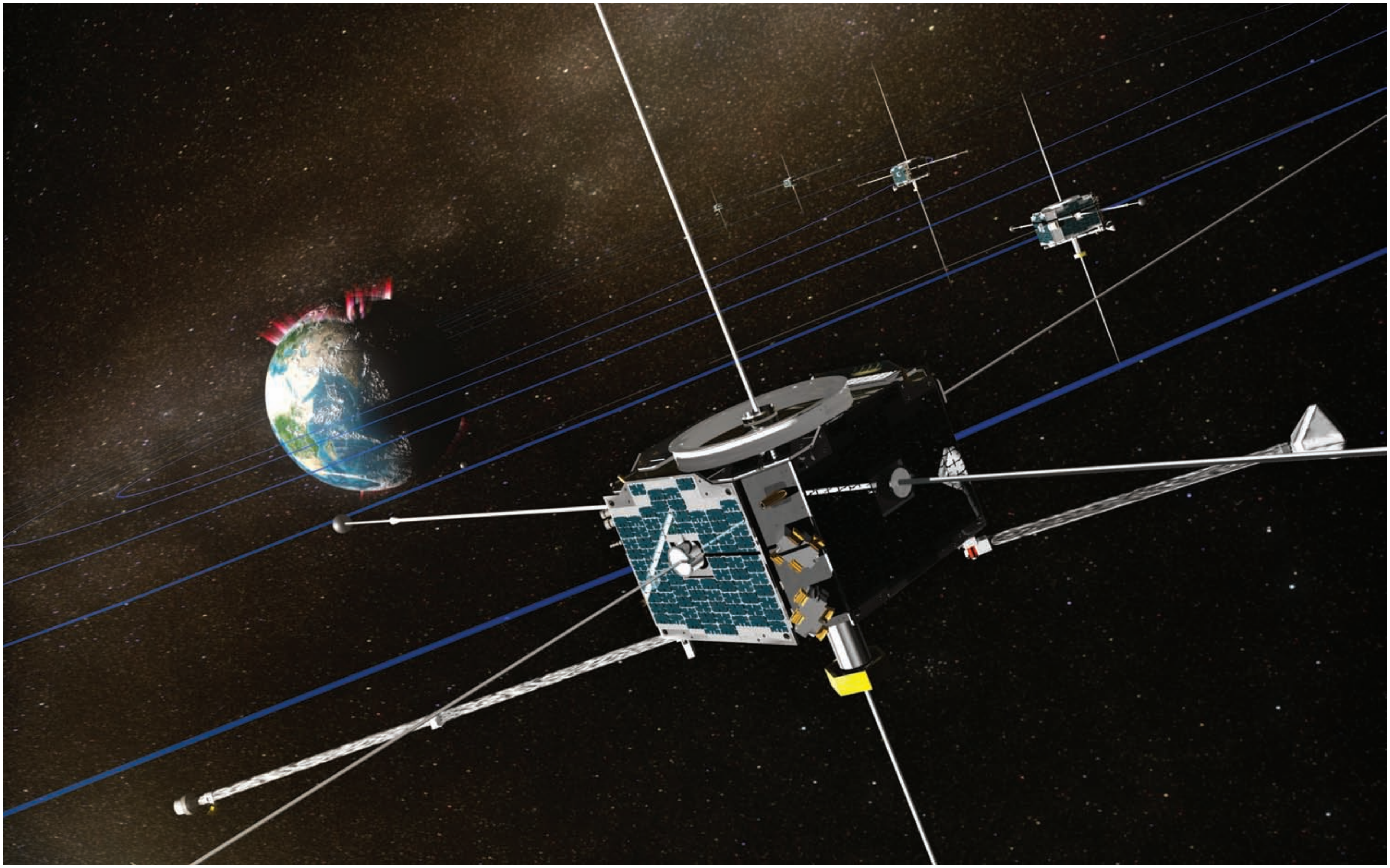
National Aeronautics and Space Administration



THEMIS—Time History of Events and Macroscale Interactions During Substorms

www.nasa.gov

THEMIS—Time History of Events and Macroscale Interactions During Substorms

NASA's Time History of Events and Macroscale Interactions during Substorms (THEMIS) will take scientists on a 2-year journey to unravel the tantalizing mystery behind auroral substorms—an avalanche of magnetic energy powered by the solar wind that intensifies the northern lights. THEMIS will help us understand how and why these components of space storms wreak havoc on satellites, power grids, and communication systems.

Each of the five identical satellites, or probes, will carry an identical suite of electric, magnetic, and particle detectors to identify the processes that result in the dynamic-aurora: colorful eruptions of light encircling both magnetic poles. These eruptions are linked to energy releases in Earth's magnetosphere, called substorms, and their trigger mechanism has remained a scientific mystery. When the five identical probes align over the North American continent—every four days for about 15 hours—scientists will collect coordinated spacecraft measurements along the Sun–Earth line. Twenty ground stations in Northern Canada and Alaska with automated, all-sky cameras and magnetometers will track the auroras. Together, these observations will provide scientists with the first comprehensive look at substorm onsets and corresponding auroral eruptions from vantage points stretching from the ground, to a distance halfway to the Moon.

