Natural Radio

News, Comments and Letters About Natural Radio

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In the pre-Internet days, 20 years ago, getting access to any research data was a long and involved process, and in most cases the data would be old. We now have access to volumes of data, much available in near real-time -- that makes it possible to do serious research or science projects by data-mining from the existing online data lode. This is not to avoid collecting your own data, which is important and sometimes the most fun, but for many persons, time constraints and location make continuous Natural Radio monitoring difficult or impossible so here's a way to stay involved even if your listening situation is less than perfect, and also this data will definitely be useful to augment and correlate with your own monitoring.

This month we'll concentrate on the data available from satellites. There are currently at least 18 satellite missions that relate to the Earth-Sun system, several of them consisting of multiple satellites.

It is worth noting that satellites are usually divided into two classes, research and operational. Most of the satellites described below are research satellites. They have a specific mission and a timeframe for that mission. Often, the mission is extended to the end of the satellites operational life if it is producing useful data. When the mission ends, the satellite is not replaced.

Operational satellites like GOES and POES provide important data on an ongoing basis. Usually, backup satellites are kept in a parking orbit in the case of geostationary satellites or there may be multiple satellites in the case of POES. New satellites and instruments are being continually developed for the program to provide an uninterrupted flow of data.

The information presented here is just an overview, condensed from the NASA and NOAA data, so you'll need to go to the web for the details. Also, be aware that on many of the satellites that carry multiple instruments, there maybe different groups operating each instrument and each instrument may have its own website.

As I was assembling this data it became obvious that the article would be too big for one issue, so here's Part I. The satellites are presented in alphabetical order.

ACE (Advanced Composition Explorer)

http://www.srl.caltech.edu/ACE/

Mission - Ace was launched on August 27, 1997. ACE observes particles of solar, interplanetary, interstellar, and galactic origins, spanning the energy range from solar wind ions to galactic cosmic ray nuclei.

Instruments - The Advanced Composition Explorer (ACE) spacecraft carries six high-resolution sensors and three monitoring instruments to sample low-energy particles of solar origin and high-energy galactic particles. CRIS: The Cosmic Ray Isotope Spectrometer, ULEIS: Ultra Low Energy Isotope Spectrometer particle instrument, SWICS: Solar Wind Ion Composition Spectrometer SWIMS: the Solar Wind Ions Mass Spectrometer, EPAM: Electron, Proton, and Alpha Monitor particle instrument, MAG: Magnetometer Instrument, SIS: The Solar Isotope Spectrometer, SEPICA: Solar Energetic Particle Ionic Charge Analyzer, SWEPAM: The Solar Wind Electron, Proton, and Alpha Monitor.

Data - ACE is positioned almost a million miles (1.5 million kilometers) from the Earth, situated in the Earth-Sun libration point called L1. By orbiting the L1 point, ACE stays in a relatively constant position with respect to the Earth as the Earth revolves around the Sun. (For more information on the libration or Lagrangian points, see http://www-istp.gsfc.nasa.gov/Education/wlagran.html) The location of ACE at the L1 libration point between the earth and the sun enables ACE to give about a one hour advance warning of impending geomagnetic activity. With the approximate one hour lead time, this is a good way to get a "heads-up" on expected (as well as unexpected) geomagnetic disturbances.

The NOAA webpage http://www.sec.noaa.gov/NOAAscales/index.html has real-time data from the ACE satellite. The dial indicates the strength of the B_z component of the interplanetary magnetic field. This component is parallel to the magnetic axis of the earth and indicates how this incoming magnetic field carried on a CME or the solar wind, will couple with the earth's field. When the interplanetary magnetic field turns south compared to the Earth's magnetic field, geomagnetic activity will increase. As the B_z (Southward pointed) value becomes more negative, the associated geomagnetic activity increases.

The dial ranges from -50 to +50 nT. The dial is a linear scale from -10 to +10 nT and a different linear scale from -10 to -50 nT and +10 to +50 nT. For values beyond the maximum and minimum, the arrow will stay pegged at the maximum or minimum. If the magnetic field data is absent, the arrow will not appear. The arrow indicates the actual value of the latest 15 minute average of the B_z component of the magnetic field vector. The letters N and S refer to North and South of the magnetic equator. The color bar indicates green for positive values, yellow for small negative values, and red for large negative values of B_z.

ACE has enough remaining fuel to maintain its orbit thru 2024.

CINDI/CNOFS (Coupled Ion-Neutral Dynamics Investigations)
http://cindispace.utdallas.edu/

Mission - CINDI was launched on April 16, 2008 as part of the CNOFS mainframe.. The Coupled Ion-Neutral Dynamics Investigations (CINDI), a mission to understand the dynamics of the Earth's ionosphere. The interaction between electrically neutral and electrically charged gases in the upper atmosphere has a major influence on the structure of the ionosphere.

