TRACERS

NASA's TRACERS (Tandem Reconnection and Cusp Electrodynamics Reconnaissance Satellites) mission uses two identical satellites in orbit around Earth to study how the solar wind's energy enters the near-Earth environment in a process called magnetic reconnection. The twin satellites fly through a narrow region in Earth's magnetic field known as a polar cusp, where solar wind funnels into Earth's atmosphere and the aftermath of magnetic reconnection and can be observed in real time.

Studying the powerful interactions in Earth's magnetic field will help answer long-standing questions that are key to understanding space weather, especially how the Sun transfers energy and mass to near-Earth space. Space weather has huge impacts on Earth, from causing the breathtaking northern and southern lights called auroras to endangering astronauts and disrupting communications and power grids on Earth.

The better we understand how the Sun and Earth's magnetic environments interact, the better we can protect the technology on which we depend.

Understanding Magnetic Reconnection

- As solar wind flows out from the Sun, it carries the Sun's embedded magnetic field out across the solar system. Reaching speeds over one million miles per hour, this soup of charged particles and magnetic field plows into planets in its path.
- Luckily, Earth's magnetosphere acts as a protective bubble that deflects the brunt force of the solar wind.
- When the Sun's field lines collide with Earth's field lines in our magnetosphere, these collisions cause the field lines to snap and explosively fling away nearby particles at high speeds. As these particles shed the energy they picked up from the collision, they produce light of different colors. This colorful light is the familiar aurora we know and love.

How Does TRACERS Study Magnetic Reconnection?

- The two TRACERS spacecraft follow each other in a relatively low orbit (~360 miles above Earth) through an opening at Earth's North Pole, called the polar cusp, several times each day.
- This allows the spacecraft to take multiple snapshots of the polar cusp, more than 3,000 snapshots in the first year alone, painting a larger picture of how magnetic reconnection works and evolves.

Why Is Magnetic Reconnection Important?

- Developing Space Weather Models
  - Space weather comes mostly from activity on the Sun. This activity creates radiation and charged particles that travel from the Sun and affect the conditions across the solar system, including near Earth.
  - Space weather can affect communication, navigation, and other types of satellites. Given our ever-increasing reliance on space-based technology, TRACERS provides valuable information that can improve computer models and prediction capabilities of space weather that are necessary to keep our society running smoothly.
- Seeking Habitable Planets
  - As NASA searches for habitable planets outside our solar system, it seeks to better understand how planetary magnetic fields interact with their stars, particularly through magnetic reconnection.
  - The more we know about how the Sun-planet connection works on Earth, the more we can learn about conditions needed for a habitable exoplanet.

Working with Other NASA Missions

- TRACERS will build off the legacy of NASA's TRICE-2 mission, a pair of sounding rockets launched at the northern polar cusp to study magnetic reconnection in 2018.
- TRACERS will work with other NASA missions:
  - PUNCH (Polarimeter to Unify the Corona and Heliosphere) investigates the solar wind and interactions in Earth's atmosphere.
  - EZIE (Electrojet Zeeman Imaging Explorer) studies electrical currents that link auroras to Earth's magnetosphere.
  - Parker Solar Probe closely observes the Sun, including magnetic reconnection there and its role in heating and accelerating the solar wind that drives the reconnection events investigated by TRACERS.
  - By combining observations from all of these missions, scientists will be able to get a more complete understanding of how and when Earth's protective magnetic shield can suddenly connect with solar wind, allowing the Sun's material into Earth's system.

Quick Facts:

- The twin TRACERS satellites, each a bit larger than a washing machine, orbit Earth at the North and South poles, taking measurements at the northern polar cusp.
- The two spacecraft will fly in tandem, following each other in a relatively low orbit (~360 miles above Earth) through the cusp several times each day.
- The spacecraft will travel at a speed of over 16,000 mph, with one spacecraft trailing about two minutes (sometimes as closely as 10 seconds) behind the other in orbit.