The mission is named after Themis, the goddess of justice, wisdom, and good counsel, the guardian of oaths, and the interpreter of the gods' will in Greek mythology. The name THEMIS was chosen for the mission since it will impartially distinguish between two disparate phenomenological and plasma-physical models of substorm onset in order to solve the mystery: When, where, and why do substorms start in the Earth's magnetosphere? This question has been the subject of scientific contention for over 30 years.

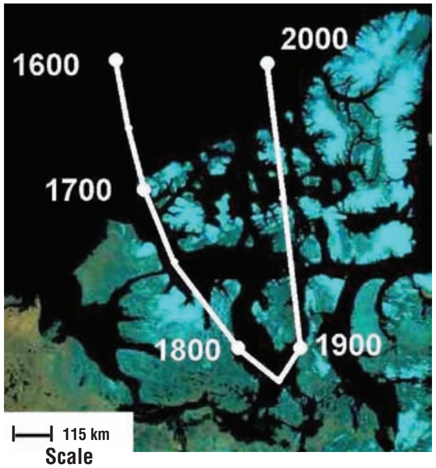
THEMIS is the fifth medium-class mission under NASA's Explorer Program, which provides frequent flight opportunities for world-class scientific investigations from space within the Heliophysics and Astrophysics science areas. The Space Science Laboratory at the University of California at Berkeley is responsible for the project management, science instruments, mission integration, postlaunch operations, and data analysis. Swales Aerospace of Beltsville, MD., manufactured the THEMIS spacecraft buses and carrier.

THEMIS is a NASA-funded mission managed by the Explorers Program Office at Goddard Space Flight Center in Greenbelt, MD.

For more information about this mission go to:
http://www.nasa.gov/themis
http://sprg.ssl.berkeley.edu/themis

Polar Wander: An Activity for Grades 7–12

Earth's magnetic field is dynamic; it changes with time, and the THEMIS ground-based magnetometers can measure its change with precision. Even the positions of Earth's magnetic poles change over time. In this activity, students are asked to find out how the magnetic poles of Earth move in complex ways over time, and solve equations that demonstrate that the speed of these changes is not constant. This movement is called Magnetic Wander. To learn more, go to:
http://ds9.ssl.berkeley.edu/themis/pdf/explore_mag_on_earth.pdf activity



The map above shows the locations of the North Magnetic Pole (80N;106W) in a region to the west of Greenland near Ellef Ringnes Island. The dates shown are AD.

The Earth rotates about an axis through its center. This axis passes through the North and South Poles at latitudes of +90.0 and -90.0 degrees respectively—these are known as the geographic poles.

The **magnetic** North and South Poles are not the same as the geographic poles. In fact, the magnetic poles change positions over time. Navigators have known of this change for centuries. Using magnetic compasses, mariners on ships found that their compass bearings for specific seaports changed significantly over the course of a few decades so that maps had to be redrawn. Today we use accurate magnetometer readings such as those of THEMIS found at: **http://ds9.ssl.berkeley.edu/themis/classroom_geons_data.html**

The curve in the figure to the left shows the location of Earth's magnetic pole in the Northern Hemisphere as it has moved around during the last 400 years.

1) From the information given in the picture, what is the scale of this image in kilometers per millimeter?
2) What is the total distance in kilometers that the magnetic pole wandered from 1600 AD to 2000 AD?
3) What is the average speed of the wander from 1600 AD to 2000 AD in km/year?
4) Which 100-year time period shows the greatest magnetic pole movement? How fast was it moving?
5) If the magnetic pole changes position, will the geographic North Pole move with it as well?

A note to teachers: If students will be using calculators, this is a good time to learn how to round numbers and warn them about excessive digits in their answers. Have the students report their answers, rounding in significance, to the nearest 100 km in distance, and the nearest tenth in calculating speeds.

Answer key: 1) Students will work from a printed copy of the picture and measure the length of the '115 km' bar using a millimeter ruler. By dividing the 115 km by their measurement in millimeters, they can compute the image scale. (The image scale should calculate to 23 km plus or minus 2 km depending on the accuracy of the measurement.) 2) About 2,200 km. Acceptable answers depend on the original measurements (ranges from 2,100 to 2,300). 3) Speed = 2,200 km/400 years or about 5.5 km/year. 4) Between 1900 and 2000 at about 900 km in 100 years, which is about 9 km/year. 5) This is a good question for discussion to correct misconceptions. The answer is no, because the location of the rotation axis is not influenced by magnetic forces.

LG-2006-7-017-GSFC