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ULYSSES SEES DIFFERENCES IN SOLAR WIND AT HIGH, LOW LATITUDES

The Ulysses (*) spacecraft, on its way to the northern pole of the Sun, has confirmed global differences in solar wind speed after completing the first phase of its high-altitude journey over the southern pole of the Sun.

Scientists presenting results today of their data at the srping meeting of the American Geophysical Union in Baltimore, Md., said the speed of the solar wind over the southern pole is high, compared to its low velocity near the Sun's equator.

The solar wind is the hot ionized gas that escapes from the solar corona and expands into interplanetary space. At the present minimum of the solar activity cycle, the angle between the Sun's rotational and magentic equators has decresed -- in these conditions Ulysses found that the region of low-speed solar winds were confined more closely to the rotational equator than in earlier portions of the solar cycle.

Now on its way to the northern solar pole, Ulysses is nearly 62 degrees north of the Sun's equator today. The seconfd phase of the primary mission -- to explore the northern pole of the Sun -- will begin on June 19, when the spacecraft reaches 70 degrees north latitude. The spacecraft will reach a maximum northern latitude of 80.2 degrees on 31 July 1995.

Ulysses' trajectory from 80 degrees south of the equator in September 1994, back down to the Sun's equator in March 1995, also brought the spacecraft within 1.3 astronomical units (121 million miles, 194 million km) of the Sun, the closest Ulysses would ever travel to the Sun since it was launched on October 6, 1990. The spacecraft picked up speed during this phase, allowing the entire region to be scanned in just six months time.

Scientists refer to this phase of the mapping as the "fast latitude scan". Ulysses had left the equatorial plane in early 1992 after a gravitational swingby of Jupiter, and had gradually climbed in latitude until reaching 80 degrees south in September 1994.

Ulysses' observations during the fast latitude scan have shown that the solar wind being continuously emitted by the Sun is distinctly different at high and low latitudes, said Dr. Edward J. Smith, Ulysses project scientist at NASA's Jet Propulsion Laboratory, for the joint NASA-European Space Agency mission.

Data from science experiments onbaord the spacecraft also revealed the strong influence of the Sun's magnetic equator, which is inclined, or tilted, with respect to the Sun's rotational equator.

"As the Sun rotates, the magentic equator appears to wobble up and down and the solar wind in the region occupied by the Earth alternates between the two types of solar wind," Smith said. The high latitude solar wind, as reported in the May 19 issue of Science, is fast and relatively smooth, whereas the low latitude solar wind travels more slowly. These velocity differences are organized by magentic latitute rather than heliographic latitude. As the Sun rotates, the wobble introduced by the magentic field causes the fast, high latitude solar wind to alternate with slow, low latitude solar wind. Before the slow solar wind has time to reach the orbit of the Earth, it is overtaken by the faster wind, forming a high pressure "front".

"These fronts are the equivalent of weather fronts on Earth and are responsible for much of the interplanetary 'weather' which causes aurora -- spectacular curtains of light seen in the northern and southern hemispheres of Earth's atmosphere," Smith said. "These fronts also cause magentic storms, which can interrupt radio and satellite communications on Earth."

Scientists at the American Geophysical Union meetings, describing the return of Ulysses to the equatorial zone, reported a drop in the solar wind speed by a factor of two -- from approximately 2 million miles per hour (800 kilometers per second) over the southern pole to approximately 1 million miles per hour (400 kilometers pre second) along the equator -- and the reappearance after two years of large excursions in speed, particle density and magnetic field strength.

"Magnetic fields characteristic of the north solar hemisphere, which point outward from the Sun, are seen interspersed with inward-directed fields from the southern hemisphere," Smith said. "This change in the magnetic field polarity indicates whether the solar wind is coming from the south or from the north. Thus, the equatorial zone in which the Earth is located is alternatingly traversed by particles originating from northern or southern regions of the Sun."

"Periodic excursions in the flux of solar magnetic particles between low and high intensity have also reappeared," added Dr. Richard G. Marsden, the European Space Agency project scientist for Ulysses. "They accompany the solar wind fronts -- called interaction regions -- in which energy is transferred to these particles by shocks associated with the interaction regions."

An unexpected feature of the Ulysses observations was the detection of these energetic particles at higher latitudes than the shocks that are known to create them.

"We really don't know for certain the explanation of these results," Marsden said. "Possible explanations are that shocks extend to higher latitudes farther from the Sun, or that the particles can diffuse rapidly in latitude without being nearly so much scattered in longitude. These results, when properly understood, will aid us in understanding the creation and propagation of solar energetic particles."

Ulysses crossed the Sun's equator on March 5, 1995, making its closest approach at the same time.

This period was also marked by a rare line-up of the Earth, Sun and spacecraft that scientists call a conjunction. At this time, radio beam path from the spacecraft to the Earth swept through all solar latitudes from the south pole to the equator as it probed the Sun's corona. Radio scientists used this opportunity to remotely measure the density of the corona.

The scientists warned that this simple global configuration of the Sun to date -- of high speeds over the poles and low speeds near the equator -- is very likely tied to the current phase of the Sun's 11-year sunspot cycle.

Currently the Sun is very near its minimum of activity, with just a few spots observed at low latitudes. In particular the equatorial zone has been found to be only half as wide during the fast pole-to-equator passage -- taking place from September 1994 throught March 1995 -- compared to the earlier equator-to-pole passage. The shrinking of the equatorial zone in the intervening two years shows the closer correspondence between the Sun's rotational and magnetic equators.

The Jet Propulsion Laboratory manages the U.S. portion of Ulysses mission for NASA's Office of Space Science, Washington, D.C.

* Ulysses is a joint ESA/NASA mission. ESA developed the probe and is contributing an estimated ECU 170 million up to 1995 to its in-flight operation. European research laboratories provided half of the scientific instruments. NASA provided the other half of the experiments flown, a radio-isotopic power generator and the launch; it is also maintaining day-to-day communications with the probe via its dedicated antennas.