Instruments:

ACE: The Analyzer for Cusp Electrons measures the electron portion of local plasma and how they move with respect to the background magnetic field.

ACI: The Analyzer for Cusp Ions measures the ion portion of local plasma and how they move with respect to the background magnetic field.

MAG: The 3-axis fluxgate magnetometer measures the background magnetic field of plasma. It can also be used to infer the presence of electrical currents and low frequency plasma waves.

MSC: The 3-axis Magnetic Search Coil measures high frequency magnetic waves.

MAGIC: The MAGnetometers for Innovation and Capability team is building fluxgate magnetometers from scratch and investigating new designs. As a technology demonstration on TRACERS, MAGIC must do no harm to the other instruments while testing its designs for future space missions.

MEB: The common Main Electronics Box hosts the electronics for electronic field instruments, MSC, and MAG.

Partners:

- TRACERS is led by David Miles at University of Iowa.
- Southwest Research Institute supports the mission.
- NASA's Heliophysics Explorers Program Office manages the mission.
- University of California, Los Angeles, and University of California, Berkeley, lead instruments.
- Millennium Space Systems built the spacecraft and leads data operations.

Launch:

Launch Provider: SpaceX
Vehicle: Falcon 9 rocket
Launch Site: Space Launch Complex 4E, Vandenberg Space Force Base, California
Rideshare: Primary rideshare with NASA's SmallSat Athena EPIC, PExT, and REAL

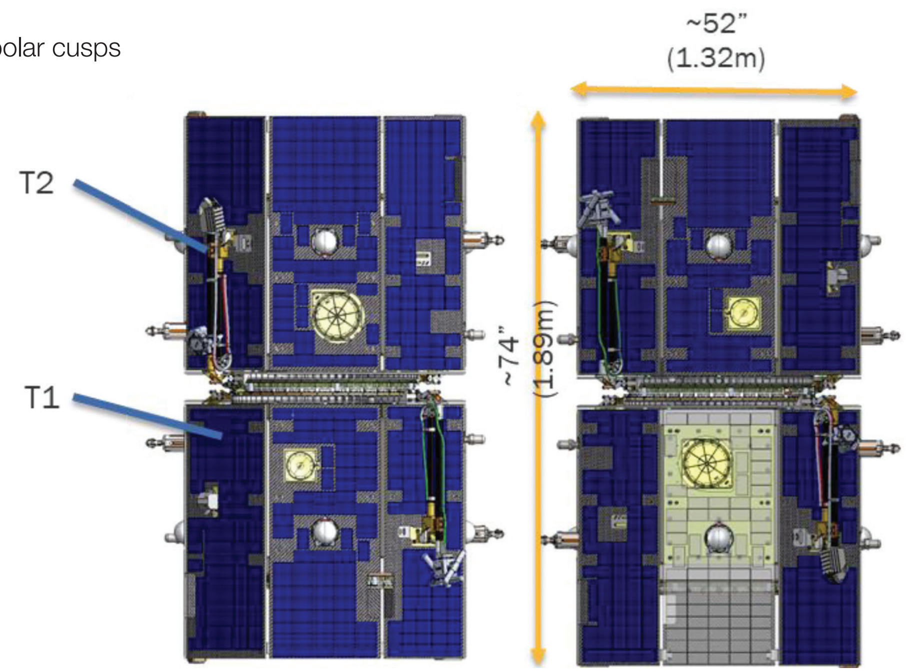
Mission:

Duration: 12 months
Location: 360 miles above Earth
Objective: Study magnetic reconnection at the polar cusps

Spacecraft:

Shape: Two nearly identical octagonal satellites
Size: 37 inches high x 52 inches across
Weight: Less than 440 pounds each

The schematics show front (left) and rear (right) viewpoints with the spacecraft in the stacked configuration for launch. Upon deployment in space, the spacecraft will separate and fly in a tandem configuration, one behind the other.



For more information, please visit:
science.nasa.gov/mission/tracers