Autonomous Antarctic Observatories Gather Space Weather Data

April 9 2009

The Aurora Australis over the South Pole. Credit: Keith Vanderlinde / NSF

(PhysOrg.com) -- An international scientific consortium has developed a series of autonomous observatories in Antarctica that for the first time provide critical year-round "space weather" data from the Earth's harshest environment.

Recently, data from these observatories were used in conjunction with the National Aeronautics and Space Administration's array of THEMIS satellites to reveal new information about magnetospheric substorms--the sudden release of energy that causes auroral displays.

"The Antarctic is magnetically connected to vast regions of space and the solar wind, and provides a unique window to observe dynamic processes in Earth's upper atmosphere and beyond," said Allan

Weatherwax of Siena College.

Weatherwax and Marc Lessard, of the Institute for the Study of Earth, Oceans and Space at the University of New Hampshire, are co-principal investigators for the multi-institutional project known as the Polar Experiment Network for Geospace Upper-atmosphere Investigations (PENGUIn).

In addition to the University of New Hampshire and Siena College, the PENGUIn science and engineering team includes investigators from Augsburg College, the University of California-Berkeley, Dartmouth College, the University of Maryland, the New Jersey Institute of Technology, Stanford University, Virginia Polytechnic Institute and State University, the University of Michigan and Japan's Tohoku University.

The U.S. investigators were supported by the National Science Foundation, which administers the U.S. Antarctic Program.

The suite of remote observatories range in size and complexity from multi-instrumented platforms that run on solar and wind power and provide around-the-clock, real-time data to microwatt units that collect and store data for retrieval.

The observatories gather data on the interaction of solar-wind energy with Earth's magnetic field lines, which arc high above our atmosphere and connect at both the North and South poles. Gathering such information in Antarctica is significantly more challenging in comparison to the more populous and relatively milder Arctic.

"In order to fully understand the phenomena we're studying, you have to know what happens with the field lines at both the poles," notes Lessard.

Earth's magnetic field extends far into space, where energy from the solar wind can be readily transferred to our "magnetosphere." A vast amount of energy follows magnetic field lines to the vicinity of the poles, driving aurora and other phenomena at high latitudes. By measuring such things as magnetic field variations, auroral emissions and other phenomena, scientists are learning more about space weather.

The term "space weather" generally refers to conditions on the Sun, in the solar wind, and within Earth's magnetosphere and upper atmosphere that can influence the performance and reliability of space-borne and ground-based technological systems and can pose risks to astronauts and people onboard aircraft in polar regions.

Besides emitting a continuous stream of plasma (solar wind), the Sun periodically releases billions of tons of matter via coronal mass ejections. These immense clouds of material, when directed toward Earth, can cause large magnetic storms in the space environment around Earth or "geospace"--the magnetosphere and the upper atmosphere.

The automated observatories have been developed over a period of years, evolving from platforms that ran on fossil fuels and required frequent maintenance to the more efficient, modular observatories that can be easily transported and installed at remote locations with extreme climates. In addition, the new-generation observatories operate by solar and wind energy alone and transfer data via satellite uplinks.

As energy from the solar wind is transferred to Earth's magnetic field it is sometimes stored for a period of time and then released to deliver large fluxes of energetic particles. The combined satellite and observatory data showed for the first time that some of these energetic particles reach very high latitudes as they collide with Earth's upper atmosphere.

Provided by NSF