Instruments - The CINDI sensors, IVM (Ion Velocity Meter) and NWM (Neutral Wind Meter), will measure the total ion concentration and the ion and neutral velocity vectors. The sensors are mounted to view along the spacecraft velocity vector and are fully integrated into the C/NOFS payload.

Data – The data from this satellite would probably be more useful to serious researchers. However, as the bugs are worked out and the program evolves, more user-friendly data should be available.

Cluster II
http://sci.esa.int/science-e/www/area/index.cfm?fareaid=8

Mission – Cluster II was launched on July 16, 2000. The Cluster II mission is an in-situ investigation of the Earth's magnetosphere using four identical spacecraft simultaneously. It will permit the accurate determination of three-dimensional and time-varying phenomena and will make it possible to distinguish between spatial and temporal variations.

Instruments - Each of the four spacecraft carries an identical set of 11 instruments to investigate charged particles, electrical and magnetic fields. These were built by European and American instrument teams led by Principal Investigators. FGM: Fluxgate Magnetometer, EDI: Electron Drift Instrument, ASPOC: Active Spacecraft Potential Control experiment, STAFF: Spatio-Temporal Analysis of Field Fluctuation experiment, EFW: Electric Field and Wave experiment, DWP: Digital Wave Processing experiment, WHISPER: Waves of High frequency and Sounder for Probing of Electron density by Relaxation experiment, WBD: Wide Band Data instrument, PEACE: Plasma Electron And Current Experiment, CIS: Cluster Ion Spectrometry experiment, RAPID: Research with Adaptive Particle Imaging Detectors, WEC: Wave Experiment Consortium (DWP, EFW, STAFF, WBD, and WHISPER).

Data – There website for this site has extensive resources on the discoveries made by this mission and is updated on an ongoing basis. It's a good place for the latest findings on the behavior of the magnetosphere.

Geotail

http://pwg.gsfc.nasa.gov/geotail.shtml

Mission - Geotail was launched on July 24, 1992 and is a collaborative project undertaken by the Institute of Space and Astronautical Science (ISAS) and the National Aeronautics and Space Administration (NASA). Its primary objective is to study the dynamics of the Earth's magnetotail over a wide range of distance, extending from the near-Earth region (8 Earth radii (Re) from the Earth) to the distant tail (about 200 Re). The GEOTAIL spacecraft was designed and built by ISAS. After fulfilling Its original objective of studying the dynamics of the Earth's magnetotail over a wide range of distance, extending from the near-Earth region (8 Earth radii (Re) from the Earth) to the distant tail (about 200 Re) its orbit was changed. Since February 1995 Geotail has been in an elliptical 9 by 30 Re orbit where it has provided data on most aspects of the solar wind interaction with the magnetosphere.

Instruments – EFD:, MGF:, LEP:, CPI: Comprehensive Plasma Investigation, EPIC: Energetic Particle and Ion Composition, PWI: Plasma Waves Investigation

Data – The websites are not particularly user-friendly, but raw data is available for serious research.

GOES (Geostationary Operational Environmental Satellite)

http://www.sec.noaa.gov/today.html

Mission - The GOES satellites are in a geostationary orbit above the equator. Their primary mission is weather photos, but they also contain sensors to monitor the Space Environment above the earth. The Geostationary Operational Environmental Satellite Program (GOES) is a joint effort of NASA and the National Oceanic and Atmospheric Administration (NOAA).

Currently, the GOES system consists of GOES-13 operating as GOES-East in the eastern part of the constellation at 75° west longitude, and GOES-11 operating as GOES-West at 135° west longitude. These spacecraft help meteorologists observe and predict local weather events, including thunderstorms, tornadoes, fog, flash floods, and other severe weather. In addition, GOES observations have proven helpful in monitoring dust storms, volcanic eruptions, and forest fires.

Instruments – In addition to the imager and sounder used for terrestrial weather and environmental imaging, the GOES satellites have a Solar X-Ray imager and a Space Environment Monitor package. The Space Environment Monitor (SEM) consists of three instrument groups: 1) an energetic particle sensor (EPS) package, 2) two magnetometer sensors, and 3) a solar x-ray sensor (XRS). Operating at all times, the SEM provides real-time data to the Space Environment Center (SEC) in Boulder, Colorado. The five-channel EUV telescope is new on the GOES-NO/P/Q satellites. It measures solar extreme ultraviolet energy in five wavelength bands from 10 nm to 126 nm. The EUV sensor provides a direct measure of the solar energy that heats the upper atmosphere and creates the ionosphere.

