flight Center. "We believe that solar wind particles flow in along these ropes, providing energy for geomagnetic storms and auroras."

A "magnetic rope" is a twisted bundle of magnetic fields organized much like the twisted hemp of a mariner's rope. Spacecraft have detected hints of these ropes before, but a single spacecraft is insufficient to map their 3D structure. THEMIS's five satellites were able to perform the feat.

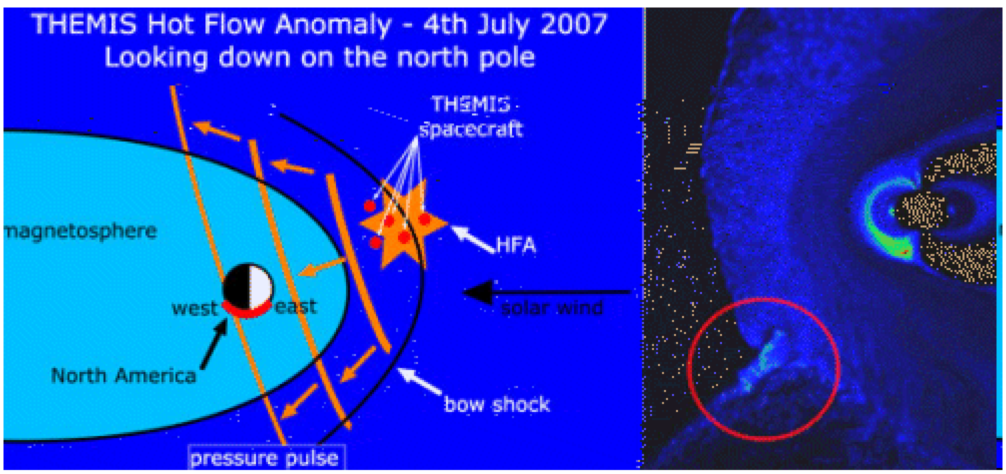


Right: A magnetic map of a magnetospheric rope observed in cross-section by the THEMIS satellites on May 20, 2007. [Larger image]

"THEMIS encountered its first magnetic rope on May 20, 2007," says Sibeck. "It was very large, about as wide as Earth, and located approximately 40,000 miles above Earth's surface in a region called the magnetopause." The magnetopause is where the solar wind and Earth's magnetic field meet and push against one another like sumo wrestlers locked in combat. There, the rope formed and unraveled in just a few minutes, providing a brief but significant conduit for solar wind energy. Other ropes quickly followed: "They seem to occur all the time," says Sibeck.

THEMIS has also observed a number of relatively small explosions in Earth's magnetic bow shock. "The bow shock is like the bow wave in front of a boat," explains Sibeck. "It is where the solar wind first feels the effects of Earth's magnetic field." When a knot of magnetism within the solar wind hits the bow shock--"Bang!" he says. "We get an explosion."

The technical term for these explosions is "hot flow anomalies" or HFAs. HFAs boost the temperature of solar wind particles ten-fold (as high as 10 million degrees) and they can stop the solar wind dead its tracks. "This is no mean achievement considering the fact that the solar wind moves at supersonic speeds near a million miles per hour."



Above: A cartoon of a hot flow anomaly observed by THEMIS on July 4, 2007, and a computer simulation of the explosion. Credit: N. Omidi. [More]

"Hot flow anomalies may not play a major role in energizing auroral substorms--they happen too infrequently, less than once a day," notes Jonathan Eastwood of the University of California, Berkeley, who is studying them. "Nevertheless they are of interest. This is a fundamental physical process that accelerates particles to high energies and we are delighted to be able to study it."

Powerful substorms, giant magnetic ropes, explosions that stop the solar wind in its tracks: "We have much more to learn about all these things," says Angelopoulos. "I can't wait to see what comes next."

For more information about THEMIS, visit http://www.nasa.gov/themis/.