Data – The data from these satellites is among the most useful in determining the current geomagnetic state of the near-earth environment**.** The GOES Hp plot at the SEC Space Weather site http://www.sec.noaa.gov/today.html contains the 1-minute averaged parallel component of the magnetic field in nano-Teslas (nT), as measured at GOES-12 and GOES-10. The Hp component is perpendicular to the satellite orbit plane and thus essentially parallel to Earth's rotation axis. This is near real-time data and is a good way to watch for a suspected CME impact with the magnetosphere.

Hinode (Solar-B)

http://solarb.msfc.nasa.gov/

Mission – Hinode Solar-B was launched on September 23, 2006. Hinode's Solar Optical Telescope is the first space-borne instrument to measure the strength and direction of the Sun's magnetic field in the Sun's low atmosphere, also called the photosphere.

Instruments - Solar Optical Telescope, X-Ray Telescope, EUV Imaging Spectrometer

Data – Hinode provides solar imaging in the visible, EUV (Extreme Ultra-Violet), and X-Ray spectrums. The images on the site are useful for watching the emergence and progression of sunspots. More detailed data is available from the various partner sites.

IBEX (Interstellar Boundary Explorer)
http://www.ibex.swri.edu

Mission – IBEX was launched on October 19, 2008. IBEX is the first mission designed to map the entire region of the boundary of our Solar System. IBEX's sole, focused science objective is to discover the nature of the interactions between the solar wind and the interstellar medium at the edge of our Solar System.

Instruments - The payload consists of two imagers specialized to detect neutral atoms from the solar system's outer boundaries and galactic medium.

Data – the data gathered by IBEX will, over the long term, help put together a picture of the interactions between the solar wind and interstellar medium at the edge of the solar system. IBEX has already discovered a bright, unexpected ribbon at this boundary that doesn't quite match any of the proposed models. New theories and discoveries are on the way!

POES (Polar Operational Environmental Satellite
http://www.swpc.noaa.gov/pmap/Index.html

Mission – Like GOES the primary mission of POES is for weather forecsting. Currently, the POES mission is composed of two polar orbiting satellites known as the Advanced Television Infrared Observation Satellites (TIROS) - N (ATN). Operating as a pair, these satellites primarily provide data used for long-range weather forecasting ensuring that infrared and non-visible data for any region of the Earth are no more than six hours old.

The SEM (Space Environment Monitor) package on board the NOAA Polar-orbiting Operational Environmental Satellite (POES) continually monitors the power flux carried by the protons and electrons that produce aurora in the atmosphere. The last POES Satellite was launched in February of 2009. The program is currently in transition with changes in the FY2011 budget. In the future, separate programs with shared data will be run by the Air Force and NOAA. NOAA's portion will notionally be named the "Joint Polar Satellite System" (JPSS) and will consist of platforms based on the NPOESS Preparatory Project (NPP) satellite. Find more information on the future of this mission at http://www.oso.noaa.gov/history/future-polar.htm

Instruments – The latest POES satellites have: the Advanced Very High Resolution Radiometer (AVHRR), the High Resolution Infrared Radiation Sounder/4 (HIRS/4), the Advanced Microwave Sounding Units (AMSU-A1 and -A2), the Microwave Humidity Sounder (MHS), and the Solar Backscatter Ultraviolet Radiometer (SBUV/2), the Data Collection System (DCS), the Search and Rescue Repeater (SARR), the Search and Rescue Processor (SARP), and the Space Environment Monitor (SEM).

Data - The POES satellites provide data from the earth's polar regions which is important if you are monitoring auroral activity or interested in over-the-pole radio propagation.

RHESSI (Reuven Ramaty High Energy Solar Spectroscope Imager)
http://hesperia.gsfc.nasa.gov/hessi/

Mission – RHESSI was launched on February 05, 2002

Researchers believe that much of the energy released during a flare is used to accelerate, to very high energies, electrons (emitting primarily X-rays) and protons and other ions (emitting primarily gamma rays). The new approach of the HESSI mission is to combine, for the first time, high-resolution imaging in hard X-rays and gamma rays with high-resolution spectroscopy, so that a detailed energy spectrum can be obtained at each point of the image. This new approach will enable researchers to find out where these particles are accelerated and to what energies. Such information will advance understanding of the fundamental high-energy processes at the core of the solar flare problem.

Instruments - The only instrument on board is an imaging spectrometer with the ability to obtain high fidelity color movies of solar flares in X rays and gamma rays. It uses two new complementary technologies: fine grids to modulate the solar radiation, and germanium detectors to measure the energy of each photon very precisely.

Data – The "Science Nuggets" page provides articles detailing some of the discoveries made by RHESSI. http://sprg.ssl.berkeley.edu/~tohban/wiki/index.php/RHESSI_Science_Nuggets